Acute Pharyngitis: Advances in Pathogen Identification and Diagnosis

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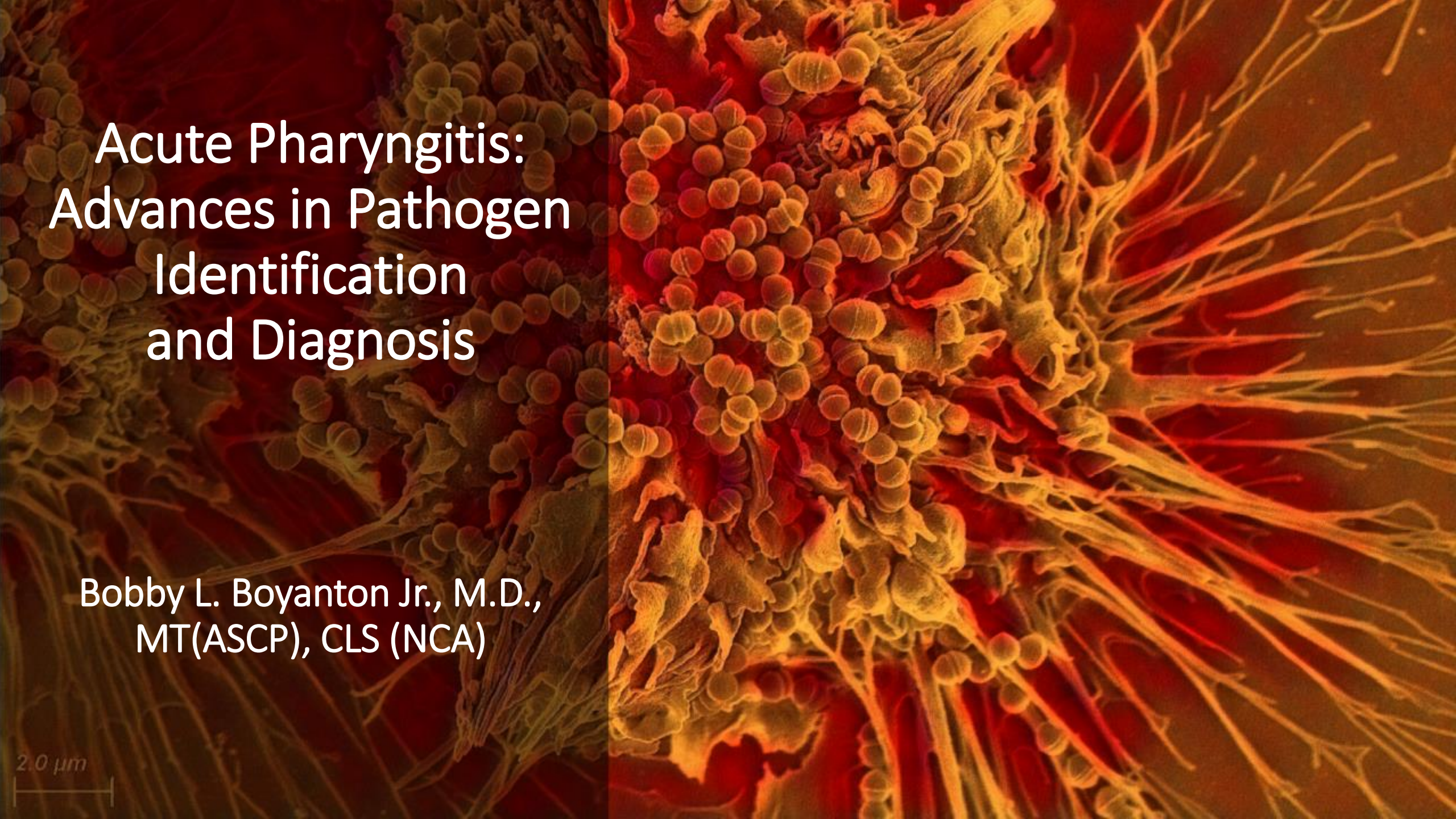

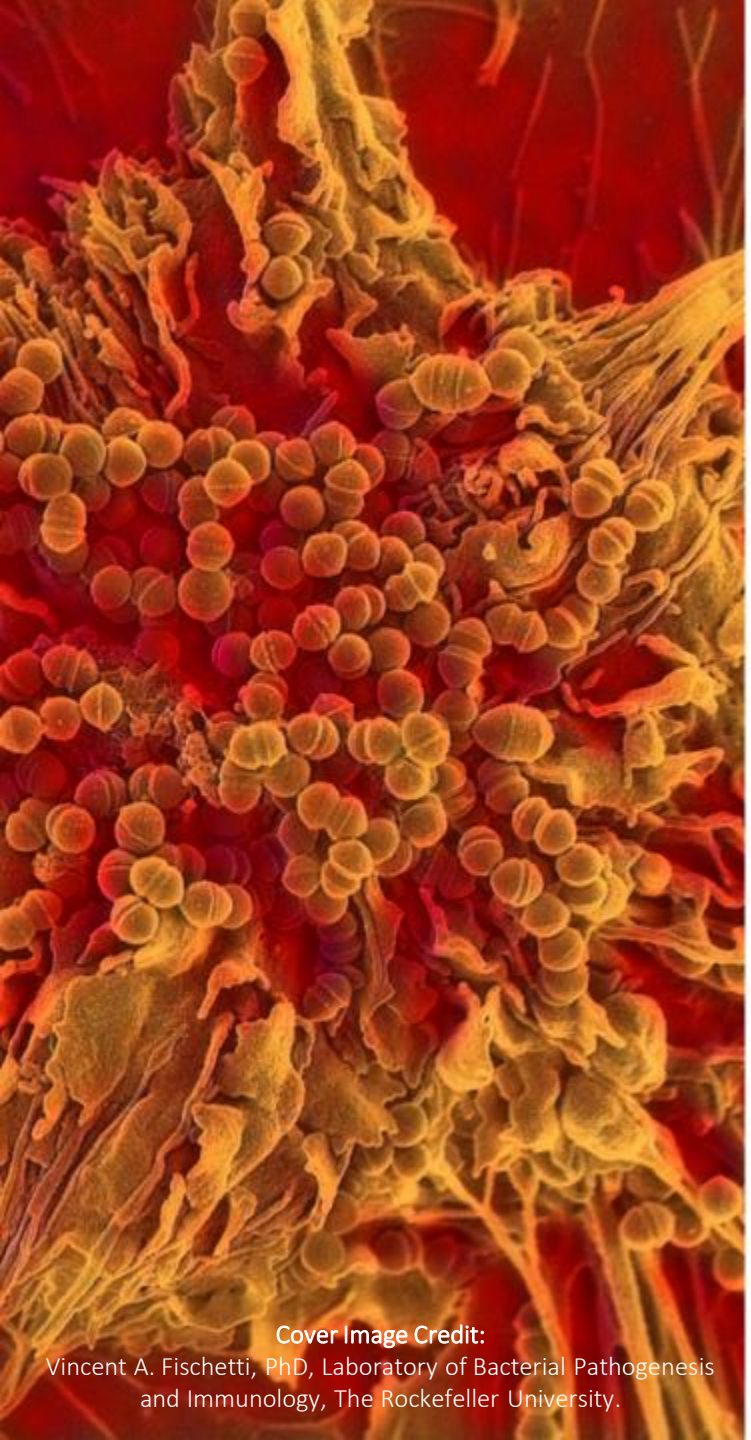

Cover Image Credit:
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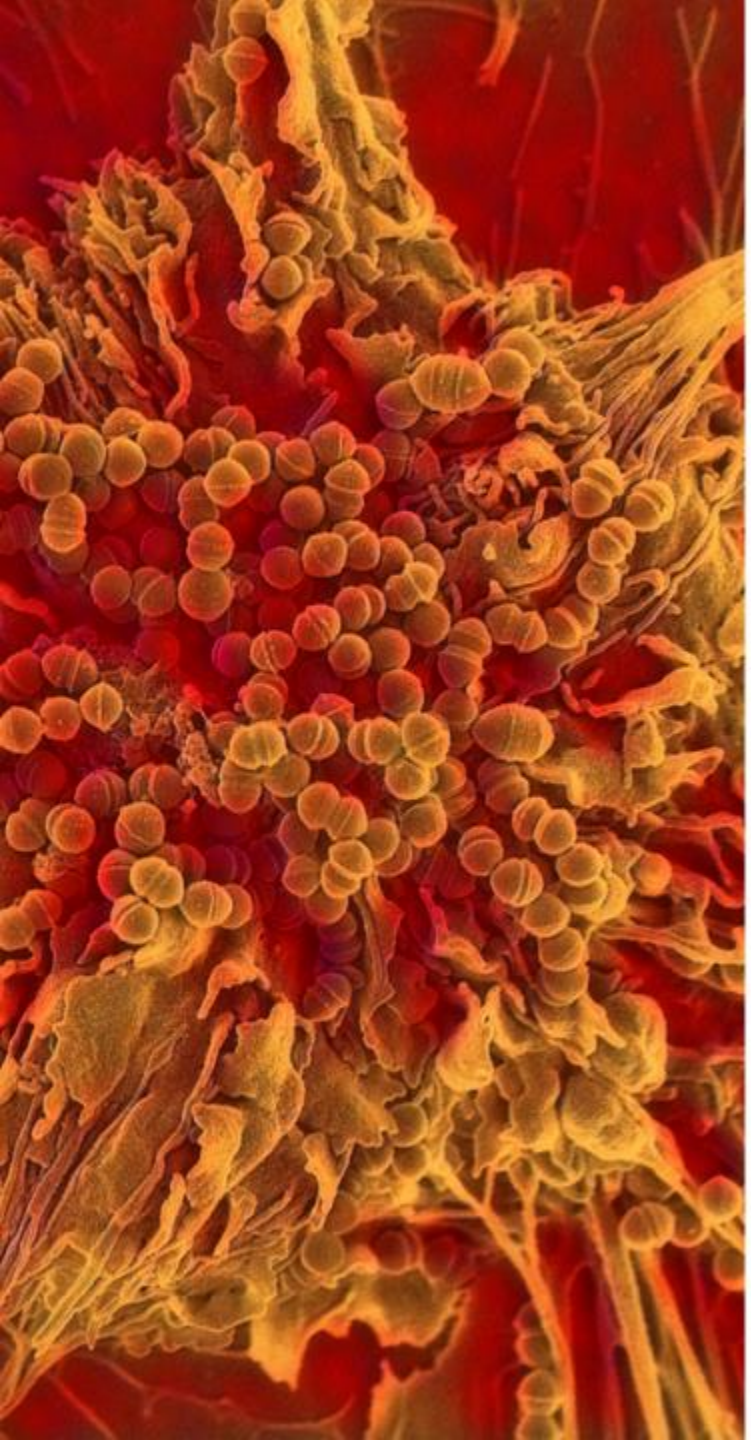
Disclosures:

- Honoraria received (Medavera) - Providing this presentation.
- Honoraria received (QuidelOrtho) - Participating in 2023 Key Opinion Leader Summit.



Agenda

- Overview of Acute Pharyngitis
- Pathogen vs. Colonization
- Lab Diagnostics (Current / Future)
- Case Studies
- Summary

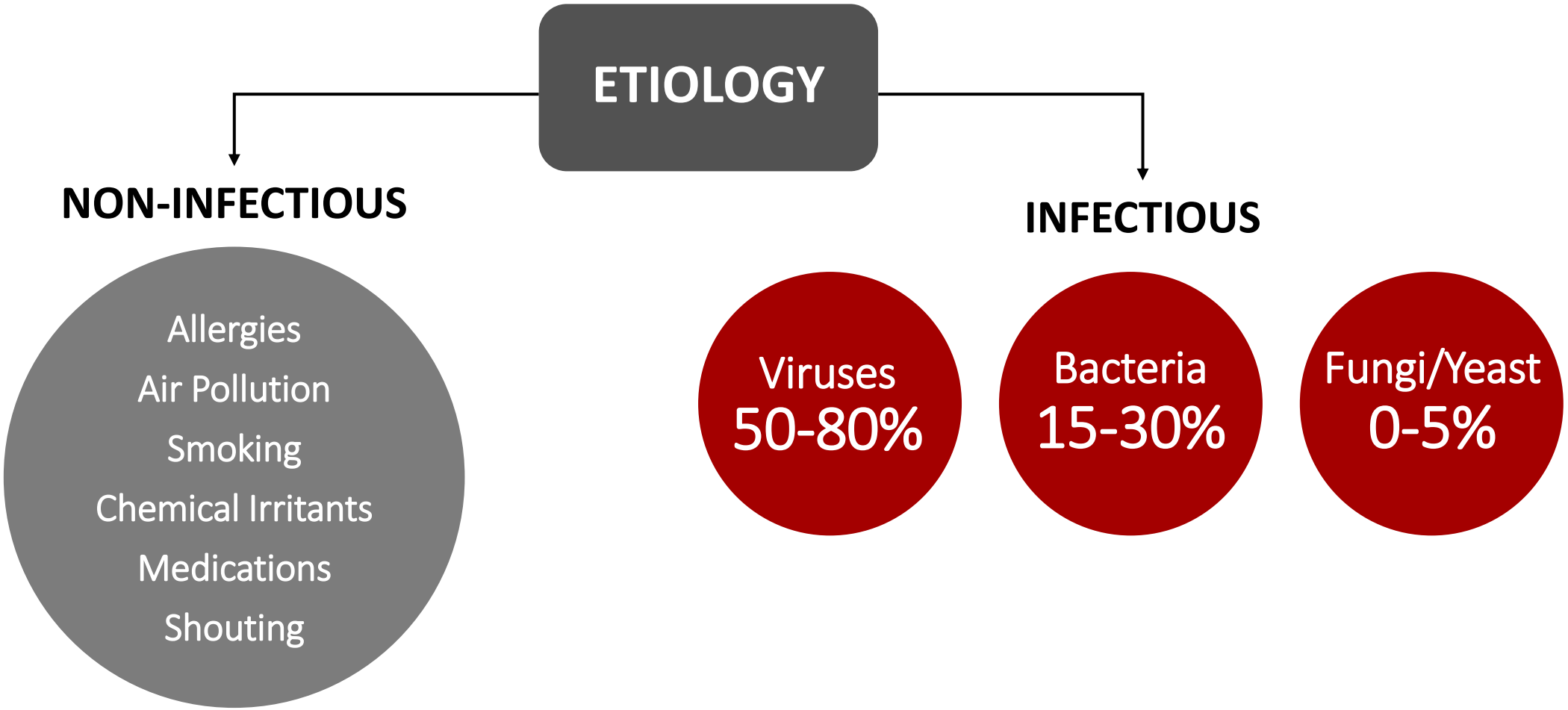
Overview of Acute Pharyngitis

Acute Pharyngitis:

- **12 Million (2%):** Annual ambulatory care visits in the U.S. annually
  - 50% are children/adolescents (<18 yrs. of age)
  - 60% of all patients receive antibiotics
- **$ 224 Million:** Annual healthcare cost for patients without complications
- **$ 1.2 Billion:** Annual healthcare cost of uncomplicated and complicated patients and antibiotic resistance

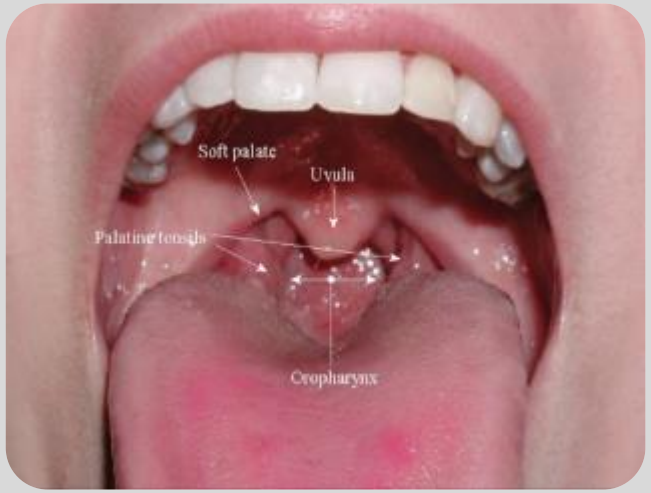
- Bilir SP, et al. *Am J Manag Care*. 2021 May 1;27(5):e157-e163. PMID: 34002967.
- Salkind AR, Wright JM. *Value Health*. 2008 Jul-Aug;11(4):621–627. PMID: 18179674.

Acute Pharyngitis: *"Sore Throat" - Inflammation of the Oropharynx and Tonsils*

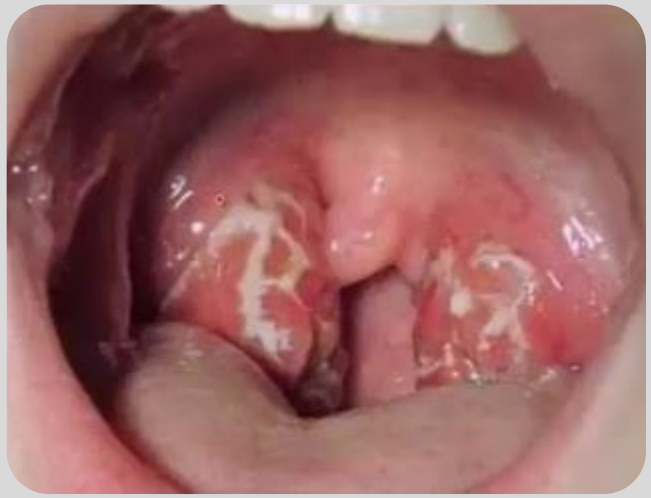


- Pharyngitis (Strep Throat): https://www.cdc.gov/groupastrep/diseases-hcp/strep-throat.html#print

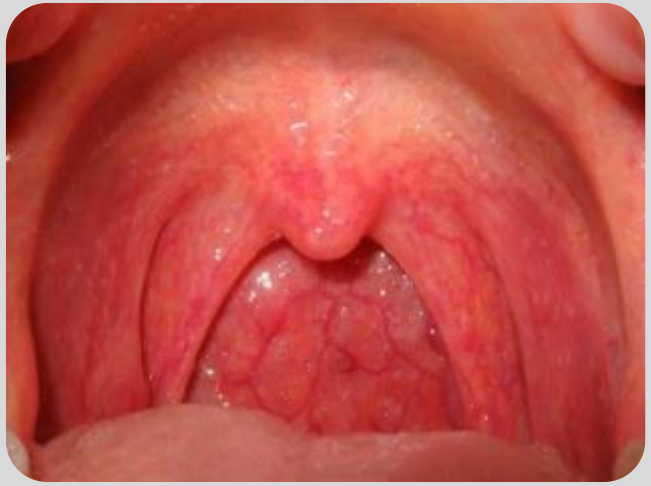
Oropharynx Anatomy



Normal



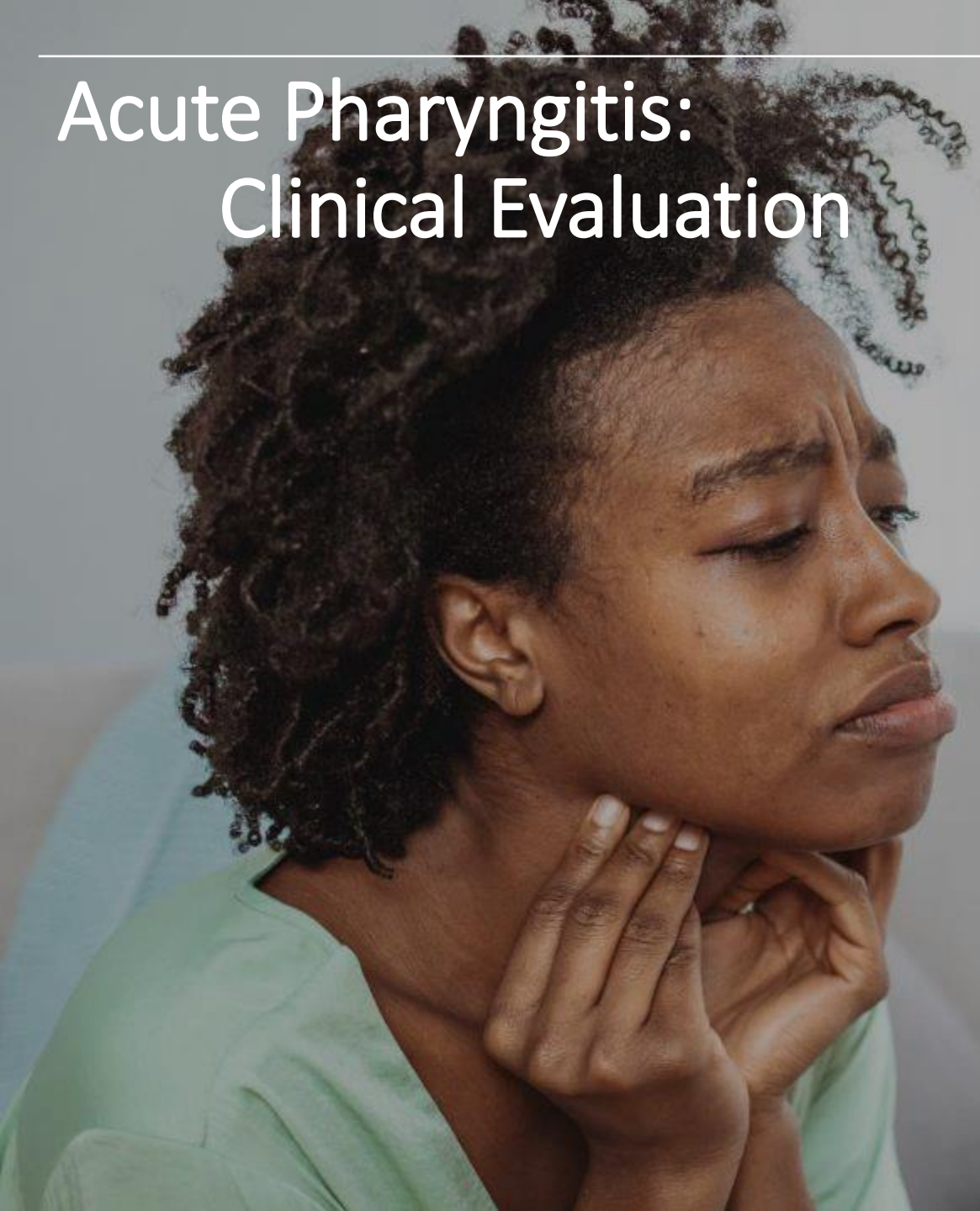
Abnormal



Abnormal

- Pharyngitis (Strep Throat): https://www.cdc.gov/groupastrep/diseases-hcp/strep-throat.html#print. Accessed September 27, 2023.

Acute Pharyngitis: Clinical Evaluation



PRIMARY GOAL

Exclude serious/life-threatening conditions:

1. Upper airway obstruction
2. Invasion into neck tissues

SECONDARY GOAL

Determine etiology:

1. Non-Infectious
2. Infectious:
   - Viral: largely supportive care
   - Bacterial: antibiotic therapy for group A *Streptococcus* (GAS) and other organisms as necessary

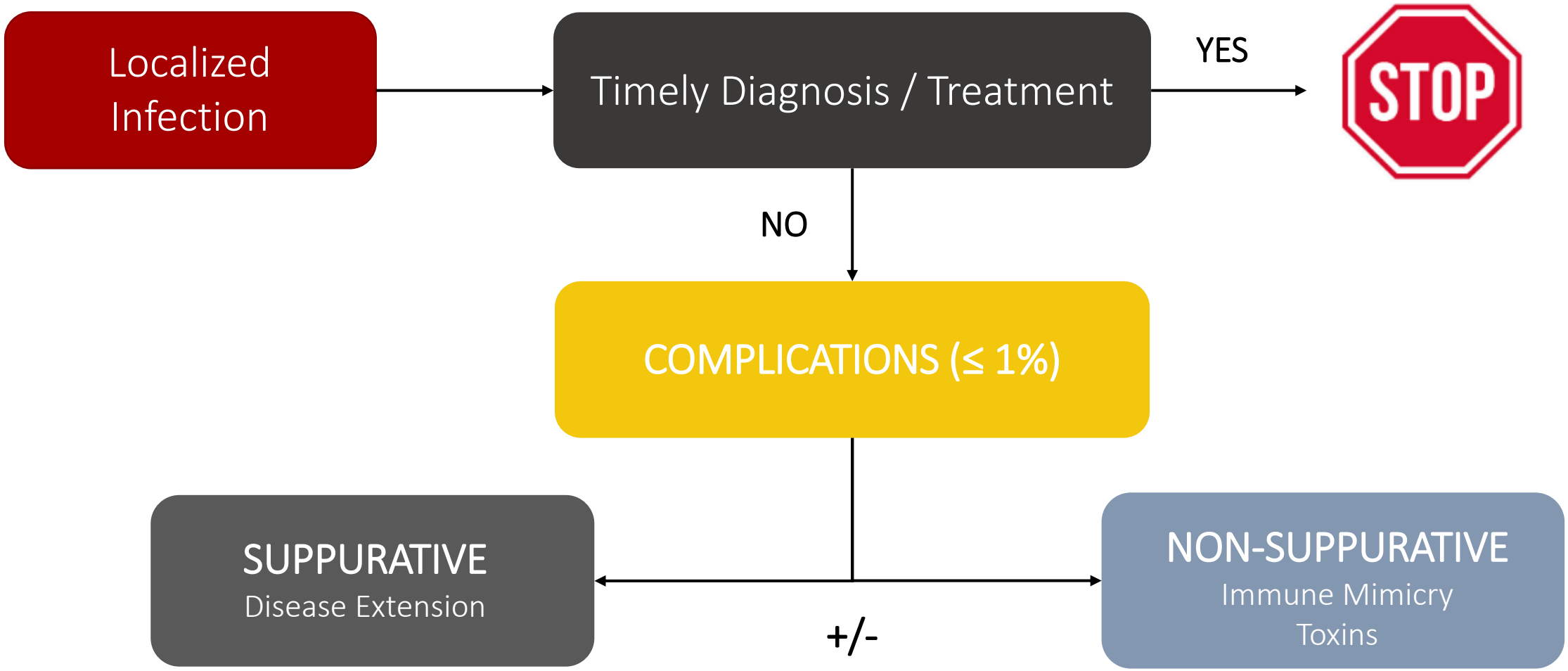
Acute Pharyngitis: Signs & Symptoms

- **Primary**
  - Red, swollen, and painful throat

- **Secondary (accompanying)**
  - Headache, chills
  - Fever (high)
  - Fever (low), except Flu and SARS-CoV-2
  - Fatigue, myalgia
  - Nausea, vomiting
  - Abdominal pain
  - Rash
  - Tonsillar exudates
  - Swollen and tender “neck” lymph nodes
  - Runny nose or congestion
  - Teary eyes, conjunctivitis

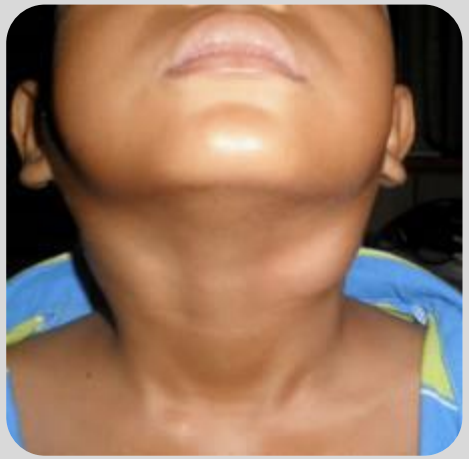
Clinical manifestations cannot reliably differentiate amongst etiologies!

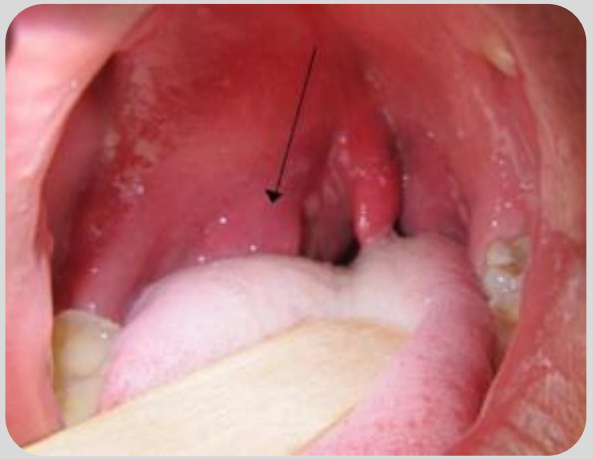
Acute Pharyngitis: Disease Course



Suppurative Complications: Bacterial Infection

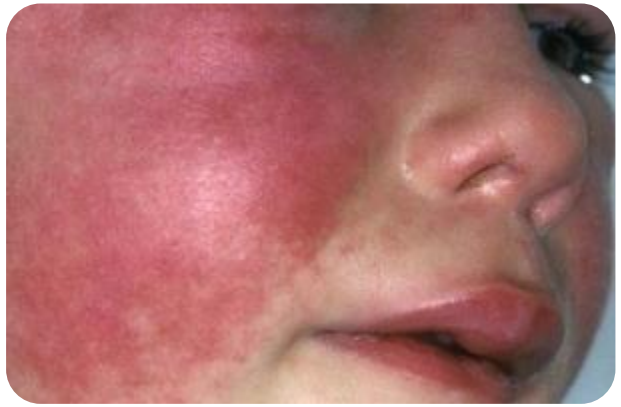
- Brain abscess
- Cervical lymphadenitis
- Jugular vein septic thrombophlebitis
- Mastoiditis
- Meningitis
- Otitis media
- Sinusitis
- Tonsillopharyngeal abscess

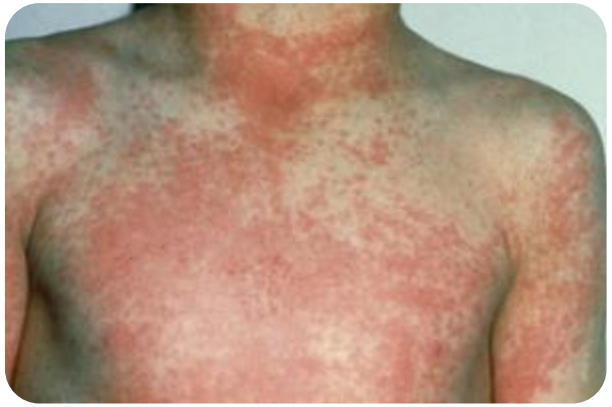


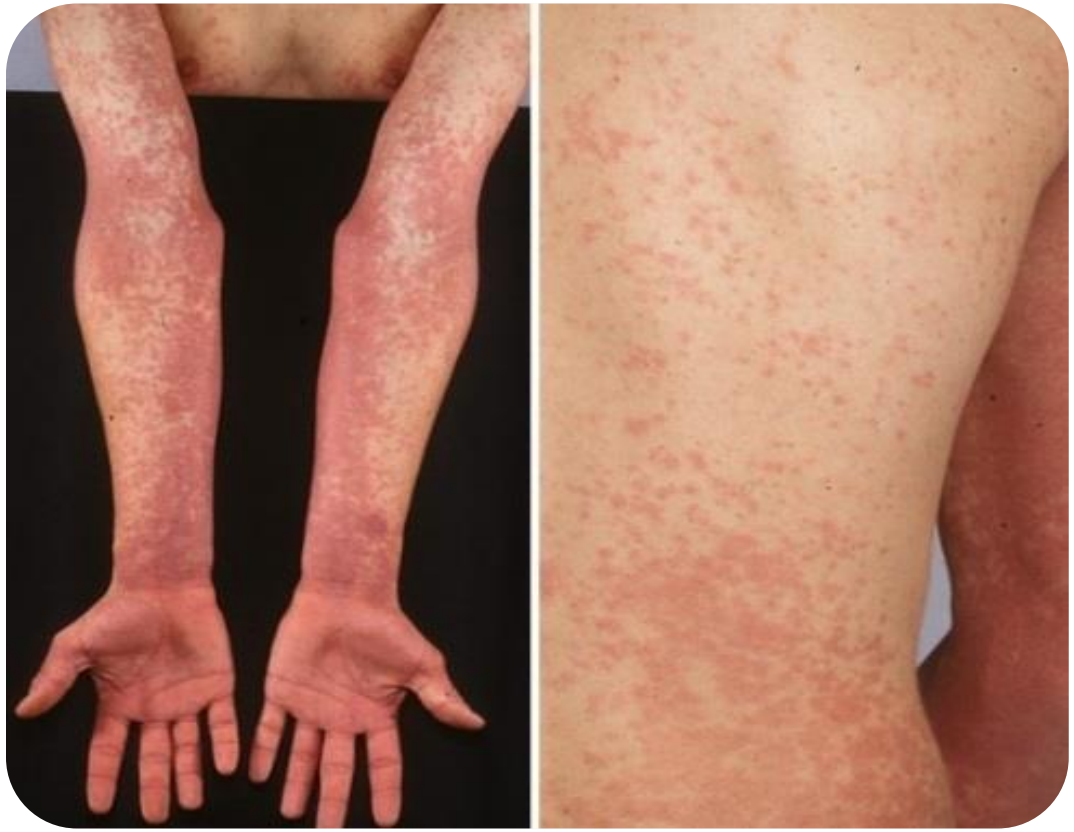


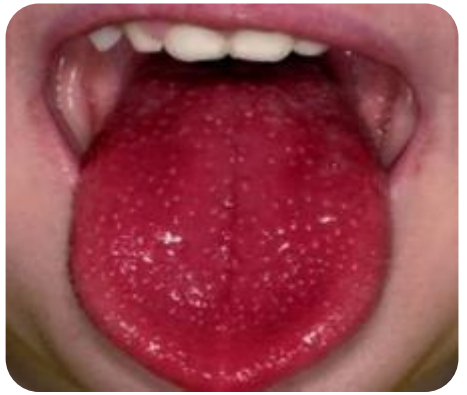
Non-Suppurative Complications: Unique to GAS Infection

Scarlet Fever "Scarlatina" - Toxin Mediated









- Choby BA. *Am Fam Physician*. 2009 Mar 1;79(5):383-90. PMID: 19275067.
- Scarlet Fever: All You Need to Know: https://www.cdc.gov/groupastrep/diseases-public/scarlet-fever.html

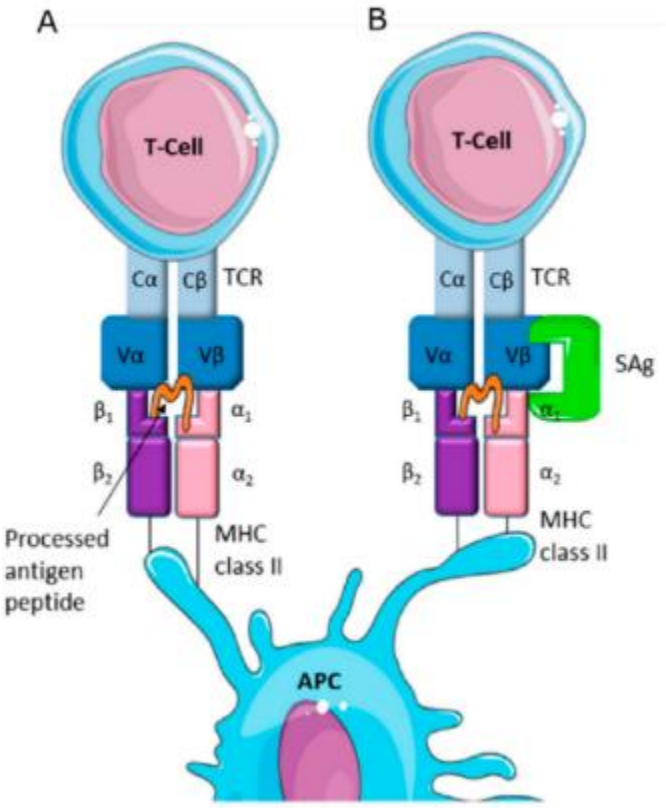
Non-Suppurative Complications: Unique to GAS Infection

Streptococcal Toxic Shock Syndrome (STSS) - Toxin Mediated

- T-cell response
  - Normal < 1% of T-cells (Panel A)
  - Super-Antigen > 20% of T-cells (Panel B)

- Abrupt onset of …..
  - Fever, chills, myalgia, nausea, vomiting
  - “Scarlatina” rash

- Rapid progression to organ failure …..
  - Kidneys, liver, and lungs
  - Fatality rate (30-70%)

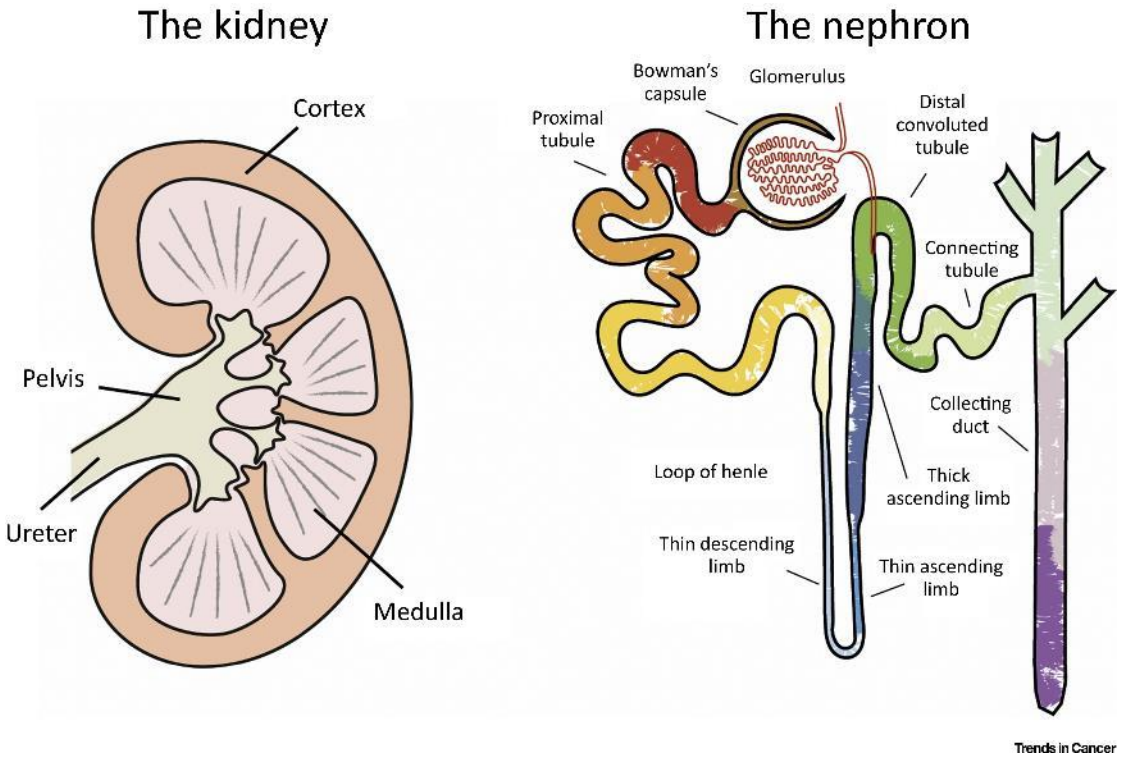


- Choby BA. *Am Fam Physician*. 2009 Mar 1;79(5):383-90. PMID: 19275067.

Non-Suppurative Complications: Unique to GAS Infection

Post-Streptococcal Glomerulonephritis (PSGN)

- Normal Kidney Anatomy:
  - The renal artery supplies blood to the cortex of each kidney where ~ 1,000,000 nephrons filter the blood and remove impurities.
  - The purified blood returns to the body via the renal vein.
  - The waste “urine” is collected in the medulla, concentrated in the medullary pyramids and eventually dumped into the bladder via the renal pelvis and ureter.



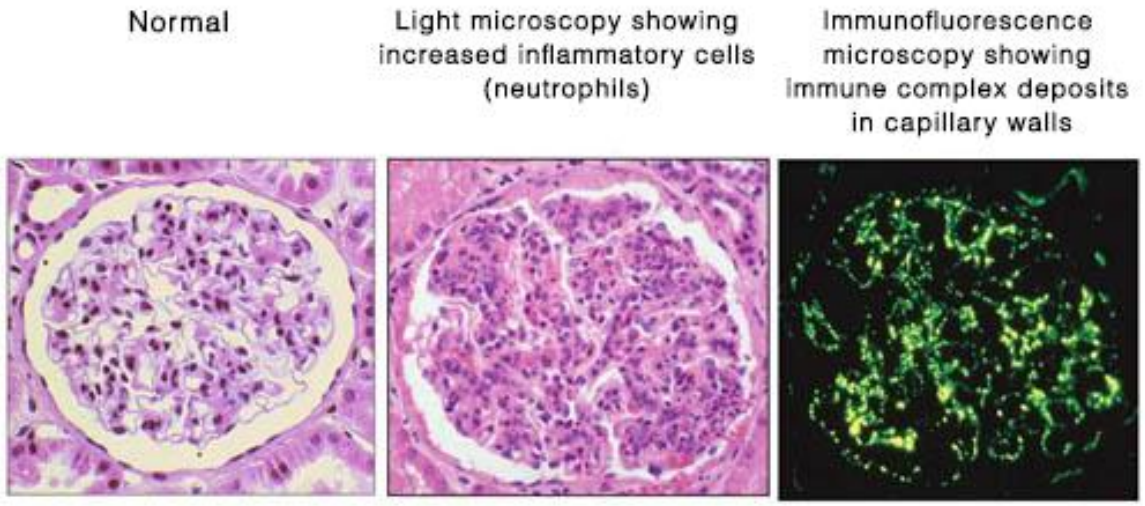
https://www.cell.com/trends/cancer/fulltext/S2405-8033%2818%2930114-6

Non-Suppurative Complications: Unique to GAS Infection

Post-Streptococcal Glomerulonephritis (PSGN)

- Immune complex deposition disease
  - Host antibodies to fight infection deposit in glomeruli and activate complement – cellular destruction.

- Clinical Signs/Symptoms
  - Edema (around face and eyes)
  - Hypertension
  - Proteinuria
  - Macroscopic hematuria
  - Lethargy, weakness



- Choby BA. Diagnosis and treatment of streptococcal pharyngitis. Am Fam Physician. 2009 Mar 1;79(5):383-90. PMID: 19275067.
- Post-Streptococcal Glomerulonephritis: https://www.cdc.gov/groupastrep/diseases-hcp/post-streptococcal.html
- https://unckidneycenter.org/kidneyhealthlibrary/glomerular-disease/post-infectious-glomerulonephritis-gn/

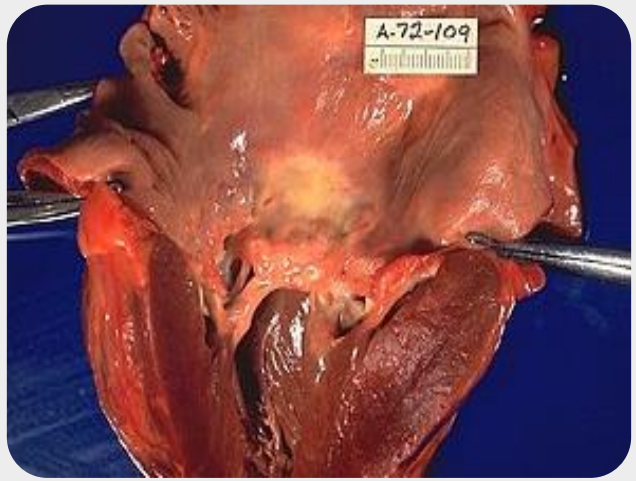
Non-Suppurative Complications: Unique to GAS Infection

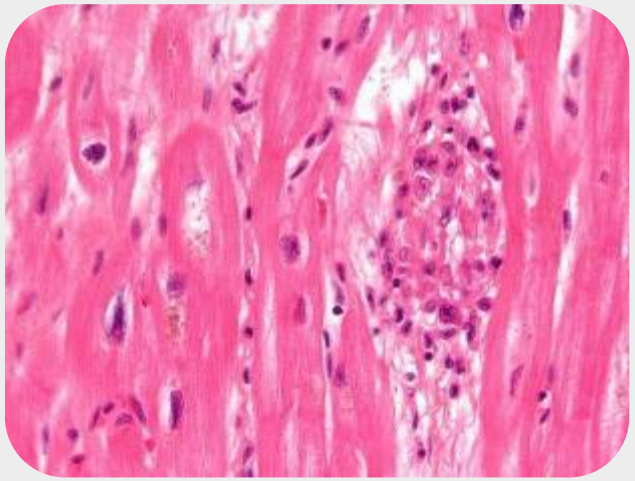
Acute Rheumatic Fever – Autoimmune Process "molecular mimicry"

- Host response to infection creates cross-reacting antibodies that target specific organ systems.

- **Heart**
  - **Inflammation of muscle/valves**
  - **Pericardial effusion**
- Musculoskeletal
- Integument
- Central nervous system

Thickening of myocardium, mitral valve, and chordae tendinea





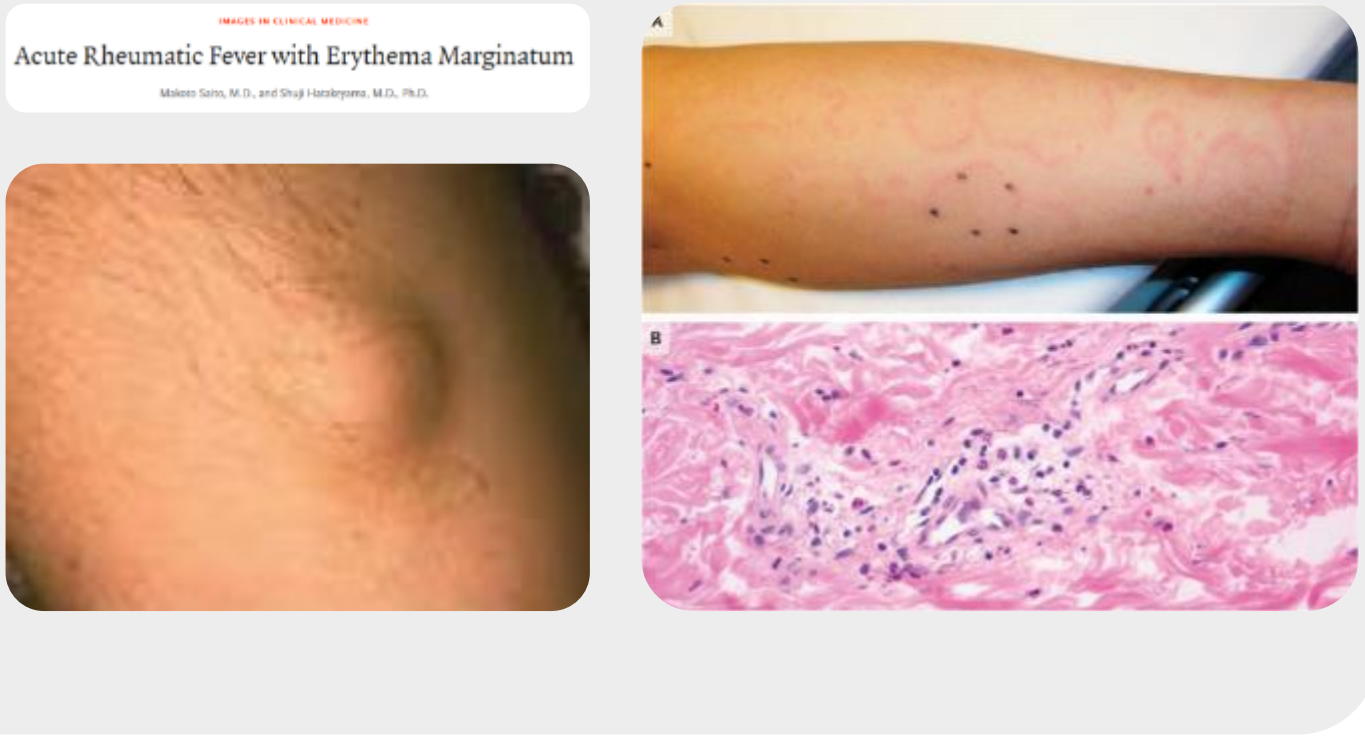
Aschoff Granuloma (Aschoff body)

- Choby BA. *Am Fam Physician*. 2009 Mar 1;79(5):383-90. PMID: 19275067.
- Acute Rheumatic Fever: https://www.cdc.gov/groupastrep/diseases-hcp/acute-rheumatic-fever.html

Non-Suppurative Complications: Unique to GAS Infection

Acute Rheumatic Fever – Autoimmune Process "molecular mimicry"

- Heart
- Musculoskeletal
  - Migratory arthritis of limb joints
- **Integument**
  - **Subcutaneous nodules**
  - **Erythema marginatum**
- Central nervous system
  - Chorea: abrupt onset of purposeless, non-rhythmic, involuntary movements associated with muscle weakness and emotional lability



- Choby BA. *Am Fam Physician*. 2009 Mar 1;79(5):383-90. PMID: 19275067.
- Acute Rheumatic Fever: https://www.cdc.gov/groupastrep/diseases-hcp/acute-rheumatic-fever.html

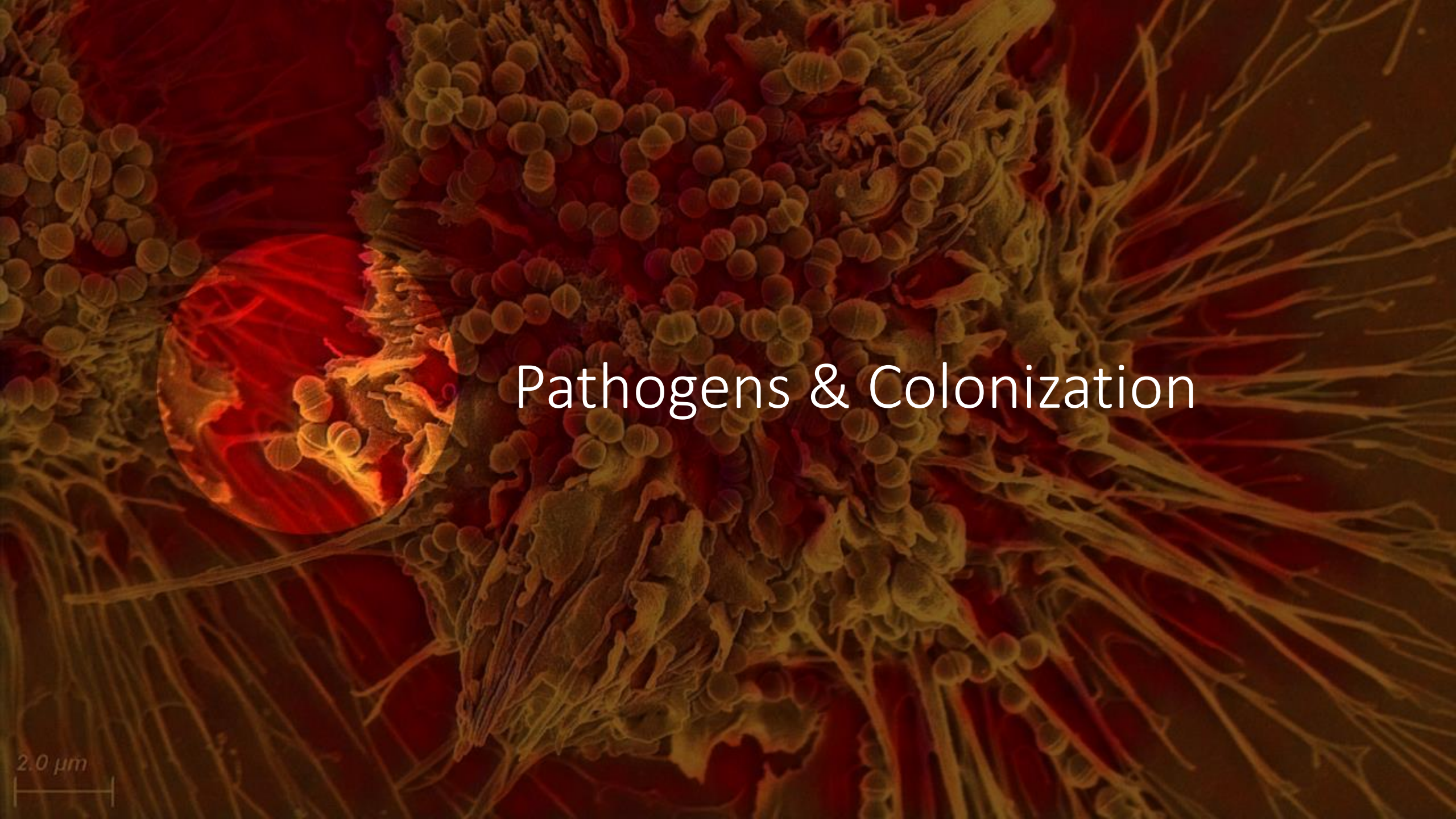
Non-Suppurative Complications: Unique to GAS Infection

Pediatric **A**utoimmune **N**europsychiatric **D**isorder **A**ssociated With **S**treptococcal Infection (**PANDAS**) – Autoimmune Process "molecular mimicry"

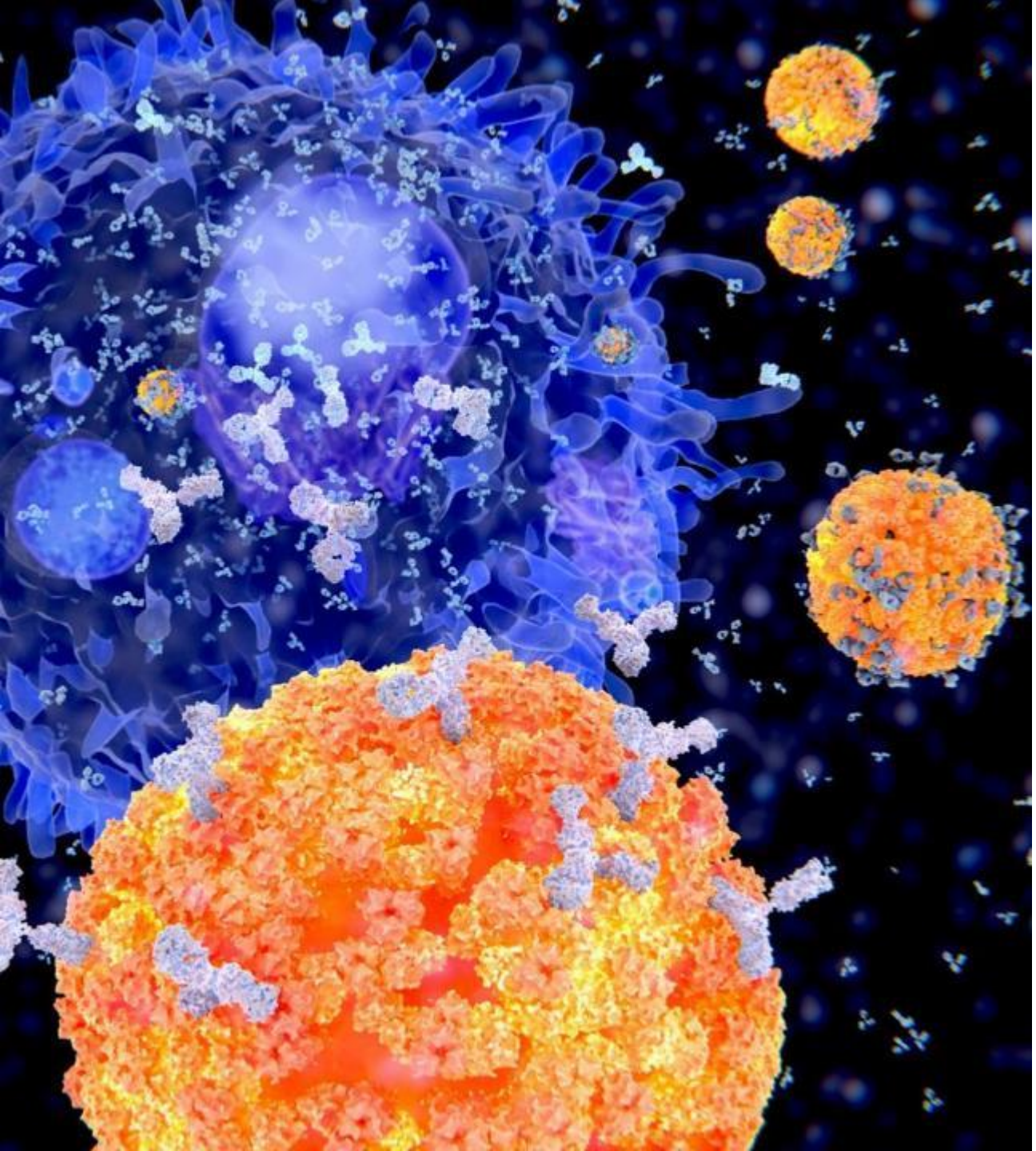
- Host immune response to infection creates cross-reacting antibodies that target specific areas of the brain.

- Abrupt onset of obsessive-compulsive ± tic disorders
- Anxiety attacks, including separation anxiety
- Attention-deficit/hyperactivity disorder
- Mood changes, sadness, irritability, emotional lability
- Trouble sleeping

- Choby BA. *Am Fam Physician*. 2009 Mar 1;79(5):383-90. PMID: 19275067.
- PANDAS – Questions and Answers: https://www.nimh.nih.gov/health/publications/pandas



Pathogens & Colonization



Viral Etiologies of Acute Pharyngitis

50-80%

Pathogen
Colonizer
Both

Respiratory Viruses

- Adenovirus
- Rhinovirus/Enteroviruses
- Human coronaviruses (including SARS-CoV-2)
- Influenza A/B
- Parainfluenza 1-4
- Respiratory syncytial virus

Sexually Transmitted Infections

- Acute Human Immunodeficiency Virus (HIV)
- Epstein-Barr virus (EBV)
- Cytomegalovirus (CMV)

- Huovienn P, et al. *Ann Intern Med.* 1989;110:612.
- Bisno AL. *N Engl J Med.* 2001;344:205.
- Flores AR, Caserta MT. Pharyngitis. In: Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases, 8th Ed, Bennett JE, Dolin R, Blaser MJ (Eds), Elsevier, Philadelphia 2015. p.753-759.

Bacterial Etiologies of Acute Pharyngitis

15-30%

Pathogen
Colonizer
Both

Streptococcal

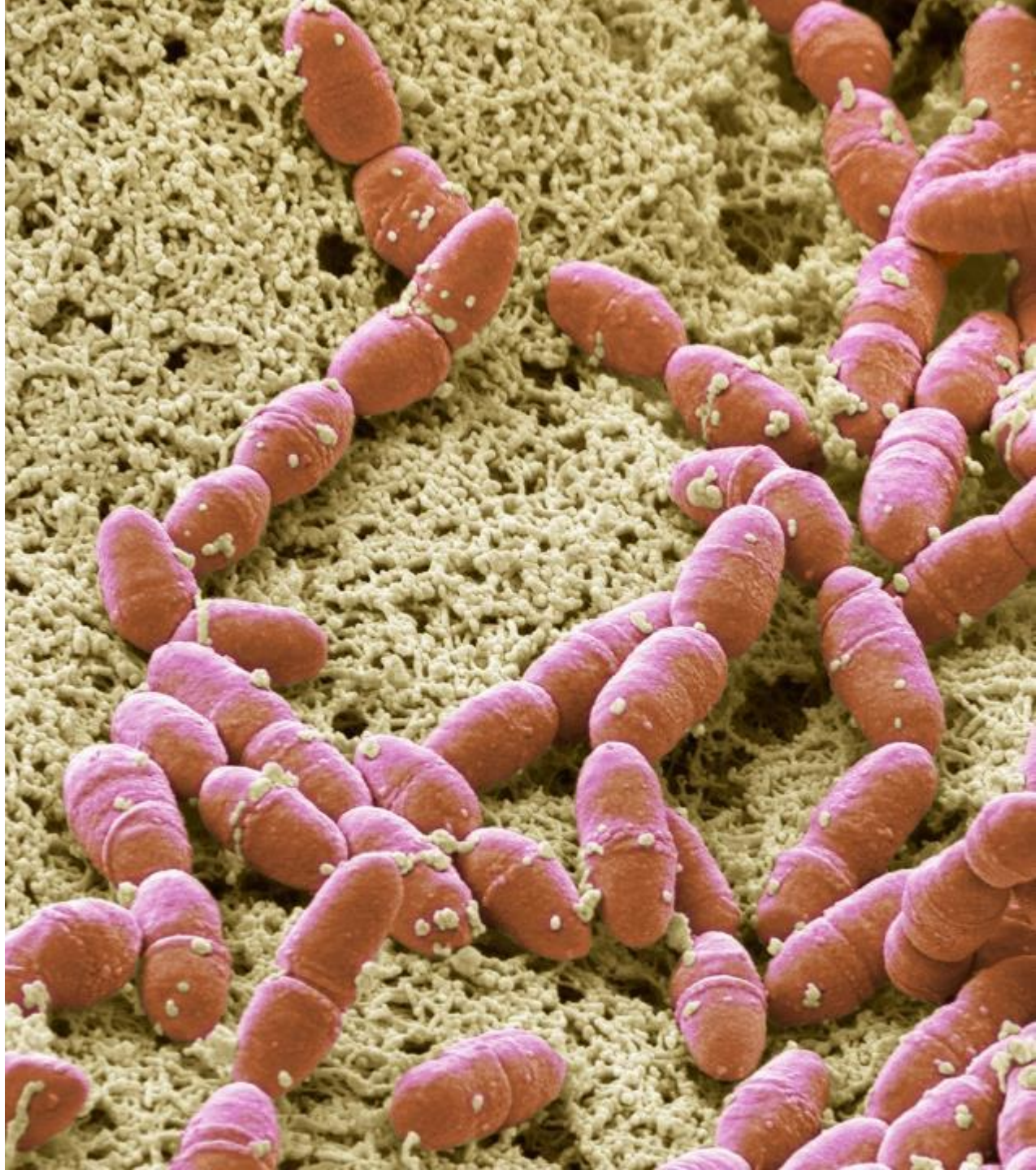
- Group A *Streptococcus*
- Groups C/G streptococci (β-hemolytic)

Non-Streptococcal

- *Arcanobacterium haemolyticum*
- *Fusobacterium necrophorum*
- *Mycoplasma/Chlamydia pneumoniae*
- *Corynebacterium diphtheriae*
- *Francisella tularensis*

Sexually Transmitted

- *Neisseria gonorrhoeae*
- *Treponema pallidum*
- *Chlamydia trachomatis*

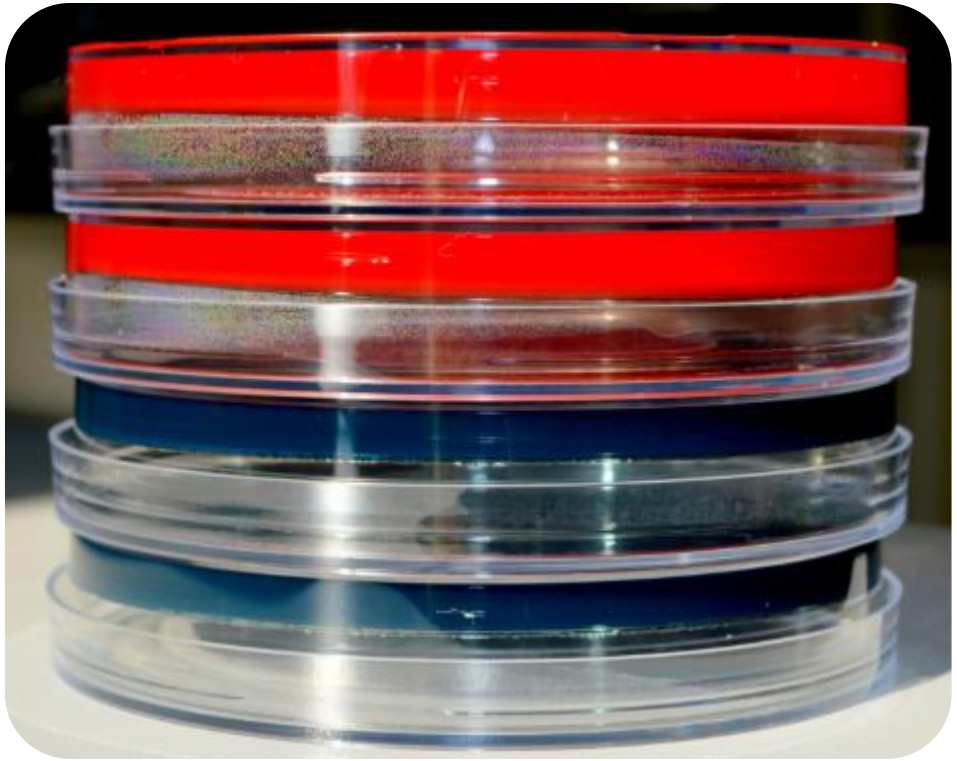


- Accorsi EK, et al. *MMWR Morb Mortal Wkly Rep*. 2022;71(37):1169–1173.
- Thai TN, *Fam Pract.* 2018 May 23;35(3):231-238. doi: 10.1093/fampra/cmx072. PMID: 29045629.

Laboratory Diagnostics

Culture of Acute Pharyngitis Pathogens

- Aerobic
  - Groups A, C/G streptococci, and *A. haemolyticum*
  - 5% SBA with TSB ± specialized agar to reduce growth of normal flora
    - SSA – Streptococcal Select Agar
- Anaerobic
  - *Fusobacterium necrophorum*
  - 5% SBA with TSB ± specialized agar to reduce growth of normal flora
    - FAA – Fastidious Anaerobe Agar
    - FSA – Fusobacterium Select Agar
- Pathogen-specific
  - *C. diphtheriae* – Tellurite, Tinsdale
  - *F. tularensis* – Cystine containing agar (MTM, BCYE)
  - *N. gonorrhoeae* – MTM, Martin-Lewis
  - *Mycoplasma* spp. – A8, Eaton's
  - *Chlamydia* spp. – McCoy cells with cyclohexamide



- Spellerberg B, Brandt C. Laboratory Diagnosis of Streptococcus pyogenes (group A streptococci) 2016 Feb 10. In: Ferretti JJ, Stevens DL, Fischetti VA, editors. Streptococcus pyogenes : Basic Biology to Clinical Manifestations [Internet]. Oklahoma City (OK): University of Oklahoma Health Sciences Center; 2016-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK343617/
- Shulman ST, et al. Clin Infect Dis. 2012;55:1279–1282.

Culture of Acute Pharyngitis Pathogens

- Utility
  - Current gold standard
  - Needed for AST and/or epidemiologic purposes
  - Needed when NAA technology is either not available or doesn't provide detection coverage for the pathogen(s) of interest

FDA-Approved Options*	
GAS	Several
CT/NG	Hologic Panther Cepheid GeneXpert
Groups A, C/G *Streptococci*	QuidelOrtho Lyra QuidelOrtho Solana

* Throat Source; GAS: group A *Streptococcus;* CT/NG: *Chlamydia trachomatis/Neisseria gonorrhoeae*

- Disadvantages
  - Slow (24-72 hr.) – delays diagnosis and treatment
  - Inefficient use of RN/PA/MD time for patient call-back (results and treatment)
  - Requires skilled technical personnel
  - Improper specimen collection and transportation leads to false negative test results
  - Can't distinguish pathogen vs. colonization

- Spellerberg B, Brandt C. Laboratory Diagnosis of Streptococcus pyogenes (group A streptococci) 2016 Feb 10. In: Ferretti JJ, Stevens DL, Fischetti VA, editors. Streptococcus pyogenes : Basic Biology to Clinical Manifestations [Internet]. Oklahoma City (OK): University of Oklahoma Health Sciences Center; 2016-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK343617/
- Shulman ST, et al. *Clin Infect Dis*. 2012;55:1279–1282.

Rapid Antigen Diagnostic Tests (RADTs)

- Advantages
  - Specificity = ~96% (94-97%) - 2 meta-analyses
    - If positive, “you have the correct result”
  - Easy to use (CLIA-waived, point-of-care setting)
  - Inexpensive, rapid (< 10 minutes)
  - Automated readers (n=2) for consistent interpretation and interfaced results to EHR/LIS

- Disadvantages
  - Sensitivity = 86% (83-88%) - 2 meta-analyses
    - If negative, “you may NOT have the correct result”
      - Confirmatory testing by culture (2012 IDSA guidelines); NAAT (U.S. FDA approved).
  - Only detect group A *Streptococcus*
  - Most require manual interpretation and data entry
  - Can’t distinguish viable/non-viable organism
  - Can’t distinguish pathogen vs. colonization

“If a human’s involved, expect errors!”

- Lean WL, et al. *Pediatrics.* 2014 Oct;134(4):771-81. Pooled Data from 48 studies: Sensitivity = 86% (83-88); Specificity = 96% (94-97).
- Cohen JF, et al. *Cochrane Database Syst Rev*. 2016 Jul 4;7(7):CD010502. Pooled Data from 98 studies: Sensitivity = 85.6% (83-88); Specificity = 95.4% (94-96) .

Rapid Antigen Diagnostic Tests (RADTs)

Manufacturer	Test Name	Method	Format	Interpretation
Abbott	Acceava, Clearview	Color LF-EIA	Cassette / Dipstick	Manual (Visual)
Cardinal Health	Rapid Strep A	Color LF-EIA	Cassette	Manual (Visual)
Fisher Health	Sure-Vue (Signature)	Color LF-EIA	Dipstick	Manual (Visual)
Meridian	ImmunoCard STAT!	Color LF-EIA	Cassette	Manual (Visual)
QuidelOrtho	Quickvue	Color LF-EIA	Cassette / Dipstick	Manual (Visual)
Sekisui	OSOM (Ultra)	Color LF-EIA	Dipsticks	Manual (Visual)
Becton Dickinson	Veritor	Color LF EIA	Cassette	Automated (Reader)
QuidelOrtho	Sofia	Fluorescence LF-EIA	Cassette	Automated (Reader)

Manual (Visual) interpretation will lead to human error: a) transcription into LIS/EHR, b) inability to determine positive vs. negative, c) ambient lighting (color/intensity) impacts perception of “line” or “no line”, d) various types of color blindness can cause issues as well. Automated readers eliminate these issues and have the ability to transmit results to LIS/EHR.

The following website list all CLIA-waived, FDA-approved tests for Group A Streptococcus since 1996.

https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfClia/results.cfm?start_search=1&Test_System_Name=&Qualifier=&Analyte_Name=Streptococcus%2C%20group%20A&Document_Number=&Clia_Analyte_Specialty=&Clia_Complexity=waived&Effective_Date_FROM=&Effective_Date_TO=&Exempt_510k=&SortColumn=ded&pagenum=500

Nucleic Acid Amplification: Advantages

Point-of-Care Testing (POCT)

- Options:
  - (5) ≤ 30 minutes “OK”
  - (1) ≤ 15 minutes “Great”
  - (0) ≤ 10 minutes “Ideal”
- Real-time definitive result = real-time patient management

Replace Back-up Culture

- 1 to 1.5 days faster than culture
- Patient management minimally delayed vs. 24-48 hours for culture

Test Performance

- Specificity ≥ 95%
  - Positive = “correct result”
- Sensitivity = 97.5%
  - Negative = “no need for culture confirmation”

- Pooled Data from 38 studies. Sensitivity = 97.5% (96-98); Specificity = 95% (94-96). Dubois C, et al. *Clin Microbiol Infect*. 2021 Dec;27(12):1736-1745. doi: 10.1016/j.cmi.2021.04.021. Epub 2021 May 6. PMID: 33964409.

Nucleic Acid Amplification: Disadvantages

Limitations

- Limited number of **rapid** POCT options
- Can't distinguish viable/non-viable organisms
- Can't distinguish pathogen vs. colonization

GAS Only

- Exceptions:
  - Lyra / Solana (QuidelOrtho)
  - GAS + β-hemolytic, groups C/G streptococci
    - *S. dysgalactiae*
    - *S. equisimilis*
    - *S. zooepidemicus*
    - *S. equi*

Cost

- Most expensive
- Many require thermocycling equipment

Nucleic Acid Amplification Options

- 11 currently approved by the U.S. FDA
  - CLIA Complexity
    - 1 High (optimal use = batch mode)
    - 6 Moderate (optimal use = batch or POCT)
    - 4 Waived (optimal use = POCT)
  - 2 also detect β-hemolytic groups C/G streptococci
- Limit of Detection (LoD) for these 11 tests
  - 5 to 84,800 CFU/mL
- 1 option nearing U.S. FDA approval (SPOTFIRE)

Nucleic Acid Amplification Assays (effective October 2023)

TEST NAME	MANUFACTURER	METHODOLOGY	CLIA STATUS	TAT (min)	LIMIT OF DETECTION (CFU/mL) GAS	GCS*	GGS*
Lyra Direct Strep	QuidelOrtho	PCR	High (batch)	60 – 90	600 – 1,500	17,500	16,000
Alethia Group A Streptococcus	Meridian Bioscience	iNAAT (LAMP)	Moderate	60	400		
Amplivue GAS	QuidelOrtho	iNAAT (HDA)	Moderate	60	19,000 – 27,400		
Solana Strep Complete	QuidelOrtho	iNAAT (HDA)	Moderate	30	84,800	70,700	70,700
ARIES Group A Strep	Luminex	PCR	Moderate	120	2,580 – 4,130		
Revogene Strep A	Meridian Bioscience	PCR	Moderate	42 – 70	333 – 1,333		
Simplexa Group A Strep Direct	DiaSorin	PCR	Moderate	60	680 – 2,350		
LIAT Strep A	Roche (Iquum)	PCR	Waived	15	5 – 20		
Xpert Xpress Strep A	Cepheid	PCR	Waived	18 – 25	9 – 18		
ID NOW	Abbott	iNAAT	Waived	8 – 10	25 – 147		
Accula Strep	Mesa Biotech	PCR + Lateral Flow	Waived	30	10 – 75		
SpotFire (TBD)	bioMerieux	PCR	Waived (TBD)	18	TBD	TBD	TBD

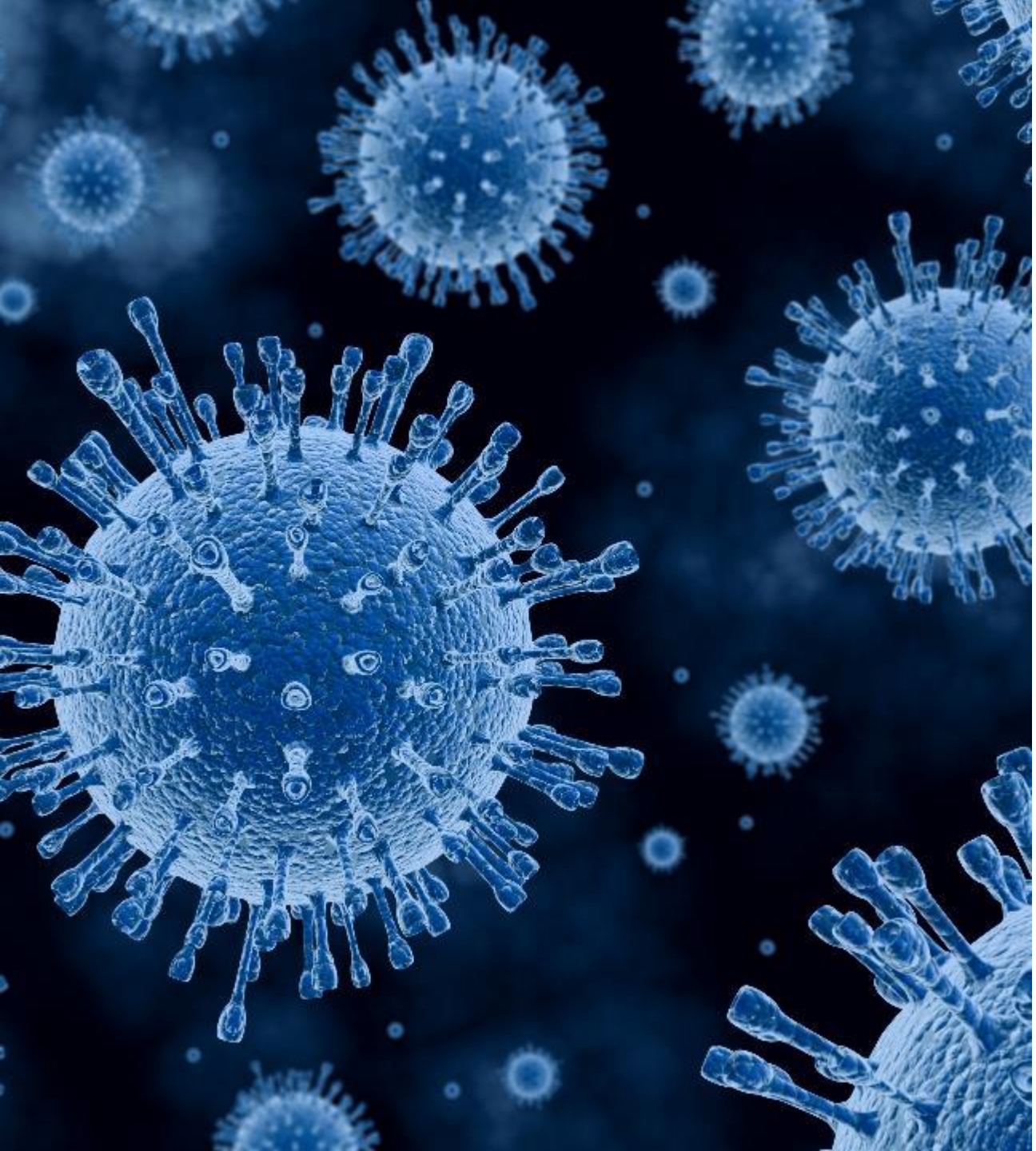
* Does NOT detect non-pyogenic, small colony forming GCS/GGS (S. anginosus group, etc.)
* Detects β-hemolytic, pyogenic, large colony groups C/G Streptococci (*S. dysgalactiae)*; however, pathogenic *S. equisimilis, S. zooepidemicus,* and *S. equi* are also detected.

SPOTFIRE R/ST Panel

bioMérieux submits Dual 510(k) and CLIA-waiver application to FDA for the BIOFIRE® SPOTFIRE® Respiratory/Sore Throat (R/ST) Panel

- Submitted to FDA (9/23/2023)
- Novel multiplex PCR test capable of detecting the most common bacteria and viruses based upon whether the sample is a nasopharyngeal swab (NPS) or throat swab (TS).

TARGET	NPS	TS
Adenovirus	X	X
Human Coronaviruses (seasonal) + SARS-CoV-2	X	X
hMPV	X	X
hRV/hEV	X	X
Influenza A + subtypes H3 and H1-2009	X	X
Influenza B	X	X
Parainfluenza viruses	X	X
Respiratory Syncytial Virus	X	X
Chlamydia pneumoniae	X	X
Mycoplasma pneumoniae	X	X
Streptococcus dysgalactiae (C/G)		X
Streptococcus pyogenes (GAS)		X
Bordetella pertussis	X	
Bordetella parapertussis	X	



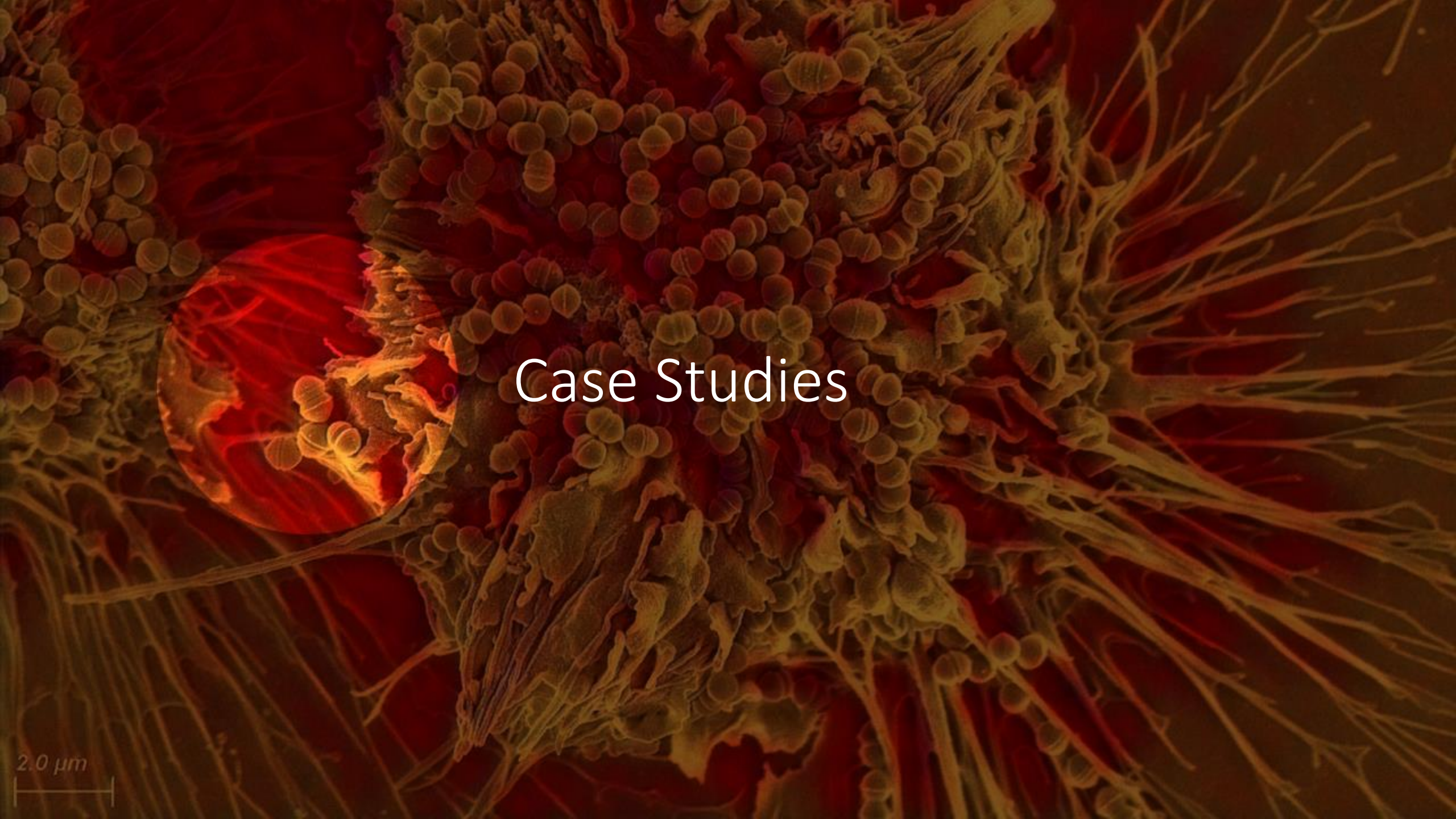
Savanna (QuidelOrtho)

- FDA Clearance – Pending (**NOT in U.S.**)
- Newest multiplex PCR test
- Respiratory Viral Panel-4
  - Influenza A
  - Influenza B
  - RSV
  - SARS-CoV-2
- An acute pharyngitis panel is being developed
- TAT ~ 22 minutes

Serology: Largely Useless for Acute Pharyngitis

- The human body has not had sufficient time to make detectable antibodies, not even IgM.
- anti-DNase-B and anti-streptolysin O
  - Retrospective diagnosis of ARF/PSGN after GAS infection
  - Maximum titer reached 3-8 weeks after infection
- Monospot
  - Diagnosis of infectious mononucleosis (EBV)
- Treponemal / Non-Treponemal
  - Diagnosis of syphilis

- Shulman S, et al. *Clin Infect Dis*. 2012 Nov 15;55(10):1279-82. Erratum in*: Clin Infect Dis*. 2014 May;58(10):1496. Dosage error in article text.



Case Studies

RADT (Positive): 2012 IDSA Guidelines

1

Presenting patient

2

Clinical evaluation
GAS RADT performed

3

Antigen
POSITIVE

4

GAS PHARYNGITIS

5

6

No treatment delays

- Shulman S, et al. *Clin Infect Dis*. 2012 Nov 15;55(10):1279-82. Erratum in*: Clin Infect Dis*. 2014 May;58(10):1496. Dosage error in article text.

RADT (Negative) + Back-Up Culture: 2012 IDSA Guidelines

1

Presenting patient

2

Clinical evaluation
GAS RADT performed

3

Antigen
NEGATIVE

4

GAS PHARYNGITIS ?

24-48
HOURS

5

GAS +/-
Other Pathogen

Treatment delayed 1-2 days

Normal flora

Final answer delayed 1-2 days

- Shulman S, et al. *Clin Infect Dis*. 2012 Nov 15;55(10):1279-82. Erratum in*: Clin Infect Dis*. 2014 May;58(10):1496. Dosage error in article text.

Case Study #1

- Elementary school aged child presents to doctor with sore throat of 1 day duration
- RADT is negative
- Back-up culture is performed
  - β-hemolytic colonies observed w/n normal respiratory flora
  - Sub-culture needed for isolation and definitive identification
  - GAS identified
  - Final answer delayed (2 days)

24
HOURS

48
HOURS

Case Study #2

- Elementary school aged child presents to doctor with sore throat of 1 day duration
- RADT is negative
- Back-up culture performed
  - β-hemolytic colonies observed w/n normal respiratory flora
  - Colonial morphology consistent with…
    - *Staphylococcus aureus* – normal flora
  - No β-hemolytic streptococci recovered
  - Final answer delayed (1-2 days).
    - Laboratories may report "No β-hemolytic streptococci recovered" at 24 and 48 hours.

24
HOURS

Case Study #3

- High-school aged student presents to doctor with sore throat of 2 days duration
- RADT was negative
- Back-up culture performed
  - Largely normal respiratory flora

Case Study #3

Back-up culture continued …

- Plate held against back-light
- β-hemolytic colony(ies) observed w/n normal respiratory flora
- Sub-culture needed for isolation and definitive identification
- Latex typing
  - β-hemolytic Group G streptococci identified
  - Final answer delayed (2 days)

24
HOURS

48
HOURS

RADT (Negative) + Back-Up NAAT:
NOT in 2012 IDSA Guidelines, but U.S. FDA-Approved

1

Presenting patient

2

Clinical evaluation
GAS RADT performed

3

Antigen
NEGATIVE

4

GAS PHARYNGITIS ?

15-60 min. (On demand)
8-24 hrs. (Batch testing)

5

Diagnosis and treatment minimally delayed

Diagnosis minimally delayed

Stand-Alone NAAT (Rapid):
NOT in 2012 IDSA Guidelines, but U.S. FDA-Approved

1

Presenting patient

2

Clinical evaluation
GAS Rapid NAAT performed

3

4

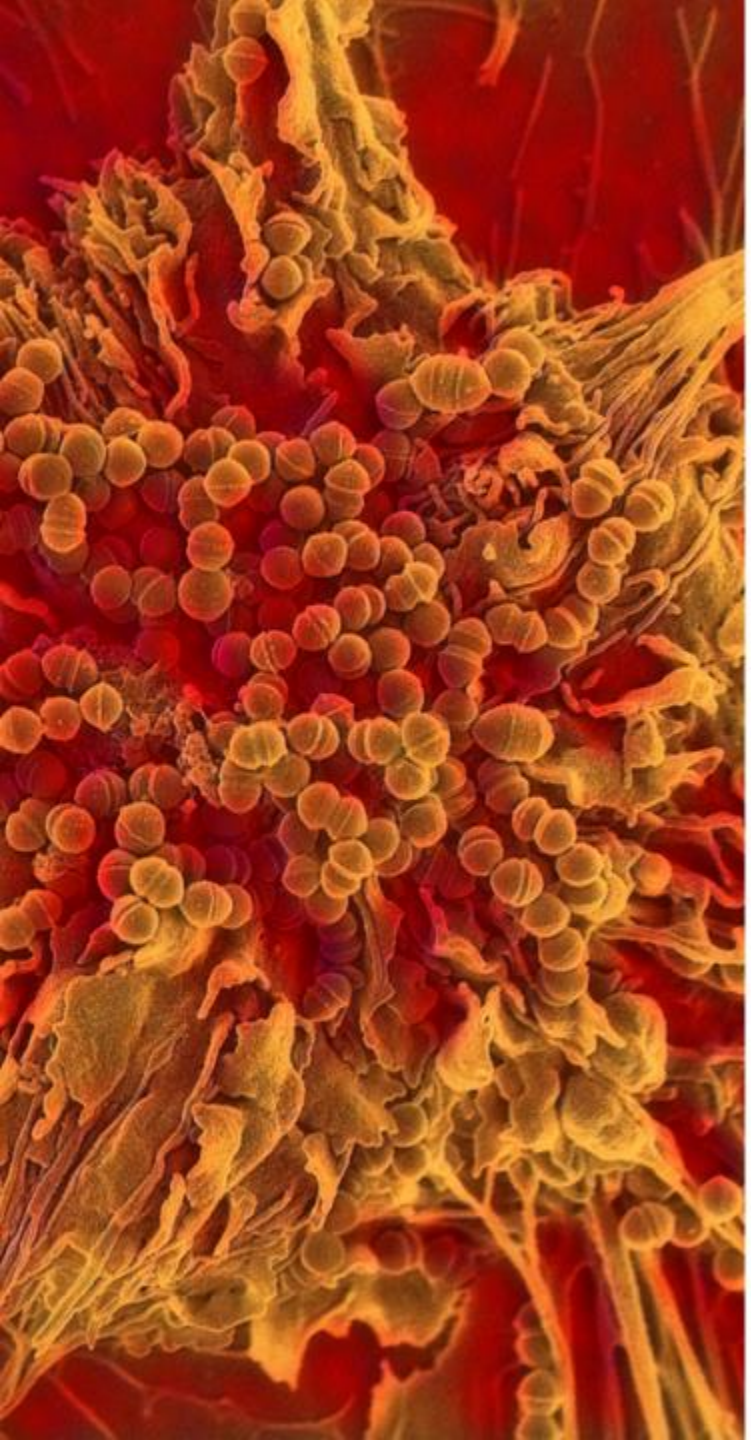
(+)

GAS PHARYNGITIS

Diagnosis and treatment not delayed

(-)

Diagnosis not delayed



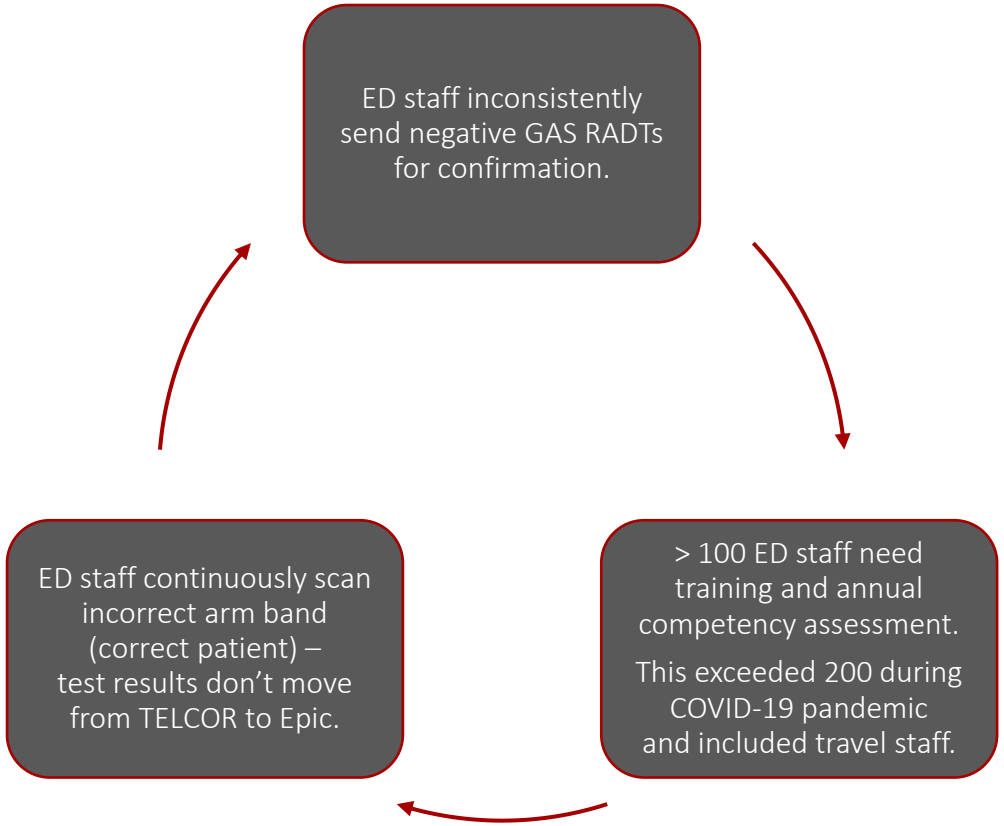
Switching from RADT (ED) to Rapid NAAT (Core Lab)

Making the Decision!

Data Driven Decisions

Existing Situation

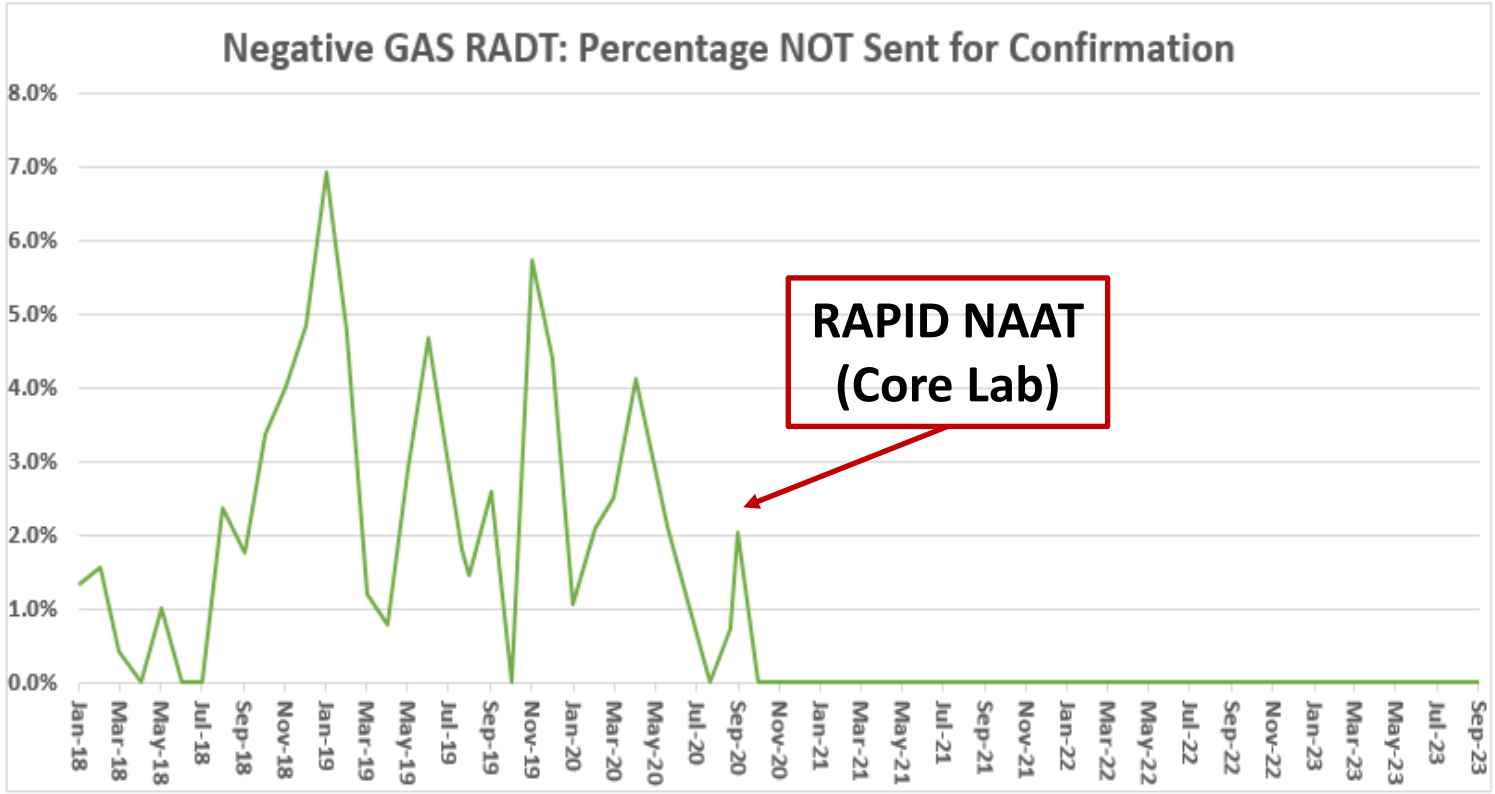
"Never let a good crisis go to waste!"



Proposed Situations

- Rapid NAAT in ED
  - Too $$$ to train/maintain annual competency assessment for ED testing personnel
  - Concerns about false-positives due to cross-contamination and improper techniques
  - ED staff focused upon patient-centric tasks
- Rapid NAAT in Core Lab
  - Less expensive to train and maintain annual competency for lab staff
  - Staff already use existing high-throughput random access NAAT instrumentation
  - Testing incorporated into routine workflow
  - No add to staff needed

Data: Baseline and Outcomes



- 196 patients didn't get confirmation over a 33-month period
- Several GAS pharyngitis cases were missed with return ED visits
- Suppurative complications: peritonsillar abscess (n = 2)
- Non-suppurative complications: ARF (n = 1)

Turnaround Time

RAPID ANTIGEN (ED)

TAT – 100% ≤ 15 min

(55-85%) need reflex confirmation

Treatment delays

Patient “call-back” logistics for providers

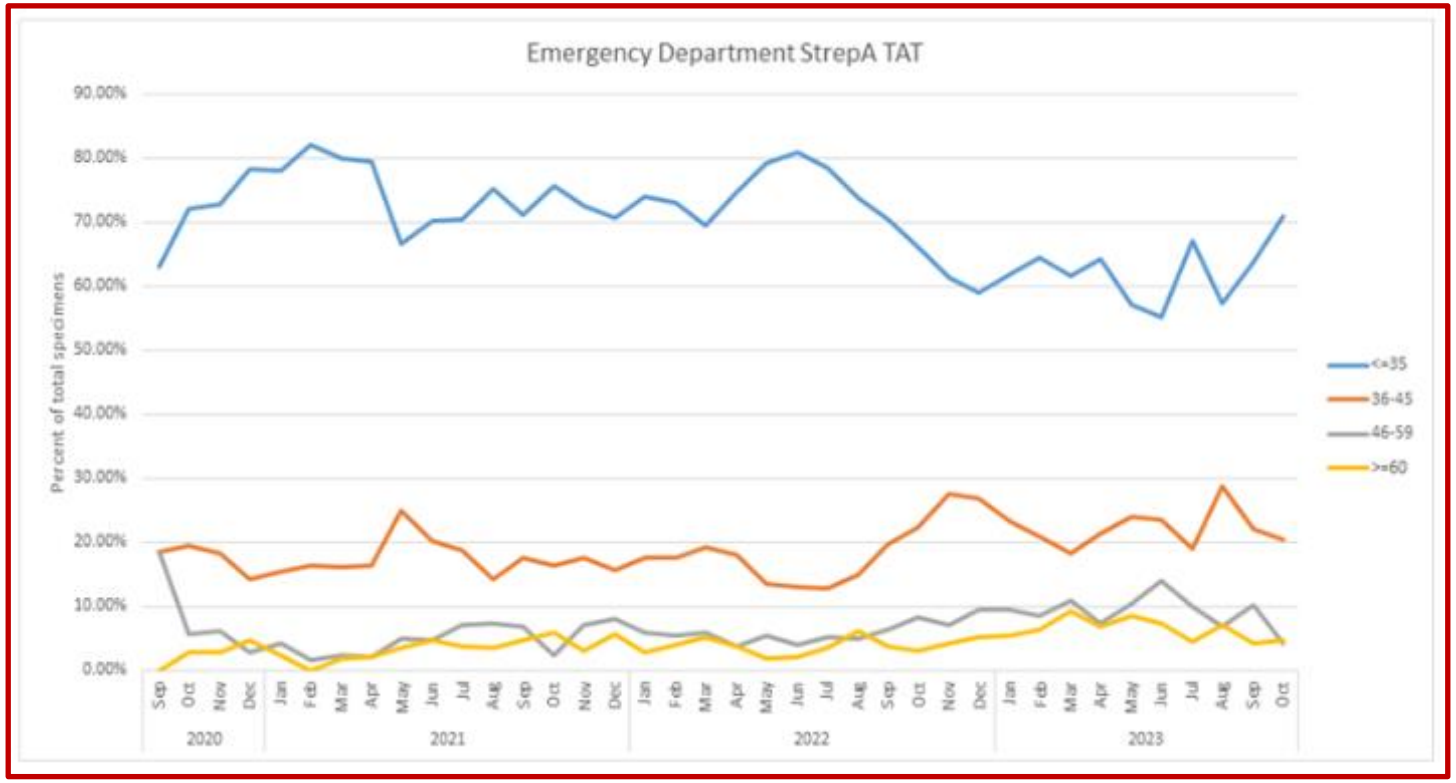
RAPID NAAT (Core Lab)

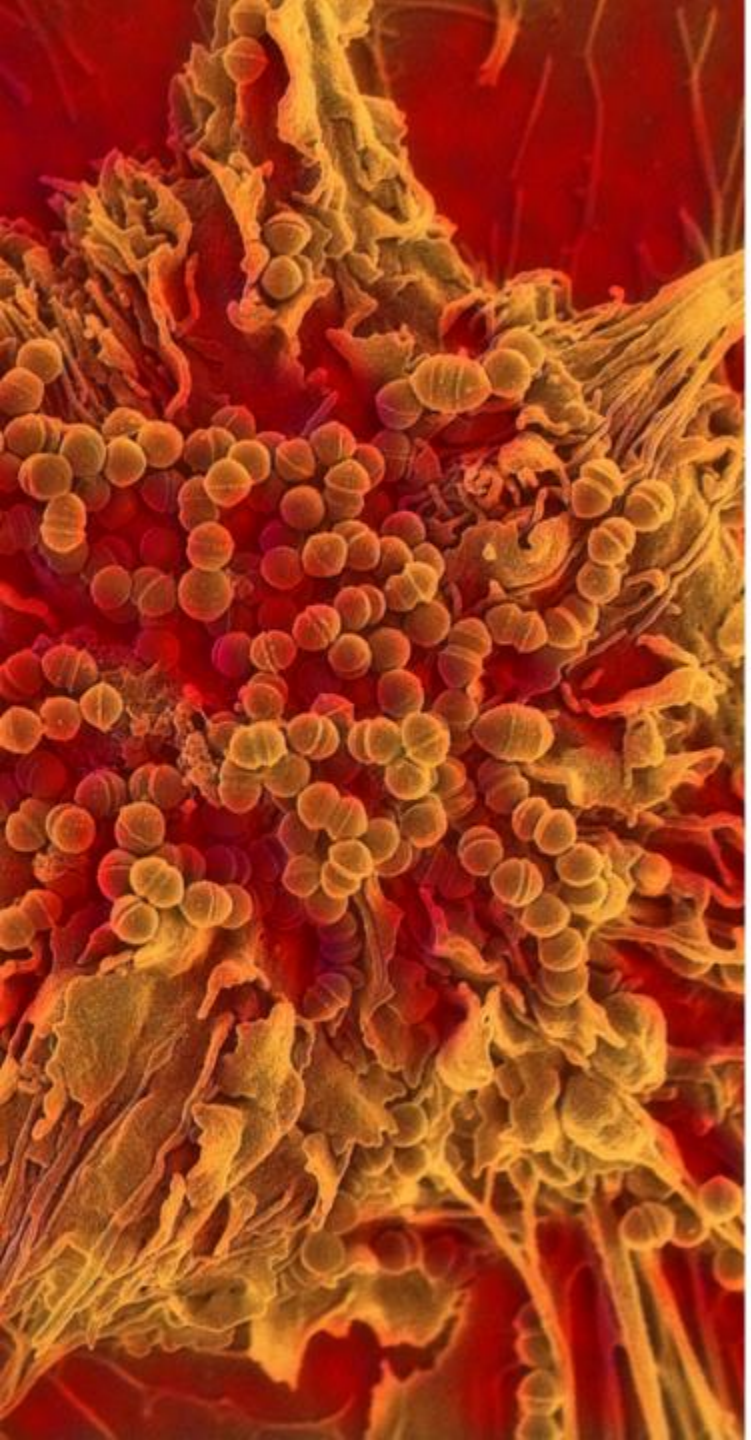
TAT – 90% < 45 min

TAT – 95% < 60 min

RN triage order set reduces TAT

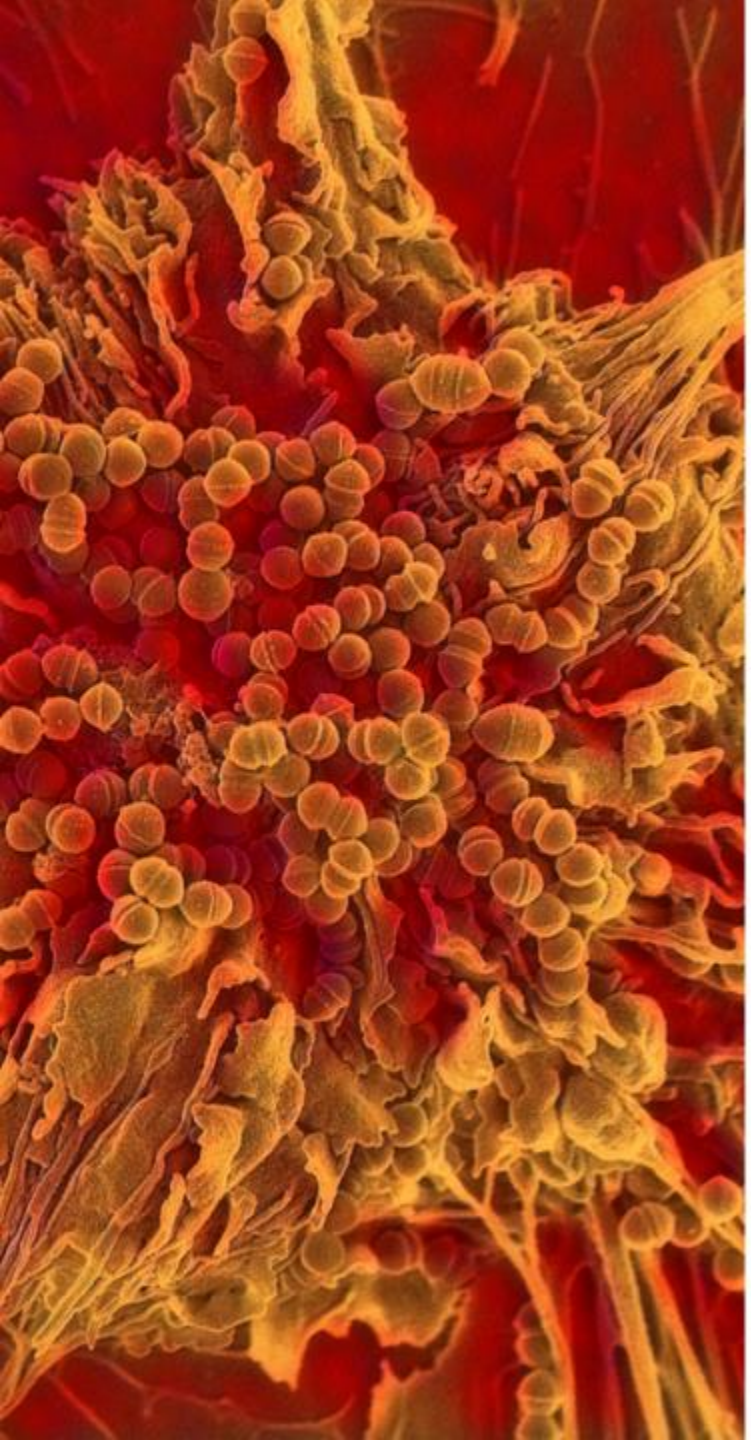
Definitive Result = Definitive Treatment





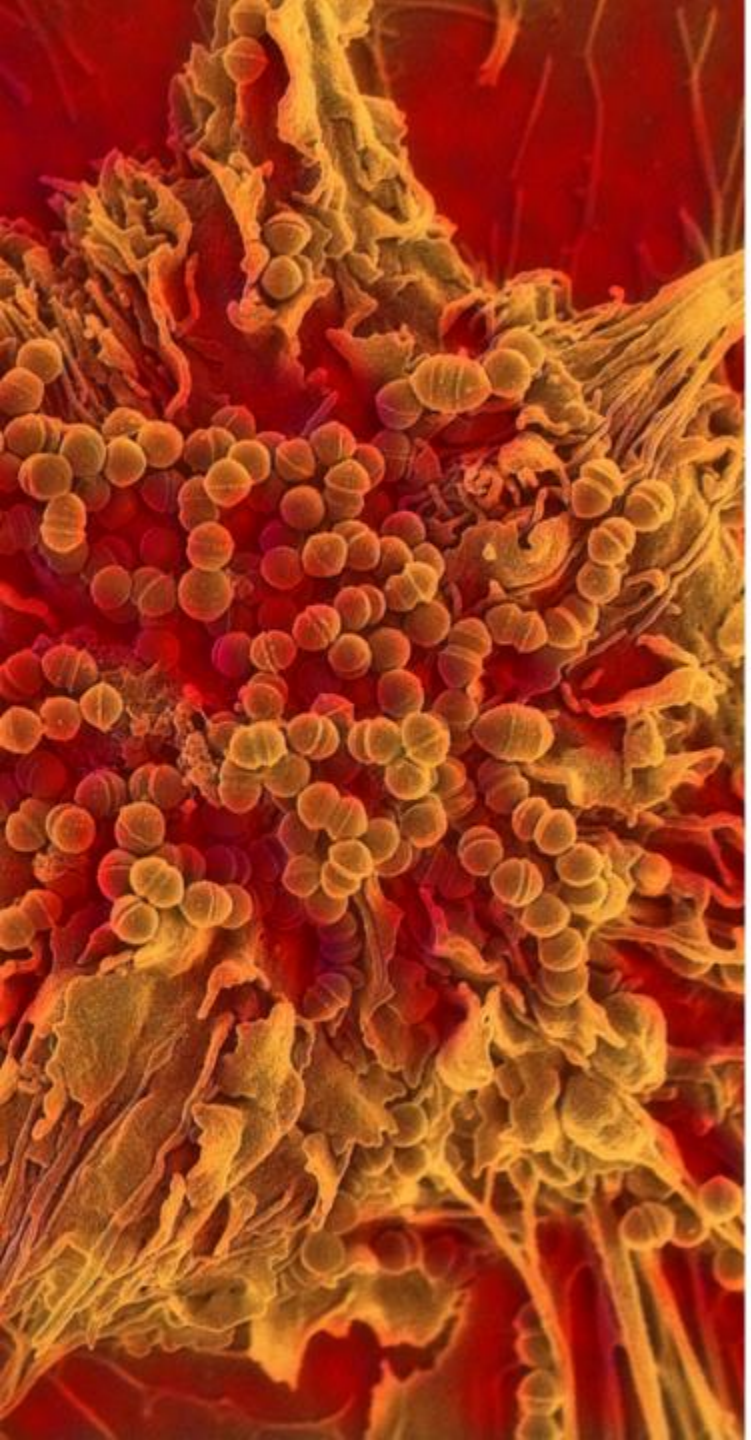
Summary

METHOD	ADVANTAGE	DISADVANTAGE	PERFORMANCE CHARACTEERISTICS	VIABLE VS. NON-VIABLE	PATHOGEN VS. COLONIZATION	TAT
CULTURE	79 Au Gold 196.97	Too Slow	Excellent Sensitivity Excellent Specificity	**YES** (growth)	NO	1-3 days
RADT	29 Cu Copper 63.55	Low Sensitivity	Acceptable Sensitivity Excellent Specificity	**No** (protein)	NO	< 15 min
NAAT	78 Pt Platinum 195.08	Most Expensive	Superior Sensitivity Excellent Specificity	**NOT YET** (DNA/RNA)	NO	15-90 min



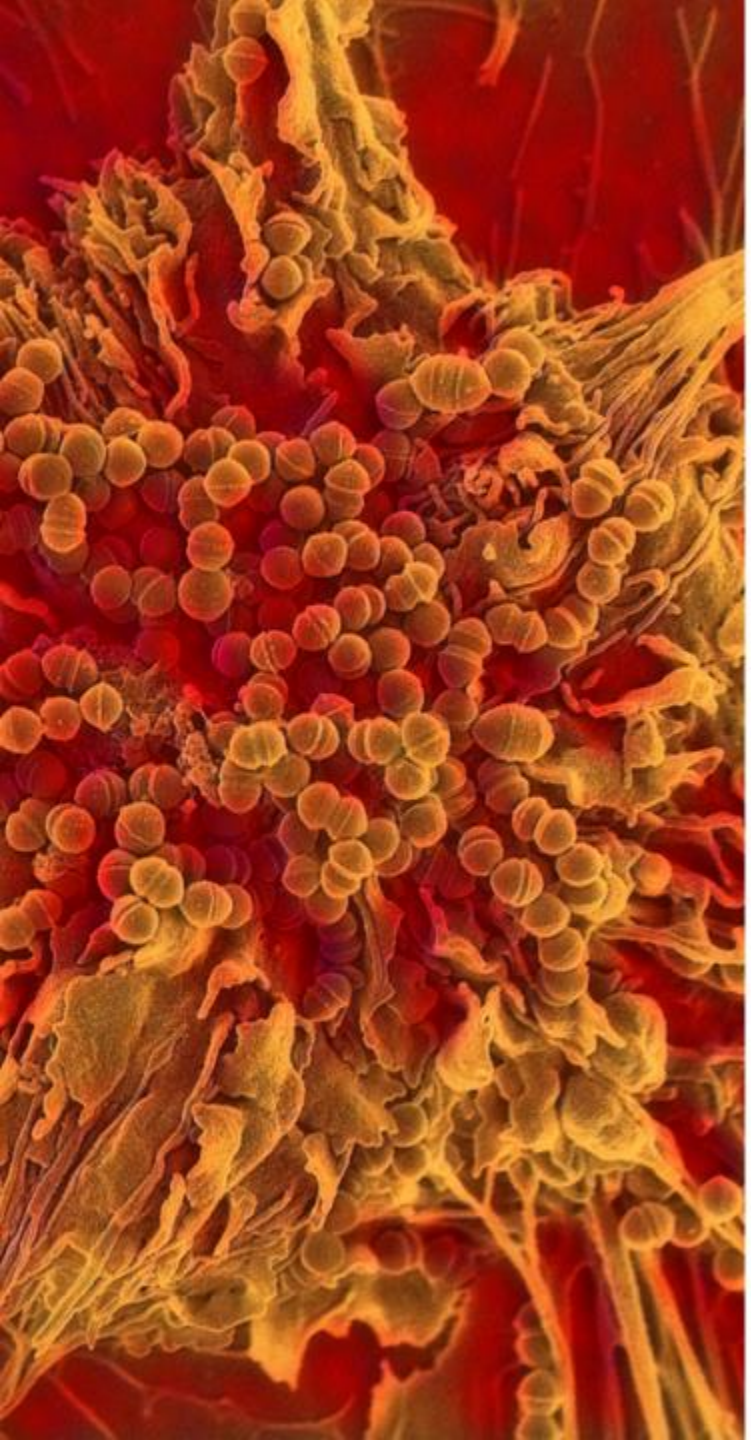
Summary

- Acute pharyngitis is primarily caused by respiratory viruses and a handful of bacterial pathogens.
- GAS must be detected and treated to prevent suppurative and non-suppurative complications.
- Non-GAS bacterial pathogens can cause suppurative complications that may require treatment.
- IDSA Guideline for the Diagnosis and Management of GAS
  - The new update (2024) will hopefully address the expanding role of NAA in the diagnosis of GAS and other bacterial pathogens in the POCT and confirmatory settings.
- Several rapid NAA POCT options are currently available and FDA-approved.
  - Rapid definitive information = rapid patient management and operational efficiency.

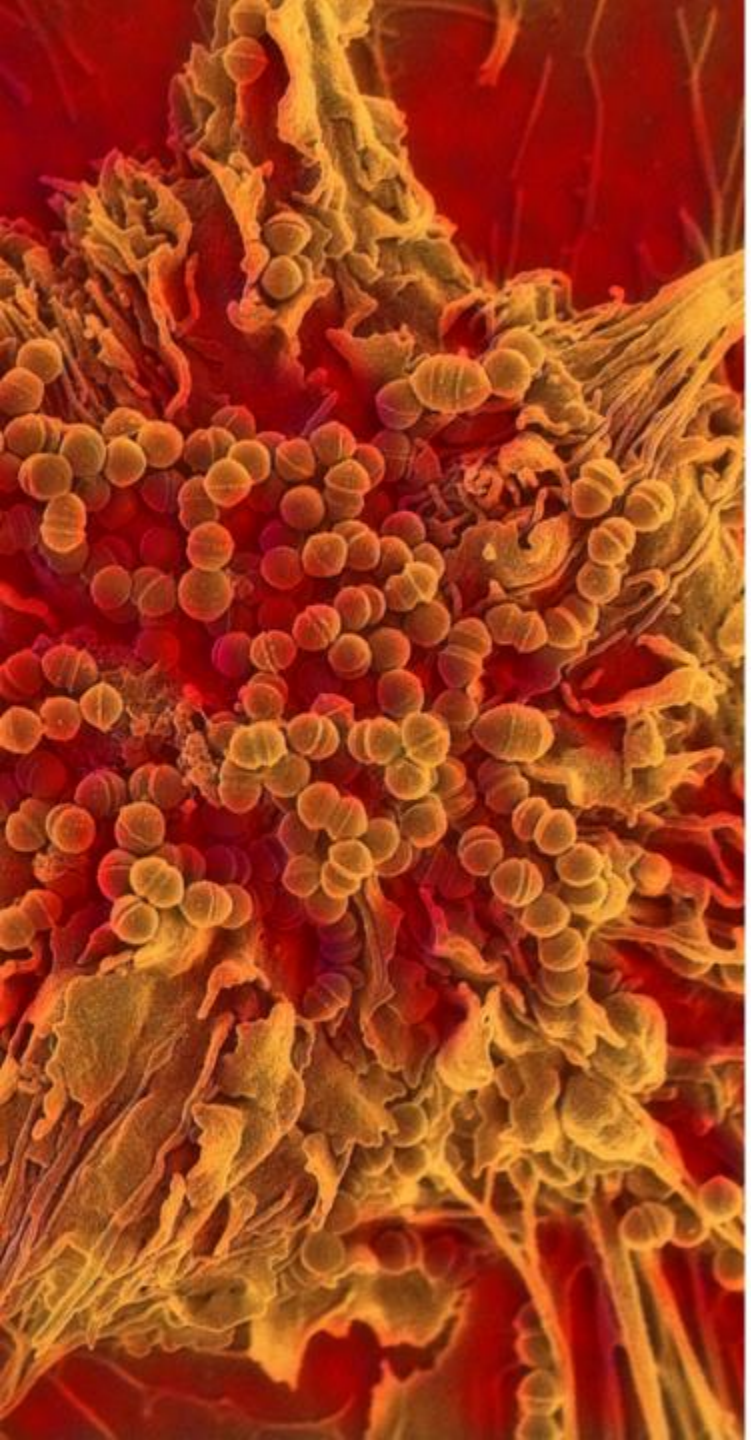


Looking Forward - The New Diagnostics Era

- Multi-target panels using ultra rapid NAA (5-10 min results)
- Ability to distinguish viable/non-viable and pathogen/colonization?
  - RNA is very labile, its' mere presence suggests viable organism activity
  - Establish organism-specific quantitative cut-off values that have been correlated with clinical infective status through rigorous clinical trials
  - Use of biomarkers in conjunction with rapid NAA results
    - Biomarkers are currently used to promote antibiotic stewardship in individuals with sepsis and pneumonia
    - Can biomarkers (currently known or to be discovered) be used from a throat swab sample and in the POC setting to rapidly determine the type of infection (bacterial vs. viral), infection vs. colonization, and viable/non-viable?



Q&A



Thank You