Introduction to Laboratory Medicine

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What pathologists do: (clinically)

We receive any tissue or fluid sample (from an FNA to a whole patient) and use any method (from gross visualization to DNA sequencing) to either make a diagnosis or provide a clinician with diagnostically or prognostically relevant information.

Tests per year (at CUMC):

Total: 4,900,000

“Anatomic pathology”:
- Autopsy: 270
- Surgical pathology: 59,000
- Cytopathology: 60,000

Tests per year (at CUMC):

Total: 4,900,000

“Laboratory medicine”: 4,800,000

Microbiology
Molec. Diagnosis
Coagulation
Cytogenetics
Hematology
Immunogenetics

Clinical chemistry
Transfusion medicine
Toxicology
Immunology
Flow cytometry
Informatics

Anatomic Pathology vs. Lab Medicine

Hematopathology:
Diagnosis of APL
- Clinical history
- CBC and smear
- Bone marrow aspirate
- Cytochemistry and IHC
- Bone marrow core biopsy
- Molecular Dx: PCR for t15-17
- Cytogenetics: FISH for t15-17
- Flow cytometry

Morphology:
- gross, light microscopy, special stains, immunofluorescence, EM

Quantitative and qualitative Analytical methods
Border skirmishes:
- Dermatopathology
- Bone marrow aspirates
- Oral pathology
- Genetic testing
- Microbiology
- Muscle and nerve biopsies
- Tissue typing

What pathologists do: (research)
Develop molecular, mechanistic understanding of how the pathogenesis of a disease leads to morphological changes and clinical consequences.
The goal is for this increased understanding to suggest new diagnostic approaches and new treatment regimens.

The cycle of laboratory testing

Idea
Order/Request
Collect
Transport
Receive
Accession
Analyze: prepare, perform, verify
Report
Assimilate
Control

Order/Request
Paper: formal requisition, prescription, FAX
Computerized physician order entry (CPOE)
Verbal: Phone call, yelling, etc.
Documentation:
- ordering physician
- ordering location, phone #, etc.
- signatures
Errors:
- wrong requisition
- wrong box checked
- requisition discarded

Idea
What test?
Why?
Necessity?
Turn-around-time (TAT):
- Seconds (Glucose POCT)
- Minutes (STAT BMET)
- Hours (Routine ELISA)
- Days (Blood culture)
- Weeks (TB susceptibilities)
How good is it? Sensitivity/Specificity
Collect
Phlebotomy:
Venous
Finger stick
Arterial
Central line
Pediatric
Urine
CSF
Sputum, wound, oral, eye, etc.
Tissue: bone marrow, lung biopsy, etc.
Temperature: RT, 4°C, 37°C, frozen

Potential errors: mislabeling

The Washington Post
“Patient Dies From Blood Mismatch”
Friday, August 29, 2003
A woman who switched beds to be closer to the window died after she was given the wrong type of blood during surgery at Inova Fairfax Hospital. A technician had taken a blood sample from her roommate, hospital officials confirmed this week. The death came at the end of a chain of events that began when a technician went to the unidentified patient's room to draw blood so the laboratory could determine her blood type for an operation the next day.

Potential errors: mislabeling
But the technician collected the sample from the patient on the wrong side of the curtain in the semiprivate room. The technician may have failed to perform two identification screens that were required: checking the name on the patient's plastic hospital bracelet and asking the patient to state her name aloud, said Russell Seneca, chairman of surgery at the hospital.

"The technician doesn't recall whether she asked the patient her name or not or whether she checked the armband," Seneca said. "I'm not certain what transpired between the technician and the patient whose blood was drawn."

Potential errors: mislabeling
The next day, surgeons performed a bowel resection on the woman, removing an abscess in her colon that perforated an intestinal wall.

The woman received two pints of the wrong blood during the operation, and toward the end, it became apparent that her blood was not clotting properly. In the recovery room, she plunged into an acute hemolytic transfusion reaction.

The medical team tried numerous treatments to reverse the reaction, but the woman died about 5:30 a.m. on July 24.

Potential errors: mislabeling
Saunders said an internal probe has prompted changes; a second person now accompanies a technician to draw blood for cross-matching and typing to guard against misidentification.

"This was a human error," Saunders said. "This individual who made the error failed to follow our procedures for identification."

The worker, who also was unidentified, was so distraught that she resigned, Saunders said. "Because of the grief ... we want to protect her privacy. We would prefer to just let you know this was an exemplary employee who never had a problem like this before."

Potential errors: mislabeling
Transport
Sneakers
Pneumatic tubes
Point-of-care (POC)
Taxi, van, courier, etc.
FedEx, DHL, etc.
Receive
Acknowledge receipt:
   Verbal
   Computer
   Pen
   Wand bar code
Read
Talk
Empty bench

Accession
Automated: bar code
Computerized
Pen and paper

Analyze: prepare, perform, verify
Visually inspect: hemolysis, lipemia, etc.
Chemical analysis: spectrophotometry, etc.
Imunoassays: ELISA, agglutination, flow cytometry, etc.
Microscopy: blood smear, gram stain, FISH, etc.
Culture: bacteria, fungi, viruses, fibroblasts
Molecular: Southern blots, PCR, sequencing, etc.
Controls: positive/negative, high/low
Quality assurance: within-run and between-run variation
Proficiency testing: NYS, CAP

Report
To whom?
   Ordering MD
   Primary care MD?
   Consultants?
   Floor?
   Paper: mail, FAX, FedEx, etc.
   Hospital/Laboratory Information System (HIS/LIS)
   Email
   Phone: critical values
   Blackberry, etc.

Assimilate
When?
How use the information?
Is it correct? Does it fit?
Repeat for confirmation?
Alternative tests for confirmation?
Accession
Analyze: prepare, perform, verify
Report

Control:
   efficiency, timeliness, productivity, cost containment
   Idea: education
   Order/Request: algorithms, repeat testing
   Collect: who, time of collection, training
   Transport: who, how, timing
   Receive: timing
   Accession: timing
   Analyze (prepare, perform, verify): timing of each step
   Report: timing
   Assimilate: ??
Final Thoughts

1. Turn-around-time
2. Specimen labeling
3. Pathology = Truth
4. Lab Error
5. Call us