PCR vs. Culture for Pathogen Detection

Pathogen detection has classically been performed using cultures, but recent advances in technology have created a more effective way to find the exact cause of an infection - PCR (polymerase chain reaction) testing. PCR has allowed doctors, healthcare professionals, and practices get answers faster, treat infections more effectively, and save time and money in the process.

1. PCR can catch what cultures can't.

While cultures have long been considered the "gold standard" in pathogen detection, this assumption is starting to be questioned. One study compared multiplex PCR (which detects multiple pathogens at once) to blood culture in patients with suspected sepsis, with PCR showing a 9% improvement in positive detection rate.[1] In another study, PCR had greater accuracy than culture, positively identifying bacteria in 36% of patients who had a negative traditional urine culture.[2]

2. PCR results much faster than culture.

While microbiological techniques have advanced over the last few centuries, our best improvements to the bacterial culture still leave us waiting 2 - 5 days to get results. Modern PCR can result much faster, which means practices can improve time-to-treat and potentially attain better patient outcomes.

3. PCR can help improve antibiotic stewardship.

Antibiotic resistance has been cited as one of the great healthcare dangers in the modern age, and it's a problem that's only getting worse. Measures to address this like Antibiotic Stewardship Programs (ASPs) are typically of short-lived effectiveness, with prescribers tending towards empiric prescribing in uncertain or complex infections. PCR avoids this problem entirely, since the exact pathogens and resistance markers can be identified before the first antibiotic is prescribed.

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What these benefits have done for our clients.

As our clients have integrated the use of PCR, we see them realizing associated benefits every day:

Test Performed	Test Results	Comments
COVID-19		**Collection Type: Nasopharyngeal Swab**
COVID-19	Not Detected	[01/31/24] COVID-19 assay reviewed and approved under FDA Emergency Use Authorization #200522.
CT Value	0	[01/31/24] CT value indicates the number of amplification cycles by real-time PCR needed to detect specific sequences in SARS-CoV-2. CT values are inversely proportional to the amount of target nucleic acid in the sample (i.e. the lower the CT level, the greater the amount of target nucleic acid in the sample). CT values of 0 indicate no SARS-CoV-2 detected. The reference range for Streamline Scientific RT-PCR assays is <40 cycles of amplification.

Test Performed	Lab Result (3) (Qualitative Low/Medium/High)	DNA Copy Number	Comments
SUMMARY COVID Respiratory Plus			**Collection Type: Nasopharyngeal Swab**
Acinetobacter baumannii	DETECTED - MEDIUM	1.00E+03	[01/31/24] Limitation: Test does not differentiate between patient with acute infection or an asymptomatic carrier.
mecA (Methicillin/Oxacillin resistance)	DETECTED	DETECTED	
Pseudomonas aeruginosa	DETECTED - MEDIUM	1.00E+03	[01/31/24] Limitation: Test does not differentiate between patient with acute infection or an asymptomatic carrier.

Snippet of the lab report.

A 4-year-old male, a long-term trach patient, presented to our client with increased secretions, cough, and congestion. Since a culture taken two weeks prior resulted negative, as well as a rapid test on the day of the visit, the provider suspected an underlying bacterial infection. The multiplex PCR panel they used indeed detected two bacterial pathogens and mecA, a gene that can confer methicillin resistance. Thanks to PCR testing, the provider swiftly initiated highly-tailored antibiotic treatment, potentially averting a hospitalization. The provider emphasized the invaluable role of PCR testing, highlighting its superiority over waiting 3-5 days for culture results.

Test Performed	Test Results	Comments
COVID-19		**Collection Type: Nasopharyngeal Swab**
COVID-19	Not Detected	[02/09/23] COVID-19 assay reviewed and approved under FDA Emergency Use Authorization #200522.
nCoV_N1 (CT Value)	0	[02/09/23] CT value indicates the number of amplification cycles of real-time PCR needed to detect COVID-19, a specific SARS-CoV-2 gene sequence. CT values are inversely proportional to the amount of target nucleic acid in the sample (i.e. the lower the CT level, the greater the amount of target nucleic acid in the sample). The reference range for Streamline Scientific Laboratories RT-PCR assays is <40 cycles of amplification.

Test Performed	Lab Result (4) (Qualitative Low/Medium/High)	DNA Copy Number	Comments
SUMMARY COVID Respiratory Panel			**Collection Type: Nasopharyngeal Swab**
Streptococcus pneumoniae	DETECTED - HIGH	1.00E+04	[02/09/23] Limitation: Test does not differentiate between patient with acute infection or an asymptomatic carrier.

Snippet of the lab report.

A 2-month-old presented to our client with a cough and nasal congestion. He had been exposed to COVID-19, but came back with a negative rapid test and was sent home. Upon returning the next day, symptoms were aggravated and the congestion had progressed to the patient's lungs. Multiplex PCR revealed the elevated presence of Streptococcus pneumoniae, which allowed prompt initiation of antibiotics. What's more, the infant's fever had spike to 103°F the night they were sent home. How much discomfort and injury could have been prevented if PCR was used the same day as the rapid and antibiotics had been administered 24 hours earlier?

Test Performed	Lab Result (3) (Qualitative Low/Medium/High)	DNA Copy Number	Comments
SUMMARY UTI Pathogens Plus			**Collection Type: Urine, Urine catheter**
Escherichia coli	DETECTED - HIGH	1.00E+04	[10/25/23] Shares homology with Shigella spp.

Class (Gene Name)	Lab Result (Qualitative)	Resistance Gene Targets Identified	Associated Resistances (Antibiotics to Avoid)
SUMMARY UTI Antibiotic Resistance Markers			**Collection Type: Urine, Urine catheter**
Sulfonamides	DETECTED	sul1; sul2; sul3	[10/25/23]Sulfadiazine, Sulfamethizole, Sulfamethoxazole, Sulfasalazine, Sulfisoxazole

Culture ID and Antibiotic Sensitivity

Summary			Collection Type: Urine, Urine catheter
Antibiotic Sensitivity Testing	**Minimum Inhibitory Concentration (ug/mL)**	**Susceptibility**	**Notes**
Culture Observation	Insufficient growth observed in culture. No further workup. ug/mL		

Snippet of the lab report.

A 4-year-old female came in to our client with symptoms of a urinary tract infection (UTI). The provider prescribed Bactrim initially, while also ordering PCR and a Culture and Sensitivity (C&S). This was a departure from their previous practice of solely relying on culture. Because of PCR, the patient was switched to a more appropriate antibiotic within 24 hours of symptom onset, whereas no antibiotic would have been administered with cultures.

The Verdict

If cultures have failed you in the past, consider what's possible with the increased accuracy, speed, and reliability of PCR, and how you could improve time-to-diagnosis, patient outcomes, and your practice of antibiotic stewardship.

References

1. Maignan M, Viglino D, Hablot M, Termoz Masson N, Lebeugle A, Collomb Muret R, Mabiala Makele P, Guglielmetti V, Morand P, Lupo J, Forget V, Landelle C, Larrat S. Diagnostic accuracy of a rapid RT-PCR assay for point-of-care detection of influenza A/B virus at emergency department admission: A prospective evaluation during the 2017/2018 influenza season. PLoS One. 2019 May 7;14(5):e0216308. doi: 10.1371/journal.pone.0216308. PMID: 31063477; PMCID: PMC6504036.
2. Wojno KJ, Baunoch D, Luke N, Opel M, Korman H, Kelly C, Jafri SMA, Keating P, Hazelton D, Hindu S, Makhloouf B, Wenzler D, Sabry M, Burks F, Penaranda M, Smith DE, Korman A, Sirls L. Multiplex PCR Based Urinary Tract Infection (UTI) Analysis Compared to Traditional Urine Culture in Identifying Significant Pathogens in Symptomatic Patients. Urology. 2020 Feb;136:119-126. doi: 10.1016/j.urology.2019.10.018. Epub 2019 Nov 9. PMID: 31715272.

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