

# Looking to the Future: How Automation will Grow the Value of Microbiology

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# Outline

- Drivers of Automation
- The Necessities of Automation
- Is there a Benefit to Automation?
- Automation of Automation

# What is the Future of Automation?



*We Practice What We Teach*

# Drivers of Automation

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# Why Automate?

- Potential answer to shrinking workforce –
  - Need to staff when plates are to be read, not just 9-5
- Answer to ergonomic realities
  - Quality of life issues/cost to organization
- Labs are consolidating – can do more potentially with less – but perhaps larger
- Better **quality product** – consistent plating
- Pressure for decreased TAT from receipt to results
  - Pressure to be open 24/7
- Increased standardization of transport media – ie liquid transport media (eSwab)

# Why Automate ?

- Pre-analytical processing of specimens reduces time to incubation – increased quality, consistency in plating
- Digital Microbiology – imaging analysis to aid the CLS
  - Useful for training/Documentation
  - Quality Assurance
  - Remote locations – less skilled CLS

Automation is NOT as Simple  
as Installing New Hardware –  
Laboratory Workflow is Critical

# Impact on productivity

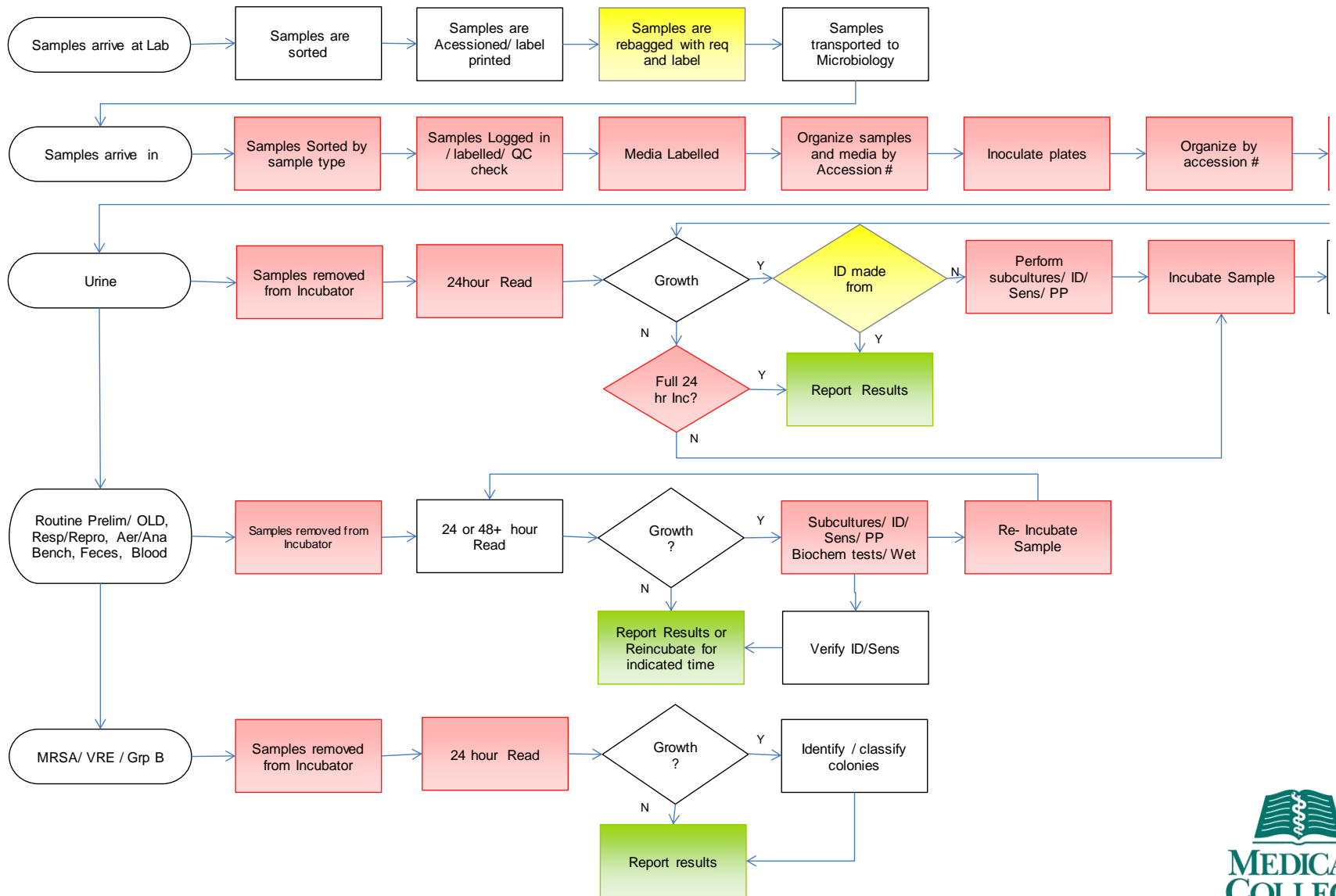
Productivity Index = #samples / #FTEs worked

Productivity for hours worked	# FTE/d	Productivity Index
Current FTE	22	23.0
Future FTE	15	34.8

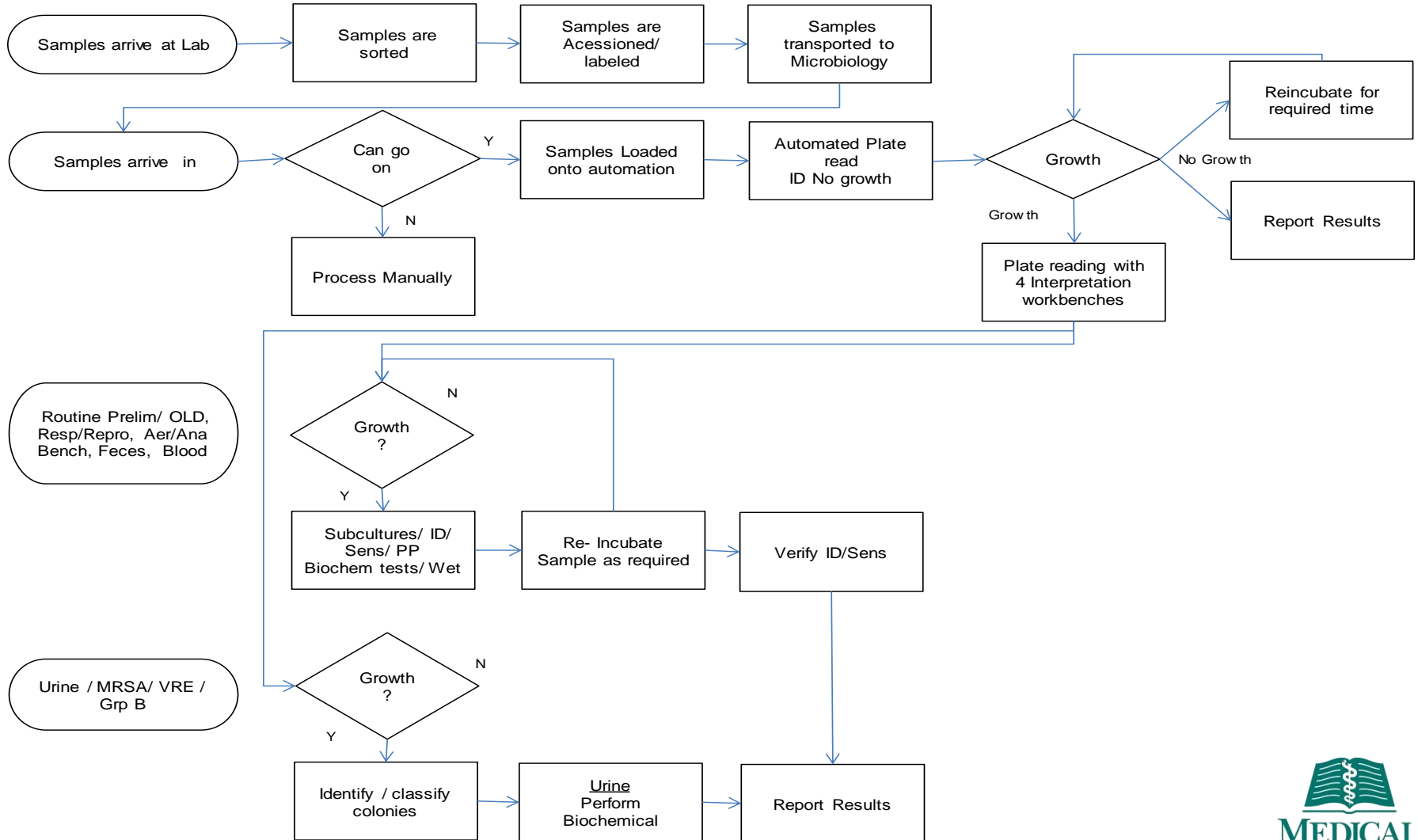
**Productivity - Increased by 51%**



# Laboratory Process Current



# Laboratory Process-Post Automation



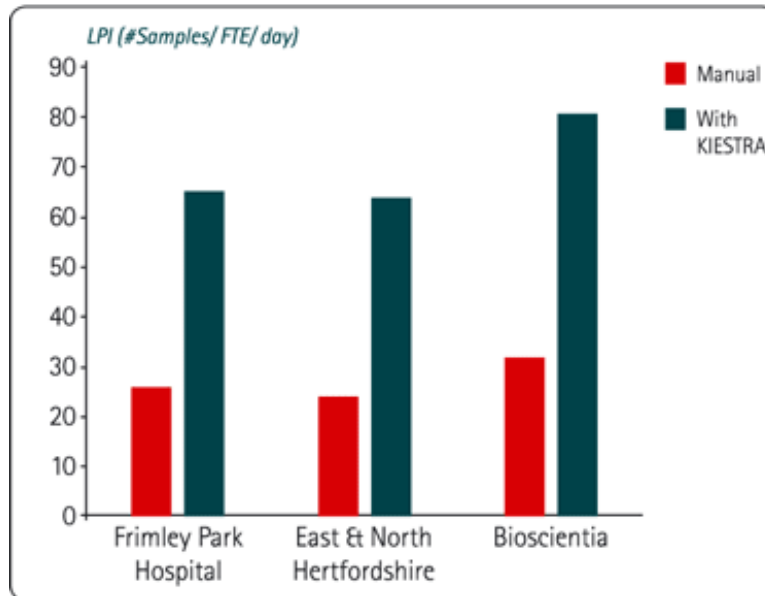
# Is There a True Benefit to Automation?

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# The future of diagnostic bacteriology


## Productivity Increase



### The Facts

- Productivity Frimley: 2.5 times higher
- Productivity Lister: 2.7 times higher
- Productivity Bioscientia: 2.5 times higher

### Dr Ian Fry, Director of Pathology PPS Frimley Park:



"The efficiency of the system has been proven by far better management of samples both in terms of archiving and analysing. We had planned our staff reductions as we went through the procurement to full implementation and were successfully able to reduce our staff by 12 WT. This involved no compulsory redundancies as this was carefully planned part of our implementation. We did achieve what we set out to do in the Quick Scan. We were able to cope with 40% increase in workload and still make savings to the original staffing base. Much of this has been worked through using the Quick Scan approach"

# Comparison of recovery rates of enteropathogens from stool cultures for a one-and two-year-period before and after introduction of automatic inoculation using Automation

Organism	N (%) of recovery at each half-year period								P value	
	With manual inoculation				With Previ Isola				1 yr pre	2 yr pre
	Aug 07-Jan 08 (n=1,331)	Feb 08-Jul 08 (n=1,238)	Aug 08-Jan 09 (n=1,210)	Feb 09-Jul 09 (n=1,361)	Aug 09-Jan 10 (n=1,369)	Feb 10-Jul 10 (n=1,487)	Aug 10-Jan 11 (n=1,432)	Feb 11-Jul 11 (n=1,596)	vs. 1 yr after	vs. 2 yr after
<i>Salmonella</i>	35 (2.6)	10 (0.8)	8 (0.7)	13 (1.0)	17 (1.2)	17 (1.1)	15 (1.0)	16 (1.0)	NS	NS
<i>Shigella</i>	0	3 (0.2)	1 (0.1)	1 (0.1)	3 (0.2)	0	0	2 (0.1)	NS	NS
<i>Yersinia</i>	2 (0.2)	0	1 (0.1)	0	0	0	2 (0.1)	0	NS	NS
<i>Campylobacter</i>	13 (1.0)	6 (0.5)	6 (0.5)	4 (0.3)	17 (1.2)	15 (1.0)	19 (1.3)	13 (0.8)	0.002	0.003
Total	50 (3.8)	19 (1.5)	16 (1.3)	18 (1.3)	37 (2.7)	32 (2.2)	36 (2.5)	31 (1.9)		

# Comparison of sensitivities and specificities of manual/LS swab to WASP/ESwab for the recovery of *S. agalactiae*

Method and swab type	No. with indicated test result				Total no.	Sensitivity (%)	Specificity (%)
	True positive	False positive	True negative	False negative			
Direct plating							
Manual/LS swab	28	0	65	4 <sup>a</sup>	97	87.5	100.0
WASP/ESwab	30	0	65	2 <sup>b</sup>	97	93.8	100.0
Enrichment culture							
Manual/LS swab	29	0	65	3 <sup>c</sup>	97	90.6	100.0
WASP/ESwab	31	0	65	1 <sup>d</sup>	97	96.9	100.0

# VALIDATION OF URINE SPECIMENS

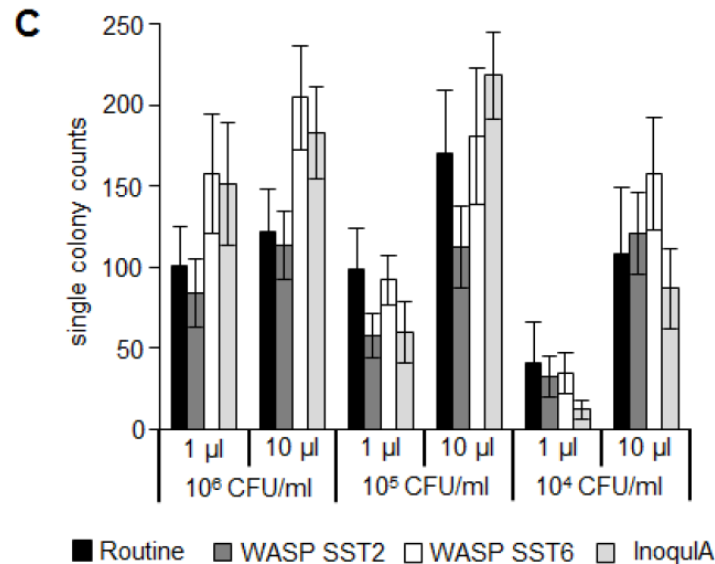
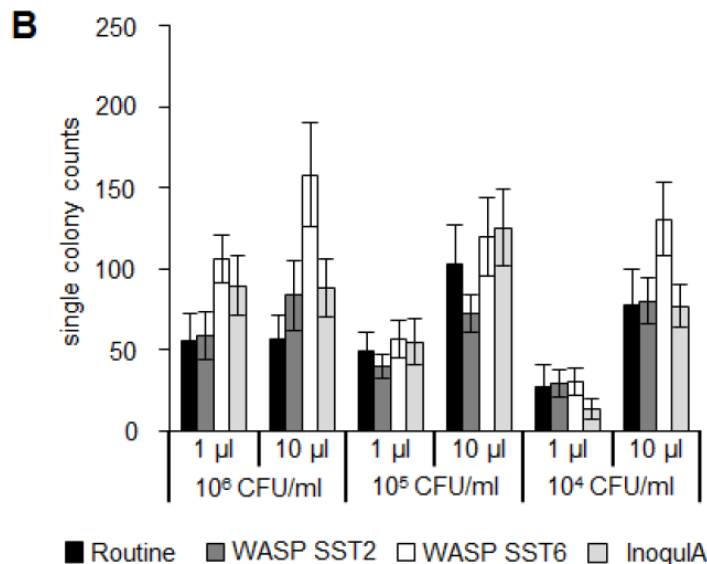
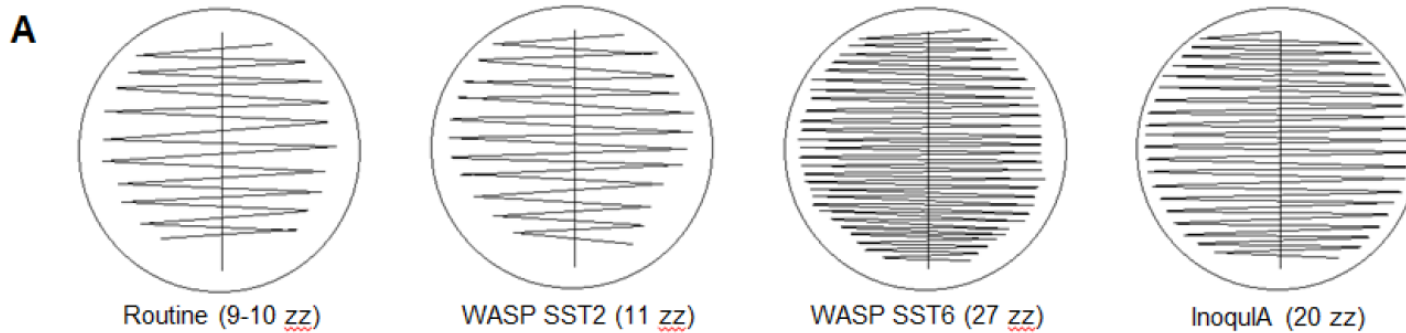
- 92 urine specimens were processed on the WASPLab, images were captured at 0, 18, and 24 hours. Plate images were initially viewed on-screen after 18 h incubation.
  - Negative cultures were automatically unloaded, negative result confirmed and discarded
  - Positive cultures designated as “pathogens requiring further workup”, “fecal contaminated”, “pathogens <10,000 cfu/mL”, or “normal skin flora”.
  - The plates were extracted from the WASPLab incubator and sent to the specified canister, manually read, and compared to the on-screen image.
- 76 of the 92 cultures were designated as positive
  - 100% concordance between manual read and WASPLab interpretation for 16 negative cultures
  - Of the 76 positive cultures, 78% concordance between manual interpretation and WASPLab. 17 cultures (22%) where the on-screen image and manual plate reading interpretations did not match.
    - 13 were due to overcalling a potential *Enterococcus* species on-screen, when the colony was actually a normal skin flora
      - Corrected through technologist education
    - 4 were due to missing a pathogen in heavily mixed cultures on the manual read
- **Turnaround was reduced by ~18 hours**

# Performance of total laboratory automation combined with MS in clinical microbiology practice

- When full laboratory automation was combined with MALDI-ToF MS:
  - Pathogen identification using Kiestra TLA combined with MS resulted in a 30.6 h time gain per isolate compared to CM.
  - Pathogens were successfully identified in 98.4% (249/253) of all tested isolates. Early microbial identification without susceptibility testing led to an adjustment of antibiotic regimen in 12% (24/200) of patients.
- Did not evaluate the effect of automation alone on TAT or accuracy of identification



# Streaking pattern details and resulting numbers of single colony counts



# Recovered Species

## B Recovered species correlation

WASP 1 $\mu$ l Manual	0	1	2	3	4	$\geq 5$
0	55	8	4			
1	1	33	6			
2		5	6			
3		1	1	1		
4						
$\geq 5$						

WASP 10 $\mu$ l Manual	0	1	2	3	4	$\geq 5$
0	161	35	5			
1	8	91	24	1		
2	4	9	30		1	
3		1	3	5		
4						
$\geq 5$				1		

# CFU Correlation between WASP and Manual Streaking

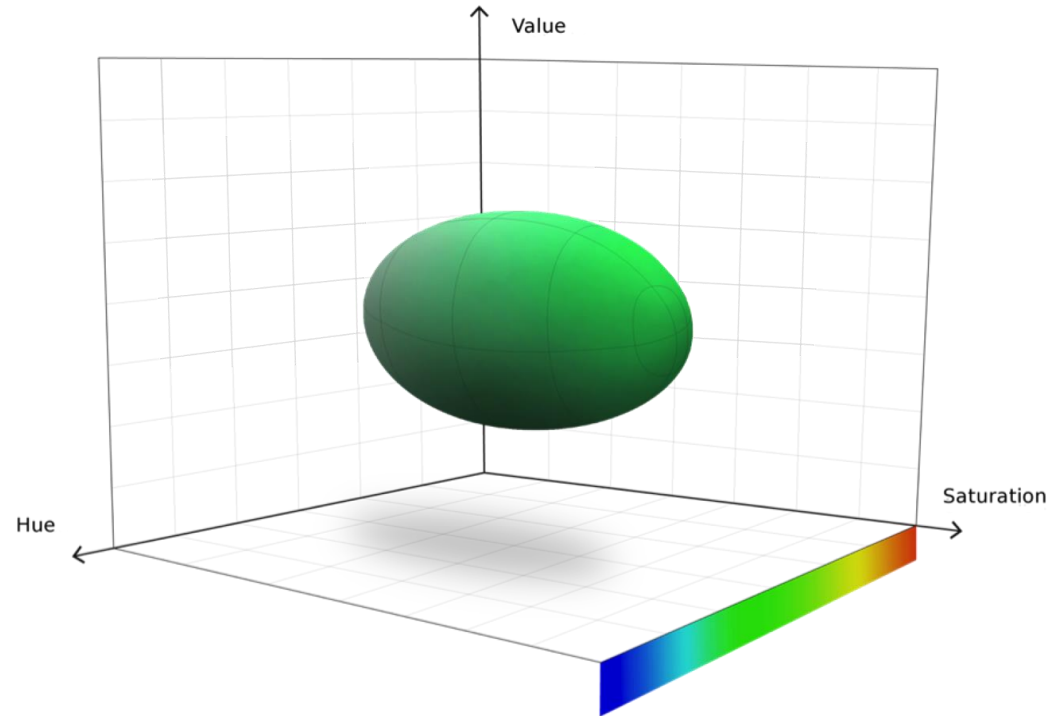
## C CFU correlation

WASP 1 $\mu$ l Manual	n. g.	< 10 <sup>4</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	$\geq 10^6$
n. g.	37	2				
< 10 <sup>4</sup>	1	17	8		1	
10 <sup>4</sup>		4	14	2		
10 <sup>5</sup>			1	12	4	
10 <sup>6</sup>				3	15	
$\geq 10^6$						

WASP 10 $\mu$ l Manual	n. g.	< 10 <sup>4</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	$\geq 10^6$
n. g.	73	40	1			
< 10 <sup>4</sup>		74	18	6	1	
10 <sup>4</sup>		11	30	19	7	
10 <sup>5</sup>		2	1	22	30	
10 <sup>6</sup>				4	40	
$\geq 10^6$						

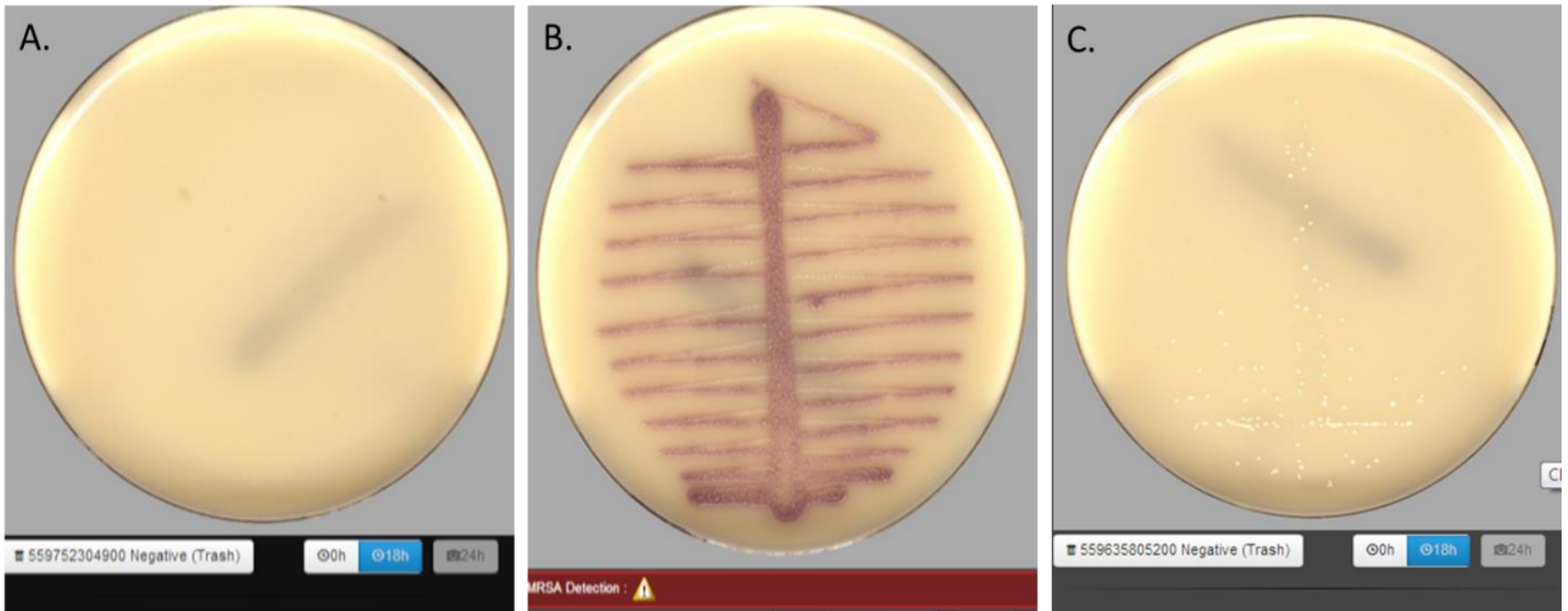
# Automated Interpretation of Chromogenic Media

# The Algorithm



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# How it Works



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# Performance by Media Type

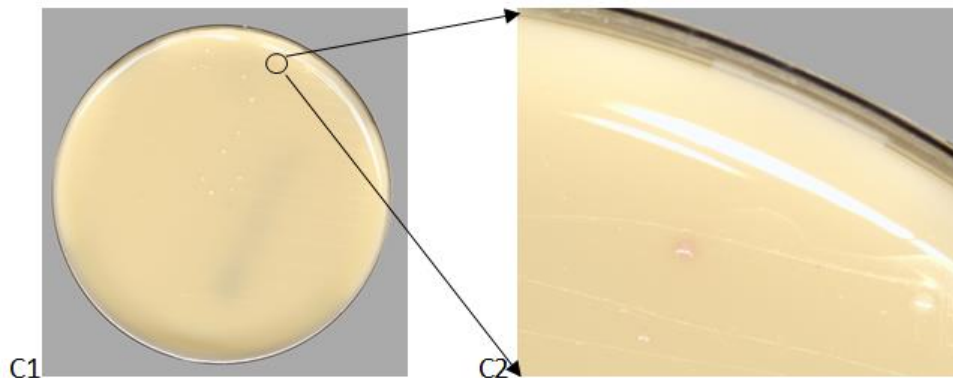
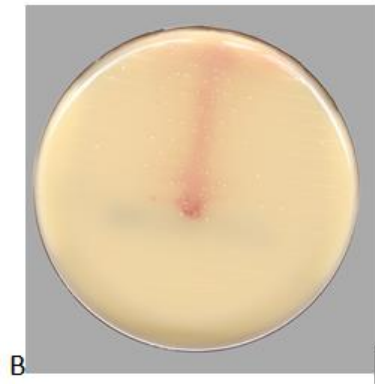
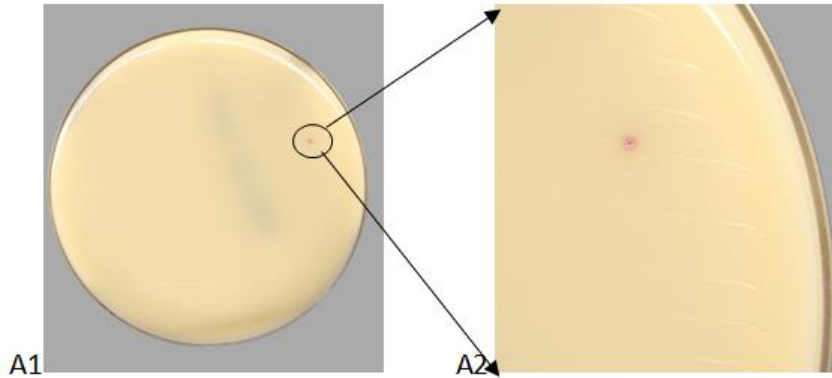
**TABLE 2 Comparison of 3 Chromogenic Agars for the detection of MRSA**

Chromogenic media	No. of specimens tested	Results (no.) <sup>a</sup>				Performance (% [95% CI]) <sup>b</sup>	
		MP/AP	MN/AN	MN/AP	MP/AN	Sensitivity	Specificity
Bio Rad	46668	799	41599	4270	0	100 (99-100)	90.7 (90-91)
chromID MRSA	2217	162	1898	157	0	100 (97-100)	92.4 (91-93)
BD Chromagar MRSA	8805	406	7616	783	0	100 (99-100)	90.7 (90-91)

<sup>a</sup> MP/AP, manual Pos/automation Pos; MN//AN, manual Neg/automation Neg; MN/AP, manual Neg/automation pos; MP/AN, manual pos/automation Neg.

<sup>b</sup> CI, confidence interval.

# Manual Negative, Automation positive plates generated by WASPLab CDM software



Automation Positive Naked  
Eye Negative showing a small  
colony not visually detected by  
manual examination but  
accurately identified as positive  
by the CDM (A1 and A2.).  
Residual Matrix on the plate  
showing lack of growth, but  
containing color due to the  
presence of specimen matrix  
(B.) and a Borderline Color  
plate demonstrating similar  
color colonies (C1 and C2).

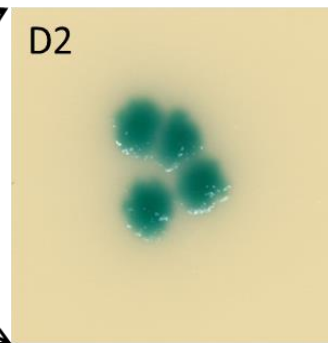
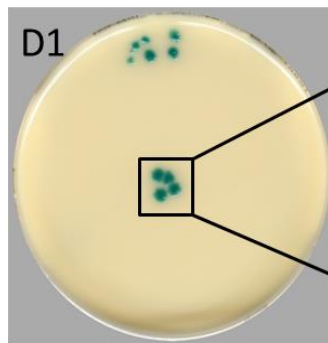
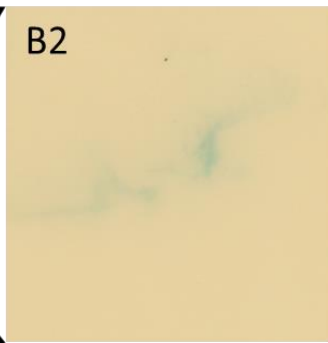
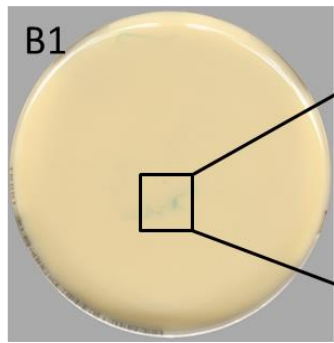
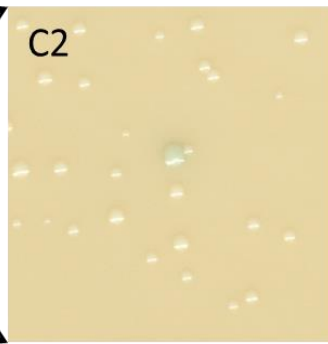
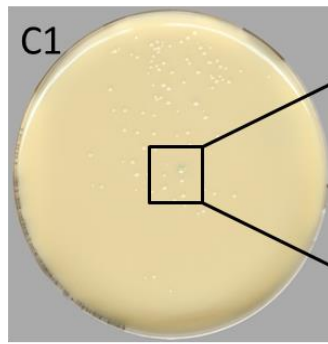
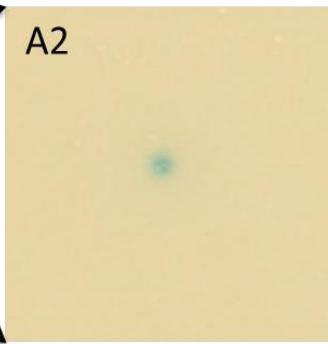
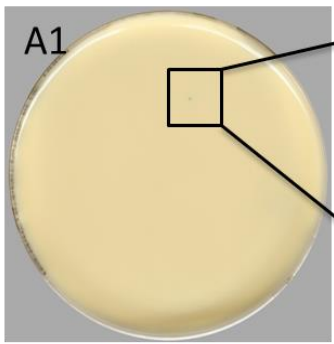


# Discrepant Analysis

**TABLE 3 Discrepant analysis of Manual Negative/Automation Positive Plates**

Discrepant Category	MN/AP <sup>a</sup>	Automation Positive Naked Eye Negative	Residual Matrix	Borderline Colors
Number of plates	5210	153	1189	3868

<sup>a</sup> Manual Negative/Automation Positive



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# Composite VRE Results

Comparison of 2 Chromogenic Agars for the detection of VRE using automated scoring

Chromogenic media	No. of specimens tested	Results (no.) <sup>a</sup>				Performance (% [95% CI]) <sup>b</sup>	
		MP/AP	MN/AN	MN/AP	MP/AN	Sensitivity	Specificity
Colorex VRE	86,956	4,296	73,664	8,996	0	100 (99-100)	89.1 (89-89)
Oxoid VRE	17,774	2,107	14,315	1,352	0	100 (99-100)	91.4 (91-92)

<sup>a</sup>MP/AP, manual Pos/automation Pos; MN/AN, manual Neg/automation Neg; MN/AP, manual Neg/automation Pos; MP/AN, manual Pos/automation Neg.

<sup>b</sup> CI, confidence interval.

TABLE 2 Discrepant analysis of Manual Negative/Automation Positive Plates

Discrepant Category	MN/AP <sup>a</sup>	Automation Positive 2 <sup>nd</sup> Manual Positive	Residual Matrix/Yeast	Borderline Colors
Number of plates	10,348	498	8,234	1,616

<sup>a</sup> Manual Negative/Automation Positive

Technologist Labor is  
\$40.00/hour  
(w/benefits)

Manual Processing

9.6 min/negative  
specimen<sup>a</sup>

\$6.40 in  
labor/negative  
specimen

\$563,065.60 in labor

Automated Processing

~2 min/negative  
specimen

\$1.33 in  
labor/negative  
specimen

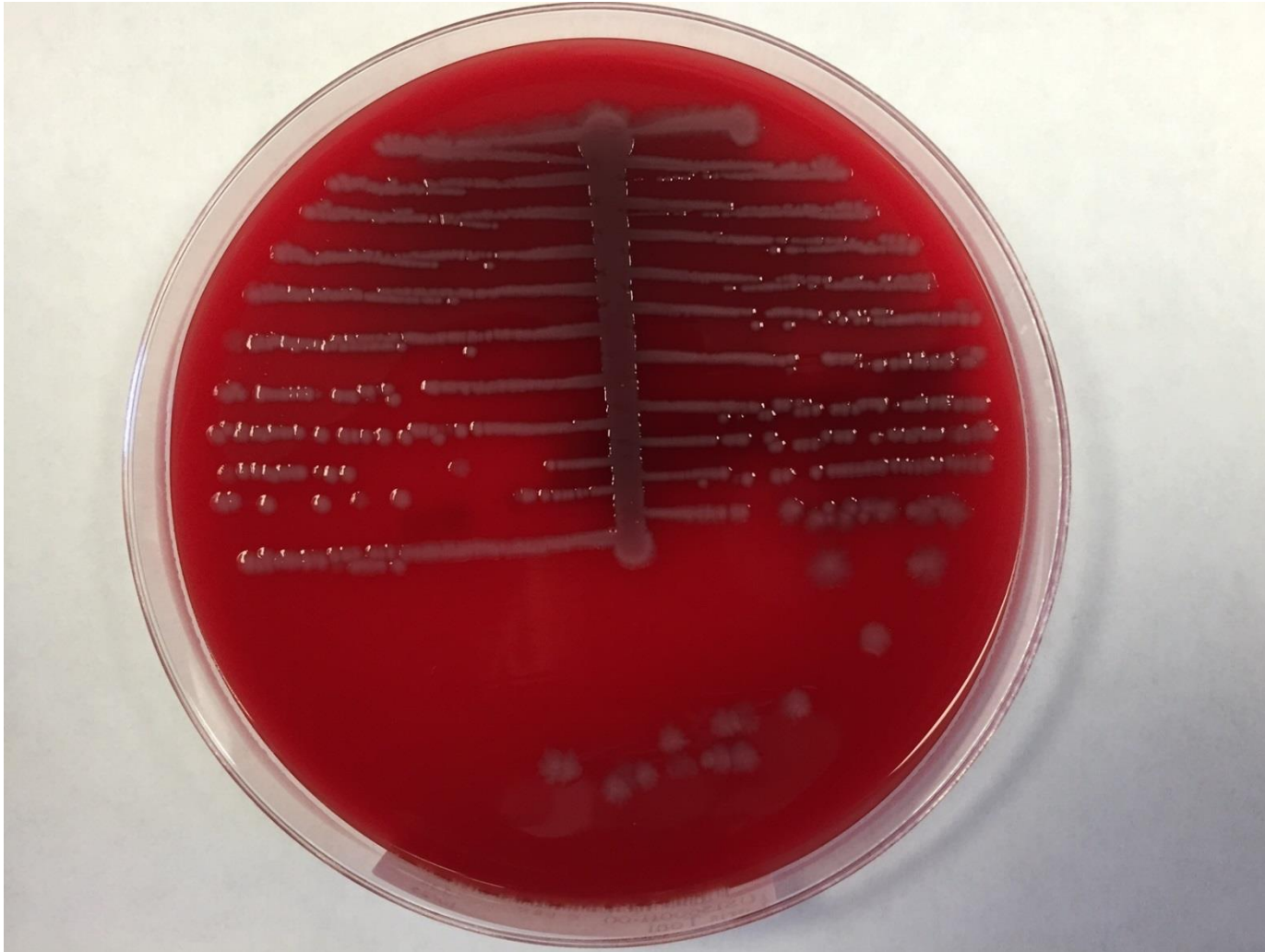
\$117,305.33 in labor

Cost of negative workup for  
the study (n = 87,979)

Savings = \$445,760.27

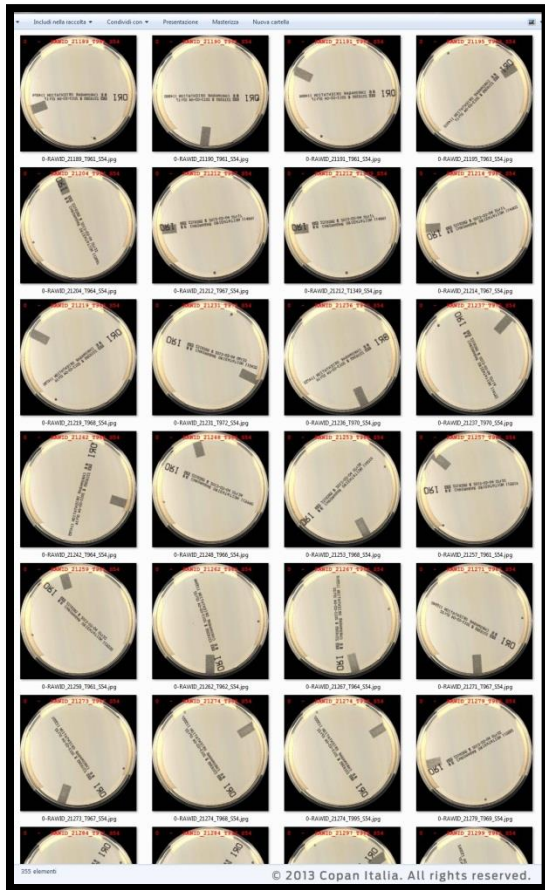


# Can it Quantitate?

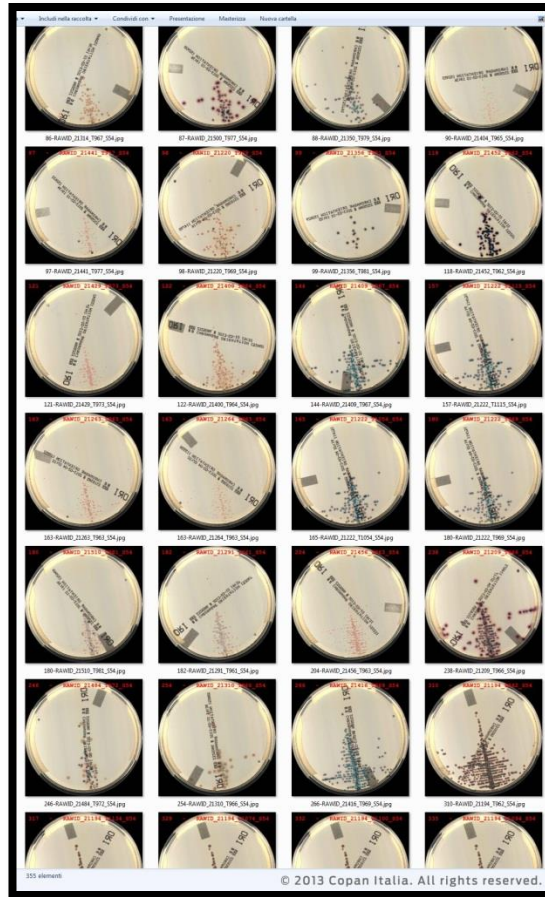


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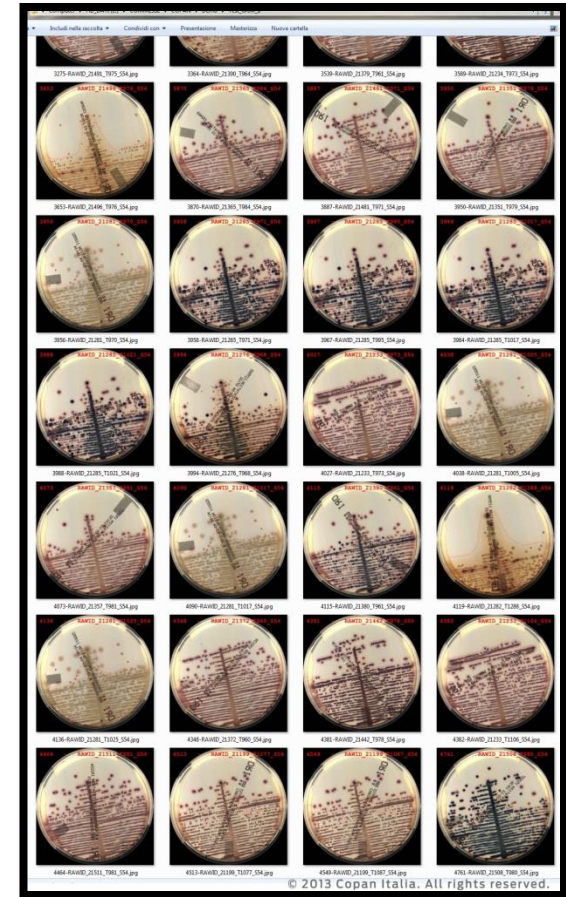
# Pre-Sorting of urine cultures – 1ul



0 CFU/ml  
24 cultures per screen



$10^4$  CFU/ml shows as  
approximately 10 colonies

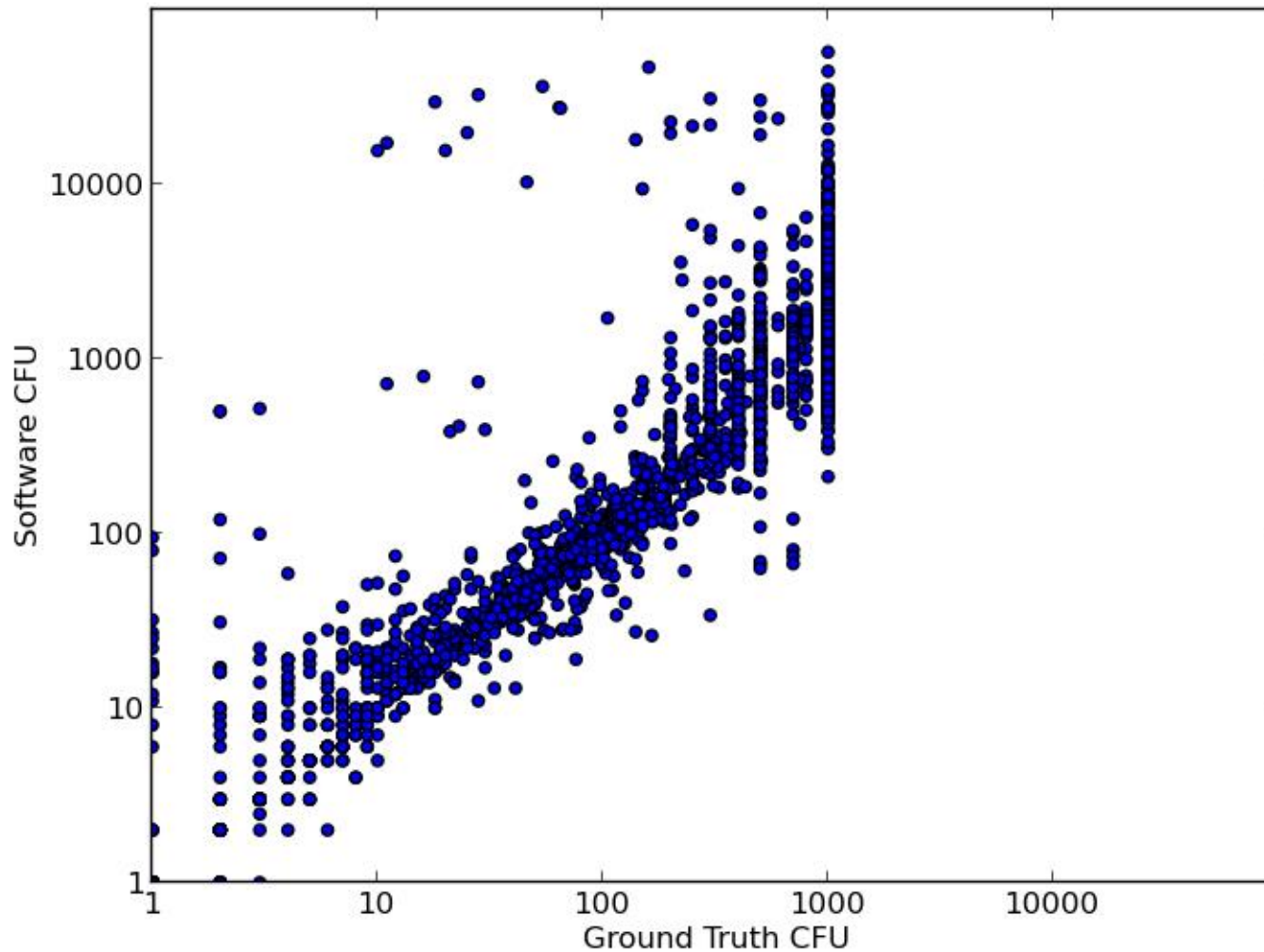


$10^5$  CFU/ml  
shows as  
approximately  
100 colonies



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# Blood Plate Reading



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# Plan Ahead



- Equipment – Initial investment
  - **Business case – this is most difficult (important) part**
  - WE NEED to prove ROI – return on investment - prior to purchase
    - What assurances are vendors giving us?
  - For a large lab **could consume large % of system capital budget**
    - **It's own project with “special funding”**
- **Change management**
  - What is change management-WORKFLOW ANALYSIS
    - Have we considered this concept fully in the laboratory before??
    - How will the automation impact the staffing??
- Information Technology needs – has to be considered!
- Costs of remodel – Facilities
  - Typically have to plan far enough in advance for most changes

# The Key is Informatics

