Getting the Value (ROI) from Laboratory Software: Outcomes, Outcomes, Outcomes

Kenneth Blick, Ph.D., ABCC, FACB
Professor
Department of Pathology
University of Oklahoma Health Sciences Center and OU Medical Center
Oklahoma University Health Sciences Center (OUHSC)

The first faculty and students, c. 1895
Oklahoma University Health Science Center/OU Medical Center
Pneumatic tube system
Observations:

- Market forces are driving tremendous change in healthcare...many hospitals need “life-support.”
- Critical care demands for real-time laboratory services increasing.
- Physician’s perceive laboratory results have more “historic” value than immediate diagnostic and therapeutic significance.#
- The word is out....hospitals are dangerous places to be, especially for patients.

#Kost, G.Am J Clin Path,1995; 104:S2
Our customers can’t afford our products!

Escalating health force firms to raise

By Paula Burkes Erickson, Business Writer

It’s open enrollment season for health benefits and Jan Mercer is, well, sick about it.

Mercer, president of Genie Staffing Services in Oklahoma City, is forced to raise out-of-pocket health care costs for her company’s health plan. Her eight staff members will have to pay $100 more before insurance kicks in and cover half of the premiums for family members.

“It hurts me to do it, but I have no choice,” Mercer said. Though the slumping economy has stunted her business, her health care costs — even with changes to her plan — will grow 18.75 percent.

Driven by cuts in Medicare reimbursements, rampant drug costs and hikes in malpractice insurance, employers are expected to face their fifth consecutive year of double-digit cost increases. Hikes will average 12 percent, or $742 per employee, according to Towers Perrin, a benefits consulting firm.

As a result, insurance costs will be hit up to $4,000 a year for family policies.

Workers pay $196 a month more than they did last year.

Now most of those additional dollars are for medical premiums, benefits managers say.

Before the latest round of hikes, workers paid a $1 check for Rx and max indemnity was $25 per claim. Now it’s $40 or more.

Still, even

Physicians can’t afford to practice...malpractice insurance up nearly 4 fold in last two years

Daily Oklahoman, October 16, 2003
What’s driving the adoption of lab automation? Answer: The lab worker shortage and it’s only going to get worse. The number of new medical technologists certified by the American Society of Clinical Pathologists (Chicago) has declined by an average of 6% annually for the past 10 years. In 2003, only 1,802 were certified, down from 3,268 in 1993. And these figures may actually understate the problem because anecdotal evidence suggests that more and more new MTs are choosing to work at pharmaceutical or biotechnology companies instead of clinical labs.
Sources of Pre-Analytical Error

- Missing Predraw instructions, no postdraw instructions, illegible collection data on label, no collection data on label, wrong person drawn, wrong container used, collected at the wrong time, drawn in the wrong order, missing label, missing order, wrong label, label misaligned, lost specimen, no tracking, etc., etc.

Clinical Lab News, Oct 2002
Not ready for prime time!
CHF: Congestive “Hospital” Failure

“Full House” Causes ED Bypass, Lost Admissions

No CCU beds available to take ED patients
No stepdown beds available to take ED patients as floor is full

Source: Cardiovascular Roundtable Advisory Board
Overcrowding #1 problem Dr. WF Peacock
75 % EDs Operating Overcapacity!
HEALTHCARE DILEMMA

- Long ED wait
- Fewer budget dollars
- Bed shortage
- Telemetry backup
- Patient risk
- Imperfect information flow
- Inappropriate admissions & discharges
- ED diversion

Rapid Testing Essential
OUMC

- Consists of multiple freestanding hospitals
  - Two adult hospitals - each with chem lab
  - Children’s hospital
  - Outpatient clinics - with own chem lab

- Together, more than 2.5 million chemistry tests per year/2,000 chemistry samples per day.
Getting enough capacity:
Eliminating batch processes whenever possible?
Old Paradigm: Increased demand for batch laboratory services has been met with increased staff.

New Paradigm: Evidenced based medicine requires real-time services. Since old solutions cannot succeed, technology is now required to change the clinical laboratory to a real-time laboratory information infrastructure.
Giving the lab back to the physicians…team effort!

It takes a multi-disciplinary team to
• enhance Quality of Care
• improve Cost Management

New SOB panel: BNP, D-dimer, Troponin-I, CK-MB, Myoglobin  6/30/04
In an effort to increase efficiency, we began a project in July 2003 to consolidate all chemistry testing into an automated core laboratory.

In March 2004, we went live on our total laboratory automation track system for chemistry.
Real-time Queueless Laboratory

New assignment for staff: Keep the information flowing
## The Queueless Core Laboratory: No Batch Processes

| Decentralized Real-Time Specimen Collection: | 1. Order Entry/Label printing on the floors and clinics  
2. Collection/labeling by nurses and housestaff  
3. Lab Phlebotomy for preadmits, etc. |
| Decentralized Specimen Transport | Intra- and Interhospital Pneumatic Tube Transport |
| Centralized Processing/Testing/Core Laboratory | Elimination of “STAT” Laboratories |
| Automatic Specimen Receive in the Laboratory | Track/Total Automation System |
| Automated Specimen Processing | Track/Total Automation System |
| Automated “Load Balanced” Testing | Track/Total Automation System |
| Autoverification/Release of Results | DataLink (BCI) and Meditech LIS |
| Specimen Repository/Add on Orders | Track/Total Automation System/Specimen Stockyard |

BCI, Beckman Coulter ; LIS, Laboratory Information System
OUMC Chemistry-Lean

- Centered around a vendor TLA (total laboratory automation) systems
  - 3 high speed walkaway chemistry analyzers
  - 2 high speed walkaway hematology analyzers
  - 2 walkaway automated immunoassay instruments
  - Track specimen handling middleware by
  - Result reporting/control by a core lab middleware solution (Chem, Hematology, etc.)
Legacy Solutions: Impact on CURRENT PROCESS
AUTOMATION SOLUTION

OU Medical Center

Automated Process

- ORDER ENTRANCE
  - Order entered in LIS
- LABEL PRINTING
  - Labels printed in phleb. area
- INLET
  - Phleb. monitors order activity
  - Phleb dispatched for collection
  - Specimen collected labeled and bagged
  - Return to lab
  - Order? (Yes/No)
  - Label Printed
    - Yes
      - Label Applied
      - Tech and Time of Draw Entered in LIS
      - Specimens RECEIVED in LIS
    - No
      - Park Tube
- VERF. BAR CODE READ
- HEM OUTLET
- CENTRIFUGE
- DE-CAPPER
- LX CONNECTION
- LX CONNECTION
- OUTLET
- CAPPER
- REFRIG STOCKYARD
- DE-CAPPER
- ADD-ON request from LIS
- DATALINK
- AUTO REVIEW OF RESULTS
- MANUAL REVIEW
- RELEASE

- DATALINK
  - Auto racked specimens
  - To Hematology Section
  - auto racked specimens
  - To Immunology and Specials Section

PROCESS
WAIT STATES
BIOHAZARD
EXPOSURE
PATIENT
SAFETY

756
1211
10
84
2
1
93
Command Central, software module which operates on a DL/Remisol 2000 console.

Consolidates the DL/Remisol 2000 functions and instrument monitoring into a single workstation.

Monitors and alert the user on the status of the attached analyzers screens to conditions that require intervention.

The alerted user will have complete access to analyzer that requires intervention.
Example of Instrument Connections
Monitored turn-around times for three analytes (potassium, troponin, thyroid stimulating hormone) between July 2003 and August 2004

Data subdivided by the hospital of origination and whether the test was ordered “stat” from the emergency department

Also examined the staffing needs and testing volumes over this time period
Other data mining outcomes since go-live March 04?

- Closed Stat laboratory at Presbyterian and Children’s Hospital Towers: TAT improved or remained the same for Stat and routine. Saved $1.5 M annually
- Eliminated Stat testing altogether: FIFO
- Staffing Core Lab: 70 FTEs to 59; 10 per diem to 1
- Productivity of entire Core Lab: paid FTE/Tests- .13 to .10
- Test volume increase over 6 %; overtime from 3.5 % to 1.3 %.
- Telephone calls reduced substantially: lab and customer support areas; 1 FTE eliminated
- Brought in 15 tests which had been referred
- Eliminated staff turnover and minimized stress on employees
- Error reduction efforts…no mined data as yet
Benefits of Lean

- More free tech time
  - To deal with problem specimens
  - Perform labor intensive test not capable of running on instruments connected to the automated line
    - Brought back in-house over 20 previous send-out reference tests
    - Thereby, reducing our reference bill (over $22,000/month) and making results available to clinicians more rapidly
Benefits of Lean

- Increased efficiency
  - Over the past year the number of techs employed decreased by 16%
  - Over the same time billable tests per month has increased by over 6%
  - Equates to a 35% improvement in our productivity index (a ratio of billable tests per tech-hour)
  - Productivity ratio 0.288 to 0.145 in the last 4 years.
Intangible Benefits

- 48 processes eliminated with over 90 high volume tests on line and available 24/7
- Redundant design with no downtime
- Patient safety issues addressed...positive sample ID with rapid results available for critical care
- Less stress with less errors
- Getting real value out of investments in technology, space and staff
- Having more fun
What Expert Systems Do?

- Reflex testing
- Cancels testing
- Data event alerts to technologists
- Physician notification/critical results
- Email, fax, remote print, coded comments
- Standing orders
- Gather data for prospective studies
- Logs for outcomes
- Etc.
Reflex Testing/Other Examples:

- Order manual differential/make the slide
- Reflex to UA microscopic (Atlas/Sysmex UF-100)
- Track Load Balance/Specimen deferral
- Selective Processing/Sorting
- Manual diff when CSF WBC <5
- Neonatal Bili when HI >= 8
- Order creatinine (if not ordered) when gentamycin results are entered
DL2000: Typical Boolean Rules
(Anion Gap Check):

- IF (INRANGE(AGAP) THEN VALID
- IF (AGAP<AGAP,VALIDLOW)
- THEN
  REFLEX(CO2);REFLEX(K);RFLEX(NA)
  ;REFLEX(CL)
DL2000: Neonatal Bilirubin: Technologist Alert

IF(HEMOL) >= 8 and (EXIST(TBIL) AND (AGE < 30D))
THEN
REFLEX(TBE); MSG (RUN TBE and result with coded comment HEMBIL)
Unacceptable Specimens

- Performs Indices
- Alerts technologist
- Order to recollect if appropriate
- Suppression of results
- Appends comment
- RSP for critical patients
- Logs data event
- Email to supervisor
Critical Results

- Involves rules at four levels: instrument, track, DataLink2000, Meditech 4.9.1 LIS
- Instrument automatically rechecks results; age and sex matched ranges
- Alerts the technologist on DataLink with filter
- Provides the physician name and phone number or gives special instructions, LIS
- Logs the event, LIS
- Documents the call/Readback, LIS
- Emails supervisor on weekends, Network
- RSP/autofax, LIS
Other Indicators of Laboratory Performance

Mean and standard deviation of TAT can be adequate measures of laboratory performance.

A better method would be setting clinically based TAT goals and monitoring success in achieving these goals.
Major Problems with POCT Computerization

- Connectivity issues with POCT devices and associated DMS
- IT challenged, primitive POCT devices
- Unique nature of POCT when compared with traditional “core” lab testing
- Unique database requirements for POCT
- Management support for plethora of remote POCT devices
Many types of laboratory billing

- Inpatient hospital-DRG, Part A
- Outpatient-hospital
- Outpatient/reference Lab
- Contract billing
- Managed care billing/tracking
- Professional billing, Part B
- CP Inpatient Professional Billing (Profee; 7-10%)
- Facility and test modifiers
- UB92s or HCFA (CMS) 1500
- Electronic versus manual claims
July 2004

Relationship between Lab % Outliers and ED Patient Turnover in hours?

- Lab % Outliers
- ER Patient Turnover in Hours

Averaged 4 BEST GC Division AVG (12 facilities)
Averaged 4 WORST GC Lab % Outliers

- 2.67
- 5.0%
- 3.18
- 6.9%
- 3.81

0.0% 10.0%
Averaged 4 BEST

2.00 4.00
Division AVG (12 facilities)

2.00 4.00
Averaged 4 WORST

2.00 4.00

OUMC Indicators of Laboratory Performance

- We have set the following goals
  - Potassium TAT $\leq$ 40 minutes
  - Core Lab Troponin TAT $\leq$ 60 minutes

- Through implementation of our automated chemistry system, we have drastically improved our success in meeting these goals
Comparison of TAT distributions for K from ER

Comparison of TAT distributions for K from ER

- **Jul 03**
  - mean = 30.3
  - SD = 13.4
  - H/W = 0.45

- **Aug 04**
  - mean = 27.3
  - SD = 9.1
  - H/W = 1.04
Comparison of TAT distributions for Troponin from ER

- Jul 03
  - mean = 48.4
  - SD = 21.9
  - H/W = 0.36

- Aug 04
  - mean = 48.4
  - SD = 9.0
  - H/W = 1.73
STAT Tests No Longer Needed

The chart shows the average turnaround time (TAT) in minutes for different test categories over two periods: 7/03 and 8/04.

- **K ER**
- **K not ER**
- **Troponin ER**
- **Troponin not ER**

**7/03**
- K ER: 30 min
- K not ER: 38 min
- Troponin ER: 60 min
- Troponin not ER: 48 min

**8/04**
- K ER: 28 min
- K not ER: 32 min
- Troponin ER: 50 min
- Troponin not ER: 48 min
“The laboratory is no longer an issue.”

John Stuemky, M.D.
Medical Director, ED
OU Medical Center
# Unpredictable LAB Service Effects on ED LOS

<table>
<thead>
<tr>
<th></th>
<th>Correlation</th>
<th>P-value</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before Automation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K Outliers &gt; 18 %</td>
<td>0.98</td>
<td>0.01</td>
<td><strong>Highly Correlated</strong></td>
<td>ED LOS depends on Lab</td>
</tr>
<tr>
<td># of ED Patients</td>
<td>0.53</td>
<td>0.28</td>
<td>ED LOS depends more on lab delays than on patient volume</td>
<td></td>
</tr>
<tr>
<td><strong>After Automation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K Outliers &lt; 5 %</td>
<td>0.54</td>
<td>0.46</td>
<td>With improved TAT the ED LOS is not dependent on Lab delays</td>
<td></td>
</tr>
<tr>
<td># of ED Patients</td>
<td>0.88</td>
<td>0.06</td>
<td><strong>Highly Correlated</strong></td>
<td>ED LOS now depends more on patient volume than on Lab delays</td>
</tr>
</tbody>
</table>

Before automation: $\text{Nadm\_LOS} = +2.79[\%K] + 78.8$
Benchmarking by percent outliers

- Potassium not ER
- Potassium ER
- Troponin not ER
- Troponin ER
- Optimal Tx, faster, can reduce IP LOS
- Reduction in variable cost / increase in revenue
## EXAMPLE: HOSPITAL “A” DATA

<table>
<thead>
<tr>
<th>Hospital Data</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total ED Visits/yr</strong></td>
<td>104,439</td>
</tr>
<tr>
<td><strong>Avg. ED LOS all pts</strong></td>
<td>4:06 hours</td>
</tr>
<tr>
<td><strong>#,% admitted, all pts</strong></td>
<td>19%</td>
</tr>
<tr>
<td><strong>Annual ED OT $</strong></td>
<td>$45,883</td>
</tr>
<tr>
<td><strong>Annual #, % LWOTs</strong></td>
<td>4.1% 4,253 patients</td>
</tr>
<tr>
<td><strong>Annual #, % Diverts</strong></td>
<td>510.22 Hours/yr</td>
</tr>
<tr>
<td><strong># ED Pts presenting w/ Chest Pain, SOB</strong></td>
<td>9,362</td>
</tr>
<tr>
<td><strong>Avg. ED LOS CP, SOB pts</strong></td>
<td>CP 5:01 hours  DIB 4:08 hours</td>
</tr>
<tr>
<td><strong>% ACS/AMI M/care</strong></td>
<td>70.6%</td>
</tr>
<tr>
<td><strong>% CHF M/care</strong></td>
<td>81.2%</td>
</tr>
</tbody>
</table>
Conclusions

- Automated/Expert systems can handle most routine and non-routine data events
- Automated/Expert systems facilitate handing problems in real-time and more predictably than humans
- By elimination of batch testing system through use of automation and expert systems, laboratories have great potential to improve the overall quality and predictability of laboratory services. Such improvements are now essential for the effective practice of Evidenced Based Medicine especially for the critically ill.