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Guidelines

Update of guidelines for management of community acquired pneumonia in adults by the French infectious disease society (SPILF) and the French-speaking society of respiratory diseases (SPLF). Endorsed by the French intensive care society (SRLF), the French microbiology society (SFM), the French radiology society (SFR) and the French emergency society (SFMU)

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1. Introduction

The objective of the present updating of the 2010 guidelines is to define the new modalities of initial management of community-acquired pneumonia (CAP) of presumably bacterial origin in outpatient and hospital-based care of adult patients. While this text is also applicable to cases of severe pneumonia, the authors do not propose specific recommendations for critical care management (Table 1). In this framework, the respective roles of antibiotic therapy and corticosteroid therapy are likewise considered, the reasons being that these treatments must be started as early as possible (in emergency units) and that some patients with severe CAP are not managed in critical care.

While the present recommendations deal with presumably bacterial CAP, they include neither respiratory infections with viral etiology (flu, SARS-CoV-2, respiratory syncytial virus…) without signs of bacterial superinfection, nor cases of aspiration pneumonia. Lastly, patients with bronchiectasis, related or not to cystic fibrosis, are excluded from these guidelines, and CAP prevention is not taken into consideration.

From the outset, CAP management necessitates assessment of the patient's clinical situation (past medical history, field, risk factors) and disease severity, the objective being to propose appropriate care (Tables 1 to 3).

The decision algorithm designed to identify place of intervention and severity scores have not been reconsidered; the 2010 guidelines remain as references [1].

In this text, recommendations are classified as grade A, B or C, according to the level of scientific evidence established in the recent literature (Table 4).

2. Antibiotic therapy and adjuvant treatment

2.1. Probabilistic choice of first-line antibiotic therapy (other than dual therapy and anti-Pseudomonas aeruginosa beta-lactam)

2.1.1. The data from the literature since 2010

2.1.1.1. Amoxicillin versus amoxicillin-clavulanic acid versus ceftriaxone. Two retrospective studies found no significant difference concerning the evolution of CAP patients with comorbidities hospitalized outside critical care, and treated by ceftriaxone *versus* ampicillin [2], or ceftriaxone *versus* amoxicillin-clavulanic acid [3]. A retrospective study noted that probabilistic utilization of ceftriaxone as treatment for CAP is inappropriate in nearly 96 % of lower respiratory tract infections [4]. Amoxicillin remains the reference beta-lactam in cases of non-severe CAP in outpatient or hospital-based settings for patients without comorbidities.

2.1.1.2. Macrolides versus doxycycline versus fluoroquinolone for atypical bacteria. Mycoplasma pneumoniae is frequent in young adults [5–7]. While macrolides are widely recognized as standard treatment [8,9], macrolide resistance in different countries is highly variable and has been spreading [10]. Fluoroquinolones and doxycycline remain active [8,11].

Treatment of *Chlamydophila pneumoniae* is based on macrolides, doxycycline and fluoroquinolones [9,12–14]. Except in the event of high antimicrobial resistance rates, macrolides remain the antibiotics of reference. There is no difference of *in vitro* activity between cyclins and fluoroquinolones.

2.1.1.3. Macrolides versus fluoroquinolones for Legionella pneumophila. *Legionella pneumophila* pneumonia has been considered in only a few

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Table 1
Definition of severe pneumonia If one major criterium or at least three minor criteria (according to ATS/IDSA) [86–90,131].

Major criteria	Septic shock
	Respiratory distress necessitating mechanical ventilation
Minor criteria	Respiratory rate ≥ 30 cycles/min
	$PaO_2/FIO_2 \leq 250$*
	Multilobar infiltrates (*i.e.*, ≥ 2)
	Confusion/disorientation
	Plasma urea ≥ 3.3 mmol/L
	Leukopenia (leukocytes < 4000/mm^3)†
	Thrombocytopenia (platelets < 100,000/mm^3)
	Hypothermia (body temperature < 36 °C)
	Hypotension necessitating volume expansion

* (FiO_2 estimated by the formula: $FiO_2 = 0.21 + 0.03$ x O_2 flow (L/min) [132].
† Due to infection alone (*i.e.*, not cancer chemotherapy).

Table 2
Elements leading to suspicion of community-acquired pneumonia (CAP) with atypical bacteria (low sensitivity and specificity) [133–135].

	***Mycoplasma pneumoniae* CAP**	**Legionellosis**
Context	Epidemics (familial, institution) No response after 48 h-72 h of well-conducted beta-lactam treatment	– At-risk situations (travel, exposure to water aerosols…) – No response after 48 h-72 h of well-conducted beta-lactam treatment
Field	Young > aged	Comorbidities, immunodepression
Clinical	– Progressive: persistent feverish cough, upper respiratory tract signs – Extra-respiratory signs: cutaneous-mucosal, digestive, neurological (headache), myalgia, arthralgia	– Rapidly progressive (2 to 3 days) – Extra-respiratory signs: digestive (abdominal pain, diarrhea, vomiting), neurological (impaired consciousness, headache), myalgia, dissociated pulse (Faget sign)
Biological	Hemolytic anemia, renal failure	Renal failure, hyponatremia, cytolysis, rhabdomyolyses
Radiological	– Unsystematized infiltrates in both lungs – Interstitial syndrome micronodular centrilobular – bronchiolitis ± alveolar infiltrates	Unilateral or bilateral alveolar opacities

recent publications. The results of studies and meta-analyses concerning the superiority of fluoroquinolones *versus* macrolides are discordant [15–19]. However, a large-scale retrospective study in intensive care settings suggests the potential benefits of fluoroquinolones [18].

2.1.1.4. Pristinamycin. Pristinamycin acts on the bacteria responsible for CAP, with interesting *in vitro* activity, particularly against pneumococci and atypical bacteria, with some favorable clinical outcomes [20,21]. No new results have been published since 2010.

2.1.1.5. Suspected bacterial co-infection in a context of viral respiratory tract infection. Viral respiratory tract infection can favor bacterial co/superinfection [22–24]. The bacteria identified in influenza pneumonia (*Streptococcus pneumoniae*, *Staphylococcus aureus*, *Haemophilus influenzae*, *Streptococcus pyogenes*) lead to recommendations of antibiotic therapy with the amoxicillin-clavulanic acid association. In cases of beta-lactam allergy, fluoroquinolone with anti-pneumococcal activity may be prescribed.

Table 4
Recommendation rating scale.

Recommendation grades	**Level of scientific evidence in the literature**
A Established scientific evidence	Level 1 – High-powered randomized comparative trials – Meta-analysis of randomized comparative trials – Analysis of decisions based on well-conducted studies
B Scientific presumption	Level 2 – Low-powered randomized comparative trials – Non-randomized, well-conducted comparative studies – Cohort studies
C Low level of scientific evidence	Level 3 – Case-control studies Level 4 – Comparative studies with major biases – Retrospective studies – Case series – Descriptive epidemiological studies (transversal, longitudinal)

Strength of recommendations:
1 = the experts strongly support;
2 = the experts moderately support;
3 = the experts weakly support.

Table 3
List of comorbidities to be considered when choosing probabilistic antibiotic therapy for CAP.

Comorbidities modifying the choice of probabilistic antibiotic therapy for CAP
Hospitalization during the preceding three months
Antibiotic therapy during the preceding month*
Chronic alcoholism
Swallowing difficulties
Severe neurological disease with risk of swallowing "the wrong way"**
Active neoplasia
Immunodepression***
Severe COPD (FEV1 < 50 %) or chronic respiratory failure (LTOT or NIV)
Congestive heart failure
Hepatic failure
Chronic renal failure (GFR < 30 mL/min)

* except nitrofurantoin, oral fosfomycin, pivmecillinam.
**(CVA, Parkinson, Dementia, MS, etc.).
***(systemic corticosteroids ≥ 10 mg/d, other immunosuppressant treatments, asplenia, agranulocytosis, HIV infection with lymphocyte count T CD4 ≤ 200/mm^3, primary immunodeficiency, etc.).
NB 1: Presence of one of the above-mentioned comorbidities suffices to modify the choice of amoxicillin as probabilistic antibiotic therapy for a CAP.
NB 2: In and of itself, asthma is not a comorbidity justifying antibiotic therapy different from first-line amoxicillin. That said, it is important when choosing a treatment to consider other parameters, such as recent antibiotic prescription.
NB 3: Age without comorbidity is not a criterium to take into account.

2.1.2. The 2025 guidelines

2.1.2.1. The ambulatory patient (Table 5).

- First-line probabilistic antibiotic therapy:
  1. Patient without comorbidities: amoxicillin (**Grade B-1**); in case of allergy: pristinamycin (**Grade B-3**)
  2. Patient with at least one comorbidity (Table 3): amoxicillin-clavulanic acid (**Grade B-1**); in case of non-severe allergy: parenteral 3GC (3rd generation cephalosporine) (**Grade B-1**); only in the event of allergy contraindicating the use of beta-lactam: levofloxacin (**Grade B-1**)

- In case of suspected bacterial co/superinfection of an influenza virus infection: probabilistic first-line antibiotic therapy covering *Staphylococcus aureus* and *Streptococcus pneumoniae*: amoxicillin-clavulanic acid (**Grade C-1**); in case of allergy: pristinamycin (**Grade C-1**)

- In case of suspected atypical bacterial pneumonia: first-line macrolide therapy, pristinamycin or doxycycline as alternatives (**Grade C-1**).

- In case of failed first-line beta-lactam antibiotic therapy, at H72 reevaluation: macrolide therapy relay (**Grade C-1**).

- In case of failed macrolide antibiotic therapy, at H72 reevaluation: beta-lactam (amoxicillin or amoxicillin-clavulanic acid or parenteral 3GC depending on comorbidities) relay (**Grade C-1**).

Remark: Given their poor bioavailability and ecological impact (selection of resistant strains), oral cephalosporins have no role to play in CAP treatment.

2.1.2.2. The patient hospitalized with non-severe CAP (Table 6).

- Probabilistic first-line antibiotic therapy:
  1. Patient without comorbidities: parenteral or oral amoxicillin *per os* (**Grade A-1**); in the event of penicillin allergy: parenteral 3GC (**Grade B-1**).
  2. Patient with comorbidities (*cf.* Table 3) (without risk factor for *Pseudomonas aeruginosa* infection, *cf.* corresponding chapter): either oral or parenteral amoxicillin-clavulanic acid, or parenteral 3GC (**Grade B-1**)

- In case of suspected bacterial co/superinfection of influenza virus infection: probabilistic first-line antibiotic therapy covering *Staphylococcus aureus* and *Streptococcus pneumoniae*: amoxicillin-clavulanic acid (**Grade C-1**)

- Suspicion of atypical bacterial pneumonia: macrolides (**Grade C-1**) (Table 7)

- In case of failed beta-lactam antibiotic therapy at H72 reevaluation, full work-up is recommended, with search for complication and/or bacteria resistant to first-line antibiotic therapy. Following which, several options are possible:
  1. Pleural drainage in case of effusion;
  2. Extended spectrum beta-lactam according to context and microbiological results;
  3. Macrolide relay in case of strongly suspected atypical bacteria (**Grade C-1**).

- Pristinamycin has no role in hospitalized patients (**Grade C-1**).

- As an alternative, only in case of allergy contraindicating the use of beta-lactam: levofloxacin (**Grade B-1**).

2.1.2.3. Hospitalized patients with severe CAP (Tables 8 and 9).

- First-line probabilistic antibiotic therapy (in the absence of risk factor for *Pseudomonas aeruginosa* infection, *cf.* corresponding chapter): parenteral 3GC associated with a macrolide or, in case of allergy to one of the two drug classes: monotherapy by anti-pneumococcal fluoroquinolone (levofloxacin) (**Grade B-1**).

- Probabilistic antibiotic therapy for suspected or confirmed CAP caused by *Staphylococcus aureus* producing Panton-Valentine leukocidin (PVL) requires the use of a molecule with antitoxin activity (Table 9) (**Grade B-1**).

Table 10 details the usual dosages of the molecules recommended during CAP treatment.

2.2. Duration of antibiotic CAP treatment

2.2.1. The data from the literature

In the literature, three meta-analyses have compared long (> 7 days) and short (3–7 days) antibiotic treatments and found no difference in terms of efficacy [25–27].

In addition, two randomized double-blind trials have evaluated 3-day *versus* 8-day beta-lactam CAP treatment [28,29].

The first trial compared the efficacy of 3-day *versus* 8-day amoxicillin treatment of patients admitted to hospital for moderately severe pneumonia and who improved (apyrexia, decreased respiratory signs) following the first three days of treatment [28]; the short treatment was found to be non-inferior. The population was composed of persons with

Table 5
Probabilistic antibiotic therapy for CAP in ambulatory adults.

	1er choix	Alternative
Without comorbidities	Amoxicillin	Pristinamycin
With at least one comorbidity*	Amoxicillin-clavulanic acid	Parenteral 3GC
Suspicion of co/superinfection of a viral bacterial infection (flu)	Amoxicillin-clavulanic acid	Parenteral 3GC Or pristinamycin
Clinical picture suggesting infection or highlighting atypical bacteria	Macrolide	Pristinamycin or doxycycline
Reevaluation at 72 h		

*cf. Table 3.
Levofloxacin: only if severe allergy to beta-lactamases and no other therapeutic possibility.
3GC: Third generation cephalosporin

Table 6
Probabilistic antibiotic therapy for non-severe CAP in hospitalized adults.

	1st choice	Alternative
Without comorbidities	Amoxicillin	Parenteral 3GC
With comorbidities	Amoxicillin-clavulanic acid	
Suspected bacterial co/superinfection of a viral infection (influenza)	Amoxicillin-clavulanic acid	
Clinical picture suggestive of atypical bacterial infection	Macrolide	Levofloxacin
Reevaluation at 72 h		

Reevaluation at 72 h and de-escalation according to clinical evolution and microbiological examinations.
Levofloxacin: only if severe beta-lactam allergy, or contraindication to macrolides in case of suspected atypical bacteria.

Table 7
Probabilistic and directed antibiotic therapy for CAP in cases of suspected or diagnosed atypical bacteria in adults.

Antibiotic therapy in cases of atypical bacteria		
	Molecule (s)	**Allergy / alternative**
Legionellosis	Macrolide	If severe form or contraindication to macrolides: levofloxacin
Mycoplasma pneumoniae	Macrolide	Cyclin If contraindication to macrolides and cyclins: levofloxacin
Chlamydophila pneumoniae	Macrolide	Cyclin If contraindication to macrolides and cyclins: levofloxacin

Macrolides: azithromycin, clarithromycin, roxithromycin, spiramycin

Table 8
Probabilistic antibiotic therapy for severe cases of CAP in hospitalized adults.

	Molecule(s)	**Allergy / alternative**
Initial	Parenteral C3G + Macrolide	Levofloxacin (only if allergy contraindicating the use of beta-lactam)
De-escalation	As early as possible according to clinical evolution and microbiological documentation	

Table 9
Probabilistic and directed antibiotic therapy for suspected* or confirmed severe CAP with *Staphylococcus aureus* producing Panton-Valentine leukocidin (PVL) toxin in adults.

Empirical and directed antibiotic therapy for suspected* or confirmed severe necrotizing CAP with *Staphylococcus aureus* producing PVL toxin		
	Molecule(s)	**Allergy / alternative**
Initial (probabilistic)	Parenteral 3GC (cefotaxime or ceftriaxone) + Macrolide + Linezolid	Parenteral 3GC (cefotaxime or ceftriaxone) + Vancomycin + Clindamycin** In case of beta-lactamase allergy: Levofloxacin + linezolid
De-escalation during documentation		
MSSA PVL+	Penicillin M (IV) or cefazoline + Clindamycin or rifampicin	1) Vancomycin + clindamycin or rifampicin or 2) Linezolid
MRSA PVL+	Linezolid	Vancomycin + clindamycin or rifampicin

* Post-influenza context, severity, suggestive presentation: hemoptysis, leukopenia, cutaneous rash and necrotizing pneumonia (multiple nodules, excavated images).
** Clindamycin acts on most atypical bacteria, but not on all strains of legionella.

a mean age of 55 years, and few comorbidities [28].

The second trial involved older (mean age: 73 years), comorbid and more severely ill patients meeting stability criteria at D3 (Table 11). It compared 3 days of beta-lactam (parenteral 3GC or amoxicillin-clavulanic acid) *versus* 8 days. The trial demonstrated the non-inferiority of the 3-day treatment [29].

2.2.2. The 2025 guidelines

- In non-severe (outpatient) and moderately severe (hospitalization outside critical care) cases of CAP, if all clinical stability criteria are met on D3, a three-day antibiotic regimen is recommended (**Grade A-1**).[1]
- If clinical stability criteria are met between three and five days of treatment, a 5-day antibiotic regimen is recommended (**Grade B-1**).
- In the other cases of uncomplicated CAP, a 7-day antibiotic regimen is recommended (**Grade A-1**).
- Duration of treatment exceeding 7 days must be justified by a complication (lung abscess, significant pleural fluid effusion…).

2.3. Indications for antibiotic combinations

2.3.1. The data from the literature

Four meta-analyses of observational and randomized studies have reported discordant results on the prognostic impact of initial dual antibiotic therapy (beta-lactam and macrolide) for hospitalized CAP patients [30–33]. The beneficial effects of this strategy seem limited to severe cases.

Table 10
Antibiotic dosage during CAP (without renal failure).

Antibiotics	**Not in critical care**	**In critical care**
Amoxicillin	1 g × 3/d	2 g × 3/d
Pristinamycin	1 g × 3/d	No
Amoxicillin-clavulanic acid	1 g × 3/d	1 or 2 g × 3/d
Cefotaxime	1 g × 3/d	80–100 mg/kg/d
Ceftriaxone	1 g × 1/d	2 g × 1/d
Levofloxacin	500 mg/d	500 mg à 1000 mg/d
Azithromycin	500 mg/d (D1), then 250 mg/d	500 mg/d (D1), then 250 mg/d
Clarithromycin	500 mg × 2/d	500 mg × 2/d
Spiramycin	1.5 MUI to 3 MUI × 3/d	3 MUI × 3/d
Doxycycline	100 mg × 2/d	100 mg × 2/d
Cefazoline	80–100 mg/kg/d	80–100 mg/kg/d*
Penicillin M	80 to 100 mg/kg/d	100 mg/kg/d*
Linezolid	600 mg × 2/d	600 mg × 2/d

*in three daily infusions or continuous infusion after a loading dose of 30 mg/kg in one hour.

Table 11
Clinical stability criteria during CAP [136].

Clinical stability criteria	**Levels**
Temperature	≤37.8 °C
Systolic blood pressure	≥ 90 mmHg
Heart rate	≤100/min
Respiratory rate	≤24/min
SpO_2 or PaO_2	≥90 % in room air ≥60 mmHg in room air

We have found no recent study conclusively demonstrating the benefits of dual antibiotic therapy other than probabilistic treatment of CAP with bacteriological documentation, particularly in cases of *Legionella pneumophila* [18,19,34]; that much said, a single retrospective study pointed to the benefits of adding an antibiotic with anti-toxin

[1] No data concerning immunosuppressed patients or patients with severe chronic respiratory, hepatic or renal insufficiency.

effects (clindamycin or rifampicin) in cases of community-acquired necrotizing pneumonia due to methicillin-sensitive *Staphylococcus aureus* (MSSA) producing Panton Valentine leukocidin (PVL) and treated with anti-staphylococcal beta-lactam [35].

2.3.2. The 2025 guidelines

- **In non-severe CAP cases**, a probabilistic combination therapy associating beta-lactam and macrolide or fluoroquinolone is not recommended; monotherapy with a macrolide in case of suspected atypical bacteria, particularly *L. pneumophila*, is to be preferred (**Grade A-1**).
- **In severe CAP cases necessitating hospitalization**, probabilistic combination therapy associating beta-lactam (3GC) and macrolide is recommended. De-escalation to monotherapy by beta-lactam should immediately be considered in the absence of any clinical or biological argument suggesting atypical bacterial CAP (**Grade B-1**).
- In CAP with bacteriological documentation (including *L. pneumophila*), dual therapy is not recommended, with the exception of severe CAP involving PVL-producing strains, for which combination therapy associating an anti-staphylococcus beta-lactam and an antibiotic with antitoxin effects (clindamycin, rifampicin) can be considered (**Grade B-1**). In the event of severe cases of CAP due to methicillin-resistant, PLV-producing *Staphylococcus aureus*, monotherapy with linezolid is recommended.

2.4. Indications for anti-Pseudomonas aeruginosa beta-lactam

2.4.1. The data from the literature

A bibliographic search did not identify any study specifically evaluating the relationship between preliminary antibiotic therapy and risk of *P. aeruginosa* CAP. However, recent antibiotic therapy (according to the different studies, in the one or three months preceding pneumonia onset) was found to be an independent risk factor for CAP due to multidrug-resistant bacteria (MDR) or to potentially antibiotic-resistant bacteria, including *P. aeruginosa* [36–39].

Moreover, recent antibiotic therapy is associated with a heightened risk of infection from resistant or multidrug-resistant strains in patients with a lower respiratory tract infection involving *P. aeruginosa*, particularly those with severe COPD (chronic obstructive pulmonary disease) [40–43]. Hospitalization during the 60 to 90 days preceding CAP [38,44], admission to critical care [45,46], immunodepression [47] and chronic hemodialysis [48,49] have been associated with heightened risk of *P. aeruginosa* CAP; however, after adjustment, this risk seems limited to other predisposing factors (exposure to antibiotics and history of *P. aeruginosa* infection during hospitalization…).

Delayed initiation of adequate antibiotic therapy is associated with an unfavorable prognosis in severe infections [50–53], including *P. aeruginosa* CAP [54,55].

2.4.2. The 2025 guidelines

- Probabilistic antibiotic therapy including an anti-*Pseudomonas* beta-lactam is recommended for hospitalized patients with **severe or non-severe CAP** and presenting with a history of colonization or recent respiratory infection (< 1 year) by this pathogen (**Grade B-1**).
- Probabilistic antibiotic therapy including an anti-*Pseudomonas* beta-lactam is recommended for hospitalized patients with **severe CAP admitted to critical care** and presenting with at least one of the following risk factors: recent parenteral antibiotic therapy (<3 months), severe COPD, bronchiectasis, tracheotomy (**Grade B-1**).
- It is recommended, in the absence of previously documented colonization with available antibiogram, to use cefepime or the piperacillin-tazobactam combination as first-line treatment. Aztreonam and ceftazidime exercise no intrinsic activity on the Gram-positive pathogens (*Streptococcus pneumoniae*…) responsible for CAP and must not be utilized as probabilistic antibiotic therapy for a patient with CAP (**Expert opinion**).
- In case of preliminarily documented colonization, it is recommended to take into account the most recent available antibiogram when choosing the beta-lactam to be utilized in the probabilistic treatment (**Grade C-1**).
- It is strongly recommended to conduct bacteriological documentation tests in case of probabilistic prescription of a beta-lactam acting on *P. aeruginosa*, the objective being to facilitate reevaluation of the antibiotic therapy and de-escalation when this bacterium is not isolated (**Expert opinion**).
- Probabilistic antibiotic therapy for severe CAP in a patient at risk of *P. aeruginosa* must also include a molecule acting on atypical bacteria (**Grade B-1**).

2.5. Indications for corticosteroids

2.5.1. The data from the literature

Two recent randomized trials on patients in critical care have recently been published.

The ESCAPe study tested the interest of delayed introduction (a median of 40 h after hospital admission) of 40 mg/d by continuous infusion of methylprednisolone, with progressive de-escalation over the following 21 days in a critical care population receiving invasive mechanical ventilation in 33 % of cases. Due to insufficient recruitment, the trial was prematurely discontinued before having reached its inclusion objective and without any benefit on mortality [56].

The CAPE-CODE trial evaluated the interest of early treatment consisting in 200 mg per day of hydrocortisone hemisuccinate (a median of 20 h after hospital admission) for severe CAP patients not in septic shock hospitalized in critical care (mechanical ventilation 44 %, high-flow nasal cannula oxygen therapy 41 %); those with myelosuppression, influenza or post-obstructive pneumonia were excluded. Following an initial period of full-dose treatment (four to seven days, according to clinical evolution), dosage decreased, with total treatment duration of 8 to 14 days. The trial was discontinued at an early stage (during the second interim analysis) due to a nearly 50 % reduction of mortality in the hydrocortisone arm, and to lessened intubation and vasopressor use [57].

2.5.2. The 2025 guidelines

- **In non-severe (outpatient or hospitalized) CAP**, the addition of corticosteroids is not recommended (**Grade A-2**).
- **In severe (hospitalized in critical care) CAP**, the addition of hydrocortisone hemisuccinate started during the first 24 h following the onset of severity signs is recommended, except in cases of myelosuppression, aspiration pneumonia, or influenza etiology. The initial dose is 200 mg per day, with reevaluation on the 4th day to determine dose tapering and a total duration ranging from 8 to 14 days (**Grade A-1**).

3. Biology

3.1. Biomarkers – C-reactive Protein (CRP)

3.1.1. Data from the recent literature

Several studies have assessed the interest of CRP dosing in pneumonia diagnosis and in differentiating the viral and bacterial etiologies of CAP [58–62].

Sensitivity and specificity of CRP levels in pneumonia diagnosis range from 40 to 90 % and vary considerably according to threshold [58–62]. No consensual threshold has been validated for positive CAP diagnosis or etiological diagnosis (bacterial *versus* viral).

From a prognostic standpoint, a high CRP level seems associated with a more severe prognosis [63–67]. That said, no study has

conclusively proven that CRP dosage and/or follow-up leads to improved patient management and evolution.

During (outpatient or hospitalized) CAP cases, isolated use of CRP enables neither CAP diagnosis nor reliable differentiation of bacterial from viral infection. Lastly, no study has assessed the impact of CRP dosage on patient evolution and/or management.

3.1.2. The 2025 guidelines

In CAP patients (outpatient or hospitalized), CRP dosage is not systematically recommended for PAC diagnosis and/or follow-up (**Grade C-1**).

3.2. Biomarkers –Procalcitonin (PCT)

3.2.1. Data from the recent literature

Several trials and meta-analyses have demonstrated the interest of PCT dosing as a means of shortening the duration of antibiotic treatment of respiratory infections necessitating hospitalization, but this shortening never went below the recommended durations [68–70].

A blinded randomized trial showed no impact of PCT dosing on the reduction of antibiotic therapy duration for hospitalized lower respiratory tract infections, compared to high-quality care and/or care in accordance with recommendations based solely on clinical evaluation. [71].

In ambulatory medicine, a few studies (including a randomized trial) have shown that in suspected bacterial CAP/respiratory infections, PCT could help to reduce the number of antibiotic prescriptions [72]. However, uncertain accessibility and non-registration in the nomenclature of medical biology actions complicates its utilization in clinical practice.

3.2.2. The 2025 guidelines

During cases of CAP necessitating outpatient or hospital-based care, systematic PCT dosing is not recommended for CAP diagnosis and/or follow-up (**Grade C-1**).

3.3. Indications for urinary antigen testing

3.3.1. The data from the literature

The recent literature confirms:

- The low positivity rate of pneumococcal urinary antigen testing (4.2 %) associated with clinicians' disinclination to de-escalate antibiotic therapy following positive results limits the impact of this test on responsible use of antibiotics [73,74];
- While the positivity rate of urinary antigen testing for *Legionella* is low (1.6 %), positive results can nevertheless improve management of patients not admitted to critical care and in some cases not receiving probabilistic treatment for *Legionella* [74,75];
- Even though they are non-specific, criteria frequently associated with *Legionella* [74,75] help to target the patients most at risk and to enhance the profitability of urinary antigen testing.

3.3.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**, it is not recommended to carry out *Legionella* or pneumococcal urinary antigen testing (**Grade C-2**).
- **In cases of hospitalization for non-severe** CAP, it is not recommended to carry out pneumococcal urinary antigen testing (**Grade B-2**). It is not recommended to carry out *Legionella* urinary antigen testing, except in the event of compelling arguments (*cf.* Table 2) (**Grade B-2**).
- **In cases of hospitalization for severe CAP**, it is recommended to carry out pneumococcal and *Legionella* urinary antigen testing[2] (**Grade B-1**).

3.4. Cytobacteriological examination of sputum (CBES) and other microbiological respiratory tract samples – Gram staining and culture

3.4.1. The data from the literature

The arguments in favor of trying to determine CAP etiology are the following: 1) A resistant pathogenic agent can be identified; 2) The antibiotherapy spectrum can be narrowed; 3) The detection of some pathogenic agents, one example being *Legionella,* has implications for public health; 4) Antibiotherapy can be adjusted when patients fail to respond to initial treatment; and 5) Constantly changing CAP epidemiology necessitates continuous evaluation.

There is a lack of high-level evidence demonstrating that CBES improves patients' individual prognosis. Indeed, the studies specifically evaluating the performances of direct testing after Gram staining of sputum and culture [76–79] or in combination with other microbiological tests [80–83] have not shown improved patient prognosis.

3.4.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**, it is not recommended to carry out CBES (**Grade C-2**).
- **In cases of hospitalization for non-severe CAP**, it is recommended to carry out CBES in cases involving mucopurulent secretions (provided that the sputum sample is of good quality, and quickly delivered to a laboratory [84]), particularly in the following situations (**Grade C-2**):
  - Patients probabilistically treated by non-conventional antibiotic therapy (other than amoxicillin, amoxicillin-clavulanic acid, macrolides or parenteral 3GC);
  - Patients preliminarily identified as having MRSA respiratory infection or *Pseudomonas aeruginosa*;
  - Hospitalized patients having received parenteral antibiotic therapy over the preceding three months;
  - In the event of non-response to first-line antibiotic treatment and/or unfavorable evolution (72 h).
- **In cases of hospitalization for severe CAP**, particularly if the patient is intubated or ventilated, it is recommended to conduct direct microscopic examination after Gram staining and development of cultures based on deep respiratory samples (preferably obtained by means of tracheal suction, protected distal sampling and bronchoalveolar lavage) (**Grade C-2**).

3.5. Hemocultures

3.5.1. The data from the literature

In hospitalization due to CAP, the interest of hemocultures is low to moderate, and few data pertaining to high-risk populations are currently available. On the other hand, due to peculiar etiology and difficulties in diagnosis, hemocultures can be of interest for immunosuppressed patients. As regards sepsis and septic shock, the *Surviving Sepsis Campaign* recommends immediate hemoculture and antibiotic therapy prescription [85].

[2] In the event of negative *Legionella* urinary antigen testing and clinical suspicion of severe *Legionella* CAP, it is recommended to carry out PCR (and culture) on lower respiratory tract specimens.

3.5.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**, it is not recommended to carry out hemoculture (**expert opinion**).
- **In cases of hospitalization for non-severe CAP,** it is recommended to carry out hemoculture only in the following situations (**expert opinion**):
  - Diagnostic uncertainty;
  - Immunodepression;
  - In patients probabilistically treated by means of non-conventional antibiotic therapy (other than amoxicillin, amoxicillin-clavulanic acid or parenteral 3GC);
  - In patients with history of MRSA respiratory infection or *Pseudomonas aeruginosa*;
  - In hospitalized patients having received parenteral antibiotic therapy over the preceding three months;
  - In the event of non-response to first-line antibiotic treatment and/or unfavorable evolution at 72 h.
- **In cases of hospitalization for severe CAP**, it is recommended to carry out hemoculture (**Grade B-1**).

3.6. Molecular biology tests

Real-time PCR (Polymerase chain reaction) is the main currently applied technique; it has become the gold standard for the detection of respiratory viruses and atypical bacteria. This method is extremely sensitive and specific and enables acquisition of rapid results (less than one to four hours, depending on working platforms and/or available equipment).

The PCRs utilized differ particularly in terms of the number of sought-after pathogens ("monoplex" = one pathogen, "biplex" = two pathogens…).

In a context characterized by co-circulation of several viruses (influenza A and B, RSV, SARS-CoV-2…), RT-PCR tests searching for a single pathogen are no longer currently recommended. Triplex and quadruplex real-time RT-PCR searches for three or four viruses (influenza A and B, SARS-CoV-2 and RSV), and differs from broad-range or broad-panel PCR ("syndromic") testing.

Available only over the last few years, syndromic panels present an appreciable advantage: Starting with a single sample, it is now possible to amplify several different genomic sequences, thereby highlighting most of the viruses responsible for respiratory pathologies, and simultaneously screening for certain bacterial pathogens (the composition of the panels varies according to the manufacturers).

Different "syndromic panels" exist:

- "High" respiratory panels: Based mainly on nasopharyngeal swab, and also on oropharyngeal swab, saliva sample and expectoration, this type of panel can (according to the different kits) highlight 10 to 15 viruses and a number of atypical bacteria: *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae* ± *Bordetella pertussis* and *parapertussis* ± *Legionella pneumophila*.
- "Low" respiratory panels: Based mainly on lower respiratory tract sampling (bronchial and tracheal aspiration, protected distal sampling, bronchoalveolar lavage) in cases of pneumonia, these panels have also been validated for analysis of expectorations. The main currently available panel can highlight 18 bacteria, 15 of which are "cultivatable" (*S. pneumoniae*, *S. aureus*, *E. coli*, *H. influenzae*, *P. aeruginosa*, *K. oxytoca*…) with semi-quantification (ML estimation of DNA copy number) and the three atypical ones (*M. pneumoniae, C. pneumoniae, L. pneumophila*) with qualitative detection, as well as nine viruses and seven determinants of antibiotic resistance (*mecA*, BLSE type CTX-M ESBL, de types KPC, NDM, VIM, IMP and OXA-48-like carbapenemases).

Due to poor performances with nasopharyngeal samples, syndromic PCR in search for *L. pneumophila* can be considered only with regard to expectoration or other deep respiratory sample [86–90].

3.6.1. The data from the literature

The impact of molecular biology tests on patient management is hard to assess, especially insofar as it depends on the testing site (medical biology laboratory or delocalized care service: emergency ward, medicine department, critical care…), on the type of panel used (simplex or quadruplex RT-PCR, "high" or "low" PCR syndromic panel), and on the sample taking site (nasopharyngeal swab *versus* deep airways).

As concerns care pathways, several studies have pointed to a positive impact of quadruplex RT-PCR and "high" syndromic panels on nasopharyngeal sample following detection of respiratory viruses; waiting periods in emergency wards and duration of hospitalization can be shortened; test results are promptly delivered, and persons with respiratory viruses can be rapidly isolated [91–101].

From a therapeutic standpoint, detection of SARS-CoV-2 or the influenza virus by PCR facilitates the introduction of earlier and more frequent antiviral treatment [102]. Of note, few specific antiviral therapies other than those addressing influenza and SARS-CoV-2 infection are currently carried out, a factor limiting the therapeutic interest of the detection of more diversified respiratory viruses.

That much said, a multicenter randomized trial conducted in an emergency unit for patients presenting with CAP [103] and a meta-analysis [104] have shown that the "high" syndromic PCR panels performed on nasopharyngeal sample have little or no impact on antibiotic consumption. This is probably due to the fact that RT-PCRs are mainly designed to search for viruses, and that the exclusive highlighting of a respiratory virus in a nasopharyngeal sample from a patient with a CAP diagnosis does not necessarily rule out an associated bacterial coinfection or superinfection of the lungs, and therefore does not allow for the cessation of antibiotic treatment. It bears mentioning that in this type of situation, the discontinuation of antibiotic treatment has got to be associated with a set of (clinical, biological, imagery-based) arguments, as well as the PCR result.

However, some "high" syndromic PCR panel conclusions obtained through nasopharyngeal sampling allow detection of *M. pneumoniae* and consequently have a positive impact on the introduction or modification of antibiotic treatment.

Lastly, and notwithstanding the substantial cost of the "high" and "low" syndromic panels, as of now we have no reliable cost-effectiveness data.

3.6.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**: Searching for respiratory viruses and utilization of multiplex PCR (syndromic testing) are not recommended (**Expert opinion**).
- **In cases of hospitalization for non-severe CAP**:
  - It is recommended, taking into account the epidemic context, to carry out quadruplex RT-CPR in search of influenza viruses A / B, RSV, and/or SARS-CoV-2.
  - **"High" syndromic RT-PCR panel** or extended search (depending on the local equipment available) including *M. pneumoniae* through **nasopharyngeal sampling** can be proposed immediately or as a second-line approach if quadruplex RT-PCR yields negative results (**Grade C- 2**):
    1- When a search for atypical bacteria, particularly *M. pneumoniae*, is under consideration (depending on clinical presentation and/or epidemiology), and if specific PCR is not available;
    2- If the highlighting of a virus other than RSV/Influenza A and B/ SARS-CoV-2 can have a pronounced impact on patient management (antibiotic de-escalation or discontinuation, isolation).
- **In cases of hospitalization for severe CAP:**

- It is recommended, taking into account the economic context, to carry out quadruplex RT-CPR in search of influenza viruses A/B, RSV and SARS-CoV-2. (**Grade C- 2**).
- **"High" syndromic RT-PCR panel** or extended search (depending on the local equipment available) including *M. pneumoniae)* through **nasopharyngeal sampling** can be proposed immediately or as a second-line approach if quadruplex RT-PCT yields negative results (**Grade C- 2**):
  1- When a search for atypical bacteria, particularly *M. pneumoniae*, is under consideration (depending on clinical presentation and/or epidemiology), and if specific PCR is not available;
  2- If the highlighting of a virus other than RSV/Influenza A and B/SARS-CoV-2 can have a pronounced impact on patient management (antibiotic de-escalation or discontinuation, isolation).

"Low" syndromic RT-PCR panel through the deep airways (tracheal aspiration, protected distal sample, bronchoalveolar lavage or, by default satisfactory expectoration) can be proposed (**Grade C- 2**):

1- When non-conventional antibiotic therapy, different from the 3GC + Macrolide association, is used in probabilistic treatment;
2- When a search for atypical bacteria, especially *Legionella*,[3] is being considered (according to presentation and epidemiology, and if PCR specific to *Legionella* is not available).

4. Imagery

*4.1. **Thoracic ultrasound** – **Indication to confirm or rule out the CAP** diagnosis*

4.1.1. The data from the literature

All in all, the studies having evaluated the diagnostic performances of clinical thoracic ultrasound in CAP diagnosis report satisfactory performance. For example the meta-analysis by Orso *et al.* [105] reported on the results of 17 prospective studies including 5108 patients admitted to emergency units for suspected CAP (41 % of confirmed cases). Pooled analysis of the results showed AUC at 0.97, sensitivity of 92 % [86–95] and specificity of 93 % [86–97]. Among these 17 studies, 11 presented sensitivity > 90 %, while six presented specificity > 90 %.

A recent review of the literature by Strøm *et al.* [106] evaluated the performances of ultrasound in CAP diagnosis; it was limited to 17 studies (2170 patients) in which the operator was neither a radiologist nor a sonographer. Sensitivity ranged from 68 to 100 % (sensitivity > 91 % for 14/17 studies) and specificity from 57 à 100 % (specificity > 80 % for 9/13 studies). The experience reported by the different operators was pronouncedly variable [107–109]. While these differences had relatively little impact on sensitivity, they reduced specificity in some studies. Lastly, when testing duration was mentioned, it was invariably lower than 10 min.

Contrarily to chest X-ray, thoracic ultrasound is difficult to reinterpret by another practitioner. Inter-operator reproducibility was only rarely assessed.

*4.1.2. **The 2025 guidelines***

In cases of suspected CAP (severe and non-severe) necessitating outpatient or hospital-based care, thoracic ultrasound is a reliable tool for the diagnosis of pneumonia and can be proposed as a first-line method and as an alternative to chest X-ray, provided that the practitioner has received validated preliminary training.

It is particularly indicated for patients suffering from acute respiratory failure, as this condition hinders the acquisition high-quality chest X-ray (**Grade B-2**).

4.2. Thoracic imaging (Chest X-ray or thoracic ultrasound) – Indication to confirm or rule out the CAP diagnosis

4.2.1. The data from the literature

To our knowledge, there is currently no randomized trial comparing a clinical-biological diagnosis strategy to a conventional chest X-ray (CXR) strategy for CAP diagnosis in terms of antibiotic consumption and adverse effects. In the absence of a highly suggestive clinical picture characterized by a unilateral crackling sound, it seems reasonable to confirm the CAP diagnosis by means of thoracic imagery [110].

4.2.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**, chest imaging (high-quality CXR or thoracic ultrasound) is recommended for diagnosis of pneumonia, and should be obtained promptly (< 3 days) (**Grade B-2**).
- In the event of strong presumption in favor of bacterial CAP, its acquisition must not delay the initiation of antibiotic therapy. When the chest imaging interpreted by a trained professional appears normal, the CAP diagnosis and the indication for antibiotic therapy are imperatively to be reconsidered.
- If not initially performed, chest imaging should be obtained in case of unfavorable evolution at 72 h of antibiotic therapy (the indication for follow-up imaging is considered in a dedicated chapter) (**Grade Expert opinion**).
- **In cases of non-severe and severe CAP necessitating hospital-based care**, chest imaging (CXR or thoracic ultrasound, or even CT-scan) is recommended (**Grade B-2**).

4.3. Chest CT-scan – Indications to confirm or rule out the CAP diagnosis

4.3.1. The data from the literature

Several clinical studies have evaluated the diagnostic performances of chest CT-scan, more particularly low-dose scan, in patients with suspected CAP diagnosis.

Regardless of the CXR result, a chest CT-scan helps refine the diagnosis of CAP. In a study including 58 patients admitted to an emergency unit due to suspected CAP and receiving CXR in a recumbent position, systematic chest CT-scan enabled revision of the diagnosis, whatever the (positive or negative) CXR result, and ensured a correct diagnosis, even when CXR had not done so [111]. A recent study demonstrated that chest CT-scan more reliably detects CAP (12 % vs. 6 %) in patients presenting with few if any respiratory signs (*Blinded Trial ancillary study*). Two studies employing similar methodology showed that a chest CT-scan carried out within four hours after admission to an emergency unit or within 72 h after admission to a geriatric ward modified CAP diagnosis based on clinical criteria in 59 % and 45 % of cases respectively. This diagnostic reclassification was congruent with the findings of an adjudication committee having taken into account the elements contributing to a diagnosis at one month [112,113].

Chest CT-scan permits more pertinent diagnostic precision in certain categories of patients; it seems to be of particular interest when a clinician is uncertain about the diagnosis [114]. Bedridden patients with suspected CAP are more often diagnosed using thoracic CT-scan when the parenchymal pathology reaches the lower lobes [111]. Two scores have been proposed to guide the indication for thoracic CT-scan in patients with suspected CAP [115,116]. They include clinical and radiological scores (presence/absence of infiltrate), as well as biological data (CRP, PCR result); given these, more than half of the concerned patients are in a zone of uncertainty and should undergo a CT scan, or even 69 % if the PCR result is not taken into account when calculating the score [115].

[3] If negativity of *Legionella Sg1* antigen testing.

Chest CT-scan modifies medical decisions, particularly regarding antibiotic therapy. Following chest CT-scan, management strategies for orientation and treatment are modified [112], and the most interesting impact is on antibiotic therapy. While antibiotic treatment starts after CXR in 65 % of patients, subsequent to chest CT-scan it is suspended, started or modified in nearly one out of two patients. All in all, the choice of antibiotic after chest CT-scan is more congruent with best practice guidelines [117].

In addition, even when radiologic semiology of the scan is non-specific, it can in some cases orient the etiological diagnosis (particularly in immunosuppressed patients), thereby modifying the choice of probabilistic antibiotic therapy [118–120].

These benefits are counterbalanced by several unresolved questions. The impact of radiation on patient health is a constant source of preoccupation. While low-dose chest CT-scan limits exposure, the latter remains greater than exposure entailed by standard CXR [121]. In fact, there is no evidence of improved vital or functional prognosis for patients; the literature reports no modification regarding mortality, admission to critical care, hospitalization duration [112,122] or quality of life at one month [123] according to whether the CAP diagnosis has been rendered by chest CT-scan or CXR. What is more, there is no evidence of reduced medical resources consumption. That said, data on this aspect remain limited; while quality of care is improved, the literature provides no evidence of lessened resource usage [112] and to conclude, there is no medico-economic assessment convincingly demonstrating that the cost of scanning device would be offset by a reduction of the overall costs of care in CAP cases.

Insofar as scanographic pictures of CAP are markedly diverse, interpretation of chest CT-scan remains highly specific and complex [120].

4.3.2. The 2025 guidelines

- **In cases of CAP necessitating outpatient care**, it is not recommended to utilize chest CT-scan for first-line CAP diagnosis (**Grade C-1**).
- **In cases of hospitalization for (severe and non-severe) CAP**, it is recommended to use low-dose chest CT-scan for patients with diagnostic uncertainty after an initial evaluation based on a combination of clinical signs and the results of either a chest X-ray or thoracic ultrasound (**Grade B-1**).

4.4. Follow-up chest imaging – Indications for systematic imaging

4.4.1. The data from the literature

The interest of follow-up imaging in cases of CAP initially consists in detection of lung cancer having gone unnoticed during the initial CAP diagnosis. In a study involving 232 patients with lung cancer, 15 % of the cancers were revealed on the occasion of an infectious episode [124]. In addition, given the non-resolution of abnormalities on chest X-ray, other significant non-tumoral pathologies such as mycobacterial or fungal infections can be revealed [125].

Several studies with diverse methodology and in heterogeneous populations have dealt with the frequency of lung cancer diagnosis on the occasion or in the aftermath of a CAP episode; the percentage ranges from 0.7 to 9.2 %, depending on populations and follow-up duration [124–130].

To sum up, and in accordance with the existing guidelines, it does not seem necessary to systematically obtain follow-up chest imaging in case of favorable clinical evolution and in the absence of risk factors for lung cancer. Conversely, chest CT-scan seems justified in the event of persistent symptoms and/or risk factors for cancer: age $\geq$ 50 years combined with active smoking or cessation within the past 15 years ($\geq$ 20 pack-years).

4.4.2. The 2025 guidelines

- **In cases of (severe and non-severe) CAP necessitating outpatient or hospital-based care**, it is not recommended to systematically obtain follow-up imaging in the event of favorable clinical evolution and in the absence of risk factor for lung cancer (**Grade C-2**).
- **In cases of (severe and non-severe) CAP necessitating outpatient or hospital-based care**, it is recommended to perform a chest CT-scan in the event of:

- Non-improvement or worsening of respiratory signs at H72 despite well-conducted first-line treatment (**Expert advice**).
- Risk factor for cancer (screening): age $\geq$ 50 years associated with smoking ($\geq$ 20 pack-years, either active or discontinued for fewer than 15 years), following a waiting period of at least two months (**Grade C-2**), and after having informed the patient within a shared decision-making framework.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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