Microbiology- One Lab's Transformation from Ordinary to Extraordinary

Christy Saum, MT (ASCP)

Laboratory Specialist-Microbiology

Bryan Medical Center

Great Plains Chapter CLMA

THE RESOURCE FOR LABORATORY PROFESSIONALS

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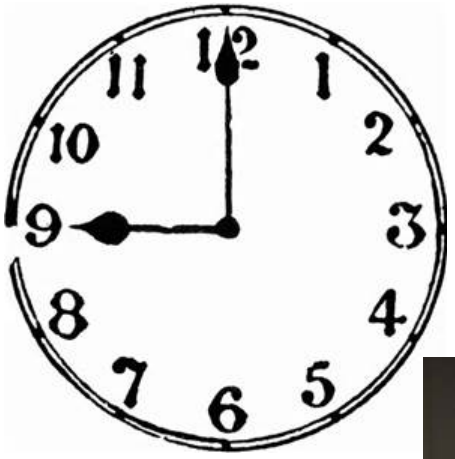
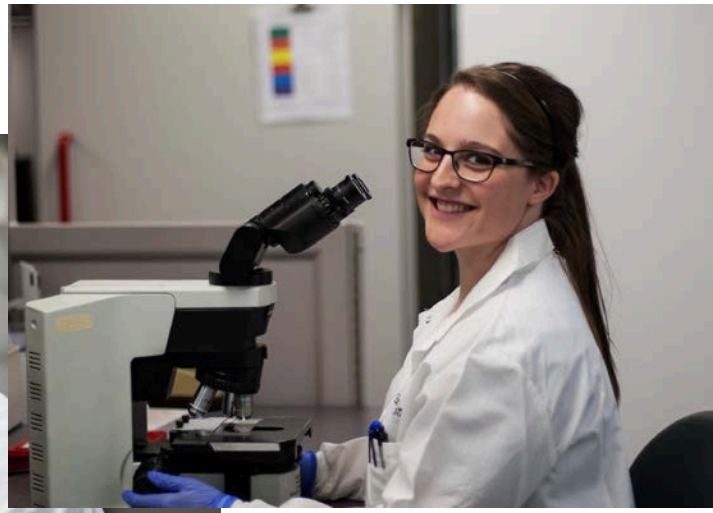
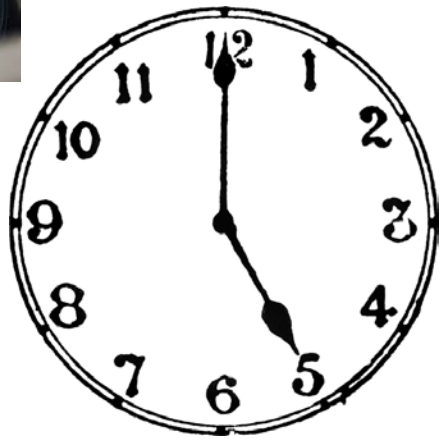


In the Beginning





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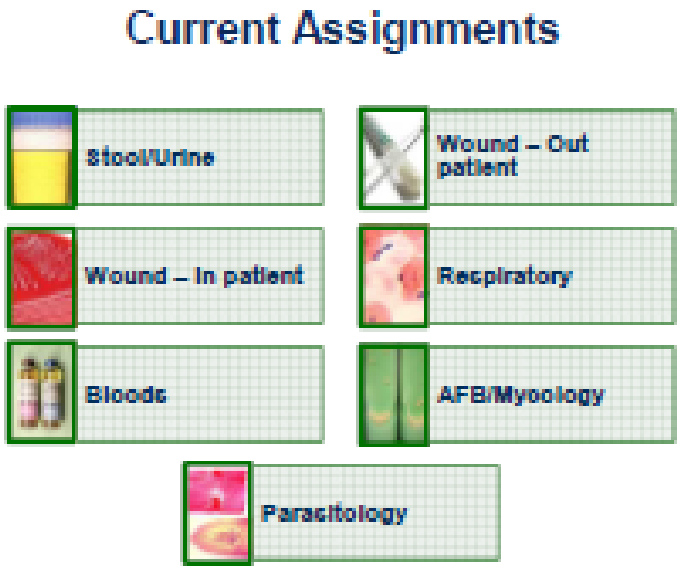
In the Beginning



Current bench assignments create

- Silos which are not conducive to team work
- Assignments are not patient centric
- Unbalanced workload:
- The amount of effort on non-value added activities is limiting the potential of the department.
- Capacity, productivity and patient care are not optimized

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In the Beginning

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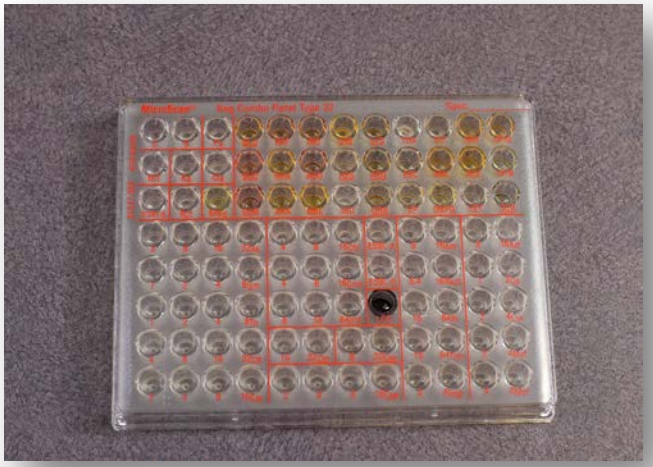
In the Beginning

Microscan for ID and Susceptibilities



Biochemicals

Rapid API strips for Corynebacterium, Anaerobic Gram positive rods, and Enterics

Unidentifiable organisms sent to a reference laboratory 2-5 days TAT

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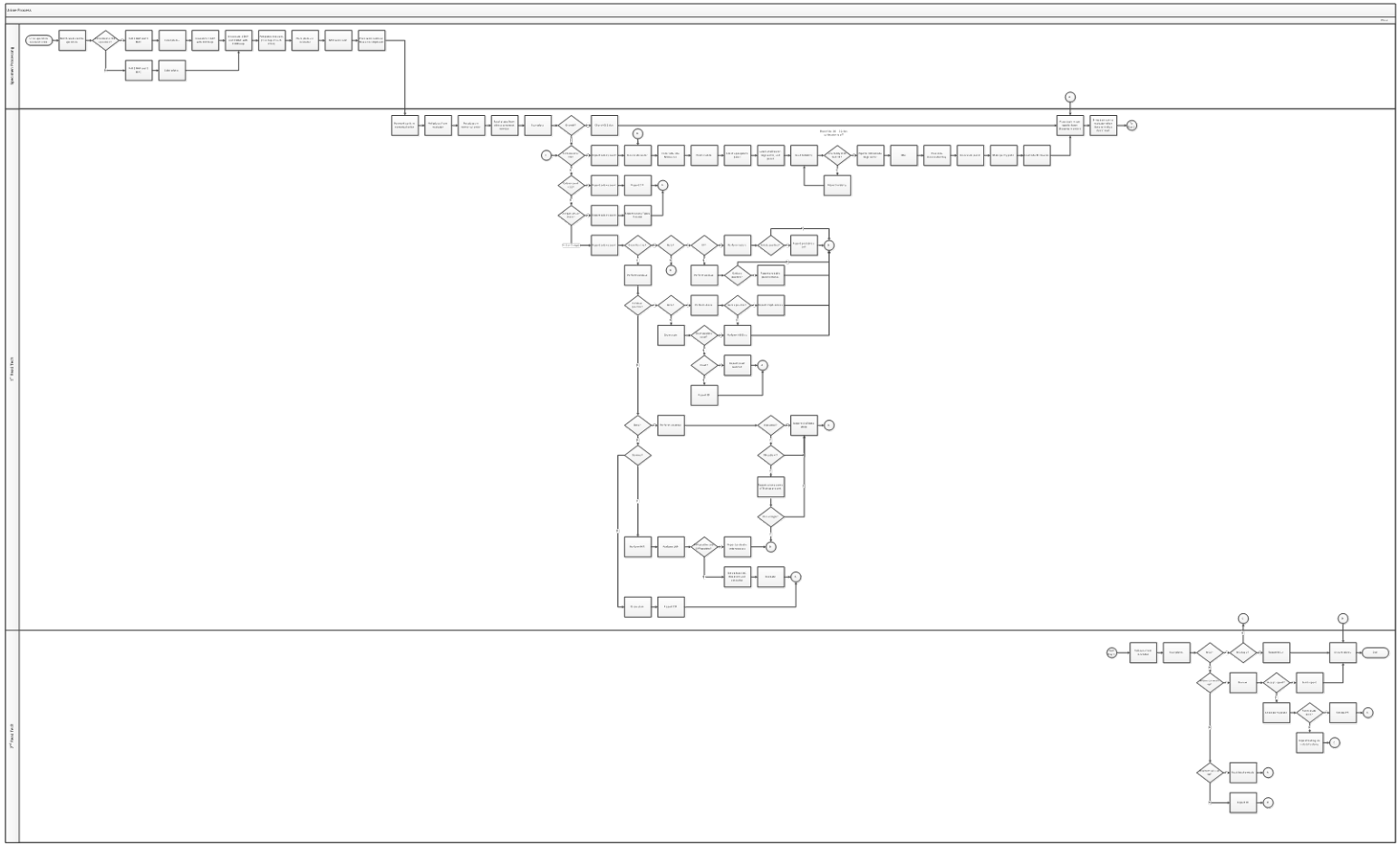
In the Beginning

Specimen Flow

In the Beginning

- Held all urine cultures for 2 days
- Worked up everything in wound cultures
- Manually gram stained >100 slides per night
- Organism identifications in positive blood cultures weren't reported until the next day
- Some organisms took 7-10 days to identify with biochemicals.
- Lots of waste with Microscan consumables
- Non value added work-putting workcards and plates in numerical order

In the Beginning



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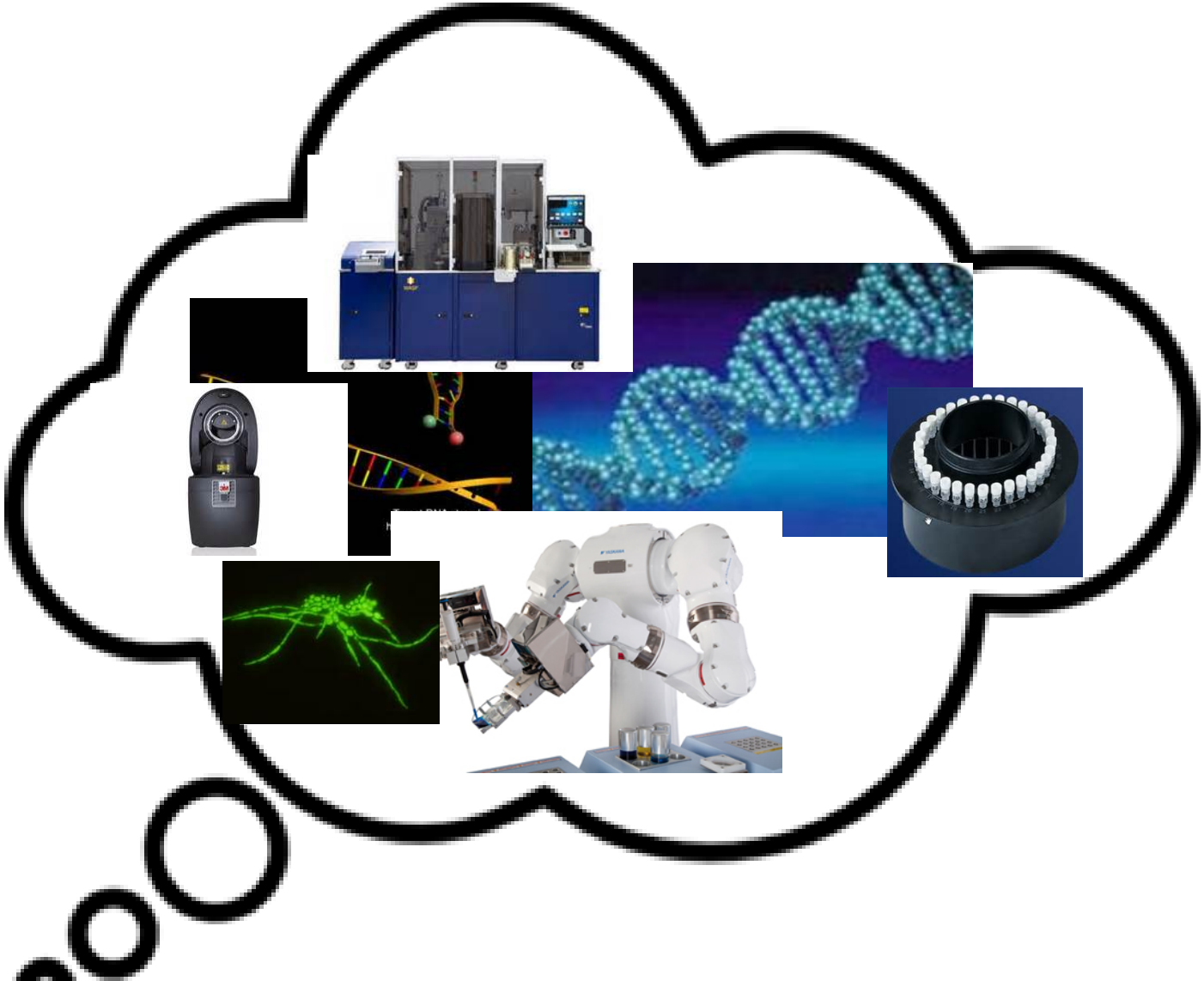

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The Journey Begins

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The Journey Begins

MALDI-TOF Mass Spectrometry

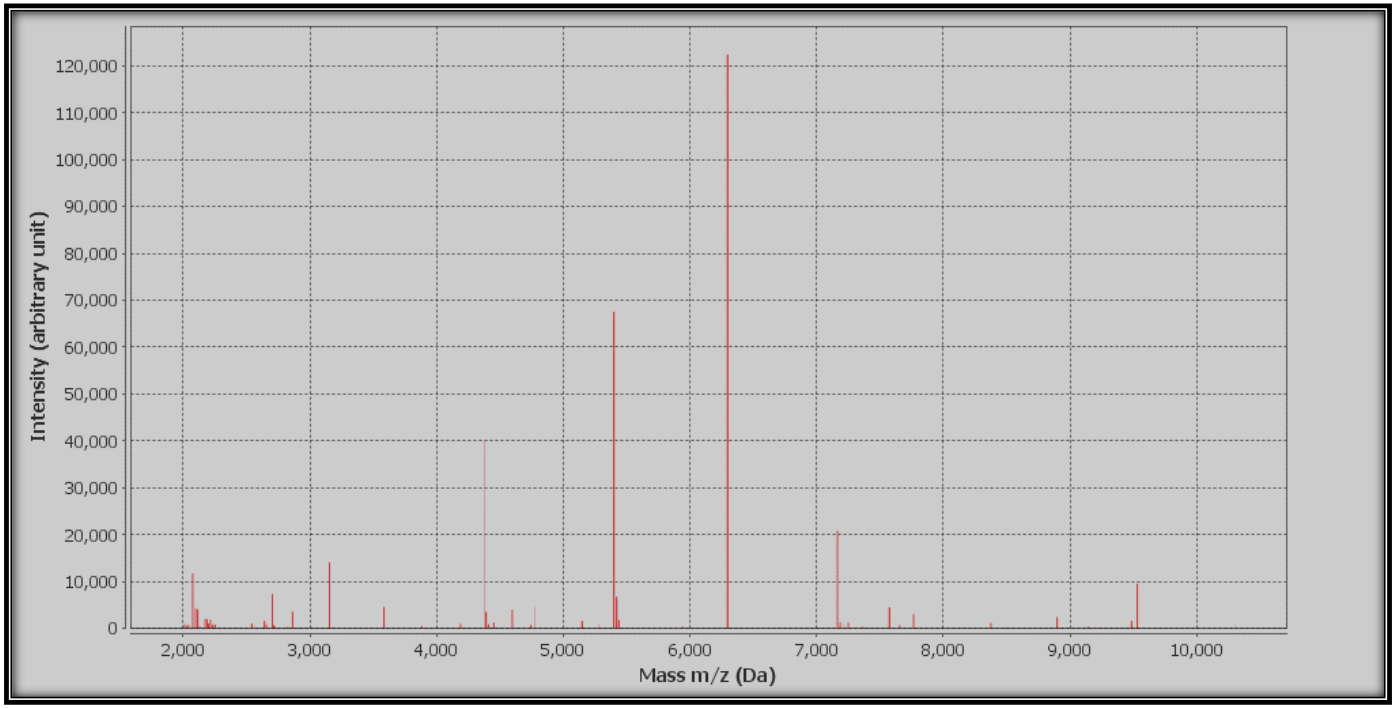
(Matrix Assisted Laser Desorption Ionization – Time Of Flight)

- Proteins in the organism become ionized by the laser
- The charged molecules are separated based on their mass-to-charge ratio
- A particle detector records the charged molecules as they reach an electrode surface in the time of flight vacuum.

  The charge is usually a constant, therefore mass becomes the determining factor.

  Heavier particles move at slower speeds, while lighter particles move at faster speeds.

The Journey Begins



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The Journey Begins

MALDI-TOF can identify organisms and yeasts in <u>minutes</u>

- After initial 18 hours of growth (required)
- A **<u>very small amount</u>** of specimen is placed on a designated spot on the slide
- The slide is then loaded into the Vitek MS (MALDI-TOF)
- The Vitek MS holds 4 slides
  - Each slide has 48 wells
- **<u>Identification is available with in 2-5 minutes</u>**

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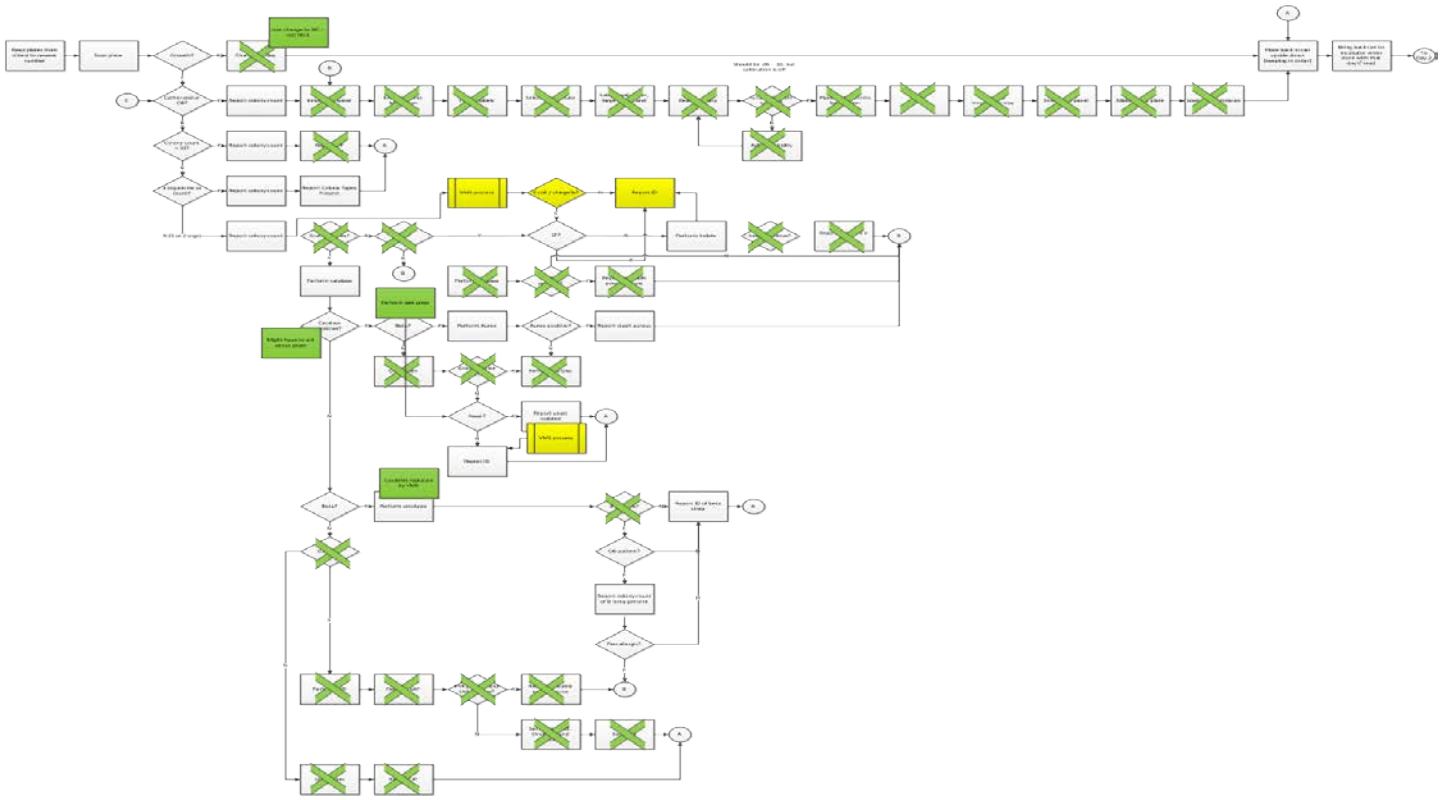

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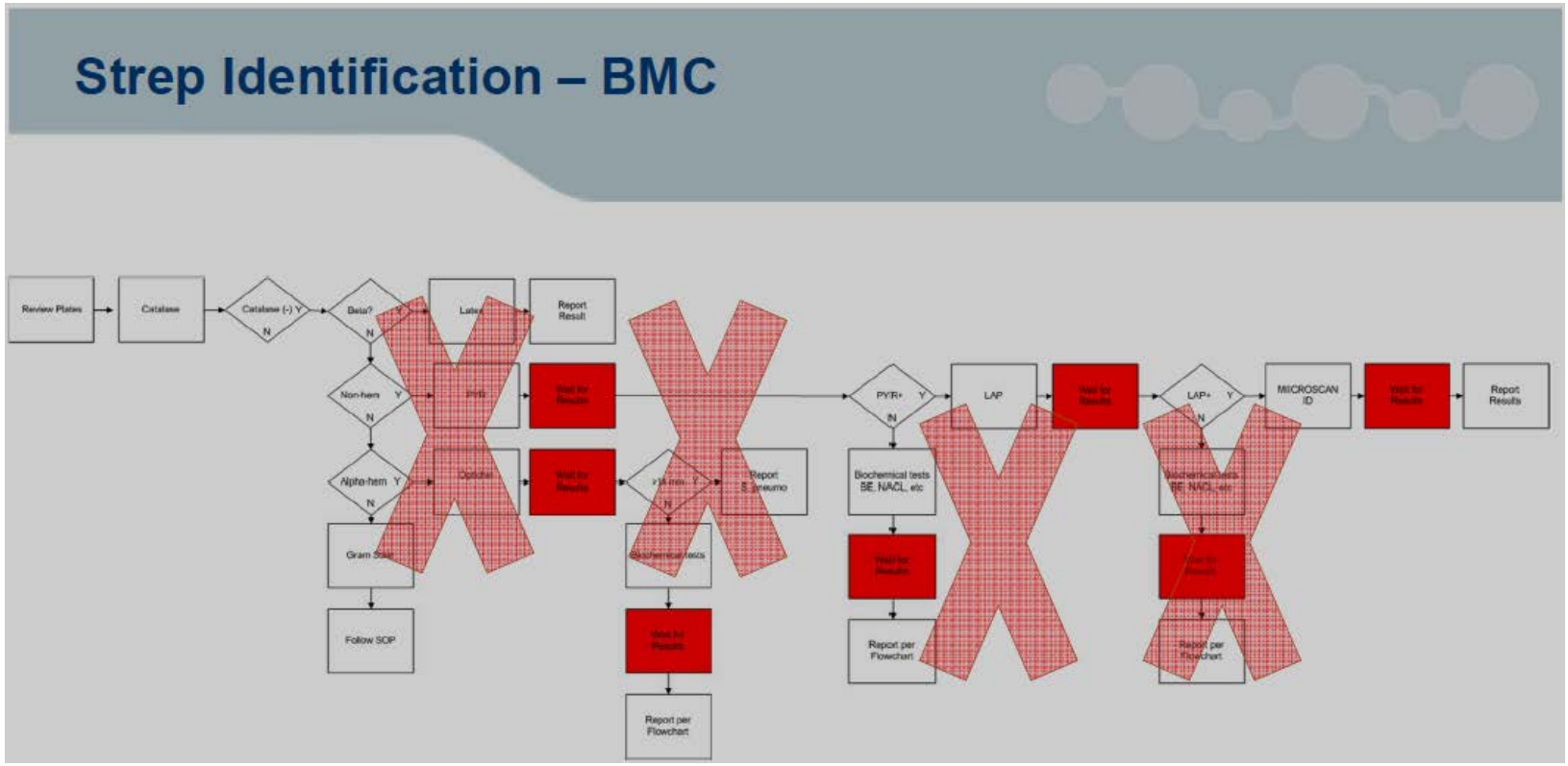

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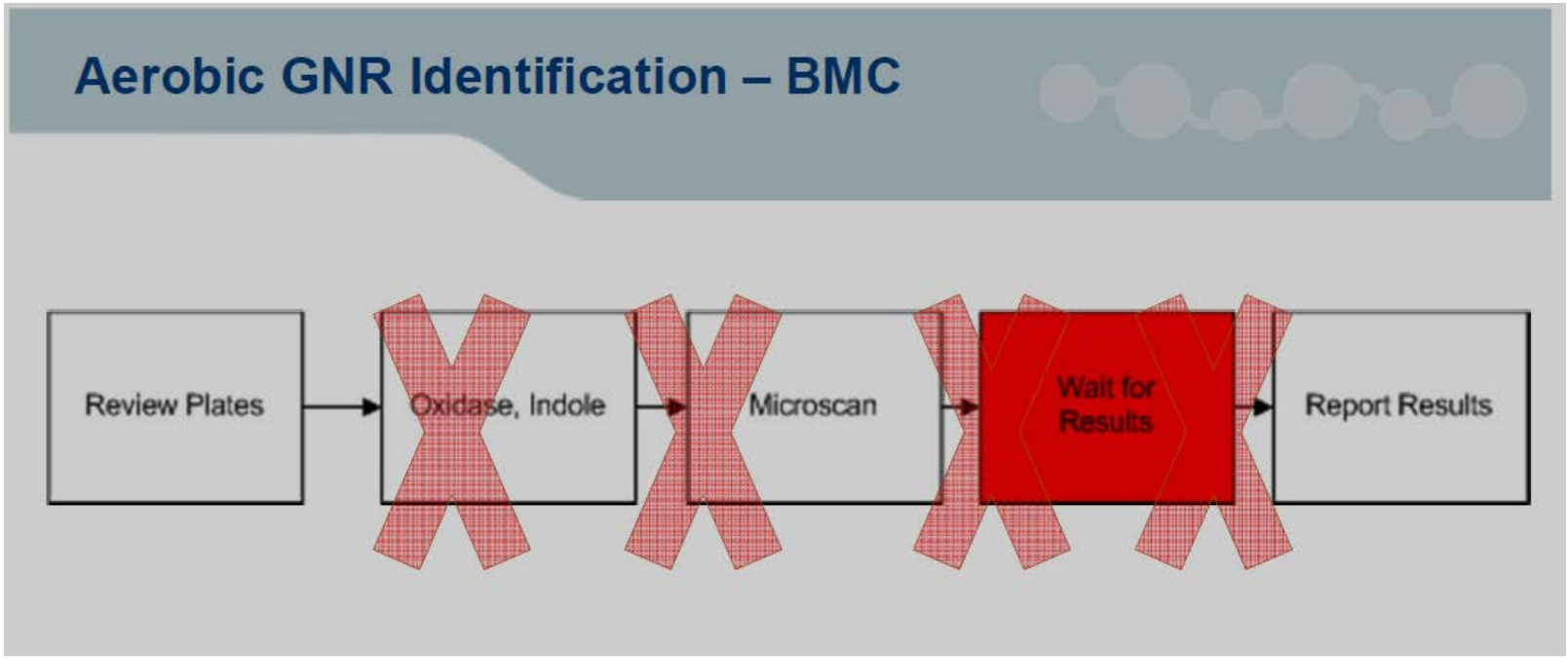

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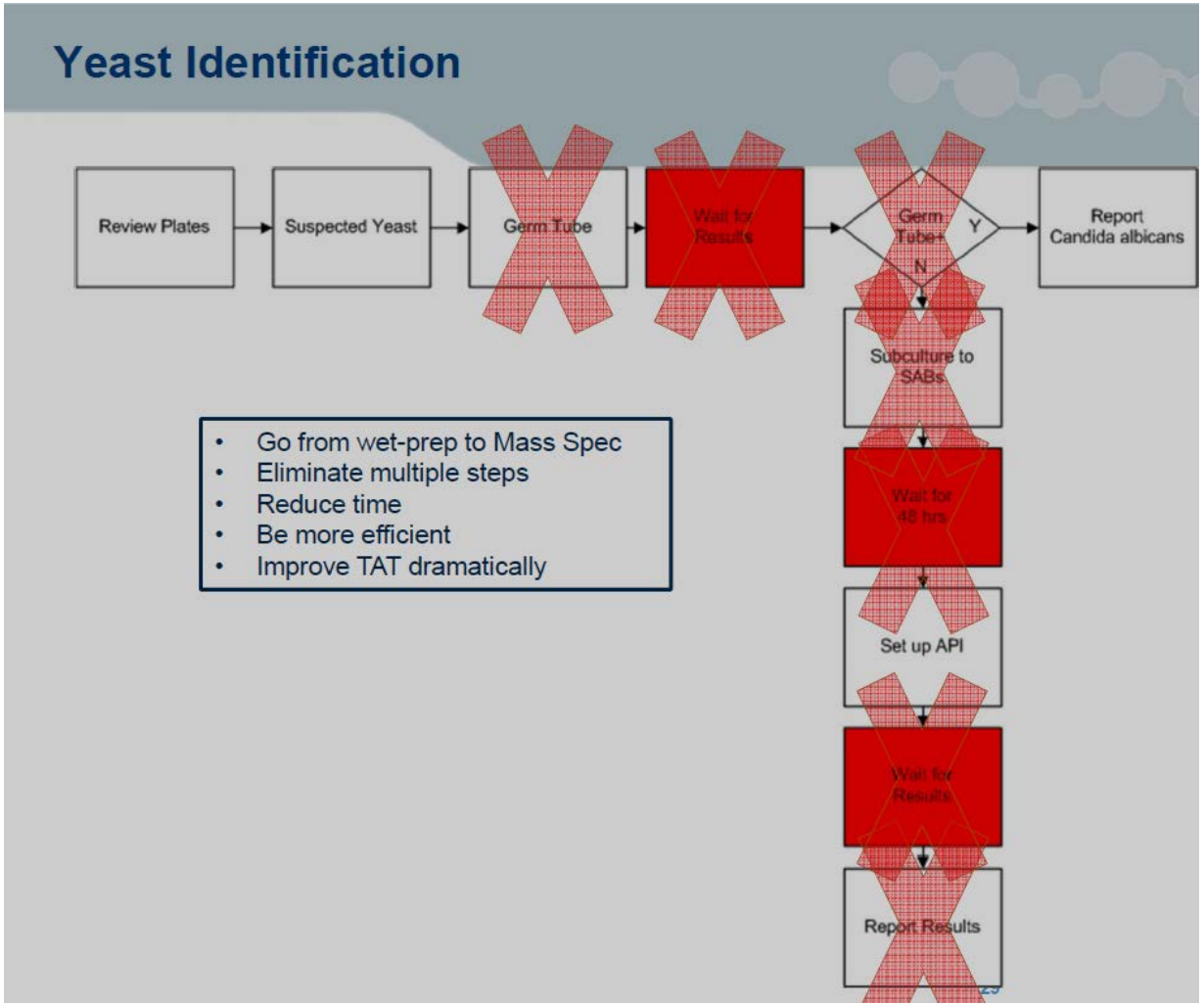

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The Journey Begins

Making of the ROI

- Reduction of media on hand
  - OF media
  - RFA media
  - CTA media
  - Key tabs
  - Heart Infusion broths
  - Discs: PYR, LAP, Anaerobe discs (Bile, Kanamycin), X, XV, V, Butyrate, Novobiocin
  - Bile esculin, NACL, TSI, decarboxylase broths, esculin, nitrate, VP broth, germ tubes

The Journey Begins

Making of the ROI

- Reduction of identification methods
    - 5 Microscan panels
    - Microscan consumables (waters, inoculators, panels, covers, reagents)
    - Identification kits (API's)
    - Serotyping kit for beta Streptococcus
    - Send out testing on organisms we were unable to identify

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The Journey Begins

Making of the ROI

- Staff
  - Eliminate 10-18 hours of OT per two week pay period
  - New staff lack experience in identifying uncommon organisms which can lead to misidentifications, improper/inadequate antibiotic therapy, decreased positive patient outcomes
  - Physician satisfaction with improved TAT

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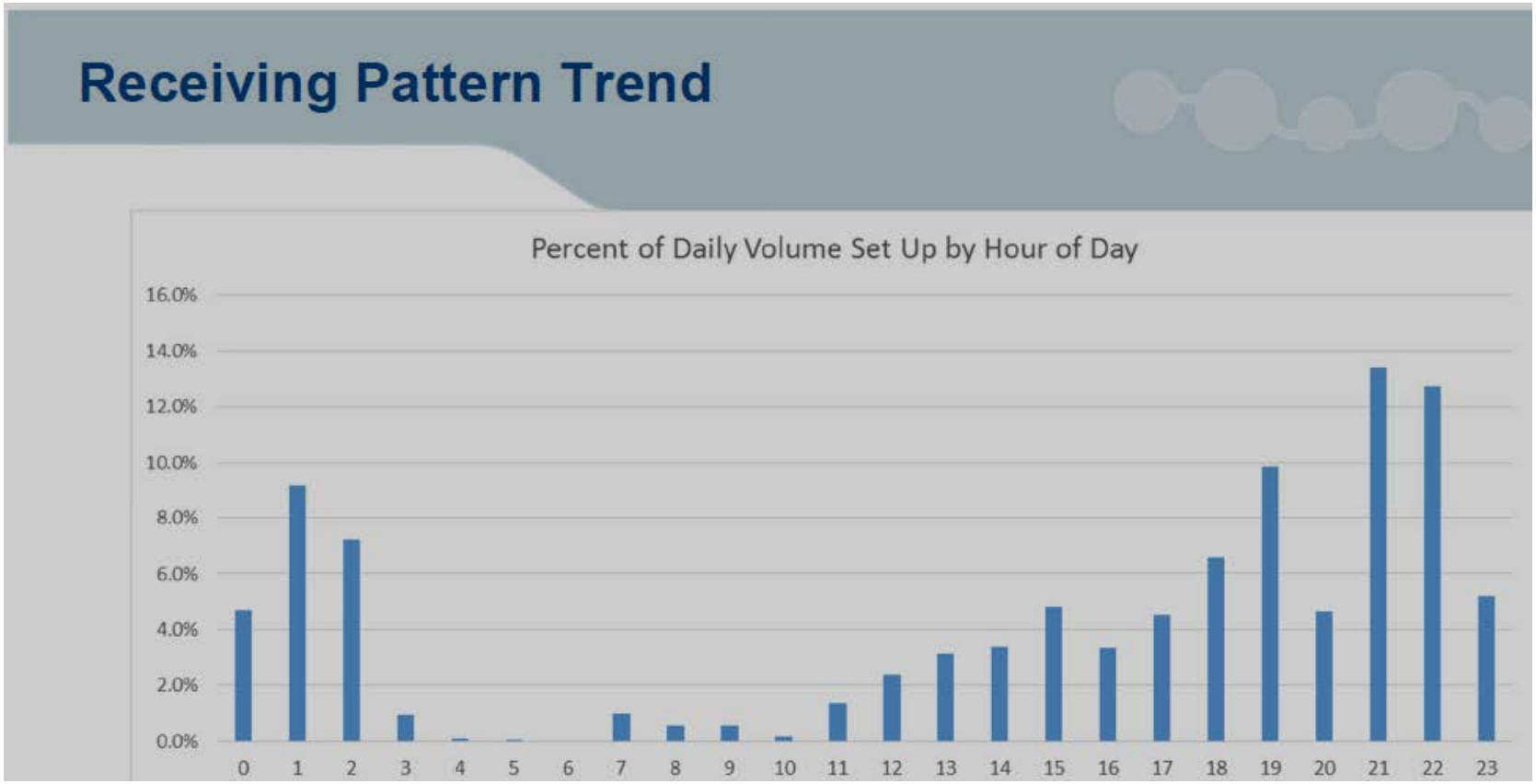
The Journey Begins



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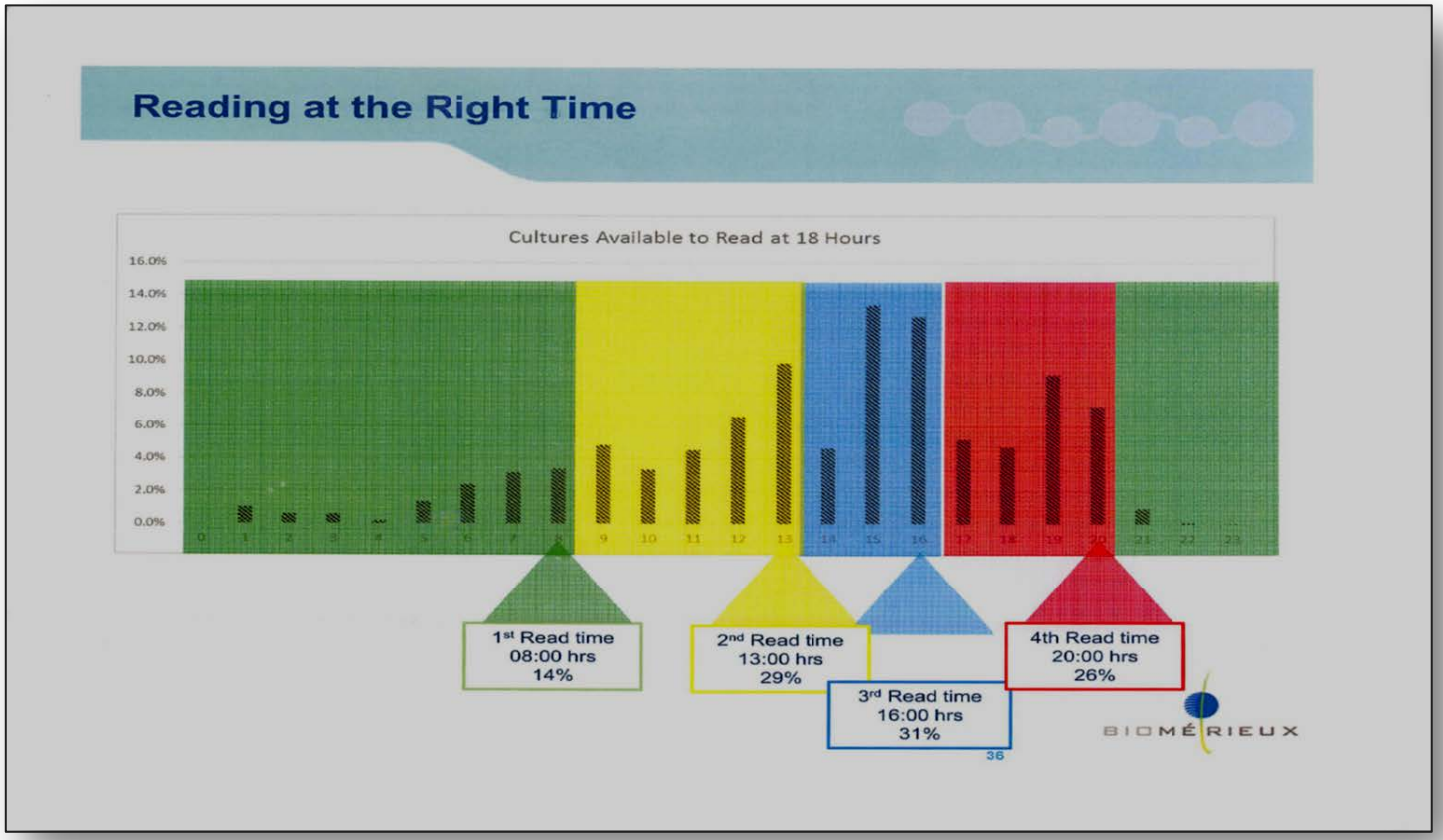
The Journey Begins



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The Journey Begins

- Create 3 shifts of plate readers:
  - 0800-1700
  - 1300-2100
  - 2200-0600
- More support for the later hours when the majority of specimens are received
- Reading and reporting results 24/7 (first in/first out)

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The Journey Begins

CULTURE LOADING & READING SCHEDULE

COLOR	INCUBATION TIME	READ TIME
GREEN	0:00- 3:59	21:00 (9p)
ORANGE	4:00 – 7:59	01:00 (1a)
YELLOW	8:00 – 11:59	05:00 (5a)
PINK	12:00- 15:59	09:00 (9a)
BLUE	16:00 – 19:59	13:00 (1p)
PURPLE	20:00 – 23:59	17:00 (5p)

- The "Incubation Time" is the actual time the plate is placed in the incubator

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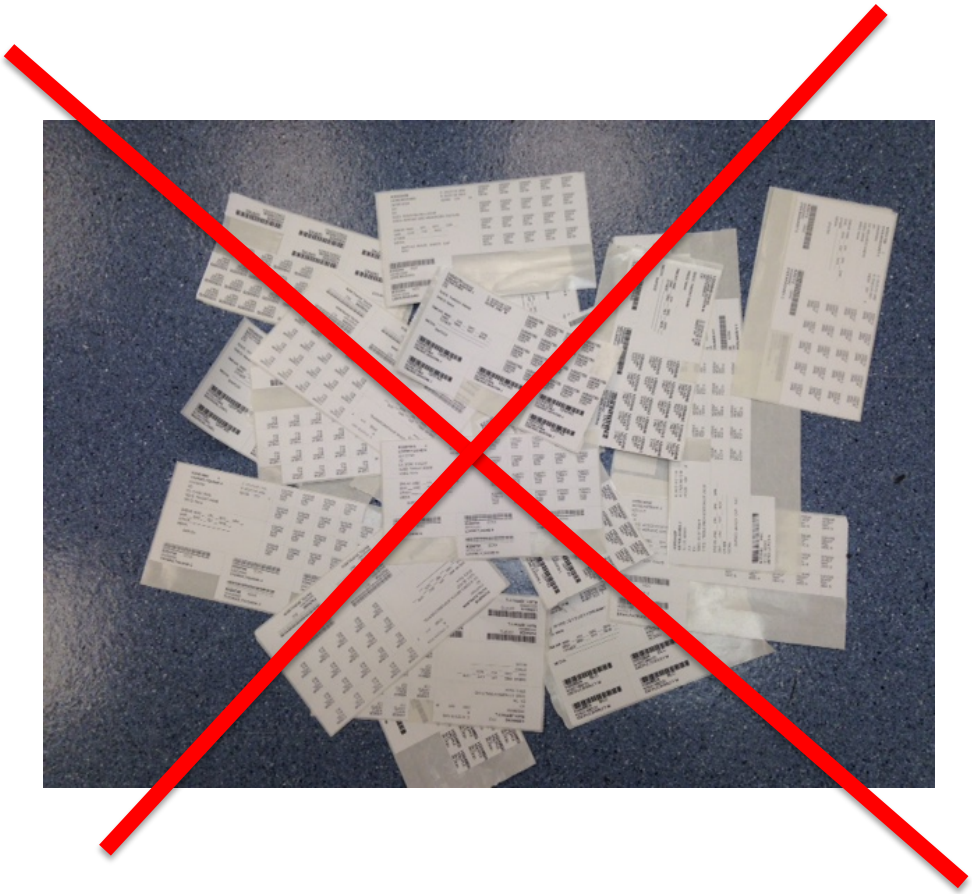
The Journey Begins

No more workcards!

Scan the patient information from the plate!



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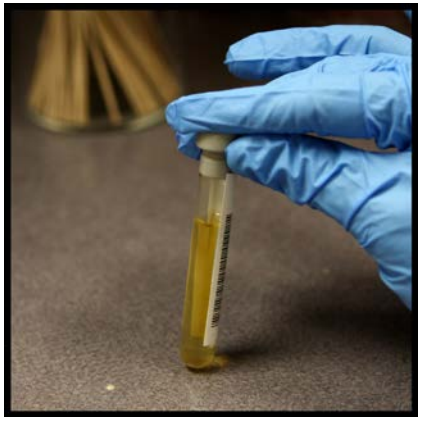
The Journey Begins

- We average **107 <u>urine cultures</u> a day** and hold all plates for two days.

107 x 2 plates= 214 plates
214 plates x 2 days = 428 plates
428 plates / 16 per can = 26 cans of urines every day



- **2 Techs on day shift ➡ 1 Tech per shift**
  Continuous reporting
- **Recommendation**: Final NG and contaminated specimens after 18 hours of growth, unless invasively collected (cath). Majority of organisms that appear on day two are contaminants - less touches saves time.

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The Journey Begins

New wound culture reading process

1. Q score:

- Up to 3 organisms can be considered potential pathogens and be worked up (ID/AST) from a good quality specimen. (Q3)
- The lower the quality of specimen the fewer the organisms worked up
- Q0 provide only morphologic ID of organisms present – no work up

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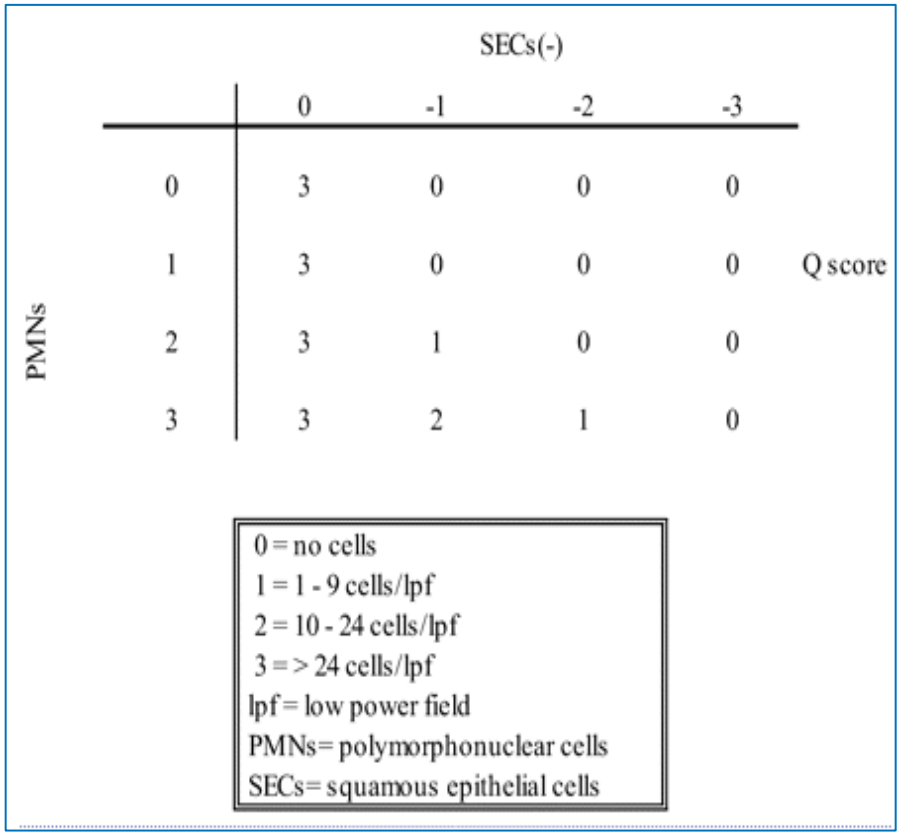
The Journey Begins



PMNs \ SECs(-)	0	-1	-2	-3
0	3	0	0	0
1	3	0	0	0
2	3	1	0	0
3	3	2	1	0

Q score

0 = no cells
1 = 1 - 9 cells/lpf
2 = 10 - 24 cells/lpf
3 = > 24 cells/lpf
lpf = low power field
PMNs= polymorphonuclear cells
SECs= squamous epithelial cells

SECs

PMNs	0	-1	-2	-3
0	3	0	0	0
1	3	0	0	0
2	3	1	0	0
3	3	2	1	0

0 = No Cells
1 = 1-9 cells/lpf
2 = 10-24 cells/lpf
3 = >24 cells per lpf

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The Journey Begins

New wound culture reading process (continued)

2. Q234:

Culture work up is based on number of potential pathogens present

- < 2 potential pathogens work up with ID/AST
- 3 potential pathogens look to direct Gram stain (work up to two if they are seen in the direct stain, if all 3 potential pathogens are seen in direct stain perform identifications only
- 4 potential pathogens perform identifications only on isolates

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The Journey Begins

Advantages of Q Systems:

- Consistent approach for interpreting cultures
- The systems are based on the quality of the specimen
- Work up is based on organisms seen in the direct Gram stain *(At least 10^5 organisms must be present to visualize them in the direct smear)*
- Limits the number of organisms worked up from mixed cultures- minimizing reporting of misleading information
- No potential pathogen is ever ignored
- Guidelines that can be modified to fit your institution

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The Journey Begins

Q234 with modifications:

- Work up all organisms isolated from a sterile body site
- Non-sterile body site culture workup is based on potential pathogens present
    - < 2 = perform ID/MIC
    - 3 = refer to Gram stain for guidance
    - >4 = perform identifications only <u>unless:</u>
        - S. aureus- *rule out MRSA*
        - Enterococcus- *rule out VRE*
        - *Always perform ID/MIC on Pseudomonas*
        - *Always identify beta streptococcus*
        - *Always identify C. perfringens*
        - *Always identify P. acnes and Actinomyces species*
    - Anaerobes (identify if predominant organism or seen in Gram stain) if several report mixed anaerobes present

The Journey Begins

Along with the new wound reporting process:

- Implementation of COPAN eSwabs replacing 3 types of collection swabs with one eSwab
- New wound collection procedure for physicians and nurses collecting these types of specimens
    - Superficial wounds – anaerobic cultures not needed on all specimen sources (such as: boils, cysts, lacerations, cellulites)
    - To swab or not to swab
    - Cleansing the collection site

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The Journey Begins

In the Beginning

Specimen Flow

Total Renovation

Renovations:

- Moved 4 incubators to be closer to the set up area and culture reading benches.
- Took out a wall in the AFB room which accommodated space to bring in incubators, another sink for staining and the MGIT reader
- Moved the BACTEC FX and a countertop biosafety cabinet (hood) closer to the blood culture bench
- Installed the Vitek MS and Vitek 2 near the culture reading benches
- Added counter space to the set-up and specimen drop off area
- Dual monitor computers
- OL monitor- to monitor STAT testing

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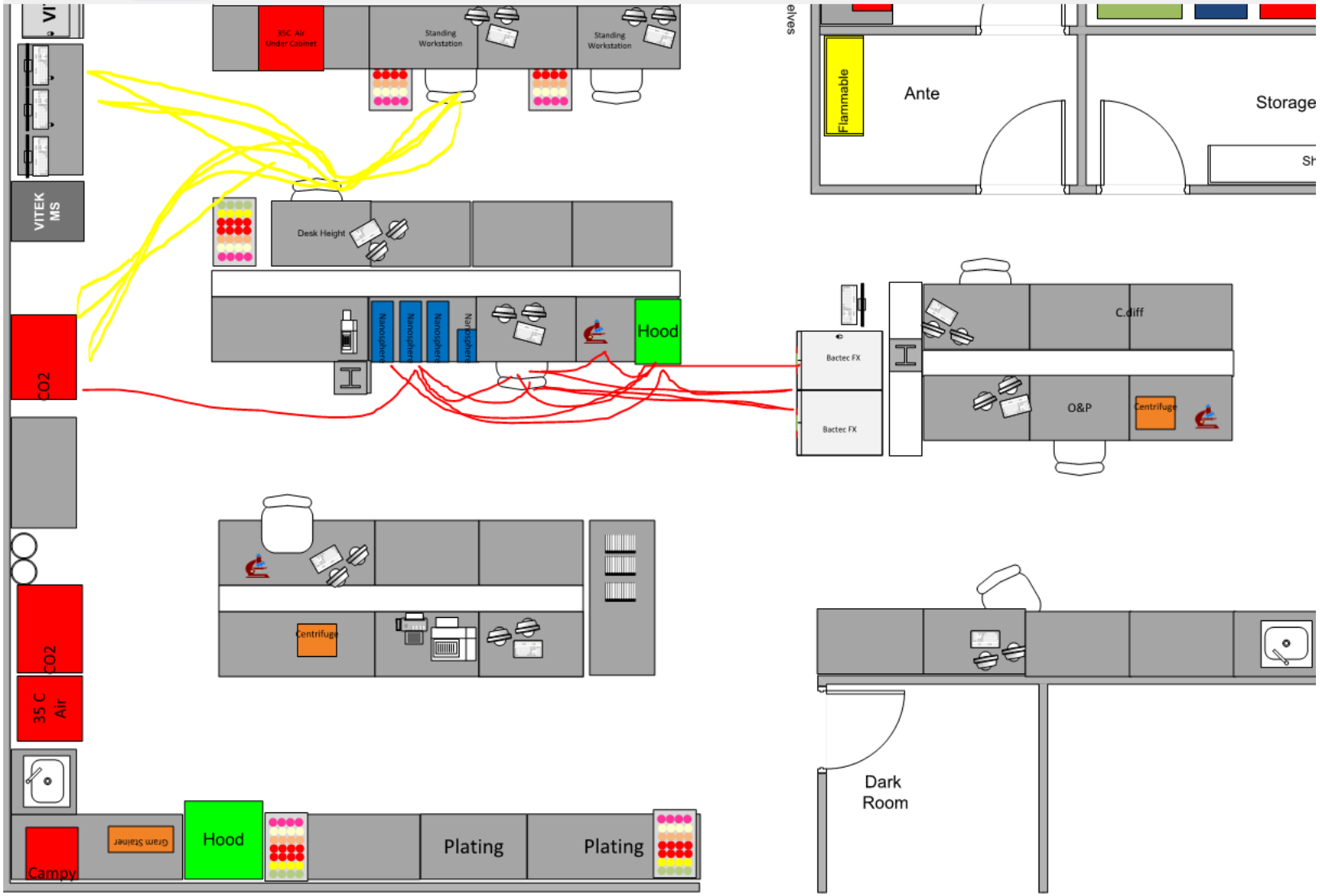
New Work Flow



Current Day

- Urine cultures with NG or contamination are reported at 18 hours – eliminates multiple touches
- Eliminated non value added work – putting workcards and plates in numerical order
- Elimination of Bunsen burners/ use disposable loops
- Standardized reading of wound cultures
- Multiple read times including 0200 – smaller more manageable workload (first in first out) **every specimen matters**
- Vitek MS virtual prep station – able to set ID and MICS at the bench while reading cultures – no large batches
- Vitek MS identifications reported at 18 hours
- Renovation of laboratory – closer proximity to needed supplies and incubators

Current Day

Before and After TAT Comparison

BIOMÉRIEUX

Baseline	Pos Urine Median	Pos Urine Q3	Neg Urine Median	Neg Urine Q3
Bryan Health	**40**	**46**	**37**	**40**
After Transformation Data: 2/19/16-3/7/16	41	46	19	25

Negative Turn Around Time decreased by 49% due to restructuring of culture reading processes.

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New Equipment

S	E	P	S	I	S
Shivering, fever, or very cold	Extreme pain or general discomfort ("worst ever")	Pale or discolored skin	Sleepy, difficult to wake up, confused	"I feel like I might die"	Short of breath

Each hour of delay to antibiotic administration has a 7.6% increase in mortality

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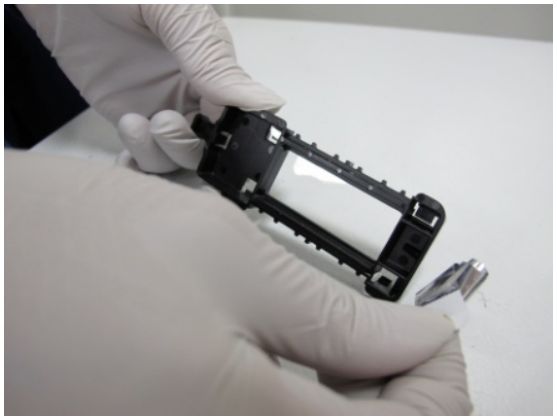
New Equipment

New Equipment

Nanosphere Verigene MicroArray Methodology



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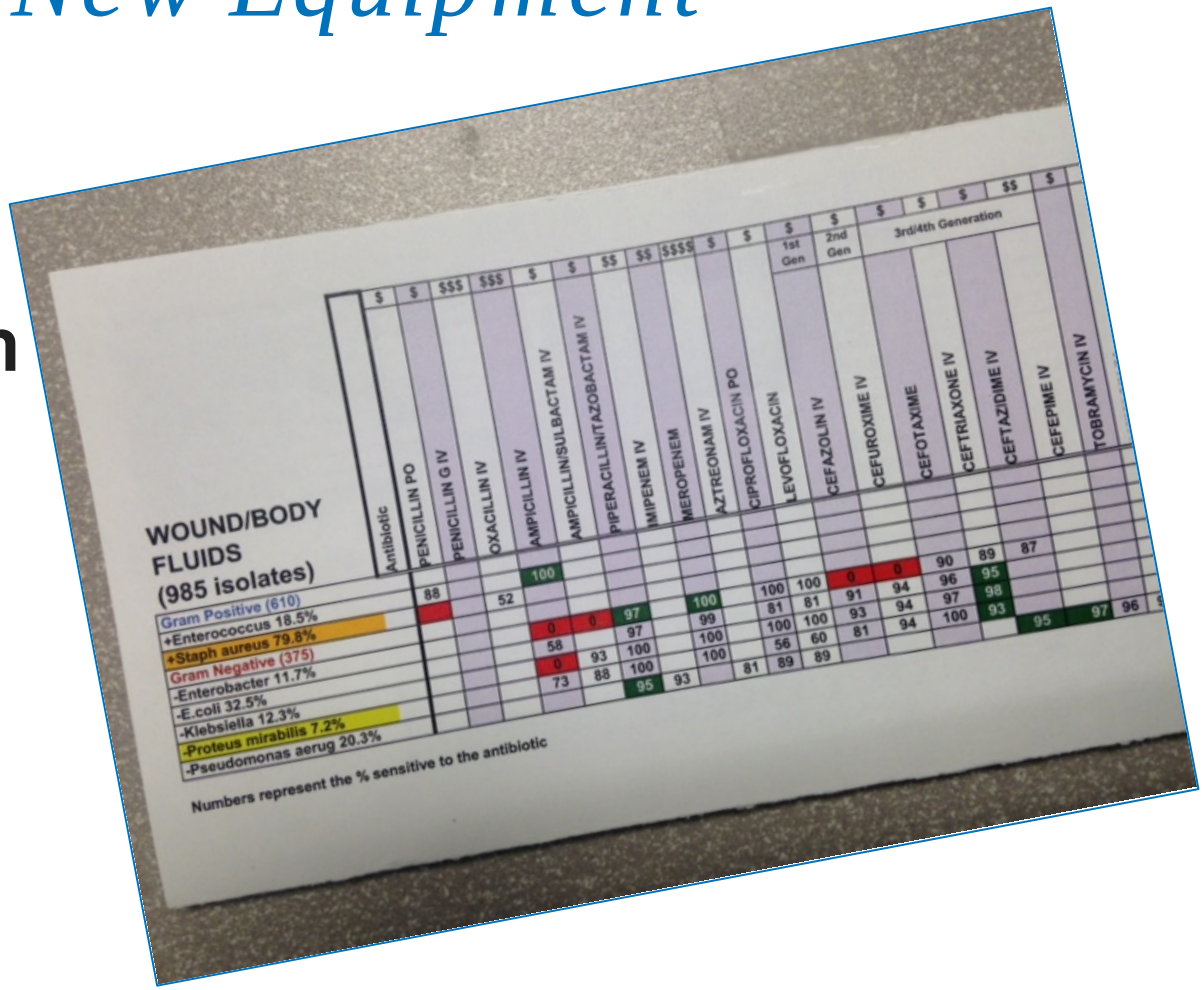
New Equipment

Faster identification = Earlier treatment with appropriate antibiotics



WOUND/BODY FLUIDS (985 isolates)

Antibiotic	$ PENICILLIN PO	$ PENICILLIN G IV	$$$ OXACILLIN IV	$$$ AMPICILLIN IV	$ AMPICILLIN/SULBACTAM IV	$ PIPERACILLIN/TAZOBACTAM IV	$$ IMIPENEM IV	$$ MEROPENEM	$$$$ AZTREONAM IV	$ CIPROFLOXACIN PO	$ LEVOFLOXACIN	$ 1st Gen CEFAZOLIN IV	$ 2nd Gen CEFUROXIME IV	3rd/4th Generation $ CEFOTAXIME	$ CEFTRIAXONE IV	$ CEFTAZIDIME IV	$$ CEFEPIME IV	$ TOBRAMYCIN IV
Gram Positive (610)	88		52	100				100			100	100	0	0	90	89	87	
+Enterococcus 18.5%											81	81	91	94	96	95		
+Staph aureus 79.8%				0	0	97		99			100	100	93	94	97	98		
Gram Negative (375)				58		97		100			56	60	81	94	100	93		
-Enterobacter 11.7%				0	93	100		100			81	89	89				95	97
-E.coli 32.5%				73	88	100	95	93										
-Klebsiella 12.3%																		
-Proteus mirabilis 7.2%																		
-Pseudomonas aerug 20.3%																		

Numbers represent the % sensitive to the antibiotic

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New Equipment

Multiplex Assay (Nanosphere Verigene)

- Directly add blood from the positive blood culture bottle to the sample well
- Both Gram negative and Gram positive identifications are done in 2 hours, also detects resistance factors (mecA, and van A and B)
- Consult the antibiogram
- Appropriate antibiotic therapy- de-escalation of initial broad spectrum antibiotics
- Better patient outcomes

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New Equipment

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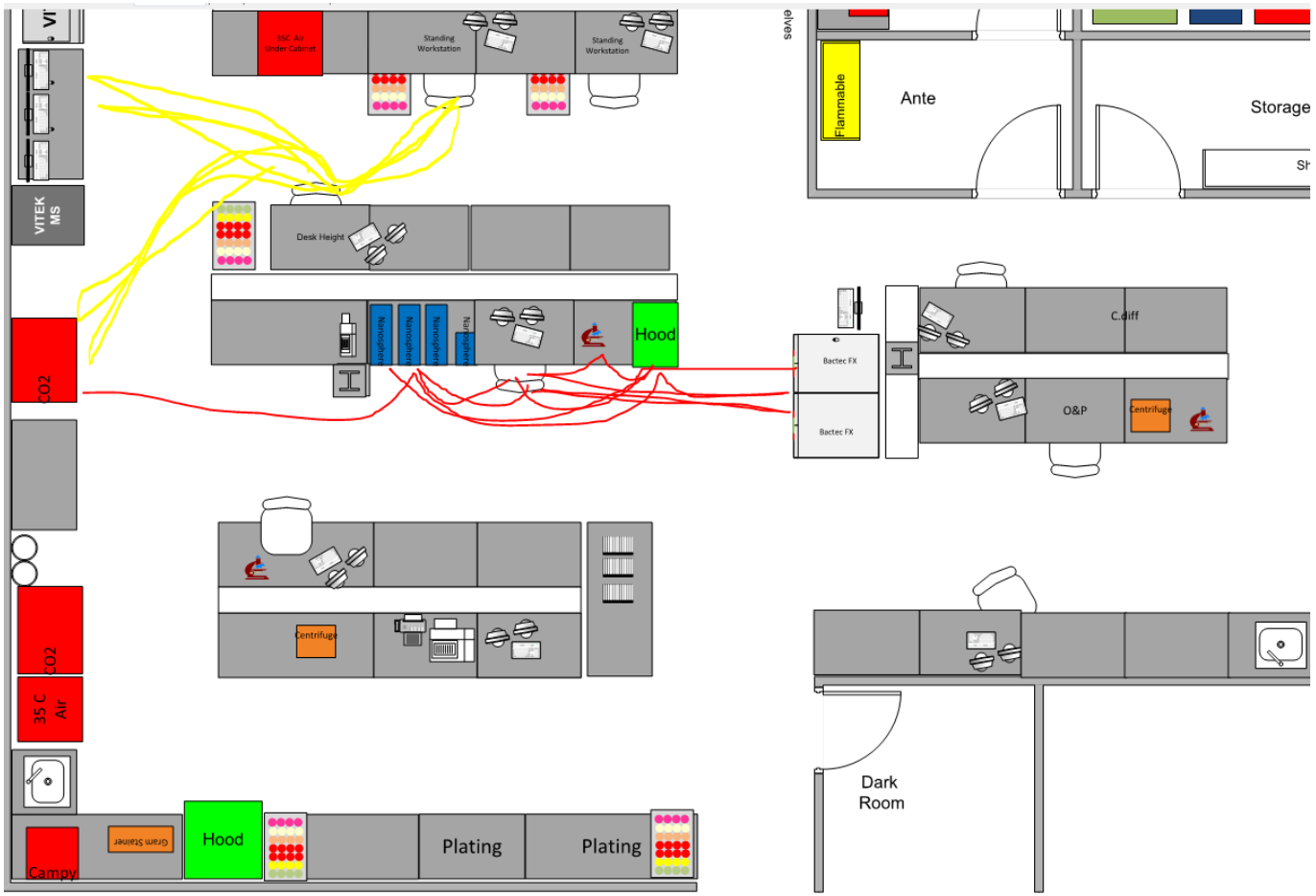
New Equipment

Automated Gram Stainer (MGS 80):

- The MGS 80 incorporates a patented computerized "electronic eye" to perfectly time the decolorization of every sample regardless of the smear thickness, guaranteeing that all slides are processed correctly every time
- During validation on duplicate patient slides, bacteria was seen and noted on the automated MGS-80 slides and **not** on the original manual Gram stains. (Mostly anaerobes and other Gram negative rods)
- Able to continually add and process stains – no longer somebody standing at the sink or purple fingers
- Reading of stains was getting put off until the end of the shift

New Equipment



New Equipment

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New Equipment- GI Panel

Case Study:

- 17 year old female student is seen in the ED. She complains of diarrhea, abdominal cramps, and gas for the last 3 days. She babysits her nephews and other neighborhood children on most weekends to earn some extra spending cash. She had sushi for lunch 2 days ago. Her roommate just returned from Cancun last weekend but she has no symptoms. Her dog Brutus has been throwing up the last 24 hours.

What tests should the doctor order??

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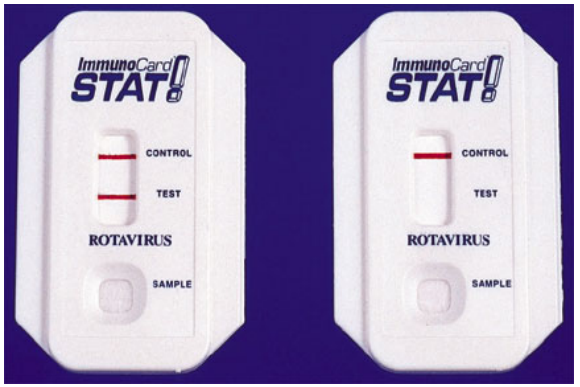
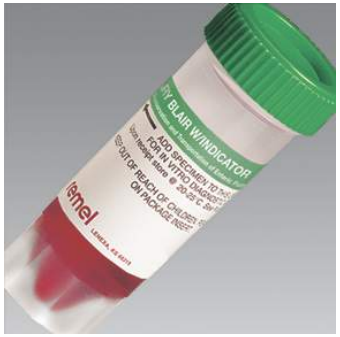
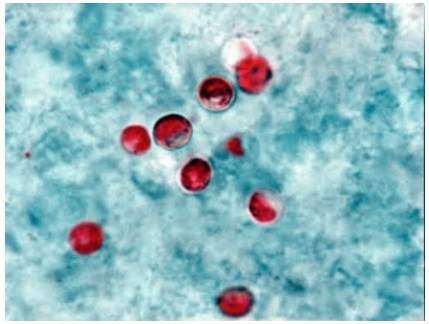
New Equipment- GI Panel







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The Current Process - Identification

- Culture results may take 3 days
- Ova and parasite concentrations and Trichrome stains are subjective.
- We would use multiple kits for other stool testing:
  - Giardia EIA
  - EHEC
  - Rotavirus
  - C. diff
  - Cryptosporidium by DFA
  - Modified AFB stain

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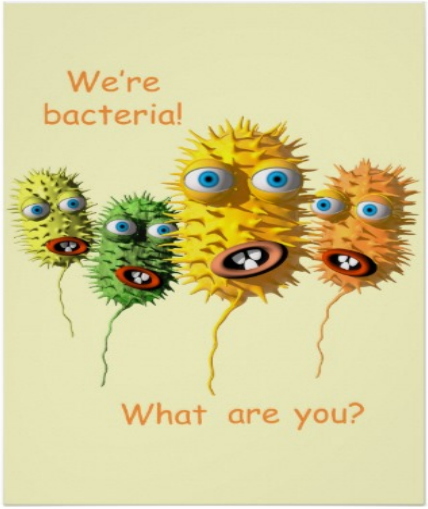
New Equipment- GI Panel

The BioFire detects enteric pathogens in **1 hour**

- ✓*Campylobacter*
- ✓*Salmonella*
- ✓*Plesiomonas*
- ✓*Yersinia*
- ✓*Vibrio*
- ✓*Shiga-like toxin producing E. coli (E, coli O157:H7)*
- ✓*Shigella*



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New Equipment- GI Panel

The BioFire can identify parasites in **1 hour**

- ✓*Cyclospora cayetanensis*
- ✓*Entamoeba histolytica*
- ✓*Giardia lamblia*
- ✓*Cryptosporidium*

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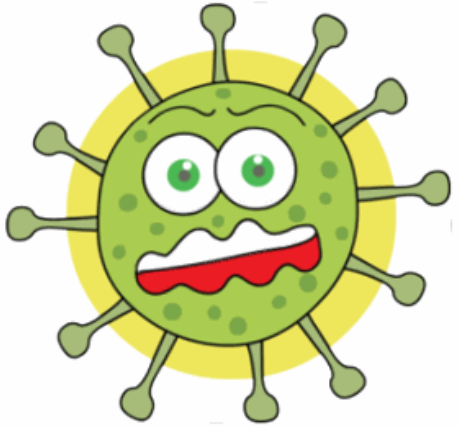
New Equipment- GI Panel

The BioFire can detect viruses in **1 hour**

- ✓*Adenovirus*
- ✓*Astrovirus*
- ✓*Norovirus*
- ✓*Rotavirus*
- ✓*Sapovirus*



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GI Panel Cost Effective?

PROS

- Eliminate 4 kits
- Remove subjective ova and parasite interpretations
- Results within an hour not 3 days for culture results
- One competency platform
- Would not have to send out Norovirus for testing

CONS

- Performed testing on 7,000 stool specimens last year.
- Many had only a few tests ordered [ova and parasite and Giardia] or [stool culture and shigatoxin assay]
- Kit costs $4,650 we would need 233 kits $1,083,450
- Is testing covered by insurance? Reimbursement?

Not possible at this time

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New Equipment Respiratory Pathogen Panel

Physicians want *faster* results on our smallest patients

Film Array (BioFire):

- **Respiratory pathogen panel**: *Influenza A, Influenza B, Adenovirus, RSV, Parainfluenza 1,2,3, and 4, Coronavirus, Enterovirus, Rhinovirus, Metapneumovirus, Bordetella, Chlamydophila pneumoniae, Mycoplasma pneumoniae*
- Results within 1 hour

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New Equipment ME Panel

Physicians want *faster* results on our sickest patients

Film Array (BioFire):

- **Meningitis/Encephalitis Panel**: *E. coli, Hemophilus Influenza, Listeria monocytogenes, Neisseria meningitides, Streptococcus pneumoniae, Streptococcus Group B, CMV, Enterovirus, Herpes simplex 1 and 2, Human herpes virus 6, Parechovirus, Varicella zoster, Cryptococcus neoformans/gattii*
- Performed on CSF
- Results within 1 hour

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Continue the Journey

Front end automation (WASP)

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Happy Staff

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Continue the Journey!

QUESTIONS???

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