Using Clinical Pathology Expertise to Engage Physicians and Develop More Sophisticated Reflex Testing Guidelines that Contribute to Better Patient Care

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Overview

- Introduction
  - Setting
  - Perspective
- Applications
  - Urine Screen
  - Pre-Op Anemia Screen
  - Transfusion Medicine
- Questions
Setting

- Tertiary Care Medical center
  - 551 beds
  - Cancer Center
  - Medical School
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Background/Perspective

- Need: Law of 7 (4?)
- Opportunity: Expanding Use of HER
- Increasing Cost/Complexity of Healthcare System
- Move to Value based payments
NOTES: EHR is electronic health record. "Any EHR system" is a medical or health record system that is either all or partially electronic (excluding systems solely for billing). Data for 2001–2007 are from in-person National Ambulatory Medical Care Survey (NAMCS) interviews. Data for 2008–2010 are from combined files (in-person NAMCS and mail survey). Estimates for 2011–2013 data are based on the mail survey only. Estimates for a basic system prior to 2006 could not be computed because some items were not collected in the survey. Data include nonfederal, office-based physicians and exclude radiologists, anesthesiologists, and pathologists.
Background/Perspective

Your New Health Care System

Secretary
Health & Human Services

NEW GOVERNMENT

Expanded Government

Private

New Relationships

PennState Hershey
Milton S. Hershey Medical Center

PennState Hershey
College of Medicine
$765 Billion Dollars in Health Care Waste

- Unnecessary Services: $210 B
- Inefficient Delivery of Care: $190 B
- Excessive Administrative Costs: $130 B
- Inflated Prices: $105 B
- Fraud: $75 B
- Prevention Failures: $55 B

Background/Perspective

POPULATION HEALTH ANALYTICS

- Observe & Optimize
- Integrate & Prepare Data
- Assess & Report Performance Across the Continuum
- Define Cohorts & Identify Gaps in Care
- Engage Patients & Coordinate Care
- Improve Care Delivery Performance
- Design Interventions & Programs
- Assess Risks & Profile Patients

SAS Center for Health Analytics and Insights: Population Health Wheel
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Applications

Three examples out of many:

✧ Urine Culture Screening
  ◆ Minimal IT resource
  ◆ Utilization
  ◆ Patient outcome

✧ Pre-op Anemia Screen
  ◆ Moderate IT resource
  ◆ Care delivery
  ◆ Portable medical home-linearization
  ◆ P4P

✧ Transfusion in hemodynamically stable patients
  ◆ Significant IT resource
  ◆ Utilization
  ◆ Education
  ◆ Competency
  ◆ Peer to peer comparisons
  ◆ P4P
Identified a gap between our current practice and best practice

- Discrete micro interface
- ~33,000 Urine cultures with microscopic/year (72% negative culture rate)
- Manual method for Urine microscopic analysis
- Urine screening every admission
Automated urine particle analyzer

- Fully automated sample preparation (mixing, aspirating, diluting, staining)
- Characterization by forward scatter, fluorescence and cluster analysis
- Adaptable auto-verification and flagging

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Urine Screen-Study Design

Urine Specimen

UF-1000i™ Screen

Resolve: WBC and RBC

Culture Results: Positive, NG, Contamination

Correlate and select screening parameters
## Urine Screen Data Review – Adults

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique urine specimens, adults</td>
<td>4088</td>
</tr>
<tr>
<td>Specimens with positive WBC and Bacteria</td>
<td>2736</td>
</tr>
<tr>
<td>Specimens with negative WBC and Bacteria</td>
<td>1215</td>
</tr>
<tr>
<td>Any positive cultures on specimens with negative WBC and Bacteria</td>
<td>55</td>
</tr>
<tr>
<td>Positive cultures (≥ 100K CFU) on specimens with negative WBC and Bacteria</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prediction Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Predictive Value (any positive culture)</td>
<td>95.5%</td>
</tr>
<tr>
<td>Negative Predictive Value (≥ 100K CFU)</td>
<td>99.3%</td>
</tr>
<tr>
<td>Estimated reduction</td>
<td>30%</td>
</tr>
</tbody>
</table>
Urine Screen ROC Curve-Adults

Test1

Sensitivity: 98.0
Specificity: 93.7
Criterion: >0
<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique urine specimens, patients &lt; 18 years old</td>
<td>373</td>
</tr>
<tr>
<td>Specimens with positive WBC and Bacteria</td>
<td>269</td>
</tr>
<tr>
<td>Specimens with negative WBC and Bacteria</td>
<td>104</td>
</tr>
<tr>
<td>Any positive cultures on specimens with negative WBC and Bacteria</td>
<td>5</td>
</tr>
<tr>
<td>Positive cultures ($\geq 100K$ CFU) on specimens with negative WBC and Bacteria</td>
<td>0</td>
</tr>
</tbody>
</table>

**Negative Predictive Value (any positive culture)**: 95.2%

**Negative Predictive Value ($\geq 100K$ CFU)**: 100%

**Estimated reduction**: 28%
Urine Screen ROC Curve-Pediatrics

Diagnosis

Sensitivity: 100.0
Specificity: 95.4
Criterion: >0
Among the adult patients, screen performance revealed: a sensitivity of 98% (CI 97.4-98.4%), a specificity of 93.7% (CI 92.1-94.9%) and a negative predictive value (NPV) of 95.5% (CI 94.3%-96.6%).

Similar data was obtained for the pediatric population (269 true positive, 99 true negatives, 5 false positives, 0 false negatives, and a NPV of 95.1%).
Urine Screen with Reflex Culture

Old Work Flow
- Urine Culture

New Work Flow
- Urine Microscopic Analysis
  - Negative (-)
    - No Urine Culture
  - Positive (+)
    - Urine Culture
UF-1000™ Changes in Workflow

- ~33,000 Urine cultures with microscopics/year (72% negative culture rate)
- Tech FTEs: 0.8-1.2 FTEs for reallocation
- Decrease TT by 3-5 minutes
- Decrease between tech variability
Empiric antimicrobial use for a presumed urinary tract infection exposes patients to therapy for up to 48 hours prior to a negative culture result.

To develop a predictive urine screen and examine the cost effectiveness of this model in reducing antibiotic use.
Among the adult patients, screen performance revealed: a sensitivity of 98% (CI 97.4-98.4%), a specificity of 93.7% (CI 92.1-94.9%) and a negative predictive value (NPV) of 95.5% (CI 94.3%-96.6%).

Similar data was obtained for the pediatric population (269 true positive, 99 true negatives, 5 false positives, 0 false negatives, and a NPV of 95.1%).

Given our annualized volume this represents a reduction in 9,990 urine culture tests per year; accounting for a savings of 19,980 patient days in saved exposure.

Estimated antimicrobial material savings range from $11,088-889,000.
Catheter-associated urinary tract infections or CAUTI represents a significant problem among healthcare professionals.

A large number of UTI’s that occur after a patient is admitted to a hospital; result from instrumentation such as urinary catheters.

Long term complications of CAUTI include longer hospital stays, patient discomfort and increased mortality/morbidity secondary to disseminated infections both locally and systemically.
We examined a case series of CAUTI and SUTI (symptomatic or non-catheter associated) patients to model the likelihood of a positive screen prior to the diagnosis of a UTI by culture.
Using data mining, we identified 81 patients with either CAUTI (26) or SUTI (55) based on traditional urine culture.

We then compared the likelihood that a patient in either group would have a positive screen.
Among the CAUTI patients, 100% had a positive screen on the UF-1000i™ and 90.9% of the SUTI patients had a positive screen.

Using the original data (see Part 1), the positive LR is 15.5 (CI 12.57-19.12).
The UF-1000i™ particle analyzer shows a high PPV and a high LR.

Using a retrospective case series analysis, we confirm these values with a 93% positive screen among culture positive patients.

This will allow clinicians to feel confident in accurately interpreting a screen result and treat patients before waiting 24-48 hours for culture results.
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Pay for Performance Target
Sporadic Care (Linearization, Laminar flow)
Multiple Engagements with Failure Points
# Pre-op Anemia Current Process

## Check Complete Blood Count (CBC)
(should be done minimum of 3 months prior to planned procedure)

A detailed history, physical exam and medication history are the most important tools in evaluating a patient with anemia. Always clinically evaluate potential cause of anemia (see below).

<table>
<thead>
<tr>
<th>Female Hgb &gt;12</th>
<th>Female Hgb 11-11.9</th>
<th>Male Hgb &lt;11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Hgb &gt;13</td>
<td>Male 12-12.9</td>
<td>Male Hgb &lt;12</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>or Abnormal WBC or Platelet counts</td>
</tr>
</tbody>
</table>

- Proceed with surgery without further evaluation
- **Check MCV (mean corpuscular volume)**
  - MCV<81 (microcytic)
  - MCH <28 (hypochromic)
  - Probable Iron Deficiency.
  - Evaluate for clinical source of bleeding (i.e. GI, GU or Gynecologic) or conditions of decreased iron absorption.
  - Check Ferritin, Serum Iron & TIBC.
  - If Ferritin <12 or iron saturation <20%, treat with Ferrous sulfate 325mgpo bid to tid for 2-3 months and evaluate source of probable bleed.
  - If no correction with iron, contact x7710 to schedule Hematology appointment.

- **Check MHC (Mean Hemoglobin Concentration)**
  - MCV 81-96 (normocytic)
  - MCH >28 (normochromic)
  - Probable Anemia of Chronic/Inflammatory Disease
  - Evaluate for associated chronic diseases (i.e. Diabetes, Cardiac Disease, Chronic Kidney Disease, Active Rheumatologic Disease, Cancer, etc.)
  - Treat underlying cause, if possible.
  - If no obvious correctable cause for anemia, contact x7710 to schedule Hematology appointment.

- **MCV >97 (macrocytic)**
  - MCH >28 (normochromic)
  - Consider B12 deficiency, Folate Deficiency, Liver or Thyroid Dysfunction, hemolytic anemia, Myelodysplastic Syndrome
  - Check Reticulocyte counts, B12 level, Folate levels, TSH, Liver Function tests.
  - Contact x7710 to schedule Hematology appointment for further evaluation.
A detailed history, physical exam and medication history are the most important tools in evaluating a patient with anemia. Always clinically evaluate potential cause of anemia (see below).

**Check MCV (mean corpuscular volume)**
- MCV<81 (microcytic)
- MCH <28 (hypochromic)
  - Reflex Ferritin, Serum Iron & TIBC.
  - If Ferritin <12 or Iron saturation <20%, treat with Ferrous sulfate 325mg po bid to tid for 2-3 months and evaluate source of probable bleed.
  - If no correction with iron, contact x7710 to schedule Hematology appointment

- MCV 81-96 (normocytic)
- MCH >28 (normochromic)
  - Probable Anemia of Chronic/Inflammatory Disease
  - Evaluate for associated chronic diseases (i.e. Diabetes, Cardiac Disease, Chronic Kidney Disease, Active Rheumatologic Disease, Cancer, etc.)
  - Contact x7710 to schedule Hematology appointment for further evaluation

- MCV >97 (macrocytic)
- MCH >28 (normochromic)
  - Reflex Reticulocyte counts, B12 level, folate levels, TSH, Liver Function tests
  - Treat underlying cause, if possible.

**Female Hgb 11-11.9**
- Male 12-12.9

- Female Hgb <11
- Male Hgb <12 or Abnormal WBC or Platelet counts

**Proceed with surgery without further evaluation**

**Contact x7710 to schedule Hematology appointment for Orthopaedic patient in need of major surgery**
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Transfusion Therapy

- Current Practice
- Evidence-Based Guidelines
- Quality Improvement
  - Education
  - Order Entry
  - Feedback
~68% of red cells were ordered when the most recent Hgb ≥ 8 g/dL

~18% of red cells were ordered when the most recent Hgb ≥ 10 g/dL

~40% of platelets were ordered when the most recent Plt ≥ 100 K/ul

~27% of platelets were ordered when the most recent Plt ≥ 150 K/ul
Most Recent Hgb Prior To Transfusion

- Hgb<8
- Hgb≥8

- Hgb<7
- 7 ≥ Hgb < 8
- 8 > Hgb < 9
- 9 > Hgb < 10
- Hgb > 10

Hgb prior to Transfusion (mg/dL)
Most Recent Hgb Prior To Transfusion

Plt≤20

Plt≥100

- Plt < 10
- 20 ≥ Plt < 10
- 50 ≥ Plt < 20
- 100 ≥ Plt < 50
- 100 ≥ Plt < 150
- Plt > 150

Plt prior to Transfusion (K/uL)
Recommendation 1: The AABB recommends adhering to a restrictive transfusion strategy (7 to 8 g/dL) in hospitalized, stable patients (Grade: strong recommendation; high-quality evidence).

Recommendation 2: The AABB suggests adhering to a restrictive strategy in hospitalized patients with preexisting cardiovascular disease and considering transfusion for patients with symptoms or a hemoglobin level of 8 g/dL or less (Grade: weak recommendation; moderate-quality evidence).
Expert consensus – based on strong evidence – indicates that historical transfusion practices are excessive.

The transfusion guidelines taught in medical school and residency in years past are not optimal.

Our EMR orders display HMC transfusion guidelines.

Use your clinical judgment always, but consider these guidelines. They reflect thoughtful, broadly endorsed, recommendations.
Order for RBC Transfusion

1. Component:
   - One unit of RBCs is expected to increase Hgb by approximately 1 g/dL or Hct by 3%
   - Evidence does not support transfusion in patients:
     - with Hgb greater than 0.8 g/dL
     - with Hgb greater than 10.0 g/dL in patients with acute coronary syndrome.

2. Details for Transfuse Red Cells:
   - All units are leukoreduced. Any special requests will require a Pathologist Consult.

3. Indications:
   - Acute ACTIV bleeding
   - Hgb < 8.0 g/dL, (hemodynamically stable)
   - Other - describe in Special Instructions
Order for RBC Transfusion

Details for Transfuse Red Cells.

- ABO/Rh: 0 POSITIVE
- Antibody Scr: NEGATIVE
- Expires at 0600AM on: 12/28/2012
- Hgb: 9.9, 9.3

It is the physician's responsibility...

- Product: Red Cells
- *Specify units or mls:
- *Start date/time: 12/11/2012 17:26
- Indication: Hgb < 10.0 g/dL (Coronary Syndrome)
- Duration:
  - Hgb < 10.0 g/dL (post CT surgery)
  - Hgb < 8.0 g/dL (hemodynamically stable)
  - Acute, ACTIVE bleeding
  - Heme/Onc patient with standing order
  - Other - describe in Special Instructions
HMC Transfusion Practices Trending in Right Direction

Patient population
- Inpatients, at least 18 years old
- Excluding all massive transfusions

Hgb targets used as markers for compliance with HMC guidelines
- \( \leq 8 \text{ g/dL} \) for non-surgical patients
- \( \leq 10 \text{ g/dL} \) for surgical patients in the first 24 hours post-op

<table>
<thead>
<tr>
<th>Timing relative to EMR intervention</th>
<th>RBC Transfusions per Admission</th>
<th>% Transfusions falling within Hgb targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year immediately prior to intervention</td>
<td>0.59</td>
<td>55 %</td>
</tr>
<tr>
<td>Year immediately following intervention</td>
<td>0.53</td>
<td>64 %</td>
</tr>
</tbody>
</table>
For the first year following the EMR intervention, was the stated **Indication for transfusion** consistent with the available lab values?

<table>
<thead>
<tr>
<th>Indication for RBC Transfusion</th>
<th>Most recent Hgb prior to order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agreed</td>
</tr>
<tr>
<td>Hgb &lt; 8.0 g/dL (hemodynamically stable)</td>
<td>90%</td>
</tr>
<tr>
<td>Hgb &lt; 10.0 g/dL (Coronary Syndrome) (post CT surgery)</td>
<td>80%</td>
</tr>
</tbody>
</table>
Joint effort
- Clinical Laboratories
- Center for Quality Innovation
- Institute for Personalized Medicine
- Faculty and staff from multiple departments

Three examples out of many:
- Urine Culture Screening (minimal resource: utilization, patient outcome)
- Pre-op Anemia Screen (moderate resource: care delivery, portable medical home, linearization, P4P)
- Transfusion in hemodynamically stable patients (significant resource: utilization, education, competency, peer to peer comparisons, P4P)
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