Culture Independent Diagnostic Tests for Gastroenteritis

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PAMET, October 2019

Conflict of interests

- Advisory board:
  - DiaSorin®
  - QIAGEN®
  - Triple Ring Technologies Inc.
- Speaker sponsorship – Luminex®
- Instrument user:
  - BioFire: Torch, DiaSorin: Liaison, Hologic: Panther, Luminex: Verigene, Aries, QIAGEN: QIA Symphony

Objectives

- Gastroenteritis: clinical presentation, common causes
- IDSA guidelines for diarrheal illnesses
- Conventional diagnostic methods in acute gastroenteritis
- CIDT's for stool pathogens
- Financial factors

Gastroenteritis & Diarrheal Illnesses

- 2nd leading cause of infectious diseases morbidity
- 3rd leading cause of mortality
  - 1.4 million deaths in 2010[1]
- 2 billion New Cases/year of diarrhea worldwide[2], resulting in 1.9 million death for children <5 years[3].
- 179 million cases/year in the US[4]

1. Mandell's Principals of Infectious Diseases, 2015
2. WHO
3. Farthing et al., 2013
4. DuPont, in NEJM 2014

Infectious Diarrhea

- Definition:
  - ≥3 unformed stools within 24 hours **AND**
  - Enteric symptoms (nausea, vomiting, pain, cramps,…)
- Severity:
  - Mild
  - Moderate
  - Severe
- Duration:
  - Acute <14 days
  - Persistent 14-30 days
  - Chronic >30 days

Top 5 Most Frequent Pathogens

Numbers of acute gastroenteritis outbreaks and outbreak-associated outcomes caused by various etiologic agents reported in the National Outbreak Reporting System, United States, 2009–2010*

	No. (%) outbreaks			No. (%) outbreak-associated outcomes		
Outbreak etiology	**Confirmed**	**Suspected**	**Total**	**Illnesses**	**Hospitalizations**	**Deaths**
Single agent†						
Norovirus‡	1,355 (64.2)	553 (78.1)	1,908 (67.7)	69,145 (77.7)	1,093 (45.9)	125 (85.6)
Salmonella spp.	344 (16.3)	11 (1.6)	355 (12.6)	8,590 (9.7)	773 (32.5)	6 (4.1)
Shigella spp.§	99 (4.7)	10 (1.4)	109 (3.9)	2,135 (2.4)	115 (4.8)	1 (0.7)
STEC	88 (4.2)	13 (1.8)	101 (3.6)	1,091 (1.2)	250 (10.5)	9 (6.2)
Campylobacter spp.¶	56 (2.7)	13 (1.8)	69 (2.4)	1,550 (1.7)	52 (2.2)	0

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Emerg Infect Dis. 2013 Aug; 19(8): 1305–1309

Most Frequent Pathogens
- caused **92.7%** of the illnesses

Numbers of acute gastroenteritis outbreaks and outbreak-associated outcomes caused by various etiologic agents reported in the National Outbreak Reporting System, United States, 2009–2010*

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Emerg Infect Dis. 2013 Aug; 19(8): 1305–1309

Most Frequent Pathogens
- caused **96.6%** of deaths

Numbers of acute gastroenteritis outbreaks and outbreak-associated outcomes caused by various etiologic agents reported in the National Outbreak Reporting System, United States, 2009–2010*

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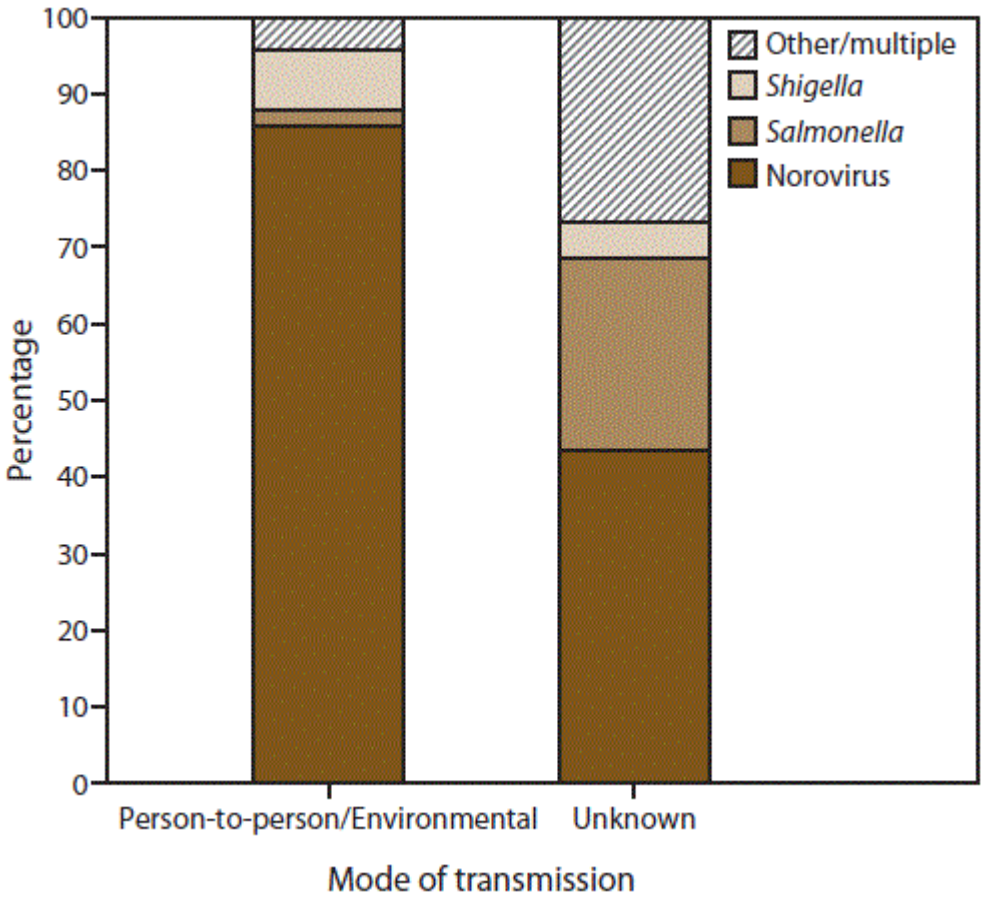
Emerg Infect Dis. 2013 Aug; 19(8): 1305–1309

Most Frequent Pathogens

Percentage of outbreaks of acute gastroenteritis transmitted by person-to-person contact, environmental contamination, and unknown mode of transmission by confirmed etiology — National Outbreak Reporting System, United States, **2009–2013**

[MMWR, Dec. 11 2015 / 64]



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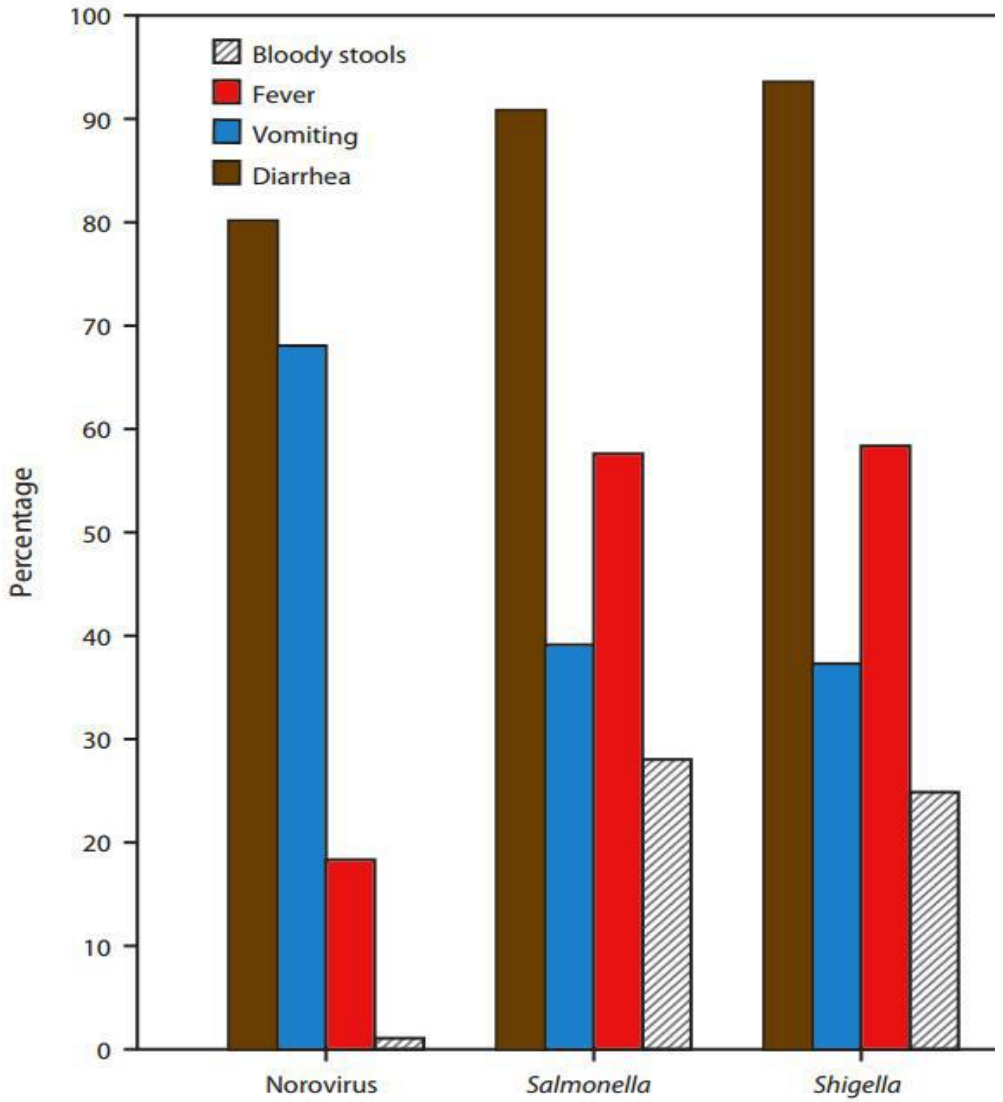
https://www.cdc.gov/mmwr/preview/mmwrhtml/ss6412a1.htm?s_cid=ss6412a1_w#Tab1

Symptoms

Nat'l Outbreak Reporting (2009 – 2013):
MMWR Surveill Summ. 2015 Dec 11;64(12):1-16.



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IDSA – Infectious Diarrhea Diagnosis

Clinical Infectious Diseases

IDSA GUIDELINE

2017 Infectious Diseases Society of America Clinical Practice Guidelines for the Diagnosis and Management of Infectious Diarrhea

Andi L. Shane, MD[1] Rajal K. Mody, MD[2] John A. Crump, MD[3] Phillip I. Tarr,[4] Theodore S. Steiner, MD[5] Karen Kotloff, MD[6] Joanne M. Langley, MD[7] Christine Wanke, MD[8] Cirle Alcantara Warren, MD[9] Allen C. Cheng, PhD[10] Joseph Cantey, MD[11] and Larry K. Pickering, MD[12]

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

Who Should be Tested?

- Test should be done if:
  - History of illness
    - Travel
    - Long-term care
    - Childcare
    - Healthcare Associated (HCA)
  - Immunocompromised
  - Zoonoses, Outbreak-associated, or Public Health risk
  - Severe Diarrhea
    - Fever, dehydration, dysentery
    - > 7 Days[1,2] or persistent

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1. Riddle MS, in AJG April 2016
2. *Clin Infect Dis*. 2017 Nov 29;65(12):e45-e80. IDSA guidelines

IDSA – What Specimens Should be Tested?

- "The optimal specimen for laboratory diagnosis of infectious diarrhea is a **diarrheal stool sample** (i.e., a sample that takes the shape of the container). For detection of bacterial infections, if a timely diarrheal stool sample cannot be collected, a rectal swab may be used (weak, low)."

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

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  - Diarrheal Stool
  - Rectal Swab

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA – Target Oriented Testing

- Organism detection depends on what pathogens and test are considered
- Factors that determine tests and targets are:
  - History (exposure)
  - Clinical presentation (signs and symptoms)
  - Immune status

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA: Test for pathogens based on condition

Condition	Target
Severe Cramping/Tenderness, Fever, Bloody or Mucoid stool, Sepsis? • Children w/ persistent abdominal pain, exposure to pork products • Travel to endemic region or Shellfish consumption	*Salmonella*, *Shigella*, *Campylobacter*, *Yersinia*, STEC, *C. difficile** • *Yersinia enterocolitica* • *Vibrio*
Possibility of Outbreaks	Broad Panel (bacterial, viral, parasitic)
Immunocompromised	Broad Panel (bacterial, viral, parasitic)
Uncomplicated Traveler's Diarrhea, which treatment is not indicated	Testing not recommended
Traveler's Diarrhea >14 days	Parasites

* usually not bloody.

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA – Who Should be Treated?

- "In immunocompetent children and adults, empiric antimicrobial therapy for bloody diarrhea while waiting for results of investigations is **not** recommended (strong, low)."

Clin Infect Dis. 2017 Nov 29;65(12):e45-e80.

IDSA – Who Should be Empirically Treated?

- "In immunocompetent children and adults, empiric antimicrobial therapy for bloody diarrhea while waiting for results of investigations is **not** recommended (strong, low)."
- Exceptions:
  - <3 months old
  - High severity
    - Fever
    - Abdominal pain
    - Dysentery (bloody stool, cramps, tenesmus, fever …)
  - Recent travel history
    - Fever
    - Signs of sepsis
  - Immunocompromised

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA – Who Should be Treated?

- Usually has fever and bloody diarrhea
- Any signs or symptoms of sepsis
- Epidemiological or travel link
- Immunocompromised with severe illness
- *Shigella*
- Some *Campylobacter* and *Salmonella*

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA – Testing for Parasites
[Exposure or Condition Associated with Pathogens]

Swimming in recreational water facility with treated water	*Cryptosporidium* and other potentially waterborne pathogens when disinfectant concentrations are inadequately maintained
Healthcare, long-term care, prison exposure, or employment	Norovirus, *Clostridium difficile*, *Shigella*, *Cryptosporidium*, *Giardia*, STEC, rotavirus
Child care center attendance or employment	Rotavirus, *Cryptosporidium*, *Giardia*, *Shigella*, STEC
Recent antimicrobial therapy	*C. difficile*, multidrug-resistant *Salmonella*
Travel to resource-challenged countries	*Escherichia coli* (enteroaggregative, enterotoxigenic, enteroinvasive), *Shigella*, Typhi and nontyphoidal *Salmonella*, *Campylobacter*, *Vibrio cholerae*, *Entamoeba histolytica*, *Giardia*, *Blastocystis*, *Cyclospora*, *Cystoisospora*, *Cryptosporidium*
Exposure to house pets with diarrhea	*Campylobacter*, *Yersinia*
Exposure to pig feces in certain parts of the world	*Balantidium coli*
Contact with young poultry or reptiles	Nontyphoidal *Salmonella*
Visiting a farm or petting zoo	STEC, *Cryptosporidium*, *Campylobacter*
Exposure or condition	
Age group	Rotavirus (6–18 months of age), nontyphoidal *Salmonella* (infants from birth to 3 months of age and adults >50 years with a history of atherosclerosis), *Shigella* (1–7 years of age), *Campylobacter* (young adults)
Underlying immunocompromising condition	Nontyphoidal *Salmonella*, *Cryptosporidium*, *Campylobacter*, *Shigella*, *Yersinia*
Hemochromatosis or hemoglobinopathy	*Y. enterocolitica*, *Salmonella*
AIDS, immunosuppressive therapies	*Cryptosporidium*, *Cyclospora*, *Cystoisospora*, microsporidia, *Mycobacterium avium*–intercellu-

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80.

IDSA – Testing for Parasites

- **Travel to resource-challenged area**
- **AIDS and immunosuppressive therapy**

- Swimming in treated water
  - *Cryptosporidium*
- Childcare related
  - *Cryptosporidium, Giardia*
- Underlying immunocompromised condition
  - *Cryptosporidium*
- Anal-genital, oral-anal, digital-anal contact
  - *E. histolytica*, *Giardia*, *Cryptosporidium*

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80.

IDSA – Testing for Parasites

- **Travel to resource challenged area**
  - *"… Entamoeba histolytica, Giardia, Blastocystis, Cyclospora, Cystoisospora, Cryptosporidium …"*

"Travelers with diarrhea lasting 14 days or longer should be evaluated for intestinal parasitic infections (strong, moderate)."

Clin Infect Dis. 2017 Nov 29;65(12):e45-e80.

IDSA – Testing for Parasites

- Travel to resource challenged area

- **AIDS and Immunosuppressive Therapy**
  - *"Cryptosporidium*, *Cyclospora*, *Cystoisospora*, microsporidia …"

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80.

How important are **molecular** tests for parasites?

Exposure or condition	Expected parasite(s)
Foodborne outbreaks in hotels, cruise ships, resorts, restaurants, catered events	***Cryptosporidium,*** *Cyclospora*
Consumption of unpasteurized milk or dairy	***Cryptosporidium***
Consumption of fruits or unpasteurized fruit juices, vegetables, leafy greens, and sprouts	***Cryptosporidium****, Cyclospora*
Swimming in or drinking untreated fresh water	***Cryptosporidium, Giardia***
Swimming in recreational water facility with treated water	***Cryptosporidium***
Childcare center, healthcare, long-term care, prison exposure, or employment	***Cryptosporidium, Giardia***
Travel to resource-challenged countries	***Cryptosporidium, Giardia,*** *Cyclospora, Cystoisospora, Blastocystis*
Exposure to pig feces in certain parts of the world	*Balantidium coli*
Visiting a farm or petting zoo	***Cryptosporidium***
Underlying immunocompromising condition	***Cryptosporidium***
AIDS, immunosuppressive therapies	***Cryptosporidium, Giardia,*** *Cyclospora, Cystoisospora, Microsporidia*
Anal-genital, oral-anal, or digital-anal contact	***Cryptosporidium, Giardia, E. histolytica***

IDSA – *C. difficile* Testing

Clinical Infectious Diseases

IDSA GUIDELINE

Clinical Practice Guidelines for *Clostridium difficile* Infection in Adults and Children: 2017 Update by the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA)

L. Clifford McDonald,[1] Dale N. Gerding,[2] Stuart Johnson,[2,3] Johan S. Bakken,[4] Karen C. Carroll,[5] Susan E. Coffin,[6] Erik R. Dubberke,[7] Kevin W. Garey,[8] Carolyn V. Gould,[1] Ciaran Kelly,[9] Vivian Loo,[10] Julia Shaklee Sammons,[6] Thomas J. Sandora,[11] and Mark H. Wilcox[12]

[1]Centers for Disease Control and Prevention, Atlanta, Georgia; [2]Edward Hines Jr Veterans Administration Hospital, Hines, and [3]Loyola University Medical Center, Maywood, Illinois; [4]St Luke's Hospital, Duluth, Minnesota; [5]Johns Hopkins University School of Medicine, Baltimore, Maryland; [6]Children's Hospital of Philadelphia, Pennsylvania; [7]Washington University School of Medicine, St Louis, Missouri; [8]University of Houston College of Pharmacy, Texas; [9]Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts; [10]McGill University Health Centre, McGill University, Montréal, Québec, Canada; [11]Boston Children's Hospital, Massachusetts; and [12]Leeds Teaching Hospitals NHS Trust, United Kingdom

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Clin Infect Dis. 2018 Mar 19:66(7)

C. difficile Infection (CDI) Definition

- **Symptoms**:
  - Diarrhea (usually)
    - Unexplained (e.g., exclude laxatives)
    - New-onset
    - ≥3 within 24 hours
    - Unformed stool
- **Tests**:
  - Detection of *C. difficile* toxins
  - Detection of Toxigenic *C. difficile*
  - Colonoscopy
  - Histopathology

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Clin Infect Dis. 2018 Mar 19:66(7)

IDSA – When Should We Test for *C. difficile*?

1. ***"VI. When should testing be performed for Clostridium difficile? Recommendation.***

   18. Testing may be considered for *C. difficile* in people >2 years of age who have a history of diarrhea following antimicrobial use and in people with healthcare-associated diarrhea." [1]

2. "Patients with unexplained and new-onset ≥3 unformed stools in 24 hours are the preferred target population for testing for CDI." [2]

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1. *Clin Infect Dis*. 2017 Nov 29;65(12):e45-e80.
2. *Clin Infect Dis*. 2018 Mar 19:66(7)

When Should We Test for *C. difficile*?

- >2 years old
- History of antimicrobial use
- Healthcare-associated diarrhea
- Persistent with no apparent etiology or risk factor
- Test only once
- Testing either toxin (EIA?) or toxigenic strain (NAAT) are acceptable

Clin Infect Dis. 2018 Mar 19:66(7)

Sutter Health System (SHS)

2nd largest Northern-California health system

- Not-for-profit
- Serving >100 communities
- 24 acute care hospital systems
- 26 clinics, medical foundations
- 40,000 physicians
- 50,000 employees

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Sutter Health Shared Laboratory (SHSL)

- Limited Chemistry, Hematology, Blood Bank, and Serology
  - 3.9 million tests/year
- Major provider of Microbiology tests for the system
  - >1 million tests/year
- Major provider of Molecular Dx (ID, Genetic)
  - 400,000 tests/year

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SHSL Gastroenteritis Testing

Bacterial cult. (20K 4.4% POS)	Viral (2,500)	Parasites (EIA 5,300)
Campylobacter (407)	Rotavirus-EIA (6.5%)	*Cryptosporidium* (1.2%)
Salmonella (259)	Norovirus-PCR (**10.7%**)	*Giardia* (0.9%)
Shigella (30)		
Aeromonas (78)		
Plesiomonas (13)		
E. coli 0157, STEC (36)		
*Vibrio** (5)		
*Yersinia** (4)		
C. difficile (12,000) EIA (5.9%) – PCR (25.2%)		

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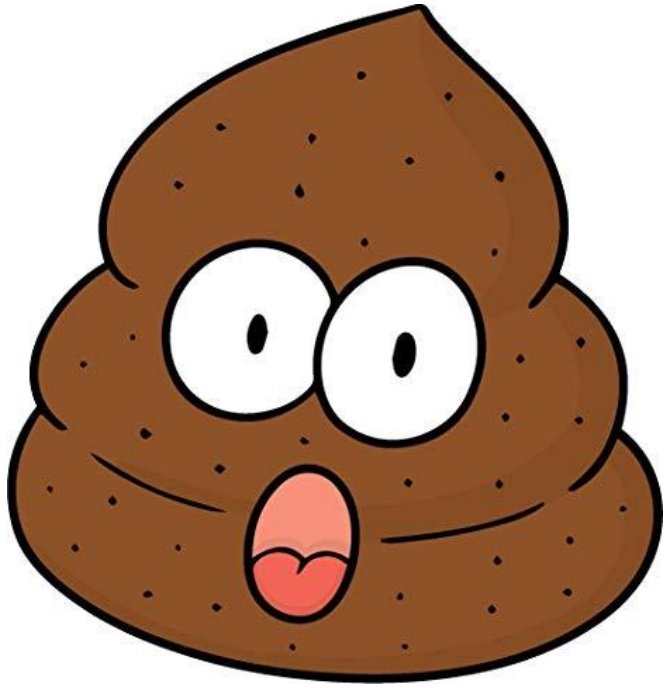
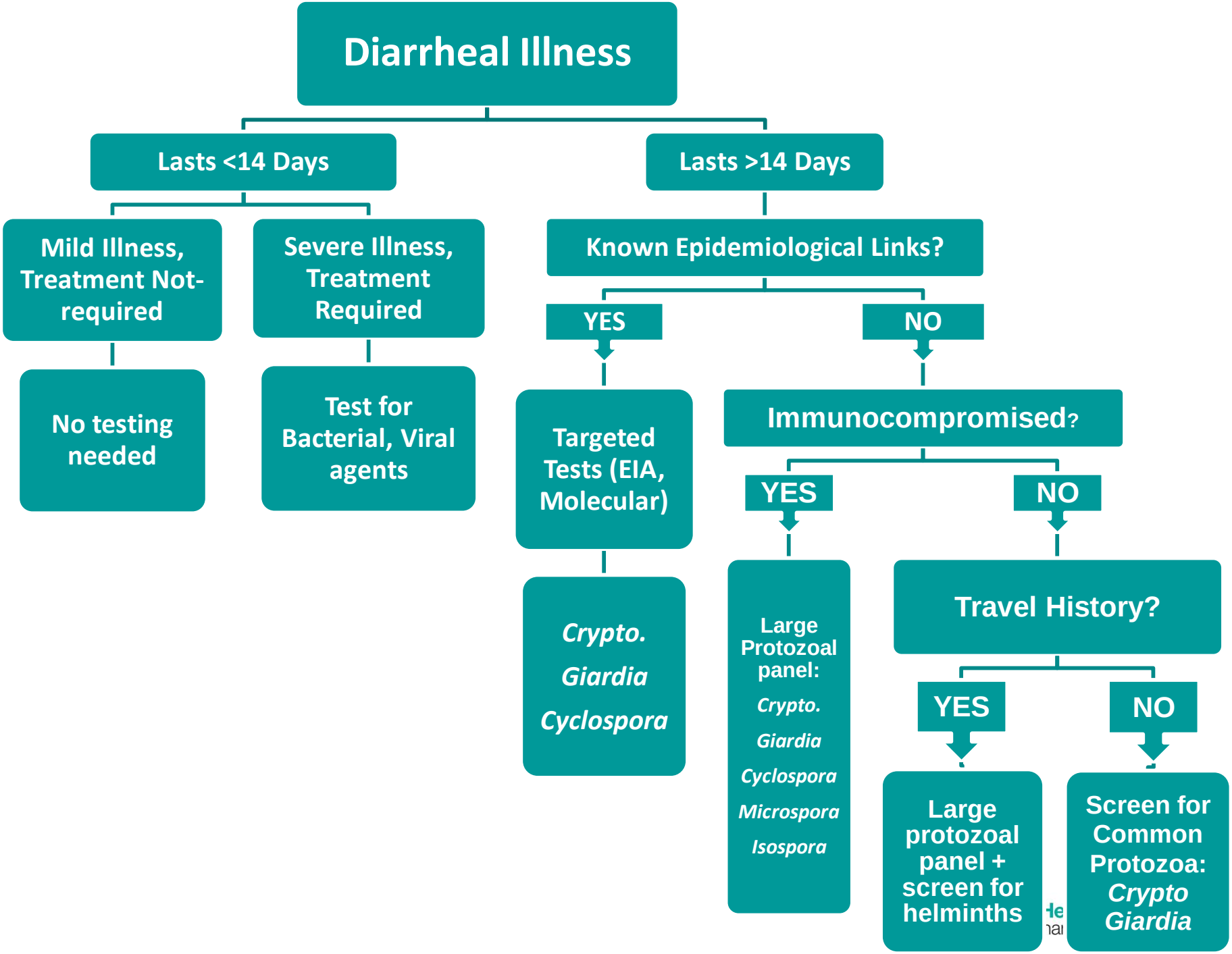
* Needs special request & media

Parasitology!

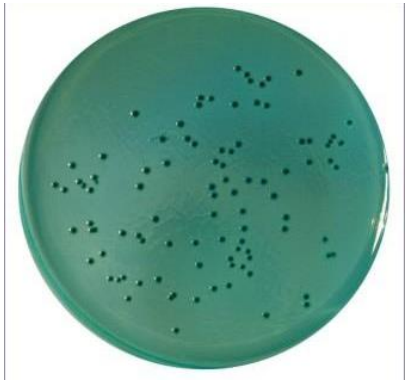
- **50,000**!!!!! in 2015
- 18,000 in 2018
- O&P?
  - Lacks
    - Sensitivity
    - Automation
    - Coverage
  - Labor intensive ($$$)




Diarrheal Illness
Lasts <14 Days
Lasts >14 Days
Mild Illness, Treatment Not-required
Severe Illness, Treatment Required
Known Epidemiological Links?
No testing needed
Test for Bacterial, Viral agents
YES
NO
Targeted Tests (EIA, Molecular)
Immunocompromised?
Crypto.
Giardia
Cyclospora
YES
NO
Large Protozoal panel:
Crypto.
Giardia
Cyclospora
Microspora
Isospora
Travel History?
YES
NO
Large protozoal panel + screen for helminths
Screen for Common Protozoa: Crypto Giardia

Stool Bacterial Culture

- GN-Broth (only if Shiga-toxin ordered)
- BAP
- MAC
- MAC/Sorb
- *Salmonella, Shigella* (SS)
- Hektoen Enteric (HE)
- Campy-CVA agar



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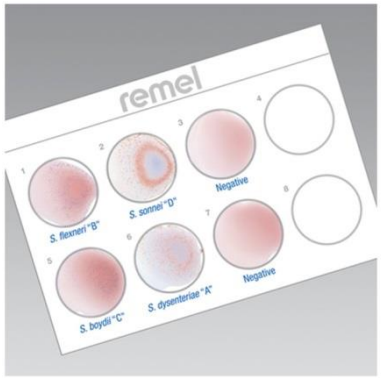
- https://www.google.com/search?q=gn+broth&safe=active&rlz=1C1GGRV_enUS751US751&source=lnms&tbm=isch&sa=X&ved=0ahU
- https://www.tuyenlab.net/2018/02/microbiology-hektoen-enteric-agar.html
- https://www.google.com/search?q=macconkey+agar&safe=active&rlz=1C1GGRV_enUS751US751&source=lnms&tbm=isch&sa

Stool Bacterial Culture (Confirmation)

- Shiga-toxin – EIA

- *E. coli* O157, H7 – EIA

- Latex agglutination: Wellcolex® Color
  - *Shigella*
  - *Salmonella*



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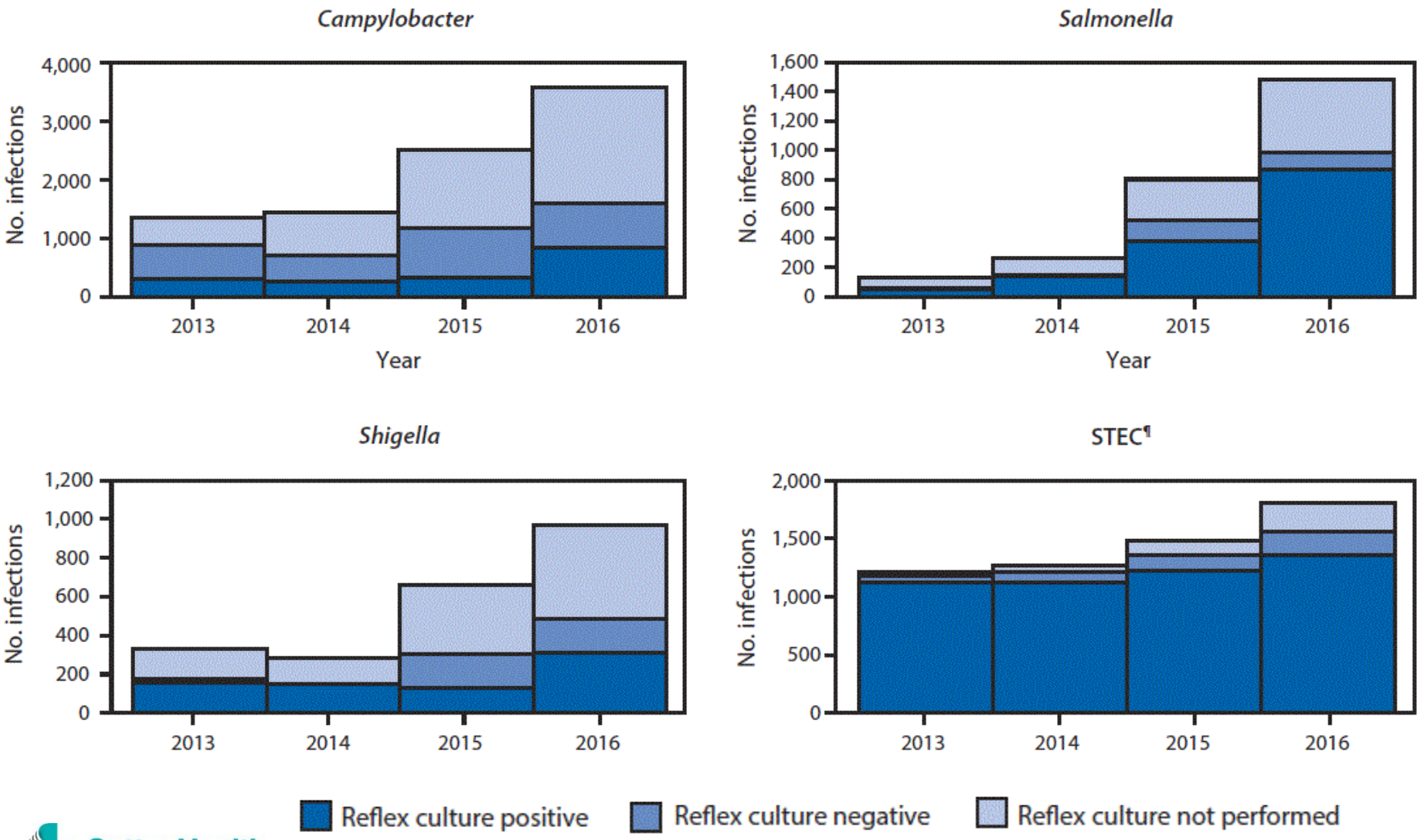
- https://www.google.com/search?q=wellcolex+shigella&safe=active&rlz=1C1GGRV_
- http://www.meridianbioscience.com/diagnostic-products/foodborne/immunocard-stat/immunocard-stat-ehec.aspx
- https://www.thermofisher.com/order/catalog/product/R24250

Culture Independent Diagnostic Tests (CIDT)
[Marder EP, et al. MMWR 2017]



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https://www.cdc.gov/mmwr/volumes/66/wr/mm6615a1.htm

CIDT's and Pathogen recovery

- Increases the recovery of all bacterial pathogens
  - It's more prominent on vulnerable or hard-to-grow organisms (up to 300%)[1]
    - *Campylobacter*
    - *Shigella*
- Standard method for viral pathogens
- Superior performance on protozoa parasites

1- Alexander, J - 2018

Culture-Independent Diagnostic Test

"V. Which diagnostic tests should be performed when enteric fever or bacteremia is suspected? Recommendation.

17. Culture-independent, including panel-based multiplex molecular diagnostics from stool and blood specimens, and, when indicated, culture-dependent diagnostic testing should be performed when there is a clinical suspicion of enteric fever (diarrhea uncommon) or diarrhea with bacteremia (strong, moderate)."

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Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

IDSA take on CIDT's

- Now CIDT's are recommended when:
  - Suspected sepsis
  - Immunocompromised patients

- Results should be interpreted with cautions and/or be confirmed by culture if:
  - non-viable organisms are suspected
  - susceptibility testing is indicated
  - outbreak investigation at Public Health level required

- CIDT's should not be used for patient management or test-of-cure

Clin Infect Dis. 2017 Nov 29;65(12):e45-e80

CIDT benefits

- Advantages:
  - Turnaround time (Days vs. Hours)
  - Easy to perform (Moderate complexity)
  - Reliability (higher sensitivity) [1, 3]
  - Reduces ER admission[2]
  - Reduces length of stay[2] (LOS)
  - Less dependent on the specimen quality, viability[3]
  - Recommended by IDSA latest guidelines[4]

1. Marder EP, et al MMWR Vol 66 No 15, 2017
2. McNabb, K. 2017
3. Alexander J, 2018
4. *Clin Infect Dis*. 2017 Nov 29;65(12):e45-e80. IDSA guidelines

CIDT

- Disadvantages:
  - $ Cost **??**
  - May detect nonviable organisms; NOT appropriate for follow- up or treatment monitoring[1]
    - Public Health studies
    - Susceptibility
      - Rarely indicated
      - Ciprofloxacin resistance in 2015[2]
        - » *Salmonella*= 4%
        - » *Shigella*= 2.5%

1. *Clin Infect Dis*. 2017 Nov 29;65(12):e45-e80
2. https://wwwn.cdc.gov/narmsnow

CIDT's cost

- Platform cost
  - Instrument
  - Service
- Cost/test
  - Reagents $$$
  - Labor $
    - MLT vs CLS (California, only?!)
- Reimbursements
  - PAMA
  - Palmetto GBA

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PAMA

- **P**rotecting **A**ccess to **M**edicare **A**ct of 2014

- Stops Clinical Laboratory Fee Schedule (**CLFS**) rates, and shifted to “Market-Based Pricing”.

- Applied to 3500 common lab tests
  - Pay rates at the median of private payer rate
  - Data obtained from 3.6% of labs (some large commercials)
  - 10% - 15% decrease/year from 2018 -2023

How PAMA affects the reimbursements

Test	2017	2018	CPT
Stool Culture	$12.93	**$11.66**	87046
O&P	$12.21	**$10.99**	87177
MOLECULAR			
GI Pathogen (3-5)	$175.98	$158.38	87505
GI Pathogen (6-11)	$292.77	$263.49	87506
GI Pathogen(12-25)	$571.55	$514.55	87507
M. pneumoniae Quant	$57.28	$302.62	87582

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www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched/Clinical-Laboratory-Fee-Schedule-Files.html

Palmetto

- **Plametto** is a MAC (Medicare Administrative Contractor)
- **Noridian** covers California Jurisdiction, and follows MolDx.
- **MolDx** program performs technical assessment of published test data, establishes reimbursements.
  - Then Palmetto determines coverage w/o document review
- GI testing coverage based on IDSA and ACG guidelines.
  - Significantly affect Medicare
  - Medicaid

https://www.palmettogba.com/palmetto/MolDX.nsf/vMasterDID/8N3ELL4072?open

Palmetto

Palmetto Final LCD Denies Coverage to Large Respiratory Panels

Sep 28, 2018

NEW YORK (GenomeWeb) – Medicare administrative contractor Palmetto GBA finalized local coverage determinations for viral respiratory panels yesterday, determining that the use of small multiplex viral panels in susceptible populations may be reasonable and necessary, but the use of highly multiplexed nucleic acid amplification tests as front-line diagnostics cannot currently be justified.

The measure had been expected after a draft LCD was issued in May 2017 and will now become effective Nov. 12, 2018.

https://www.genomeweb.com/reimbursement/palmetto-final-lcd-denies-coverage-large-respiratory-panels

Palmetto LCD

- Out patients test coverage:
  - Initially required tests to be ordered by ID practitioners, unless there is none available!
  - Will pay but at a lower cost

GI panel Sizes	Patient Presentation	Rate	CPT
3-5	Healthy Adults	$158.38	87505
6-11	Recently Hospitalized, or possible *C. difficile*	$263.49	87506
12-25	Immunocompromised, or severely ill	$514.55	87507

How Palmetto effects reimbursements

- Mainly affects Medicare
- Medicaid: not affected yet
- Private payers affect varies and still forming!
  - Blue Cross/Blue Shield: limited coverage
  - Aetna: not affected yet.

How to deal with financial

- Diagnostic testing stewardship
- Tests done as a part of DRG?
  - Usually don't work for GI tests
- Break up larger panels to smaller ones
- See if flexible panels fits your clinical needs and operation
- Work with Biotech companies for creative finance options
- Work with stakeholder and clinicians for considering the bigger picture of impact on patient care
- Consolidate testing platforms, and use automation.
- **PLA codes**

How to deal with financial – PLA codes

- Proprietary Laboratory Analyses (PLA), a subset of CPT
- Originally created by CMS for LDT's reimbursement
- Biofire® applies them to their GI and RP panels

GI Panels

Test	Instrument	Manufacturer	Targets	Time (h)
Enteric Panel (EP)	**VERIGENE®**	**Luminex**	**9**	**2**
GI Pathogen	**xTAG®**	**Luminex**	**14**	**~5**
FilmArray® GI Panel	**Torch®**	**BioFire Dx**	**22**	**1**
EBP	**BD Max®**	**BD**	**4**	**~3**
ProGastro	**GenProbe®**	**Hologic**	**4**	**4**
*EP	Verigene-2	Luminex	25	~2
*GI	ePlex®	Genmark	?	~ 1.5

*FDA approval pending

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BioFire FilmArray® - GI Panel

Bacteria	Parasites	Virus
Campylobacter *C. difficile* *Plesiomonas* *Salmonella* *Y. enterocolitica* *Vibrio* STEC, ETEC, EPEC, EAEC *Shigella/*EIEC	*Cryptosporidium* *Cyclospora* *E. histolytica* *Giardia*	Adenovirus Astrovirus Norovirus Rotavirus Sapovirus

https://www.biofiredx.com/wp-content/uploads/2016/03/IS-FLM1-MKT-0158-FilmArray-Brochure-Insert.pdf

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VERIGENE® - Enteric Panel

Bacteria
Campylobacter Group
Salmonella spp.
Shigella spp.
Vibrio Group
Y. enterocolitica
Toxins
Shiga Toxin 1
Shiga Toxin 2
Viruses
Norovirus
Rotavirus

https://www.luminexcorp.com/clinical/our-technology/verigene-nanogrid-technology/

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Factors to Consider CIDT's

- Reliability
  - Results accuracy, analytical specificity / sensitivity
  - Vulnerability to contamination
- Ease-of-use
- Ability to detect major pathogens
- Flexibility to match the right-patient/right-test concept
- Avoid over-diagnosis (e.g. *C. difficile*)
- Cost:
  - Capital
  - Per test

Summary

- **CIDT** performance are generally superior to conventional methods
- Over-diagnosis has to be addressed by choosing the right **patient**, the right **test**, and the right **specimen** [e.g. *C. difficile*]

- Consider testing for **parasites** only when the clinical features (lack of fever, chronicity…) and exposure links (travel, daycare …) are established or patient is immunocompromised.

- Financial impacts including, capital, Labor cost and reimbursements are key factors in acquisition of CIDT's for GI pathogens
- PLA codes created a practical avenue for better reimbursements

Thank you!

- Sutter Health Shared Laboratory
  - **Kamaljit Sandhu**, QA Specialist
  - **Melinda Dow**, Director Finance
- **Jose Alexander, MD** (Director, Clinical Microbiologist at Florida Hospital, Orlando)
- **Stephanie Ibbotson** (Director, Market Access)

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