Guidelines for the management of community-acquired pneumonia in the elderly patient

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ABSTRACT

The incidence of community-acquired pneumonia (CAP) increases with age and is associated with an elevated morbimortality due to the physiological changes associated with aging and a greater presence of chronic disease. Taking into account the importance of this disease from an epidemiological and prognostic point of view, and the enormous heterogeneity described in the clinical management of the elderly, we believe a specific consensus document regarding this patient profile is necessary. The purpose of the present work was to perform a review of the evidence related to the risk factors for the etiology, the clinical presentation, the management and the treatment of CAP in elderly patients with the aim of elaborating a series of specific recommendations based on critical analysis of the literature. This document is the fruit of the collaboration of different specialists representing the Spanish Society of Emergency Medicine and Emergency Care (SEMES), the Spanish Society of Geriatrics and Gerontology (SEGG), the Spanish Society of Chemotherapy (SEQ), the Spanish Society of Internal Medicine (SEMI), the Spanish Society of Pneumology and Thoracic Surgery (SEPAR) and the Spanish Society of Home Hospitalization (SEHAD).

Key words: guidelines, community-acquired pneumonia, elderly, diagnosis, treatment

Guía de manejo de la neumonía adquirida en la comunidad en el anciano

RESUMEN

La incidencia de la neumonía adquirida en la comunidad (NAC) se incrementa con la edad y se asocia a una elevada morbimortalidad debido a los cambios fisiológicos asociados al envejecimiento y a una mayor presencia de enfermedades crónicas. Debido a la importancia desde un punto de epidemiológico y pronóstico que tiene, y a la enorme heterogeneidad descrita en el manejo clínico, creemos que existía la necesidad de realizar un documento de consenso específico en este perfil de paciente. El propósito de éste fue realizar una revisión de las evidencias en relación con los factores de riesgo para la etiología, la presentación clínica, el manejo y el tratamiento de la NAC en los ancianos con el fin de elaborar una serie de recomendaciones específicas basadas en el análisis crítico de la literatura. Este documento es fruto de la colaboración de diferentes especialistas en representación de la Sociedad Española de Medicina de Urgencias y Emergencias (SEMES), Sociedad Española de Geriatría y Gerontología (SEGG), Sociedad Española de Quimioterapia (SEQ), Sociedad Española de Medicina Interna (SEMI), Sociedad Española de Neumología y Cirugía Torácica (SEPAR), Sociedad Española de Hospitalización a Domicilio (SEHAD) y Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica (SEIMC).

Palabras clave: guías, neumonía adquirida comunidad, anciano, diagnóstico, tratamiento

INTRODUCTION

The incidence of community-acquired pneumonia (CAP) increases with age, reaching 25 to 35 cases per 1000 inhabitants/year in the population over the age of 65 years. This disease is associated with an elevated morbimortality and is a frequent cause of emergency care and hospital admission[1-3]. The elevated incidence of CAP in the elderly population has been related to a series of physiological changes associated with aging, the respiratory tract (reduction in cough reflex and mucociliary clearance) and the immune system (both innate and adaptative) together with a greater probability of clinical and social situations (edentulism, dysphagia, malnutrition, institutionalization) and chronic disease accumulated with age (diabetes mellitus, chronic obstructive pulmonary disease, chronic heart failure, cancer and chronic renal insufficiency) which make the elderly more vulnerable to the development of infections, and more specifically to pneumonia, as well as to an increased risk of a worse outcome[4-6].

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With regard to the health care of elderly subjects, it is known that it is generally more complex, being associated with delays in the diagnosis and treatment, greater requests for complementary tests, elevated risk of adverse events, more prolonged hospital stay and a higher rate of hospital admission compared to younger adults, thereby translating into a greater consumption of health care resources[7,8].

All of the above make CAP in the elderly a first order health care problem considering the high prevalence and important clinical and health care consequences. Thus, despite the guidelines and consensus documents published in relation to CAP[7,8], the development of a consensus document with more specific approaches to CAP in this patient profile was considered necessary. This document is the fruit of the work of a group of experts representing several medical societies with the aim of establishing a series of specific recommendations related to the etiology, the clinical presentation and management of CAP in the elderly based on the scientific evidence available. The elaboration of this consensus was carried out after requesting the participants to make a systematic search and a selection of good quality studies published and to establish a series of recommendations for daily clinical practice. Nonetheless, the clinical evidence available is limited, and therefore, many of the recommendations presented are based on the experience and the opinion of the experts themselves. Finally, a document was developed after the discussion and approval of all the members of the working group.

CATEGORIZATION OF THE ELDERLY PATIENT

All people 65 years of age or more are considered elderly. This definition is based on purely sociological aspects, originating a clinically very heterogeneous populational group. In this sense, the need to categorize the elderly has arisen and to do this a new concept has been introduced, that is, the frail elderly. This category is understood as a elderly person with greater vulnerability of having an adverse outcome with an acute precipitating factor such as in the case of pneumonia. This state is explained by a diminishment in the physiological reserves as a consequence of aging and thus, of the accumulation of diseases over time which leads to a loss in the capacity of response to situations of stress. This concept is, therefore, more related to biological than chronological age[9].

With respect to clinical decision making and the planning of health care, it is important to identify frail elderly patients with pneumonia, that is, those with a greater probability of developing an adverse outcome[10,11]. From a practical point of view and based on the definition of frailty as an accumulation of deficiences[12] we should distinguish:

1. **The elderly patient without clinical criteria of frailty**: this patient performs basic and instrumental daily life activities independently and does not usually have significant comorbidity or other associated mental or social problems. From a management and prognostic point of view there are no differences compared to an adult patient.

2. **The elderly patient with clinical criteria of frailty**: pneumonia in this patient may produce a functional and/or cognitive impact and condition short term results. The risk of having an adverse outcome depends on the grade of deficiencies accumulated, on the **medical** (comorbidity, polypharmacy, sensory, nutrition, use of hospital services...) **functional** (equilibrium and mobility, history of falls, daily life activities, continence...) **neuropsychiatric** (cognition, mood, delirium...) and **social areas** (social support, institutionalization...), that is, the greater the number of deficiencies the greater the grade of frailty and thus, of the risk of having an adverse outcome. In this sense, we can differentiate two wide phenotypic profiles based on the grade of frailty.

a) The elderly patient with clinical criteria of mild frailty: this patient performs basic activities of daily life independently or "almost" independently but within the setting of pneumonia may present acute functional and/or cognitive impairment and increase the grade of comorbidity and dependence for instrumental activities of daily life and is not usually identified as a frail patient. In the basal situation this patient usually presents a mild alteration in gait speed or impairment in physical and/or cognitive function. With respect to management, early identification is mandatory since it requires a specific intervention regarding the maintenance of function and quality of life.

b) The elderly patient with clinical criteria of moderate-severe frailty or the classically denominated geriatric patient: this patient requires help or is dependent for daily life activities and presents a greater probability of associated severe comorbidity, polypharmacy, dementia, malnutrition and a situation of social risk. With regard to decision making it is important to take certain aspects such as the grade of dependence into account since these aspects may condition the etiology, invasive diagnostic and therapeutic procedures and the final placement of the patient.

This categorization of elderly patients with pneumonia aims to changes the classical model of care which is generally unidimensional and centered on the acute episode, does not recognize the peculiarities of aging and ignores the functional, cognitive and social situation as well as the presence of geriatric syndromes[10-13]. Evaluation of these aspects allows the identification of the grade of frailty of an elderly patient with pneumonia and thereby better stratifies the risk and the planning of more specific care to the needs of each patient.

The best diagnostic tool to categorize the frailty of an elderly patient with pneumonia is integral geriatric assessment (IGA). This assessment carried out by an interdisciplinary team (physicians, nurses, occupational therapists and social workers) is aimed at identifying all the clinical, functional, mental and social problems as well as the geriatric syndromes in these patients in order to establish a health care plan to improve the functionality and quality of life[14]. This tool detects a greater number of problems in relation to the standard unidimensional

Table 1 **Integral Geriatric Assessment (IGA) adapted to emergency care**

Area examined	Scale	Questions
Cognitive situation	Six-Item Screener	Name 3 objects for the subject to learn : What year is it? What monthsis it? What day of the week is it? What 3 objects did I ask you to remember? **At risk if has 3 or more errors**
Confusional syndrome	Confusion Assessment Method	1. Acute onset or fluctuating course 2. Lack of attention 3. Disorganized thoughts 4. Altered level of consciousness **At risk if 1 and 2, more if 3 or 4**
Depresision	Emergency Department Depression Screening Instrument	1. Do you often feel sad or depressed? 2. Do you often feel defenseless? 3. Do you often feel discouraged or unhappy? **At risk with 2 positive answers**
Functional situation	Barthel index	**At risk if has acute functional impairment (Barthel ≤ 60, moderate-severe dependence)**
Comorbidity	Charlson index	**Greater risk with higher score (≥ 3 points, high comorbidity)**
Polypharmacy	Criterias of STOP & START	Identify inappropriate medication and lack of prescription of medications indicated
Falls	Get up and Go test	Time from getting up from an armless chair, walking 3 m and returning and sitting in the chair. **At risk of frailty if > 10-20 sec and falls > 20 sec.**
Social situation	Family situation of the Gijón Scale of Sociofamilial assessment	Lives with family without physical/psychological dependence (1); lives with spouse of similar age (2); lives with family and/or spouse and presents some grade of dependence (3); lives alone and has children nearby (4); lives alone with no children or these live at a distance (5). **Higher score greater risk.**

medical assessment[15], and improves the results in several scenarios including a reduction in mortality or impairment, improvement in cognition, quality of life, a reduction in the mean hospital stay and the percentage of readmissions and the use of long stay centers and costs[16].

It is difficult to perform the IGA in the setting of hospital emergency departments (HED) and thus, increasingly more authors have proposed the use of the IGA adapted to emergency care[11-13] based on the combination of brief, simple and validated screening scales of the different spheres of the patient to help diagnose frail elderly patients and detect the problems in the different spheres. Table 1 shows the proposal of a model of IGA adapted to the emergency department, although there is currently no evidence to perform universalized recommendations related to the most adequate tools in the HED.

With regard to the selection of candidates who would most benefit from this intervention different screening scales have been published, such as the "Identification of Senior at Risk" (ISAR) and the "Triage Risk Screening Tool" (TRST) (table 2), which allow the identification of frail elderly patients in the emergency department. A total score of 2 or more points is associated with high risk of a short term adverse outcome after discharge from the emergency department. Some authors therefore consider these scales as a possible method of initial screening for the selection of patients who would most benefit from an IGA. From our point of view and taking into account the lack of evidence related to models of geriatric care within the emergency setting, the use of an IGA adapted to the emergency department is recommended in all elderly patients with pneumonia previously identified as having high risk (ISAR or TRST greater than or equal to 2) and/or in patients presenting suspicion of acute functional and/or cognitive impairment secondary to the infectious process since this assessment may provide important information for decision making.

Table 2 Screening scales in the elderly patient

	TRST	ISAR
Age	≥ 75 years	≥ 65 years
Functional	Has difficulty walking, transfers or has a history of recent falls?	Prior to the acute process for which the patient was visited, was help reguarly necessary in basic activities?
		After the acute process for which the patient was visited was more help than necessary required for care?
Mental	Does the patient have cognitive impairment?	Do the patient have serious memory problems?
Social	Does the patient live alone or have a capacitated care provider?	
Sensorial		Does the patient see well in general?
Drugs	Does the patient take 5 or more different drugs?	Does the patient take 3 or more different drugs a day?
Use of hospital services	Without taking this visit into account, has the patient been to the emergency department in the last 30 days or hospitalized in the last 3 months?	Has the patient been admitted to hospital one or more days (excluding a visit to the emergency department) in the last 6 months?
Professiona l recommendation	The nurse believes that this patient requires home follow up for some reported reason.	

An elderly patient is considered to be at risk with a global score of greater than or equal to 2 in Identification of Senior at Risk (ISAR) or the Triage Risk Screening Tool (TRST).

ETIOLOGY

The etiology of CAP is conditioned by different aspects such as comorbidity, the basal functional situation, the severity of the acute episode, the antimicrobial treatment received, contact with the hospital system or the place of residence. Table 3 summarizes the principal risk factors which may condition infection by less common microorganisms. The most recent Spanish and European studies have demonstrated that even in institutionalized patients *Streptococcus pneumoniae* is the most frequent microorganism in CAP in the elderly, and that the percentage of multiresistant bacteria (MRB) is low[17-20], even when stratified according to the concept of health care-associated pneumonia (HCAP). Nonetheless, a recent Spanish study[21] comparing the etiology of CAP versus HCAP described an increase in the incidence of infection by methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa* in HCAP while the incidence of infection by enterobacteriacea was similar in both groups and greater than that published in other studies, being of around 12%.

Health care-associated pneumonia is defined as that presented in patients from residences, long stay centers, day hospitals, dialysis centers or homes attended by health care personnel in the last 30 days or have been hospitalized at least 48 hours in the last 90 days. This pneumonia includes a group of patients with risk factors for *Pseudomonas* and MRSA and is included in the guidelines for nosocomial pneumonia of the American Society of Infectious Diseases and the American Thoracic Society in 2005, based on the analysis of two retrospective studies[22,23]. However, the importance of these microorganisms in the profile of patients associated with health care has not been confirmed in Europe[24]. Indeed it is considered that the concept of HCAP should be revised[25], and it has been recommended that an etiological approach should be performed based on the clinical profiles of the patients and the risk factors for infections by these microorganisms.

In this respect, scales to characterize this risk have been described. Shorr et al.[26] proposed a scale with a score of: 4 for recent hospitalization, 3 residence, 2 hemodialysis and 1 critical patient. When the total score is zero there is a high negative predictive value of MRB (84%). Nonetheless, this study reported a high prevalence of MRSA (22%) and *Pseudomonas* (19%) and, therefore, does not reflect our setting. Thus, despite including patients with at least one risk factor, in a European study with a lower frequency of MRB (6%) Aliberti et al.[27] reported that the independent factors of isolation of MRB were living in a residence and previous hospitalization within the last 90 days. These data were later validated in two posterior cohorts, especially in patients in intensive care[28]. In another study in patients fulfilling HCAP criteria and presenting signs of severity it was observed that those with 2 risk factors (immunosuppression, hospitalization in the previous 90 days, severe dependence quantified with a Barthel index < 50 and the use of antibiotics in the previous 6 months) presented a greater frequency of MRB (2 % vs. 27 %) compared to patients without these microorganisms[29].

Table 3 Risk factors for different microorganisms

MICROORGANISM	RISK FACTORS
P. aeruginosa	Severe COPD with FEV1<35%
	COPD > 4 cycles of antibiotic treatment in the last year
	Bronchiectasias with previous colonization
	Nasogastric tube for enteral alimentation
	Admission in the ICU
Enterobacteriaceae and/or Anaerobes	Functional impairment
	Risk factors of aspiration
	Dysphagia
	Gastroesophageal reflux
	History of vomiting
	Cerebrovascular diseases
	Dementia
	Periodontal disease
	Bad oral hygiene
Methicillin-resistant *S. aureus*	Submitted to bed sores or wounds
	Clinical severity + recent hospitalization + previous endovenous antibiotic + institucionalization
	Previous colonization

On the other hand, it has been reported that the probability of infection by *Pseudomonas* or MRSA increases in severe CAP understood as the need for admission in an intensive care unit (ICU) or with risk class V according to the PSI of Fine[20,30]. If we take into account the approach proposed in Europe by Ewig[31] and by Brito and Niederman[24] in the USA, the initial situation of clinical severity and previous functional capacity are key in making decisions related to empiric treatment. Thus, in the presence of less than two factors of multiresistance (severe pneumonia, hospitalization in the previous 90 days, living in a residence, severe basal dependence for basic daily life activities, immunodepression or the taking of antibiotics in the previous 6 months) coverage against MRB should be included if the patient presents severe disease.

In regard to viral etiology, the influenza virus and respiratory syncytial virus cause the greatest morbimortality in the elderly, often within the context of epidemic outbreaks in institutionalized patients and may cause both viral primary pneumonias such as bacterial superinfection by *S. pneumoniae*, *S. aureus* and *Haemophilus influenzae*. Other respiratory viruses such as parainfluenza, metapneumovirus, adenovirus, coronavirus and rhinovirus produce less severe respiratory infection in immunocompetent adults.

Risk factors of colonization and microaspiration

Colonization may favor the development of pneumonia by uncommon microorganisms through microaspiration which is more frequent in the elderly than in the young population[17,32-35]. Bacterial colonization of the pharynx depends on multiple factors such as age, comorbidity, the basal functional situation, bacterial load, the use of antimicrobials, the presence of devices, instrumentalization and previous contact with health care centers or residences. The functional situation has been associated with a greater speed of colonization of MRB and Gram-negative bacteria. In a study carried out in institutionalized patients an average of 75 days was found for colonization by Gram-negative pathogens and 176 days for MRSA, with the risk being greater in cases with functional impairment[36].

An elevated percentage of silent pharyngeal microaspirations has been demonstrated in elderly patients with CAP, being observed in up to half of these patients hospitalized for pneumonia[32,33].This is related to the physiological modifications associated with age, with the greater risk of associated diseases and with the taking of certain drugs which may produce difficulties in swallowing or an alteration in the cough reflex. One systematic review reported risk factors of microaspiration including male sex, dementia, pulmonary disease (COPD) and the taking of determined drugs (antipsychotics, proton pump inhibitors) and protector factors such as antiotensin converting enzyme inhibitors[34]. Taylor et al[35] simplified the risk factors in the presence of chronic neurological diseases, esophageal disease, diminishment in the level of consciousness and a history of vomiting.

Risk factors of uncommon microorganisms

With respect to *Enterobacteriaceae* it has been observed that the functional situation is associated with a greater speed of colonization by Gram-negative bacteria, especially *Enterobacteriaceae*[36]. Von Baum[37] described the presence of heart failure and cardiovascular disease as risk factors of infection by *Enterobacteriaceae*. According to studies performed in patients with severe urinary infection and infection of the surgical and intraabdominal field, the factors related to infection by extended-spectrum beta-lactamase-producing *Enterobacteriaceae* (ESBL) are advanced age, diabetes mellitus, previous hospitalization, recent administration of antibotics, previous infection by *Enterobacteriaceae* with ESBL, repeated urinary infections and permanent vesical catherization[38,39].

Despite the classical risk factors related to anaerobes, their precise implication is not currently known since their detection has not been described in any recent study. In a study performed in institutionalized patients with aspirative pneumonia, El-Sohl et al.[40], identified *Enterobacteriaceae* (49%) and anaerobes (16%) as the most frequently isolated pathogens, with the functional state being the determining factor for the isolation of anaerobes.

In the particular case of *P. aeruginosa*, the frequency in the elderly is low (1-2%). Chronic respiratory disease and having a nasogastric tube are of note among the main risk factors for infection by this pathogen[37]. Taking into account that up to 30 % of the patients admitted for pneumonia have COPD, this microorganism should be suspected in cases of severe COPD (FEV<35%), in subjects taking previous antibiotics, admission to the ICU[41,42] and/or in cases of bronchiectasias colonized by this microorganism[43].

Lastly, it is known that colonization by *S. aureus* is more frequent in patients who have had a previous episode of influenza[44,45]. The probability of MRSA in patients hospitalized in conventional wards is low (2.4 %), being more frequent in critical care units[46]. Spanish studies have shown an incidence of MRSA of less than 1% in CAP[47] and of 12% in patients fulfilling criteria of HCAP[21]. Garcia Vidal et al.[17] found a higher frequency (10%) in patients with a history of endovenous treatment at home or in those receiving ulcer care, being very low in the case of the remaining factors included in the HCAP concept. Shorr et al.[48] proposed a scale for a low probability of MRSA if the score is ≤ 1 (2 points: recent hospitalization of admission in the ICU; 1 point for each of the following: < 30 or >79 years, exposure to previous endovenous antibiotic, dementia, cerebrovascular disease, diabetic woman, residing in a residence). Infection by MRSA should be suspected in the presence of pneumonia with bilateral radiologic infiltrates with cavitations or the presence of risk factors shown in table 3, and fundamentally in patients with clinical severity[46]. If an elderly patient has a history of living in a residence in the previous year, it is important to know the prevalence of MRSA in this institution.

CLINICAL AND MICROBIOLOGICAL DIAGNOSIS

Clinical diagnosis of pneumonia in the elderly is complex. The classical symptoms of pneumonia are usually less frequent than in younger adult patients, being more common in institutionalized patients[49]. On occasions, the only clinical expression may be the presence of unspecific complaints, decompensation of chronic disease, falls, functional impairment, confusional syndrome or the lack of collaboration with care givers[50,51]. The absence of fever, hypoxemia or respiratory symptoms does not allow the diagnosis of pneumonia to be ruled out.

Conventional chest X-ray in daily clinical practice is usually sufficient for the confirmatory diagnosis of pneumonia in most elderly patients. However, it should be taken into account that in up to 30 % of the cases radiological signs may not be evident, with this being more frequent in patients with dehydratation and neutropenia[8,52,53]. In one study, the sensitivity of chest radiography, taking computerized tomography (CT) as a reference, was of 43.5 %, with a positive predictive value of 26.9%[54]. Thus, on suspicion of pneumonia it is recommended to repeat the radiography at 24-48 hours. In general, CT is reserved for patients with an atypical radiological pattern or as a second step in cases not responding to the initial treatment in order to discard other possible diagnostic alternatives[55].

With respect to laboratory tests, inadequate inflammatory response as a consequence of immunosenescence may condition their results, underestimating the severity of the process. Regarding the performance of biomarkers of inflammatory response, few studies have specifically evalauted their role in pneumonia in elderly patients. Thiem et al.[56] compared the C-reactive protein (CRP) and leukocytes with the CURB and PSI prognostic scales in patients over 65 years of age with CAP and did not find an association between mortality and CRP or leukocyte count. With regard to procalcitonin, the series by Stucker et al.[57] questioned its sensitivity for the diagnosis of acute bacterial infection in elderly patients, despite the demonstrated utility in the general population[58-61]. Pro-adrenomedulin, a peptide produced by the endothelium, which is released in situations of physiological stress, has also been evaluated in observational studies and seems promising as a prognostic marker in respiratory infection[62-64].

In relation to the role of other imaging studies, it is of note that bed-side echography allows confirmation of the presence of pleural effusion and guides possible thoracocentesis. The remaining procedures, including not only fibrobronchoscopy and CT-guided needle biopsy but also biopsy by thoracotomy or videothoracoscopy do not differ from those of young adults except for the logical consideration of the life expectancy of the patient, wishes and vital expectations and the risk of contraindications related to comorbidities.

The microbiological diagnosis includes the performance of blood cultures, staining and culture of respiratory samples and the detection of bacterial antigens (immunochromatographic tests of pneumococci and legionella). The guidelines of the ERS/ESCMD of 2011 recommend the performance of blood cultures

in all hospitalized patients[65], while North American guidelines[8] reserve these studies for more severe patients, that is, those with cavitated infiltrates, leukopenia, alcoholism, severe liver disease, asplenia, positve antigenuria test for pneumococci or pleural effusion. Despite their scarce clinical impact in non selected patients with CAP considering the high frequency of atypical clinical presentations in elderly patients, blood cultures may contribute to both confirmation of diagnostic suspicion on isolation of potential pulmonary pathogens and reorientation of the disease of the patient on obtaining isolates indicating a diagnostic alternative. In prospective studies on sputum yield for the diagnosis of extrahospitalary pneumonia in adults, assessable samples are obtained in around one third of the patients[66]. The importance of Gram staining and sputum culture lays in their influence on the modification of the initial antibiotic treatment. The presence of *S. aureus*, *Klebsiella pneumoniae* or *P. aeruginosa* in purulent sputum with a concordant Gram stain makes it necessary to consider these pathogens in choosing the antibiotic regimen and, likewise, their absence in the culture of quality respiratory samples has a high negative predictive value, allowing the spectrum of antimicrobial treatment to be narrowed. The problem in elderly patients with functional impairment is, on one hand, the inability to obtain a evaluable sputum sample and, on the other hand, the greater frequency of oropharyngeal colonization by Gram-negative microorganisms, *S. aureus* and MRB[67].

The detection of bacterial antigens of pneumococci and *Legionella pneumophila* in urine by immunochromatographic techniques has led to important advances in the detection of these two pathogens[68]. The sensitivity of the pneumococcal antigen is estimated as being of more than 60 % with a specificity of greater than 90 % in adult patients even in those with chronic bronchitis and pneumococci colonization in contrast with the infant population in which nasopharyngeal colonization by pneumococci is a frequent cause of false positives of the test. It also is of diagnostic value in pleural fluid and its yield is not altered by either previous antibiotic treatment or pneumococcal vaccination. However, this test often remains positive up to 3 months after the resolution of pneumonia, thereby limiting its utility in patients with recurrences for the evaluation of response to treatment. With regard to the *Legionella* antigen, the test is specific versus *L. pneumophila* serogroup I, with a sensitivity of greater than 90% and should be performed in all patients with severe pneumonia and in mild forms with clinical or epidemiological suspicion of Legionellosis.

The use of tests to detect viruses in nasopharyngeal aspirates is important not only for epidemiological but also therapeutic aspects in patients diagnosed with influenza who are candidates for antiviral treatment. These techniques are costly and thus, should be indicated in very specific epidemiological or clinical settings.

TREATMENT

Bacterial resistance

Knowledge of the rate of resistance to the antimicrobials of each of the most frequent pathogens involved in the etiology of pneumonia is key in relation to adequate selection of empiric antibiotic and reduces the probability of therapeutic failure.

In regard to *S. pneumoniae* a decrease in strains non susceptible to treatment with penicillin has been observed following the introduction of the pneumonoccal 7 valent conjugate vaccine in the infant vaccination schedule. The rates of resistance in Spain do not reach 1% in respiratory disease[69]. Although the resistance to pneumococci has declined and the cut offs of the minimum inhibitory concentration has risen, it is advisable to administer high doses of beta-lactams to achieve adequate serum levels and be able to act against pneumococci with an intermediate level of resistance[7]. The resistance of pneumococi to macrolides has diminished in the last years in parallel with a reduction in the resistance to penicillin. At present, resistance continues to be present in 25 % of the strains, with therapeutic failure having been described in patients treated with monotherapy. The rate of resistance to levofloxacin and moxifloxacin remains low (< 5%). Nonetheless, an increase has been observed to these antimicrobirals in the last years, being more frequent in patients who have undergone treatment with quinolones in the 6 months prior to the episode of pneumonia[70] and with an elderly age[71].

Regarding *S. aureus,* it is of note that MRSA is present is around 25 % of the patients with infection by this pathogen, and in the last years this percentage has remained stable. Resistance to linezolid is practically null, although some studies have reported its incidence in clinical samples of patients with recurrent infection by MRSA who have received oral antibiotic treatment over months or years and in those hospitalized during a long period of time with significant comorbidity, immunodepression and who required admission to the ICU with previous, prolonged cycles of antibiotics including linezolid[72-77]. The rate of resistance to cotrimoxazol by *S. aureus* remains, being below 10 % in Spain. Nonetheless, although MRSA may be sensitive to cotrimoxazol *in vitro* the clinical result is variable. Empiric treatment with quinolones would not be an appropriate option since resistance to these antimicrobials in our media is greater than 20 %. In the last years infection by strains of community-acquired *S. aureus* with resistance to methicillin and sensitive to a wide range of non beta-lactams antibiotics has been described. However, this is more often presented in young, previously healthy populations, but it is highly transmittable and presents great virulence due to the presence of a necrotizing cytotoxin denominated Panton-Valentine leukocidin, leading to multilobar, bilateral pneumonia with a trend to cavitation and empyema[78].

In relation to the resistance of *H. influenzae* to beta-lactams in Spain, the SAUCE studies[79] observed a reduction in the resistance to ampicillin produced by beta-lactamases, from 25 % to 15 %, similar to the case of resistance by beta-lactamase negative ampicillin resistant (BLNAR), a mutation producing resistance to amoxicillin-clavulanate, piperacillin/tazobactam and cefuroxime, which has decreased from 14% to 0.7%.

P. aeruginosa presents intrinsic resistance to several classes of antibiotics and acquires resistance to other families, and thus, there is a limited number of therapeutic options for the treatment of these infections. The classes of antibiotics which remain active include some fluoroquinolones (ciprofloxacin and levofloxacin), aminoglycosides (gentamicin, tobramycin and amikacin), some beta-lactams (piperacillin-tazobactam, ceftazidime, cefepime, imipenem, doripenem and meropenem) and polymixins (polymixin B and colistin). Nonetheless, high levels of resistance above 10 % have been observed in the isolation of *P. aeruginosa* for all these antimicrobials and resistance to carbapenems is frequent. Combined resistance is also frequent. Indeed, around 14 % of the isolates are resistant to at least 3 groups of antimicrobials and 6 % present resistance to the 5 classes of antibiotics usually tested[80]. Tobramycin presents a similar spectrum of action to that of gentamicin, although it has greater activity versus *P. aeruginosa.* In Spain there are several local variations which must be known to select to the best therapeutic option, but, in general, resistance is of around 3 % for amikacin, 7% for pipercillin-tazobactam, 9% for ceftazidime, 16% for carbapenems and aminoglycosides and 21% for fluoroquinolones[80]. Colistin is increasingly more frequently used for the treatment of infections by multiresistant Gram-negative bacilli. Resistance of *Pseudomonas* to colistin is infrequent, although it has been reported in some microbiological studies[81].

In the last years an increase has been observed in the resistance to *Enterobacteriaceae* not only in the hospital but also in community infection due to the increase in strains with ESBL. This confers a loss of susceptiblity to beta-lactams including those associated with beta-lactamase inhibitors and third and fourth generation cephalosporins. Studies have shown an increase in the presence of strains with ESBL of greater than 10 %, especially in patients with recent hospitalization or elderly age[82]. In these circumstances carbapenems, including ertapenem, continue to have good activity versus ESBL-producing strains resistant to amoxicillin-clavulanate, piperacillin-tazobactam and fluoroquinolones. In non ESBL-producing strains the resistance to amoxicillin-clavulanate has also risen, being greater than 10% and even reaching up to 20% in some centers[82]. In the last years a steady and particularly worrisome increase has been observed in the case of resistance to third generation cephalosporins which has risen in the last 10 years from 1.6 % in 2002 to 13.5 % in 2012[83]. Resistance to carbapenems continues to be infrequent except for the presentation of an endemic outbreak in some centers, but, in general, remains below 1%[80].

In regard to atypical pathogens it is necessary to be aware that these are resistant to beta-lactams because they lack a cellular wall and are sensitive to macrolides, tetracyclines and fluoroquinolones. Acquired resistance is currently exceptional for these families of antibiotics except for *Mycoplasma pneumoniae*, in which the emergence of isolates resistant to macrolides due to ribosomal mutations has been described, especially in Asia.

Recommendations for the choice of antibiotic treatment

The therapeutic schedule is summarized in table 4 with the recommended doses in table 5. In these consensus recommendations it was decided not to include the concept of HCAP as an independent entity but rathe to include it within the group of CAP. According to our point of view and given the heterogeniety of elderly patients considering both comorbidity and the functional, cognitive and social situation, as well as the individual risk factors for determined microorganisms and possible resistances to these antimicrobials, it is recommended to consider two main questions in relation to the decision making as to the choice of the empiric antibiotic treatment. Taking into account aspects such as the severity of the clinical situation and local resistances it should first be asked: Are there risk factors of uncommon microorganisms?, and second: Is the patient frail? and if so, What is the grade of frailty? If the answers to these questions are negative, the scenario would involve that of a non frail elderly patient without risk factors for uncommon pathogens. With this patient profile the therapeutic regimens provided in the consensus guidelines for CAP in adult patients may be followed[7,43] taking into account a series of aspects.

In the elderly, pneumonia by intracellular pathogens is less frequent. Nonetheless, recent studies[84] have shown that the percentage of *L. pneumophila* in non severe pneumonia is similar to that of pneumonia in patients requiring hospitalization. Thus, if infection by *Legionella* can not be ruled out the association of a macrolide is necessary in the case of using a beta-lactam. Among the quinolones, moxifloxacin may be more advisable in patients with risk factors for anaerobes because of better coverage versus these pathogens[85]. The combination of a beta-lactam plus a macrolide is the most adequate in patients with severe pneumonia. Quinolones in monotherapy is another alternative. In this case, if the clinical picture is subacute or has an uncomon presentation, precaution should be taken in their use because of the tuberculostatic activity and the possiblity of masking pulmonary tuberculosis[86].

1. Considerations in elderly patients with risk factors for uncommon pathogens.

Risk factors of *Enterobacteriaceae* and /or anaerobes

In patients with risk factors of aspiration an antibiotic should be used which should also cover *S. pneumoniae* and be effective against anaerobes and *Enterobacteriaceae* since these may be the causal microorganisms involved. In most guidelines, amoxicillin-clavulanate is considered to be the antibiotic of choice. Taking into account the worse prognosis of this type of patient and the increasing rise of resistances of *Enterobacteriaceae* to this drug as well as to third generation cephalosporins, ertapenem is a good therapeutic option because of its good sensitivity versus anaerobes, *S. pneumoniae* and all the *Enterobacteriaceae*, including ESBL producers. Their rapid bactericide action as well as the dose of once daily constitute another important advantage for elder-

Table 4 Empiric treatment in CAP in the elderly

	SCENARIO	TREATMENT
Patient without frailty	Outpatient treatment	Amoxicillin/clavulanate or cefditoren + clarithromycin or moxifloxacin or levofloxacin
	Treatment at admission	Amoxicillin/clavulanate or ceftriaxone + azithromycin or moxifloxacin or levofloxacin
Patient with frailty	Mild frailty*	Amoxicillin/clavulanate or ceftriaxone + azithromycin or moxifloxacin or levofloxacin
	Moderate-severe frailty	Ertapenem or amoxicillin/clavulanate**
Uncommon pathogens	*Enterobacteriaceae*/anaerobes	Ertapenem or amoxicillin/clavulanate**
	Methicillin-resistant *S. aureus*	Add linezolid
	P. aeruginosa	Piperaciliin/tazobactam or imipenem or meropenem or cefepime + levofloxacin or ciprofloxacin or amikacin or tobramycin

*** Evaluate risk factors for microaspiration and multiresistant bacteria with special caution.**

**** Evaluate local resistance to amoxicillin/clavulanate and patient severity.**

ly patients[87]. The indication of clindamycin, which has classically been the treatment of choice in aspirative pneumonia and lung abscess, is reportedly limited due to the increase in the resistances of the pneumococci and anaerobes of the oropharyngeal flora. Moxifloxacin is a possible alternative, but it is reserved for certain situations such as allergies to beta-lactams because of problems of resistance of *Enterobacteriaceae* to quinolones in our setting.

Risk factors of MRSA

In our country the presence of community MRSA is anecdotic. In severe patients with risk factors the initiation of empiric treatment versus MRSA would be justified collecting conventional culture samples and a nasopharyngeal swab to seek this pathogen. Based on the evolution and the results of the cultures, treatment versus MRSA could be discontinued[88]. The treatment of choice is linezolid combined with antibiotic coverage chosen according to the remaining risk factors. Vancomycin is not advised because of its demonstrated lesser efficacy as well as the greater number of secondary effects, especially at a renal level[89]. Although cotrimoxazol may be sensitive *in vitro*, there is no clinical experience.

Risk factors of *P. aeruginosa*

Empiric treatment combined with two parenteral antimi-

Table 5 Antibiotic doses

ANTIBIOTIC	DOSE	DOSE IN RENAL INSUFFICIENCY (ml/min)	
AMIKACIN	15-20 mg/kg/24 h	60-80: 9-12 mg/kg/24 h;	40-60: 6-9 mg/kg/24 h
		30-40: 4,5-6 mg/kg/24 h;	20-30: 3-4,5 mg/kg/24 h
		10-20: 1,5-3 mg/kg/24 h;	< 10: 1-1,5 mg/kg/24 h
AMOXICILLIN-CLAVULANATE IV	2 g/6-8 h	30-50: 1 g/8 h;	10-30: 500mg/12 h
		< 10: 500mg/24 h	
AMOXICILLIN-CLAVULANATE VO	2/0,125 g/12 h	30-50: 500 mg/8 h;	10-30: 500mg/12 h
		< 10: 500mg/24 h	
AZITHROMYCIN IV/VO	500 mg/24 h	No adjustment required	
CEFDITOREN VO	400 mg/12 h	30-50: 200mg/12 h;	< 30: 200 mg/24 h
CEFEPIME IV	2 g/8 h	30-50: 2 g/12 h;	10-30: 2 g/24 h
		< 10: 1 g/24 h	
CEFTRIAXONE IV	1-2 g/12-24 h	> 10: not required	< 10: máximo 2 g/24 h
CIPROFLOXACIN IV	400 mg/12 h	30-50: not required;	< 30: 200 mg/12 h
CIPROFLOXACIN VO	500 mg/12 h	30-50: not required;	< 30: 250 mg/12 h
ERTAPENEM IV	1 g/24 h	< 30: 500 mg/24 h	
IMIPENEM IV	1 g/6-8 h	30-50: 250-500 mg/6-8 h;	< 30: 250-500 mg/12 h
LEVOFLOXACIN IV/VO	500 mg/12-24 h	20-50: 250 mg/12-24 h;	10-20: 125 mg/12-24 h
		< 10: 125 mg/24 h	
LINEZOLID IV/VO	600 mg/12 h	No adjustment required	
MEROPENEM IV	1 g/8 h	30-50: 1 g/12 h;	10-30: 500 mg/12 h
		< 10: 500 mg/24 h	
MOXIFLOXACIN IV/VO	400 mg/24 h	No adjustment required	
PIPERACILLIN/TAZOBACTAM IV	4/0,5 g/6-8 h	20-50: 2/0,25 g/6 h;	< 20: 2/0,25 g/8 h
TOBRAMICINA IV	4-7 mg/kg/24 h	60-80: 4 mg/kg/24 h;	40-60: 3,5 mg/kg/24 h
		30-40: 2,5 mg/kg/24 h;	20-30: 2 mg/kg/24 h
		10-20: 1,5 mg/kg/24 h	

crobials is recommended, although the observational studies available have not demonstrated the benefits of combined treatment compared to monotherapy with a single active antimicrobial[90,91]. The most adequate schedule is probably the combination of piperacillin-tazobactam or a carbapenem (meropenem, imipenem or doripenem) in continuous perfusion selected based on the pattern of local resistance of *P. aeruginosa*, together with a quinolone with antipseudomonic activity (ciprofloxacin or levofloxacin) or an aminoglycoside (amikacin).

The administration of antimicrobials in aerosol has the advantage of increasing the concentration of the antibiotic in the lung, reducing systemic toxicity to a minimum. Some data have demonstrated that aminoglycosides such as tobramycin or gentamicin, colistin and aztreonam in aerosol are effective to reduce bacterial load in the respiratory tract. Recent studies have shown positive clinical results with a reduction in the score of clinical severity, a diminishment in the use of systemic antibiotics and less frequent appearance of microbial resistance with the use of antibiotics in aerosol as adjuvant therapy. The addition of antibiotics in aerosol to systemic antibiotics may be considered in the treatment of patients not responding to the latter or in those with pneumonia by MRB.

2. Considerations in frail elderly patients

Frail elderly patients have a high risk and thereby require evaluation aimed at achieving the correct staging of frailty in view of decision making.

In the case of a **mild frail elderly patient** early diagnosis and specific intervention is required with the view of maintaining possible impaired functions and quality of life. In this

sense, adequate management of the clinical situation is necessary as well as an integral geriatric assessment, functional monitoring and an intervention to recover the previous basal and nutritional situation[9]. Early diagnosis of the intercurrent process is therefore fundamental and is not always easy. "Aggressive" treatment including control of the infectious foci early is necessary and allows a reduction in the functional impact of the acute process in the elderly. In this scenario, the antibiotic treatment to be implementated from an etiological point of view is the same as that in an independent patient. In contrast, the administration of more powerful antimicrobials with fewer adverse effects and pharmacological interactions should be considered and the risk factors for less common pathogens should be carefully evaluated since therapeutic failure may carry a prolongation of hospitalization with the consequent risk of a definitive situation of dependence.

The diagnostic and therapeutic complexity of **moderate-severe frail elderly patients** is great and includes circumstances which may condition the etiology, the diagnostic and invasive therapeutic procedures and the final placement of the patient. These patients usually have severe comorbidity and polypharmacy making them more vulnerable to the appearance of adverse reactions to medications. In addition, they may have important risk factors which determine a different etiology by MRB or an alteration in the oropharyngeal flora which determines a less usual etiology involving a greater probability of colonization by *Enterobacteriaceae*. Impairment in the functional state has been associated with a greater speed of colonization by Gram-negative bacteria, especially *Enterobacteriaceae*[36], and thus, the same recommendations mentioned previously in the section on risk factors of *Enterobacteriaceae* and/or anaerobes are made. In addition, ertapenem, is an ideal antibiotic for home treatment controlled by Home Hospitalization Units (HHU).

The relationship of the time of administration and the duration of the antibiotic

The time of antibiotic administration is not clearly defined except for pneumonia associated with severe sepsis or septic shock. Nonetheless, guidelines recommend their administration as soon as the diagnosis of pneumonia is made whether by the emergency department or at the first site of evaluation[7]. With regard to the duration of antibiotic treatment the standard schedule of 7 to 10 days may be valid except when there is suspicion of infection by *Pseudomonas* since the treatment should then be prolonged to 14 days. Other clinical situations may require prolonged antibiotic treatment such as the persistence of fever for more than 72 hours, the persistence of more than one criteria of clinical instability, inadequate initial coverage or the appearance of complications. The use of biomarkers such as procalcitonin or the C-reactive protein may be useful to shorten the duration of antibiotic treatment[92,93].

Pharmacokinetic and pharmacodynamic aspects

Aging produces certain pharmacokinetic and pharmacodynamic modifications of medications which should be taken into account at the time of prescribing an antibiotic as should the possible appearance of adverse reactions which, in turn, favor the grade of associated comorbidity and polypharmacy. The main pharmacokinetic modifications which occur at different levels condition a diminishment in the absorption of pH dependent antibiotics, modifications in the distribution of the medications due to changes in tissue composition, increasing the half life of lipophilic antibiotics and the concentration of hydrophilic antibiotics, raising the free concentrations of acidic antibiotics (penicillin, cephalosporins and clindamycin) and reducing the alkaline antibiotics (macrolides), and also condition a diminishment in the hepatic first pass metabolism of antibiotics (clindamycin and chloramphenicol) and a diminishment in the renal clearance of antibiotics eliminated by the kidney[94]. In this sense, since most antibiotics are eliminated renally an adjustment is required in the dose based on renal clearance calculated by the Cockroft-Gould or MDRD formula, with the latter being of choice in the case of low patient weight. On the other hand, it is important to take into account that tissue penetration of antibiotics in the elderly is lower compared with young patients and may thereby not allow antibiotics to achieve sufficient concentrations at the site of the infection.

With respect to possible pharmacologic interactions, it is important to take into account medications which are metabolized through cytochrome P-450. Inhibition of the enzyme CYP3A4 may cause an alteration in the metabolism of azoles and certain antibiotics such as macrolides and quinolones. To the contrary, certain antibiotics may prolong the half life of other drugs potentiating their effects and possibly producing adverse reactions such as vitamin K antagonists (aminopenicillins, cephalosporins, metronidazol and erythromycin), antiplatelet drugs (aminopenicillins, cephalosporins), furosemide (cephalosporins), selective serotonin reuptake inhibitors (linezolid), digoxin (penicillins and macrolides), calcium antagonists (erythromycin and clarithromycin) and theophylline (macrolides)[94].

As a general recommendation all antibiotics may be used with the same indications as in younger patients. However, in the elderly the dose and the intervals should be adapted to body weight (or body mass index), renal function clearance and the contraindications which may be more frequent with the presence of associated diseases or drugs. As a general rule at the time of prescribing medications in the elderly and with the aim of minimizing the adverse reactions to medications, low doses should be initiated with a progressive increase in the same ("start low and go slow"). In relation to antibiotics this principle is not followed and the treatment should be aimed at achieving the full therapeutic dose early ("hit hard and early"). In addition, a sufficient dose should be administered and some experts recommend, for example, a loading dose of beta-lactams or continuous infusion to achieve a sufficiently high dose at the site of the infection. Use of the correct antibiotic dose is also key to avoid resistances since an association has been observed between a suboptimal antibiotic dose and the appearance of resistant pathogens.

Concomitant treatment

Hypoxemia is a risk factor of mortality by pneumonia, especially in elderly patients and, thus, the administration of oxygen therapy should be implemented early in patients with respiratory insufficiency. Different alternatives may be used based on the grade of ventilatory failure and the basal situation of the patient such as non invasive mechanical ventilation or endotracheal intubation or even palliative treatment in end of life situations. It is usual to find volume depletion in elderly patients with pneumonia and, thus, correct hydratation is another measure to be carried out as soon as possible, being even more important in patients, with criteria of sepsis. In the absence of contraindication, all patients should receive low molecular weight heparin as prophylaxis for deep vein thrombosis. In older patients with a poor nutritional status or difficulty in swallowing, adequate nutrition is practically obligatory[95-97]. In admitted patients mobilization should be started early, from the first day of admission if possible, with sitting out of bed for at least 20 minutes, with a posterior progressive increase in mobilization[98].

Palliative treatment

One important aspect when considering the treatment of pneumonia is that this may be a frequent complication in elderly patients with severe fragility and a prognosis of limited life, often being the final cause of death. Identification of these patients by geriatric assessment adapted to emergency care is very important with a view towards providing adequate palliative treatment. No clear benefits of endovenous antibiotic treatment have been demonstrated in patients with advanced dementia and therapeutic abstention, and active implementation of palliative treatment should be considered on an individual basis[97,99].

Management of therapeutic failure

Therapeutic failure is defined as the absence of clinical stability after 3-4 days of antibiotic treatment or the appearance of clinical impairment, respiratory insufficiency or septic shock in the first 72 hours, increasing the mortality of the patient 5-fold. However, it is important to note that in the elderly with severe pneumonia or the concomitant presence of decompensated heart failure or severe COPD it may take longer to achieve clinical stability without implying therapeutic failure.

Possible causes of failure have been described as the resistance of microorganisms to the antibiotic treatment administered, the implication of uncommon pathogens in the etiology, the absence of control of patient comorbidity or the presence of an undiagnosed concomitant process (pulmonary embolism, pulmonary neoplasm). The risk factors for this circumstance to concur are the initial severity of the disease, the presence of significant comorbidity, the virulence of the microorganism involved or the bad choice or dose of the antimicrobial treatment administered.

In these conditions, it is recommended to opt for better control of the comorbidity, consult the microbiologic studies, evaluate the performance of new microbiologic studies or the collection of invasive respiratory samples, request new imaging studies, evaluate the performance of immunosuppression studies and consider extending the antimicrobial spectrum. On decision making the basal functional situation of the patient should be considered as should the survival expectancy presented. To extend the antimicrobial spectrum the risk factors presented by the patient should be reconsidered for uncommon pathogens or the possibility of infection by fungi, mycobacteria, *Nocardia* and other uncommon pathogens. In patients with risk factors of fungal infection (severe COPD, severe immunosuppression, long term treatment with corticoids) and compatible radiologic study, empiric treatment with voriconazol or liposomal amphotericin B may be indicated.

PROGNOSTIC STAGING

Different factors related to mortality have been described including age, comorbidity, microbial etiology and early, adequate antibiotic treatment. The adequacy of the antibiotic treatment is the only modifiable factor once pneumonia is produced. Previous studies have demonstrated that functional dependence is associated with a greater long term mortality (>1 year) in hospitalized patients with CAP[100].

The decision to hospitalize a patient is individual and is based on clinical aspects. However, the decision as to patient admission is a complex task and even more so in the elderly. To facilitate this decision different help tools have been developed in the last years in the form of scales for the staging of severity, the most used being the Pneumonia Severity Index (PSI)[101] and CURB-65[102]. Different studies comparing the PSI and CURB-65 have shown a similar predictive ability for mortality at 30 days[103]. Nonetheless, both have limitations. The PSI bestows excessive weight to age, relative to hypoxemia and does not take risk factors of adverse results such as COPD and others specific for elderly patients such as the functional situation, social factors, correct oral intake of the patient or the capacity for good therapeutic compliance into account. CURB-65 presents the limitation of not including hypoxemia and the functional situation in the assessment. Indeed, certain studies have suggested oxygenation as the best prognostic indicator in the elderly[104].

Other scales such as SCAP[105], Severity Community Acquired Pneumonia (SMART-COP)[106] or ATS/IDSA[8] have been developed in relation to help in the clinical decision related to admission to an ICU. The SCAP is a scale which allows the identification of patients requiring surveillance and more aggressive treatment, and it is very useful to determine hospital mortality and/or the need for mechanical ventilation or ionotropic support. SMART-COP helps in the decision as to the need for more aggressive treatment although it does not necessarily predict the need for ICU admission.

As mentioned previously, geriatric assessment adapted to emergency care is a complementary tool to these scales of

prediction of hospital admission and/or to the ICU and may provide valuable information in relation to decision making regarding aggressive diagnostic and therapeutic procedures as well as the need for hospital admission and for defining the most adequate heath care level.

ALTERNATIVES TO CONVENTIONAL HOSPITALIZATION

In the last years different units have been developed for treating patients with CAP: observation units (OU), short stay units (SSU), day hospitals (DH) and HHU[107]. The OU and SSU have shown to be effective and safe both alone and integrated within a multidisciplinary model with early discharge and follow up in the DH or HHU[108,109]. Specifically in the elderly the SSU may be considered an alternative to conventional hospitalization for CAP with PSI III and IV[110]. The HHU are a safe, efficacious and cost-effective method for the treatment of severe infections in situations of clinical stability[111]. Patients with PSI II with associated comorbidity and those with PSI III are considered candidates for admission in the HHU regimen and patients with PSI IV-V admitted in a SSU or conventional hospitalization may later be admitted to the HHU on achieving clinical stabilization[112].

Another possibility of treatment for institutionalized patients is to undertake the treatment of pneumonia in the geriatric residence itself. In the United States 63-78% of the episodes of pneumonia are treated in the geriatric centers with a mortality ranging from 13-22%[113]. Several studies have analyzed the advantages of treating the patient or in the residence and have detected the same morality adjusted for the functional status between the cases treated in the hospital and those treated in geriatric residences and only found an improvement in early mortality in the cases of severe pneumonia treated in the hospital but with no differences in the mortality and functional status at two months[114,115]. It therefore seems reasonable to recommend that the treatment of pneumonia in most institutionalized patients, especially those with great functional impairment, be performed in the residence, leaving transfer to the hospital for more unstable patients with difficult control of symptoms or following the wishes of the patient and relatives[116]. The possibility of carrying out endovenous antibiotic treatment by personnel of the residence or with the support of HHU units facilitates the decision of treating the patient in the geriatric center.

CONSIDERATIONS FOR HOSPITAL DISCHARGE

Clinical stabilization is produced when the vital signs normalize, the mental state is normal or returns to the basal condition and improvement in gas exchange diminishing oxygen requirements is observed (table 6)[117]. Most patients with pneumonia are usually clinically stabilized between the third and fourth day. However, in frail elderly patients this time may increase and delay the time to clinical stability 2-7 days. It is important to consider than the physiological modifications associated with aging may produce a less expressive clinical presentation with respect to clinical or analytical signs and thus, in this patient profile it is considered more useful to monitor the normalization of the clinical and/or analytical parameters which were altered on arrival of the patient to the Emergency Department.

Table 6 Clinical stabilization criteria

- Heart rate < 100 bpm
- Respiratory rate < 24 rpm
- Axillary temperature < 37.2 ºC
- Systolic blood pressure > 90 mmHg
- O_2 saturation > 90%
- Good level of consciousness
- Tolerance to oral route

After achieving clinical stability sequential therapy may be implemented. These criteria must be adequately applied to change to the oral route. This has demonstrated a reduction in hospital stay without increasing the risks for the patient. The presence of bacteremia does not seem to be a determining factor for deciding whether to prolong the endovenous antibiotic treatment once the criteria have been achieved. In the case of obtaining the isolation of the causal microorganism, oral antibiotic treatment must accordingly be adjusted to its sensitivity. When this microorganism is not identified it is advisable to use the same endovenous treatment as that used initially or equivalent antibiotics with respect to the spectrum of activity. Thus, patients receiving treatment with amoxicillin-clavulanate, quinolones, macrolides or clindamycin should continue with the same antibiotic administered intravenously since oral treatment is available with good bioavailability. Patients under treatment with cephalosporins may continue oral treatment with cefditoren since it has a similar spectrum. In patients receiving endovenous antibiotic treatment with no possibility of changing to oral treatment because of the absence of an adequate oral formula for the coverage these provide may be discharged with HHU, completing the necessary length of antibiotic treatment at home.

PREVENTION OF CAP

Vaccination in the elderly has demonstrated a reduction in the cases of death as well as the associated complications, despite a lower response as a consequence of the immunosenescence[118,119]. All elderly patients should be vaccinated against the flu annually and versus pneumococci[120]. The polysaccharide vaccine (VNP23) versus pneumococci has been used for decades, however, although it includes the greatest number of serotypes, it does not generate immune memory and produces over immune response in the elderly and is, therefore, clinically ineffective. A recent consensus document[121] recommends

the conjugate vaccine (VNC13) in immunocompetent subjects with underlying diseases or risk factors such as COPD, chronic liver disease, cardiovascular disease, diabetes mellitus, smoking and alcohol abuse. The conjugate vaccine generates immune memory and a more potent immune response than the polysaccharide vaccine, with clear foreseen benefits.

An association has been described between respiratory pathogens and the dental state (the presence of periodontal disease, the number of dental pieces missing in dentulous patients and complete prosthesis in edentulous patients). In the elderly, and particularly in institutionalized patients, a decrease in respiratory complications has been reported when patients receive mechanical and buccal chemical hygiene. Oral hygiene is recommended with daily mechanical cleaning (brushing and lavage with sponge of the mucous and lips twice daily as well as dental flossing once a day) and mouth washes with gluconate chlorhexidine in the case of gingivitis and saliva substitutes in the case of xerostomy as well as weekly oral evaluation. In the case of partial or total prosthesis, this should be brushed and left in a cleaning solution for 10 minutes daily and the mouth should be washed with the same procedure as in patients with teeth[122].

Measures related to the alimentation technique are recommended such as postural measures (elevation of the head of the bed and remaining in this posture until 2 hours after ingestion), consistence of the alimentation and prevention of gastroesophageal reflux. There are increasingly more data on pharmacological interventions which act on the swallowing reflex such as those which intervene in the thermoregulatory centers and the cough reflex[122,123]. It is important to avoid medications which may potentiate aspiration such as sedatives and especially antipsychotic drugs. The use of proton pump inhibitors is a debatable subject because of the possibility of producing achlorhydria which may allow the proliferation of bacteria.

Other measures of prevention are early mobilization, treatment of the chronic disease such as diabetes mellitus or cardiac insufficiency, improvement of nutritional status and abstinence from smoking.

CONCLUSIONS

The diagnosis of CAP in the elderly may be more complex due to the physiological changes which occur with age and the accumulation of comorbidity, making it important to categorize these patients fundamentally for the detection of mild frail elderly patients and implement an interdisciplinary approach with the objective of recovering the previous functional status. The pathogen most commonly implicated is *S. pneumoniae*. However, we should assess the risk factors for infection by uncommon pathogens because of the relative increase in their frequency in the elderly and know that the most important risk factors are functional impairment, recent hospitalization, previous antibiotic treatment, the presence of instrumentation and the severity of the process. Infection by MRSA is very infrequent in Spain and infection by *P. aeruginosa* is mainly observed in patients with chronic respiratory, disease and enterobacteriacea are related to functional impairment. It is important to know the situation of local resistance to adapt the antibiotic treatment of the patient to the etiological suspicion. And lastly, prevention measures which diminish the incidence and severity of pneumonia in the elderly should be taken into account.

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