Stanford University

HIGH VALUE CARE CURRICULUM LABORATORY UTILIZATION

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Objectives

- Understand the lab ordering landscape: United States / Stanford
- Describe the difference between lab charge vs. lab cost
- Articulate opportunities for increasing value of lab ordering at Stanford
- Apply lessons learned from lab ordering interventions to increase value
Meta-analysis of inappropriate lab testing 1997-2012.

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<th>Test type/review</th>
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<td>Microbiology tests</td>
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- Lab testing 3-5% of health spending in US.
- 43% of expenditures on lab tests worldwide occurs in U.S.
- U.S. spends 5x as much as U.K. as percentage of medical expenditures

PLoS ONE 2013. e78962
PATIENT REASONS:
- Hospital-induced anemia
- Patient comfort / morbidity from repeated venipuncture

MEDICAL REASON:
- Follow-up clinically irrelevant abnormalities

ENVIRONMENTAL REASON:
- Biohazardous waste generation

Adapted from Tim Hamill, MD USCF
SMOLLER ET. AL NEJM 314, 1986;

- General Med: 1.1 draws/day; AVG: 12.4 mL/day, Total 175 mL for hospitalization
- ICU: 3.4 draws/day; AVG: 41.5 mL/day, Total 762 mL for hospitalization
- ICU w/Art Line: 4 draws per day; Total 944mL

LOW ET AL CHEST 108 (1): JUL 1995

- Presence of Art Line in ICU pts increased blood volume loss from phlebotomy by 44%!

Adapted from Tim Hamill, MD USCF
# Iatrogenic Anemia: Outcomes

## Hospital-Acquired Anemia: Prevalence, Outcomes, and Healthcare Implications

Colleen G. Koch, MD 12, *, Liang Li, PhD 1, Zhiyuan Sun, MS 1, Eric D. Hixson, PhD 4, Anne Tang, MS 3, Shannon C. Phillips, MD 2, Eugene H. Blackstone, MD 3, J. Michael Henderson, MD 3

<table>
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<td>Mild vs. none</td>
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*In-hospital mortality*

3x the mortality

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Adapted from Tim Hamill, MD USCF
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**Cost:**
- money needed to produce health care services for patients
- Fixed vs. Variable Costs
- Volume-based

**Charge:**
- amount that is billed to the customer in exchange for health service

Cost vs. Charges in Neonatal Care
Source: health.data.ny.gov
Fixed vs. Variable Costs

**Fixed Costs:**
- Equipment
- Direct Overhead Costs
- Indirect Overhead Costs (ex. Legal / accounting fees / malpractice / telephones / housekeeping)

**Variable Costs:**
- Labor (ex. Technicians and supervisors)
- Supplies

The chemistry laboratory. Development of average, fixed, and variable costs for incorporation into a management control system.
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88 M with Parkinson’s disease presents from assisted living to ED with 1 day of weakness, fever to 101F. +Diarrhea, chronic dysphagia

PMH: Hearing impaired, remote h/o prostate CA

Meds: ASA, Sinemet, Aricept

PEX: T102, HR 110, Bp 106/83, RR 17
    A+Ox2-3 (baseline)
    +crackles on LLL

What Labs Will You Get?
Case 1

- CBC w/ diff -> WBC 19.3 w/ 86% PMN
- CMP -> Cre 1.2 (unknown baseline)
- VBG
- UA
- Blood cultures
- C. diff -> Positive

**Plan:**
- ?CAP vs. C. diff colitis -> Moxi, Flagyl
- ?Acute Kidney Injury -> Fluids
- Patient improves clinically by HD2

Are daily labs needed? If so, which?
## Case 1

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**# AKI:** Cr on admission 1.2, unknown baseline. Given sepsis and poor po intake, likely prerenal. Corrected with fluids.

- Daily BMP
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</tbody>
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“(5) Do not perform repetitive complete blood count and chemistry testing in the face of clinical and lab stability.”
**BEST PRACTICE ALERTS REDUCED CMP ORDERING BY 67%**

**INTERVENTION:**
- Electronic reminders for redundant test ordering (CMP, UA, urine/stool cultures, etc.)
- If test previously ordered within 20 hours, physician received reminder that test had been performed recently or was pending, result was given if available (with option to override)

**RESULTS:**
- Overall: 69% of tests canceled in response to reminders
- CMP: 67% decrease in CMP test volume
- Adverse effects on patient care: determined whether a canceled test was followed within 3 days by an abnormal test result
  - 53% were followed by repeat test within 72 hours, 24% of these were abnormal

Brigham and Women’s Hospital Am J Med. 1999;106:144-150
Do not order recurrent BMP/CMP or CBC in the setting of clinical stability
HPI: 53 Y female with HTN, T2DM with neuropathy, ESRD on HD MWF who presents with left eye redness, swelling, pain, and decreased vision x6 weeks. CTH from OSH showed L sinus mass.

MEDS: Atorvastatin, Dilaudid, Fentanyl patch, Plavix, Insulin, Sevelamer, Hydralazine, Isosorbide

PEX: R eye NL; L eye dilated 5 mm, nonreactive to light and accommodation. EOM NOT intact pt unable to move eye, blinks to threat. Dialysis cath R groin intact. Exam o/w nl.

What labs?
Case 2

- CBC w/ diff -> WBC 10.5, Hgb 9.9, plt 290
- CMP: Na 134, K 3.4, Cl 98, HcO3 26, BUN 18, Cr 2.5
- Lytes: Ca 8.5, Phos 4.3. Mg not checked.
- Blood cultures

PLAN:
- ? Mass is infectious vs malignant vs autoimmune
- Needs dialysis for ESRD
- MRI ordered
- Nephrology, optho, ENT consulted

What daily labs will you order?
Because pt has ESRD: Nephrology consult note says…

# Metabolic Bone Disease: ca/phos controlled on last check. Continue binders if eating, may need to start holding if phos drops (query patient appetite). Would recommend checking phos q week while inpatient.
Hospital day 10: K drops to 3.1 so we check mag & phos
But then we keep checking...and checking...and checking
......Even though K is stable
This patient was hospitalized for 60 days. Mag was checked 60 times. Phos was check 49 times. Mag & phos repletion was given 7 times.
Why check Mag/ Phos?
Case 2

**Hypomagnesemia Clinical Manifestations Seen @ <1mg/dl**

- Neuromuscular: tremor, tetany, convulsions, weakness
- Cardiovascular: widening of the QRS and peaking of T waves, widening of the PR interval, diminution of T waves, arrhythmia
- Electrolyte metabolism: hypocalcemia & hypokalemia

- Intracellular ATP levels fall
- Metabolic encephalopathy, paraesthesias, seizures
- Skeletal muscle weakness
- Hemolysis
- Bone disease
Mag/Phos

What about arrhythmia?

The data is not very good. Studies from the 1980’s
Confounders like hypokalemia

Early administration of intravenous magnesium to high-risk patients with acute myocardial infarction in the Magnesium in Coronaries (MAGIC) Trial: a randomised controlled trial

Hypomagnesemia in heart failure with ventricular arrhythmias. Beneficial effects of magnesium supplementation

L. Ceremuzynski, J. Gebalska, R. Wolk, E. Makowska
From the Klinika Kardiologii CMKP, Szpital Grochowski, Warszawa, Poland

Some shows no effect
Or limited to specific Populations like CHF
RESULTS:

- 1,477 had Ca, Mg or PO4 checked in ER
- 260 had abnormal value +/- 15% of nl reference range
- 5 patients received tx of abnormal values
- Only patients who had clinically significant treatment were:
  - Diabetic patients
  - Alcoholic patients
  - Renal Failure

TAKE HOME:
Most Mg, Ca and Phos checks don’t result in tx and are of little clinical utility

Brigham and Women’s Hospital Am J Med. 1999;106:144-150
**Mag/Phos**

**DO NOT ORDER RECURRENT MAGNESIUM & PHOSPHOROUS**
IN STABLE PATIENTS WITHOUT CLINICAL INDICATION

**Admission Mg/Phos**
- DKA
- ETOH Abuse
- Starvation
- Hypokalemia
- Hypocalcemia
- Concern for TLS
- Seizures
- EKG abnormalities/arrhythmia
- Chovstek/Trousseau sign
- Ingestion of Mg
- Hyporeflexia

**Recurrent Mag/Phos**
- Continuation of sx’s and/or management of admission sx’s
- Recurrent hypokalemia
- Dialysis patient (Weekly?)
- Arrhythmia (controversial)
- RTA
- Diuresis

**Appropriate clinical indications include…**
Mag/Phos

**Take Home Point**

- Checking/Treating of Mag/Phos of little clinical utility in majority of medicine admissions
- Only check Mag/Phos in specific clinical situations which may have clinical relevance
Calcium

TAKE HOME POINT

- When to check calcium? (Part of standard BMP at Stanford): Tetany, Chovstek sign, Seizure, QT prolongation, low magnesium

- When to check Ionized Calcium: Almost never since corrected calcium is just as good

Calcium Correction for Hypoalbuminemia
Calculates a corrected calcium level for patients with hypoalbuminemia.

<table>
<thead>
<tr>
<th>Calcium</th>
<th>mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>g/dL</td>
</tr>
<tr>
<td>Normal Albumin</td>
<td>4</td>
</tr>
</tbody>
</table>
A. Early myoglobin or CK-MB w/AMI
B. Troponin w/AMI
C. Peak Myoglobin or CK-MB after AMI
D. Peak Troponin in unstable angina
Troponin is more sensitive and specific at all time points.

Cumulative sensitivity of Cardiac Biomarkers by Time Point

When to use CK-MB: Possibly never.

For further reading

Uptodate: “Troponins and creatine kinase as biomarkers of cardiac injury”
Objectives

- Understand the lab ordering landscape: United States / Stanford
- Describe the difference between lab charge vs. lab cost
- Articulate opportunities for increasing value of lab ordering at Stanford
- Apply lessons learned from lab ordering interventions to increase value
Past Incentives

1. Reference lab cost/TAT transparency
2. Hospitalists discussion on attending rounds.
3. Micro lab to reduce inappropriate c diff ordering.
4. Removing qday orders from all order sets
5. Removing ck mb from medicine order sets
6. ICU to decrease daily CXR
Solutions

- Avoid ordering repeat CBC/BMP panels if recurrently stable labs
- Avoid CBC with Diff and CMP if not needed
- Mag/Phos of little clinical utility outside specific situations and should not be routinely checked
- Ionized calcium should not be checked
- CK-MB of no/little clinical utility
Thank You!

- All members of the Resident Research Project.
- Iris Ma for contributing her slides!
- Lab test ordering team

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Taulant Consultant
Ida Consultant
Trishna Project Manager