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# *Chlamydia pneumoniae* and *Mycoplasma pneumoniae* pneumonia: comparison of clinical, epidemiological characteristics and laboratory profiles

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## SUMMARY

The purpose of our retrospective 3-year study was to analyse and compare clinical and epidemiological characteristics in hospitalized patients older than 6 years with community-acquired pneumonia (CAP) caused by *Chlamydia pneumoniae* (87 patients) and *Mycoplasma pneumoniae* (147 patients). *C. pneumoniae* and *M. pneumoniae* infection was confirmed by serology. *C. pneumoniae* patients were older (42·12 *vs.* 24·64 years), and were less likely to have a cough, rhinitis, and hoarseness ($P<0{\cdot}001$). *C. pneumoniae* patients had higher levels of C-reactive protein (CRP), and aspartate aminotransferase (AST) than *M. pneumoniae* patients ($P<0{\cdot}001$). Pleural effusion was recorded more frequently in patients with *M. pneumoniae* (8·84 *vs.* 3·37%). There were no characteristic epidemiological and clinical findings that would distinguish CAP caused by *M. pneumoniae* from *C. pneumoniae*. However, some factors are indicative for *C. pneumoniae* such as older age, lack of cough, rhinitis, hoarseness, and higher value of CRP, and AST.

## INTRODUCTION

Atypical pneumonia agents such as *Chlamydia pneumoniae* and *Mycoplasma pneumoniae* are an important cause of community-acquired pneumonia (CAP) [1]. The prevalence of CAP caused by *C. pneumoniae* and *M. pneumoniae* varies from 3 to 43% of all CAP cases [2–7]. These organisms share similar epidemiological and clinical characteristics in human infection and disease [8]. Pneumonia caused by these pathogens is usually associated with low severity but this may vary with the patient's age, the presence of co-pathogens, or the existence of comorbidity [9]. The diagnosis of *C. pneumoniae* and *M. pneumoniae* CAP has been made by several diagnostic techniques: antibody tests, culture, antigen detection, and identification of specific DNA sequences by polymerase chain reaction (PCR) [10]. The isolation and identification of *C. pneumoniae* and *M. pneumoniae* is difficult, time consuming, not routinely available and expensive [11]. Serology remains the main diagnostic tool in clinical practice.

*C. pneumoniae* has been associated with atherosclerotic cardiovascular disease including coronary artery disease [12]. However, *C. pneumoniae* may cause acute exacerbation of chronic obstructive pulmonary disease (COPD) [13]. The microbiological eradication of *C. pneumoniae* may be difficult with effective antimicrobial therapy even when good clinical response occurs [14]. Failure to eradicate may have significant clinical consequences such as reactivation of COPD being of most concern, in association with coronary artery disease [15, 16].

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*M. pneumoniae* is responsible for producing a wide spectrum of non-pulmonary manifestations including neurological, hepatic, cardiac, and haematological manifestations [17]. Central and peripheral nervous system manifestations are common complications associated with *M. pneumoniae* infection [18]. The outcome of CNS involvement ranges from normal to severe residual deficits [19].

We studied a group of 89 patients with CAP caused by *C. pneumoniae* and compared them with 147 patients with CAP caused by *M. pneumoniae*. Serological tests are regarded as diagnostic, although the results are usually not available in a timely manner. The hypothesis is that clinical, radiological, and laboratory manifestations of the pneumonia caused by *C. pneumoniae* closely resemble those of *M. pneumoniae*. The goal of this study was to determine whether we may distinguish pneumonia caused by *C. pneumoniae* from *M. pneumoniae* on the basis of epidemiological, clinical, laboratory and radiological characteristics before serological confirmation of infection. The goal was also to establish a presumptive diagnosis of pneumonia that can be useful for both prognostic and therapeutic purposes.

## METHODS

We analysed retrospectively patients with CAP caused by *C. pneumoniae* and *M. pneumoniae* hospitalized at the University Hospital for Infectious Diseases, Zagreb, during the 3-year period from 1 January 1998 to 31 December 2000. The University Hospital serves a population of 1 000 000 inhabitants of Croatia's capital, Zagreb, and its surrounding region. Annually, 600–800 patients of all ages are hospitalized with CAP, accounting for $\sim$10% of all hospitalized patients.

Patients who met the following criteria were included in the study: age $>$6 years, clinical findings suggestive of pneumonia (cough, fever, rales), evidence of a new pulmonary infiltrate on chest X-ray, and confirmed acute infection of *C. pneumoniae* and *M. pneumoniae*. Exclusion criteria included nosocomial pneumonia, patients with active tuberculosis, HIV-positive patients, and patients who were discharged from hospital $<$21 days prior to their current hospitalization due to pneumonia.

The diagnosis of *C. pneumoniae* and *M. pneumoniae* infection was based on serological testing of antibodies. *C. pneumoniae* was diagnosed by microimmunofluorescence (MIF) based on *C. pneumoniae* elementary bodies (Savyon Diagnostics Ltd, Ashdod, Israel) as antigen to detect specific IgG, IgA and IgM antibodies. Evidence of acute infection was defined as four-fold rise in *C. pneumoniae* antibody titre between acute and convalescent serum samples or an IgM antibody titre of $\geqslant$16. Patients with a serum IgG titre of $\geqslant$512 in both acute and convalescent serum samples without a four-fold rise in titre in convalescent serum were excluded.

Serum antibodies to *M. pneumoniae* were assayed by enzyme-linked immunosorbent assay (ELISA) by using P1 membrane protein as antigen (Savyon Diagnostics Ltd). Evidence of infection was defined as either a single positive serum IgM titre ($\geqslant$10) in any serum sample or a four-fold increase in IgG titre in paired sera.

Paired serum samples were tested for antibodies to *Chlamydia psittaci*, *Legionella pneumophila* and *Coxiella burnetii*. In addition, urine samples from patients were tested for *L. pneumophila* serogroup-1 antigen. We also performed blood culture specimens and in selected patients' sputum culture prior to antibiotic therapy.

We analysed epidemiological data (age, gender, and cluster of patients, seasonal variations, date of onset of present illness, underlying comorbidity), clinical signs and symptoms (fever, cough, headache, chest pain, hoarseness, sore throat, rhinitis, myalgias/arthralgias, vomiting, diarrhoea), and laboratory findings [erythrocyte sedimentation rate (ESR), white blood cell count, sodium, aspartate aminotransferase (AST), alanine aminotransferase (ALT), C-reactive protein (CRP), alpha-2 globulin, urine, electrocardiogram (ECG)].

A chest radiograph was obtained on admission to hospital. The radiological manifestations of pulmonary infiltrates were described as: interstitial infiltrate, bronchopneumonia or alveolar infiltrate.

### Statistical analysis

Means and standard deviations were calculated to summarize continuous variables. For categorical variables, group percentages were calculated. Differences between patient groups were calculated using Fisher's exact one-tailed test for categorical variables and Student's *t* test for continuous variables. Results were considered significant at *P* value of $<$0·05. All tests were performed with the Statistica for Windows software package [20].

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Table 1. *Baseline demographic and epidemiological details of patients with CAP caused by* C. pneumoniae *and* M. pneumoniae

| Characteristics | *C. pneumoniae* ($n=89$) (%) | *M. pneumoniae* ($n=147$) (%) | *P* value |
|---|---|---|---|
| Males | 73 (82·02%) | 102 (69·39%) | 0·022* |
| Females | 16 (17·98%) | 45 (30·61%) | |
| Age (years) | 42·12 ± 17·92 | 24·64 ± 13·59 | 0·028** |
| Comorbidity† | 14 (15·73%) | 9 (6·12%) | 0·016* |
| Current smoker | 26 (29·21%) | 46 (31·29%) | 0·426* |
| Outbreak‡ | 12 (13·48%) | 45 (30·61%) | 0·002* |
| Duration of symptoms prior to admission | 6·24 ± 2·79 | 6·53 ± 2·71 | 0·989** |

CAP, Community-acquired pneumonia.
† Comorbidity: liver disease, renal disease, congestive heart failure, cerebrovascular disease, neoplastic disease, chronic obstructive pulmonary disease.
‡ Outbreaks in families, schools, military barracks, nursing homes.
Statistical analysis: * Fisher's exact one-tailed test; ** Student's *t* test.

## RESULTS

From 1 January 1998 to 31 December 2000, we studied 89 patients with CAP caused by *C. pneumoniae* and 147 with CAP caused by *M. pneumoniae* treated at the University Hospital for Infectious Diseases, Zagreb. These were chosen out of a larger group of 1285 hospitalized patients with CAP >6 years old including 774 (60·73%) patients whose serum samples were tested for evidence of infection. *C. pneumoniae* infection was confirmed in 89 patients, accounting for 6·93% of all patients with CAP, and 11·5% of patients whose serum samples were tested. Of these, 11 patients had more than one pathogen identified as a cause of pneumonia. *Streptococcus pneumoniae*, as a co-pathogen, was confirmed in six, *M. pneumoniae* in three, and *L. pneumophila* in two patients. *M. pneumoniae* infection was confirmed in 147 patients, accounting for 11·44% of all CAP patients, and 18·99% of patients whose serum samples were tested. Ten patients with *M. pneumoniae* infection had a co-pathogen. *S. pneumoniae* was confirmed in five, *C. pneumoniae* in three, and *L. pneumophila* in one patient.

Details of patients with *C. pneumoniae* infection and *M. pneumoniae* infection are presented in Table 1. The majority of patients were males in both study groups ($P=0·022$). The mean age in the *C. pneumoniae* group was 42·12 ± 17·92 years, significantly higher compared to the *M. pneumoniae* group (24·64 ± 13·59 years, $P<0·028$). There were significant differences between *C. pneumoniae* patients and *M. pneumoniae* patients in terms of comorbidity (14/89 *vs.* 9/147, $P=0·016$). Nearly one third of patients in both groups were smokers ($P=0·426$). The duration of symptoms prior to admission to hospital was similar (6·24 *vs.* 6·53 days, $P=0·989$). A lower incidence of *C. pneumoniae* than *M. pneumoniae* patients had a history of contact with a person with similar symptoms (12/89 *vs.* 45/147, $P=0·002$). Most cases of mycoplasma outbreaks occurred in schools (22), among family members (13), and military recruits (10). Six patients with *C. pneumoniae* CAP but none with *M. pneumoniae* infection came from nursing homes.

Table 2. *Age-specific rates of infection in patients with CAP caused by* C. pneumoniae *and* M. pneumoniae

| Age group (years) | *C. pneumoniae* | | *M. pneumoniae* | |
|---|---|---|---|---|
| | No. | % | No. | % |
| 7–14 | 3 | 3·37 | 27 | 28·36 |
| 15–19 | 7 | 7·87 | 34 | 23·13 |
| 20–29 | 18 | 20·22 | 44 | 29·93 |
| 30–39 | 9 | 10·11 | 23 | 15·64 |
| 40–49 | 21 | 23·60 | 8 | 5·45 |
| 50–59 | 14 | 15·73 | 8 | 5·45 |
| ⩾60 | 17 | 19·10 | 3 | 2·04 |
| Total | 89 | 100·00 | 147 | 100·00 |

CAP, Community-acquired pneumonia.

The oldest patient with *C. pneumoniae* CAP was 85 years of age (Table 2). CAP caused by *C. pneumoniae* was uncommon in school-aged children, and its

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Table 3. *Distribution of infection in patients with CAP caused by* C. pneumoniae *and* M. pneumoniae *by month*

| | *C. pneumoniae* | | *M. pneumoniae* | |
|---|---|---|---|---|
| Month | No. | % | No. | % |
| January | 4 | 4·49 | 2 | 1·36 |
| February | 5 | 5·62 | 0 | 0 |
| March | 3 | 3·37 | 1 | 0·68 |
| April | 4 | 4·49 | 7 | 4·76 |
| May | 4 | 4·49 | 7 | 4·76 |
| June | 16 | 17·98 | 2 | 1·36 |
| July | 14 | 15·73 | 11 | 7·48 |
| August | 6 | 6·74 | 16 | 10·89 |
| September | 10 | 11·24 | 26 | 17·69 |
| October | 7 | 7·87 | 34 | 23·13 |
| November | 8 | 8·99 | 34 | 23·13 |
| December | 8 | 8·99 | 7 | 4·76 |
| Total | 89 | 100·00 | 147 | 100·00 |

CAP, Community-acquired pneumonia.

Table 4. *Symptoms in patients with CAP caused by* C. pneumoniae *and* M. pneumoniae

| | *C. pneumoniae* | | *M. pneumoniae* | | |
|---|---|---|---|---|---|
| Symptoms | No. | % | No. | % | *P* value |
| Temperature (>37·5 °C) | 87 | 97·75 | 144 | 97·96 | 0·617 |
| Cough | 73 | 82·02 | 143 | 97·28 | <0·001 |
| Rhinitis | 6 | 6·74 | 45 | 30·61 | <0·001 |
| Hoarseness | 14 | 15·74 | 52 | 35·37 | <0·001 |
| Sore throat | 8 | 8·99 | 22 | 14·87 | 0·127 |
| Chest pain | 8 | 8·99 | 22 | 14·87 | 0·127 |
| Headache | 53 | 59·55 | 78 | 53·06 | 0·201 |
| Vomiting | 17 | 19·10 | 14 | 9·52 | 0·029 |
| Diarrhoea | 10 | 11·24 | 7 | 4·70 | 0·056 |
| Myalgias/ arthralgias | 36 | 40·45 | 48 | 32·65 | 0·142 |
| Pleural effusion | 3 | 3·33 | 13 | 8·84 | 0·101 |

CAP, Community-acquired pneumonia.
Statistical analysis: Fisher's exact one-tailed test.

occurrence increased with age. Eighty patients (20·22%) were in the 20–29 years age group, nine (10·11%) were aged 30–39 years, 21 (23·60%) were aged 40–49 years, 14 (15·73%) were aged 50–59 years, and 17 (19·10%) were ⩾60 years. *M. pneumoniae* most frequently affected older children and younger adults (ages 15–30 years). The oldest patient with *M. pneumoniae* CAP was 65 years old.

The seasonal distribution of *C. pneumoniae* infections is shown in Table 3. A higher proportion of *C. pneumoniae* patients was recorded in the summer months, between June and October while *M. pneumoniae* was more frequent between August and November.

Patients in both groups had similar signs and symptoms on admission to hospital (Table 4). The most common symptoms in patients with *C. pneumoniae* and *M. pneumoniae* infection were fever (97·75 *vs.* 97·96%), cough (82·02 *vs.* 97·28%), and headache (53·06 *vs.* 59·55%) respectively. Patients with *C. pneumoniae* CAP were less likely to have a cough on admission ($P<0·001$). Upper respiratory tract symptoms were less commonly associated with *C. pneumoniae* CAP than with *M. pneumoniae* CAP. Gastrointestinal tract symptoms such as vomiting ($P=0·029$) and diarrhoea ($P=0·056$) were more commonly associated with *C. pneumoniae*. Patients in both groups had similar laboratory results (Tables 5 and 6). The mean ESR did not significantly differ between the *Chlamydia* and *Mycoplasma* group ($P=0·900$), but more patients in the *Chlamydia* group had accelerated ESR ($P=0·047$). The mean leucocyte count was similar in both groups of patients ($10·32\times10^9$/l *vs.* $9·87\times10^9$/l, $P=0·310$). Fifty-one patients (57·3%) from the *C. pneumoniae* group and 86 (58·50%) from *M. pneumoniae* group had a normal leucocyte count ($P=0·481$). The major difference among the groups regarding laboratory results was recorded in the CRP and AST levels. Patients with *C. pneumoniae* CAP had higher levels of CRP ($178·3\pm129·81$ mg/l), and AST ($33·93\pm31·91$ IU/l) than *M. pneumoniae* ($100·9\pm87·73$ mg/l, $22·58\pm17·63$ IU/l respectively). The differences were statistically significant ($P<0·001$, $P<0·001$ respectively). More than one third of *C. pneumoniae* patients and one-fifth of *M. pneumoniae* patients had increased level of AST and ALT ($P=0·019$, $P=0·013$ respectively).

Radiological manifestations of pneumonia in the *C. pneumoniae* group were as follows: interstitial infiltrate in 79 (88·76%), homogeneous segmental or lobar in five (5·62%), and bronchopneumonia in five patients (5·62%). Seven patients had multiple-lobe involvement (7·86%), and only three patients had pleural effusion (3·36%). Out of 147 patients with *M. pneumoniae* CAP chest X-ray showed interstitial infiltrate in 133 (90·48%), alveolar infiltrate in 13 (8·84%), and bronchopneumonic infiltrate in

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Table 5. *Normal range and pathological laboratory findings in patients with CAP caused by* C. pneumoniae *and* M. pneumoniae

| Laboratory finding | Normal range | Pathological finding | | *P* value |
|---|---|---|---|---|
| | | *C. pneumoniae* ($n=89$) | *M. pneumoniae* ($n=147$) | |
| ESR↑ | >20 mm/1.h | 81 | 121 | 0·047 |
| CRP↑ | 10 mg/l | 50/50 | 86/95 | 0·392 |
| WBC↑ | $4–10\times10^9$/l | 38 | 61 | 0·481 |
| AST↑ | 11–38 IU/l | 34 | 36 | 0·019 |
| ALT↑ | 12–48 IU/l | 30 | 29 | 0·013 |
| Alpha-2 globulin↑ | 5·5–9·5 rel. % | 62 | 91 | 0·142 |
| Gamma globulin↑ | 14·5–19·5 rel. % | 29 | 36 | 0·116 |
| Sodium↓ | 138–146 mmol/l | 50 | 74 | 0·231 |
| Abnormal ECG | | 32/76 | 42/125 | 0·248 |

↑, Increased values; ↓, decreased values.
CAP, Community-acquired pneumonia; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; WBC, white blood cell; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ECG, electrocardiogram.
Statistical analysis: Fisher's exact one-tailed test.

Table 6. *Laboratory findings in patients with CAP caused by* C. pneumoniae *and* M. pneumoniae

| Laboratory finding | *C. pneumoniae* | | *M. pneumoniae* | | *P* value |
|---|---|---|---|---|---|
| | $x\pm$S.D. | Range | $x\pm$S.D. | Range | |
| ESR (mmHg/1.h) | 58·82±24·46 | 8–130 | 47·64±24·79 | 6–112 | 0·900 |
| CRP mg/l ($n=95$, $n=50$) | 178·3±129·81 | 12–496 | 100·9±87·73 | 2–331 | <0·001 |
| WBC ($\times10^9$/l) | 10·32±4·30 | 4·6–29·0 | 9·87±3·91 | 3·8–35·8 | 0·310 |
| AST (IU/l) | 33·93±31·91 | 8–137 | 22·58±17·63 | 8–137 | <0·001 |
| ALT (IU/l) | 41·22±43·77 | 11–212 | 27·52±37·13 | 7–383 | 0·079 |
| Alpha-2 (rel. %) | 11·26±2·43 | 6·9–17·1 | 10·14±2·20 | 5·4–16·5 | 0·271 |
| Gamma (rel. %) | 16·64±3·06 | 11·2–28·6 | 16·51±2·80 | 9·4–25·9 | 0·336 |
| Sodium (mmol/l) | 136·87±2·67 | 128–142 | 137·41±2·67 | 130–144 | 1·000 |

CAP, Community-acquired pneumonia; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; WBC, white blood cell; AST, aspartate aminotransferase; ALT, alanine aminotransferase.
Statistical analysis: Student's *t* test.

one patient (0·68%). Ten patients (6·80%) had involvement in more than one lobe, and 13 patients had pleural effusion (8·84%). The two aetiological groups could not be differentiated by radiographic findings on admission.

## DISCUSSION

In total, 1285 patients with CAP who had been hospitalized at the University Hospital for Infectious Diseases 'Dr Fran Mihaljević', Zagreb were included in a retrospective study conducted over a course of 3 years. They were residents of Zagreb or its surrounding area, included both genders and were >6 years old. *C. pneumoniae* and *M. pneumoniae* were common causes of pneumonia in our study (6·93 and 11·44% respectively). The most prevalent concomitant aetiological agent was *S. pneumoniae* in both patient groups. The limitation of the study was its reliance on serological techniques alone for the diagnosis of *C. pneumoniae* and *M. pneumoniae* infection. The preferred diagnostic finding is documentation of a four-fold increase in titre from acute to convalescent specimen, with supporting evidence by PCR or culture [21, 22].

*M. pneumoniae* was the most commonly confirmed pathogen of CAP described in our previously

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published report [23]. *M. pneumoniae* causes a small percentage of cases of CAP that require hospitalization [24]. The incidence of infection with *M. pneumoniae* among hospitalized adults with CAP ranges from 3 to 30% [4, 6, 25], and it is much higher among young adults who are treated as outpatients [26]. Although the prevalence varies from year to year and between different geographical settings, *C. pneumoniae* causes approximately 5–15% of cases of CAP [2–4, 27, 28]. The majority of cases of pneumonia are relatively mild and associated with low mortality.

In the present study *C. pneumoniae* affected adults of all ages with the most frequent incidence in the 40–49 years age group. *M. pneumoniae* infection was most common among older children and young adults. The mean age of patients with *C. pneumoniae* CAP was significantly higher than that of *M. pneumoniae* CAP. On the basis of serological criteria 11 (12·56%) patients with *C. pneumoniae* CAP had an acute primary infection (IgM antibody response), and 78 (87·44%) patients had a recurrent acute infection. Only three of our patients were heavy smokers with COPD. *C. pneumoniae* may lead to inhibition of ciliary motion and facilitate infection of the lower respiratory tract [13]. Five of our patients with serologically confirmed *C. pneumoniae* infection had heart disease. Of these, two patients had severe pneumonia with *S. pneumoniae* as the co-pathogen. The patients were discharged as improved, but after a prolonged hospital stay. However, clinical characteristics in these patients may reflect manifestations of *S. pneumoniae*, with *C. pneumoniae* aggravating the cardiac disease. Certainly, *C. pneumoniae* infection has been associated with cardiovascular diseases [12]. Our study has shown that elderly patients, and those with underlying diseases had an elevated risk of CAP caused by *C. pneumoniae*, and comorbidities undoubtedly played a significant role in the clinical course.

Other studies described similar findings and reported that the highest incidence of *C. pneumoniae* pneumonia was among the elderly, and *M. pneumoniae* in adolescents and young adults [4, 7, 25–27]. Males were affected more often than females in both groups of patients which corresponds to findings of other researches [4–7, 25–27].

In our study, a higher incidence of *C. pneumoniae* CAP was recorded between June and October, but *M. pneumoniae* infection had the highest incidence in autumn. We noted a small outbreak of *C. pneumoniae* infection during the summer months in 1999. It was preceded by an outbreak of *M. pneumoniae* pneumonia from August to December. In 1999 there was an outbreak of CAP caused by both *C. pneumoniae* and *M. pneumoniae*. In the inter-epidemic period, we recorded no significant differences in the incidence of CAP in these two patient groups.

Several publications have recorded no seasonal differences in the incidence of *C. pneumoniae* CAP [29, 30], although one study described *C. pneumoniae* infection during all seasons with a higher incidence in the summer months [31]. *C. pneumoniae* epidemics are characterized by an initial high incidence period which lasts from a few months to 2–3 years followed by 3–4 years of lower incidence [32]. Some studies suggest that there is no seasonal variation in *M. pneumoniae* infection; however, other data suggest that its incidence is greatest during the autumn and winter months [33]. For less clear reasons, *M. pneumoniae* outbreaks occur every 3–6 years [22, 33, 34].

Several differences between the symptoms produced by *C. pneumoniae* and *M. pneumoniae* were recorded. The patients with *C. pneumoniae* were less likely to have a cough and upper respiratory tract symptoms (rhinitis, hoarseness and sore throat) than patients with *M. pneumoniae* CAP. Analysis of the laboratory findings in our study showed that CRP as well as AST were the most important laboratory findings in differentiating *C. pneumoniae* from *M. pneumoniae* CAP. The reason is that *C. pneumoniae* invades the blood and spreads into different organs, while *M. pneumoniae* remains on the respiratory tract epithelia causing a weaker inflammatory reaction with lower values of CRP and AST. The results suggest that CAP caused by *C. pneumoniae* is a more severe disease than pneumonia caused by *M. pneumoniae*. However, a higher proportion of *C. pneumoniae* patients had an increased aminotransferase level. There were no differences regarding radiological presentation of pneumonias, and most patients had interstitial infiltrates. Pleural effusion was more frequently recorded in *M. pneumoniae* patients. Numerous studies indicate that clinical symptoms, laboratory findings, and radiographic manifestations of *C. pneumoniae* pneumonia resemble those in patients with *M. pneumoniae* pneumonia [1, 8, 9, 25, 27]. Pneumonia caused by these pathogens is usually mild, but in some cases it can be severe even in normal healthy individuals [35, 36].

Electrocardiographic changes were found in nearly one-third of our patients. All ECG manifestations were transient and all patients completly recovered.

Seedat et al. described ECG changes in 31% of patients of CAP [37]. Mechanisims of ECG changes in patients with pneumonia may be multifactorial and may include hypoxia, electrolyte changes, adrenergic stimulation, and direct cardiac involvement [37].

In conclusion, there are no clinical signs or symptoms or routine, rapid laboratory tests that would differentiate *C. pneumoniae* CAP from *M. pneumoniae* CAP. However, some features of *C. pneumoniae* infection are indicative, such as older age of patients, cough and symptoms from the upper respiratory tract (rhinitis, hoarseness), and higher values of CRP and AST.

## DECLARATION OF INTEREST

None.

## REFERENCES


1. **File TM, Tan JS, Plouffe JF.** The role of atypical pathogens: *Mycoplasma pneumoniae*, *Chlamydia pneumoniae* and *Legionella pneumophila* in respiratory infection. Infect Dis Clin North Am 1998; **12**: 569–592.
2. **File TM, Tan JS.** *Chlamydia pneumoniae* pneumonia. Sem Resp Crit Care Med 2000; **21**: 285–294.
3. **Kauppinen M, Saikku P.** Pneumonia due to *Chlamydia pneumoniae*: prevalence, clinical features, diagnosis, and treatment. Clin Infect Dis 1995; **21**: 244–252.
4. **Porath A, Schlaffer F, Lieberman D.** The epidemiology of community-acquired pneumonia among hospitalized adults. J Infect 1997; **34**: 41–48.
5. **Kaupinnen MT, Herva E, Kujala P, Leinonen M, Saikku P, Syrjala T.** The etiology of community-acquired pneumonia among hospitalized patients during a *Chlamydia pneumoniae* epidemic in Finland. J Infect Dis 1995; **172**: 1330–1335.
6. **Socan M, Marinic-Fiser N, Kraigher A, Kotnik A, Logar M.** Microbial aetiology of community-acquired pneumonia in hospitalized patients. Eur J Clin Microbiol Infect Dis 1999; **18**: 777–782.
7. **Ishida T, Hashimoto T, Arita M, Ito I, Osawa M.** Etiology of community-acquired pneumonia in hospitalized patients: a 3-year prospective study in Japan. Chest 1998; **114**: 1588–1593.
8. **Nelson CT.** *Mycoplasma* and *Chlamydia pneumonia* in pediatrics. Semin Respir Infect 2002; **17**: 10–14.
9. **Ruiz M, Ewig S, Marcos MA, et al.** Etiology of community-acquired pneumonia: impact of age, comorbidity, and severity. Am J Respir Crit Care Med 1999; **160**: 397–405.
10. **Hindiyeh M, Carroll KC.** Laboratory diagnosis of atypical pneumonia. Semin Resp Infect 2000; **15**: 101–113.
11. **Schneeberger PM, Dorigo-Zetsma JW, van der Zee A, van Bon M, van Opstal JL.** Diagnosis of atypical pathogens in patients hospitalized with community-acquired respiratory infection. Scand J Infect Dis 2004; **36**: 269–273.
12. **Gaydos CA, Quinn TC.** The role of *Chlamydia pneumoniae* in cardiovascular disease. Adv Intern Med 2000; **45**: 139–143.
13. **von Hertzen L, Alakarppa H, Koskinen R, et al.** *Chlamydia pneumoniae* infection in patients with chronic obstructive pulmonary disease. Epidemiol Infect 1997; **118**: 155–164.
14. **Hammerschlag MR, Chirgwin K, Roblin PM, et al.** Persistent infection with *Chlamydia pneumoniae* following acute respiratory illness. Clin Infect Dis 1992; **14**: 178–182.
15. **von Hertzen L.** *Chlamydia pneumoniae* and its role in chronic obstructive pulmonary disease. Ann Med 1998; **30**: 27–37.
16. **Campbell LA, Kuo CC, Grayston JT.** *Chlamydia pneumoniae* and cardiovascular disease. Emerg Infect Dis 1998; **4**: 571–579.
17. **Wisniewska-Ligier M, Wozniakowska-Gesicka T, Sobanska A, Wierzbicka E.** Extrapulmonary complications of *Mycoplasma pneumoniae* infections. Przegl Lek 2003; **60**: 832–835.
18. **Pfausler B, Engelhardt K, Spiss H, Taferner E, Schmutzhard E.** Post-infectious central and peripheral nervous disease complicating *Mycoplasma pneumoniae* infection. Report of three cases and review of the literature. Eur J Neurol 2002; **9**: 93–96.
19. **Delmas MC, Gauthier C, Rapin F.** Neurologic manifestations of *Mycoplasma pneumoniae* infections. Arch Pediatr 1996; **3**: 573–575.
20. **Statistica for Windows.** Computer program manual, 1995 [StatSoft I]. Tulsa, OK: StatSoft.
21. **Gaydos CA, Roblin PM, Hammerschlag MR, et al.** Diagnostic utility of PCR-enzyme immunoassay, culture and serology for detection of *Chlamydia pneumoniae* in symptomatic and asymptomatic patients. J Clin Microbiol 1994; **32**: 903–905.
22. **Hammerschlag MR.** *Mycoplasma pneumoniae* infections. Curr Opin Infect Dis 2001; **14**: 181–186.
23. **Kuzman I, Petricevic I.** Clinical and epidemiological features of acute respiratory infections caused by *Mycoplasma pneumoniae*. Lijec Vjesn 1990; **112**: 216–221.
24. **Bohte R, van Furth R, van den Broek PJ.** Aetiology of community-acquired pneumonia: a prospective study among adults requiring admission to hospital. Thorax 1995; **50**: 543–547.
25. **Lieberman D, Schlaeffer F, Lieberman D, Horowitz S, Horowitz O, Porath A.** *Mycoplasma pneumoniae* community-acquired-pneumonia: a review of 101 hospitalized adult patients. Respiration 1996; **63**: 261–266.
26. **Marrie TJ.** Epidemiology of mild pneumonia. Semin Resp Infect 1998; **13**: 3–7.
27. **Lieberman D, Ben-Yaakov M, Lazarovich Z, et al.** *Chlamydia pneumoniae* community-acquired pneumonia: a review of 62 hospitalized adult patients. Infection 1996; **24**: 109–114.

28. **Marrie TJ, Peeling RW, Reid T, De Carolis E and the Canadian community-acquired pneumonia investigators.** *Chlamydia* species as a cause of community-acquired pneumonia in Canada. Eur Respir J 2003; **21**: 779–784.
29. **Almirall J, Morato I, Riera F, et al.** Incidence of community-acquired pneumonia and *Chlamydia pneumoniae* infection: a prospective multicentre study. Eur Resp J 1993; **6**: 14–18.
30. **Grayston JT.** Infections caused by *Chlamydia pneumoniae* strain TWAR. Clin Infect Dis 1992; **15**: 757–763.
31. **Chirgwin K, Roblin PM, Gelling M, Hammerschlag MR, Schachter J.** Infection with *Chlamydia pneumoniae* in Brooklyn. J Infect Dis 1991; **163**: 757–761.
32. **Kuo CC, Jackson LA, Campbell LA, Grayston JT.** *Chlamydia pneumoniae* (TWAR). Clin Microb Rev 1995; **8**: 451–461.
33. **O'Handley JG, Gray LD.** The incidence of *Mycoplasma pneumoniae* pneumonia. J Am Board Fam Pract 1997; **10**: 425–429.
34. **Dominguez A, Minguell S, Torres J, Serrano A, Vidal J, Salleras L.** Community outbreak of acute respiratory infection by *Mycoplasma pneumoniae*. Eur J Epidemiol 1996; **12**: 131–134.
35. **Cosentini R, Blasi F, Raccanelli R, et al.** Severe community-acquired pneumonia: a possible role for *Chlamydia pneumoniae*. Respiration 1996; **63**: 61–65.
36. **Takiguchi Y, Shikama N, Aotsuka N, Koseki H, Terano T, Hirai A.** Fulminant *Mycoplasma pneumoniae* pneumonia. Intern Med 2001; **40**: 345–348.
37. **Seedat MA, Feldman C, Skoularigis J, Promnitz DA, Smith C, Zwi S.** A study of acute community-acquired pneumonia, including details of cardiac changes. Quart J Med 1993; **86**: 669–675.