MAYO CLINIC LABORATORIES

Test Definition: SPUTS

Bacterial Culture, Aerobic, Respiratory with Antimicrobial Susceptibilities, Varies

Overview

Useful For

Aiding the diagnosis of lower respiratory bacterial infections, including pneumonia

Determining the in vitro antimicrobial susceptibility of potentially pathogenic aerobic bacteria, if appropriate

This test is **not intended for** medicolegal use.

Reflex Tests

Test Id	Reporting Name	Available Separately	Always Performed
COMM	Identification Commercial Kit	No, (Bill Only)	No
RMALD	Ident by MALDI-TOF mass spec	No, (Bill Only)	No
GID	Bacteria Identification	No, (Bill Only)	No
REFID	Additional Identification Procedure	No, (Bill Only)	No
STAP	Identification Staphylococcus	No, (Bill Only)	No
STRP	Identification Streptococcus	No, (Bill Only)	No
SALS	Serologic Agglut Method 1 Ident	No, (Bill Only)	No
EC	Serologic Agglut Method 2 Ident	No, (Bill Only)	No
SHIG	Serologic Agglut Method 3 Ident	No, Bill Only)	No
SIDC	Ident Serologic Agglut Method 4	No, (Bill Only)	No
ISAE	Aerobe Ident by Sequencing	No, (Bill Only)	No
PCRID	Identification by PCR	No, (Bill Only)	No
BLA	Beta Lactamase	No, (Bill Only)	No
MIC	Susceptibility, MIC	No, (Bill Only)	No
SUS	Susceptibility	No, (Bill Only)	No
MARP1	mecA PCR (Bill Only)	No, (Bill Only)	No

Testing Algorithm

When this test is ordered, the reflex tests may be performed at an additional charge. Antimicrobial agents appropriate

to the organism and specimen source will be tested according to Mayo Clinic's practice and the laboratory's standard operating procedures.

The following tables provide a listing of the antimicrobials routinely tested in the laboratory as well as antimicrobials that may be tested upon request. These tables are organized by isolate groups and are not all inclusive. Call 800-533-1710 and ask to speak to the Bacteriology Antimicrobial Susceptibility Testing Laboratory if the organism or antimicrobial of interest are not listed in these tables.
-Aerobic Gram-Negative Bacilli Antimicrobials
-Additional Gram-Negative Bacteria Antimicrobials
-Staphylococcus, Enterococcus, Bacillus, and Related Genera Antimicrobials
-Additional Gram-Positive Bacteria Antimicrobials

Special Instructions

- Aerobic Gram-Negative Bacilli Antimicrobials
- Additional Gram-Negative Bacteria Antimicrobials
- Staphylococcus, Enterococcus, Bacillus, and Related Genera Antimicrobials
- Additional Gram-Positive Bacteria Antimicrobials

Method Name

Conventional Culture Technique with Minimal Inhibitory Concentration (MIC) (Agar Dilution or Broth Microdilution or Gradient Diffusion) or Disk Diffusion, (if appropriate)

NY State Available

Yes

Specimen

Specimen Type

Varies

Shipping Instructions

Specimen must arrive within 24 hours of collection.

Necessary Information

Specimen source is required.

Specimen Required

Specimen Type: Respiratory
Patient Preparation: Have patient rinse his/her mouth with water immediately prior to specimen collection. This reduces the number of contaminating oropharyngeal bacteria.
Sources: Sputum, bronchoalveolar lavage, trachea, endotracheal tube, etc.
Container/Tube: Sterile container

Specimen Volume: Entire specimen
Collection Instructions: An **early-morning** expectorated sputum is preferred.

Specimen Minimum Volume
2 mL

Reject Due To
All specimens will be evaluated at Mayo Clinic Laboratories for test suitability.

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Varies	Refrigerated (preferred)	24 hours	
	Ambient	24 hours	

Clinical & Interpretive

Clinical Information
Common bacterial agents of acute pneumonia include *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, and members of the *Enterobacterales* (eg, *Escherichia coli*, *Klebsiella* species, and *Enterobacter* species). Clinical history, physical examination, and chest X-ray are usually adequate for the diagnosis of pneumonia, and antimicrobial treatment is typically based on these findings.

Culture of expectorated sputum is used by some for the evaluation of pneumonia, although controversy exists regarding this practice; both sensitivity and specificity of sputum cultures are generally regarded as poor (<50%). Specificity is improved by collecting expectorated purulent matter from the lower respiratory tract and avoiding mouth and oropharyngeal matter, thereby reducing contamination. Prior to culture, the specimen should be examined for the presence of white blood cells (evidence of purulent matter) and a paucity of squamous cells (evidence of minimal contamination by oral matter).

Blood cultures should be performed to establish the definitive etiology of an associated pneumonia. However, only 20% to 30% of patients with bacterial pneumonia are bacteremic.

Antimicrobial susceptibility testing should be performed on pure culture isolates of pathogenic (or potentially pathogenic in special situations) bacteria grown from specimens that have been appropriately collected so as not to confuse clinically significant isolates with normal flora.

Antimicrobial susceptibility testing determines the minimual inhibitory concentration (MIC) value of selected antimicrobial agents against isolated potentially pathogenic bacteria. The MIC is the lowest antimicrobial concentration (of a series of increasing concentrations) that inhibits growth of the bacterium. Agar dilution MIC testing is performed by testing for growth of bacteria on agar plates containing varying concentrations of antimicrobial agents.

For each organism-antimicrobial agent combination, the Clinical and Laboratory Standards Institute and/or the European

Committee on Antimicrobial Susceptibility Testing provides interpretive criteria for determining whether the MIC should be interpreted as susceptible, susceptible dose dependent, intermediate, nonsusceptible, resistant, or epidemiological cutoff value.

Reference Values

Susceptibility results are reported as minimal inhibitory concentration (MIC) in mcg/mL Breakpoints (also known as "clinical breakpoints") are used to categorize an organism as susceptible, susceptible-dose dependent, intermediate, resistant, or nonsusceptible according to breakpoint setting organizations, either the Clinical and Laboratory Standards Institute (CLSI) or the European Committee on Antimicrobial Susceptibility Testing (EUCAST), as applicable.
In some instances, an interpretive category cannot be provided based on available data and the following comment will be included: "There are no established interpretive guidelines for agents reported without interpretations."

Clinical and Laboratory Standards Institute (CLSI) Interpretive Category Definitions:
Susceptible:
A category defined by a breakpoint that implies that isolates with an MIC at or below or a zone diameter at or above the susceptible breakpoint are inhibited by the usually achievable concentrations of antimicrobial agent when the dosage recommended to treat the site of infection is used, resulting in likely clinical efficacy.

Susceptible-Dose Dependent:
A category defined by a breakpoint that implies that susceptibility of an isolate depends on the dosing regimen that is used in the patient. To achieve levels that are likely to be clinically effective against isolates for which the susceptibility testing results (either MICs or zone diameters) are in the susceptible-dose dependent (SDD) category, it is necessary to use a dosing regimen (ie, higher doses, more frequent doses, or both) that results in higher drug exposure than that achieved with the dose that was used to establish the susceptible breakpoint. Consideration should be given to the maximum literature-supported dosage regimens because higher exposure gives the highest probability of adequate coverage of a SDD isolate. The drug label should be consulted for recommended doses and adjustment for organ function.

Intermediate:
A category defined by a breakpoint that includes isolates with MICs or zone diameters within the intermediate range that approach usually attainable blood and tissue levels and/or for which response rates may be lower than for susceptible isolates.
Note: The intermediate category implies clinical efficacy in body sites where the drugs are physiologically concentrated or when a higher-than-normal dosage of a drug can be used. This category also includes a buffer zone, which should prevent small, uncontrolled, technical factors from causing major discrepancies in interpretations, especially for drugs with narrow pharmacotoxicity margins.

Resistant:
A category defined by a breakpoint that implies that isolates with an MIC at or above or a zone diameter at or below the resistant breakpoint are not inhibited by the usually achievable concentrations of the agent with normal dosage schedules and/or that demonstrate MICs or zone diameters that fall in the range in which specific microbial resistance mechanisms are likely, and clinical efficacy of the agent against the isolate has not been reliably shown in treatment studies.

Nonsusceptible:
A category used for isolates for which only a susceptible breakpoint is designated because of the absence or rare occurrence of resistant strains. Isolates for which the antimicrobial agent MICs are above or the zone diameters are below the value indicated for the susceptible breakpoint should be reported as nonsusceptible.
Note: An isolate that is interpreted as nonsusceptible does not necessarily mean that the isolate has a resistance mechanism. It is possible that isolates with MICs above the susceptible breakpoint that lack resistance mechanisms may be encountered within the wild-type distribution after the time the susceptible-only breakpoint was set.

Epidemiological Cutoff Value:
The MIC that separates microbial populations into those with and without phenotypically detectable resistance (non-wild-type or wild-type, respectively). The epidemiological cutoff value (ECV) defines the highest MIC for the wild type population of isolates. ECVs are based on in vitro data only, using MIC distributions. ECVs are not clinical breakpoints, and the clinical relevance of ECVs for a particular patient has not yet been identified or approved by CLSI or any regulatory agency.

When an ECV is reported, an interpretive category is not assigned, and the following comment will be included: "This MIC is consistent with the Epidemiological Cutoff Value (ECV) observed in isolates (WITH / WITHOUT) acquired resistance; however, correlation with treatment outcome is unknown."

-Wild-type (WT) - an interpretive category defined by an ECV that describes the microbial population with no phenotypically detectable mechanisms of resistance or reduced susceptibility for an antimicrobial agent being evaluated.

-Non-wild-type (NWT) - an interpretive category defined by an ECV that describes the microbial population with phenotypically detectable mechanisms of resistance or reduced susceptibility for the antimicrobial agent being evaluated.

“Note”: MIC values for which ECV’s are defined are not to be interpreted or reported as susceptible, intermediate or resistant but rather as WT or NWT. The ECV’s should not be used as clinical breakpoints.(Clinical and Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Susceptibility Testing. 31st ed. CLSI supplement M100. CLSI; 2021:4-6, 268-269)

European Committee on Antimicrobial Susceptibility Testing (EUCAST) Interpretive Category Definitions:
S - Susceptible, standard dosing regimen: A microorganism is categorized as "Susceptible, standard dosing regimen", when there is a high likelihood of therapeutic success using a standard dosing regimen of the agent

I - Susceptible, increased exposure*: A microorganism is categorized as "Susceptible, Increased exposure*" when there is a high likelihood of therapeutic success because exposure to the agent is increased by adjusting the dosing regimen or by its concentration at the site of infection.

R - Resistant: A microorganism is categorized as "Resistant" when there is a high likelihood of therapeutic failure even when there is increased exposure*.

*Exposure is a function of how the mode of administration, dose, dosing interval, infusion time, as well as distribution and excretion of the antimicrobial agent will influence the infecting organism at the site of infection.

(The European Committee on Antimicrobial Susceptibility Testing. Breakpoint tables for interpretation of MICs and zone diameters. Version 11.0, 2021. Available at www.eucast.org)

Interpretation

A negative test result is no growth of bacteria or growth of only usual flora. A negative result does not rule out all causes of infectious lung disease (see Cautions).

Organisms associated with lower respiratory tract infections are reported.

For positive test results, pathogenic bacteria are identified. Cystic fibrosis patients may be colonized or chronically infected by some organisms over a long period of time, therefore, positive results must be interpreted in conjunction with previous findings and the clinical picture to appropriately evaluate results.

A susceptible category result and a low minimal inhibitory concentration value indicate in vitro susceptibility of the organism to the antimicrobial tested.

Refer to the Reference Values section for interpretation of various antimicrobial susceptibility interpretive categories (ie, susceptible, susceptible-dose dependent, intermediate, nonsusceptible, resistant, or epidemiological cutoff value).

Cautions

When culture of sputum is delayed, successful isolation of bacterial pathogens is less likely, due to the overgrowth of usual oropharyngeal flora.

Some bacterial agents that cause lower respiratory infections (eg, mycobacteria, *Legionella* species, *Mycoplasma pneumoniae*) are not detected by this assay and require special procedures. If the bacterial culture is negative, clinicians should consider additional testing to detect other bacterial, viral, or fungal agents.

Results must be interpreted in conjunction with clinical findings and previous culture results.

When antimicrobial susceptibilities are performed, in vitro antimicrobial susceptibility does not guarantee clinical response. Therefore, the decision to treat with a particular agent should not be based solely on the antimicrobial susceptibility testing result.

Clinical Reference

1. Miller JM, Binnicker JM, Campbell S, et al: A guide to utilization of the microbiology laboratory for diagnosis of infectious diseases: 2018 Update by the Infectious Diseases Society of America and the American Society for Microbiology. Clin Infect Dis. 2018 Aug 31;67(6):e1-e94. doi: 10.1093/cid/ciy381
2. Procop GW, Church DL, Hall GS, eds, et al: Introduction to Microbiology Part II: Guidelines for the collection, transport, processing, analysis, and reporting of cultures from specific specimen sources. In: Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 7th ed. Wolters Kluwer Health; 2017:66-110
3. Leber AL, ed. Clinical Microbiology Procedures Handbook. Vol 1. 4th ed. ASM Press; 2016:chap 3.11.2

Performance

Method Description

All sputum and induced sputum specimens are screened microscopically by Gram stain to avoid culturing specimens that do not represent lower respiratory secretions; specimens with more than 25 squamous epithelial cells per low-power field will not be cultured.

Lower respiratory specimens are inoculated onto sheep blood agar, eosin methylene blue agar, and chocolate agar and are incubated for 48 hours. Pathogens or possible pathogens are identified using one or a combination of the following techniques: commercial identification strips or panels, matrix-assisted laser desorption/ionization time-of-flight mass spectrometry, conventional biochemical tests, carbon source utilization, real-time polymerase chain reaction, and nucleic acid sequencing of the 16S ribosomal RNA (rRNA) gene. The following organisms are identified and reported: *Streptococcus pneumoniae*, *Streptococcus pyogenes*, other beta-hemolytic *Streptococcus* species groups B, C and G, *Haemophilus* species, *Staphylococcus aureus*, *Moraxella catarrhalis*, *Neisseria meningitidis*, Gram-negative bacilli, and predominant yeast or *Corynebacterium pseudodiphtheriticum/propinquum*. Other organisms are classified as usual oropharyngeal flora.(York MK, Gilligan P, Alby K: Lower respiratory tract cultures. In: Leber AL, ed. Clinical Microbiology Procedures Handbook. Vol 1. 4th ed. ASM Press; 2016:section 3.11.2)

When antimicrobial susceptibility testing is performed, an agar dilution method is used for routine testing. The agar dilution method employs the use of antimicrobial agents incorporated in agar plates. The antimicrobial is added to agar in various concentrations depending upon levels attainable in serum, urine, or both. A standardized suspension of the organism is applied to the agar plates, which are incubated for a minimum of 16 to 18 hours at 35 degrees C. Complete inhibition of all but one colony or a very fine residual haze represents the end point. (Clinical and Laboratory Standards Institute [CLSI]: Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically. 11th ed. CLSI standard M07. CLSI; 2018.)

Daptomycin and tigecycline are tested by agar gradient diffusion.(Clinical and Laboratory Standards Institute [CLSI]: Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically. 11th ed. CLSI standard M07. CLSI; 2018) (package insert: Etest Biomerieux;15203E-EN-2016/07. 07/2016)

Colistin is tested by the CLSI-approved Colistin agar test for *Enterobacterales* and *Pseudomonas aeruginosa*. (Clinical and Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Susceptibility Testing. 31st ed. CLSI supplement M100. CLSI; 2021:142-147.)

Cefiderocol is tested by disk diffusion.(Clinical and Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Disk Susceptibility Tests. 13th ed. CLSI standard M02. CLSI; 2018.)

PDF Report

No

Day(s) Performed

Monday through Sunday

Report Available
3 to 6 days

Specimen Retention Time
1 day

Performing Laboratory Location
Rochester

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification
This test has been cleared, approved, or is exempt by the US Food and Drug Administration and is used per manufacturer's instructions. Performance characteristics were verified by Mayo Clinic in a manner consistent with CLIA requirements.

CPT Code Information
87070-Bacterial, Culture, Aerobic, Respiratory
87077-Identification commercial kit (if appropriate)
87077-Ident by MALDI-TOF mass spec (if appropriate)
87077-Bacteria Identification (if appropriate)
87077-Additional Identification procedure (if appropriate)
87077-Identification Staphylococcus (if appropriate)
87077-Identification Streptococcus (if appropriate)
87147 x 1-3-Serologic agglut method 1 ident (if appropriate)
87147-Serologic agglut method 2 ident (if appropriate)
87147 x 4-Serologic agglut method 3 ident (if appropriate)
87147 x 2-6-Serologic Agglut Method 4 Ident (if appropriate)
87153-Aerobe ident by sequencing (if appropriate)
87150-Identification by PCR (if appropriate)
87185-Beta lactamase (if appropriate)
87186-Antimicrobial Susceptibility, Aerobic Bacteria, MIC-per organism for routine battery (if appropriate)
87181-Susceptibility per drug and per organism for drugs not in routine battery (if appropriate)
87150-mec A PCR (if appropriate)

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value

SPUTS	Bacterial Culture, Aerobic + Susc	89643-1

Result ID	Test Result Name	Result LOINC® Value
SPUTS	Bacterial Culture, Aerobic + Susc	89643-1