

Biomerieux Vitek® 2 Identification Cards

Eric Beck, PhD

Clinical Laboratory Director – Microbiology

ACL Laboratories/Advocate Health

WCLN Spring Conference

4 April 2023



We are  Advocate Aurora Health

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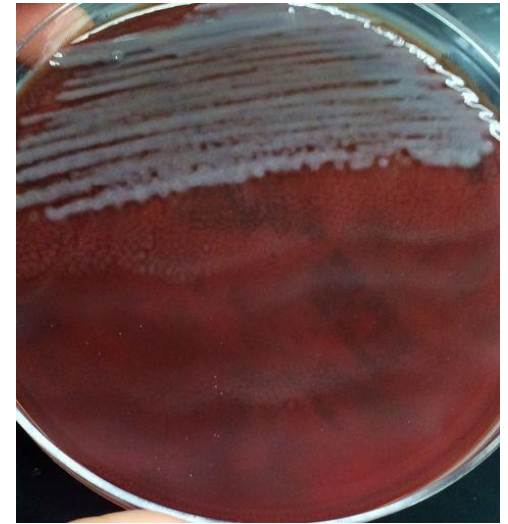
4 April 2023



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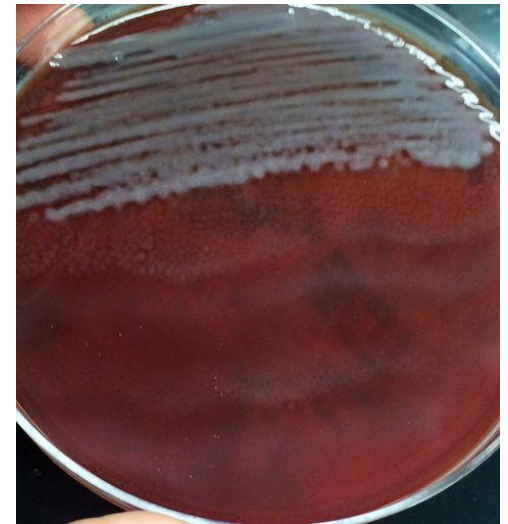
Case Study

- Blood Cultures submitted from ED patient
- Positive aerobic bottle showing GNR
- BioFire BCID2 Test:
 - *Enterobacterales*
 - *Proteus* sp.
- Subculture Results:
 - Swarming motility on BAP
 - Non-lactose fermenter on MacConkey
 - Oxidase negative
- Vitek 2 Identification = *Proteus penneri*



Do we accept the Vitek 2 result?

- A) Yes, the swarming gives it away as a *Proteus*
- B) Yes, because the BCID2 indicated *Proteus* sp.
- C) No, you should only blindly trust the MALDI
- D) No, there is still relevant information we don't know



Case Study

- The organism is indole positive

TABLE 7 Biochemical characterization of members of the genera *Proteus*, *Providencia*, and *Morganella*^a

Organism	Indole	H ₂ S	Urea	ODC	Acid ^b from:				
					Maltose	D-Adonitol	D-Arabitol	Trehalose	myo-Inositol
<i>Proteus</i>									
<i>P. hauseri</i>	+	V	+	-	+	-	-	+	-
<i>P. mirabilis</i>	-	+	+	+	-	-	-	+	-
<i>P. penneri</i>	-	V	+	-	+	-	-	V	-
<i>P. vulgaris</i> ^c	+	V	+	-	+	-	-	-	-

Chapter 40, Manual Clinical Microbiology 12th Edition.

- MALDI-TOF identification = *Proteus vulgaris*



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VITEK Identification Panels

- Designed for use with Vitek® 2 Instruments
- Options available for identification of:
 - Gram Negative Bacilli
 - Gram Positive Cocci
 - Pathogenic Yeast
 - Fastidious Gram Negatives
 - Anaerobic Bacteria



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VITEK Identification Panels

- Vitek Densichek
 - Used to make 0.5 McFarland suspensions
 - Prepare suspension
 - Place in reader
 - Adjust suspension as needed
 - New version is Bluetooth capable
 - Can incorporate McF reading to final report
 - Easy to review competency or training
 - Assists in troubleshooting




Laboratories

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VITEK Identification Panels

- Microfluidic cartridges
 - Size of a playing card
 - Inoculation straw in bacterial suspension
- Vitek instrument
 - Series of vacuum steps force suspension into the test card
 - Cartridge barcodes scanned
 - Inoculation straws heated to cut and seal
 - Test cards loaded into incubator
 - Optical reader interprets results at set time
 - Completed cartridges sent to discard position




Laboratories

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Vitek Gram Negative ID Panel

- ID of clinically significant glucose fermenting and non-fermenting GNRs
- 47 biochemical reactions measuring:
 - Carbon source utilization
 - Enzymatic activities
 - Resistance mechanisms
- Results in ~ 10 hours
- Results compared to database of reaction profiles for GNRs



Laboratories

We are  Advocate Aurora Health

Vitek Gram Negative ID Panel

- Convenient result report

bioMérieux Customer:		ACL		Laboratory Report		Printed by:											
System #:						Patient ID:											
Patient Name:						Bench:											
Isolate:																	
Card Type: GN Bar Code: 2412248403172821		Testing Instrument: 00001925EE42															
Setup Technologist:																	
Bionumber: 6625735757175011																	
Organism Quantity:				Selected Organism: Raoultella planticola													
Comments:																	
McFarland:																	
Identification Information	Card:	GN	Lot Number:	2412248403	Expires:	Jan 22, 2024 12:00 CST											
	Status:	Final	Analysis Time:	4.80 hours	Completed:	Mar 17, 2023 02:53 CDT											
Organism Origin	VITEK 2																
Selected Organism	99% Probability		Raoultella planticola														
	Bionumber: 6625735757175011		Confidence: Excellent identification														
Analysis Organisms and Tests to Separate:																	
Analysis Messages:																	
Contraindicating Typical Biopattern(s)																	
Biochemical Details																	
2	APPA	-	3	ADO	+	4	PyrA	+	5	IARL	-	7	dCEL	+	9	BGAL	+
10	H2S	-	11	BNAG	+	12	AGLTp	-	13	dGLU	+	14	GGT	-	15	OFF	+
17	BGLU	+	18	dMAL	+	19	dMAN	+	20	dMNE	+	21	BXYL	+	22	BAlap	+
23	ProA	+	26	LIP	-	27	PLE	+	29	TyrA	+	31	URE	+	32	dSOR	+
33	SAC	+	34	dTAG	-	35	dTRE	+	36	CIT	+	37	MNT	+	39	SKG	+
40	ILATk	+	41	AGLU	-	42	SUCT	-	43	NAGA	+	44	AGAL	+	45	PHOS	+
46	GlyA	+	47	ODC	-	48	LDC	+	53	IHISa	-	56	CMT	-	57	BGUR	-
58	O129R	+	59	GGAA	-	61	IMLTa	-	62	ELLM	+	64	ILATa	-			

Vitek Gram Negative ID Panel

- Convenient result report
- Patient information section

bioMérieux Customer:		ACL															
System #:		Laboratory Report															
Patient Name:		Printed by:															
Isolate:		Patient ID:															
Card Type: GN Bar Code: 2412248403172821 Testing Instrument: 00001925EE42		Bench:															
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10	H2S	-	11	BNAG	+	12	AGLTp	-	13	dGLU	+	14	GGT	-	15	OFF	+
17	BGLU	+	18	dMAL	+	19	dMAN	+	20	dMNE	+	21	BXYL	+	22	BAlap	+
23	ProA	+	26	LIP	-	27	PLE	+	29	TyrA	+	31	URE	+	32	dSOR	+
33	SAC	+	34	dTAG	-	35	dTRE	+	36	CIT	+	37	MNT	+	39	SKG	+
40	ILATk	+	41	AGLU	-	42	SUCT	-	43	NAGA	+	44	AGAL	+	45	PHOS	+
46	GlyA	+	47	ODC	-	48	LDC	+	53	IHISa	-	56	CMT	-	57	BGUR	-
58	O129R	+	59	GGAA	-	61	IMLTa	-	62	ELLM	+	64	ILATa	-			

LABORATORIES

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Vitek Gram Negative ID Panel

- Convenient result report
- Patient information section
- Test card information

bioMérieux Customer:		ACL		Laboratory Report		Printed by:											
System #:						Patient ID:											
Patient Name:						Bench:											
Isolate:																	
Card Type: GN Bar Code: 2412248403172821		Testing Instrument: 00001925EE42															
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46	GlyA	+	47	ODC	-	48	LDC	+	53	IHISa	-	56	CMT	-	57	BGUR	-
58	O129R	+	59	GGAA	-	61	IMLTa	-	62	ELLM	+	64	ILATa	-			

LABORATORIES

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Vitek Gram Negative ID Panel

- Convenient result report
- Patient information section
- Test card information
- Individual biochemical results

bioMérieux Customer:		ACL		Laboratory Report		Printed by:											
System #:						Patient ID:											
Patient Name:						Bench:											
Isolate:																	
Card Type: GN Bar Code: 2412248403172821		Testing Instrument: 00001925EE42															
Setup Technologist:																	
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17	BGLU	+	18	dMAL	+	19	dMAN	+	20	dMNE	+	21	BXYL	+	22	BAlap	+
23	ProA	+	26	LIP	-	27	PLE	+	29	TyrA	+	31	URE	+	32	dSOR	-
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40	ILATk	+	41	AGLU	-	42	SUCT	-	43	NAGA	+	44	AGAL	+	45	PHOS	+
46	GlyA	+	47	ODC	-	48	LDC	+	53	IHISa	-	56	CMT	-	57	BGUR	-
58	O129R	+	59	GGAA	-	61	IMLTa	-	62	ELLM	+	64	ILATa	-			

LABORATORIES

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Vitek Gram Negative ID Panel

- Convenient result report
- Patient information section
- Test card information
- Individual biochemical results
- Final results, including:
 - Confidence level
 - Possible close matches
 - Internal messages

McFarland:																	
Identification Information	Card: GN	Lot Number: 2412248403	Expires: Jan 22, 2024 12:00 CST														
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10	H2S	-	11	BNAG	+	12	AGLTp	-	13	dGLU	+	14	GGT	-	15	OFF	+
17	BGLU	+	18	dMAL	+	19	dMAN	+	20	dMNE	+	21	BXYL	+	22	BAlap	+
23	ProA	+	26	LIP	-	27	PLE	+	29	TyrA	+	31	URE	+	32	dSOR	+
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40	ILATk	+	41	AGLU	-	42	SUCT	-	43	NAGA	+	44	AGAL	+	45	PHOS	+
46	GlyA	+	47	ODC	-	48	LDC	+	53	IHISa	-	56	CMT	-	57	BGUR	-
58	O129R	+	59	GGAA	-	61	IMLTa	-	62	ELLM	+	64	ILATa	-			

Vitek Gram Negative ID Panel

- Instances when test can not discriminate:
 - Will list possible organisms
 - Gives additional messages
 - Includes biochemicals that may help discriminate

McFarland:			
Identification Information	Card:	GN	Expires: Feb 3, 2024 12:00 CST
	Status:	Final	Completed: Mar 22, 2023 17:29 CDT
Organism Origin	VITEK 2		
Selected Organism	Low Discrimination		
	Bionumber:	0005010140104212	Confidence: Low discrimination
Analysis Organisms and Tests to Separate:			
Low Discrimination Organism			
Shigella group			
Shigella dysenteriae	MOB(1),		
Shigella flexneri	MOB(1),		
Shigella boydii	MOB(1),		
Escherichia coli	MOB(99),		
Analysis Messages:			
Confirm by serological tests			
Contraindicating Typical Biopattern(s)			
Shigella group	PHOS(95),LDC(1),		
Escherichia coli	ILATk(4),LDC(4),dMAN(96),		



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Vitek Gram Positive ID Panel

- ID of *Staphylococcus*, *Streptococcus*, *Enterococcus*, and other clinically relevant GPCs
- 43 biochemical reactions measuring:
 - Carbon source utilization
 - Enzymatic activities
 - Resistance mechanisms
- Results in ~ 8 hours
- Results compared to database of reaction profiles for GPCs



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Vitek Yeast ID Panel

- ID of *Candida*, *Cryptococcus*, and other clinically relevant yeast
- Includes identification of *C. auris* (if using current software)
- 46 biochemical reactions measuring:
 - Carbon source utilization
 - Nitrogen source utilization
 - Enzymatic activities
- Results in ~ 18 hours
- Results compared to database of reaction profiles for clinically relevant yeast



Laboratories

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VITEK Identification Panels

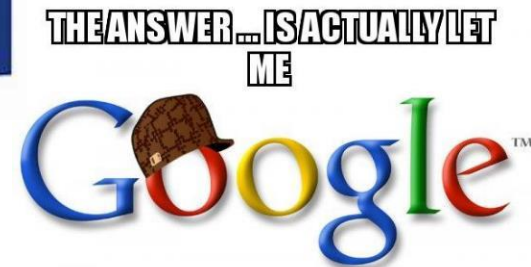
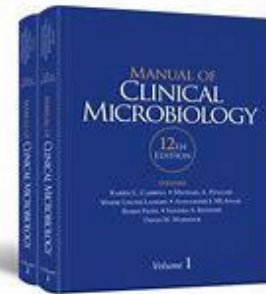
- Inherent issues:
 - Database of organisms is much smaller than MALDI
 - Occasionally requires additional confirmatory testing
 - Confirmatory tests often not available
 - Struggles w/ ID of species w/in complexes
 - *C. freundii* complex
 - *A. baumannii* complex
 - Lacks indole and oxidase
 - Occasional issue differentiating *E. coli/Shigella*
 - Takes a long time (8-12 hours)



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VITEK Identification Panels

- Critical Thinking:
 - Need to retain general knowledge of basic biochemicals that aren't included on the panel
 - Gram stain
 - Indole
 - Oxidase
 - Catalase
 - LAP
 - We have different systems in the lab:
 - MALDI, BCID2, Vitek 2
 - Not all yield same result
 - Which is correct?



THATFORYA

makeameme.org

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Summary

- Biomerieux Vitek® 2 Identification Cards:
 - Available for several different groups of organisms (GNR, GPC, Yeast, Anaerobes, Fastidious orgs)
 - Panels identify organisms through biochemical reactions and compare results to databases
 - Provide results in 8 – 12 hours
- Limitations of Vitek ID cards include:
 - Nomenclature not updated as frequently as MALDI-TOF
 - Requires technologists to maintain critical thinking skills and recall basic biochemical reactions for many organisms
 - Technologists need to have access to helpful resources



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BD Phoenix™ and Microscan Identification Systems

TIM BLOCK

LABORATORY MANAGER

FROEDTERT WEST BEND HOSPITAL

WCLN SPRING CONFERENCE

APRIL 4, 2023

ID Mismatch

Patient admitted to ED with diagnosis of pancreatitis.

- UA/reflex to culture
- Blood culture

Urinalysis with Reflex to Culture

Res	Component	Value	Units
1	Color	Yellow	
1	Clarity	Clear	
1	Glucose	Negative	mg/dL
1	Bilirubin	Negative	
1	Ketones	Trace	mg/dL
1	Specific Gravity	1.010	
1	Blood	Trace-Lysed	
1	pH	7.0	
1	Protein	Negative	mg/dL
1	Urobilinogen	0.2	mg/dL
1	Nitrite	Negative	
1	Leukocyte Esterase	Negative	
1	RBC	0-2	/HPF
1	WBC	6-10	/HPF
1	Bacteria	Present	
1	Squamous Epithelial Cells	0-2	/HPF

ID Mismatch

- Patient admitted to ED with diagnosis of pancreatitis.
 - Blood culture
 - Flags positive after 17 hours incubation
 - Gram stain – Gram negative bacilli
 - Verigene Gram negative panel set up

Summary

* **Enterobacter** Detected

Detail

Acinetobacter	Not Detected	Citrobacter	Not Detected
* Enterobacter	Detected	Proteus	Not Detected
E. coli	Not Detected	P. aeruginosa	Not Detected
K. oxytoca	Not Detected	K. pneumoniae	Not Detected
VIM	Not Detected	OXA	Not Detected
CTX-M	Not Detected	KPC	Not Detected
NDM	Not Detected	IMP	Not Detected

ID Mismatch

Culture results:



Phoenix Gram negative panel inoculated.

ID Mismatch

Phoenix Report:

Isolate Number:	1			
Organism Name:	Klebsiella oxytoca			
Isolate Classification:	Significant / Unknown			
Isolate AST Results				
Antimicrobial	MIC or Concentration	Interp	Expert SIR	Final SIR
Amikacin	<=8	S		S
Ampicillin	>16	R		R
Ampicillin-Sulbactam	16/8	I		I
Aztreonam	<=2	S		S
Cefazolin	>16	R		R
Cefepime	<=1	S		S
Ceftazidime	<=2	S		S
Ceftriaxone	<=1	S		S
Ciprofloxacin	<=0.25	S		S
Ertapenem	<=0.25	S		S
Gentamicin	<=2	S		S
Levofloxacin	<=0.5	S		S
Meropenem	<=0.5	S		S
Nitrofurantoin	32	S	X	X
Piperacillin-Tazobactam	<=2/4	S		S
Tetracycline	<=2	S		S
Tobramycin	<=2	S		S
Trimethoprim-Sulfamethoxazole	<=0.5/9.5	S		S

ID Mismatch

What next??

- A. Accept the Phoenix ID
- B. Override the Phoenix ID with results obtained from Verigene
- C. Do additional work
- D. Give up and go home

BD Phoenix™ ID/AST Systems

Instrument

BD Phoenix™ M50 instrument



BD Phoenix™ ID/AST Systems

Instrument

BD Phoenix™ M50 instrument

- 50 panel capacity (49)
- Ability to “stack” two analyzers for 100 panel capacity



BD Phoenix™ AP instrument

- Automated dilutions



Phoenix Workflow

- Create 0.5 McFarland suspension of organism.
- Select isolated colonies and suspend in BD Phoenix ID broth
- Vortex, read on nephelometer
- Add drop of AST indicator to AST broth
- Transfer 25 μ L of suspension from ID tube to AST tube
- Pour both ID and AST broth into respective side of panel



Phoenix Workflow (Alternate)

- Phoenix™ AP
 - Create suspension
 - AP adjusts suspension to correct McFarland equivalent
 - AP adds AST indicator and pipettes suspension to AST broth
 - Manually pour both ID and AST broth into respective side of panel



Phoenix Workflow, Cont'd

- Cap panels
- Load panel onto instrument
- Instrument takes initial read on panel, then every 20 minutes for up to 16 hours.



BD Phoenix™ ID/AST Systems

Panel Technology

Identification

- Conventional biochemical
 - Chromogenic biochemical reactions
 - Fluorogenic biochemical reactions
-
- Available for Gram positive, Gram negative, Streptococcus spp, and yeast

BD Phoenix™ ID/AST Systems

Gram Negative Panels

GRAM-NEGATIVE ID TAXA¹

ENTEROBACTERIACEAE

Cedecea davisae
Cedecea lapagei
Cedecea neteri
Citrobacter amalonaticus
Citrobacter braakii
Citrobacter farmeri
Citrobacter freundii
Citrobacter koseri
Citrobacter sedlakii
Citrobacter werkmanii
Citrobacter youngae
Edwardsiella hoshinae
Edwardsiella ictaluri
Edwardsiella tarda
Enterobacter aerogenes
Enterobacter amnigenus biogroup 1
Enterobacter amnigenus biogroup 2
Enterobacter asburiae
Enterobacter cancerogenus
Enterobacter cloacae
Enterobacter gergoviae
Enterobacter hormaechei
Enterobacter intermedius
Enterobacter sakazakii
Escherichia coli
Escherichia fergusonii
Escherichia hermannii
Escherichia vulneris
Ewingella americana
Hafnia alvei
Klebsiella oxytoca
Klebsiella pneumoniae subsp. *ozaenae*
Klebsiella pneumoniae subsp. *pneumoniae*
Klebsiella pneumoniae subsp. *rhinoscleromatis*
Kluyvera ascorbata
Kluyvera cryocrescens
Leclercia adecarboxylata
Leminorella grimmontii
Leminorella richardii
Moellerella wisconsensis
Morganella morganii
Pantoea agglomerans

Pragia fontium
Proteus mirabilis
Proteus penneri
Proteus vulgaris
Providencia alcalifaciens
Providencia rettgeri
Providencia rustigianii
Providencia stuartii
Rahnella aquatilis
Raoultella (Klebsiella) ornithinolytica
Salmonella choleraesuis subsp. *arizonae*
Salmonella choleraesuis subsp. *choleraesuis*
Salmonella gallinarum
Salmonella paratyphi A
Salmonella pullorum
Salmonella species
Salmonella typhi
Serratia ficaria
Serratia fonticola
Serratia liquefaciens
Serratia marcescens
Serratia odorifera 1
Serratia odorifera 2
Serratia plymuthica
Serratia rubidaea
Shigella boydii
Shigella dysenteriae
Shigella flexneri
Shigella sonnei
Shigella species
Tatumella ptyseos
Yersinia enterocolitica
Yersinia frederiksenii
Yersinia intermedia
Yersinia kristensenii
Yersinia pseudotuberculosis
Yersinia ruckeri
Yokenella regensburgi

NONFERMENTER

Achromobacter species
*Acinetobacter baumannii**
Acinetobacter baumannii-
calcoaceticus complex

Acinetobacter haemolyticus
Acinetobacter lwoffii
Acinetobacter species*
Alcaligenes faecalis
Bergeyella zooheicum
Bordetella bronchiseptica
Brevundimonas diminuta
Brevundimonas vesicularis
Burkholderia cepacia
Burkholderia gladioli
CDC group EF4a
CDC group EF4b
CDC group E02
CDC group Vb3
Chromobacterium violaceum
Chryseobacterium gleum
Chryseobacterium indologenes
Chryseobacterium meningosepticum
Comamonas terrigena
Comamonas testosteroni
Delftia (Comamonas) acidovorans
Empedobacter brevis
*Kingella denitrificans**
*Kingella kingae**
*Methylobacterium extorquens**
*Moraxella (Branhamella) catarrhalis**
Moraxella species*
Myroides odoratus/odoratimimus
Ochrobactrum anthropi
Oligella ureolytica
Oligella urethralis
Pseudomonas (Chryseomonas) luteola
Pseudomonas (Flavimonas) oryzihabitans
Pseudomonas aeruginosa
Pseudomonas fluorescens
Pseudomonas mendocina
*Pseudomonas pseudoalcaligenes**
Pseudomonas putida
Pseudomonas species*
Pseudomonas stutzeri
Ralstonia (Burkholderia) pickettii
Wautersia (Ralstonia) paucula
(CDC group IVC2)
Rhizobium (Agrobacterium) radiobacter

Shewanella putrefaciens
Sphingobacterium multivorum
Sphingobacterium spiritivorum
Sphingobacterium thalophilum
Sphingomonas paucimobilis
Stenotrophomonas maltophilia
Suttonella indologenes
Weeksella virosa

MISCELLANEOUS

Actinobacillus lignieresii
Actinobacillus suis
Actinobacillus ureae
Aeromonas caviae
Aeromonas hydrophila
Aeromonas salmonicida subsp. *masoucida*
Aeromonas salmonicida subsp. *salmonicida*
Aeromonas salmonicida subsp. *smithia*
Aeromonas schubertii
Aeromonas sobria
Aeromonas veronii
Cardiobacterium hominis
Eikenella corrodens
Mannheimia (Pasteurella) haemolytica
Pasteurella aerogenes
Pasteurella multocida
Pasteurella pneumotropica
Photobacterium damsela
Plesiomonas shigelloides
Vibrio alginolyticus
Vibrio cholerae
Vibrio fluvialis
Vibrio hollisae
Vibrio metschnikovii
Vibrio mimicus
Vibrio parahaemolyticus
Vibrio vulnificus



BD Phoenix™ ID/AST Systems

Gram Positive Panels

GRAM-POSITIVE ID TAXA¹

<i>Aerococcus urinae</i>	<i>Enterococcus casseliflavus</i>	<i>Micrococcus luteus</i>	<i>Staphylococcus schleiferi</i> subsp. <i>schleiferi</i>
<i>Aerococcus viridans</i>	<i>Enterococcus durans</i>	<i>Micrococcus lylae</i>	<i>Staphylococcus sciuri</i>
<i>Alloiococcus otitidis</i>	<i>Enterococcus faecalis</i>	<i>Oerskovia xanthineolytica</i> *	<i>Staphylococcus simulans</i>
<i>Arcanobacterium haemolyticum</i> *	<i>Enterococcus faecium</i>	<i>Paenibacillus (Bacillus) alvei</i> *	<i>Staphylococcus vitulinus</i>
<i>Arcanobacterium (Actinomyces) pyogenes</i> *	<i>Enterococcus gallinarum</i>	<i>Paenibacillus (Bacillus) macerans</i> *	<i>Staphylococcus warneri</i>
<i>Bacillus cereus</i> *	<i>Enterococcus hirae</i>	<i>Pediococcus acidilactici</i>	<i>Staphylococcus xylosum</i>
<i>Bacillus circulans</i> *	<i>Enterococcus raffinosus</i>	<i>Pediococcus damnosus</i>	<i>Streptococcus acidominimus</i> *
<i>Bacillus coagulans</i> *	<i>Erysipelothrix rhusiopathiae</i> *	<i>Pediococcus dextrinicus</i>	<i>Streptococcus agalactiae</i>
<i>Bacillus licheniformis</i> *	<i>Gardnerella vaginalis</i> *	<i>Pediococcus parvulus</i>	<i>Streptococcus anginosus</i>
<i>Bacillus megaterium</i> *	<i>Gemella haemolysans</i>	<i>Pediococcus pentosaceus</i>	<i>Streptococcus bovis</i> biotype I
<i>Bacillus pumilus</i> *	<i>Gemella morbillorum</i>	<i>Rhodococcus equi</i> *	<i>Streptococcus bovis</i> biotype II
<i>Bacillus sphaericus</i> *	<i>Globicatella sanguinis</i>	<i>Rothia dentocariosa</i> *	<i>Streptococcus canis</i>
<i>Bacillus subtilis</i> *	<i>Helcococcus kunzii</i>	<i>Rothia (Stomatococcus) mucilaginosus</i>	<i>Streptococcus constellatus</i>
<i>Bacillus thuringiensis</i> *	<i>Kocuria (Micrococcus) kristinae</i>	<i>Staphylococcus aureus</i>	<i>Streptococcus cristatus</i>
<i>Brevibacillus brevis</i> *	<i>Kocuria (Micrococcus) rosea</i>	<i>Staphylococcus auricularis</i>	<i>Streptococcus dysgalactiae</i>
<i>Brevibacterium species</i> *	<i>Kocuria (Micrococcus) varians</i>	<i>Staphylococcus capitis</i> subsp. <i>capitis</i>	subsp. <i>dysgalactiae</i> *
<i>Cellulomonas (Oerskovia) turbata</i> *	<i>Kytococcus (Micrococcus) sedentarius</i>	<i>Staphylococcus capitis</i> subsp. <i>ureolyticus</i>	<i>Streptococcus dysgalactiae</i>
<i>Corynebacterium amycolatum</i> *	<i>Lactococcus garvieae</i> *	<i>Staphylococcus caprae</i>	subsp. <i>equisimilis</i> *
<i>Corynebacterium bovis</i> *	<i>Lactococcus lactis</i> subsp. <i>cremoris</i>	<i>Staphylococcus carnosus</i>	<i>Streptococcus equinus</i> *
<i>Corynebacterium diphtheriae</i> *	<i>Lactococcus lactis</i> subsp. <i>hordniae</i>	<i>Staphylococcus chromogenes</i>	<i>Streptococcus equi</i> subsp. <i>equi</i>
<i>Corynebacterium jeikeium</i> *	<i>Lactococcus lactis</i> subsp. <i>lactis</i> *	<i>Staphylococcus cohnii</i> subsp. <i>cohnii</i>	<i>Streptococcus equi</i> subsp. <i>zooepidemicus</i>
<i>Corynebacterium kutscheri</i> *	<i>Lactococcus plantarum</i>	<i>Staphylococcus cohnii</i> subsp. <i>urealyticum</i>	<i>Streptococcus gordonii</i>
<i>Corynebacterium matruchotii</i> *	<i>Lactococcus raffinolactis</i> *	<i>Staphylococcus epidermidis</i>	<i>Streptococcus group C/G</i>
<i>Corynebacterium minutissimum</i> *	<i>Leifsonia (Corynebacterium) aquatica</i> *	<i>Staphylococcus equorum</i>	<i>Streptococcus intermedius</i>
<i>Corynebacterium propinquum</i> *	<i>Leuconostoc citreum</i>	<i>Staphylococcus felis</i>	<i>Streptococcus mitis</i>
<i>Corynebacterium pseudodiphtheriticum</i> *	<i>Leuconostoc lactis</i>	<i>Staphylococcus gallinarum</i>	<i>Streptococcus mutans</i>
<i>Corynebacterium pseudotuberculosis</i> *	<i>Leuconostoc mesenteroides</i> subsp. <i>cremoris</i> *	<i>Staphylococcus haemolyticus</i>	<i>Streptococcus oralis</i>
<i>Corynebacterium renale</i> *	<i>Leuconostoc mesenteroides</i>	<i>Staphylococcus hominis</i>	<i>Streptococcus parasanguinis</i>
<i>Corynebacterium striatum</i> *	subsp. <i>mesenteroides</i>	<i>Staphylococcus hyicus</i>	<i>Streptococcus pneumoniae</i>
<i>Corynebacterium ulcerans</i> *	<i>Leuconostoc pseudomesenteroides</i> *	<i>Staphylococcus intermedius</i>	<i>Streptococcus porcinus</i>
<i>Corynebacterium urealyticum</i> *	<i>Listeria grayi</i> *	<i>Staphylococcus kloosii</i>	<i>Streptococcus pyogenes</i>
<i>Corynebacterium xerosis</i> *	<i>Listeria innocua</i>	<i>Staphylococcus lentus</i>	<i>Streptococcus salivarius</i>
<i>Dermabacter hominis</i> *	<i>Listeria ivanovii</i> *	<i>Staphylococcus lugdunensis</i>	<i>Streptococcus sanguinis</i>
<i>Dermacoccus (Micrococcus)</i>	<i>Listeria monocytogenes</i>	<i>Staphylococcus pasteurii</i>	<i>Streptococcus sobrinus</i>
<i>nishinomiyaensis</i>	<i>Listeria welshimeri</i> *	<i>Staphylococcus saprophyticus</i>	<i>Streptococcus uberis</i>
<i>Enterococcus avium</i>	<i>Macrococcus (Staphylococcus) caseolyticus</i>	<i>Staphylococcus schleiferi</i> subsp. <i>coagulans</i>	<i>Streptococcus vestibularis</i>

BD Phoenix™ ID/AST Systems

Streptococcus and Yeast Panels

STREPTOCOCCI ID TAXA^{1*}

Streptococcus acidominimus
Streptococcus agalactiae
Streptococcus anginosus
Streptococcus bovis biotype I
Streptococcus bovis biotype II
Streptococcus canis
Streptococcus constellatus
Streptococcus cristatus
Streptococcus dysgalactiae
 subsp. *dysgalactiae*

Streptococcus dysgalactiae
 subsp. *equisimilis*
Streptococcus equi subsp. *equi*
Streptococcus equi subsp. *zooepidemicus*
Streptococcus equinus
Streptococcus gordonii
Streptococcus intermedius
Streptococcus mitis
Streptococcus mutans
Streptococcus oralis

Streptococcus parasanguinis
Streptococcus pneumoniae
Streptococcus porcinus
Streptococcus pyogenes
Streptococcus salivarius
Streptococcus sanguinis
Streptococcus sobrinus
Streptococcus uberis
Streptococcus vestibularis

YEAST ID TAXA¹

Blastoschizomyces capitatus
Candida albicans
Candida apicola
Candida boidinii^{***}
Candida bracarensis^{**}
Candida catenulata
Candida ciferrii
Candida dubliniensis
Candida firmetaria
Candida freyschussii
Candida glabrata
Candida guilliermondii
Candida guilliermondii
 var. *membranaefaciens*
Candida haemulonii
Candida inconspicua
Candida kefyr
Candida krusei
Candida lipolytica
Candida lusitanae
Candida magnoliae
Candida melibiosica

Candida membranaefaciens
Candida norvegensis
Candida parapsilosis complex
Candida pararugosa
Candida pelliculosa
Candida pulcherrima
Candida rugosa
Candida sake
Candida sphaerica^{**}
Candida tropicalis
Candida utilis
Candida viswanathii
Candida zeylanoides
Cryptococcus albidus
Cryptococcus humicola
Cryptococcus laurentii^{***}
Cryptococcus luteolus
Cryptococcus neoformans
Cryptococcus terreus^{**}
Cryptococcus uniguttulatus
Exophiala species
Geotrichum species

Hortaea werneckii
Kloeckera species^{**}
Malassezia furfur complex^{**}
Malassezia pachydermatis^{**}
Malassezia sympodialis^{**}
Pichia burtonii
Pichia farinosa
Prototheca wickerhamii
Prototheca zopfii
Rhodotorula glutinis
Rhodotorula minuta
Rhodotorula mucilaginosa
 var. *mucilaginosa*
Saccharomyces cerevisiae
Sporobolomyces salmonicolor
Trichosporon asahii
Trichosporon inkin^{**}
Trichosporon loubieri^{**}
Trichosporon mucoides
Trichosporon ovoides^{***}
Wangiella dermatitidis
Zygosaccharomyces bailli^{**}

BD Phoenix™ ID/AST Systems

Panel Technology

Identification

- Will only provide ID if meets a 90% threshold

Performance Characteristics

Gram negative

- 95.6% agreement to species level

Gram positive

- 95.4% agreement to species level

Microscan

Instrument

MicroScan WalkAway



Microscan

Panel Inoculation



Microscan

Panel Technology

Identification

- Conventional biochemical
- Chromogenic biochemical reactions
- Available for Gram positive, Gram negative, Streptococcus spp.
- Rapid 4-hour panel for yeast, Haemophilus, anaerobes.

Microscan

Gram Negative Panels

Gram-negative

Glucose fermenters

<i>Aeromonas caviae</i> complex	<i>Escherichia hermannii</i>	<i>Salmonella enterica</i>
<i>Aeromonas hydrophila</i> complex	<i>Escherichia vulneris</i>	serotype Paratyphi A
<i>Aeromonas veronii</i> complex	<i>Ewingella americana</i>	<i>Salmonella enterica</i>
<i>Cedecea davisae</i>	<i>Grimontia hollisae</i>	serotype Typhi
<i>Cedecea lapagei</i>	<i>Hafnia alvei</i>	<i>Salmonella enterica</i> ssp.
<i>Cedecea neteri</i>	<i>Klebsiella oxytoca</i>	arizonae
<i>Cedecea species 3</i>	<i>Klebsiella ozaenae</i>	<i>Serratia ficaria</i>
<i>Cedecea species 5</i>	<i>Klebsiella pneumoniae</i>	<i>Serratia fonticola</i>
<i>Chromobacterium violaceum</i>	<i>Klebsiella rhinoscleromatis</i>	<i>Serratia liquefaciens</i>
<i>Citrobacter amalonaticus</i>	<i>Kluyvera ascorbata</i>	complex
<i>Citrobacter braakii</i>	<i>Kluyvera cryocrescens</i>	<i>Serratia marcescens</i>
<i>Citrobacter farmeri</i>	<i>Kluyvera intermedia</i>	<i>Serratia odorifera</i>
<i>Citrobacter freundii</i>	<i>Leclercia adecarboxylata</i>	<i>Serratia plymuthica</i>
<i>Citrobacter gillenii</i>	<i>Leminorella grimontii</i>	<i>Serratia rubidaea</i>
<i>Citrobacter koseri</i>	<i>Leminorella richardii</i>	<i>Shigella sonnei</i>
<i>Citrobacter murlinae</i>	<i>Mannheimia haemolytica</i>	<i>Shigella species</i>
<i>Citrobacter rodentium</i>	<i>Moellerella wisconsensis</i>	<i>Tatumella ptyseos</i>
<i>Citrobacter sedlakii</i>	<i>Morganella morganii</i>	<i>Vibrio alginolyticus</i>
<i>Citrobacter werkmanii</i>	<i>Pantoea agglomerans</i> group	<i>Vibrio cholerae</i>
<i>Citrobacter youngae</i>	<i>Pasteurella aerogenes</i>	<i>Vibrio fluvialis/furnissii</i>
<i>Cronobacter sakazakii</i>	<i>Pasteurella multocida</i>	<i>Vibrio metschnikovii</i>
<i>Edwardsiella tarda</i>	<i>Photobacterium damsela</i>	<i>Vibrio mimicus</i>
<i>Enterobacter aerogenes</i>	<i>Photorhabdus luminescens</i>	<i>Vibrio parahaemolyticus</i>
<i>Enterobacter amnigenus 1</i>	<i>Plesiomonas shigelloides</i>	<i>Vibrio species group</i>
<i>Enterobacter amnigenus 2</i>	<i>Proteus mirabilis</i>	<i>Vibrio vulnificus</i>
<i>Enterobacter asburiae</i>	<i>Proteus penneri</i>	<i>Yersinia enterocolitica</i>
<i>Enterobacter cancerogenus</i>	<i>Proteus vulgaris</i>	<i>Yersinia frederiksenii/</i>
<i>Enterobacter cloacae</i>	<i>Providencia alcalifaciens</i>	<i>kristensenii/intermedia</i>
<i>Enterobacter gergoviae</i>	<i>Providencia rettgeri</i>	<i>Yersinia pestis</i>
<i>Enterobacter hormaechei</i>	<i>Providencia rustigianii</i>	<i>Yersinia pseudotuberculosis</i>
<i>Escherichia albertii</i>	<i>Providencia stuartii</i>	<i>Yersinia ruckeri</i>
<i>Escherichia coli</i>	<i>Raoultella ornithinolytica</i>	<i>Yokenella regensburgei</i>
<i>Escherichia coli</i> (inactive)	<i>Salmonella enterica</i>	
<i>Escherichia fergusonii</i>	<i>Salmonella enterica</i> serotype	
	Choleraesuis	

Glucose non-fermenters

<i>Achromobacter piechaudii</i>	<i>Cupriavidus pauculus</i>	<i>Ralstonia mannitolilytica</i>
<i>Achromobacter species</i>	<i>Cupriavidus species</i>	<i>Ralstonia pickettii</i>
<i>Achromobacter xylooxidans/</i>	<i>Delftia acidovorans</i>	<i>Rhizobium radiobacter</i>
<i>denitrificans</i>	<i>Elizabethkingia</i>	<i>Roseomonas species</i>
<i>Acinetobacter baumannii</i>	<i>meningoseptica</i>	<i>Shewanella algae</i>
complex/haemolyticus	<i>Empedobacter brevis</i>	<i>Shewanella putrefaciens</i>
<i>Acinetobacter lwoffii</i> group	<i>Myroides species</i>	<i>Sphingobacterium</i>
<i>Alcaligenes faecalis</i>	<i>Ochrobactrum anthropi</i>	<i>multivorum</i>
<i>Bordetella bronchiseptica</i>	<i>Paracoccus yeii</i>	<i>Sphingobacterium</i>
<i>Bordetella trematum</i>	(CDC group EO-2)	<i>spiritivorum</i>
<i>Brevundimonas diminuta</i>	<i>Pseudomonas aeruginosa</i>	<i>Sphingomonas paucimobilis</i>
<i>Brevundimonas vesicularis</i>	<i>Pseudomonas alcaligenes/</i>	<i>Stenotrophomonas</i>
<i>Burkholderia cepacia</i> complex	<i>pseudoalcaligenes</i>	<i>maltophilia</i>
<i>Burkholderia gladioli</i>	<i>Pseudomonas fluorescens/</i>	<i>Wautersiella falsenii</i>
<i>Burkholderia pseudomallei</i>	<i>Pseudomonas putida</i>	<i>Weeksella virosa</i>
<i>Chryseobacterium</i>	<i>Pseudomonas luteola</i>	
<i>indologenes</i>	<i>Pseudomonas mendocina</i>	
<i>Comamonas testosteroni</i>	<i>Pseudomonas oryzae</i>	
	<i>Pseudomonas stutzeri</i>	

Microscan

Gram Positive Panels

Gram-positive

Staphylococcus and related genera

Kocuria kristinae
Listeria monocytogenes
Micrococcus and related species
Rothia dentocariosa
Rothia mucilaginosa
Staphylococcus aureus
Staphylococcus auricularis
Staphylococcus capitis ssp. *capitis*
Staphylococcus capitis ssp. *ureolyticus*
Staphylococcus cohnii ssp. *cohnii*
Staphylococcus cohnii ssp. *urealyticus*
Staphylococcus epidermidis
Staphylococcus haemolyticus
Staphylococcus hominis ssp. *hominis*
Staphylococcus hominis ssp. *novobiosepticus*
Staphylococcus hyicus
Staphylococcus intermedius
Staphylococcus lugdunensis
Staphylococcus saprophyticus
Staphylococcus schleiferi ssp. *coagulans*
Staphylococcus schleiferi ssp. *schleiferi*
Staphylococcus sciuri
Staphylococcus simulans
Staphylococcus warneri
Staphylococcus xylosum

Streptococcaceae

Aerococcus urinae
Aerococcus viridans
Enterococcus avium
Enterococcus casseliflavus
Enterococcus durans/hirae
Enterococcus faecalis
Enterococcus faecium
Enterococcus gallinarum
Enterococcus raffinosus
Gemella species
Leuconostoc species
Pediococcus species
Rhodococcus equi
Streptococcus agalactiae
(Group B)
Streptococcus anginosus group
Streptococcus bovis group
Streptococcus dysgalactiae group
Streptococcus equi group
Streptococcus iniae
Streptococcus mitis/oralis
Streptococcus mutans
Streptococcus parasanguinis
Streptococcus pneumoniae
Streptococcus pyogenes
(Group A)
Streptococcus salivarius
Streptococcus sanguinis

Microscan

Yeast Panels

Rapid Yeast ID B1017-70

<i>Blastoschizomyces capitatus</i>	<i>Candida pintolopesii</i>	<i>Hansenula polymorpha</i>
<i>Candida albicans</i>	<i>Candida rugosa</i>	<i>Kluyveromyces lactis</i>
<i>Candida catenulata</i>	<i>Candida tropicalis</i>	<i>Pichia anomala</i>
<i>Candida famata</i>	<i>Candida viswanathii</i>	<i>Pichia farinosa</i>
<i>Candida glabrata</i>	<i>Candida zeylanoides</i>	<i>Prototheca</i> species
<i>Candida guilliermondii</i>	<i>Cryptococcus albidus</i>	<i>Prototheca wickerhamii</i>
<i>Candida inconspicua</i>	<i>Cryptococcus humicola</i>	<i>Rhodotorula glutinis</i>
<i>Candida kefyr</i>	<i>Cryptococcus laurentii</i>	<i>Rhodotorula minuta</i>
<i>Candida krusei</i>	<i>Cryptococcus melibiosum</i>	<i>Rhodotorula mucilaginosa</i>
<i>Candida lambica</i>	<i>Cryptococcus neoformans/gattii</i> complex	<i>Saccharomyces cerevisiae</i>
<i>Candida lipolytica</i>	<i>Cryptococcus terreus</i>	<i>Sporobolomyces salmonicolor</i>
<i>Candida lusitanae</i>	<i>Cryptococcus uniguttulatus</i>	<i>Trichosporon beigelii</i> complex
<i>Candida parapsilosis</i> group	<i>Geotrichum</i> species	

Microscan

Identification

- Will provide ID call regardless of percentage
- Offers additional biochemical to delineate ID

Performance Characteristics

Gram negative

- 97.4% agreement to species level

Gram positive

• Staph

- 97.5% agreement to species level

• Strep

- 92.1% agreement to species level.

“type of bacterial population expected in a routine clinical laboratory.”

Performance Characteristics - Literature

Microscan

Evaluation of Matrix-Assisted Laser Desorption Ionization–Time of Flight Mass Spectrometry-Based VITEK MS System for the Identification of *Acinetobacter* Species from Blood Cultures: Comparison with VITEK 2 and MicroScan Systems

- 13.1% error rate in identification of *Acinetobacter* sp.

Evaluation of three phenotypic identification systems for clinical isolates of *Raoultella ornithinolytica*

- 92.6% accuracy in identification of *Raoultella* spp.

Species identification of *Enterococcus* spp: Whole genome sequencing compared to three biochemical test-based systems and two Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS) systems

- 71.8% accuracy in identification of *Enterococcus faecium* .
29% identified as *E. casseliflavus*

J Med Microbiol, 60 (2011), pp. 492-499

Journal of clinical laboratory analysis, 34(8), e23348. <https://doi.org/10.1002/jcla.23348>

Annals of laboratory medicine, 35(1), 62–68. <https://doi.org/10.3343/alm.2015.35.1.62>

Performance Characteristics - Literature

Phoenix

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry for the identification of beta-hemolytic *streptococci*

- 79.2% accuracy in identification of beta-hemolytic streptococcus

Comparison of Bruker Biotyper Matrix-Assisted Laser Desorption Ionization–Time of Flight Mass Spectrometer to BD Phoenix Automated Microbiology System for Identification of Gram-Negative Bacilli⁷

- Total – 83% correct ID to species level.
 - Common – 95%
 - Uncommon – 34%

Journal of thoracic disease, 7(4), 591–595.

JOURNAL OF CLINICAL MICROBIOLOGY, Mar. 2011, p. 887–892

ID Mismatch

Enterobacter sp. vs. *Klebsiella oxytoca*

What next??

- A. Accept the Phoenix ID
- B. Override the Phoenix ID with results obtained from Verigene
- C. **Do additional work**
- D. Give up and go home

ID Mismatch

Investigation

Verigene Limitation

- Rare strains of *Klebsiella* may cross react with probes and provide a *Enterobacter* detected result.

Susceptibility profile.

- *Enterobacter* spp. – 0% susceptible
- *K. oxytoca* – 59 % susceptible.

Definitive ID via MALDI-TOF

- *Enterobacter cloacae* complex

Organism Name: *Klebsiella oxytoca*
Isolate Classification: Significant / Unknown

Isolate AST Results

Antimicrobial	MIC or Concentration	Interp
Amikacin	<=8	S
Ampicillin	>16	R
Ampicillin-Sulbactam	16/8	I
Aztreonam	<=2	S
Cefazolin	>16	R
Cefepime	<=1	S

Urine culture

“Do we care about Listeria in a urine specimen?”

Patient Name: ██████████ O
Birth Date: █/█/1922
Ordering Physician: 54599
User Name: micro
Accession #: ██████████
Specimen Type: Urine
Hospital Service: SJHED
Body Site: Unspecified
Collection Date: 12/17/2022 05:08:00PM
Antimicrobial Therapy:

Isolate Number: 1
Organism Name: Listeria monocytogenes/innocua
Isolate Classification: Significant / Unknown

Expert Triggered Rules
8001

Test Types:	ID/AST Combo
Test Name:	PMIC/ID-106
Sequence Number:	426062230121 Lot #: 2203819
Location:	1/B07
Organism Name:	Listeria monocytogenes/innocua
Instrument ID Results	Confidence Value
Listeria monocytogenes/innocua	99%



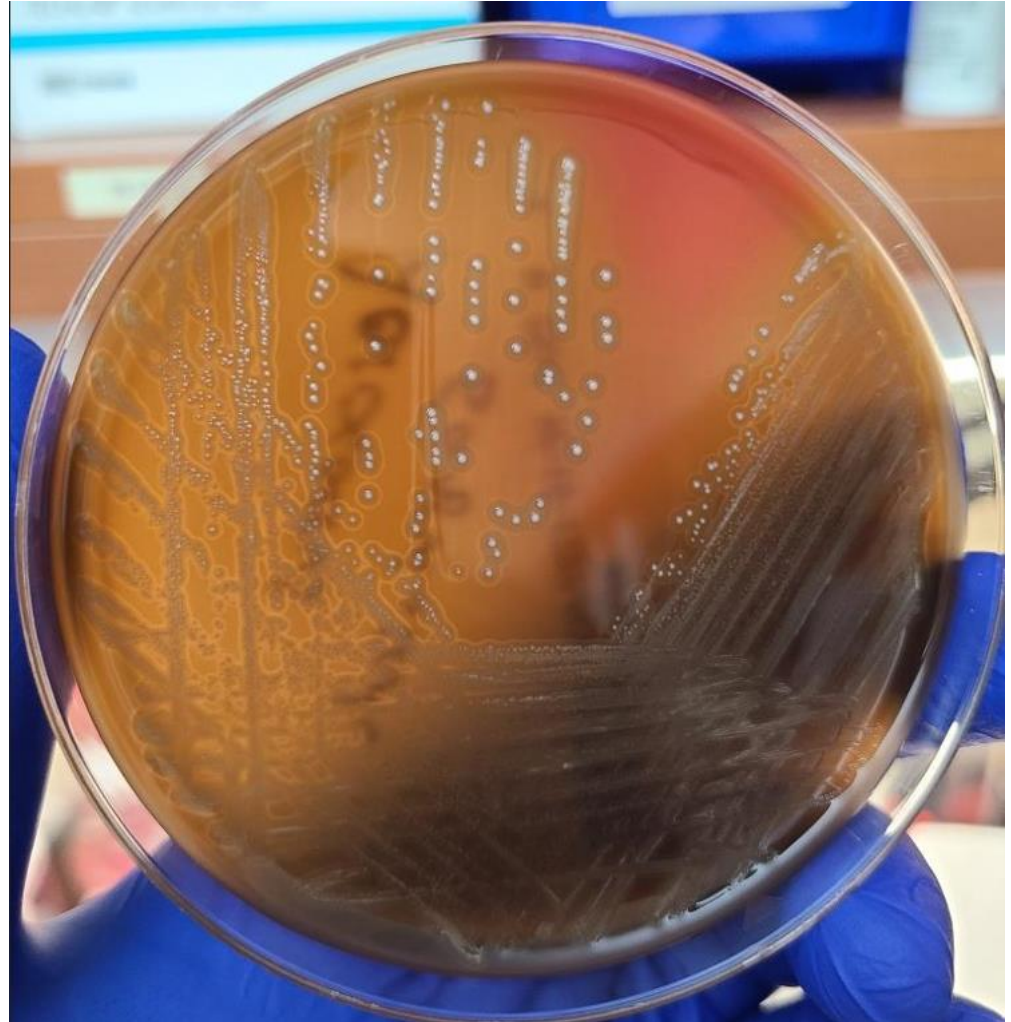
- The instrument produced an ID result of L. monocytogenes/innocua. L. monocytogenes is beta hemolytic on sheep blood agar, L. innocua is not.

Urine culture

“Do we care about Listeria in a urine specimen?”

Definitive ID via MALDI-TOF

➤ *Enterococcus faecalis*



Blood Culture

- Bottle flags positive after 24 hours – GS = GNR
- Verigene detected no organisms
- Tan colonies on Choc
- Gram stain: Small GNR

Component	Value
Acinetobacter species	Not Detected
Citrobacter species	Not Detected
Enterobacter species	Not Detected
Proteus species	Not Detected
Escherichia coli	Not Detected
K. pneumoniae	Not Detected
K. oxytoca	Not Detected
P. aeruginosa	Not Detected



Blood Culture

Phoenix Identification

Isolate Number:	1
Organism Name:	Rodentibacter pneumotropicus
Isolate Classification:	Significant / Unknown

Expert Triggered Rules

8001

Definitive ID via MALDI-TOF

➤ *Aggregatibacter aphrophilus*

Test Types:	ID/AST Combo
Test Name:	NMIC/ID-307
Sequence Number:	502891289786 Lot #: 2291573
Location:	1/A04
Organism Name:	Rodentibacter pneumotropicus
Instrument ID Results	Confidence Value
Rodentibacter pneumotropicus	96%

Final Thoughts

- Automated ID systems are good with common clinical isolates.
- Despite claims, IDs of rare isolates should be questioned/confirmed.
- Organism identifications should be correlated with culture type and clinical picture.
- “The interpretation of test results require trained clinical personnel who should use judgment, knowledge and additional confirmatory tests where required prior to accepting the identification of an organism.”

Microscan Product Insert

Questions???