

Diagnosis of acute Lower Respiratory Tract Infections



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PREFACE

This simplified guide is intended to provide an overview of some of the key elements in the diagnosis of acute respiratory infections in adults and children.

It discusses the most common respiratory infections, placing an emphasis on acute pneumonia and on the best use of local and international recommendations.

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ACUTE LOWER RESPIRATORY TRACT INFECTIONS

Unlike upper respiratory tract infections, located in the respiratory tract situated above the vocal cords and without signs on auscultation, lower respiratory tract infections include a whole range of conditions which may or may not involve the parenchyma.

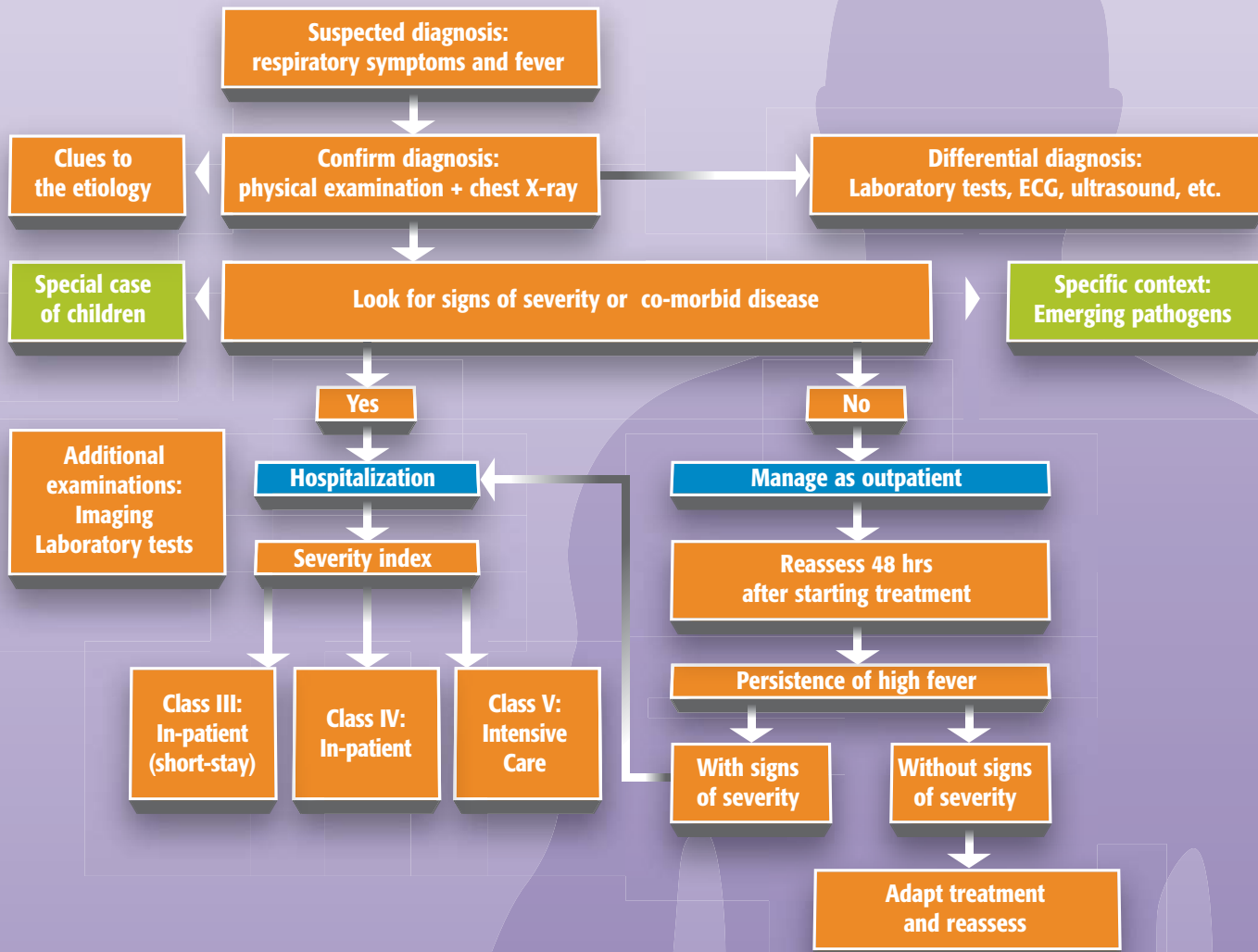
- Infections involving the parenchyma: pneumonia.
- Infections not involving the parenchyma: acute bronchitis and exacerbation of chronic bronchitis, bronchiolitis in young children.

IMPACT ON PUBLIC HEALTH

■ Respiratory infections are the primary cause of death in developing countries. Worldwide, they are responsible for more than 5 million deaths per year, i.e. 10,000 to 15,000 deaths per day.

In industrialized countries, respiratory infections are one of the main causes of outpatient consultations.

MANAGEMENT OF PATIENTS PRESENTING WITH ACUTE PNEUMONIA



CLINICAL DIAGNOSIS

ACUTE PNEUMONIA

The combination of a cough, expectoration, dyspnea, chest pain, symptoms of infection with fever, shivering, myalgia and the presence of crepitant rales on auscultation classically suggests the diagnosis, which is confirmed by chest X-ray. In practice, the clinical symptoms are rarely all observed at the first examination.

The presence of unilateral crepitant rales has a good positive predictive value, whereas the combination of a breathing rate $< 30/\text{min}$, a heart rate $< 100/\text{min}$ and a temperature $< 38^{\circ}\text{C}$ has a good negative predictive value.⁽¹⁾

Clinical symptoms of pneumonia are not specific.

Due to the poor predictive value of the symptoms, clinical and radiological examinations must be repeated to confirm the diagnosis and monitor progression. A CT-scan may be useful.⁽¹⁾

Reassessment 48 hrs after starting treatment.

PNEUMONIA IN THE ELDERLY

■ The clinical symptoms, often less discernable (possible absence of fever, etc.), and the presence of underlying diseases (heart failure, chronic bronchitis, etc.) make diagnosis more difficult.

PNEUMONIA IN CHILDREN

■ Acute pneumonia in a child may present an acute abdominal picture, with digestive symptoms (abdominal pain and febrile vomiting) predominating, or as a meningitis syndrome.

ACUTE BRONCHITIS

The differential diagnosis between acute bronchitis and pneumonia is not always easy in general practice. The combination of respiratory symptoms (cough, expectoration), symptoms on auscultation (bronchial rales +/- bronchospasm) and fever, but above all the absence of symptoms such as crepitant rales, dyspnea, chest pain or signs of severe infection help make the diagnosis and select the treatment. Indeed, unlike pneumonia, it is generally admitted that antibiotics should not be prescribed for the treatment of acute bronchitis in individuals in general good health.⁽²⁾ A chest X-ray, which is normal in bronchitis, is not indicated, except to exclude another disease, particularly pneumonia.

A "post-infection" cough may often persist for 2 to 3 weeks. Prescribing antibiotics will have no effect on the duration of this cough and is therefore not indicated.⁽²⁾ A cough persisting beyond 3 weeks indicates that another diagnosis should be considered, such as an ENT condition, allergy, gastro-esophageal reflux, heart failure or pertussis.

If there is any doubt, a chest X-ray should be performed.

CONSIDER PERTUSSIS

■ Due to its recrudescence, the possibility of this disease should be considered if a paroxysmal cough, very often nocturnal, persists in adults. The risk of transmission to unvaccinated infants justifies diagnosing and treating the infected subject correctly. Antibiotic (macrolides) prophylaxis of contact subjects should also be considered.

Confirmation of diagnosis is based on molecular tests for hospitalized infants and in the case of coughs in adults and children lasting less than 3 weeks. This technique, carried out on sputum samples or nasopharyngeal aspirates, is more sensitive than culture, has good specificity and gives same-day results. Bacterial culture from a nasopharyngeal sample is essentially of epidemiological interest and must be performed within the first 3 weeks of illness. After 3 weeks, serology remains the method of choice, but is limited to specialized laboratories. Two serum samples taken at an interval of 3 or 4 weeks, or a single elevated antibody concentration in an adolescent or an adult vaccinated more than 3 years previously will confirm the diagnosis.

BACKGROUND/ CONTEXT

Taking the patient history or underlying conditions into consideration is a fundamental part of medical management. The context may indicate that an unusual infectious etiology should be considered, for which specific management may be necessary for microbiological confirmation and treatment. It may also mean that potentially more rapid and more frequent aggravation in debilitated patients can be anticipated (HIV positive patients, immunocompromised persons, cystic fibrosis cases, chronic alcoholics, etc.).

NOSOCOMIAL PNEUMONIA

■ Respiratory infections are the second most common cause of hospital-acquired infections.

Inhalation of rhinopharyngeal secretions colonized by the patient's flora or by environmental flora is facilitated by swallowing disorders and altered mental status, by assisted ventilation or quite simply by the body's defenses being lowered. Diagnosing these nosocomial infections becomes difficult when there are multiple concomitant pathologies.

■ "Early" respiratory infections (within 5 days of hospitalization) are mainly due to community-acquired microorganisms. After 5 days, the microbiological characteristics of "late" respiratory infections are:

- Predominance of Gram negative bacilli (*Pseudomonas aeruginosa*, *Serratia*, *Enterobacter*, *Klebsiella*, *Acinetobacter*, *Proteus* and *E. coli*) and *Staphylococcus aureus*.
- Intracellular microorganisms and fungi (*Aspergillus*).
- Frequency of multi-microbial infections.

■ Nosocomial pneumonia acquired under mechanical ventilation should be suspected if there is fever or hypothermia, hyperleukocytosis or leukopenia, if secretions are purulent and there is a decline in respiratory gas values, with a new or extensive infiltrate on the chest X-ray.

DIFFERENTIAL DIAGNOSIS

DIFFERENTIAL DIAGNOSIS OF ACUTE PNEUMONIA

The non-specificity of the clinical symptoms of pneumonia should evoke and lead to the elimination of certain misleading diagnoses, particularly as extra-pulmonary symptoms such as acute abdominal pain, vomiting or headaches are not uncommon in acute pneumonia.

Pulmonary embolism, particularly in an immobilized patient, in the context of surgery, cancer, or a history of phlebitis, especially if fever is absent or only moderate. The D-dimer test can contribute greatly to excluding pulmonary embolism in patients at low to moderate risk.⁽⁴⁾

Heart failure, in the presence of crackling sounds, possibly accompanied by a moderate fever. Patient medical history and other symptoms of cardiac insufficiency will clarify this diagnosis. NT/Pro-BNP* measurement is an additional rapid, non-invasive method for confirming cardiac insufficiency.⁽⁵⁾

In children, aspiration of a foreign body may simulate the onset of a respiratory infection and delay the decision to hospitalize, which must be rapid and systematic.

* NT/Pro-BNP : N-Terminal Pro-Brain Natriuretic Peptide

ETIOLOGICAL DIAGNOSIS

WHICH INFECTIOUS AGENT IS RESPONSIBLE?

The etiology of a community-acquired respiratory infection plays a role in medical decision-making as it concerns:

- the treatment: antibiotic treatment or not, choice of empirical antibiotic treatment;
- isolation measures, particularly in the context of an epidemic (influenza, RSV, etc.);
- hospitalization/special measures, for example when emerging pathogens are suspected (SARS, etc.).

Etiological diagnosis may be influenced by the clinical picture and the X-ray findings which can differentiate between two major forms of acute pneumonia:

- typical acute lobar pneumonia essentially due to *S. pneumoniae*,
- atypical pneumonia due to intracellular bacteria: *Mycoplasma pneumoniae*, *Chlamydia pneumoniae* or *Legionella pneumophila*, or to a virus.

In practice, the clinical and radiographic elements are not discriminatory enough to reliably guide the choice of empirical antibiotic treatment (e.g. macrolides for intracellular microorganisms, β -lactams for a *pneumococcus*).

Empirical antibiotic treatment of acute pneumonia in healthy adults not showing severe symptoms must take *pneumococcus* into account because of its frequency and potential severity.

ORIENTATION OF ETIOLOGY FROM CLINICAL AND RADIOLOGICAL FINDINGS

Physical examination	Medical history	Chest X-ray	Most likely organisms
Typical acute lobar pneumonia	Sudden onset Chest pain	Consolidated well-defined density	<i>S. pneumoniae</i>
Atypical pneumonia	Outbreak, URI* Cough	Patchy non-defined infiltrate, contrasting with discrete crackling sounds on auscultation	<i>M. pneumoniae</i> <i>C. pneumoniae</i> Influenza <i>L. pneumophila</i>
Acute bronchitis	Commonly associated with URI*	Normal X-ray	Virus = 90% (Influenza, Rhinovirus...) <i>H. influenzae</i> <i>M. catarrhalis</i> <i>M. pneumoniae</i> <i>C. pneumoniae</i>
Acute exacerbation of COPD**	Known chronic bronchitis Smoker		<i>H. influenzae</i> <i>M. catarrhalis</i> <i>S. pneumoniae</i>
Pneumonia	Nursing home residents Outbreak		<i>S. pneumoniae</i> RSV Influenza
Pneumonia	Chronic alcoholism Swallowing disorders		<i>S. pneumoniae</i> <i>K. pneumoniae</i> Anaerobic bacteria
Pneumonia	Immunocompromised patients Neutropenia		CMV Enterobacteria <i>Pseudomonas</i> <i>Aspergillus</i> <i>Pneumocystis</i> <i>M. tuberculosis</i> <i>Nocardia</i>
Pneumonia	HIV-infected patients		<i>S. pneumoniae</i> <i>Pneumocystis</i> <i>Cryptococcus</i> Mycobacteria
Pneumonia	Cystic fibrosis		<i>P. aeruginosa</i> <i>B. cepacia</i>
Pneumonia	Nosocomial		<i>L. pneumophila</i> Gram negative bacteria Virus <i>S. aureus</i>
Pneumonia	Child under 2 years		RSV, Rhinovirus, hMPV

* URI: Upper Respiratory Tract Infection

** COPD: Chronic Obstructive Pulmonary Disease

The majority of lower respiratory tract infections are poorly documented due to the limitations of conventional diagnostic methods. In most cases, antibiotic treatment is empirical, based on presumptions and on epidemiological data obtained from studying microbiological results collected by an institution, a region or a country.

PNEUMONIA SEVERITY INDEX⁽²⁾

MORTALITY RISK FACTORS

PHYSICAL EXAMINATION

- Altered mental status
- Vital signs suggesting severe sepsis:
 - Systolic Blood Pressure < 90 mmHg
 - Pulse > 120/min
 - Respiratory rate > 30/min
 - Temperature < 35°C or > 40°C
- Cyanosis, sweating, increased work of breathing
- Peripheral symptoms of shock
- Suspected aspiration pneumonia or known/suspected inhalation of foreign matter into the lungs

LABORATORY OR CHEST X-RAY FINDINGS

- Leukopenia < 4000/mm³ or hyperleucocytose > 20,000/mm³
- Anemia: Hb < 9 g/l
- Creatinine > 12 mg/l
- Hypoxemia: PaO₂ < 60 mm Hg in ambient air or saturation < 90%
- Hypercapnia: PaCO₂ > 50 mm Hg in ambient air
- Acidosis: pH < 7.3
- Pleural effusion, cavitory lesion, or multi-lobar involvement on chest X-ray examination

SIMPLIFIED SCORE OF THE BRITISH THORACIC SOCIETY, SUITABLE FOR USE IN GENERAL PRACTICE: (CRB 65)⁽⁶⁾

Confusion

Respiratory Rate ≥ 30/min

Blood pressure: systolic < 90 ou diastolic ≤ 60 mmHg

Age ≥ 65 years old

0 criteria: Treat on out-patient basis

1 to 2 criteria: Evaluation in Emergency Dept. or short hospitalization

3 to 4 criteria: Immediate hospitalization

SEVERITY INDEX FOR MANAGING PATIENTS WITH C.A.P.* (FINE CLASSIFICATION)⁽⁷⁾

Risk factors

Assigned points

Age > 50 years old	+30
Coexisting illnesses	
Congestive heart failure	+10
Chronic renal disease	+10
Chronic liver disease	+20
Cerebro-vascular disease	+10
Cancer	+30
Physical examination	
Altered mental status	+20
Systolic blood pressure < 90 mmHg	+20
Pulse > 120/min	+10
Respiratory rate > 30/min	+20
Temperature < 35°C ou > 40°C	+15
Laboratory and chest X-ray examinations	
Acidosis: pH < 7.3	+30
Urea: > 30 g/l	+20
Sodium: < 130 mmol/l	+20
Glucose: > 2.5 g/l	+10
Hematocrit < 30%	+10
PaO ₂ < 60 mmHg in ambient air or saturation < 90%	+10
Pleural effusion, cavitory lesion or multi-lobar involvement on chest X-ray examination:	+10
Total	<i>Sum of points</i>

If total < 70 points: Class I and II: manage as out-patient

If total is between 71 and 90: Class III: in-patient (short-stay)

If total is between 91 and 130: Class IV: admit to hospital

If total > 130 points: Class V: hospitalization in an Intensive Care Unit

WHEN SHOULD A PATIENT WITH C.A.P.* BE ADMITTED TO HOSPITAL?

Mortality risk factors: from FINE class III

At least one CRB 65 criterion

Presence of at least one sign of severity

Precarious socio-economic situation: non-compliance, isolated persons, etc.

Situations compromising oral treatment (vomiting, etc.)

* C.A.P.: Community-Acquired Pneumonia

CLINICAL DIAGNOSIS

ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

Exacerbation of COPD, caused in over half of cases by infection, can be confirmed by associating pre-existing documented COPD (PFT*) with increased severity of dyspnea, cough or sputum production. Sputum purulence is highly predictive of a bacterial infection. Fever is not constant.

Non-infectious causes of exacerbation of COPD should be considered: cardiac decompensation, pulmonary embolism, rhythm disorders, sedatives, etc.

COPD severity stages and antibiotic strategy during exacerbation ⁽²¹⁾

Stages according to PFT*	Clinical	Indication for antibiotic treatment
Stage 0 : FEV1/VC ** >= 70% (no obstructive disorder)	Simple chronic bronchitis No dyspnea on exertion	Not recommended as a first-line treatment
Stage I : FEV1 >= 80%	No dyspnea on exertion	Yes
Stage II : FEV1 between 30% and 80%	Dyspnea on exertion	Yes
Stage III : FEV1 < 30% or 30% < VEMS < 50% with chronic respiratory insufficiency (PaO ₂ < 60 mmHg)	Dyspnea during rest	Yes

*PFT: Pulmonary Function Tests ** FEV1: Forced expiratory volume in 1 second VC: Vital Capacity

WHEN SHOULD A PATIENT WITH EXACERBATION OF COPD BE ADMITTED TO HOSPITAL?⁽¹⁾

- Significant change in usual symptoms
- COPD Stage III
- Occurrence of new clinical symptoms (cyanosis, etc.)
- Coexisting illnesses
- Occurrence of arrhythmia
- Uncertain diagnosis
- Age > 70 years old
- Precarious socio-economic situation

EMERGING PATHOGENS

Severe Acute Respiratory Syndrome (SARS)

Emerging disease caused by a coronavirus, described for the first time in Hanoi in 2003.

When should this diagnosis be considered?

Patient with a fever above 38°C, combined with symptoms of lower respiratory tract involvement, coming from a country where active transmission of SARS exists or having been in contact with a possible or probable case of SARS.⁽⁸⁾

Procedure to follow with a suspected SARS patient

Clinical examination with protection: mask (FFP2), gloves, protective glasses, and a mask for the patient. Isolation of the patient. Contact the competent authorities for patient management.

Avian influenza

Disease caused by an influenza virus of subtype H5N1, detected for the first time in humans in Hong Kong in 1997.

When should this diagnosis be considered?

Patient with an acute respiratory syndrome combined with a fever above 38°C, returning from a country where the epizooty is prevalent with notified human cases, and having had contact with birds or with a confirmed human case of H5N1 during the previous 7 days.⁽⁹⁾

Procedure to follow

Clinical examination with protection: mask (FFP2), gloves, protective glasses, and a mask for the patient. Isolation of the patient. Contact the competent authorities for patient management.

LOWER RESPIRATORY TRACT INFECTIONS IN CHILDREN

Respiratory infections are one of the most common reasons for medical visits with children. Clinically, they combine fever and respiratory symptoms (cough, tachypnea, etc.) but the symptoms may be completely non-specific in young children (isolated fever, predominance of digestive symptoms, etc.).

YOUNG CHILDREN (UNDER 3 YEARS)

- Predominance of viral infections, particularly bronchiolitis during the first year
- Causative virus: RSV*, *Rhinovirus*, hMPV**, *Influenza*, *Parainfluenza*, *Adenovirus*, etc.
- Wheezing, cough, moderate fever
- Contagiousness +++

Detection of the virus in a hospital environment enables the patient to be isolated thus limiting nosocomial transmission.

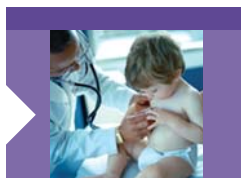
CHILDREN OVER 3 YEARS

- Predominance of pneumococci among bacterial causes
- Also *M. pneumoniae*, *S. pyogenes*, etc.
- Crepitant rales, extra-respiratory symptoms, fever above 38°C
- Impairment of general condition in case of *pneumococcus*

BRONCHIOLITIS

■ Bronchiolitis is common in infants under 2 years and occurs in the epidemic period from October to March. It is mainly due to the Respiratory Syncytial Virus and affects the bronchioles. The clinical symptoms are rhinorrhea associated with coughing and moderate fever, followed by expiratory dyspnea and wheezing or crackling rales on auscultation. Antibiotic treatment is not indicated unless there are symptoms of severity or associated illness (e.g. acute otitis media).

Frequency of viral/bacterial co-infection (10 to 40%),
viral/viral co-infection (10 to 20%)^(9,10)



* RSV: Respiratory Syncytial Virus
** hMPV: Human metapneumovirus: a new virus recently identified (Netherlands) belonging to the paramyxovirus family⁽¹⁾⁽²⁾

CRITERIA FOR HOSPITALIZING CHILDREN WITH A LOWER RESPIRATORY TRACT INFECTION⁽²⁾

Toxic appearance / significant impairment in general condition

Age < 3 months

Digestive disorders compromising hydration

Respiratory distress: significant tachypnea, struggling for breath, cyanosis, SaO₂ < 95%, apnea

Underlying conditions (heart disease, chronic lung disease)

Unfavorable social situation

LABORATORY AND CHEST X-RAY EXAMINATIONS

WHICH ADDITIONAL TESTS ARE NECESSARY?

FOR OUTPATIENTS

• **Chest X-ray:**

Confirms diagnosis, indicates the type of lung disease (non-defined infiltrate or consolidated density), enables assessment of severity (multi-lobar, associated pleural effusion, etc.) and progression (normalization within 2 weeks on average).

• **Non-specific laboratory tests:**

Blood counts, CRP and gas exchanges (to assess repercussions).

■ Procalcitonin (PCT), a bacterial infection marker, is a useful guide for the management of lower respiratory tract infections. Some studies have shown that integrating PCT into a decision-making algorithm to guide therapeutic strategy enables not only early implementation of suitable treatment but also optimization of treatment duration.^(12, 26)

FOR INPATIENTS

• In severe respiratory infections or in specific circumstances, microbiological tests are essential. Similarly, for nosocomial infections, the antibiotic resistance profile must be determined due to the frequency of multi-resistant bacteria.

• Antibiotic treatment is generally empirical, taking into account the **epidemiology** of the healthcare establishment, and often depends on broad-spectrum antibiotic therapy, while awaiting the results of bacterial identification and antibiotic susceptibility tests.



MICROBIOLOGICAL TESTS

NON-INVASIVE TESTS

Sputum Gram stain and culture:

Particular care is needed both when undertaking this examination (sputum difficult to obtain) and when interpreting results (multi-organism flora, oropharyngeal contamination, compliance with validity criteria for the test).

• **Gram stain** provides a quick pointer for treatment (e.g. Gram positive diplococci suggest the presence of *pneumococci*).

• **Culture:**

- **Interpreting the test:** infection if $>10^7$ bacteria per ml, only considering respiratory pathogens.

- **Determining the antibiotic resistance profile** of isolated and identified bacteria particularly enables detection of:

- reduced susceptibility of *S. pneumoniae* to β -lactams,

- the presence of β -lactamases for *Haemophilus* or *Moraxella*,

- multi-drug resistance, for hospital microorganisms.

These are determining factors for the choice of antibiotic treatment or for adapting the initial empirical therapy.

Monitoring bacterial resistance within a healthcare establishment provides information on the specific epidemiology of the site and enables empirical antibiotic treatment protocols to be adapted appropriately.

INVASIVE TESTS

Invasive diagnostic techniques enable a better quality of sample to be obtained, as contamination by oropharyngeal flora is limited.

They are recommended in cases of pneumonia in ventilated or immunocompromised patients.

Each technique enables Gram staining of the specimen:

- **Bronchoscopy with a protected brush catheter**

Threshold: 10^3 CFU/ml

- **Broncho-alveolar lavage:**

allows detection of bacteria such as *Legionella* and *Mycoplasma*, and also of viruses (CMV, *Herpes*, etc.), parasites (*Pneumocystis carinii*) or fungi and yeasts (*Aspergillus*, *Candida*, etc.).

Threshold: 10^4 CFU/ml

- **Endotracheal aspiration:**

aspiration via the endotracheal tube is less invasive than the previous methods but the risk of contamination by ENT flora is greater.

Threshold: 10^5 CFU/ml



WHICH MICROBIOLOGICAL TESTS SHOULD BE PERFORMED AND WHEN?

- Out-patients: not indicated
- Hospitalized patients: blood cultures and bacteriological examination of the sputum, *Legionella* antigens if indicated.
- Therapeutic failure at 48 hrs: blood cultures and bacteriological examinations are repeated and possibly pneumococcal antigens.
- Patients in I.C.U.*, nosocomial pneumonia or immunocompromised patients: extensive testing is indicated to document the case as well as possible.

OTHER LABORATORY TESTS

- **Blood cultures:** high specificity for certain microorganisms, low sensitivity (10 to 15%, up to 27% in I.C.U.*).
- **Serological testing** of intracellular microorganisms (*M. pneumoniae*, *C. pneumoniae*, *L. pneumophila*) is essentially of epidemiological interest because of delayed results.
- **Rapid tests** for detecting viruses: influenza, RSV, adenovirus, etc. Rapid and easy to use, they are valuable tools providing pointers in emergency departments (decisions concerning admission or isolation, etc.).

The urinary pneumococcal antigen test:

- In adults, its sensitivity is around 80% in cases of bacteremic pneumonia, but only around 50% in non-bacteremic cases. It has a high positive predictive value. This test provides a rapid diagnosis, which is not rendered negative by a 7-day antibiotic treatment and the presence of antigen persists for several weeks⁽¹⁾.
- In children, its interpretation is more difficult, due to the frequency of pneumococcal infections/carriers at this age and the period of antigenuria. It does however have a good negative predictive value.

Testing for **urinary *Legionella* antigens** provides a rapid response (less than 1 hour) with specificity > 95%.

NEW DIAGNOSTIC TECHNIQUES

- **Molecular testing:** Initially limited to specific hospital laboratories or reference laboratories, molecular testing is becoming more generalized due to the use of more user-friendly technology. Based on PCR** or NASBA*** type amplification techniques and on real-time detection, these tests increase detection sensitivity (e.g. when compared with rapid tests) and reduce time-to-result to 3 or 4 hours (compared with more than 2 days with culture-based techniques). They are used for detecting "atypical" microorganisms (*M. pneumoniae*, *C. pneumoniae*, *L. pneumophila*), RSV, hMPV, *Bordetella pertussis*, influenza and other viruses, as well as emerging pathogens: SARS, avian influenza, etc.⁽¹⁴⁾

Molecular techniques reduce the time-to-result to a few hours while providing excellent sensitivity and specificity.

* I.C.U.: Intensive Care Unit

** PCR: Polymerase Chain Reaction

*** NASBA: Nucleic Acid Sequence-Based Amplification

BIOMERIEUX'S PRODUCT RANGE

MICROBIOLOGY TESTS

- Automated systems for identification/antibiotic susceptibility testing (ID/AST) reduce time-to-result to a few hours. On-board expert software interprets the resistance profile of the isolated bacteria. The VITEK® 2 Pneumo card enables ID/AST of *pneumococcus* within 6 to 8 hours.



Culture media: conventional or more specific (such as **Haemophilus Chocolate 2 for Haemophilus**, GVPC for *Legionella*, BCSA for *B. cepacia*, Lowenstein Jensen and Coletsos for Mycobacteria)

Automated identification and antibiotic susceptibility testing:

VITEK® 2 and VITEK® 2 Compact

Automated blood culture: **BacT/ALERT® range**

Epidemiological monitoring and alert software: **VIGI@ct®**

Clinical intervention (antibiotic guidance) software: **STELLARA® ***

Automated detection of Mycobacteria: BacT/ALERT® 3D

RAPID TESTS

Slidex pneumoKit, RSV Direct IF

MOLECULAR TESTS

- NucliSENS® tests use real-time N.A.S.B.A.® amplification technology, as well as BOOM® nucleic acid extraction technology.



NucliSENS EasyQ® RSV A+B

NucliSENS EasyQ® hMPV *

NucliSENS EasyQ® Influenza H5&N1 **

NucliSENS EasyQ® SARS **

NucliSENS EasyQ® Mycoplasma pneumoniae

NucliSENS EasyQ® Chlamydia pneumoniae

Tests under development:

Legionella, Influenza A/B

OTHER TESTS FOR DIFFERENTIAL DIAGNOSIS



Exclusion of Deep Vein Thrombosis/Pulmonary Embolism:

VIDAS® D-Dimer Exclusion™ (4)

Acute Coronary Syndrome: **VIDAS® Troponin I Ultra (25)**

Acute Congestive Heart Failure: **VIDAS® NT/pro-BNP *** (5)**

Bacterial infection marker/Procalcitonin:

VIDAS® B.R.A.H.M.S PCT (12,26)

* US market only

** Research use only

*** Under development

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