Microbiology Meets Process Improvement: Secrets and Tricks of the Trade That Produce Big Gains

Anne R Beall, BS MT
November 3, 2010

Objectives

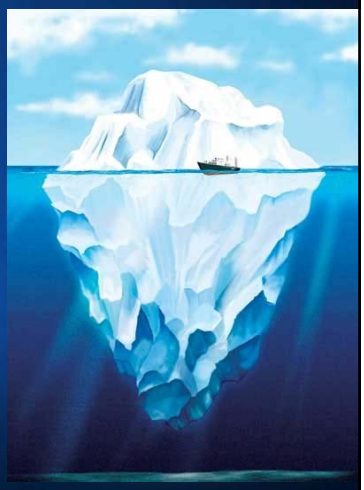
- Differentiate microbiology lab practices from other departments in the laboratory
- Explain how Lean principles apply and transfer to the clinical microbiology lab
- Identify areas of opportunity for improving efficiency in microbiology
- Describe how employing process improvements through Lean improves TAT

Microbiology as it operates yoday is on a collision course…

- In the last 30 years Microbiology processes have remained relatively unchanged
  - Mostly manual work
  - Dependent on organism growth
  - Prone to error in many areas (labeling, streaking of plates, etc.)
- Growing Culture Volumes & Number of tests required
  - Increasing antibiotic resistance ("D" test, Hodge Test, ESBL, KPC, VRE)
  - Diversifying methods of testing (e.g., molecular)
  - Mandatory MRSA screens..

… with an Iceberg

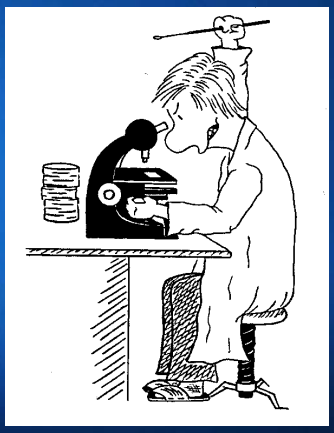
- Microbiology laboratories are expected to do MORE, deliver FASTER results, with FEWER resources
- Aging Work Force
  - Heavy reduction in Medical Technologist programs
  - Developing a skilled microbiologist takes a significant amount of time and resources



Laboratory Administrators need to look to the future

- Focus on activities that create value for the patient, the clinician and the hospital
- Eliminate non-value added activities
- Look at automation

"Status quo" is no longer meeting the needs



Workflow and process improvement will chart a course to better future

Secrets and Tricks to navigate to a successful future

- 3 Key Mantras
  - Limit the number of steps/touches
  - Keep it simple (KISS) at all time
  - It's all about the patient

Start at the beginning

- Collect quality specimens
  - Blood Culture
  - Sputum
  - Swab
  - Tissue for OR
  - No swab for AFB and Fungus
  - Stools…. It's complicated

- Limit the number of acceptable specimen containers

"Garbage in = Garbage out"

Collect specimens in container used for testing/culture

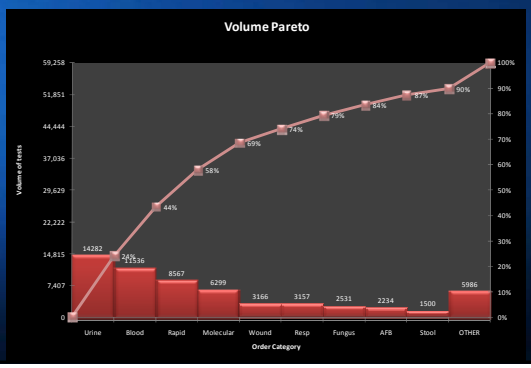
- Urine & Stool
  - Shared between departments
  - Have multiple tests
  - Split or Pour-off
  - Some tests require preservatives

Eliminate pour-offs of Urine samples

- Non-value added activity - ↑ Labor cost
  - Re-labeling
- Prone to errors
  - Re-labeling
- ↑ Contamination
- Spills

A closer look at Urine samples

- Highest volume of specimens sent to microbiology
- Urine leaks during transport
- Urine must be refrigerated or tested within 2 hrs
  - Leads to contaminated samples
- Sample shared with Urinalysis
  - Split
  - Relabel
  - Leads to lost specimens
  - Delay in testing



Contamination leads to false positive results

- Clinically relevant microbiology vs. Exhaustive microbiology
- 3 or more colony types are considered contaminated
- If you are not using boric acid
  - ≥ 30% urine cultures are contaminated
  - 50% of the contaminated are worked up
  - Increasing
    - non-value added activities
    - Labor & cost
    - Workload

Cost of urine contamination

- 30% contaminated urine samples

Avg # of urines per day	150
30% contaminated	45
50% of contaminated are worked-up	23
3 minutes to work up a positive culture	69 min
Total non-value added activity	69 min/day
Annual Cost of Labor (based on $52,000 salary)	$10,500/year
Cost of reagents avg $ 5.00/work-up	$115.00/day
Annual Reagent spent on contamination	$ 42,000/year

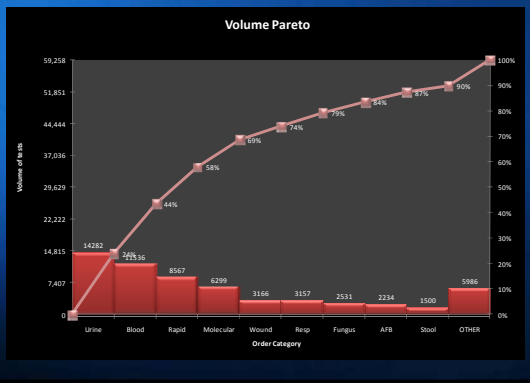
Improve Urine collection

- Aliquot at point of collection
  - By Nurse
- Preserve sample
  - Boric acid

Standardize container & Collect by Nurse
- Eliminate pour-offs
- Relabeling
- Reduce Contamination

A look at Stool specimens

- Not a huge volume but…
- Multiple requirements for testing
  - Preserved, temperature, etc..
- Stool pathogens – finicky



The problem with stool samples

- Multiple containers
- Requires aliquot
- Lack specimen quality
- Prone to errors
  - Re-label

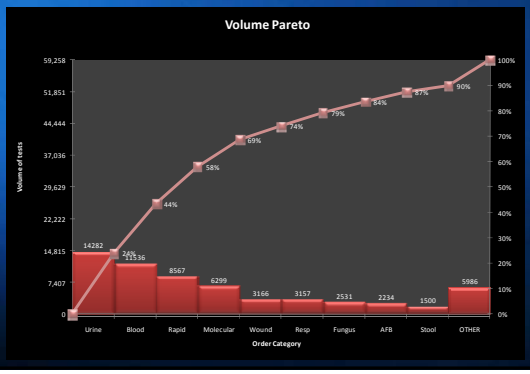
Improving Stool collection

Standardize container & Collect by Nurse

- Eliminate pour-offs
- Relabeling
- Improve specimen quality

Blood cultures samples

- 2nd Highest volume of specimens sent to microbiology
- Should we look at collection?



Blood culture contamination

- > 40% of all Positive Blood Cultures may represent contaminants. [1]

Monthly	
Number of Blood Cultures (2 bottles)	1500
Positivity Rate	10%
# of positive Blood Cultures	150
40% are contaminated Cultures (2 bottles)	60
Avg Cycle time for New Positive bottle	21 min/bottle
Total non-value added activity	42 hrs/month
Annual Cost of Labor (based on $52,000 salary)	$ 12,600/year

1. Weinstein MP et al. CID 24: 584-602,1997

Blood culture contamination cost

Literature	Year	Extra LOS (Days)	Cost (Per Contam)	Cost (2004 U$)*
Bates et al.	1991	4.3	$4,385	$7,761
Souvenir et al.	1995	N/A	$1,000	$1,350
Weinbaum et al.	1996	N/A	$2,500	$3,275
Surdulescu et al.	1998	4.5	$6,743	$8,294

Table created from material in the listed references

** ΔMedical Care CPI to 2004 (1991 = 77%, 1995 = 35%, 1996 = 31%, 1998 = 23%)*

Source: 1. Bates et al. JAMA 1991 Jan; 265(3): 365-9
2. Souvenir et al. J. Clin. Micro. 1998 Jul: 36(7); 1923-1926
3. Weinbaum et al. J. Clin. Micro. 1997 Mar; 35(3): 563-565
4. Surdulescu et al. Clin. Perform. Qual. Health Care. 1998 Apr-Jun; 6(2): 60-2

Bureau of Labor Statistics website: http://www.bls.gov/data/home.htm

Blood culture contamination additional impact

- 20% increase in laboratory costs. [1]
- 39% higher anti-microbial charges. [1]
- ~ $1000 per patient more in inappropriate therapy costs for false positive. [2]
- What about HAI?

1. Bates DW et al. JAMA 1991; 265: 365-9
2. Souvenir D et al. 1998; JCM 36: 1923-6

Do the Math…

Monthly	
# of positive Blood Cultures	150
# of Contaminated Blood Cultures	60
# of patients (4 bottles)	15
Avg Cost of Contaminated Blood Culture*	$5,000
Total Cost	$75,000/month
Annual Cost	$ 900,000

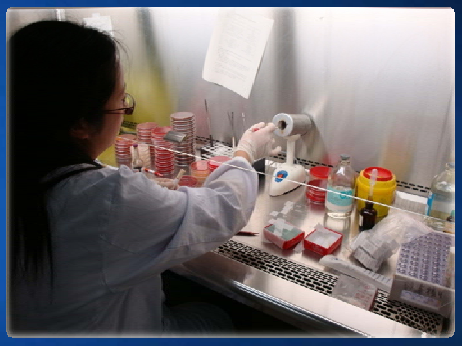
** Avg cost from 2004 contamination cost slide*

Standardize specimen collection & containers

- Simplify specimen processing
- Eliminate re-labeling errors
- Improve Specimen quality
- Eliminate pour-offs
- Reduce cost

Specimen Processing

- How are specimens received?
- Who is receiving specimens?
- When are specimens received?



Organize at the Front end….

- How are specimens received in your laboratory?
  - Courier
  - Microbiology has to go an pick up
  - Pneumatic tube system
  - Robot
- Who is receiving the specimens ?
  - Central receiving
  - Microbiology

Delays and Bottlenecks

- This does not happen in your lab?
  - Specimen waiting?

Bottlenecks with Critical Samples

- Be aware of bottlenecks before (loading) and after (unloading) blood culture bottles

Impact of Delay on Critical Specimen

Table 1
Differences in 99 Pairs of Patients by TAT for Laboratory Results

	TAT			
	<1 h	≥1 h	Difference	*P*
Time to detection (h)	13.7	13.6	0.1	.7860
Gram stain TAT (h)	0.1	3.3	–3.2	<.0001
Mortality rate (%)	10.1	19.2	–9.1	.0389
Length of stay (d)	11.0	10.5	0.5	.6936
Positive length of stay (d)*	7.9	7.7	0.2	.7920
Variable costs ($)	9,543	9,361	182	.9150
Male sex (% of group)	47	49	–2	.7773
Age (y)	69.2	66.6	2.6	.3054

TAT, turnaround time.
* The number of days between the date the culture became positive and the date of discharge.

Am J Clin Pathol 2008;130:870-876 **873**
DOI: 10.1309/AJCPVMDQU2ZJDPBL

- Decreased Mortality Associated With Prompt Gram Staining of Blood Cultures, Barenfanger Joan, *et al.* ***Am J Clin Pathol* 2008;130:870-876**.

Clinical Studies

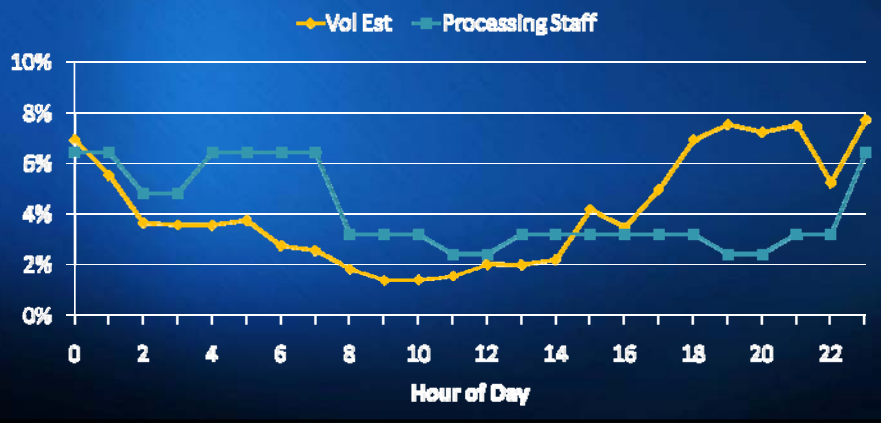
"…patients with less than 1 hour TAT had a statistically significant reduction in mortality. Maintaining high quality coverage of blood cultures as soon as they become positive may be in the best interests of patients; this study supports constant "24/7" coverage of these instruments. "

" We also have documented that with sufficient effort, changes in processing and staffing can result in significant improvements in TATs, even during times that are difficult to staff."

- Decreased Mortality Associated With Prompt Gram Staining of Blood Cultures, Barenfanger Joan, *et al.* ***Am J Clin Pathol* 2008;130:870-876**.

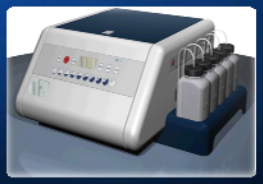
Specimen Arrival Patterns

- Get to know when specimens are coming in
  - By hour of day
  - Match to staff



Consider Automation

- May help reduce bottlenecks
- Improve time to incubator
- Assist staff in reducing non-value activities



Introduce "first in-first out" process

- Batch if you must
  - Keep to small batches

Establish and Monitor Specimen Processing targets

- Received to plating (Bottleneck area)
  - 2 hours
- Plating to incubator (Bottleneck area)
  - 2 hours
- Where are you today ?

Placing Plates in Incubator….

Sort up Front

- By Specimen Type
  - Same workflow
  - Common normal flora
  - Common pathogens
  - Decrease learning curve
  - Improve TAT

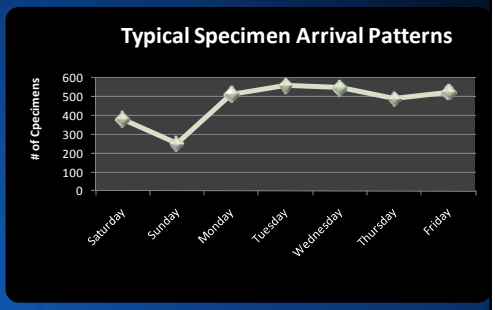
Design Plate Filing System

- Color racks
- Baskets

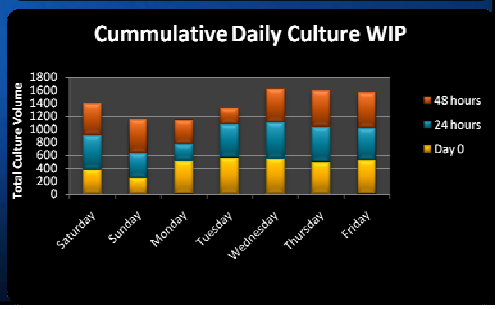
Not Rocket Science

Work In Process

- Typical arrival pattern of specimens
- Culture protocol is 24-72 hrs



- WIP is cumulative from one day to the next



The Impact of "WIP"

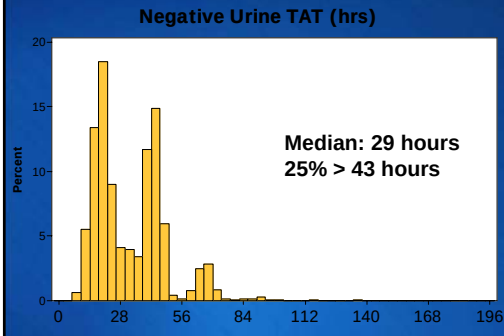
High level of WIP MASKS opportunities

Can you see the WASTE
- # Repeats
- # of re-isolations
- Excess motion
- What is set aside for supervisor

Lower WIP EXPOSES opportunities

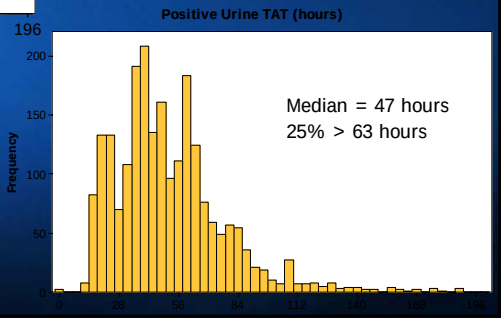
Reducing WIP reduces TAT and makes it much easier to see other WASTES and improve the process

Typical Reading Schedule



- Cultures read on day shift only
- 24 & 48hr bench

Drives TAT



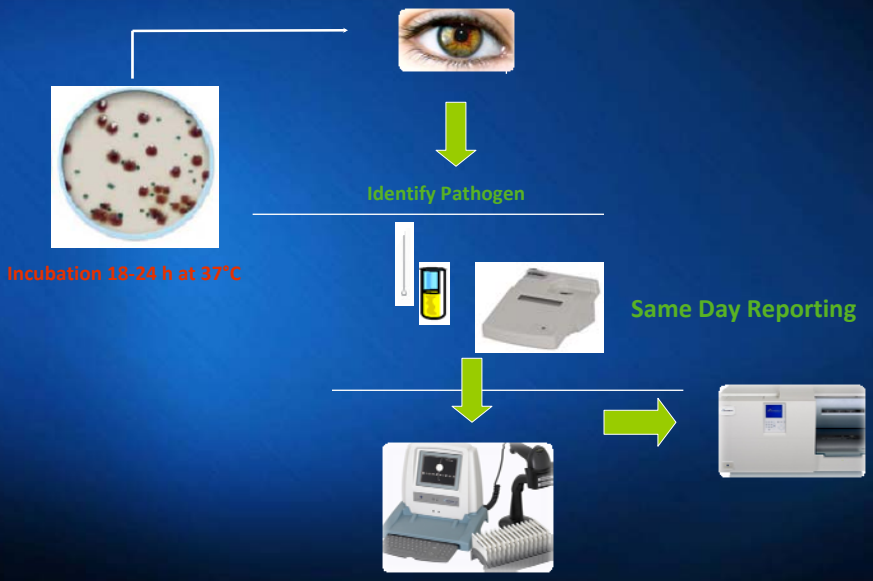
Reading Cultures Tips

- Gain efficiency by reading like cultures e.g. urine, stools, throat etc..
  - Common normal flora
  - Common pathogens
  - Same workflow
  - Training can be focused and expedited

Triage positive from negative cultures

- Helps manage workload e.g. 40-50% of urines are negative
- Negative cultures results are entered real time
  - Cycle time seconds
- Positive cultures require additional steps e.g. biochemical, ID/AST
  - Cycle times minutes
- Decreases time to ID/AST
  - Introduce continuous flow – NO batching
- Implement multiple reads per day
  - Depending on your volumes & receiving volumes

LEAN -Continuous Load



Implement same day reporting of ID/AST

- ID/AST results available to be reported in afternoon
  - Reduces WIP
  - Improves TAT by 12-24 hours

Secrets and Tricks

- Review specimen collection & containers
- Review contamination rates
  - Urine culture
  - Blood culture
- Look for bottlenecks in specimen processing
  - Investigate automation
- Read cultures by specimen type
  - Small batches
  - Same day reporting

Conclusion

- Improve your processes before your laboratory becomes a tragedy