THE UNIVERSITY OF CHICAGO
MEDICINE & BIOLOGICAL SCIENCES

Clinical Informatics and Clinical Decision Support

Pathology Informatics Summit

David McClintock, MD

May 22, 2017

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- Relevant disclosures include:
  - Scientific Advisory Board, Philips Digital Pathology
  - Strategic Advisory Board, Sunquest Information Systems
  - Medical Advisory Board, XIFIN

Case Scenario

An 46-year old African-American man has a primary care visit, during which his PCP informs him of the need for a colonoscopy.

Patient: "A colonoscopy? Why do I need to do that already? I heard that doesn't start until age 50!"

PCP: "Recent guidelines recommend colonoscopy in African Americans at age 45 and higher. Our newest EMR update allows us to integrate national cancer screening guidelines into our care practice – I received an alert upon opening your medical record that you hadn't yet had a screening colonoscopy."

Case Scenario

The patient undergoes colonoscopy during which an advanced adenoma is found. It is fully resected and the patient is declared cancer-free.

Five years later, the patient receives a reminder through his patient portal recommending repeat colonoscopy given his prior diagnosis.

What Happened Here?

Electronically captured clinical data

was combined with a simple rules-based algorithm

comparing patient demographics with known procedure history

resulting in an effectively timed electronic alert

that improved patient care

What Should You Get Out Of This Presentation?

- Defining clinical decision support (CDS) within the realm of clinical informatics
- Considerations for implementing CDS tools and systems
- Examples of current and future state CDS tools for laboratorians, pathologists and clinicians

What Is Informatics?

The science of information

Study of how data is:

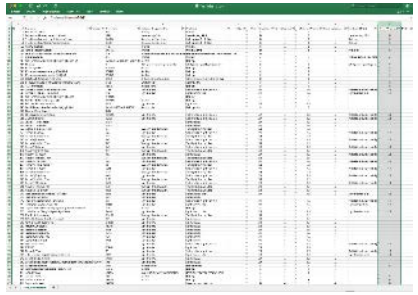
- Acquired
- Structured
- Stored
- Processed
- Retrieved
- Analyzed
- Presented / Communicated

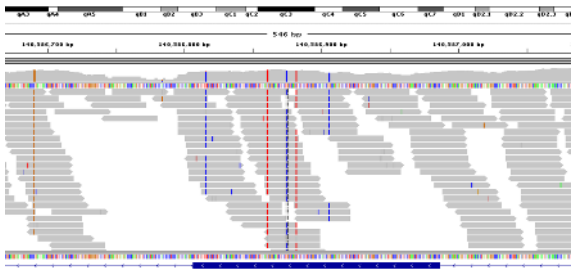
Modified from: John Sinard. Practical Pathology Informatics, 2006

Informatics Defined

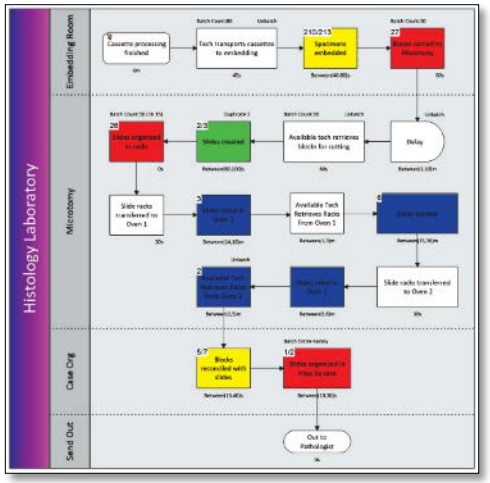
Informatics is studying how to deliver the **right information**, to the **right person** in the **right place and time**, in the **right way**

What Informatics is ALL About



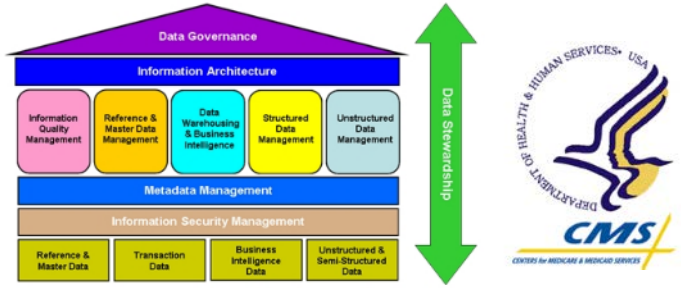


Understanding the fundamentals of information and how its used



Understanding and optimizing information workflows

Understanding information systems ecosystems and leveraging resources



Applying proper information governance within regulatory frameworks

Clinical Informatics (CI)

The application of informatics to the practice of medicine and clinical care

*Delivering the **right clinical information** to the **right person**, in the **right place and time**, in the **right way***

Scope of Clinical Informatics

- AMIA Core Content for Clinical Informatics, 2009
  - Assess information and knowledge needs of health care professionals and patients
  - Characterize, evaluate, and refine clinical processes
  - Develop, implement, and refine clinical decision support systems
  - Lead or participate in the procurement, customization, development, implementation, management, evaluation, and continuous improvement of clinical information systems

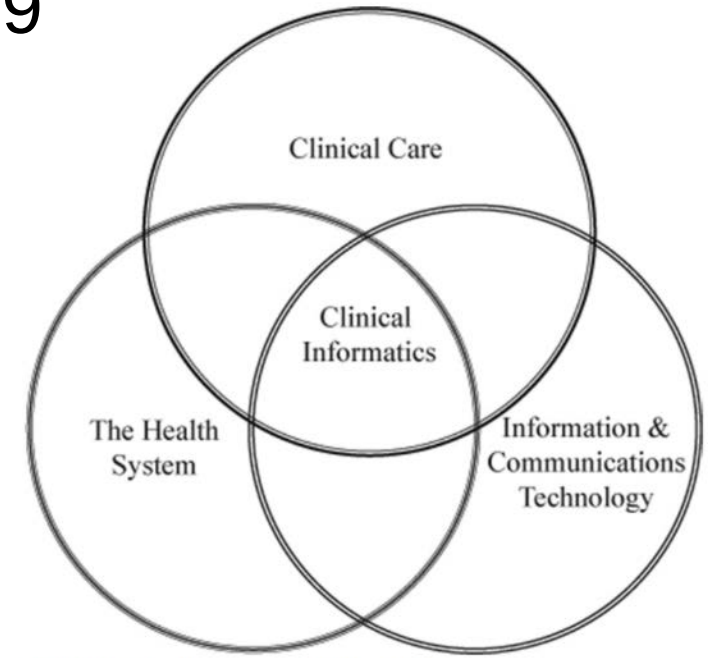


Figure 1. Domains of Clinical Informatics.

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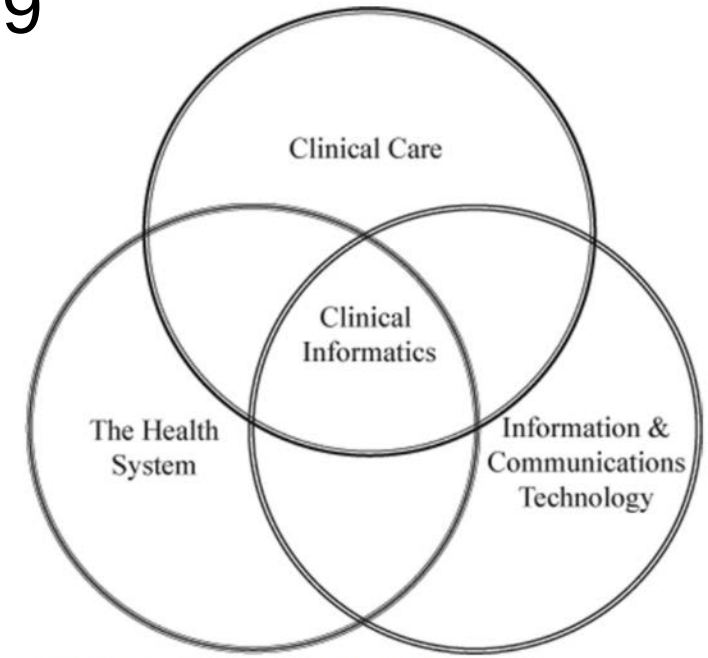

Figure 1. Domains of Clinical Informatics.

Clinical Decision Support - Defined

Providing clinicians, patients or individuals with knowledge and person-specific or population information, intelligently filtered or presented at appropriate times, to foster better health processes, better individual patient care, and better population health

From: Osheroff JA, et.al. A roadmap for national action on clinical decision support. J Am Med Inform Assoc. 2007;14(2):141–5.

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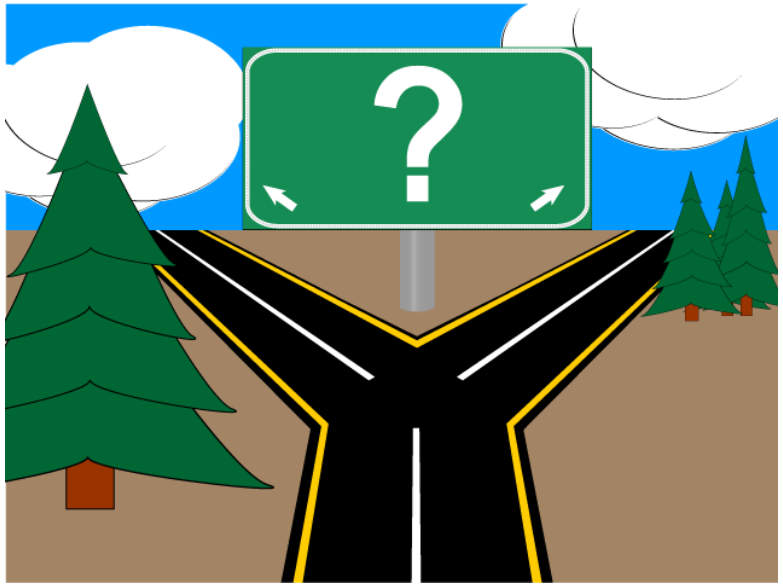
Clinical Decision Support (CDS)

- Adding the capability to AID clinical judgment
  - Does NOT make clinical decisions for providers
  - OFFERS information to providers to PAIR with their clinical knowledge
- Driven by knowledge
- MUST take clinical workflows and goals in account
- End game is to improve patient outcomes and overall health

Why do we need Clinical Decision Support?

- ALL medical decisions involve uncertainty; many involve risk
- The following are rarely 100% ”certain” in medicine:
  - Patient histories / accounts of health
  - Results of lab / procedural testing
  - Diagnosis of disease
  - Natural course of disease
  - Effects of treatment
  - Patient outcomes



Challenges in Clinical Decision Making

- Goal is to move quickly from chief complaint → clinical history → findings/results → diagnosis → therapy→ outcome

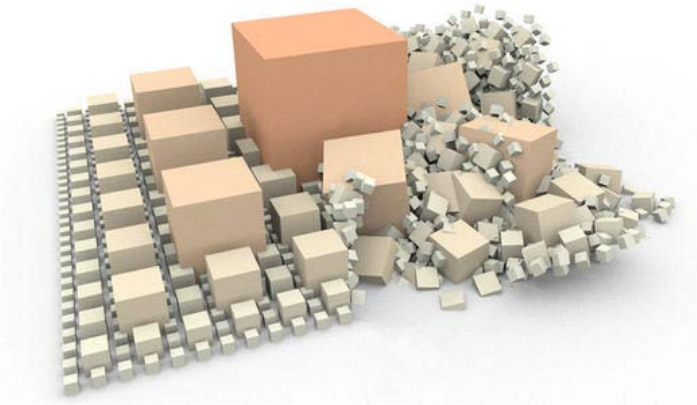
- In many cases, there is no definitive answer
  - Each patient can be both unique and complex
  - Getting to an acceptable answer takes time

Challenges in Clinical Decision Making

- Issue → TOO MANY variables to test everything
  - Increased complexity of testing
  - Increased numbers of tests available
    - E.g. Mayo Medical Laboratories lists **over 3400** tests in their test catalog!!
- For many clinicians, approach is to:

Bringing Order to Chaos

- "Five Rights" of Clinical Decision Support
  1. The right information
  2. To the right person
  3. In the right intervention format
  4. Through the right channel
  5. At the right time in workflow



From: The five rights of clinical decision support: CDS tools helpful for meeting meaningful use [Internet]. [Cited 21 May 2017]. Available from: http://library.ahima.org/xpedio/groups/public/ documents/ahima/bok1_050385.hcsp?dDocName=bok1_050385.

The Right Information

- Evidence-based information
  - From literature, national guidelines, national performance measures, expert opinions
  - Source of information should be clear to user (e.g. link to guidelines)

- ONLY ENOUGH information for the user to act on

The Right Person

- GOAL: present information only to individuals who can take action

- Examples:
  - Medication alert requiring a change in dose should be triggered within physician workflows (since they are responsible for changing the dose) and not nursing workflows
  - Refine order preference lists for each clinical subspecialty (one size does not fit all!)

The Right Intervention Format

- Identify issue/problem and choose the best format for resolution

- Requires knowledge of current systems to determine CDS tools available
  - Included in HIS
  - Developed in-house
  - 3rd party vendor

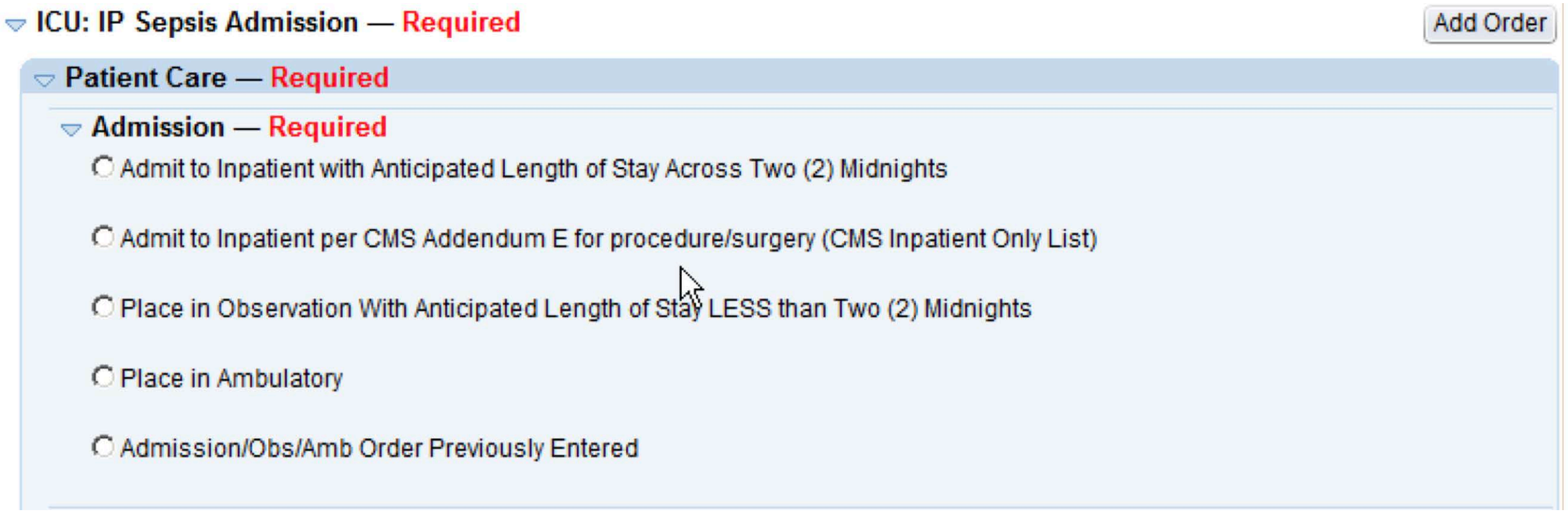
The Right Intervention Format

- Various CDS formats:
  - Computerized alerts, reminders, and prompts
  - Order sets
  - Documentation templates, Smart forms
  - Protocols
  - Patient monitoring systems
  - Reports and summaries
  - Decision algorithms
  - Knowledge and references

Alerts

From: JT Finnell and BE Dixon. Clinical Informatics Study Guide, 2016, p.116

Order Sets


ICU: IP Sepsis Admission — Required
Add Order
Patient Care — Required
Admission — Required
Admit to Inpatient with Anticipated Length of Stay Across Two (2) Midnights
Admit to Inpatient per CMS Addendum E for procedure/surgery (CMS Inpatient Only List)
Place in Observation With Anticipated Length of Stay LESS than Two (2) Midnights
Place in Ambulatory
Admission/Obs/Amb Order Previously Entered

Vital Signs/Monitoring

- [x] Adult Cardiac Monitoring - Uninterrupted
  P ROUTINE, UNTIL SPECIFIED starting Today at 1606 Until Specified
  Type of Cardiac Monitoring: Uninterrupted
- [ ] Arterial Pressure Monitoring
  EVERY HOUR & AS NEEDED
- [ ] Central Venous Pressure (CVP) Monitoring
  EVERY HOUR & AS NEEDED
- [ ] Continuous Pulse Oximetry
  ROUTINE, UNTIL SPECIFIED
- [x] Orthostatic Blood Pressure & Heart Rate
  ROUTINE, ONCE First occurrence Today at 1606, On Admission
- [ ] Pulmonary Artery Pressure Monitoring
- [ ] Pulmonary Wedge Pressure
- [x] Strict Intake & Output
  ROUTINE, EVERY HOUR First occurrence Today at 1606 Until Specified, Intake and output documentation to include ALL fluids and/or meds administered as well as, any drain(s) output if applicable.
- [x] Vital Signs
  ROUTINE, EVERY HOUR First occurrence Today at 1606 Until Specified
  Continue Vitals Throughout the Night: Yes
- [x] Weight Once
  ROUTINE, ONCE First occurrence Today at 1606, Once on Admission
- [x] Weight Daily (0600)
  ROUTINE, DAILY (0600) First occurrence Tomorrow at 0600 Until Specified

Laboratory

Arrival

- [ ] Arterial Blood Gas
  ONCE
- [ ] Basic Metabolic Panel
  ONCE
- [ ] Blood Culture (Bacterial & Fungal)
  ONCE, Peripheral #1
- [ ] Blood Culture (Bacterial & Fungal)
  ONCE, Peripheral #2
- [ ] Blood Culture (Bacterial & Fungal)
  ONCE, Central Line
- [ ] C. difficile Toxin Assay by PCR and Contact Isolation Panel
- [ ] CKMB Isoenzyme Panel
  ONCE
- [ ] Complete Blood Count
  ONCE
- [ ] Comprehensive Metabolic Panel
  ONCE
- [ ] Cortisol
  ONCE
- [ ] Differential
  ONCE
- [ ] Hepatic Function Panel
- [x] ICU Methicillin Resistant Staph Aureus Screen by PCR
  P ROUTINE, ONCE First occurrence Today at 1606
  Specimen Source: NASL
  Regular Swab
- [ ] Lactic Acid
  ONCE
- [ ] Mixed Venous Blood Gas
  ONCE, Central Line.
- [ ] Partial Thromboplastin Time
  ONCE
- [ ] Prothrombin Time/INR (PTI)
  ONCE
- [ ] Renal Function Panel
  ONCE
- [ ] Respiratory Culture & Stain
  ONCE
- [ ] Tobramycin Peak Assay
- [ ] Tobramycin Trough Assay
- [ ] Urinalysis Chemistry Screen w/Microscopic
  ONCE
- [ ] Urinalysis Chemistry Screen w/Microscopic and Culture Reflex
  ONCE
- [ ] Urine Culture - Select One if Appropriate
- [ ] Vancomycin Trough Assay

Medications - Infectious Disease/Antibiotics

PLEASE READ THE FOLLOWING INFORMATION - Empiric Antibiotic Therapy

Please select one of the following regimens. Page the PharmD Resident on-call (CCD - #6338 or Mitchell - #4230) for dosing recommendations in renal impairment.

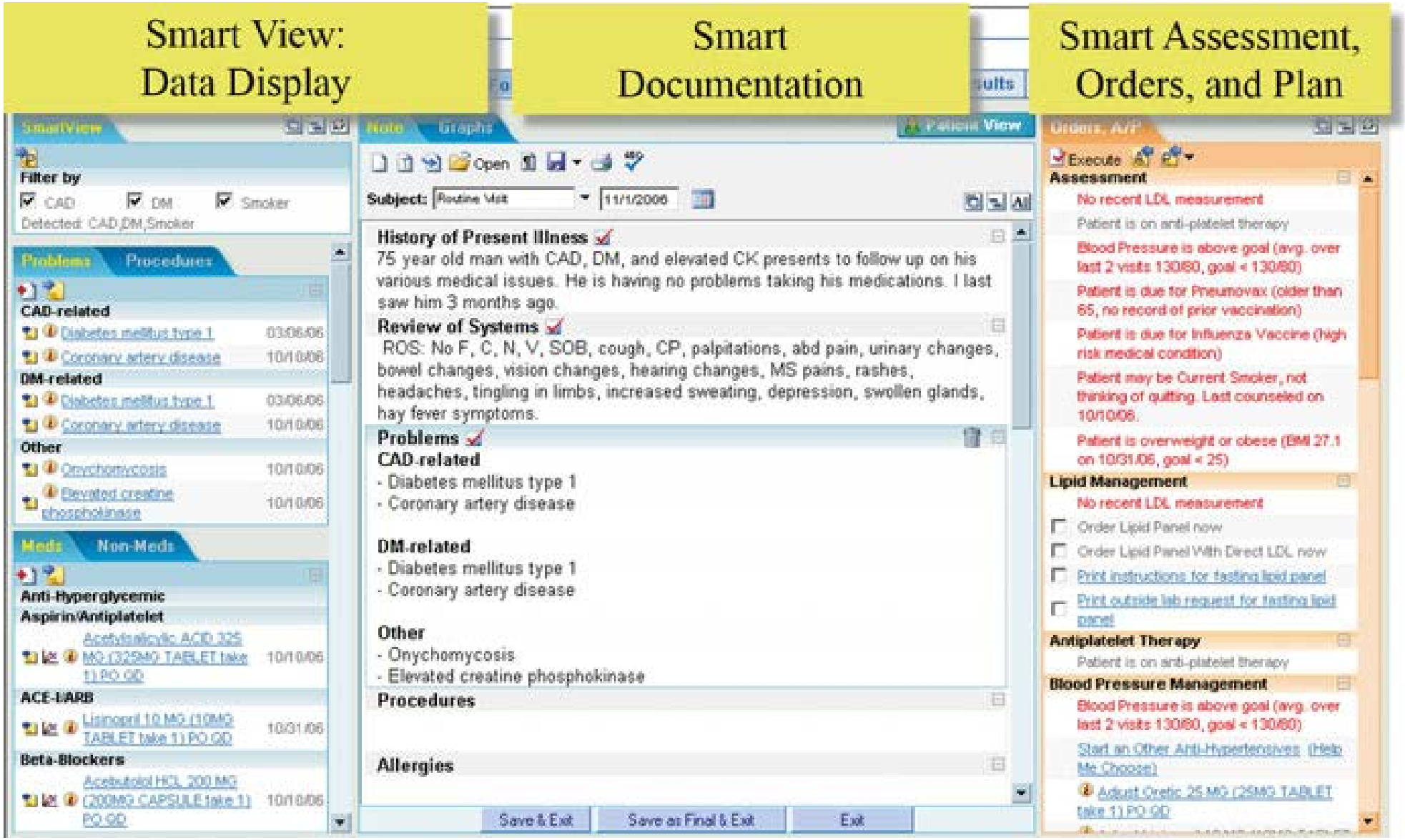
ID Empiric Therapy: Preferred Option

Please select cefepime AND vancomycin AND metronidazole.

A loading dose is recommended for VANCOmycin.
Add TOBRAmycin if initiating a vasopressor.

- ☐ cefepime (MAXIPIME) 1 g ICU panel for extended infusion (Adjust in Renal Impairment)
- ☐ cefepime (MAXIPIME) 2 g ICU panel for extended infusion - If TBW is Greater than or Equal to 80 kg (Adjust in Renal Impairment)
- ☐ vancomycin (VANCOCIN) IVPB (loading dose, max 2,500 mg - if patient morbidly obese (BMI greater than or equal to 40 kg/m2) max loading dose - 3000mg) - PK consult #4229 recommended for further dosing
  Intravenous, ONCE
- ☐ vancomycin (VANCOCIN) IVPB (maintenance dose, max 2,000 mg - time to start 12 hr after the loading dose; PK consult #4229 recommended)
  Intravenous, EVERY 12 HOURS, Starting H+13 Hours
- ☐ vancomycin (VANCOCIN) IVPB (maintenance dose, max 2,000 mg - time to start 24 hr after the loading dose; PK consult #4229 recommended)
  Intravenous, EVERY 24 HOURS, Starting H+25 Hours
- ☐ metronidazole (FLAGYL) 500 mg in 100 mL IVPB
  Intravenous, EVERY 8 HOURS

Smart Forms

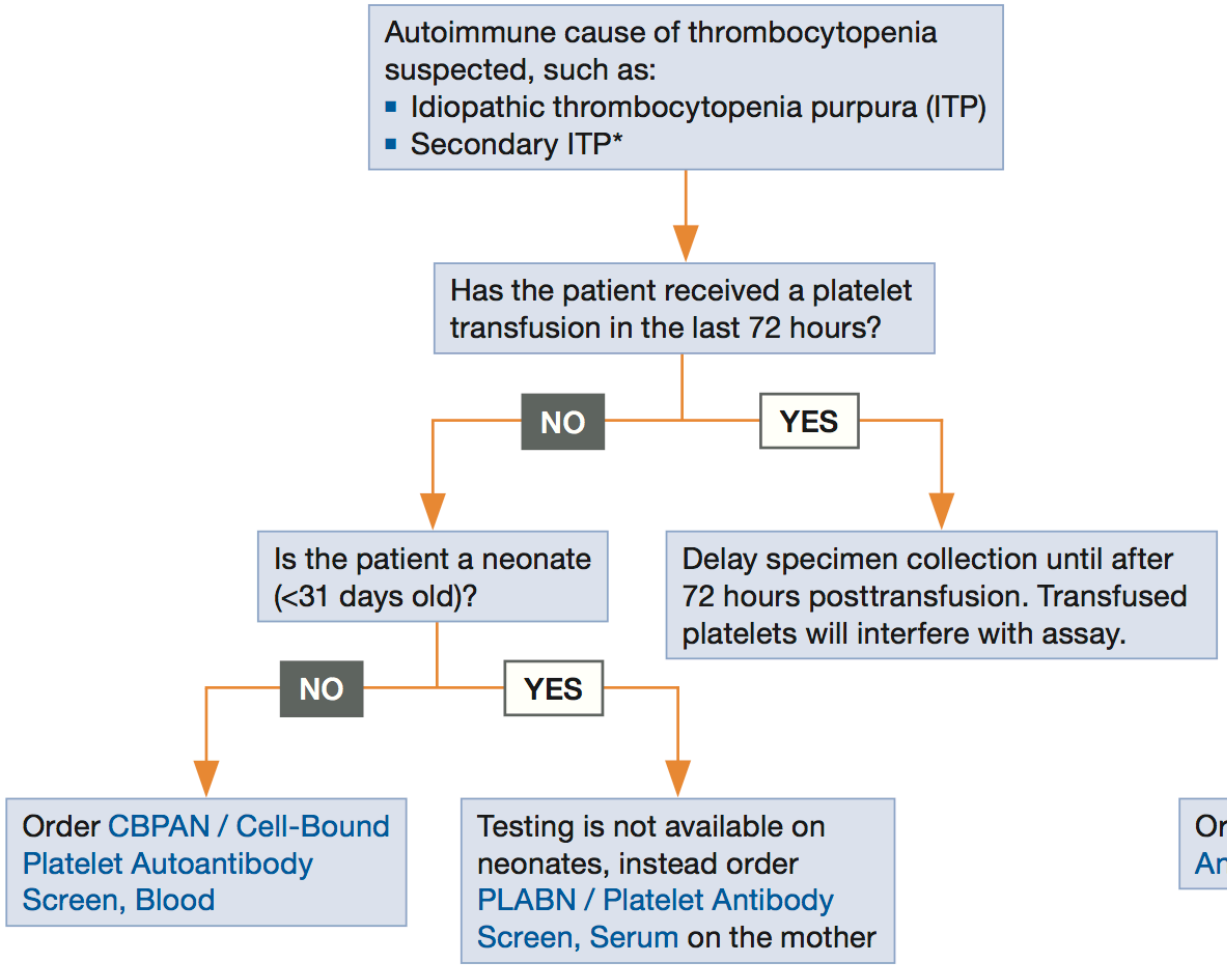

Smart View: Data Display
Smart Documentation
Smart Assessment, Orders, and Plan
SmartView
Filter by
CAD
DM
Smoker
Detected: CAD,DM,Smoker
Problems
Procedures
CAD-related
Diabetes mellitus type 1 03/06/06
Coronary artery disease 10/10/06
DM-related
Diabetes mellitus type 1 03/06/06
Coronary artery disease 10/10/06
Other
Onychomycosis 10/10/06
Elevated creatine phosphokinase 10/10/06
Meds
Non-Meds
Anti-Hyperglycemic
Aspirin/Antiplatelet
Acetylsalicylic ACID 325 MG (325MG) TABLET take 1) PO QD 10/10/06
ACE-I/ARB
Lisinopril 10 MG (10MG) TABLET take 1) PO QD 10/31/06
Beta-Blockers
Acebutolol HCL 200 MG (200MG) CAPSULE take 1) PO QD 10/10/06
Note
Graphs
Patient View
Open
Subject: Routine Visit
11/1/2006
History of Present Illness
75 year old man with CAD, DM, and elevated CK presents to follow up on his various medical issues. He is having no problems taking his medications. I last saw him 3 months ago.
Review of Systems
ROS: No F, C, N, V, SOB, cough, CP, palpitations, abd pain, urinary changes, bowel changes, vision changes, hearing changes, MS pains, rashes, headaches, tingling in limbs, increased sweating, depression, swollen glands, hay fever symptoms.
Problems
CAD-related
· Diabetes mellitus type 1
· Coronary artery disease
DM-related
· Diabetes mellitus type 1
· Coronary artery disease
Other
· Onychomycosis
· Elevated creatine phosphokinase
Procedures
Allergies
Save & Exit
Save as Final & Exit
Exit
Orders, A/P
Execute
Assessment
No recent LDL measurement
Patient is on anti-platelet therapy
Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)
Patient is due for Pneumovax (older than 65, no record of prior vaccination)
Patient is due for Influenza Vaccine (high risk medical condition)
Patient may be Current Smoker, not thinking of quitting. Last counseled on 10/10/06.
Patient is overweight or obese (BMI 27.1 on 10/31/06, goal < 25)
Lipid Management
No recent LDL measurement
Order Lipid Panel now
Order Lipid Panel With Direct LDL now
Print instructions for fasting lipid panel
Print outside lab request for fasting lipid panel
Antiplatelet Therapy
Patient is on anti-platelet therapy
Blood Pressure Management
Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)
Start an Other Anti-Hypertensives (Help Me Choose)
Adjust Cretic 25 MG (25MG) TABLET take 1) PO QD

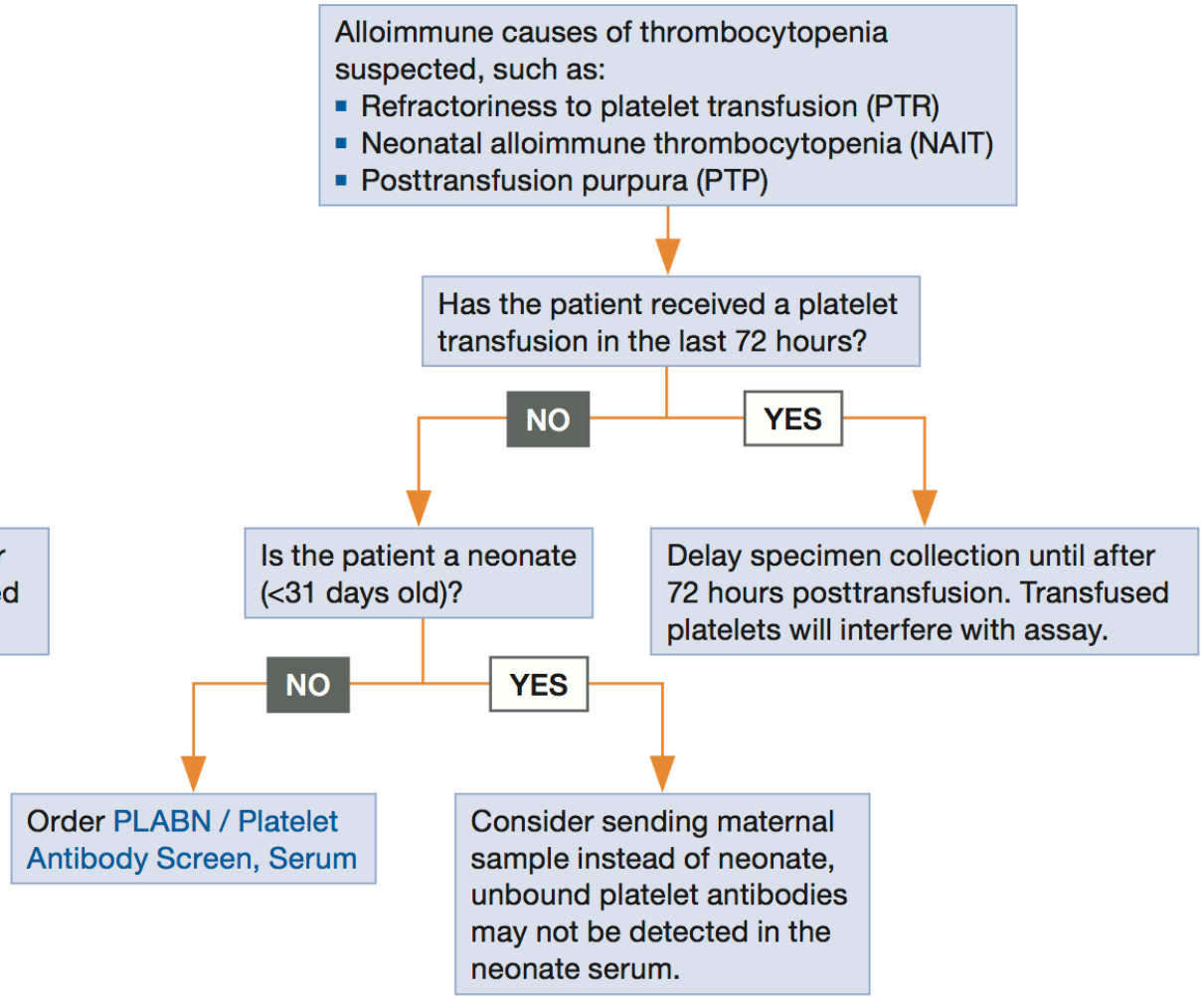
Decision Algorithms

Platelet Antibody Testing Algorithm

MAYO CLINIC
Mayo Medical Laboratories

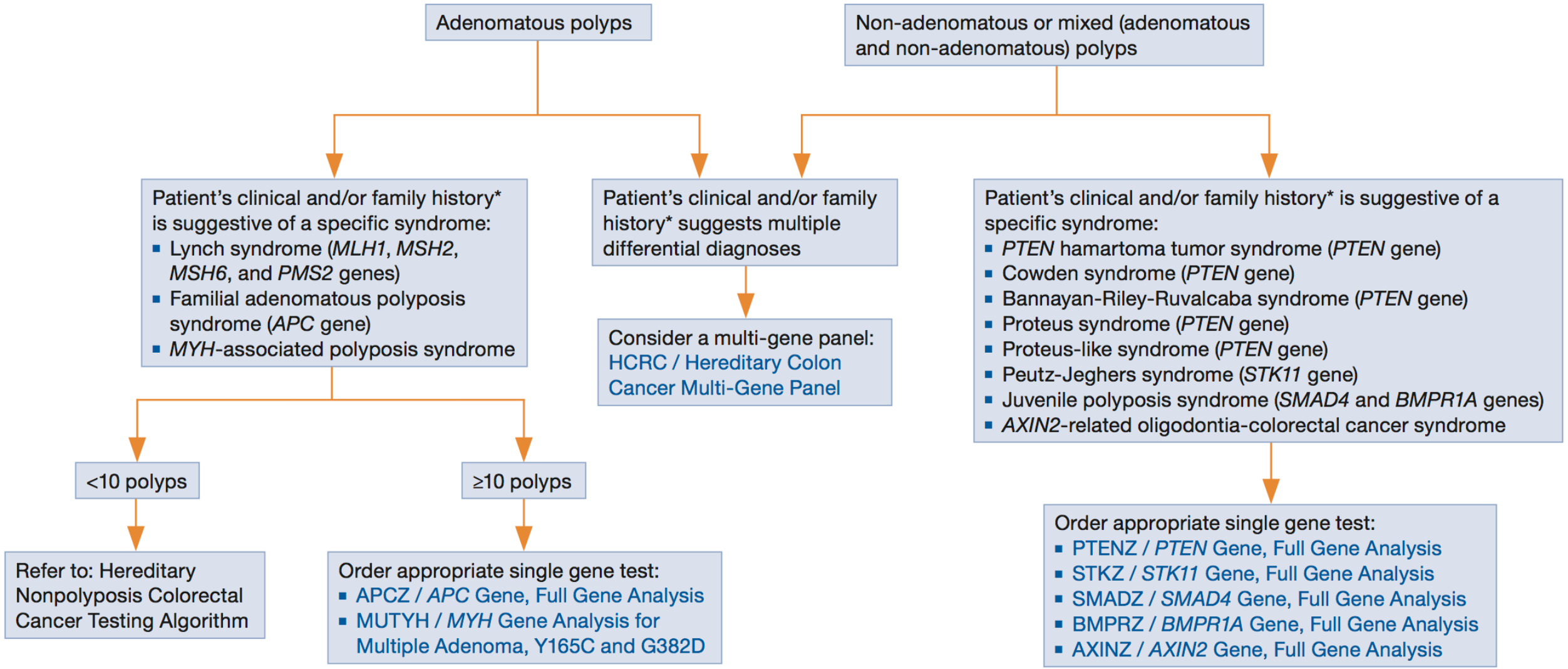
Clickable PDF
Click on blue tests to view test catalog information





Colonic Polyposis Syndromes Testing Algorithm

MAYO CLINIC
Mayo Medical Laboratories



The Right Channel

- What is the best way to communicate the information within the intervention to the right person?
  - EMR/EHR most common place today for providers
  - Third party application
  - Smartphone app
  - Web link
  - Secure email
  - Paging
  - Text messaging
  - Phone calls
  - Paper – labels, requisitions, forms

The Right Time in Workflow

- For successful interventions, clinical processes must be:
  - Documented
  - Understood
  - Analyzed
- Requires subject matter expert involvement
- Intervention should COMPLEMENT the clinical workflow

Workflow is IMPORTANT

- Clinician orders a medication for an patient for which a contraindication is present
- An alert fires as the physician sends the electronic script to the pharmacy
- ISSUE!!
  - Successful alert → poor timing
- Better solution
  - Fire alert upon order entry
  - Allows clinician to correct issue immediately, saves times
  - EVERY CLICK SAVED IS A WIN!!

Synthesis of Research Paper ■

Ten Commandments for Effective Clinical Decision Support: Making the Practice of Evidence-based Medicine a Reality

David W. Bates, MD, MSc, Gilad J. Kuperman, MD, PhD, Samuel Wang, MD, PhD, Tejal Gandhi, MD, MPH, Anne Kittler, BA, Lynn Volk, MHS, Cynthia Spurr, RN, MBA, Ramin Khorasani, MD, Milenko Tanasijevic, MD, Blackford Middleton, MD, MSc, MPH

Abstract While evidence-based medicine has increasingly broad-based support in health care, it remains difficult to get physicians to actually practice it. Across most domains in medicine, practice has lagged behind knowledge by at least several years. The authors believe that the key tools for closing this gap will be information systems that provide decision support to users at the time they make decisions, which should result in improved quality of care. Furthermore, providers make many errors, and clinical decision support can be useful for finding and preventing such errors. Over the last eight years the authors have implemented and studied the impact of decision support across a broad array of domains and have found a number of common elements important to success. The goal of this report is to discuss these lessons learned in the interest of informing the efforts of others working to make the practice of evidence-based medicine a reality.

■ **J Am Med Inform Assoc.** 2003;10:523–530. DOI 10.1197/jamia.M1370.

Ten Commandments of CDS

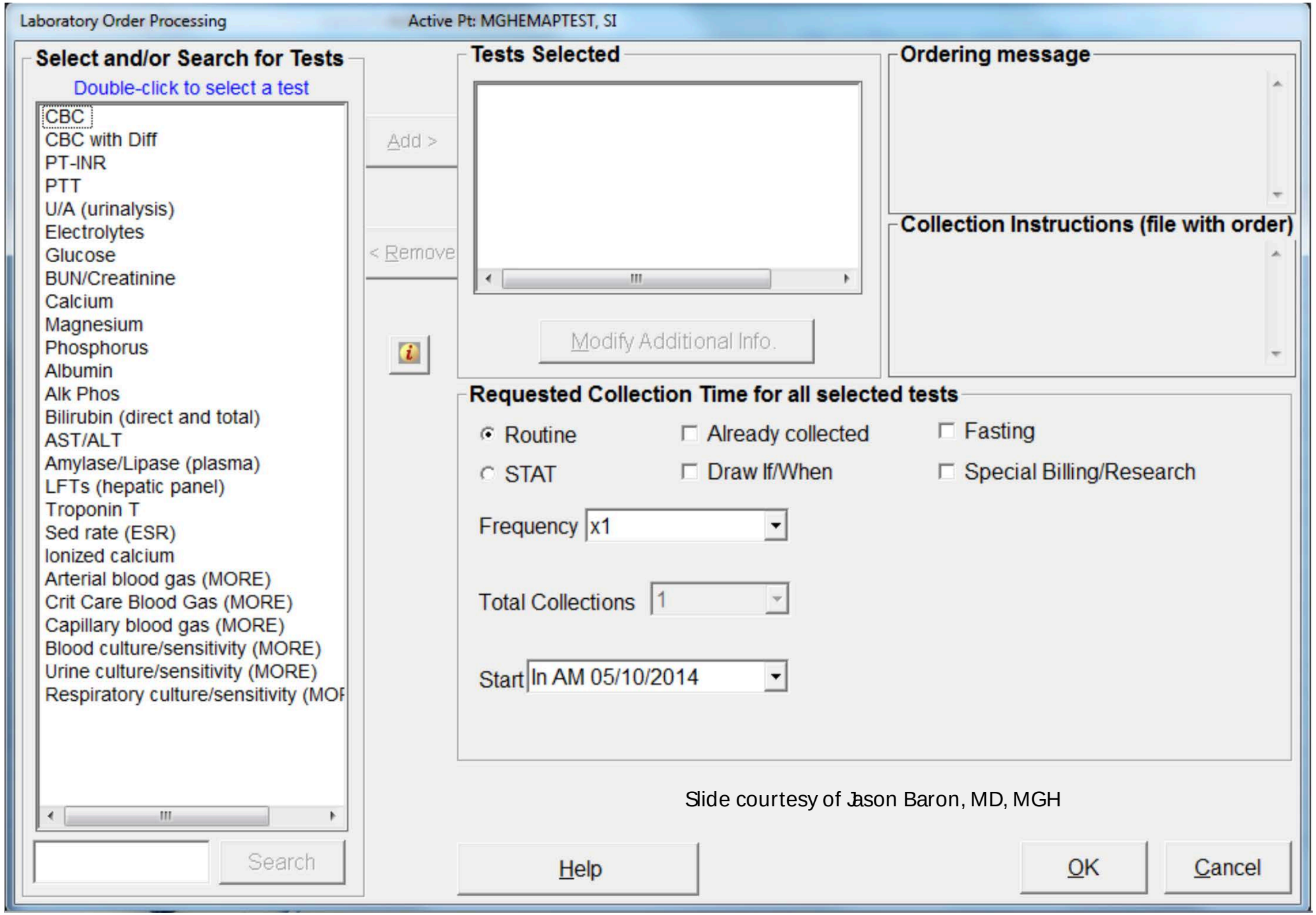
1. Speed is everything
2. Anticipate needs and deliver in real time
3. Fit into the user's workflow
4. Little things can make a big difference
5. Recognize that physicians will strongly resist stopping

Ten Commandments of CDS

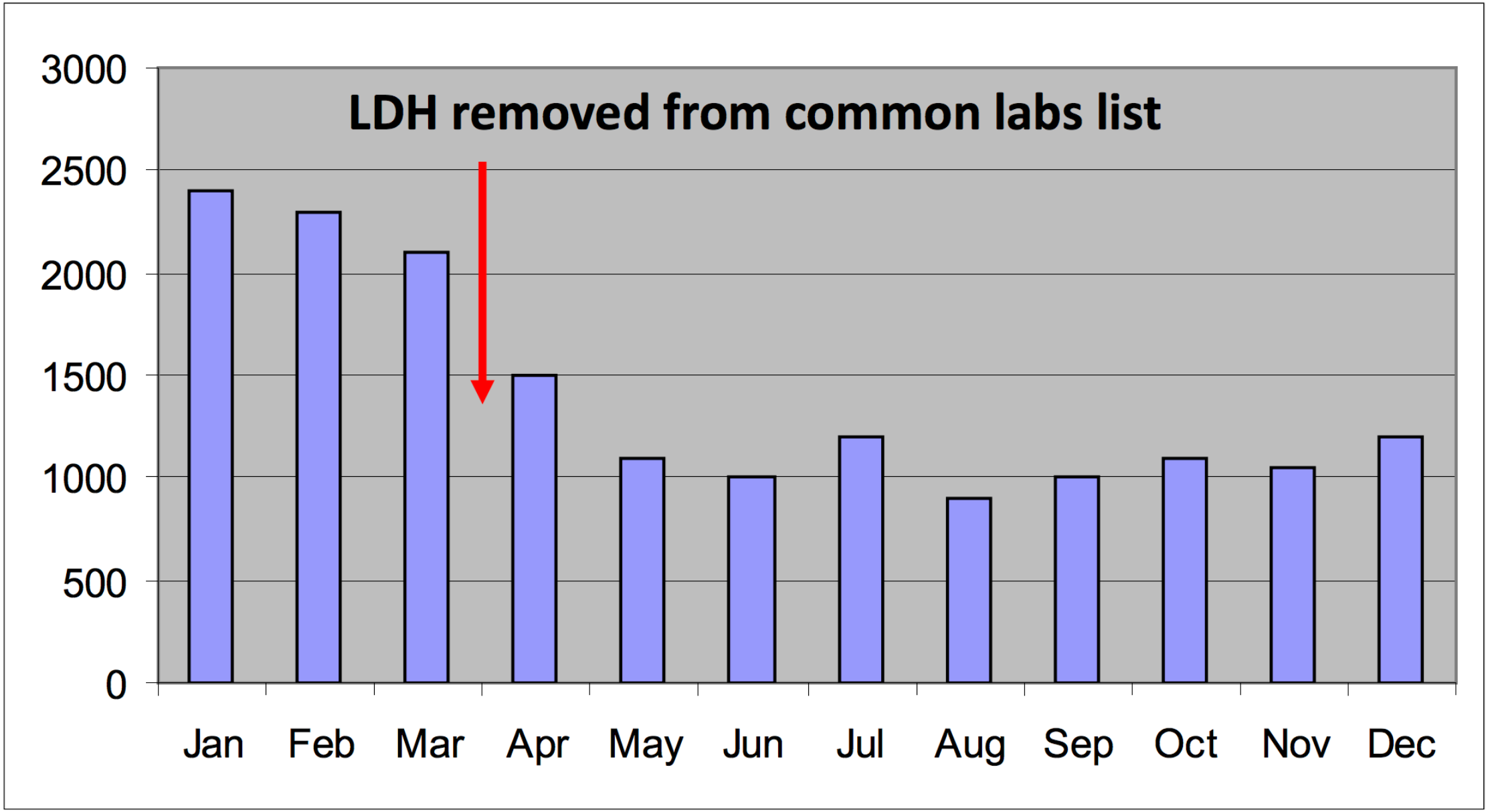
6. Changing direction is easier than stopping
7. Simple interventions work best
8. Ask for additional information only when you really need it
9. Monitor impact, get feedback, and respond
10. Manage and maintain your knowledge-based systems

Human Factors Engineering

- GOAL: Design systems to encourage a particular outcome
- Guiding principle:
  - Make it **easy to do the right thing** and **hard to the wrong thing**
- Examples
  - Contextually appropriate preference lists/pick lists
  - Orders only active for the services that use them (e.g. umbilical cord ABG orderable only for OB service, limit send outs to outpatient only)
  - Create a lab formulary



Slide courtesy of Jason Baron, MD, MGH



Slide courtesy of Anand Dighe, MD, PhD, and Jason Baron, MD, MGH

Use Case: CDS in Whole Slide Imaging

- Issue: Whole slide imaging, by itself, adds time and cost to the typical surgical pathology clinical workflow

- Potential solution: With a completely digital workflow (using WSI) , we can add value to the process, reduce turn-around-time, improve quality, and increase case volume to offset increased costs

CDS Tool #1

- Contextually driven workflow improvements
  - Use existing EMR and LIS data to identify contextually relevant data that aids in working up pathology cases
  - E.g. Part type = lung biopsy
    - Gather all relevant chest radiology (X-ray, CT, MRI)
    - Gather relevant prior surgical pathology cases (primary lung vs. metastatic secondary)
    - Gather relevant laboratory data, molecular data
    - Gather relevant clinical notes, op notes, etc.
- Can leverage tools from Radiology that perform similar functions

Leveraging Informatics Tools from Radiology

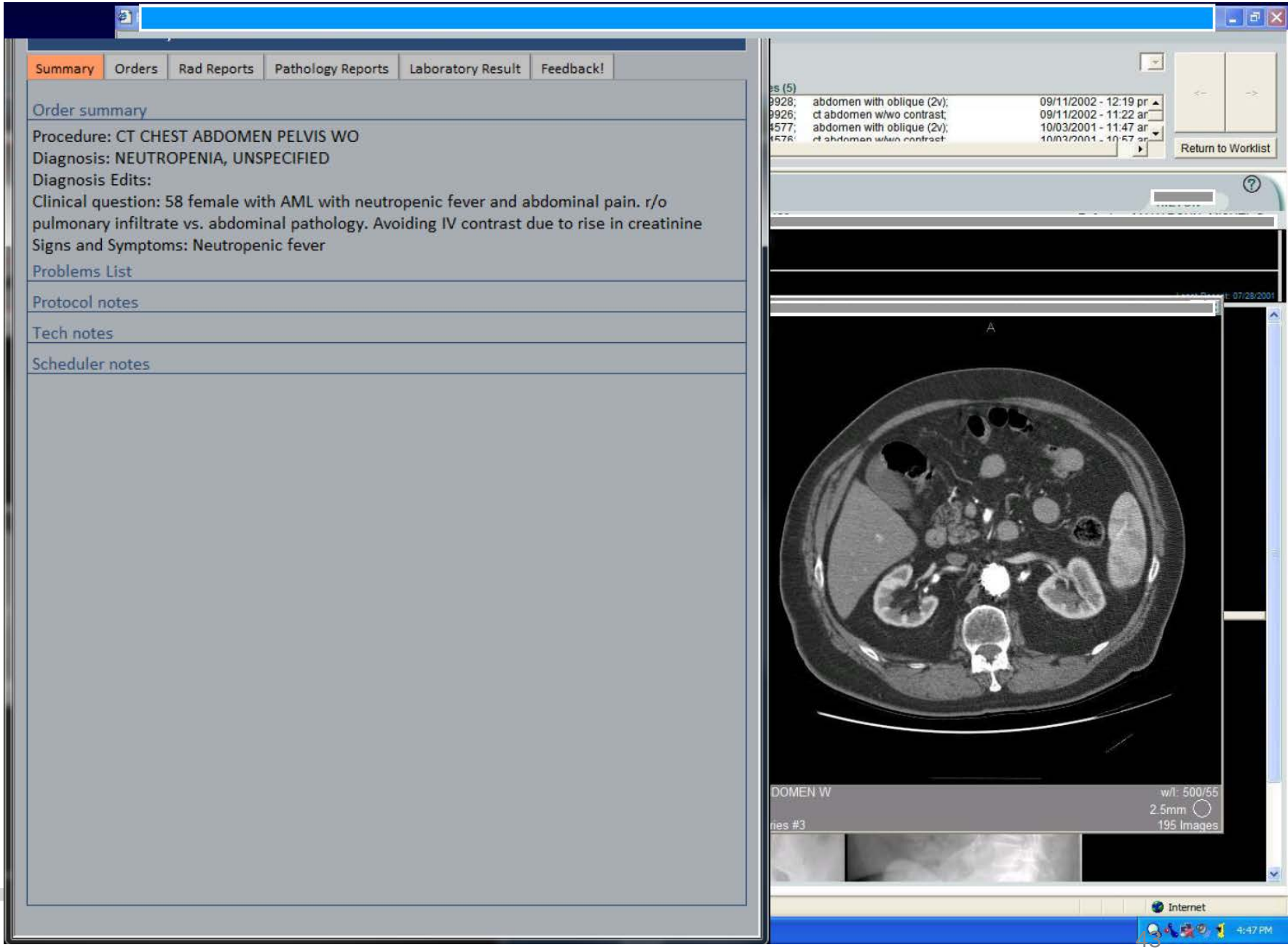


Image courtesy of Paul Chang, MD

Leveraging Informatics Tools from Radiology

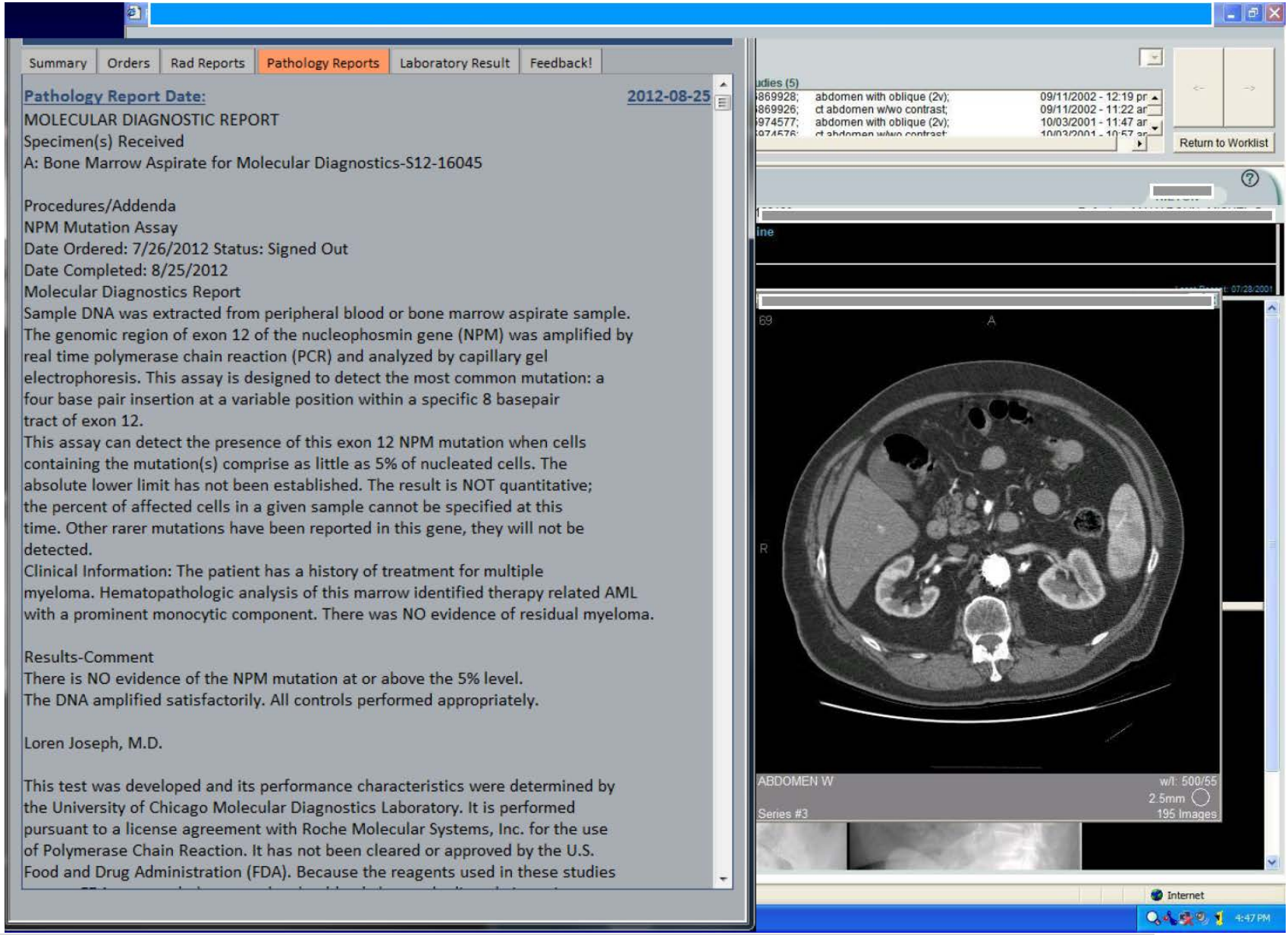


Image courtesy of Paul Chang, MD

Leveraging Informatics Tools from Radiology

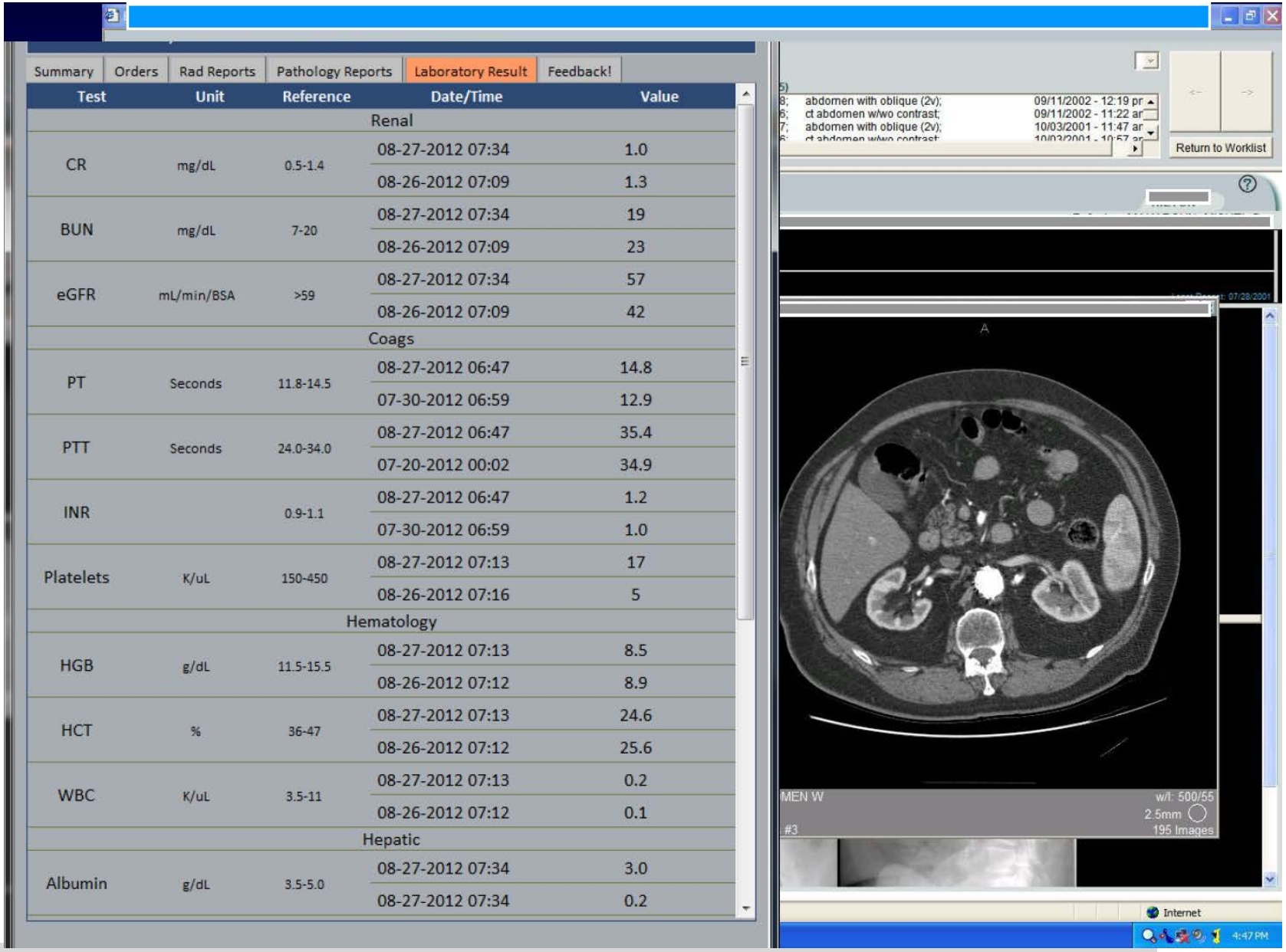


Image courtesy of Paul Chang, MD

CDS Tool #2

- Automating Image Analysis/Computational Pathology
  - Contextually driven prior to virtual slide delivery to the pathologist
- Example: Prostate biopsies
  1. Image Analysis to detect potential tumor
  2. If absent – prioritize and send to “negative for tumor” queue
     - Option – auto-verify and release negative result, similar to cytology and paps
  3. If present, perform:
     - Computational analysis to quantify tumor volume (if present)
     - Machine learning algorithms to estimate Gleason Grading
     - Order IHC on ”questionable” cases
     - Prefill relevant data into synoptic report
     - Prioritize cases for pathologist

A High Level View of Clinical Decision Support

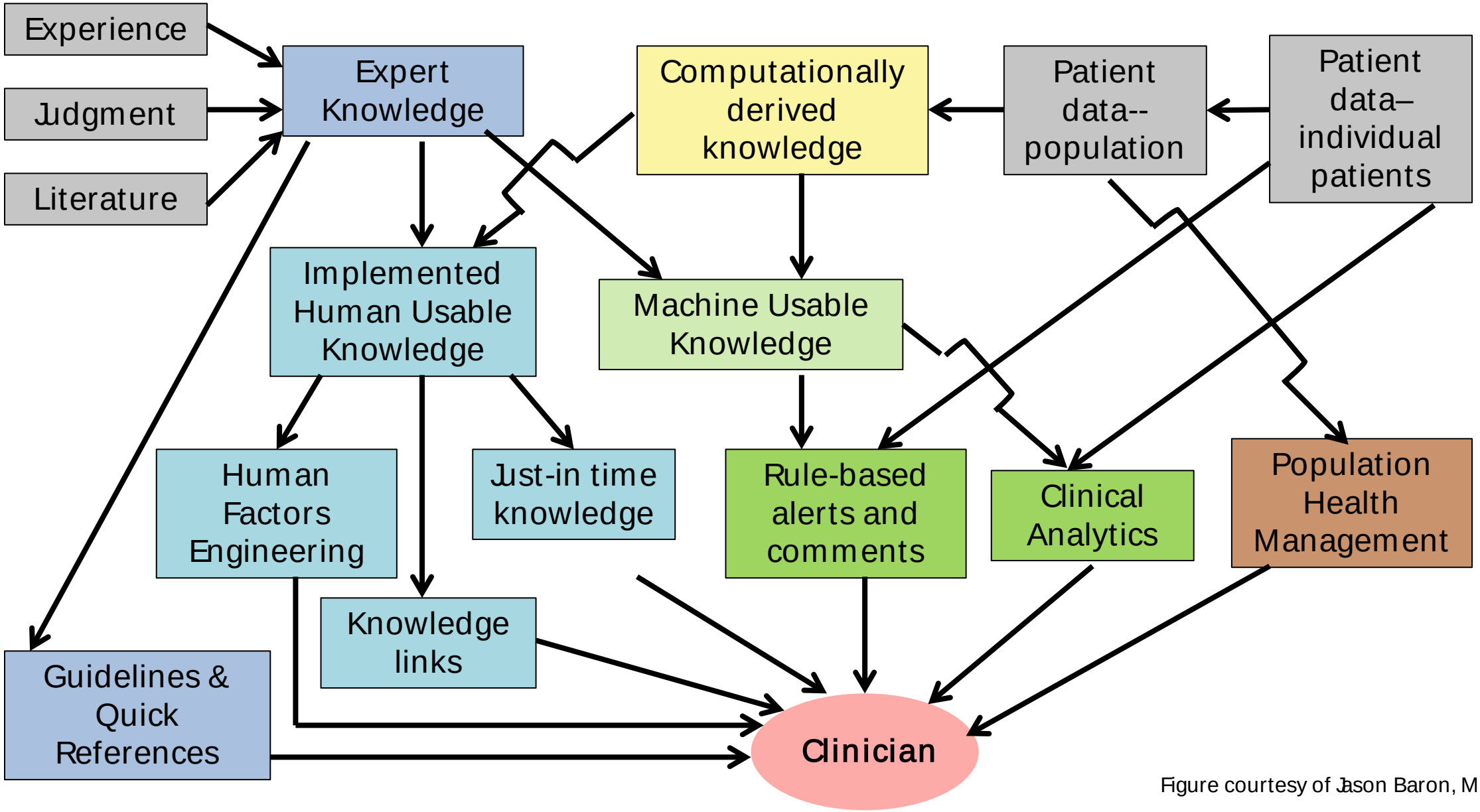


Figure courtesy of Jason Baron, MD

Summary – Clinical Decision Support

- Clinical decision support is only possible with the proper implementation and support of Clinical Informatics
- Goal of CDS is to AID the clinician/provider by providing patient or population specific knowledge to foster better health
- Proper implementation can be summarized by the 5 ”Rights” and the 10 Commandments of CDS

Questions??

Email david.mcclintock@uchospitals.edu