The Role of Clinical Informatics and Knowledge Management in Patient Safety

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Clinical Informatics Research & Development

Partners HealthCare System, Inc.

Overview

- Knowledge Management and Safety
- Organizational Alignment before Informatics
- Informatics Infrastructure
  - Knowledge Application
  - Knowledge Discovery
  - Knowledge Asset Management
- Examples from Partners and others

What is Knowledge Management?

"the systematic process of making sure everyone knows what the best of us knows."

Dr. Winnie Schmeling

How do you know you are succeeding at knowledge management?

- Everyone has timely access to the best data and knowledge available to make the best decisions
- Everyone responsible for acting on a given clinical decision knows that their task is to achieve a quality process and superior outcome
- Everyone has access to the performance data necessary to know how they are doing and where they must focus to improve

Are these not the same success factors for patient safety?

# Healthcare Systems are Inherently chaotic, hence unsafe…
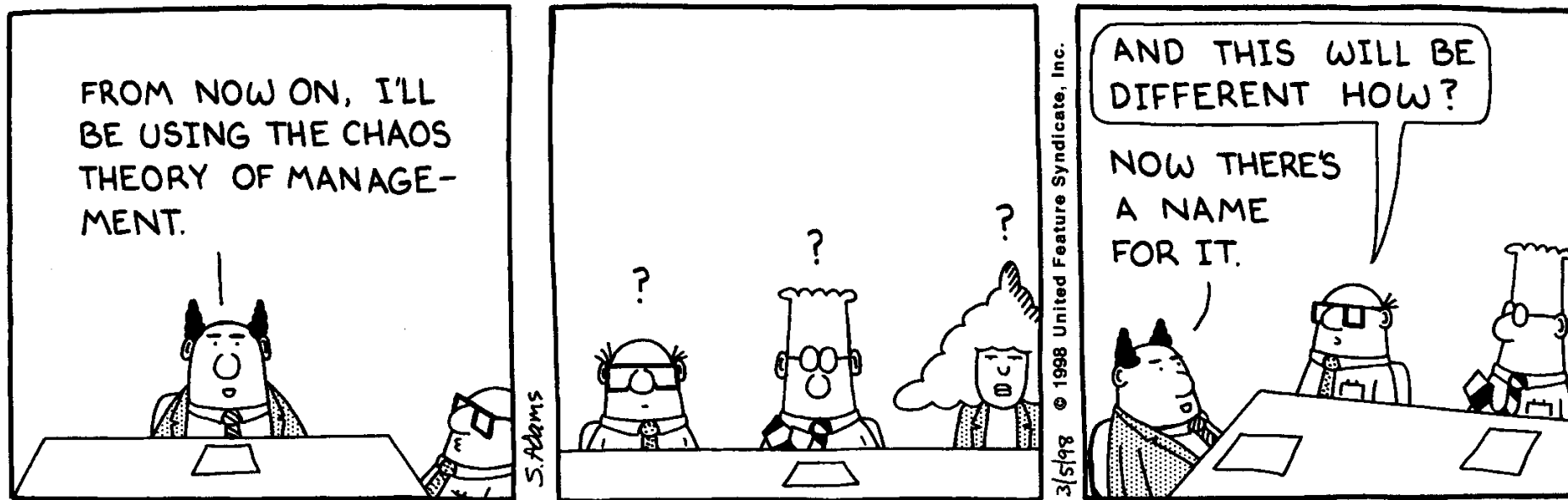
The Culture of Infallible Reliance on Memory doesn't help…

- "Instead of teaching doctors to be intelligent map readers, we have tried to teach every one to be a cartographer."
- "We practice healthcare as if we never wrote anything down. It is a spectacle of fragmented intention."
                    - L. Weed, M.D.

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FCG Patient Safety Model
a 7 point KM framework
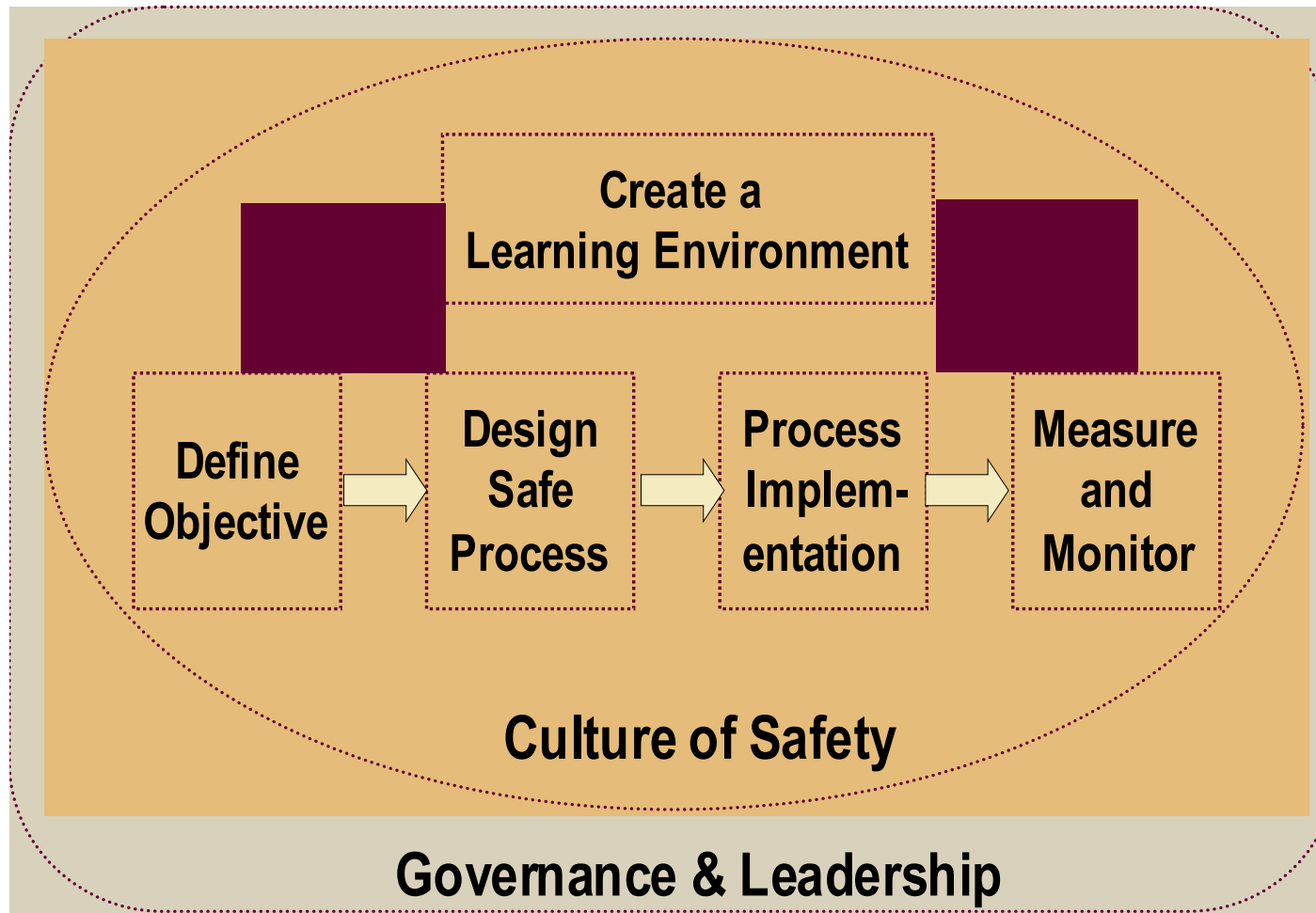
KM can't succeed without Goal Clarity and a Commitment to Measure Performance

- **Safety**
  - □ ADEs, Bedsores, Iatrogenic Infections, Falls, Surgical Misadventures, etc

- **Effective**
  - □ readmits, infant mortality, maternal morbidity, preventive measures compliance, SF 36 after intervention, variance from identified standards

- **Patient Centered**
  - □ Patient Satisfaction, Employee Satisfaction, Access measures, Convenience, Pain scores

- **Timely**
  - □ Access, wait times, follow-up

- **Efficient**
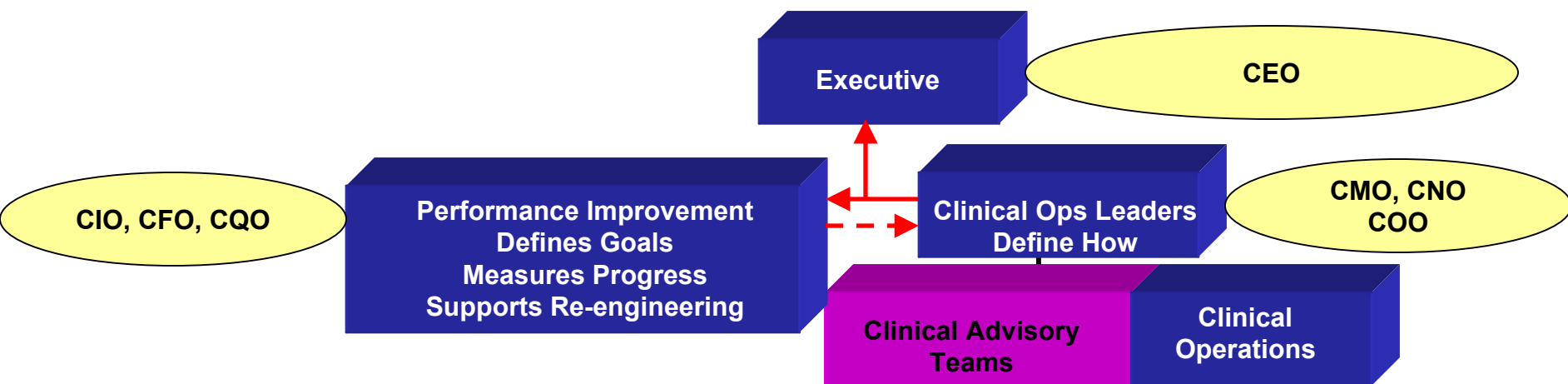 - □ profitability, ROAssets, ROPeople, Market Share

- **Equitable**
  - □ compare above by socioeconomic status, ethnicity

IOM 6 Aims as a Balanced Scorecard

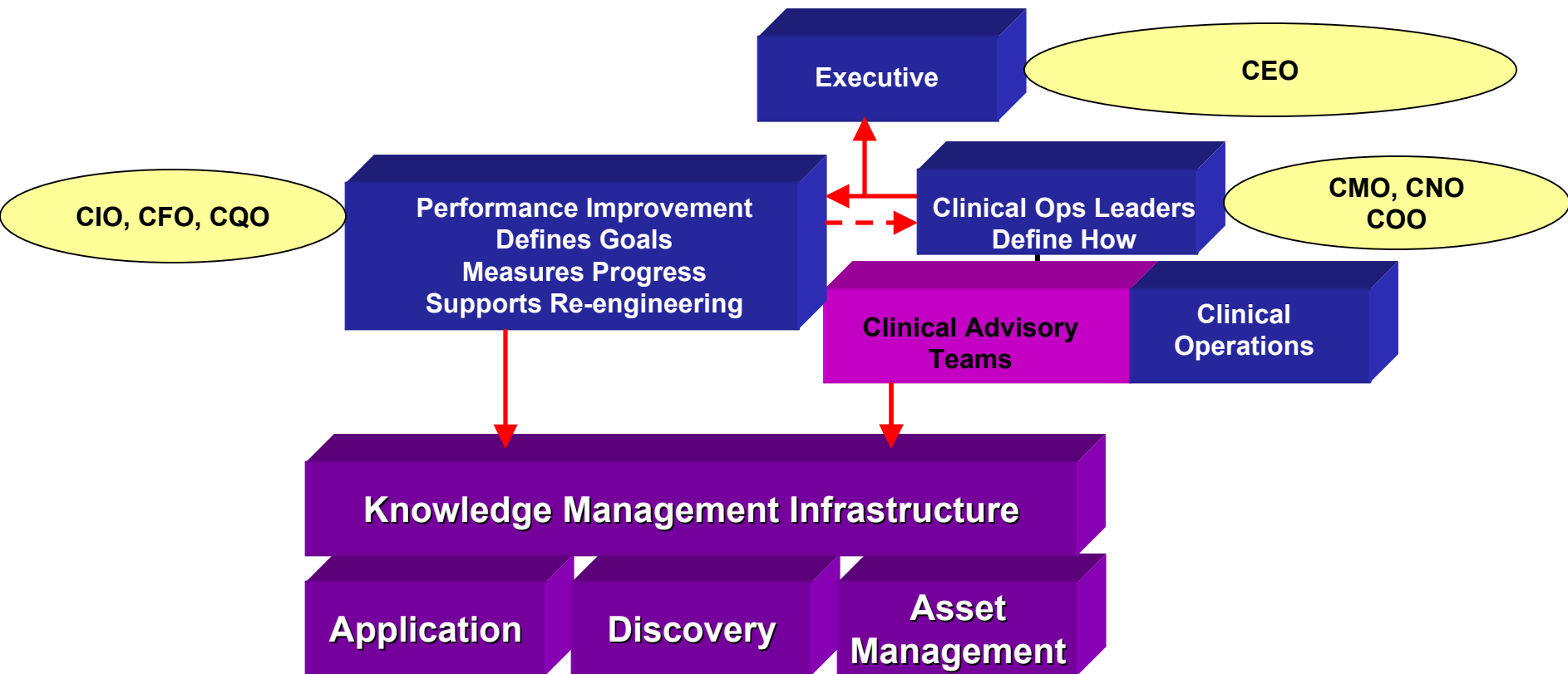# And Organizational Alignment….

Committed to Knowledge Sharing and Transparency without Blame

360° Accountability Supported by Incentives

And Investment In the Core Infrastructure for Rapid-Cycle Improvement

A Continuum Knowledge Application and Discovery

■ Surveillance   ■ Interactive   ■ Proactive   ■ Learning

Paper-based Information And Knowledge	Online Access To Data and Knowledge	Safety Net	Anticipation	Understanding Performance

■ Monitoring patient data with passive decision support

■ Intercepting incorrect clinical decisions

■ Making the right decisions the easiest decisions

■ Rapid Self-Improving Health System

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Address http://healthcare.partners.org/pchinet/references/index.htm Go | Links »

PCHInet

Communications | **References** | My Patients | My Office | My Links

March 18, 2001

- ▶ Clinical Research
- ▶ Clinical Topics
- ▶ Continuing Education
- ▶ Disease Management
- ▶ Journals & References
- ▶ Medical Guidelines
- ▶ Patient Instructions
- ▶ Pharmacy
- ▶ ??? Questions

Partners Handbook
Journals and References

Home
Search

Literature Search:

OVID
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Journal Abstracts / Table of Contents:

American College of OB/Gyn (ACOG) ▾   Go

References:

Harrison's Principles of Internal Medicine
The Merck Manual of Diagnosis and Therapy
MicroMedex
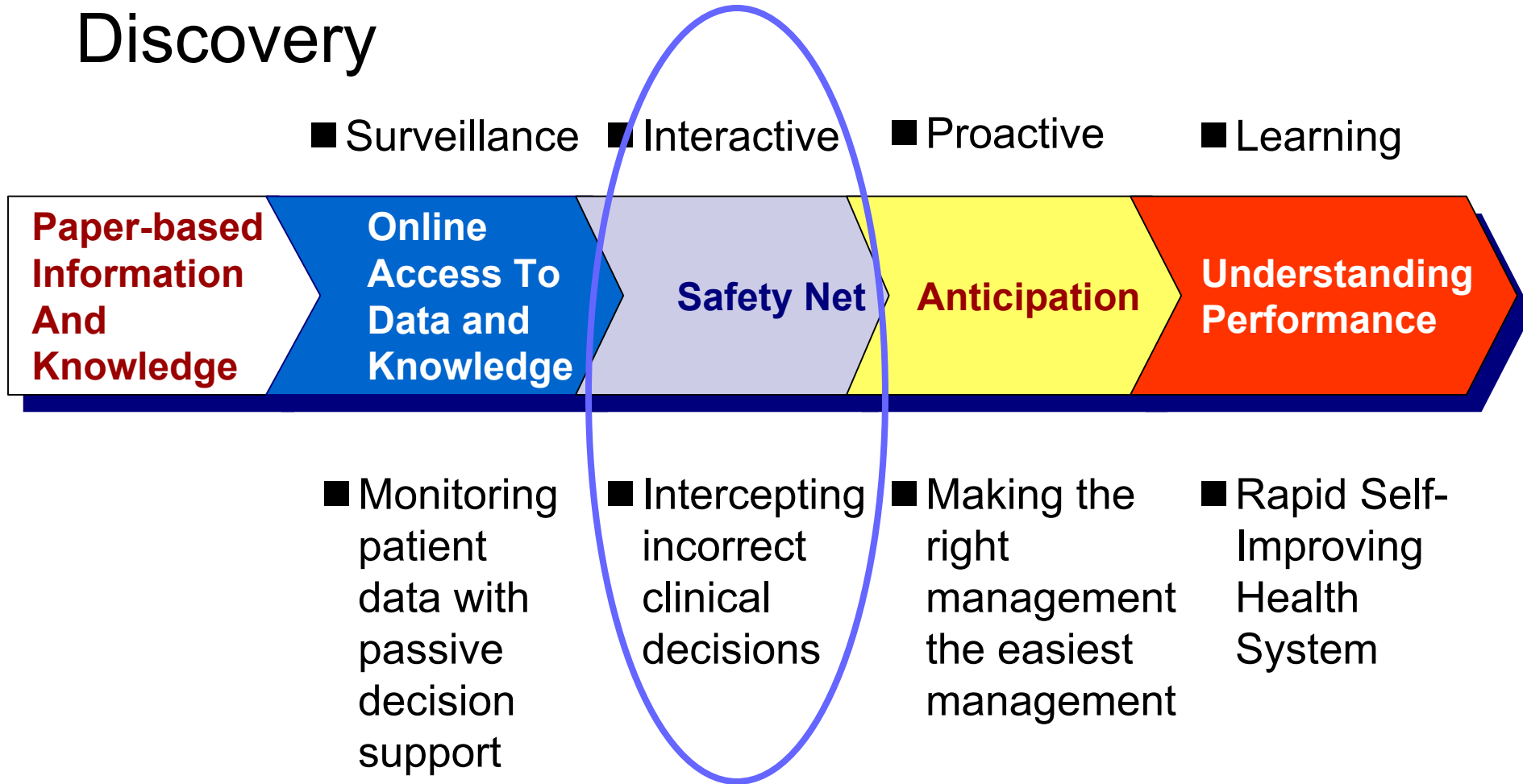**Physicians Desk Reference**(PDR)

Primary Care Online which includes:

- Lippincotts Manual of Nursing Practice
- Nursing Care Plans
- Lippincotts Nursing Drug Guide
- Laboratory and Diagnostic Tests
- Primary Care Medicine
- Textbook of Internal Medicine
- Interpretation of Diagnostic Tests
- Washington Manual of Medical Therapeutics
- Facts and Comparisons Pocket Drug Guide
- Griffiths 5-Minute Clinical Consult

MicroMedex Drug Summary

Scientific American Medicine
Scientific American Surgery
*
_
StatRef

UpToDate

Done | Internet

Start | FreeCell Game #9... | FreeCell Game #9... | Inbox - Microsoft ... | References In... | Microsoft PowerP... | 11:07 PM

A Continuum Knowledge Application and Discovery

- Surveillance
- Interactive
- Proactive
- Learning

Paper-based Information And Knowledge	Online Access To Data and Knowledge	Safety Net	Anticipation	Understanding Performance

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Knowledge Application in the Surveillance/Monitoring Stage

- Patient safety alerts for lab data only:
digoxin level/electrolyte; liver toxicity; renal toxicity; bone marrow toxicity; electrolyte imbalances

- High-risk patient identification:
Low albumin; low hematocrit; admission from nursing home,

- Disease Management with combined lab/claims data:
HgA1c/IDDM; CHF readmits, CAD/Lipid Levels, etc.

- Infection control: patterns of nosocomial spread; readmission of VRE or MRSA patients

Laboratory Alert

A Continuum Knowledge Application and Discovery

■ Surveillance   ■ Interactive   ■ Proactive   ■ Learning

| Paper-based Information And Knowledge | Online Access To Patient Data | Safety Net | Anticipation | Understanding Performance |

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Alternate Procedures

A Continuum Knowledge Application and Discovery

- Surveillance
- Interactive
- Proactive
- Learning

| Paper-based Information And Knowledge | Online Access To Data and Knowledge | Safety Net | Anticipation | Understanding Performance |

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Dose-adjustment for age

Inappropriately sedated elderly inpatients on average incur $5600 excess costs over expected for severity of illness

Sticky Notes

Family and Social History

VITAL SIGNS: 08/17/2000

BP 120/80 **PULSE** 77 **RESP** 20 **TEMP** 98.4 **Height** N/A **Weight** 147

Reminders

- Patient has coronary artery disease on problem list and aspirin is not on the medication list. Recommend aspirin.
- Patient is overdue for Mammogram (rec: q 1 year).
- Patient has CAD and/or CHD risk equivalent and is overdue for total cholesterol and/or LDL cholesterol (rec: q 1 year)

Medications	Problems	Procedures	Allergies
Synthroid 100 QD [N]	Coronary artery disease	Hysterectomy	Codeine
Inderal 20 TID [N]	Congestive heart failure	Appendectomy	Sulfa
Lisinopril 20 QD [N]	Hypothyroidism [N]	Ptca	
	Sinusitis		
	Hypertension [N]		
	Gerd [N]		

Preventive Reminders

Dr. John Bingham   Thursday 10/17/02 3:15 PM   Logout

Organizer   Clinical Overview   Order   Review Orders   Results   References

tients: **7 Patients**   New Results

▼Name	Age	Location	Admit Date	Admit Dx	Results	Insurance	Prim. Care Phys.	Acct. No.
Doreston, John	76y M	ER-11	10/17 6:47 AM	Viral Enteritis NEC		Cigna	Dr. Zachary Smith	000000987151
Flanderburger, Jim Jr.	27y M	1W/150-A	10/14 9:48 PM	Food Poisoning		Cigna	Dr. Judy Anderson	000000987168
Johnston, Bill	49y M	2N/227-B	10/16 11:56 PM	Salmonella Enteritis		Cigna	Dr. Jamie Audet	000000987165
Kim, Anna	82y F	2N/122-A	10/17 7:19 PM	Bacterial Pneumonia NOS		Medicaid	Dr. Frank Lippincott	000000987133
Lauder, Jake	55y M	3S/110-B	10/16 9:47 PM	Cardiac Dysrythmias NEC		Prudential Health Plan	Dr. Michelle Wallace	00000987170
Matheson, Farah	23y F	1W/151-B	10/16 2:13 AM	Asthma W Status Asthmaticus		Blue Cross of Virginia	Dr. Zachary Smith	000000987137
Moore, David	56y M	ER-3	10/17 1:49 AM	Acute Chest Pain		Aetna HealthCare	Dr. Jamie Audet	000000987140

gnatures Required: **12 Requests**

ame	Type	Date
ordua, Peter	Verbal	10/15
eNault, Celeste	DC Summary	10/14
oldsmith, Alice	H&P	10/16
ohnston, Bill	Verbal	10/17
achace, Archie	Co-sign	10/16
uhr, Jim	H&P	10/15
uhr, Jim Jr.	Co-sign	10/15
illiams, George	DC Summary	10/16
illiams, Paco	OP Note	10/16
inestein, Cindy	OP Note	10/16
onka, Robin	H&P	10/16
oung, Sarah	Co-sign	10/16

Notifications: **3 Notifications**   Compose   Delete

	Date/Time	Patient	Subject	From
⚠	10/17 2:00 PM	Anderson, Pat	Possible Hospital Acquired Pneumonia	TheraDoc Sentinel

Chest X-ray showing new infiltrate, hospital day 5, immunocompromised host with chronic disease [Diabetes], low grade fever and elevated WBC, positive respiratory culture.
Location: 2N/125-B

Antibiotic Assistant   Access Clinical Overview   Close Message   Next Message

| | 10/17 8:15 AM | Vazquez, Steven | Referral | Dr. Andrea Jones |
| | 10/17 7:45 AM | Vale, Patty | Referral | Dr. Andrea Jones |

Surveillance with advice

ne   My Computer

Dr. John Bingham   Sunday 12/29/02 9:26 AM   ⇥ Logou

| 🖾 Organizer | 📓 Clinical Overview | 📝 Order | 📋 Review Orders | 📑 Results | 📚 References |

Patient Demographics

				Admit Date	Insurance	Prim. Care Phys.	Acct. No.
Anderson, Pat	67y F	DOB: 11/24/1935	5'4" 129 lbs.	12/25 11:49 AM	American Life & Health	Dr. James Black	000000987126

Patient Specific References:

AntibioticAssistant

| Recommendation | ID Summary |

Treatment Recommendation

Admit Diagnosis: Umbilical Hernia Repair

	Drug	Dose	Duration	Acquisition Cost / Day
Order	imipenem-cilastatin [MG]	250 mg IV q8h*	14 - 21 days	$31.41
	*Dose is adjusted for patient's renal function			

▼ Caveats
▶ Logic

- The recommended therapy is based on chest x-ray results and respiratory culture with Enterobacter, susceptibilities pending
- Imipenem is selected for its activity at the site of infection (lung)
- Imipenem is the institution's formulary carbapenem

▶ Alternative Therapies (13)
▶ References (23)

CrCl	31 mL/min **Moderate Impairment** Cockroft Gault

Past 24 [48] Hour Max Values

Temp (°C)	WBC (K/uL)	Bands (%)	Bili (mg/dL)	SCr (mg/dL)
39 [37]	15 [8.18]	13 [--]	1.1 [--]	1.5 [1.5]

Other References:

Add Reference

▦ Intelligent Instructions here

🖥 My Computer

Pressure Ulcer Prevention

- Pressure ulcers occur at rates between 6% and 17%. Add $2,000 per case.

- If sued, average $500,000 per malpractice judgement.

- Accepted standards prevention and management.

Once Braden Assessment Automated, Pathway Orders Ensure Assessments are Scheduled and Added to Nursing Activity List

Logic Table Behind the Braden Assessment Alert Posts Activities to Nursing List, Orders Appropriate Consults and Supplies

Braden[*]	Condition	Intervention
≥ 17 **(for age > 75, 19)** **— No Risk —**	Ulcer Stage 0	Standard Bed
	Ulcer Stage 1-2	Hospital Replacement Mattress
	Ulcer Stage 3-4	KCI Overlay
15-16 **(for age > 75, 15-18)** **— Mild Risk —**	Ulcer Stage 0	Hospital Replacement Mattress
	Ulcer Stage 1-2	Hospital Replacement Mattress

A Continuum Knowledge Application and Discovery

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Paper-based Information And Knowledge → **Online Access To Data and Knowledge** → **Safety Net** → **Anticipation** → **Understanding Performance**

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Section of Manual Chart Abstraction Tool- this costs a fortune!

Tallahassee Memorial HealthCare
Total Knee Replacement Clinical Pathway Analysis Form

Patient Demographics

Medical Record Number	Clinical Number	Admit Date	Date of Surgery	Discharge Date
		___/___/___	___/___/___	___/___/___

Age ___ ___   Physician ID# ___ ___ ___

Type
○ Revision
○ Primary

Rehab Questions

REHAB (during activity)

Patient rates pain on a scale of 0-10 (with 10 being worst) in past 24 hrs.

Day of Surgery	POD 1	POD 1	POD 1	POD 4	Day of DC
____	____	____	____	____	____

DISCHARGE INFORMATION

What was ROM at discharge?

FLEX	EXTENSION
__ __ __	___ ___

Is skin without breakdown?   Yes ○   No ○

Pre-Admission

Attended Pre-Op Ed Class   Yes ○   No ○

Nursing Questions

Type of pain medication?

	DOS	POD 1	POD 2	POD 3	POD 4	Day of DC
PCA	○	○	○	○	○	○
PCE	○	○	○	○	○	○
IV	○	○	○	○	○	○
Toradol	○	○	○	○	○	○
PO	○	○	○	○	○	○

PO Day 1

Patient got up to chair with assist?
Yes ○
No ○

If no, why not?
○ Pain
○ N & V
○ Dizziness
○ Pt. Condition
○ Pt. Compliance
○ Dept Closed

Is wound without sign of infection?   Yes ○   No ○

Was patient discharged to disposition per PT recommendation?   Yes ○   No ○

If no, why not?
○ MD Decision

Criteria for Data Abstraction from Billing/Admin Systems

Implementation Date	TMH Definition	Dynamo Criteria
Jul-98	DRG 121 - Circulatory Disorders with Acute Myocardial Infarction and Major Complications, Discharged Alive DRG 122 - Circulatory Disorders with Acute Myocardial Infarction without Major Complications, Discharged Alive	DRG 121 - Circulatory Disorders with Acute Myocardial Infarction and Major Complications, Discharged Alive DRG 122 - Circulatory Disorders with Acute Myocardial Infarction without Major Complications, Discharged Alive
Jun-95	DRG 104 - Cardiac Valve Procedures with Cardiac Catheterization DRG 105 - Cardiac Valve Procedures without Cardiac Catheterization DRG 107 - Coronary Bypass without Cardiac Catheterization DRG 109 - Coronary Bypass with Cardiac Catheterization	DRG 104 - Cardiac Valve Procedures with Cardiac Catheterization DRG 105 - Cardiac Valve Procedures without Cardiac Catheterization DRG 107 - Coronary Bypass without Cardiac Catheterization DRG 109 - Coronary Bypass with Cardiac Catheterization
Apr-98	All inpatients and outpatient in a given discharge date range with a primary procedure code = 37.21-37.23 which occurs at one of their first 5 procedures.	Primary Procedure of 37.21, 37.22, 37.23
Nov-96	DRG 89 - Simple Pneumonia and Pleurisy, Age Greater than 17 with CC DRG 90 - Simple Pneumonia and Pleurisy, Age Greater than 17 without CC	DRG 89 - Simple Pneumonia and Pleurisy, Age Greater than 17 with CC DRG 90 - Simple Pneumonia and Pleurisy, Age Greater than 17 without CC
Feb-97	DRG 127 - Congestive Heart Failure and Shock	DRG 127 - Congestive Heart Failure and Shock
Jul-95	DRG 209 - Major Joint and Limb Reattachment Procedures of Lower Extremity *Procedure Code = 81.51 - Replacement, Hip, Total *Procedure Code = 81.53 - Revision, Hip Replacement DRG 471 - Bilateral or multiple Major Joint Procedures of Lower Extremity *Procedure Code = 81.51 - Replacement, Hip, Total *Procedure Code = 81.53 - Revision, Hip Replacement	Primary Procedure of 81.51 or 81.53
May-97	DRG 209 - Major Joint and Limb Reattachment Procedures of Lower Extremity *Procedure Code = 81.54 - Replacement, Knee, Total *Procedure Code = 81.55 - Revision, Knee Replacement DRG 471 - Bilateral or multiple Major Joint Procedures of Lower Extremity *Procedure Code = 81.54 - Replacement, Knee, Total *Procedure Code = 81.55 - Revision, Knee Replacement	Primary Procedure of 81.54 or 81.55
Aug-97	All inpatients with a procedure code of one of the following which appears as one of their first 6 coded procedures: 81.00, 81.01, 81.03, 81.05, 81.08, 81.09, 03.02, 03.09, 03.1, 03.32, 03.39, 03.4, 03.53, 03.59, 03.6, 03.99, 80.50, 80.51, 80.59	Primary Procedure of 81.00, 81.01, 81.03, 81.05, 81.08, 81.09, 03.02, 03.09, 03.1, 03.32, 03.39, 03.4, 03.53, 03.59, 03.6, 03.99, 80.50, 80.51, 80.59
Oct-97	All inpatients with a diagnosis code of one of the following which appears as one of their first 15 coded diagnoses: 436, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 434.00, 434.10, 434.90, 997.02, 674.01, 674.02, 674.03, 674.04	DRG 14
May-97	DRG 209 - Major Joint and Limb Reattachment Procedures of Lower Extremity *Procedure code = 81.52 - Replacement, Hip, Partial DRG 210 - Hip and Femur Procedures Except Major Joint Procedures, Age Greater than 17 with CC DRG 211 - Hip and Femur Procedures Except Major Joint Procedures, Age Greater than 17 without CC	
Jun-97	All inpatients with a procedure code of one of the following which appears as one of their first 6 coded procedures: 36.01, 36.02 , 36.03, 36.05, 36.09	Primary Procedure of 36.01, 36.02, 36.03, 36.05, 36.09
Dec-96	All inpatients with a primary procedure code = 60.5 - Prostatectomy, Radical	Primary Procedure of 60.5
Jul-95	All inpatients with a primary diagnosis code = 282.62 and AGE > 17.	Primary Diagnosis of 282.62
Jan-99	DRG 15	DRG 15
Oct-98	All inpatients with a procedure code of one of the following which appears as one of their first 3	Primary Procedure of 68.3, 68.4, 68.6

Performance Measurement
Beyond HCFA 1500/UB92 data:
Relating Rationale, Process and Outcomes

- Correlation of antibiotic selection, timing and post-operative temperatures, post-operative infection rate
- Impact of interactive alerts on incidence of prescribing errors and adverse events
- Geriatric drug decision support correlation with falls rate, length of stay, incidence of confusion
- Compliance with Foley Catheter protocol and incidence of nosocomial urinary tract infection
- Impact of decubitus ulcer protocol on decubitus rate

Serious Medication Errors Before and After Order Entry

Delta = -55%

p < .01
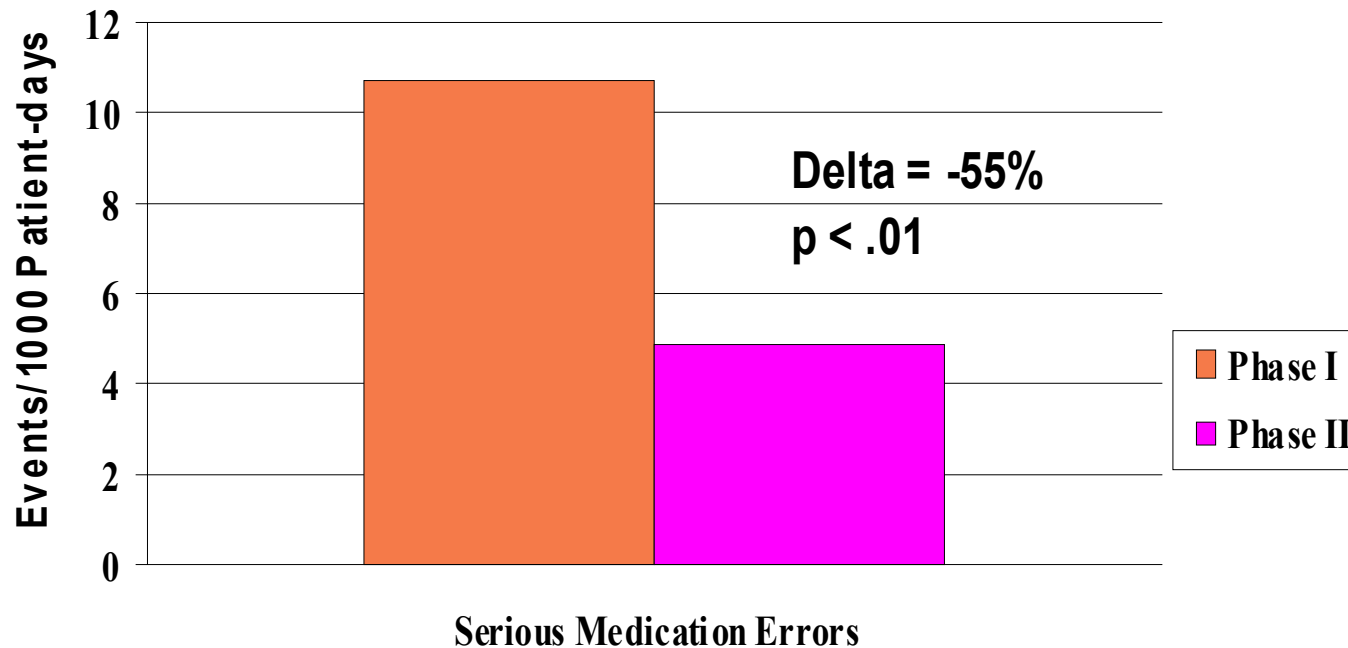
Bates et al, JAMA, 1998

About Knowledge Asset Management Processes:

- Authoring and support of authoring by end-users and drivers of the various quality agendas
- Validation and audit trail maintenance
- Inventory (knowledge librarian)
- Publishing and Sharing
- Support of controlled terminology
- Tools licensing/development to support above

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Knowledge Asset Management Infrastructure:

- Knowledge engineering tools for embedding knowledge into the applications (pathways, rules, templates, etc)

- Publishing tools for upload, download, merge, share, etc.

- Vocabulary tools for controlled terminology

- Knowledge repository for storing and managing engineered knowledge and source material (paper, specs, date, origin, process flow diagrams)

- Reporting tools for measuring impact/usability of knowledge sources

Knowledge Asset Management:
Translating Goals into a Taxonomy for your Knowledge Repository

Measurement Framework Based on IOM 6 Requirements
Define Organizational Goals

Data/Knowledge Seeking	Assessment	Dx/Rx Decision Making	Order Fulfillment, Communication and Coordination	Billing Reporting
				Transfer/ Handoff

CORE CARE PROCESSES Taxonomy

Care Oversight, Med Mngmt, Measurement and Reporting

Clinical Knowledge Domain Taxonomy

Role and Venue Domain Taxonomy

Requirements

Care Applications
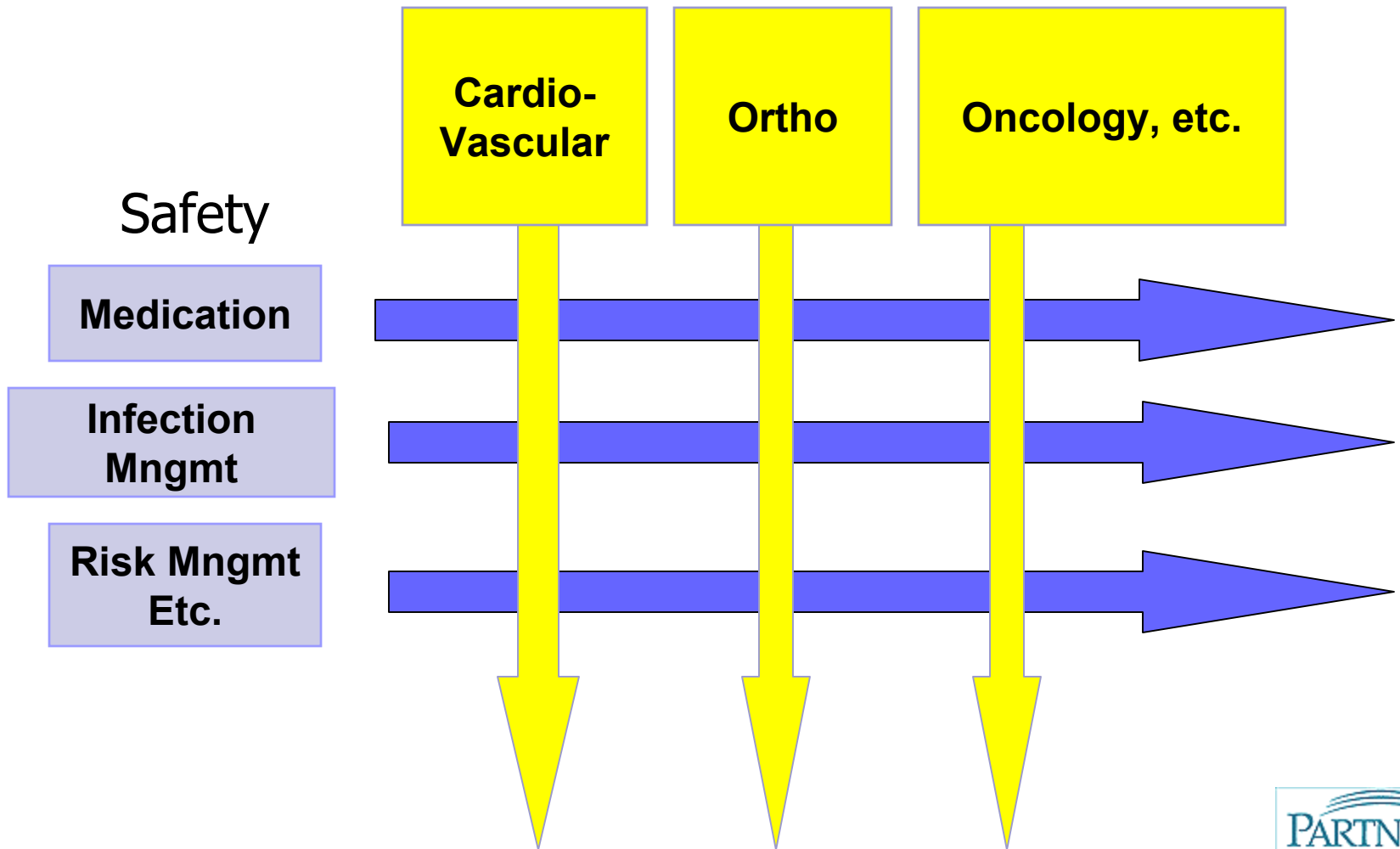**and Knowledge Bases**

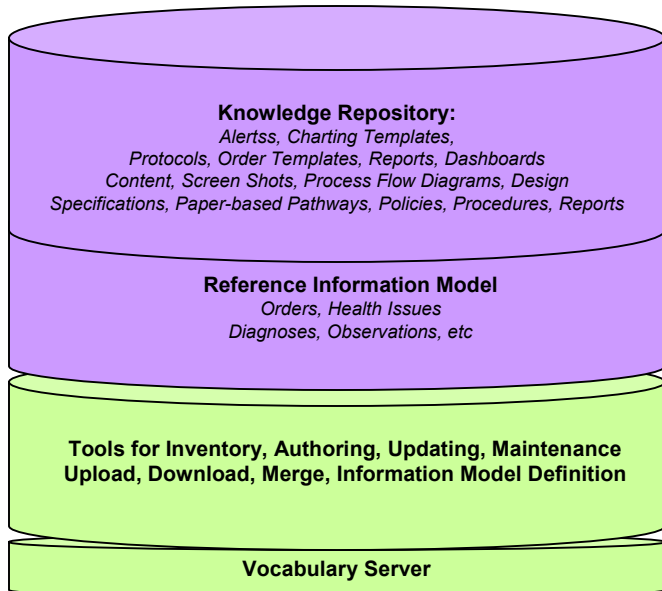**Reference Information Model**

Role and Venue Domains

Settings

	Self-Mngmt	Ambulatory	Acute	Post-Acute

Roles

Consumer

Physician

Nurse

Etc.

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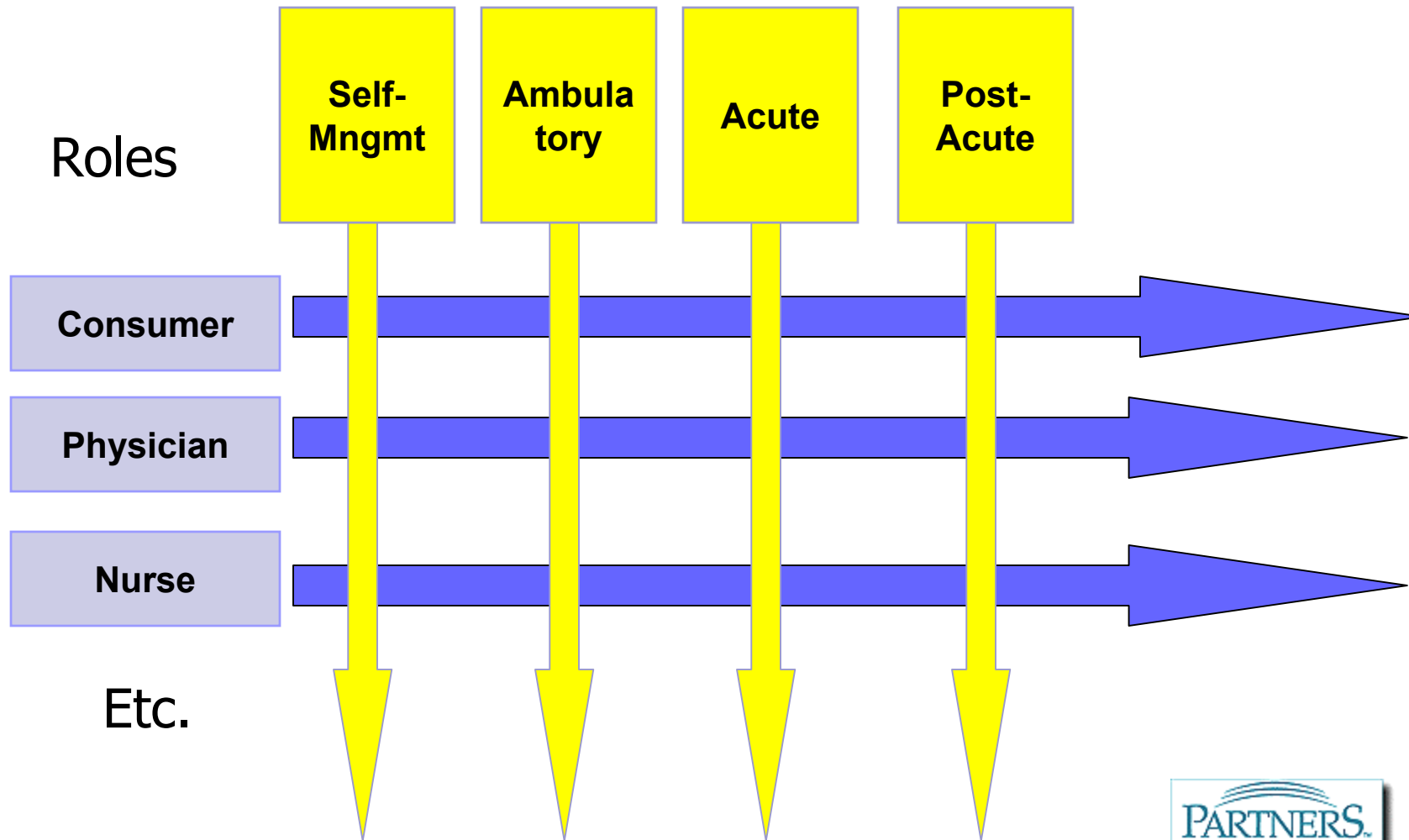
Knowledge Domains

Knowledge Engineering Factory

KNOWLEDGE ASSET MANAGEMENT

KNOWLEDGE APPLICATION

KNOWLEDGE DISCOVERY

Knowledge Repository:
Alertss, Charting Templates,
Protocols, Order Templates, Reports, Dashboards
Content, Screen Shots, Process Flow Diagrams, Design
Specifications, Paper-based Pathways, Policies, Procedures, Reports

Reference Information Model
Orders, Health Issues
Diagnoses, Observations, etc

Tools for Inventory, Authoring, Updating, Maintenance
Upload, Download, Merge, Information Model Definition

Vocabulary Server

Knowledge Factory Website

Content organized
By Site
Role,
Venue,
Diagnosis,
Safety,
Process,
Application,
Function

DEPLOYED at PARTNERS MEMBER SITES Via SERVICES ARCHITECTURE

Quality Measurement Warehouse

Content Engineering Collaboration

Distributed Knowledge Authoring & Discovery Across Partners

| **Partners Content** |
| **Other Third Party Content** |
| **Literature** |
| **JCAHO/NQF/NCQA Standards** |

Central Team coordinates Asset Management,
Supports Knowledge Discovery, Authoring Tools,, Editing,
Updating, Organization, Validation Review,

Quality and Value Assessment

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Partners HealthCare 2001

- Licensed Beds   3196
- Births   18,478
- Admissions   134,991
- Patient Days   871,321
- Average LOS   5.31
- Total Outpatient Visits   2,324,073

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Partners Information Systems

- 45,000 devices attached to the Partners network
- 500+ servers
- 800 applications
- 520 active projects
- 680 employees based in 19 locations
- FY02 operating budget of $92.3M
- FY02 capital budget of $47M

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PHS Systems Integration Components
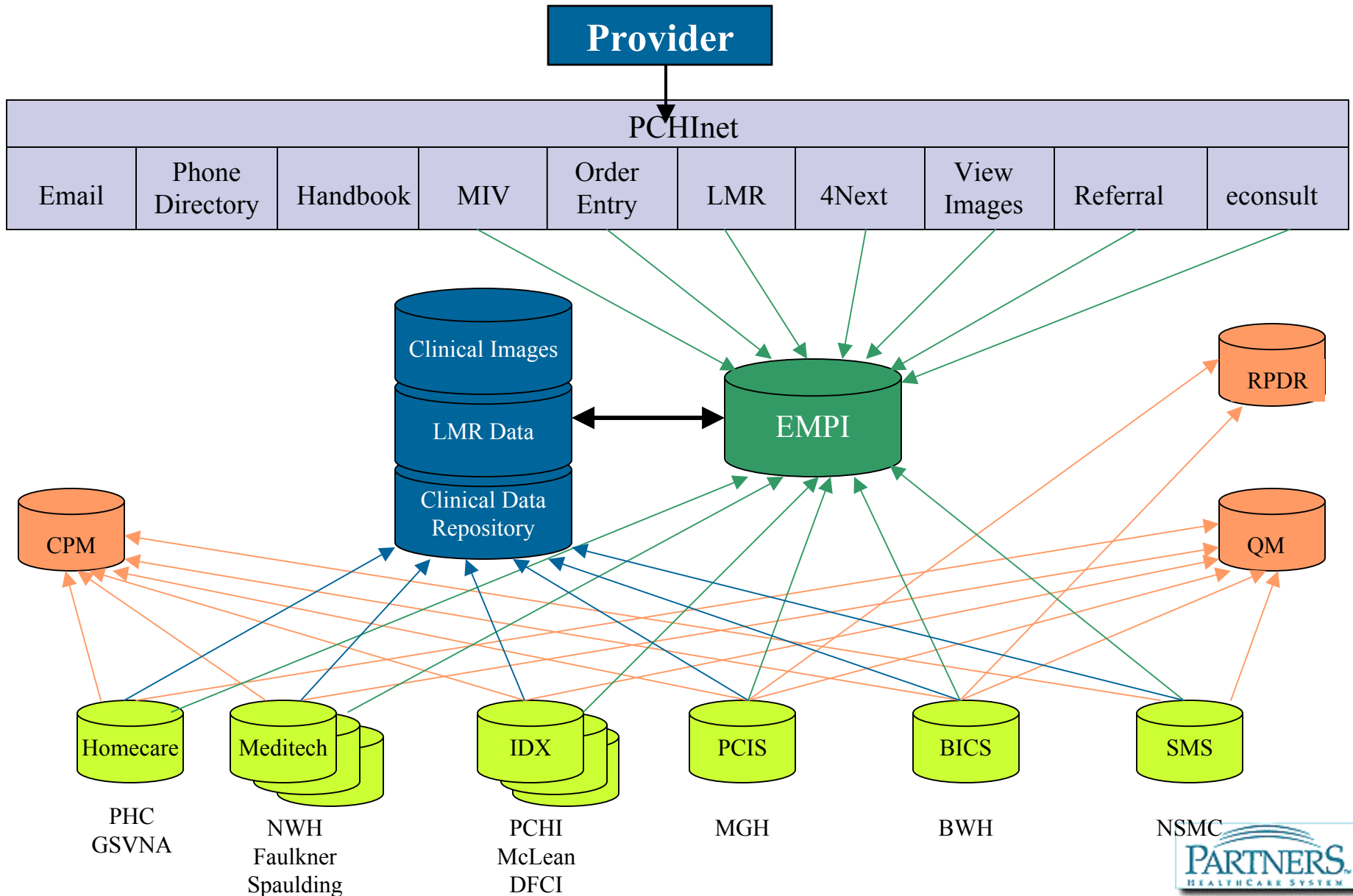
Humility is important: Systems have a long way to go…

"I typed in your description of the symptoms. The computer says you have Dutch elm disease."

Current State Challenges

- Knowledge "hardwired" into applications
- Not re-usable
- Requires engineers to update/maintain
- No OLAP real estate to support deeper analytic processing for richer personalization

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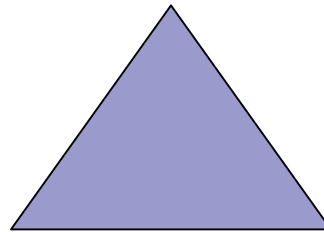
Personalization vs Standardization

- Challenge with software design in healthcare today is assumption that workflow/preferences should adapt to software and content constraints

- Given today's constraints, knowledge management must be supported by labor-intensive factory processes

- How does software let us "choose our battles" re: what to agree on, what's important, leave the rest to preference until measurement data supports otherwise?

- How does software "adapt" to user preferences and support agreed upon standards of clinical practice?

- How does software anticipate the needs of the encounter and preferences of the participants to support an effective, efficient conversation?

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Clinical Encounters
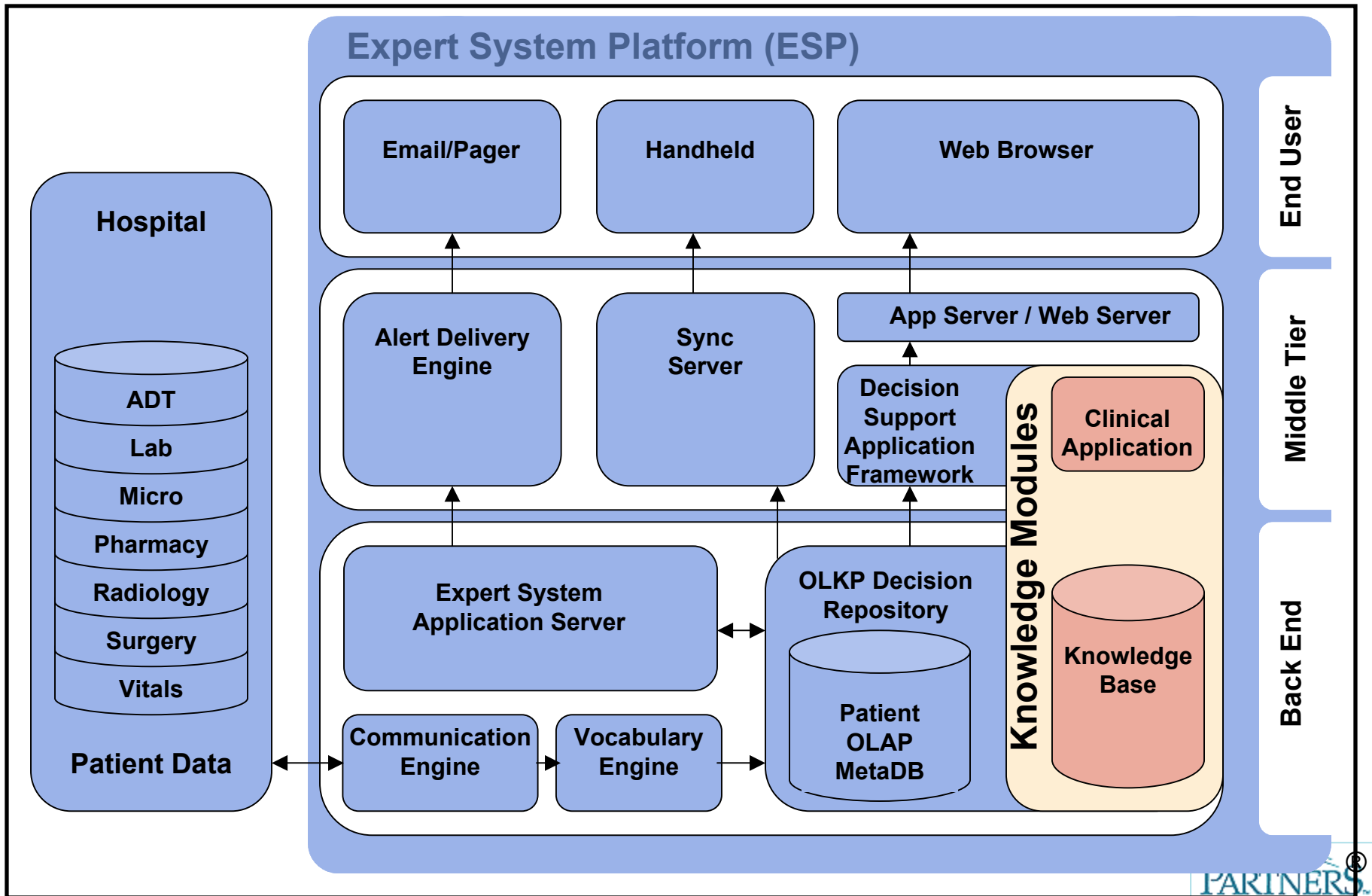# Multiple Dimensions of Anticipation

Knowledge Bases

Standards of Practice,
Role/Venue Requirements
Billing/Regulatory Requirements

Patient
Preferences

Caregiver
Preferences

Clinical Decision Support Services Approach

Expert System Platform (ESP)

Hospital — Patient Data: ADT, Lab, Micro, Pharmacy, Radiology, Surgery, Vitals

End User: Email/Pager, Handheld, Web Browser

Middle Tier: Alert Delivery Engine, Sync Server, App Server / Web Server, Decision Support Application Framework

Back End: Expert System Application Server, Communication Engine, Vocabulary Engine, OLKP Decision Repository, Patient OLAP MetaDB

Knowledge Modules: Clinical Application, Knowledge Base

Some Current Clinical Knowledge Assets Developed at Partners

- Medication Data Dictionary and DDIs
  - Dedicated team
- Inpatient alerts and order rules
- Radiology Ordering decision support
- Preventive health reminders
- Outpatient lab result decision support

Barriers to Success at the Intersection of Safety, Informatics, and KM

- Leadership inadequately committed
- Products inadequate to support processes
- Business case intangible
- Fear of exposure (technology increases transparency)
- Few roadmaps to success are proven in the healthcare arena

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Market Drivers will Propel Progress

- Genomics: personalized medicine will require technologies for personalization, these same technologies will enable more user-friendly safety solutions
- Aging population is computer literate and population growth will outstrip service capacity, informatics must support self-management and protection
- Leapfrog/Govt beginning to purchase quality
- Business community will aid transition from commodity to value based purchasing by employers and consumers

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Address http://cachedev.partners.org/scripts/phsweb.mwl?   Go

PATIENT GATEWAY

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Directions
Services
**Professional Staff**
Contact Us

Welcome

Welcome Bilbo Oetest

You have no new messages in your Inbox.

THE BRIGHAM AND WOMEN'S PHYSICIAN GROUP provides comprehensive adult medical care, from routine health screening to complex diagnostic evaluations. Our 10-physician general medicine practice includes a nephrologist, endocrinologist and cardiologist. All of these physicians are affiliated with Brigham and Women's Hospital and are faculty of Harvard Medical School.

Done   Internet
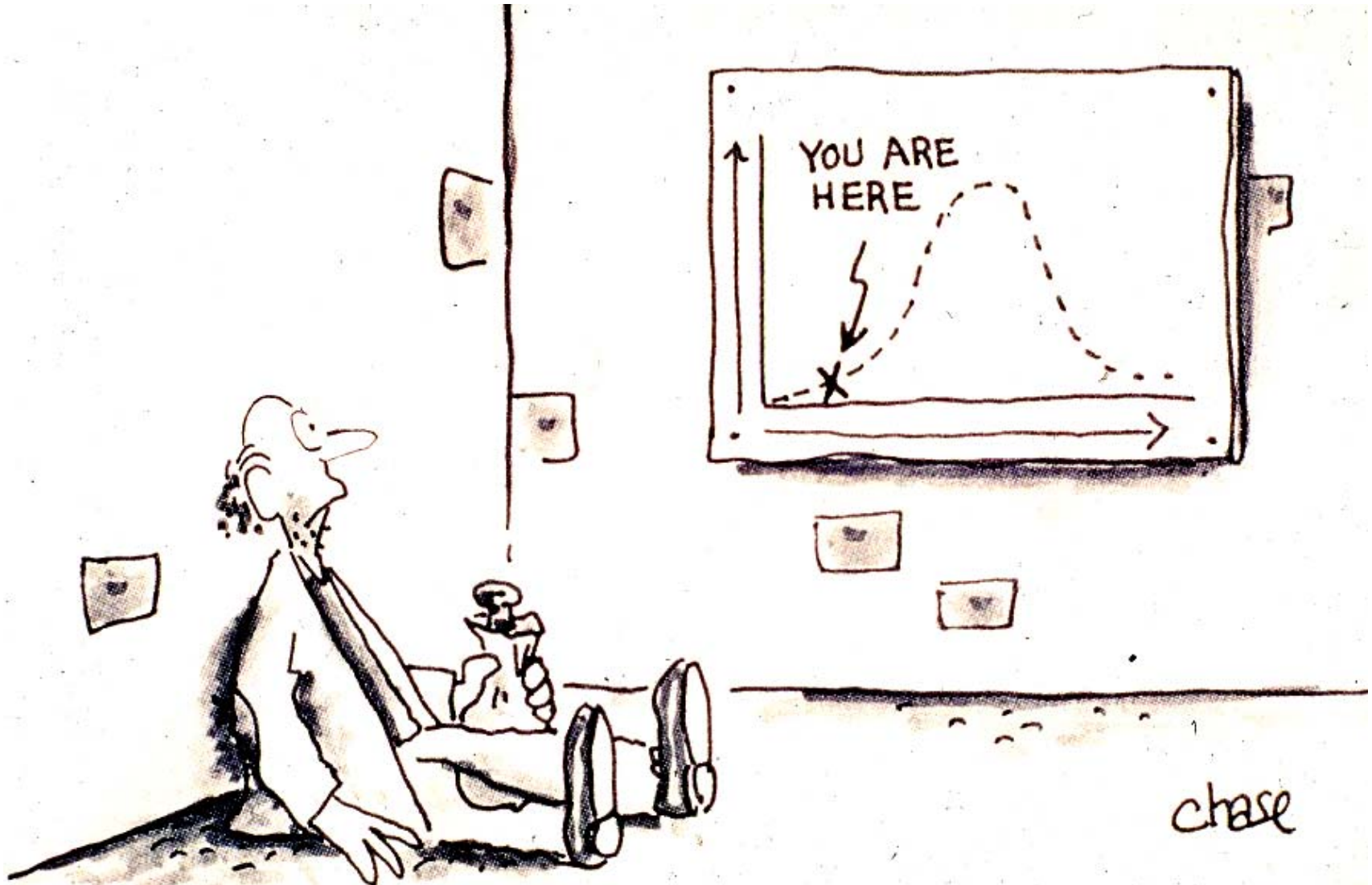
Where are we?

Conclusions

- Culture eats strategy for lunch
- Effective KM is critical to patient safety
- Informatics is a cornerstone for both