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The Most Common Detected Bacteria in Sputum of Patients with Community Acquired Pneumonia (CAP) Treated In Hospital

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ABSTRACT

Introduction: Community acquired pneumonia (CAP) is the most common infective pulmonary disease. **Objective:** To show the most common detected bacteria in bacterial culture of sputum in patients with CAP hospitalized in Clinic for Pulmonary Diseases and TB "Podhrastovi" in four-year period: from 2012 to 2015. **Material and methods:** This is the retrospective analysis. Each patient gave sputum 3 days in a row when admitted to hospital. Sputum has been examined: bacterial culture with antibiotics sensitivity, Gram stain, Mycobacterium tuberculosis; in cases with high temperature blood cultures were done; when we were suspicious about bronchial carcinoma bronchoscopy with BAL (bronchoalveolar lavage) was done. We show analyzed patients according to age, sex, whether they had pneumonia or bronchopneumonia, bacteria isolated in sputum and in BAL. **Results:** 360 patients with CAP were treated in four-year period (247 males and 113 females). 167 or 43, 39 % had pneumonia (119 males and 48 females). Number of males was significantly bigger ($\chi^2 = 30,186$; $p < 0,001$). 193 or 53, 61 % had bronchopneumonia (128 males and 65 females). Number of males was significantly bigger ($\chi^2 = 20,556$; $p < 0,001$). Number of patients with negative bacterial culture of sputum (131-78, 44%) was significantly bigger than number of patients with positive culture (36-21, 56%) ($\chi^2 = 50,042$; $p < 0,001$) in pneumonia. Number of patients with negative bacterial culture of sputum (154- 79, 79%) was significantly bigger than number of patients with positive culture (39- 20, 21%) ($\chi^2 = 68,523$; $p < 0,001$) in bronchopneumonia. Streptococcus pneumoniae was significantly most common detected bacterium compared with the number of other isolated bacteria; in pneumonia ($\chi^2 = 33,222$; $p < 0,001$) and in bronchopneumonia ($\chi^2 = 51,231$; $p < 0,001$). **Conclusion:** It is very important to detect the bacterial cause of CAP to administrate the targeted antibiotic therapy.

Key words: CAP, bacterial sputum culture.

1. INTRODUCTION

Pneumonia is as an infection of lung parenchyma (1, 2). Pneumonia is an acute illness with symptoms and signs of consolidation in the chest or new changes on the chest X-ray. It is usually caused by bacteria (1, 2).

Pneumonia is classified on the basis of:

- The circumstances in which it originates (community or hospital acquired pneumonia

or pneumonia in immunocompromised hosts);

- Anatomy (lobar pneumonia or bronchopneumonia);
- Organisms causing pneumonia (bacterial, atypical, viral, fungal, protozoan).
- It is now common to use the first classification because the anatomical site is of limited benefit in treatment and the causing organisms may be undetected (1-5).

Lobar pneumonia occurs when organisms colonize alveolar spaces, bronchopneumonia when organisms colonize bronchi and extend in alveoli (1, 2).

The lung and tracheobronchial tree are usually sterile below the larynx. An infecting agent reaches this site via breach in host defenses. This may be by micro-aspiration from upper airways or mouth, haematogenous spread, spread from an adjacent structure, inhalation, activation of previously hidden infection (2, 5, 6).

Factors that undermine the lung's defense increase the risk of pneumonia: aspiration, cigarette smoking, alcoholism, corticosteroids/immunosuppression; comorbidities: COPD, cardiovascular diseases, chronic kidney or liver disease, cancer, diabetes, dementia, cerebrovascular diseases, immunodeficiency, use of gastric acid-suppressive medications (7), nursing home residents. The risk of aspiration is increased by alcoholism, anesthesia, neurological diseases, and disorders of the gastrointestinal tract (8). Mixed flora including anaerobes is involved in many cases (9, 10). Smoking is associated with an increased frequency of CAP because smoking alters mucociliary transport, humoral and cellular defenses, affects epithelial cells, and increases adhesion of bacteria to epithelium (11). Alcohol facilitates bacterial colonization of the oropharynx, impairs cough reflexes and cellular defenses and alters swallowing and mucociliary transport (12). The most frequent comorbidity associated is COPD because of alterations in mechanical and cellular defenses (13).

CAP is usually caused by Gram-positive, hospital acquired pneumonia by Gram-negative bacteria (1). The etiological agent cannot be predicted from clinical features; some features are more likely associated with one bacterium than another (1, 2).

- **Streptococcus pneumoniae** (the pneumococcus): causes a high mortality; the most frequently identified, commonest in winter; elderly, comorbidity (especially cardiovascular); acute onset, high fever, pleural pain, dry or no cough, female; bacteremic *Streptococcus pneumoniae*: alcoholisms, diabetes, COPD.
- **Mycoplasma pneumoniae**: usually in young patients; many extrapulmonary manifestations as hemolysis, hepatitis, skin and joint problems.
- **Influenza**: epidemic, common in the winter, pneumonia in 3% of cases. *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae* occur secondarily; 10% of those admitted to hospital have *Staphylococcus aureus* infection; patients with underlying lung disease.
- **Legionella pneumophila**: Gram negative; found in cooling towers and air conditioning; high mortality; common in the autumn. Younger patients, smokers, no comorbidity, neurological symptoms, abnormal liver enzymes and raised creatine kinase.
- **Chlamydia pneumoniae**: epidemics; it is not clear whether it has a direct role, or is an associated infectious agent. Headache is very common.

- **Haemophilus influenzae**: Gram negative; common associated with exacerbations of COPD.
- **Viruses other than influenza.**
- **Staphylococcus aureus**: Gram positive; often follows flu; commonest in winter. Coincident influenza infection in 39% of those requiring hospital admission, alcoholics and patients with mitral valve disease are susceptible; often cavitating pneumonia; often fatal.
- **Klebsiella pneumoniae**: Gram negative; often in alcoholics; often cavitates, low platelet count and leukopenia, male.
- **Chlamydia psittaci**: acquired from birds and animals, 20% of cases have a history of bird contact. Human-to-human spread may occur.
- **Coxiella burnetii (Q fever)**: epidemics; animal sources (usually sheep), occupational exposure only present in 8%.
- **Acinetobacter**: elderly, often history of alcoholism or mechanical ventilation.
- **Streptococcus milleri**: dental or abdominal source of infection.
- **Streptococcus viridians**: aspiration.

For any pathogen, the severity of disease is determined by the subject's age and the presence and type of coexisting illness (14).

Investigations for CAP: chest x-ray, sputum-bacterial culture and Gram stain (15), blood culture (low sensitivity, high specificity), pleural fluid-culture, bronchoscopy with BAL, blood gas analysis, CT- chest, blood tests: a white cell count (WCC) $>15 \times 10^9$ suggests bacterial infection; counts of >20 or <4 indicate severe infection (1). Deranged renal and liver function tests indicate severe infection, or underlying disease (1, 2); C-reactive protein (CRP) is very useful. If CRP does not fall by $>50\%$ at 4 days it suggests treatment failure or the development of a complications (2).

There are specific serological tests for Pneumococcal pneumonia; Legionnaires' disease; Mycoplasma pneumoniae; Chlamydia pneumoniae; Influenza A and B, adenovirus, respiratory syncytial virus (RSV); *Coxiella burnetii* (1, 2).

Antibiotic treatment should be started immediately, without waiting for microbiology results.

2. OBJECTIVE

To show the most common detected bacteria in sputum of patients with CAP treated in Clinic for pulmonary diseases and TB "Podhrastovi" in four-year period: from 2012 - 2015 year.

3. MATERIAL AND METHODS

This is the retrospective study. We analyzed the microbiological findings of sputum in patients with CAP treated in Clinic for pulmonary diseases and TB "Podhrastovi" in four-year period. Most of these patients (74%) were previously treated with antibiotics in community by family doctor or a pulmonologist. Each patient gave sputum 3 days in a row when admitted to hospital. Sputum has been examined in Department for microbiology of Clin-

ical Center - bacterial culture with antibiotics sensitivity and Gram stain, and for Mycobacterium tuberculosis to exclude TB in Microbiological laboratory of Clinic "Podhrastovi"; in severe cases with high temperature blood cultures were done; when we had doubts about diagnosis bronchoscopy with BAL was done and material was tested for bacterial culture and cytological analysis was done. We show analyzed patients according to age, sex, whether they had pneumonia or bronchopneumonia, bacteria isolated in sputum and BAL.

4. RESULTS

In four-year period (from 2012 to 2015) 10128 patients were treated in Clinic "Podhrastovi". and 360 or 3,56 % of them had CAP. There were 167 patients with pneumonia, and 193 with bronchopneumonia. The difference of patients with pneumonia and bronchopneumonia is not significant ($p=0,171$). There were 247 males and 113 females. Number of males is significantly bigger ($\chi^2 = 49,878$; $p < 0,001$). 167 or 43, 39 % of patients had pneumonia (119 males and 48 females). Number of males was significantly bigger ($\chi^2 = 30,186$; $p < 0,001$). 193 or 53, 61 % of patients had bronchopneumonia (128 males and 65 females). Number of males was significantly bigger ($\chi^2 = 20,556$; $p < 0,001$) (Figure 1). There were 119 males (41,18% of males) average aged of $55,56 \pm 2,34$ years with pneumonia and 128 (51,82% of males) average aged $58,78 \pm 3,18$ years with bronchopneumonia. There were 48 females (42,48% of females) average aged $60,75 \pm 1,19$ years with pneumonia and 65 (57,52% of females) average aged $61,63 \pm 2,08$ years with bronchopneumonia.

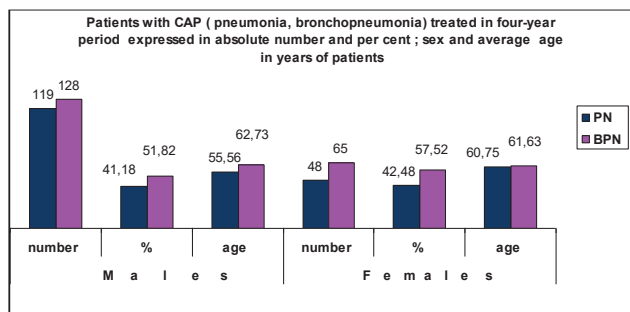


Figure 1. Patients with CAP: type of pneumonia, sex and age. Legend: PN= pneumonia, BPN= bronchopneumonia

Of 167 patients with pneumonia 131 (78, 44%) had negative bacterial culture of sputum; 36 (21, 56 %) patients had positive culture. Number of patients with negative culture was significantly bigger ($\chi^2 = 50,042$; $p < 0,001$).

Of 193 patients with bronchopneumonia 154 (79,79 %) had negative bacterial culture of sputum; 39 (20,21%) patients had positive culture. Number of patients with negative culture was significantly bigger ($\chi^2 = 68,523$; $p < 0,001$).

We found Streptococcus pneumoniae in 16 patients with pneumonia (PN) and in 17 with bronchopneumonia (BPN), Klebsiella pneumoniae in 8 patients with PN and 8 with BPN, Staphylococcus aureus in 3 PN and 1 BPN, Pseudomonas aeruginosa in 3 PN and 3 BPN, Escherichia coli in 1 PN and 3 BPN, Enterobacter cloacae in 4 PN and 4 BPN, Proteus mirabilis in 1 PN and 1 BPN,

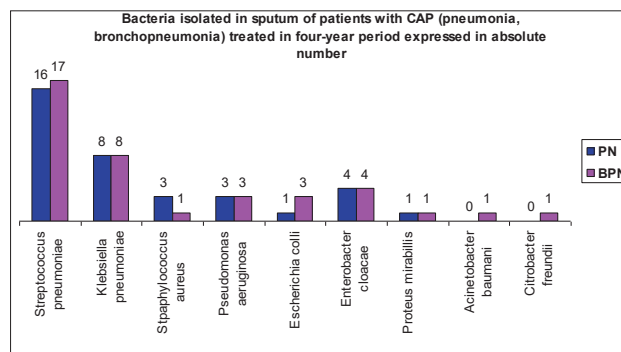


Figure 2. Bacteria isolated in sputum of patients with CAP (pneumonia, bronchopneumonia) Legend: PN= pneumonia, BPN= bronchopneumonia

Acinetobacter baumannii in 1 BPN, Citrobacter freundii in 1 BPN, normal flora was in 131 with PN and 154 with BPN (Figure 2).

The most common detected bacterium was Streptococcus pneumoniae (16 patients with PN, 17 with BPN). Normal flora was found in 131 patients with PN and 154 with BPN. Streptococcus pneumoniae was significantly most common detected bacterium compared with other bacteria; in PN ($\chi^2 = 33,222$; $p < 0,001$) and in BPN ($\chi^2 = 51,231$; $p < 0,001$).

In 360 patients with CAP etiological agent was detected in 75 or in 20, 83 %.

In patients with pneumonia there were 9,58 % patients with Streptococcus pneumoniae in sputum, 4,79% with Klebsiella pneumoniae, 1,8% with Staphylococcus aureus, 1,8% Pseudomonas aeruginosa, 0,6% Escherichia coli, 2,4% Enterobacter cloacae, 0,6% Proteus mirabilis , normal flora was detected in 78,44% (Figure 3).

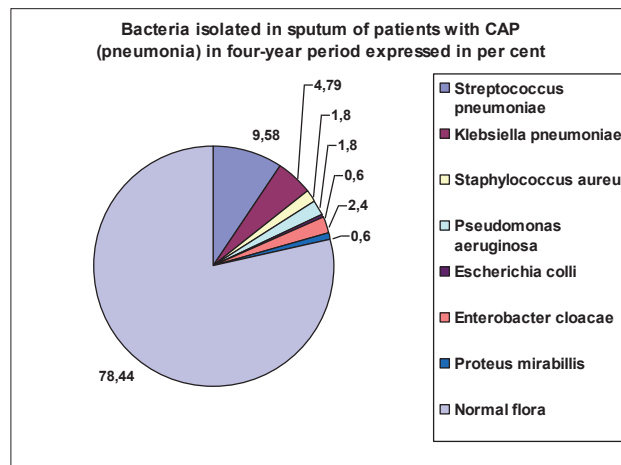


Figure 3. Bacteria isolated in sputum of patients with CAP (pneumonia)

As presented on Figure 3, 78, 44% of patients with pneumonia had normal flora. In 9, 58% Streptococcus pneumoniae was detected .That was significantly bigger than other isolated bacteria ($\chi^2 = 33,222$; $p < 0,001$).

In patients with bronchopneumonia there were 8,8 % patients with Streptococcus pneumoniae in sputum, 4,15% with Klebsiella pneumoniae, 0,52% with Staphylococcus aureus, 1,55% Pseudomonas aeruginosa, 1,55% Escherichia coli, 2,07% Enterobacter cloacae, 0,52%

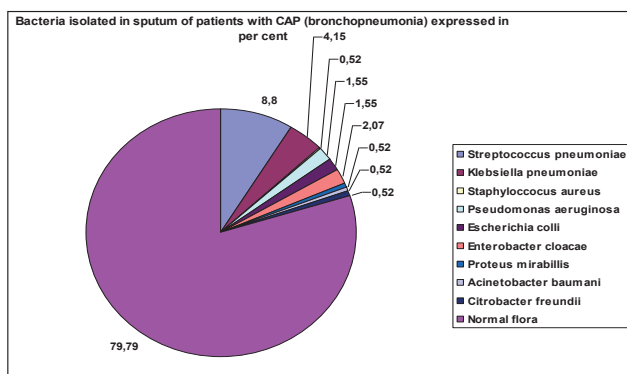


Figure 4. Bacteria isolated in sputum of patients with CAP (bronchopneumonia)

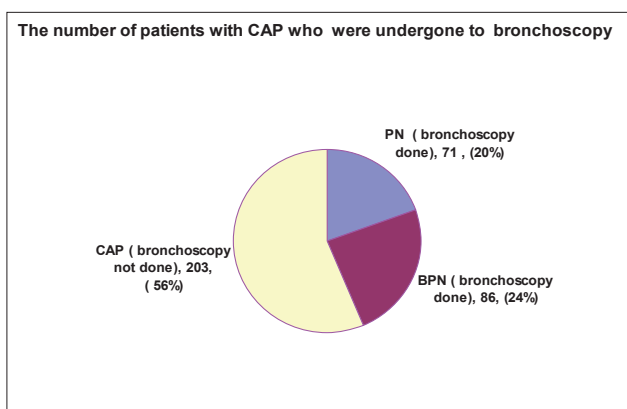


Figure 5. Patients with bronchoscopy done

Proteus mirabilis , 0,52%, *Acinetobacter baumannii*, 0,52% *Citrobacter freundii*, normal flora was detected in 79,79% (Figure 4).

Figure 4 shown that 79,79% of patients with bronchopneumonia had normal flora. In 8,8% *Streptococcus pneumoniae* was detected. That was significantly bigger than other isolated bacteria ($\chi^2 = 51,231$; $p < 0,001$).

In 157 (44%) patients (71 pneumonia and 86 bronchopneumonia) bronchoscopy with BAL was done (Figure 5). Bacterial culture was positive in 1 case of pneumonia (*Klebsiella pneumoniae* as in sputum) and in 2 cases of bronchopneumonia (*Pseudomonas aeruginosa* and *Streptococcus pneumoniae* as in sputum).

Bronchoscopy with BAL was done in 157 (44%) of patients with CAP (Figure 5).

Blood bacterial culture was done in 150 patients. It was positive in less than 1% of them.

5. DISCUSSION

CAP is the most common infective pulmonary disease and is usually caused by bacteria (1, 2). The true incidence of CAP is uncertain because the illness is not reportable and only 20% to 50% of patients require hospitalization (16,17). 5-10% of patients with CAP require ICU (intensive care unit) admission with mortality up to 50% (2, 4, 6). In our clinic mortality from CAP was 2%, may be because in this study we considered only the patients with CAP without underlying diseases such as bronchial carcinoma etc. 6% of our patients required treatment in ICU. Patients with zoonoses and HIV were transferred to Clinic for infective diseases.

It is difficult to detect pathogens causing CAP. In around third cases no cause is found (1). The cause for CAP is not found in 25-60% of patients (2). The responsible pathogen is not isolated in 50% to 60% of patients with severe CAP (18). We did not isolate causing bacteria in 78, 44% patients with pneumonia and 79, 79% with bronchopneumonia possibly because that great number of patients was treated with antibiotics prior to hospitalization. BAL was done in patients older than 50 years to exclude bronchial carcinoma, in slow radiological remission, unusual X-ray appearance, and slow clinical recovery.

We had very poor results in detecting causing bacteria by BAL because we did not do bronchoscopy while patient was in respiratory or cardiac failure or was febrile. That entire period patient was under antibiotic therapy. We had 73 patients sent to hospital with diagnosis of CAP but by bronchoscopy we diagnosed bronchial cancer. These patients were not included in this study.

In our study we had only 3 patients with 2 different bacteria isolated in sputum.

In 150 patients with high fever when we suspected that septicemia may be presented blood culture was done. Less than 1% was positive. In other studies about 10% of patients with CAP have positive blood cultures if examination is done (2).

Antibiotics given before admission in hospital can influence the results of microbiological investigations (3, 4, 5, 6). 74% of our patients were treated with antibiotics in community.

Antibiotics administered according to bacterial culture of sputum lead to successful treatment. In the case of treatment failure we should consider: slow clinical response, incorrect diagnosis, pulmonary and extrapulmonary complications, impaired immunity or inappropriate antibiotics, less common bacteria, resistance to antibiotics; mixed infection (2, 3, 6, 19).

Streptococcus pneumoniae causes, according to some authors, 55-75 % of all CAP (1) and two-thirds of all cases of pneumonia with bacteraemia (2, 7, 20). In our study *Streptococcus pneumoniae* was the most common detected bacteria but only in 9,58% of cases with pneumonia and in 8,8 % with bronchopneumonia .

6. CONCLUSION

It is very important to detect the causing microorganism of CAP because the organism specific-therapy is so enabled. Targeted antibiotic therapy limits the risk of antibiotic toxicity and its adverse effects, reduces costs and duration of treatment and the possibilities of development of antibiotic resistance and complications of illness. Clinical doctor should be very tenacious in searching for causing bacteria of CAP. Early administration of antibiotics leads to a better outcome so that sputum bacterial culture should be done as soon as patient is admitted to hospital.

• Conflict of interest: none declared.

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