



**Clinical Decision Support:
A practical guide to developing your
program to improve outcomes**

TEPR 2007: Tutorial Su5b
20 May 2007
1215 - 1515

Faculty

Robert A. Jenders, MD, MS, FACP, FACMI



Tutorial Objectives

- Understand a systematic approach to measurably improving key healthcare organization outcomes with CDS.
- Understand the broad range of potential clinical decision support interventions, and opportunities to use them to accomplish specific objectives.
- Describe (and take back) specific approaches for successfully applying CDS in your organization.



Tutorial Agenda

1215 - 1345

- Didactic presentation on CDS approach: questions welcome

1345 - 1415 - Break

1415 - 1515

- 'Hands-on' workshop: creating a CDS program
- Group read-outs and discussion

Introductions: Faculty

Robert A. Jenders, MD, MS, FACP, FACMI

Associate Professor, Department of Medicine, Cedars-Sinai Medical Center
and the University of California, Los Angeles
Co-Chair HL7 Clinical Decision Support Technical Committee

Jerome A. Osheroff, MD

Chief Clinical Informatics Officer, Thomson Micromedex
Adjunct Assistant Professor of Medicine, University of Pennsylvania
Chair HIMSS Clinical Decision Support Task Force

Eric A. Pifer, MD

Assistant Professor of Medicine and Chief Medical Information Officer,
University of Pennsylvania Health System

Jonathan M. Teich, MD, PhD

Dept. of Emergency Medicine, Brigham & Women's Hospital
Assistant Professor of Medicine, Harvard University

Dean F. Sittig, PhD

Director of Applied Research in Medical Informatics, Northwest Permanente;
Adjunct Associate Professor of Medical Informatics and Clinical Epidemiology,
Oregon Health and Science University



Introductions: Participants

Sector?

- Healthcare delivery vs. other (consultant, vendor)

Role?

- Informatics (CMIO/director) vs. IT vs. other

CDS stage?

- Contemplation/preparation vs. early implementation vs. late

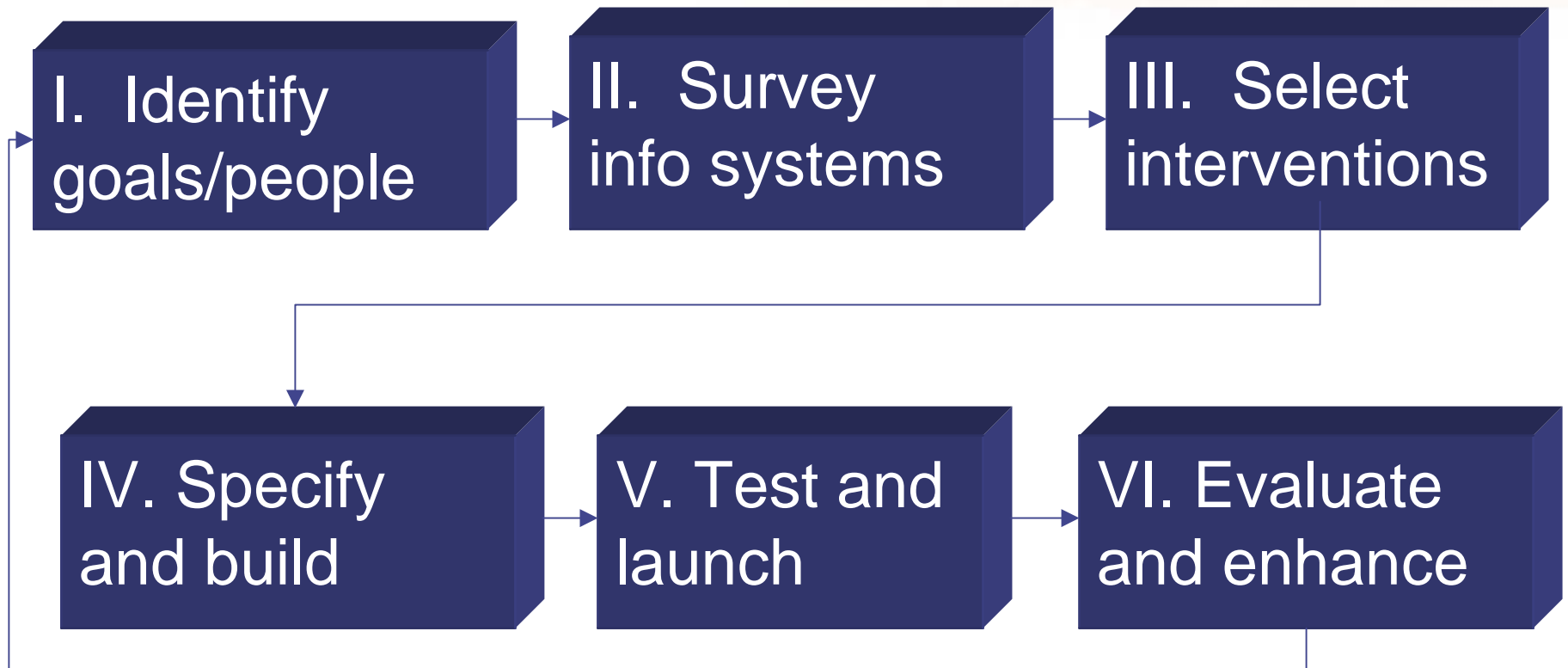


CDS Definition

“Providing clinicians or patients with **clinical knowledge** and patient-related information, intelligently filtered or presented at appropriate times, **to enhance patient care.**”

- *Includes and builds on what's already being done on a daily basis in your organization...*
- **NOT** *just rules and alerts...*

How can we improve care process/outcomes with CDS?





Step 1: CDS Stakeholders, Goals

- Who needs to be involved?
- What goals will the CDS program address?
- How will CDS activities be governed/managed?
- How can the CDS program be cost-justified?



Stakeholders

CDS is a team sport!

- **Positions:** *CMO, CMIO, CQO*
- **Committees:** *quality, safety, P&T*
- **Admin:** *hospital/office staff*
- **Clinicians:** *Nurses, pharmacists, MDs*
- **Patients!**
- **Others...**

Types of CDS Goals

- Best clinical practices
 - quality measures, dz mgt, accreditation, EBM
- Patient/medication safety
 - Avoid sentinel events, litigation/malpractice
- Patient empowerment
 - satisfaction (MD/patient), retention, quality
- Financial well-being
 - P4P, cost-effective care, adverse events
- *Deliver the **right information** to the **right person** in the **right format** at the **right point in workflow** through the **right channel***



Determining CDS Goals

- External drivers
 - P4P
 - Reporting, accreditation
- Internal drivers
 - Process/outcome data
 - Committees (quality, safety, P&T, UR)
 - Departments
 - Clinicians/patients/community

Prioritizing Targets

Figure 1-8: Factors affecting the desirability of a CDS objective

Clinical Objective Value Score = $(P+O+C+N+G)-(D+C)$, where*

P= Patient impact (individual/population) (positive, e.g., quality, safe, cost-effective care; improved morbidity and mortality, of interest to patients)

O= Organizational impact (positive, e.g., regulatory or audit compliance, appropriate resource use, liability)

C= Clinician impact (favorable, e.g. enhanced workflow; consistent with consensus, local standards, feasible to address, of interest to clinicians)

N= Number of patients positively affected

G= Gap between ideal and actual behavior pertinent to the intervention

D= Difficulty associated with addressing the objective

C= Cost of addressing the objective



Decompose Goals Into Measurable Objectives

High-level CDS Goal: Improve care quality/core measures

Clinical Goal: Follow preventive care guidelines better

Objective: **Increase use of pneumovax (P4P)**

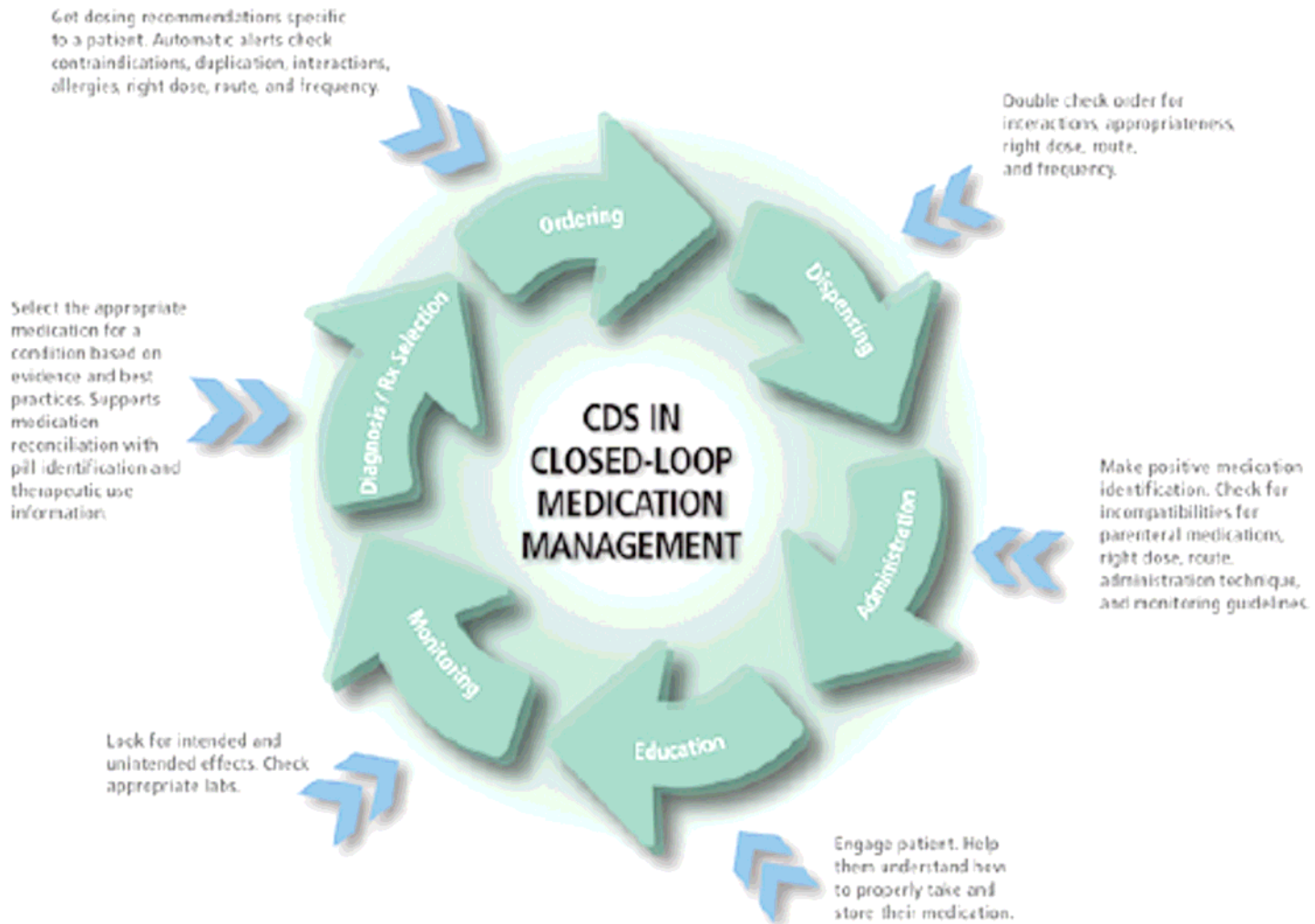
Objective: Increase cancer screening

Objective: Increase counseling

Specify the Target

Clinical objective	Desired action	Baseline performance	Desired outcomes	Notes
Increase pneumovax use	Provider orders pneumovax; nurse administers	Approximately 62%	100% compliance for appropriate patients	Synch with P4P criteria/ measures

Bigger Example: Eliminate ADEs





CDS Program Governance

- CDS is ***NOT*** an IS project
- Need strong clinical/organizational leadership
- Consider ownership/management of
 - Content
 - Workflow/processes
 - Triage – “I need a rule for ...”
 - Outcomes

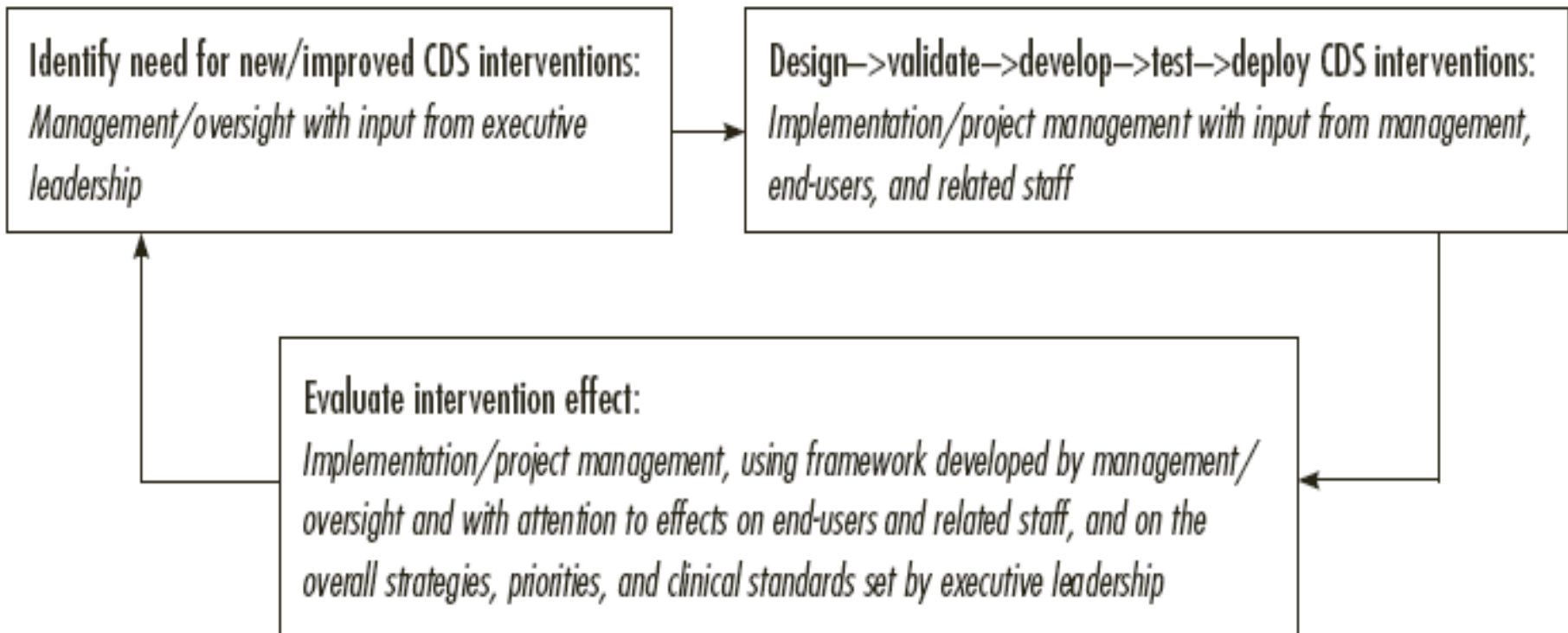


Stakeholder Responsibilities

- **Executives:** strategy, standards, resources
- **Management/Oversight**
 - **Departments:** responsible for care processes
 - **CDS oversight:** guides/reviews CDS initiatives
 - **IT steering:** responsible for CDS IT infrastructure
- **Project mgt:** develops/deploys/monitors CDS
- **End-users/other:** receive/support interventions
 - **Champions:** help bring along the crowd

CDS Program Steps/Management

**Figure 1-3: CDS program components:
steps and responsible parties***





How Can We Afford CDS?

- What are costs of current efforts related to addressing (& not meeting) goals?
- How fully are CIS investments leveraged?
- What benefits are realized from current efforts and investments? Anticipated from CDS?
- **How can we afford *not* to have a more systematic approach to deploying clinical knowledge to improve key outcomes?**

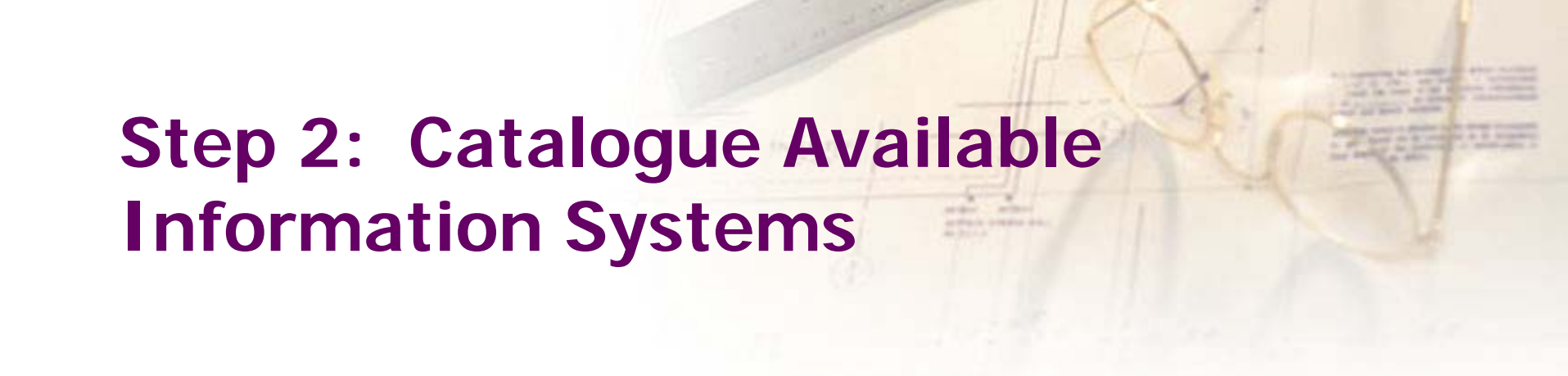


Step 1: Key Lessons

- Cultivate inter-relationships between organizational performance improvement initiatives and CDS program
- Develop program goals based on survey of pertinent initiatives and stakeholders
- Establish appropriate governance and management structures for CDS
- Cultivate and use champions



Step #2: Understanding Infrastructure for CDS



Step 2: Catalogue Available Information Systems

- Key Steps
 - Prepare an inventory of available information systems
 - Document:
 - CDS capabilities: 6 types.
 - Coding systems and vocabularies
 - **Tip:** CPOE and EHR systems are key but not the only game in town



Systems to Consider

- Departmental data management
 - Lab, radiology and pharmacy systems
- Clinical Records
 - EHR, OR systems, medication administration
- Ordering
 - CPOE and e-prescribing.
- Content
 - Reference for clinicians
- Administrative.
 - Charge capture, scheduling and registration



Code Sets pertinent to CDS

- SNOMED: Many applications
- ICD-9 or 10: Diagnostic Codes
- CPT-4: “Procedures”
- NDC: Drug Names
- LOINC: Lab tests
- RxNorm: Drug names and dose forms.



Intervention Types

- Documentation forms and templates
- Relevant Data Presentation
- Order Creation Facilitators
- Time-based Checks and Pathway support
- Reference Information and Guidance
- Reactive Alerts and Reminders

Documentation Template

History | Multi-System Exam | Medical Decision Making

Established patient
 New patient
 Consult
 Referring physician:

CC/HPI: (Location, Quality, Duration, Timing, Severity, Context, Modifying Factors, Associated Signs & Symptoms)

CONSULT/NEW: LVL 5,4,3(>=4); LVL 2,1(<=3)
 EST: LVL 5,4(>=4); LVL 3,2(<=3); LVL 1(N/A)

Medications:

PERCOCET 5-325 MG OR TABS
 METHADONE HCL 10 MG OR TABS
 LOPRESSOR 50 MG OR TABS
 ZETIA 10 MG OR TABS

Allergies:

Verified on 10/24/1998
 No Known Allergie

Review of system: CONSULT/NEW: LVL 5, 4 (10); LVL 3(2); LVL 2 (1); LVL 1(0)
 EST: LVL 5(10); LVL 4(2); LVL 3(1); LVL 2(0); LVL 1 (N/A)
 Remainder ROS negative

	NL	Comments (positives or pertinent negs)		NL	Comments (positives or pertinent negs)
Constitutional	<input type="checkbox"/>		Musculoskeletal	<input type="checkbox"/>	
Eyes	<input type="checkbox"/>		Skin	<input type="checkbox"/>	
Ears/Nose/Mouth/Throat	<input type="checkbox"/>		Neurologic	<input type="checkbox"/>	
Respiratory	<input type="checkbox"/>		Psychiatric	<input type="checkbox"/>	
Cardiovascular	<input type="checkbox"/>		Endocrinologic	<input type="checkbox"/>	
Gastrointestinal	<input type="checkbox"/>		Hematologic	<input type="checkbox"/>	
Genitourinary	<input type="checkbox"/>		Immuno/Lymph	<input type="checkbox"/>	

Family history:

Patient's family history
 None on file

Social history:

wife is post menopausal
 Marital Status: MARRIED Spouse Name
 Years of Education: Number of childre

Past medical/surgical history:

There is no previous medical history on file.
 There is no previous surgical history on file.

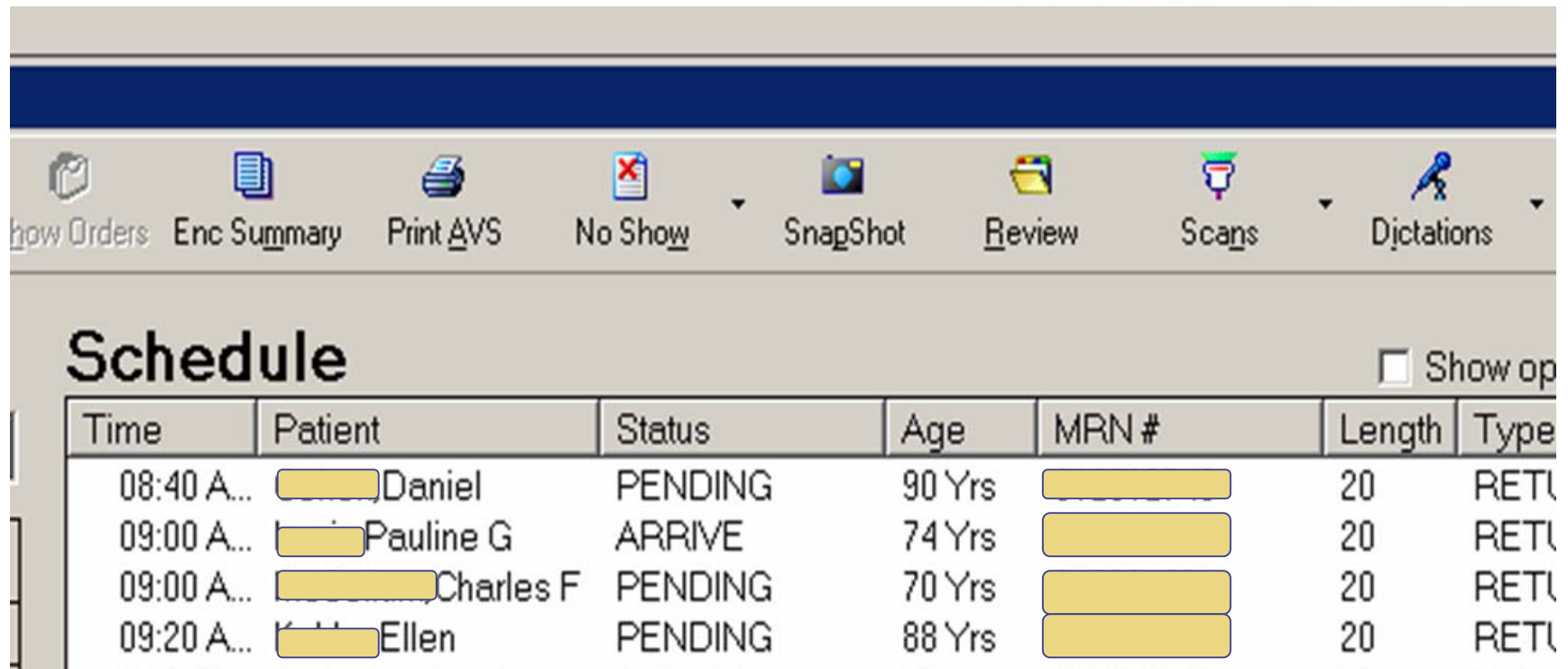
Gynecologic History:

L.P. : 12:00:00 AM Cycle length/interval: Birth control method:

Last mammo: Last pap:

Accept Cancel

Relevant Data Display



The screenshot displays a medical software interface. At the top, there is a toolbar with several icons and labels: 'Show Orders', 'Enc Summary', 'Print AVS', 'No Show', 'SnapShot', 'Review', 'Scans', and 'Dictations'. Below the toolbar is a section titled 'Schedule' with a checkbox labeled 'Show op'. The main content is a table with the following columns: Time, Patient, Status, Age, MRN #, Length, and Type. The table contains four rows of patient data.

Time	Patient	Status	Age	MRN #	Length	Type
08:40 A...	[redacted] Daniel	PENDING	90 Yrs	[redacted]	20	RETU
09:00 A...	[redacted] Pauline G	ARRIVE	74 Yrs	[redacted]	20	RETU
09:00 A...	[redacted] Charles F	PENDING	70 Yrs	[redacted]	20	RETU
09:20 A...	[redacted] Ellen	PENDING	88 Yrs	[redacted]	20	RETU

Order Creation Facilitators

Order Set Summary

Order Set: Generic Admission Order Set HUP

Order Items

Admission

- Admit To: (HUP)
- Vital Signs - Every 8 Hours
- Activity - Up Ad Lib As Tolerated
- Activity - Ambulate With Assist
- Activity - To Chair/Commode
- Activity - Bedrest
- Precautions:
- Call Physician For: - Routine

All inpatients over 65

- Pneumococcal Vaccine 0.5 mL -
Give: 0.5 ml
INDICATIONS/PRECAUTIONS - Pneumovax is indicated for all inpatients over 65 who have not received the vaccine and have no contraindications.

Food & Nutrition Services

- Diet Options
- Mechanical Soft
- Carb Controlled

Time-Based Checks and Pathways

Path Order Help					
ALL 2993 - Induction Phase 1					
	Day 14	Day 15	Day 16	Day 17	Day 18
	Day 14 Start of Chemotherapy +13	Day 15 Start of Chemotherapy +14	Day 16 Start of Chemotherapy +15	Day 17 Start of Chemotherapy +16	Day 18 Start of C
Chemotherapy		Ondansetron Tablet 24 mg. Ch...		Asparaginase Skin Test - Giv...	
		DAUNOrubicin injection(Undilu...		Asparaginase Skin Test Contr...	
		Vincristine Sulfate injection - ...		Diphenhydramine 25 mg cap/t...	
		Methotrexate (intrathecal) (Un...		Acetaminophen Tablet 325 mg...	
				Asparaginase injection - Give:...	

Context Sensitive Reference Information

-My Recent Patients ▾

Allergies: Penicillin, hives; dust, sneezing; Morphine, nausea; Penicillin, hives; dust, sneezing; Morphine, nausea;

Prescription Writer ▶

WARNING: Drug-Drug interaction! Severity - Moderate.
You are ordering **Prozac (fluoxetine)**. This interacts with an existing order for **warfarin**. [More Info](#)

Med Name: Prozac (fluoxetine) Route: PO

Strength/form	Disp	Refills	Start Date
Rx <input type="text" value="10 mg capsule"/>	<input type="text"/>	<input type="text" value="0"/>	<input type="text" value="5/4/2000"/> Change date
Dose	Frequency	Duration	
Sig: <input type="text" value="1"/> <input type="text" value="CAP"/>	<input type="text" value="QD"/>	For <input type="text"/> day (s)	<input type="checkbox"/> PRN <input type="text"/>

Other dose options:

Alternative Variable Taper

Instruction

Prescription Print Patient leaflet

Print Rx No substitutes

Tell Me More About ...

-
- All
- Brand Names
- Category
- Pharmacology
- Side Effects**
- Warnings
- Pregnancy
- Lactation
- News

et
nish

Home

Message Center

Patient Records

[What's New?](#)

[Demographics](#)

[Summary](#)

[Problems](#)

[Medications](#)

[Allergies](#)

[Test Results](#)

[Notes](#)

[End of Visit](#)

[Appointments](#)

[Messages](#)

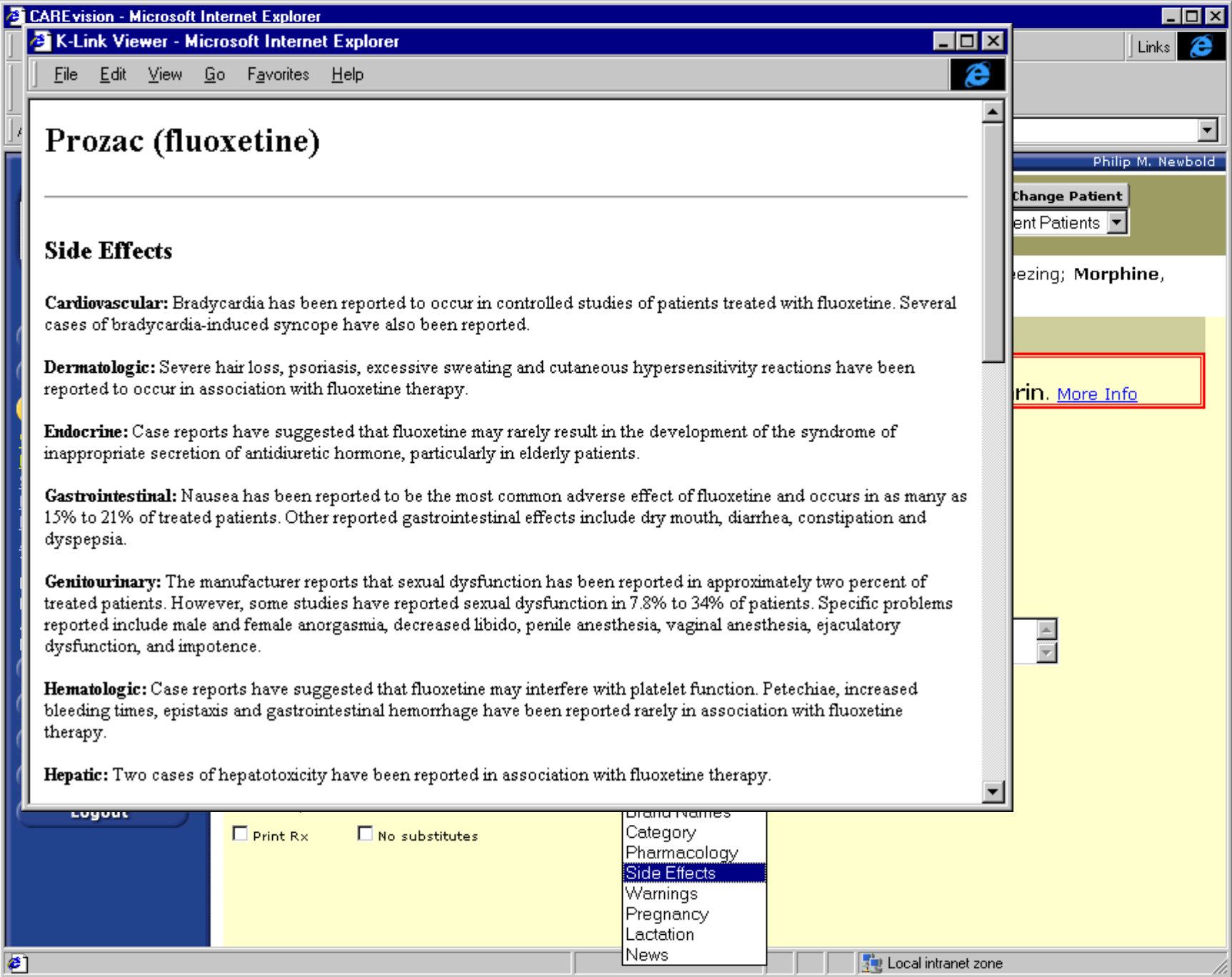
Reference Library

Personalized News

Clinical

Administration

Logout



Prozac (fluoxetine)

Side Effects

Cardiovascular: Bradycardia has been reported to occur in controlled studies of patients treated with fluoxetine. Several cases of bradycardia-induced syncope have also been reported.

Dermatologic: Severe hair loss, psoriasis, excessive sweating and cutaneous hypersensitivity reactions have been reported to occur in association with fluoxetine therapy.

Endocrine: Case reports have suggested that fluoxetine may rarely result in the development of the syndrome of inappropriate secretion of antidiuretic hormone, particularly in elderly patients.

Gastrointestinal: Nausea has been reported to be the most common adverse effect of fluoxetine and occurs in as many as 15% to 21% of treated patients. Other reported gastrointestinal effects include dry mouth, diarrhea, constipation and dyspepsia.

Genitourinary: The manufacturer reports that sexual dysfunction has been reported in approximately two percent of treated patients. However, some studies have reported sexual dysfunction in 7.8% to 34% of patients. Specific problems reported include male and female anorgasmia, decreased libido, penile anesthesia, vaginal anesthesia, ejaculatory dysfunction, and impotence.

Hematologic: Case reports have suggested that fluoxetine may interfere with platelet function. Petechiae, increased bleeding times, epistaxis and gastrointestinal hemorrhage have been reported rarely in association with fluoxetine therapy.

Hepatic: Two cases of hepatotoxicity have been reported in association with fluoxetine therapy.

Links

Philip M. Newbold

Change Patient

ent Patients ▾

ezing; **Morphine**,

rin. [More Info](#)

Print Rx No substitutes

- Brand Names
- Category
- Pharmacology
- Side Effects**
- Warnings
- Pregnancy
- Lactation
- News

Reactive Alerts

Alert Detail - ██████████ - Ibuprofen Susp 100 mg / 5 mL

Alert Summary

Ackn	View	Alert	Priority	Type	Comment	Scope
	<input checked="" type="checkbox"/>	Pneumovax Alert	HIGH	WARNING		Chart

Alert 1 of 1

Alert:

Message: Your patient is **74** years old and a candidate for **pneumococcal vaccine**, now **mandated by state law**.
Unless there is a contraindication (**Vaccination within 5 years, Previous adverse reaction, Patient refusal**), the dose should be ordered.

Acknowledgement Comment:

This Alert must be acknowledged and a comment added before clicking Proceed.

Alert 1 of 1

To view suggested actions for the Ibuprofen Susp 100 mg / 5 mL order click View Actions

To continue with the Ibuprofen Susp 100 mg / 5 mL order unchanged click Proceed.

To return to the Ibuprofen Susp 100 mg / 5 mL order and discard alerts click Go Back.



CPOE-Why it's so powerful...

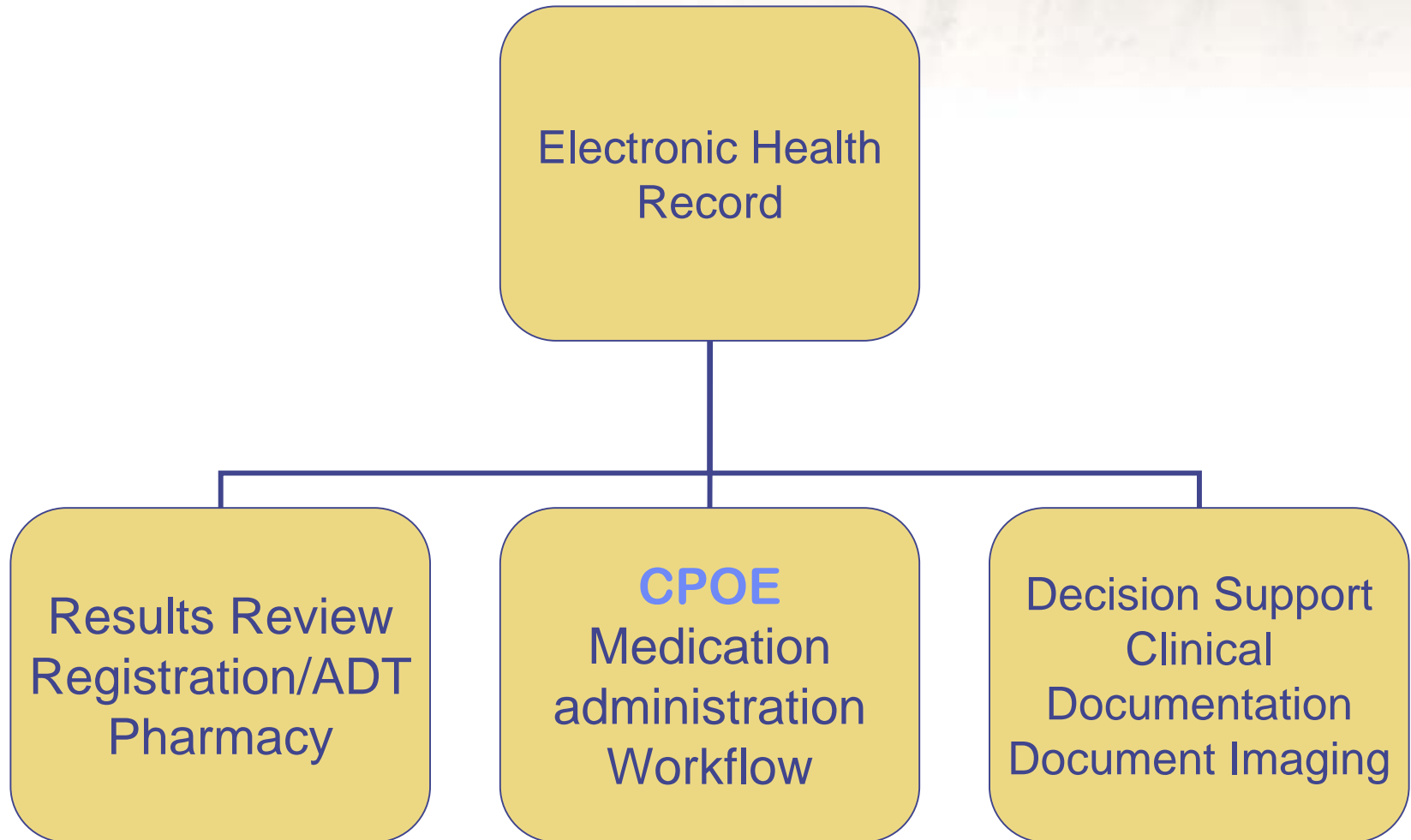
- The Critical moment in healthcare is that moment when a decision is being “born”.
- CPOE is the only technology available that allows a “just in time” electronic intervention to be delivered to the ordering provider.
- Careful thought, therefore, needs to go into every aspect of how the system will display information to the ordering provider.

CPOE and Decision Support



- Types of CDS common in CPOE:
 - Order creation facilitators
 - Relevant data display
 - Pathway support
 - Context sensitive reference information
 - Reactive alerts which can be quite sophisticated
- CPOE with CDS may result in as much as 55%-86% drop in medication errors.
 - Bates et al. 1998-1999

CPOE in context and the EHR





Putting it all together

- Interventions don't always fall neatly into categories.
- That is ok!
- In many cases, linking them together makes for the most powerful approach.
 - ***Documentation form-reactive alerts***
 - ***Order creation facilitator-relevant data display***
 - ***Protocols-context sensitive reference material.***

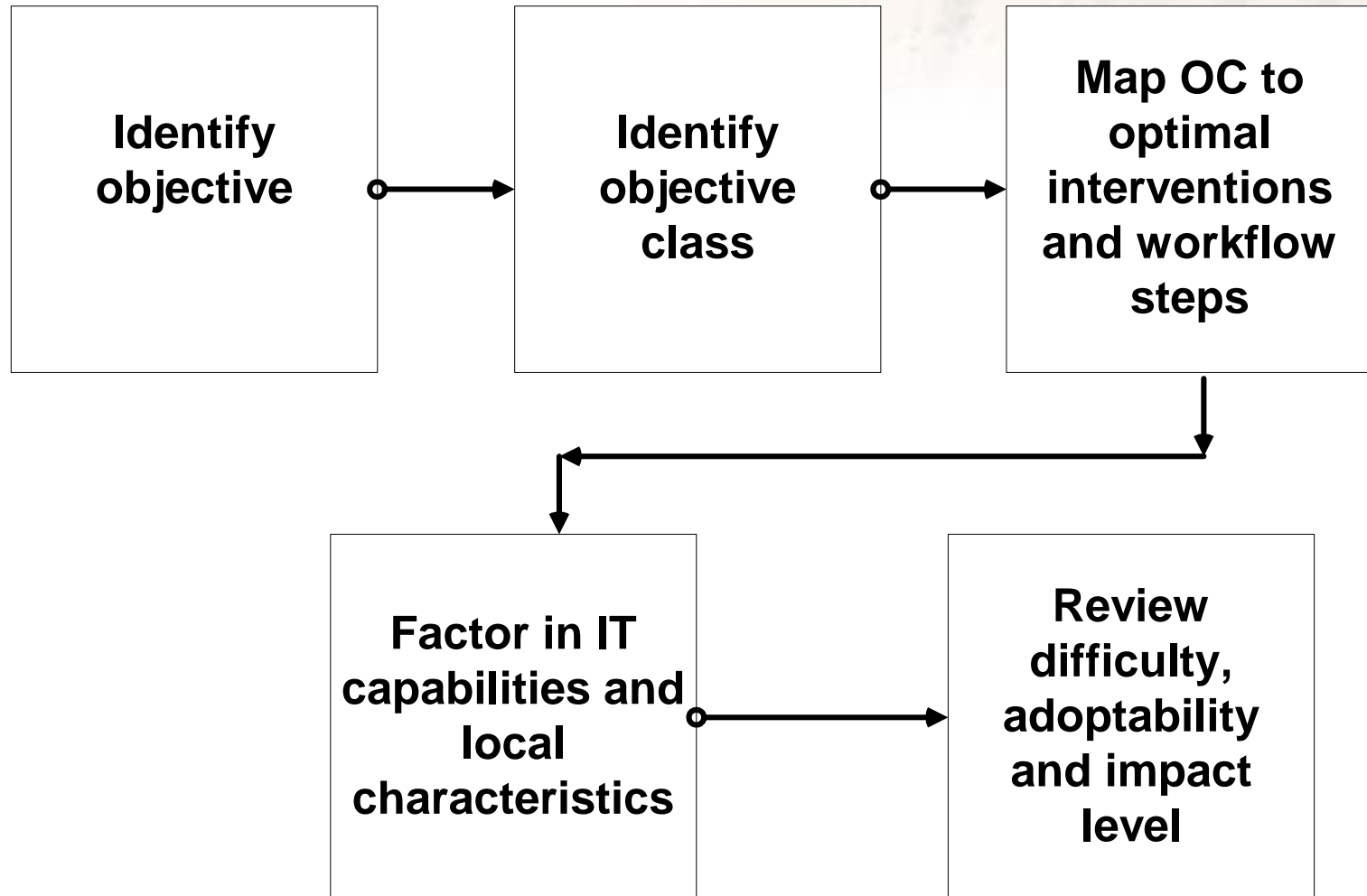


Step 2: Key Lessons

- Be inclusive
 - Any system may have valuable CDS capability.
- Be accurate and thoughtful with vocabulary inventory.
- Be detailed with the intervention inventory,
 - The more details, the easier it is to build later.
- Understand the power of CPOE
- Think about “chaining” interventions.

Step #3: Selecting and Specifying CDS Interventions

Selecting CDS Interventions





Objective Classes

- Prevent Errors
 - Errors of Omission
 - Errors of Commission
- Optimize Decision Making
 - Choice of Individual Tests and Therapies
 - Simple Care Guidelines Compliance
 - Appropriate Acute Workup
 - Chronic Condition Management
 - Compliance with Multi-Step Protocols



Objective Classes

- Improve Care Processes
 - Improve Documentation
 - Improve patient education
 - Improve Communication

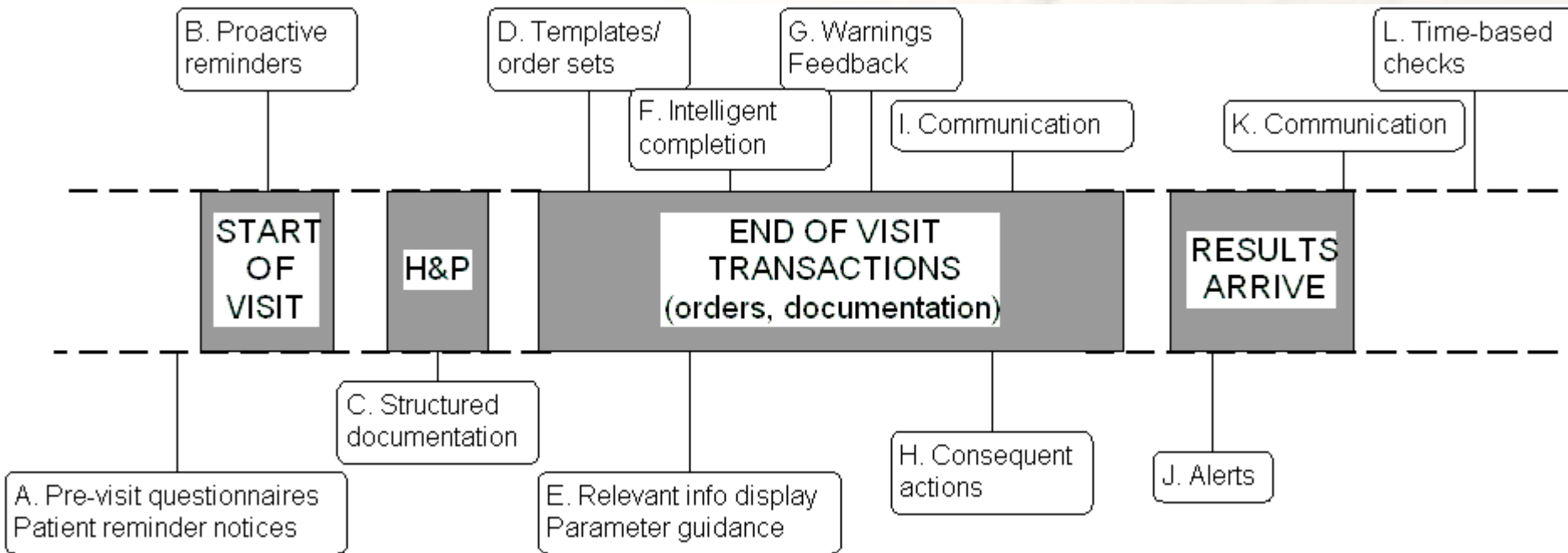


Map Objective Classes to CDS Interventions

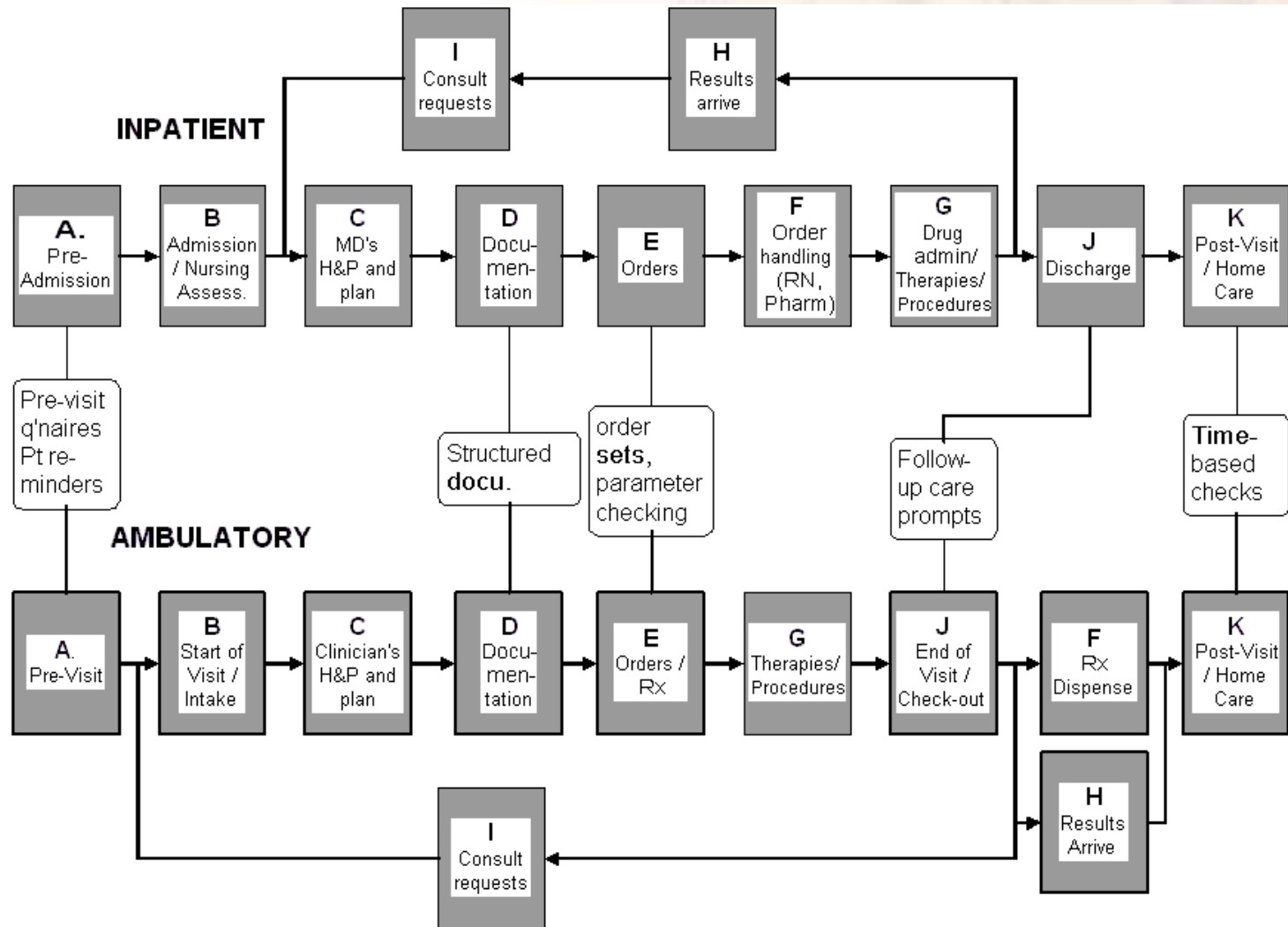
Existing knowledge from research

Slots / taxonomy for new research

Workflow Opportunities



Workflow Opportunities





Pneumovax

Objective: Improve appropriate pneumovax immunizations per national recommendations

Objective class: Improve compliance with simple care guidelines

Actions / Clinical analysis:

- Identify patients that need it
- Remind the physician to order it
- Ensure that ordered shot is administered

Put it All Together

<u>Objective Class</u>	<u>Intervention type</u>	<u>Workflow Step</u>
Improve compliance with simple care guidelines (e.g., health maintenance, dz mgt.)	Clinical flowsheets (1.5) Screening tests over time; disease registries	Start of visit (B; Documentation (D); Ordering (E); Discharge (J) Results arrive (H)
	Alerts and reminders to foster best care (6.2) Reminders for needed items	Ordering (E)
	Order sets (3.2) Contain appropriate interventions	Ordering (E)
	Multidisciplinary documentation forms (1.4)	Documentation (D)
	Clinician encounter forms (1.3)	Documentation (D)
	Patient self-assessment forms (1.1) Health maint. questionnaires	Pre-encounter (A) Office check-in (B)
<u>From CDS Guide, fig 3-3</u>	Reference information (5.2) (context-sensitive preferred) Recommendations based on problem list.	Pre-visit (A); Clinician H and P (C); Ordering (E); End of visit (J)



Pneumovax

Interventions:

- Ambulatory flowsheet / Start of Visit
- Ambulatory order set / Ordering
- Specialized encounter form / Docu.
- Alert / Ordering (inpatient)
- Reference info / Pre-Visit
- Report of target patients / Pre-visit



Ease / Acceptability / Impact

- Relevant data display (Flowsheet)
 - Ease of development – Moderate
 - Acceptability – High (no work)
 - Impact – Moderate
- Special considerations
 - Changing codes
 - Unavailable data
 - Costs difficult to display



Step #3 Key Lessons

- Map objective → Objective Class
- Map Objective Class → Intervention type and Workflow step
- Filter based on capabilities
- Understand ease / acceptability / impact factor for each type of intervention



Step #4: Specifying Details and Building Interventions



Step #4: Key Tasks

- Define parameters and logistical details for each intervention
- Validate and approve chosen interventions
- Develop a program for the planned interventions



Intervention Parameters

- When/How is intervention triggered
- Criteria for intervention delivery
- Source of data to satisfy intervention logic
- Content of intervention
- Method of intervention
- Recipient of intervention
- Method for feedback from recipients

Optimize Intervention Effectiveness



- Provide clear, practical recommendations
- Link recommendation to action opportunities
- Aggregate interventions (when appropriate)
- Prepare organization for result of successful interventions
- Special attention to interventions sent to patients (language, education level)



Optimize Intervention Safety

- Consider potential adverse consequences
- Develop a fail-safe plan if system (CDSS, underlying CIS) fails
- Minimize intervention overload



Optimize Intervention Acceptability and Use

- Maximize access and usability of information
- Include evidence and justification with recommendations
- Tailor interventions to specific recipients (practices, practitioners, etc) without losing value of standardization (e.g., uniform order sets)
- Provide incentives to comply



Special Considerations When Intervention is an Alert

- **When** (in workflow) to deliver alert?
- **Who** will receive it?
- **How long** will alert be available?
- **How urgent** is the intervention?
- **Which medium** will be used to deliver it?



Alert Considerations (continued)

- What is the expected alert burden?
- Will alerts interact?
- Allow opt out?
- When and how can alerts be retracted?
- How are alerts overridden?



Special Considerations for Feedback

- Prompt response
- Manage expectations: Keep users informed
- Methods:
 - Direct observation
 - Subjective feedback (questionnaires or unsolicited)
 - Query clinical champions
 - Objective measures of use of interventions



Feedback Considerations (continued)

- How often is intervention used?
- How often are alerts overridden?
- User perception of effect on workflow?



Management Considerations

- Establish clear accountability for results
 - Team with clinical, administrative, financial and informatics expertise
- Pay close attention to (re-engineering) workflow
- Engage detractors

Example:

Intervention Specification = Pneumovax

- **Clinical objective:** Increase eligible outpatients receiving Pvx
- **Desired action:** Identify patients > 65 years without prior shot
- **Baseline performance:** 2/3 of eligible are vaccinated
- **Desired outcome:** Reduction in admission for pneumonia
- **Associated intervention:** Postcard reminders
- **Workflow step:** Reminders printed with daily schedule
- **Intervention:** Use data warehouse + scheduling application to find eligible patients with scheduled visits. Import into scheduler.
- **Approach:** Reminder to give shot on schedule sheet
- **Target population:** RNs + PCPs
- **Evaluation:** Proportion of eligible patients who receive shots
- **Affected personnel:** RNs (who give shots)

Example: Validation/Approval

Clinical Objective	Intervention Name	Reviewer (role)	Date presented	Comments	Date approved
Increase Pvx use	Schedule reminder	Dr Smith (chief resident)	6 September 2005	Make sure prior recipients are excluded	12 September 2005



Step #4: Key Lessons

- Focus on logistical details, especially determining recipients of interventions and how interventions fit into workflow
- Obtain feedback on interventions and adjusting as needed
- Build organizational changes needed to support interventions
- Build mechanisms for collecting and using feedback



Step #5: Putting Interventions into Action

Key Tasks

- Test content, mechanics and logistics
- Develop a rollout plan, including training, feedback and monitoring
- Gather and address feedback before, during and after rollout



Testing

- Incorporate typical use cases into testing scenarios
- Unit testing: Check intervention components with appropriate data
- Integration testing: Bring together all the components
- User acceptance testing
- Pilot launch
- Full-live evaluation



Aspects of Communication

- Apprise users of what's happening
- Listen to feedback
- Use champions/super users
- Use multiple methods (formal & informal):
 - Staff meetings
 - Notices: Email, brochures, posters



Aspects of Training

- Catalog training resources: (vendor) printed material, Web sites, etc
- Train the trainer
- Training documentation
- Make training convenient
- Tailor training to users
- Listen to concerns during training
- Follow-up training after rollout



Aspects of Rollout

- Wait for stable underlying CIS
- Carefully analyze speed, scope and order of rollout of interventions
 - Complex interventions may require phasing
 - Potentially disruptive interventions may require limited live testing
- Consider pilot locations
 - Representative? Size? Availability of support staff?
- Start with greatest returns posing least disruption

Example: Testing & Launch

Pre-launch testing

Intervention type	Intervention name	Test scenario	Date/tester	Results	Notes
Schedule reminder	Pvx	Print daily clinic schedule	30 September 2005	All eligible patients detected	None

Launch plan

CIS	Intervention name	Training plan	Feedback plan	Maintenance plan	Notes
Schedule system	Pvx	Staff lunch	Interview RNs	Quarterly Pvx administration report	None

Example: Rollout Follow-up

Implementation status

CIS	Intervention Name	Testing started	Testing complete	Planned Launch Date	Actual Launch Date	Location / Users
Schedule system	Pvx	30 September 2005	1 October 2005		15 October 2005	6NE

Feedback issues

CIS	Intervention Name	Feedback date/user	Feedback	Plan/ Resolution	Target/Actual date	Priority
Schedule system	Pvx	25 October 2005	Too many false pos reminders	Enter previous Pvx in data warehouse	15 December 2005	High



Step #5: Key Lessons

- Careful and complete testing
- Communication with all those affected
- Convenient training opportunities
- Close attention to speed, scope and order of rollout of different interventions



Step # 6: Monitoring Results and Refining the Program

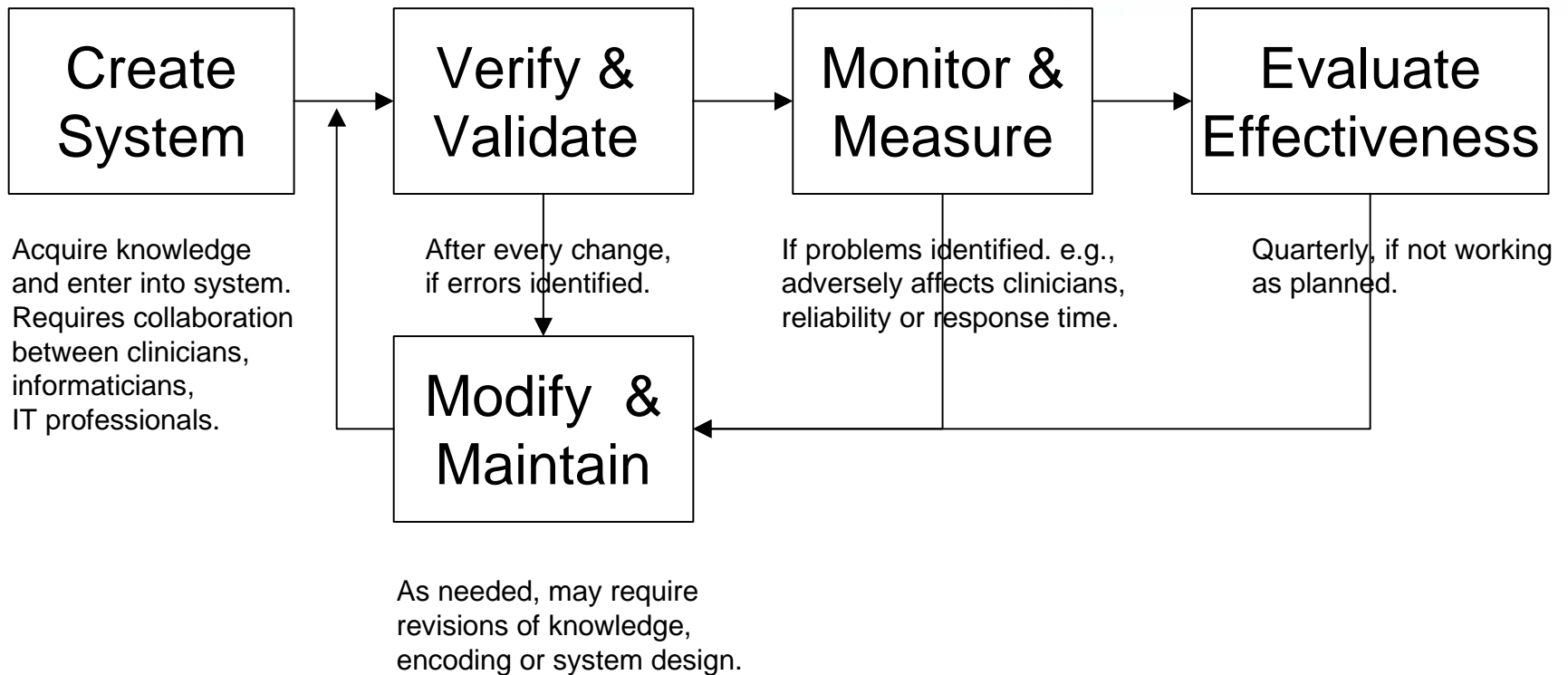


Evaluation Tasks

- Efficiently gather, process, and prioritize feedback.
- Assess intervention use and usability.
- Evaluate intervention impact on target objectives.
- Identify and address major concerns, (e.g., excessive or inappropriate invasive alerting, unacceptably slow system response times).
- Maintain content currency and appropriateness.
- **Continually enhance the CDS intervention program's value.**

An Iterative Multi-dimensional Model for Evaluation of Clinical Decision Support Systems

Steady State





CDS to be Evaluated

- Alerts
- Order entry templates
- Information Resources
- ?

Evaluation Philosophy



- **Availability** – CDS must be available to clinicians.
- **Use** – Clinicians must use the system.
- **Benefits** – Only after these are assured, can you begin looking for improvements.



Evaluate Availability...

- Did alerts fire?
- Were order templates available in the system?
- Was the web site functioning?
- Were reports printed?
 - Did clinicians get the reports?



Example User Feedback...

“Again! This problem predates May 9, 2005. I believe that it is actually a 2 year old problem. If it hasn't been fixed by now I believe it would be appropriate for me to be dubious of our ability to fix it. **Please exercise thermonuclear option and remove it entirely.**”

P...

Evaluate Use of the CDS



- Assess intervention use and usability.
 - Direct observations of users
 - Subjective user feedback
 - Input from clinical champions
 - Objective measurements of intervention usage.
- How often is each intervention used (reference material accessed, specific order sets and templates completed?)
- How often are alerts presented? Heeded? Overridden?
- What do users perceive as the intervention's effects on workflow?

System-generated log file...

Alert or recommendation code	Provider ID	Patient ID	Physical location of terminal	Date/time	Alert accepted (e.g. an offered intervention was selected), rejected (e.g. alert overridden), or simply closed
Periodic LDL	893283	4329023	Briarwood exam 3	09:45 07/04/06	Escape out
PneumoVax	003343	0048973	3-south	10:34 11/09/06	Accepted
Prophylaxis VTE	739202	8973234	OR	07:30 04/04/06	Rejected

Sample measures...

- **Total number of alerts of all types generated per patient per visit for outpatients or per day during the inpatient stay.**
 - More than 10 alerts per day
 - patient is very ill,
 - has not been seen for a long time, or
 - that there are too many alerts in the system.
 - underlying clinical problem with the quality of care being delivered.
- Remember, alerts and reminders are not an effective method to educate clinicians .

Sample measures...

- **Acceptance rate for each alert.**
 - low acceptance rates (for example, less than 50 percent) are candidates for further investigation.
 - High rejection rates
 - signify false positives, or
 - errors in alert generation,
 - general clinician disagreement with the recommendation or
 - insufficient appreciation of the evidence or the rationale behind it,
 - data errors and so on.
- Your appropriate response depends on their reason(s).

CDS intervention usability issues

Intervention	Use/usability Issue	How issue was identified	Date first noted	Priority for addressing	Responsible individual/committee	Remediation plan
Pneumo Vax	Alert text hard to read	[name]; feedback submitted on routine user survey	05/12/06	Medium	IT	Increase font size of all alerts from 12 to 14 point. Put key info in bold
Diabetic foot exam reminder	Pops up in operating room	[name]; irate call from OR assistant to IT help line	12/04/06	High	Clinical Decision Support oversight committee	Turn off all health maintenance reminders to terminals in the OR
Diabetic foot exam	Pops up when entering diabetes on problem list for first time	[name]; issue submitted to IT via email suggestion link	03/04/06	Medium	Diabetic steering committee	Check date of diabetes problem list entry. If less than 12 months before now, do not generate reminder

CDS intervention effects...

Intervention	Target objective	Performance against target	Other effects (+ and -), e.g. clinical, \$, process	Plans to modify/enhance intervention value	Notes/comments
Yearly LDL	85% of Diabetics with yearly LDL documented	73%	- slows down clinicians	Send postcards / email to patients one month before test is due	Need to begin collecting email addresses from patients
Diabetic foot exams at least every 6 months on appropriate patients	90% of eligible diabetics	40% (by automated analysis)	- clinicians documenting exam results in free text rather than using coded data entry field	Develop natural language processor to scan progress notes for evidence of foot exams on diabetics	Need to collaborate with University Informatics department

Ex. Clinical Outcome Measures

Intervention type	Outcome/process measure
Health maintenance reminders	Accesses/overrides (if applicable); percentage of patients in compliance with recommendation
In-patient clinical laboratory alerts	Override frequency; average time patients spend in abnormal physiological state
Outpatient laboratory alerts (e.g. excessive hemoglobin A1C levels)	Override frequency; average HbA1C levels for all diabetic patients; percentage of patients with HbA1c levels above recommendation
Clinical charting templates	Percent of applicable patients for which it was used; percentage of patients with a particular critical data item from the template (e.g. smoking status) for whom the data was acted upon (e.g. with educational intervention)
Order sets	Percent of patients with the condition covered by the order set and for whom it was used
Information Resources	Assess usage; number of searches; page views

Maintain Knowledge Assets



- What intervention types are deployed?
- How many of each type is deployed and what domains/topics are covered? Sources?
- Currency, quality, appropriateness
- Are the clinical information and recommendations consistent across interventions?
- What is the monitoring and maintenance plan/responsibility for each intervention? Review/expiration dates?

Maintain content currency and appropriateness

- Re-evaluate intervention logic to ensure clinical knowledge is accurate and up to date,
 - Changes to elements require revalidating to ensure that system continues to behave as expected.
- Assign responsibility for the different content areas to respected individuals with domain expertise
- Assign an “expiration date” to all CDS interventions.
- Vocabularies and coding schemes evolve
 - Ensure that changes don’t have any adverse effects on the behavior of CDS interventions.



Step 6: Key Lessons...

- Establish reasonable measurement intervals and expectations.
- Evaluating intervention effectiveness requires both quantitative and qualitative approaches.
- Log files and other approaches to tracking intervention use can be helpful for monitoring intervention effects.
- Plan on iteratively refining interventions to improve their use and benefits.
- It is important to have a systematic approach to managing organizational knowledge assets.



Thank You!

Robert A. Jenders

jenders@ucla.edu

<http://jenders.bol.ucla.edu>

Venous Thromboembolism: An Overview

Dean F. Sittig, PhD

“A pulmonary embolism (PE), or thromboembolism, occurs when a blood clot, generally a venous thrombus, becomes dislodged from its site of formation and embolizes to the arterial blood supply of one of the lungs. Symptoms may include difficulty breathing, pain during breathing, and more rarely circulatory instability and death.

Deep vein thrombosis, or DVT, is the occlusion of a deep vein by a blood clot ("thrombus"). It generally affects the leg veins, such as the femoral vein or the popliteal vein, or occasionally the veins of the arm.

Venous Thromboembolism (VTE), which includes both PEs and DVTs, remains a significant cause of morbidity and mortality despite the availability of effective therapies for thromboprophylaxis.” [Wikipedia, 2005] “Pulmonary embolism and deep vein thrombosis are treated using similar drugs and physical methods. The efficacy of intravenous infusion of unfractionated heparin was first proved in a randomized trial in 1960.” [Turpie, 2002]

“Randomized, controlled trials of hospitalized medical patients have shown that certain measures safely prevent venous thromboembolism, yet both European and North American surveys show persistent under use of prophylaxis. For example, in a registry of 5451 consecutive patients with ultrasonographically confirmed deep-vein thrombosis from 183 U.S. institutions, only 42% of inpatients had received prophylaxis within 30 days before deep-vein thrombosis developed.” [Kucher, 2005]

Despite the existence of detailed European and North American consensus guidelines, the use of prophylaxis against venous thromboembolism remains underutilized.

Identification of Patients at Risk for Venous Thromboembolism

The following risk factors are associated with a hospitalized patient's risk profile for venous thromboembolism. Major risk factors include: [from Kucher, 2005]

- Cancer (e.g., cervical, colon, lung, ovarian, prostate, rectal, renal, thyroid, uterine, pancreatic, liver, stomach, brain, esophageal, and head and neck, as well as sarcoma and melanoma – aka ICD-9 codes 149.0 to 172.99 and 174.0 to 209.99),
- Prior venous thromboembolism (e.g., ICD-9 codes 415.1, 415.19, 453.8, 453.9, and 671.31 to 671.50), and
- Hypercoagulability (i.e., based on laboratory test results, including the presence of factor V Leiden, lupus anticoagulant, and anticardiolipin antibodies);

Intermediate risk factors include:

- Major surgery (lasting more than 60 minutes); and

Minor risk factors include:

- Advanced age (e.g., >70 yrs),

- Obesity (e.g., Body Mass Index > 29 or ICD-9 code 278.0),
- Bed rest (e.g., an active order for bed rest that was not related to surgery), and
- Use of hormone-replacement therapy or oral contraceptives.

Common mechanical or pharmacologic prophylactic measures

- Use of graduated-compression stockings
- Intermittent pneumatic-compression boots
- Use of unfractionated heparin (5,000 U administered subcutaneously bid or tid), enoxaparin (40 mg), dalteparin (5,000 IU), danaparoid, hirudin, Fondaparinux (currently approved for VTE prophylaxis in patients undergoing hip fracture surgery, hip replacement surgery, or knee replacement surgery), or warfarin.

Common Safety Outcomes or End points

- Mortality within 30 days of discharge
- Rate of hemorrhagic events within 90 days of discharge
- 90 day readmission rate
- Major bleeding described as: intracranial, intraocular, retroperitoneal, or pericardial bleeding, or
- Bleeding that required surgical intervention or
- Hemoglobin loss of more than 3 g per deciliter

Deep-vein thrombosis diagnosis Gold Standard:

- Ultrasonographic evidence of the loss of vein compressibility or
- Evidence of a filling defect on conventional contrast venography

Pulmonary embolism diagnosis Gold Standard findings from:

- Ventilation–perfusion scanning,
- Computed tomography of the chest with contrast medium, or
- Conventional pulmonary angiography.

Identification of Venous Thromboembolism using ICD-9 codes [Mosen, 2004]

- 415.1
- 451.11; 451.18; 451.2; 451.81; 451.9
- 453.1; 453.2; 453.8; 453.9

Initial antithrombotic therapy for deep vein thrombosis with unfractionated heparin [Turpie, 2002]

1. Check baseline APTT, prothrombin time, full blood count
2. Confirm there are no contraindications to heparin therapy
3. Intravenous bolus 5000 IU
4. Choose between:
 - *Continuous unfractionated heparin infusion*—Start infusion at 18 IU/kg/hour (~30 000/24 hours in a 70 kg man)
Check APTT every six hours for first 24 hours, then daily thereafter
Aim for APTT 1.5-2.5×normal
Recheck APTT at six hours after each adjustment

Continue infusion for five to seven days

Subcutaneous—Start at 17 500 IU every 12 hours (or 250 IU/kg every 12 hours)

5. Check platelet count daily for thrombocytopenia
6. Warfarin therapy can be started on the first day of heparin therapy according to local protocol
7. Continue heparin for at least four to five days after starting warfarin
8. Stop heparin when INR greater than 2 for more than 48 hours
9. Continue warfarin therapy for at least 3 months keeping INR between 2 and 3 (target 2.5)

Example computer-based implementation strategies and workflow alterations

- CDS accessible via terminals located outside each operating room. After surgery, clinician enters data describing the case and orders treatment. Computer critiques plan based on guidelines. Clinician notified immediately if additional therapeutic suggestions apply. [Durieux, 2000]
- Computer screens all patients at risk for venous thromboembolism in the absence of appropriate prophylaxis. Computer-generated alerts sent to clinician responsible for patient. Clinician can decide to override alert or order appropriate prophylaxis directly from alert screen. [Kucher, 2005]
- Computer searches patient database 3x/day for patients about to undergo one of 224 surgical procedures identified as requiring VTE prophylaxis. A reminder (DVT) appears next to each eligible patient on both the online and printed operating room schedule. Surgical staff has modified work patterns to assure that all designated patients receive appropriate anticoagulation or sequential compression devices prior to surgery. [Mosen, 2004]
- Corollary order to remind clinician to check coagulation rates 4 hours post injection of Low Molecular Weight Heparin [Castellone, 2005]
- Allow computer to calculate appropriate medication dosage based on patient's body weight. [Starmer, 2000]
- If a heparin infusion was discontinued, but the monitoring test specific to the infusion (PTT) was not, a warning message is displayed.[Starmer, 2000]
- If ordering test to confirm PE, suggest prophylactic administration of anticoagulation therapy immediately.

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Tutorial Su5B
Clinical Decision Support
Guide to Worksheet Tasks

Worksheet 1

Task Key

- **Clinical Objective:** For the goal of reducing VTE in the hospital setting, determine specific objectives that would help achieve that goal. Key: Think of the different populations of patients and the different people that could help with prevention in those populations. **Good: 5 objectives, Excellent: 7 objectives, Superior: 10 objectives.**
- **Desired Action:** Each goal should be associated with specific actions. For example, if the goal is improving use of compression devices, you can increase use by focusing on the doctor or NP ordering it or the nurse applying it. **Good: 2 actions per objective, Excellent: 3 actions per objective.**
- **Desired Outcome:** Each desired action should have an associated desired outcome.
- **Notes and People:** Use this column to record notes about the people in the hospital that will make the intervention successful.

Worksheet 2

Task Key

- **System Name:** Go around the table and discuss the various information systems at your organizations that could be used for decision support. We have started you off with 4 systems commonly used for decision support.
- **CDS-Related Functionality:** Fill out the interventions that can be achieved through these systems. For CPOE, EMR, Pharmacy and reference (e.g. developed locally, accessed free on the internet, or purchased from vendors), include what you would like to have if none of the organizations at the table have one.
- **Coding Schemes:** For each system, record the data types and the coding schemes used to store them.
- **System Users and Use:** For each system, take notes in this column about which types of users use the system

Worksheet 3

Task Key

- **Clinical objective:** The specific clinical outcome(s) that you wish to achieve, e.g., “Improve compliance with flu-shot guidelines”
- **Objective Class:** Find the most relevant objective class matching the objective (from table 3-1 or 3-3 in the book).
- **Desired Action:** List the major actions and processes that you wish to improve to achieve the objective, e.g., remind patients about flu shots, ensure that the physician order flu shots for appropriate patients, ensure that the order is correct, ensure that the shot is given, etc.
- **Workflow Step** and Intervention Type. Using Table 3-3 and your own experience, identify the optimal CDS intervention(s), the application that will be used to apply it (such as CPOE), and when in the workflow the intervention should be applied, to fulfill the objective.

Try to identify at least three different interventions that could impact the VTE objective.

Worksheet 4a and 4b

Task Key

In this task, you will become familiar with the creation of 2 types of specifications. One for your organizational validation of the intervention and one intended for a programmer to use to build the intervention itself. For the purpose of the exercise you should create an intervention for an alert, but if time permits you should create one for another type of intervention. Notice how different the intervention is when you are considering an order set or documentation tool as compared with an alert. Think about items not bolded in part A, but don't worry about listing specific information for this exercise.

Worksheet 5

Task Key

- **System Name:** Record the system names that you worked on in the Chapter 2 worksheet.
- **Intervention Name:** Record the interventions that you derived in the Chapter 3 worksheet.
- **Testing Plan:** For each intervention, devise a strategy to test the proper functioning and effect of the intervention. Notice how the testing strategy differs with the intervention type.
- **Training Plan:** For each intervention, devise a strategy to train users on responding appropriately to the intervention. Notice how the training plan differs with the intervention type.
- **Feedback Plan:** Devise a plan for how to receive feedback on the intervention. Record the people who will be communicated with, when and how.
- **Maintenance Plan:** Devise a plan for ongoing upkeep of your intervention. For example, how often should the content be reviewed for currency? How is new information incorporated into the intervention (e.g. drug withdrawal)?

Worksheet 6a and 6b

Task Key

In this task, you will respond to hypothetical situations that have arisen in your decision support program. Record the remediation plans for the issues described in the first worksheet. In the second worksheet, you will be asked to consider results of an organizational knowledge management assessment for a 299-bed community hospital. Please comment on the adequacy of each knowledge management component, and whether and how it might be improved.

Chapter 1: Developing CDS Goals

Worksheet 1: Characterizing components of achieving CDS goal

Clinical Goal: Prevent thrombosis in hospitalized patients

Clinical Objectives	Desired Actions (Therapy, Assessment, Process, etc.)	Desired Outcomes (Measurable)	Notes and People

Clinical Objectives	Desired Actions (Therapy, Assessment, Process, etc.)	Desired Outcomes (Measurable)	Notes and People

Chapter 2: Information System Inventory: Tools and Coding Schemes

Worksheet 2: Information systems pertinent for thrombosis-prevention CDS

System Name	(Desirable) CDS-Related Functionality	(Desirable) Coding Schemes	System Users and Use
CPOE			
EMR			
Reference Information			
Pharmacy System			

System Name	(Desirable) CDS-Related Functionality	(Desirable) Coding Schemes	System Users and Use

Chapter 3: Selecting and Specifying Interventions

Worksheet 3: Mapping objective classes to intervention types and workflow steps

Clinical objective	Objective Class	Desired action	Workflow Step	Intervention type (and Application)

Chapter 4: Specifying, Validating and Building Interventions

Worksheet 4a: Intervention Specification Form

A. Specification Form for Validation

Intervention Name: Heparin Post-op Alert

- 1. Clinical objective:**
- 2. Desired objective:**
- 3. Baseline performance:**
- 4. Desired outcome:**
- 5. Associate interventions:**
- 6. Workflow step:**
- 7. Specific CDS intervention and pertinent CIS application(s):**
- 8. Approach:**
- 9. Clinical background:**
- 10. Selection criteria:**
- 11. Exclusion criteria:**
- 12. Target population for intervention:**
- 13. User interface:**

- 14. Monitoring:**
- 15. Evaluation:**
- 16. Primary stakeholders:**
- 17. Clinical champion for this project:**
- 18. Urgency / required delivery time:**
- 19. Whose jobs do you expect to be affected by this project?**
- 20. What are possible adverse consequences of implementing this project?**

B. Worksheet 4b: Specification Form for Developers

II. CDS intervention name	Heparin Post-op Alert
Description	
CDS application affected	
Intervention type	
Workflow step	
Specifically triggered by	
Presentation type	
What (information presented)	
Alerting	

Who (user)	
Action items	
Feedback channels and plan	

Chapter 5: Putting Interventions Into Action

Worksheet 5: Intervention Launch Planning

System Name	Intervention Name	Testing Plan (pre-rollout)	Training Plan (Who, sequence, timetable)	Feedback Method	Maintenance Plan

Chapter 6: Evaluation

Worksheet 6a: Use and usability issues log

Intervention Name	Usage and usability issues (source/channel)	Date Noted	Remediation Plan (responsible party)	Priority for fixing
<i>Heparin post-op alert</i>	<i>Avg. 20 firings/day across all deployed units; 30% rejection rate. High user dissatisfaction (Anne M).</i>	<i>1 Mar 2005</i>		
<i>PTT order set</i>	<i>Avg. 16 uses/day; are they using it enough? No issues noted; good user satisfaction.</i>	<i>1 Apr 2005</i>		
<i>PTT alert</i>	<i>Avg. 50 firings/day; 80% rejection rate. Nurses do not feel that it is accurate and don't have time to contact physicians after it fires.</i>	<i>1 Apr 2005</i>		
<i>Heparin post-op order set</i>	<i>Avg. 13 uses/day; no issues noted.</i>	<i>1 Apr 2005</i>		
VTE Guideline	2 hits/day on web. Max 17 hits/day. Thromboembolism found in search entry log misspelled 8 different ways.	8 June 2005		

Worksheet 6b: Organizational knowledge management assessment

Your task is to discuss whether the current clinical knowledge management elements are appropriate for a 299 bed, community medical center. Comment on any opportunities for improvement.

- **What intervention types are deployed throughout the enterprise?** Access to PubMed, Nursing Handbook, Medications on formulary (names only), Internally developed clinical care guidelines for Asthma, Gestational Diabetes, and Myocardial Infarction work-up, Harrison's Textbook of Medicine

- **What are the content sources, monitoring/maintenance plans, and effects of each intervention?** All content except for Harrison's has been internally developed or is freely available via the Internet. The CIS Oversight committee meets yearly to review current offerings. No use logs, or online feedback mechanisms are in place.

- **How are individuals (e.g., subject matter experts) compensated for their role in maintaining the knowledge assets?** No, strictly volunteer basis.