Table 30. Laboratory Diagnosis of Pulmonary Infections in Cystic Fibrosis

Etiologic Agents	Diagnostic Procedures	Optimum Specimens	Transport Issues
Bacteria			
Staphylococcus aureus *Haemophilus influenzae* *Streptococcus pneumoniae* *Enterobacterales* *Pseudomonas aeruginosa* *Stenotrophomonas maltophilia* *Achromobacter* spp.	Culture	Expectorated sputum; throat swabs[a]; other respiratory samples	Sterile container, RT, 2 h; >2–24 h, 4°C
Burkholderia cepacia complex	Culture using *B. cepacia* selective agar	Throat swabs[a], expectorated sputum; other respiratory samples	Sterile container, RT, 2 h; >2–24 h, 4°C
Opportunistic glucose non-fermenting gram-negative rods *Burkholderia gladioli* *Inquilinus* spp. *Ralstonia* spp. *Cupriavidus* spp. *Pandorea* spp. *Chryseobacterium* spp. *Herbaspirillum* spp. *Sphingobacterium* spp.	Culture	Expectorated sputum; throat swabs[a]; other respiratory samples	Sterile container, RT, 2 h; >2–24 h, 4°C
Mycobacterium spp.			
Mycobacterium abscessus *Mycobacterium avium* complex	Mycobacteria culture Mycobacteria culture	Expectorated sputum, bronchoscopically obtained cultures; other respiratory samples	Sterile container, RT, 2 h; >2–24 h, 4°C
Fungi			
Aspergillus spp. allergic bronchopulmonary	Anti-*Aspergillus* IgE, IgG antibodies	Serum	Clot tube 4°C, ≤5 d; >5 d, −70°C
Aspergillus spp. *Scedosporium apiospermum complex* *Lomentospora prolificans* *Apiotrichum mycotoxinivorans* *Exophiala dermatitidis* *Rasamsonia argillacea complex*	Galactomannan enzyme immunoassay Calcofluor-KOH or other fungal stain Fungal culture	Serum; BAL Expectorated sputum, bronchoscopically obtained cultures; other respiratory cultures	Clot tube 4°C, ≤5 d; >5 d, −70°C BAL fluid, sterile container, RT, 2 h; >2–24 h, 4°C Sterile container, RT, 2 h; >2–24 h, 4°C
Viruses			
RSV Influenza Adenovirus Rhinovirus Coronavirus including SARS-CoV-2 Parainfluenza virus Human metapneumovirus	Rapid antigen detection DFA Viral culture methods NAAT[b]	Nasal aspirates, nasal washes, NP swabs, throat washes, throat swabs; bronchoscopically obtained specimens	Transport in viral transport media, RT or 4°C, 5 d; −70°C, >5 d

Abbreviations: DFA, direct fluorescent antibody; KOH, potassium hydroxide; NAAT, nucleic acid amplification test; NP, nasopharyngeal; RSV, respiratory syncytial virus; RT, room temperature; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a]Young children < 8 years of age only; often called "gag sputum."

[b]Several US Food and Drug Administration (FDA)-cleared NAAT platforms are currently available and vary in their approved specimen requirements and range of analytes detected. Readers should check with their laboratories regarding availability and performance characteristics, including certain limitations. See Table 26.

the abnormality on radiographs; otherwise, in diffuse disease, the scope is usually wedged in the right middle-lobe or lingula. It is suggested that microbiology laboratories in collaboration with infectious diseases physicians and pulmonologists, develop an algorithm for processing samples that includes testing for all major categories of pathogens as summarized in the table. Cytologic analysis and/or histopathology may assist with interpretation of positive NAAT for herpesviruses, for example, and to definitively diagnose filamentous fungi. It should be noted, however, that histopathology alone is not sensitive enough to diagnose fungal infections and should be accompanied by culture and, when available, NAAT [210, 250, 252]. Although frequently over-utilized in non-immunocompromised patients, serum and BAL galactomannan, and serum 1,3 b-D-glucan tests are helpful in patients in whom radiographic or clinical evidence suggests fungal pneumonia [233, 242]. However, cytology and/or histopathology are quite useful for distinguishing conditions such as pulmonary hemorrhage and rejection from infectious causes of infiltrates. Transthoracic needle aspiration, computed tomography-guided biopsies of pleural-based lesions and open lung biopsies likewise may be considered if less invasive diagnostics are unrevealing.

Currently, progress is being made with metagenomic next generation sequencing methods. Plasma cell free DNA