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Title: CRP, PCT, CPIS AND PNEUMONIA SEVERITY SCORES IN NURSING HOME ACQUIRED PNEUMONIA

Ilias Porfyridis[1] MD,PhD, Georgios Georgiadis[1] MD,PhD, Paris Vogazianos[1] PhD, Georgios Mitis[2], Andreas Georgiou[1] MD,PhD

[1]*Pulmonary Department, Nicosia General Hospital, Strovolos 2029, Nicosia, Cyprus*

[2]*Immunology Department, Nicosia General Hospital, Strovolos 2029, Nicosia, Cyprus*

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Corresponding author: Ilias Porfyridis MD, PhD, Respiratory Physician, Pulmonary Department, Nicosia General Hospital, 215 Nicosia-Limassol Old Road, Strovolos 2029, Nicosia, Cyprus**, ilias_porfi@yahoo.gr , Telephone:** +35722604380, **Fax:** +35722604266

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ABSTRACT

Introduction: Patients with nursing home acquired pneumonia (NHAP) represent a distinct group of lower respiratory track infections with different risk factors, clinical presentation and mortality rates.

Aim: To evaluate the diagnostic value of clinical pulmonary infection score (CPIS), CRP and procalcitonin (PCT) and compare the accuracy of pneumonia severity scores (CURB-65, PSI, NHAP index, SMART-COP, SOAR) in predicting inpatient mortality of NHAP.

Methods: Nursing home residents admitted to hospital with acute respiratory illness were enrolled in the study. Subjects were classified as having NHAP (*group A*) or other pulmonary disorders (*group B*). Clinical, imaging and laboratory data were assessed to compute CPIS and severity scores. CRP and PCT were measured by immunonephelometry and immunoassay respectively.

Results: 58 subjects were diagnosed with NHAP (group A) and 29 with other pulmonary disorders (group B). Mean ± SD CRP was 16.38±8.6mg/dl in group A and 5.2±5.6mg/dl in group B ($p<0.001$). Mean ± SD PCT was 1.52±2.75ng/ml in group A and 0.24±0.21ng/ml in group B ($p=0.001$). Mean± SD CPIS was 5.4±1.2 in group A and 2.3±1.5 in group B ($p<0.001$). At cut-off value of 0.475ng/ml, PCT had sensitivity 83% and specificity 72%. At cut-off value of 8.05mg/dl, CRP had sensitivity 81% and specificity 79%. PCT and CRP levels were significantly higher in Gram (+) NHAP. The inpatient mortality was 17.2% in group A. PCT levels were 4.67±5.4ng/ml in non-survivors and 0.86±0.9ng/ml in survivors ($p<0.001$). Area under the curve (AUC) for PCT in predicting inpatient mortality was 0.84(95%CI 0.70-0.98, $p=0.001$). A PCT level on admission above 1.1ng/ml was an independent predictor of inpatient mortality. Amongst

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pneumonia severity scores CURB-65 showed greater accuracy in predicting inpatient mortality [AUC 0.68(95%CI 0.53-0.84, p=0.06)].

Conclusion: The CPIS, PCT and CRP are reliable for the diagnosis of NHAP. PCT and CURB-65 were accurate in predicting inpatient mortality in NHAP.

Keywords

Geriatrics/elderly patients/aging, infections/infectious diseases/infection control, severity of illness/scoring system

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Introduction

Nursing home acquired pneumonia (NHAP) is the leading cause of hospitalization, morbidity and mortality among nursing home residents, with different clinical presentation and causative pathogens from community acquired pneumonia (CAP) [1]. Nursing home residents usually have comorbidities, such as heart failure, chronic respiratory diseases, cognitive impairment, advanced age, worse functional status, history of alcoholism and use of immunosuppressant, which make the diagnosis of NHAP a challenge, since clinical and laboratory signs are neither sensitive nor specific enough, and microbiological studies often remain negative. Moreover, these subjects have unique risk factors for colonization with resistant pathogens. Hospitalization rates for NHAP vary from 15 to 46% and mortality rates from 5 to 40% [2].

Many biomarkers, such as leukocyte count, C-reactive protein (CRP) and procalcitonin (PCT) have been found to have a role in the early diagnosis and prognosis of pneumonia, especially CAP and ventilator associated pneumonia (VAP) [3-6]. In addition, clinical infection scores, such as the clinical pulmonary infection score (CPIS), have been evaluated in the early diagnosis of VAP and CAP [6,7] . However, there are only limited data on NHAP.

Assessment of the disease severity is an important early step in the management of patients. Several severity scoring systems have been used to predict prognosis of pneumonia. The accuracy of confusion, urea, respiratory rate, blood pressure and age>65 (CURB-65) score and its modifications (CRB-65) and the pneumonia severity index (PSI) are the most commonly used prediction rules in clinical practice [3,8-10]. More recently, proposed scoring systems, such as the SMART-COP (systolic blood pressure, multilobar involvement, albumin, respiratory rate, tachycardia, confusion, oxygen, arterial pH) [11] and SOAR (systolic blood pressure, oxygen,

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age>65 and respiratory rate) [9] appeared to be useful in the prognosis of CAP and pneumonia in the elderly patients. Also, the NHAP index has been used to predict mortality in NHAP [12]. However, the accuracy of these prediction rules has not been compared in subjects hospitalized with NHAP.

The aim of the present study is to evaluate the diagnostic and prognostic value of the clinical pulmonary infection score (CPIS), CRP and PCT in predicting inpatient mortality for patients diagnosed with NHAP. In addition, we aim to compare the accuracy of pneumonia severity scores in this group of patients.

Methods

In this observation trial, all consecutive subjects, nursing home residents, admitted to the Pulmonary Department with acute respiratory illness from November 2010 to January 2012 were evaluated for participation. Inclusion criteria were: i) Age > 16, ii) nursing home residents, iii) written informed consent and iv) acute respiratory illness. Exclusion criteria were: i) Human immunodeficiency virus (HIV) infection, ii) documented extrapulmonary infection, iii) neutropenia and iv) oral intake of corticosteroids (defined as more than 1 mg/kg of prednisone for more than 1 month) or chemotherapy during the previous 90 days. The study protocol was approved by the Bioethics Committee of the Cyprus Government and written informed consent was obtained from all subjects or their relatives within the first 12 hrs after admission.

Clinical, laboratory and imaging data were recorded immediately after admission for each subject including: i)past medical history and clinical presentation, ii)prior use of antibiotics, steroids, iii)body temperature, iv)arterial blood gases, v)peripheral blood cell counts, vi)gram stains and cultures of all biological fluids obtained (blood, sputum, bronchial secretions, BAL, and pleural fluid), vii)imaging findings and viii)antigen serology (*Legionella pneumophila* and

Streptococcus pneumonia urinary antigen). Subjects' functional status before admission was assessed, according to the Eastern Cooperative Oncology Group (ECOG) score [13], which runs from 0 to 5, with 0 denoting perfect health and 5 death. The clinical pulmonary infection score (CPIS) which combines six variables: tracheal secretions, chest X-ray infiltrates, body temperature, white blood cells count, oxygenation (PaO_2/FiO_2 ratio) and microbiology from tracheal secretions was calculated and recorded [14].

The diagnosis of nursing home acquired pneumonia (NHAP) was made according to current guidelines and recommendations [15,16]. NHAP was defined by the following criteria observed at initial presentation or within 24h following hospitalization: admission from nursing home, presence of a new radiographic pulmonary infiltrate and acute onset of at least two of the following clinical or biological findings suggestive of pneumonia: cough, sputum production, fever, shortness of breathing, pleuretic chest pain, altered mental status, pulmonary consolidation on physical examination and total leukocyte count >12,000/mm^3 or <4,000/mm^3. The severity of pneumonia was assessed, immediately after admission, by calculating the CURB-65(confusion, urea, respiratory rate, blood pressure and age>65)[3], PSI[3], NHAP index (respiratory rate >30/min, heart rate>125bpm, confusion and dementia) [12], SMART-COP (systolic blood pressure, multilobar involvement, albumin, respiratory rate, tachycardia, confusion, oxygen, arterial pH) [11] and SOAR(systolic blood pressure, oxygen, age>65 and respiratory rate) [9] scoring systems.

Pneumonia was considered to be absent either when an alternative cause for pulmonary infiltrate was established (e.g. pulmonary embolus) or when there was no new pulmonary infiltrates in radiological images.

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Serum CRP and PCT were assessed within 12 hours after hospital admission. CRP was measured by immunonephelometry in serum using automated analyzers (BN PROSPEC®, Siemens®) and was expressed in mg/dl, whilst PCT was assessed by a PCT immunoassay kit (Brahms, Germany) on a Brahms-Kryptor® immunoassay system and was expressed in ng/ml, following manufacturer's instructions.

All cases were evaluated by two clinicians and agreement about the diagnosis was achieved in all cases. Subjects were divided in two groups: group A included all subjects diagnosed with NHAP and group B subjects diagnosed with other pulmonary disorders. In-hospital mortality for each group was also recorded.

Statistical analysis

Values are presented as mean ±SD. Comparisons between groups were made by the use of chi-square test (testing for the null hypothesis that the relative proportions of the variable are independent of the group and thus changing the group will not change significantly the proportions of the dependent variable) and paired samples T-test (testing for the null hypothesis that the difference is not significantly different from zero, versus the alternative hypothesis that the difference is significantly different from zero). Probability values less than 5% ($p<0.05$) were considered statistically significant. Receiver Operator Characteristic (ROC) curves were also designed to assess sensitivity, specificity, positive and negative predictive values for the estimated parameters. Survival was assessed by Kaplan-Meier and comparisons were drawn by log-rank test. All statistics and graphs were prepared using the Statistical Package for the Social Sciences software version 17.0.0 (SPSS Inc, Chicago, IL).

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Results

87 subjects were included in the study. Demographic characteristics, clinical and laboratory data of the study population are summarized in table 1.

Group A (n=58) consisted of subjects with NHAP. 27 had microbiological evidence of pulmonary infection, based upon positive cultures from sputum, blood or BAL samples (when bronchoscopy was performed). The rest were diagnosed with NHAP on the basis of clinical and radiological presentation and good response to antibiotic therapy. The clinical presentation and the comorbidities of subjects in group A are presented in table 1. The main radiological findings consisted of right pulmonary infiltrates in 33 subjects (two with combined pleural effusion), left pulmonary infiltrates in 20 (one with combined pleural effusion) and bilateral lung infiltrates in 5. 31 subjects (53.4%) were diagnosed with aspiration pneumonia.

Group B (n=29) consisted of subjects with other pulmonary disorders, most of them with clinical presentation at admission simulating chest infection. The diagnoses, clinical presentation and the comorbidities of subjects in group B are also presented in table 1. In radiological imaging, four subjects presented bilateral pulmonary infiltrates or pleural effusions, 5 presented left pulmonary infiltrates or pleural effusion and 4 presented right pulmonary infiltrates. Finally, in 16 cases no significant pathologic findings were observed on their chest X-ray images.

In 18% of cases with pathological findings in chest x-ray images an alternative cause for pulmonary infiltrate was established. The accuracy of the following clinical characteristics at presentation: fever, shortness of breathing and cough, showed an area under the curve (AUC) value of 0.59 (95%CI: 0.47-0.72, p=0.15). The addition of a raised white blood cells (WBC) value of greater than 12.000/mm^3 showed a similar AUC value [0.59 (95%CI: 0.48-0.72, p=0.15)] (Figure 1).

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CPIS in admission, CPIS after 48h and concentrations of CRP and PCT in serum of both groups are also given in table 1. All four parameters were significantly higher in group A than in group B.

ROC curves for CPIS, CRP and PCT for the diagnosis of NHAP are shown in figure 2. AUC of PCT was 0.82 (95%CI: 0.73 – 0.9, p= 0.001) and of CRP 0.87 (95%CI: 0.8 – 0.95, p= 0.001). AUC of CPIS in admission and CPIS after 48h were 0.93 (95%CI: 0.8 – 0.9, p= 0.001) and 0.95(95%CI: 0.9 – 0.99, p= 0.001) respectively. At a cut-off value of 0.475ng/ml, PCT had a sensitivity of 83%, a specificity of 72%, positive predictive value (PPV) of 86% and negative predictive value (NPV) of 68%. At a cut-off value of 8.05mg/dl, CRP had a sensitivity of 81%, a specificity of 79%, PPV of 88% and NPV of 67% for the diagnosis of NHAP.

Among all subjects (group A and B) mean±SD CRP was 16.8±8.45mg/dl in culture positive and 10.88±9.2mg/dl in culture negative (p=0.006). Mean±SD PCT was 2.52±3.8ng/ml in culture positive and 0.45±0.42ng/ml in culture negative (p<0.001). In group A, the relationships between serum CRP and PCT levels and the identified causative pathogen of NHAP are shown in figure 3. Mean±SD CRP levels were 22.24±8.9mg/dl in cases of NHAP caused by Gram (+) pathogens and 13.58±6.43mg/dl in NHAP cases due to Gram (-) pathogens (p=0.007), whilst mean±SD PCT levels were 4.1±5.1ng/ml in Gram (+) NHAP cases compared to 1.6±2.4ng/ml in Gram (-) NHAP cases(p=0.09).

The inpatient mortality in group A was 17.2%. Mean ± SD CRP, PCT and the pneumonia severity scores of survivors and non-survivors in group A are presented in table 2. PCT and CURB65 were significantly greater among non-survivors (p<0.001 and p= 0.034 respectively). The accuracy of CRP to predict inpatient mortality showed an AUC value of 0.63(95%CI 0.43-0.84, p=0.2), whilst accuracy of PCT was better with an estimated AUC of 0.84(95%CI 0.7-0.98,

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p=0.001) (figure 4). A threshold PCT value of 1.1ng/ml achieved a sensitivity of 80% and specificity of 82% in predicting inpatient mortality. A survival analysis, using Kaplan-Meier curves and the log-rank test, demonstrated that serum levels of PCT in admission lower than 1.1ng/ml were associated with better survival (log-rank test, p<0.001) (figure 5). From the statistical analysis, no similar threshold value was found for WBC, CRP or CURB-65.CURB-65 showed better accuracy in predicting inpatient mortality [AUC 0.68(95%CI 0.53-0.84, p=0.06)], when compared to other pneumonia severity scores. AUC values of the other pneumonia severity scores were as following: PSI 0.65 (95%CI 0.49-0.82, p=0.12), NHAP index 0.58 (95%CI 0.41-0.75, p=0.41), SMART-COP 0.57(95%CI 0.36-0.78, p=0.45) and SOAR 0.62(95%CI 0.42-0.82, p=0.23) (figure 6).

Discussion

To our knowledge, this is the first study to evaluate and compare the diagnostic and prognostic accuracy of PCT, CRP, the CPIS and the pneumonia severity scores in NHAP. The results of the present study indicate that the CPIS, serum PCT and CRP are reliable markers for the early diagnosis of NHAP. The serum levels of CRP and PCT were found to be higher in cases of NHAP caused by Gram (+) pathogens compared to Gram (-) NHAP cases; however, CPIS scores did not follow similar trend. PCT appeared to have greater accuracy in predicting in-hospital mortality from NHAP than the pneumonia severity scores. CURB-65 and PSI performed better than the other proposed severity scoring systems. Serum levels of PCT in admission higher than 1.1ng/ml were an accurate independent predictor of in-hospital mortality from NHAP.

Pneumonia is the most common cause for hospitalization and death amongst residents in nursing homes [1]. Early diagnosis of NHAP remains a challenge. Institutionalized subjects frequently present atypical clinical signs and symptoms of pneumonia [2]. Depressed mental

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status, congestive heart failure, chronic obstructive pulmonary disease (COPD), prior use of antibiotics, subject' s lack of corporation and poor quality of chest radiographs may complicate the diagnosis. The presence of a new pulmonary infiltrate on chest X-ray is considered indicative for diagnosing pneumonia. However, many nursing home residents who are transferred to acute care departments with acute respiratory illness and pathological findings in radiological imaging do not have NHAP. The differential diagnosis in the majority of such cases includes non-infectious cardiac and pulmonary disorders, whose clinical presentation may resemble pneumonia. The delayed correct diagnosis results in delayed treatment, which contributes to higher mortality rates [17]. Therefore, easily available, objective, sensitive and specific biomarkers for a rapid diagnosis and differential diagnosis of NHAP are important.

Clinical infection scores and biomarkers have been shown to be useful in the early diagnosis of CAP and VAP [3-5, 18], however their value in diagnosis and prognosis of NHAP is unclear. Our data show that the combination of fever, shortness of breathing, cough and raised white blood cells were less accurate for the diagnosis of NHAP ($p=0.15$) and that the diagnosis of infection is not always clear in the acute setting. In our study we evaluated the role of CRP and PCT for the early diagnosis of pneumonia in the heterogeneous group of nursing home residents. The results are promising, since CRP and PCT were significantly higher in group A compared to group B ($p<0.001$). In addition, diagnostic accuracy of serum CRP and PCT was higher compared to the combination of clinical characteristics and raised white blood cells. CRP and PCT levels can be useful tools in clinician's decision making whether to initiate or withhold empiric antibiotic treatment to nursing home residents with acute respiratory illness.

Former studies showed that the CPIS was useful in the diagnosis of CAP and VAP [6, 7]. The assessment of CPIS is simple, calculating 6 variables (tracheal secretions, chest X-ray

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findings, temperature, WBC, PaO_2/FiO_2 ratio, and microbiology). Tracheal secretions can be obtained with suction from subjects having difficulty to secrete their sputum. In agreement with previous studies, we found that the CPIS is a reliable tool in the early diagnosis of NHAP, since subjects diagnosed with NHAP had significantly higher CPIS scores in admission and after 48 hours when compared to subjects diagnosed with other pulmonary disorders ($p<0.001$).

The results from our study showed that *Streptococcus pneumoniae* was the most common pathogen amongst subjects diagnosed with NHAP. Whilst *methicillin-resistant S. aureus (MRSA)* represented 7.4% (n=2 from 27) of all isolates, there were higher incidents of Gram-negative pathogens 40% (n=11 from 27). Although these findings differ, when compared to the results from previous studies [1, 19, 20], we acknowledge that this is likely to reflect the relatively small number of patients in our study. Furthermore, the results from our study indicate a relationship between levels of CRP and PCT and the causative pathogens. More precisely, NHAP caused by Gram (+) pathogens were accompanied by greater levels of CRP and PCT than NHAP from Gram (-) pathogens. In contrast, Charles PE et al [19] found that PCT levels were higher in cases with Gram (-) compared to Gram (+) bacteraemia, whilst there was no difference in CRP levels between the two study groups. However, data from a heterogeneous population were analysed in the latter study, including patients from intensive care unit (ICU), with a broad spectrum of medical or surgical infections with bacteraemia, whereas only subjects with NHAP were enrolled in our study.

Former studies show that pneumonia severity scores, functional status, comorbidities, nutritional status, serum albumin levels and CRP are significant prognostic factors of mortality of NHAP [1,2,8-10,12,17, 20-24]. The results from our study showed that the CURB-65 and the PSI were more accurate in predicting in-hospital mortality in NHAP compared to the other

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pneumonia severity scores. The findings are in agreement with former studies [10, 20,24], but in contrast to other studies [8-10,12]. These differences are likely to reflect the fact that most nursing home residents have worse general condition due to comorbidities, making the estimation of the risk of death based on clinical parameters difficult and less accurate [2].

CRP and PCT have been described as reliable markers for the diagnosis and prognosis of CAP and VAP with contradictory results, especially for VAP [3-6, 24-30]. According to ATS/IDSA guidelines, NHAP is considered a distinct group of respiratory infections with more similarities with hospital acquired pneumonia (HAP) and VAP than with CAP [15]. However, there are only limited data in the literature on the role of biomarkers in NHAP. Arinzon et al [23] found that serum CRP levels, at the time of diagnosis of pneumonia, predict the severity and outcome of nursing home acquired pneumonia. However, the latter did not compare the CRP levels in patients diagnosed with NHAP and patients with other respiratory diseases, the study population was small and PCT levels were not measured.

The role of PCT in prognosis and antibiotic guidance has been studied in CAP, VAP or pneumonia in the elderly patients, but not in NHAP. In our study serum PCT levels in admission lower than 1.1ng/ml were associated with an improved survival. These results are in agreement with previous studies about the value of PCT in the prognosis of severe CAP [24,25,29,30], where a similar cut-off value of PCT (less than 0.95ng/ml) was associated with a favorable outcome.

Our study presents three main limitations: a) this was a single centre study and the number of subjects was limited, b) no documented cases of NHAP caused by *Legionella pneumophila*, *Mycoplasma pneumoniae*, protozoa or parasites were enrolled in group A; c) DNR (do not resuscitate) order was not part of the exclusion criteria, because medical intervention

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would be identical to other subjects, apart from intubation, mechanical ventilation, or use of vasopressors.

Conclusions

The CPIS, PCT and CRP are reliable for the diagnosis of NHAP. CRP appeared to perform better in diagnosing NHAP, whilst PCT demonstrated a better correlation in predicting in-hospital mortality. PCT and CRP levels were significantly higher in subjects with NHAP from Gram (+) pathogens. Serum PCT levels in admission higher than 1.1ng/ml.were an accurate independent predictor of in-hospital mortality of NHAP. In subjects with NHAP, CURB-65 and PSI performed better than the other proposed pneumonia severity scoring systems for predicting in-hospital mortality. Future research could focus on a possible role for a PCT-based diagnostic and therapeutic strategy in NHAP.

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Figure legends

Figure 1. Receiver operator characteristic (ROC) curves of the following clinical characteristics at presentation: fever, shortness of breathing and cough and of fever, shortness of breathing, cough and raised white blood cells for the diagnosis of nursing home acquired pneumonia (NHAP)

Figure 2. Receiver operator characteristic (ROC) curves of CRP, procalcitonin (PCT), clinical pulmonary infection score (CPIS) in admission and CPIS after 48h for the diagnosis of nursing home acquired pneumonia (NHAP)

Figure 3. Serum levels of CRP and procalcitonin (PCT) among subjects with nursing home acquired pneumonia (NHAP). Subjects are divided into two groups: 1=Gram (+) and 2=Gram (-)

Figure 4. Receiver operator characteristic (ROC) curve of CRP and procalcitonin (PCT) to predict inpatient mortality from nursing home acquired pneumonia (NHAP)

Figure 5. Kaplan-Meier analysis of subjects with nursing home acquired pneumonia (NHAP) and procalcitonin (PCT) levels >1.1ng/ml (n=24) and <1.1ng/ml (n =34). There was a significant difference between the two curves (log-rank test, $p<0.001$)

Figure 6. Receiver operator characteristic (ROC) curve of CURB-65 (confusion, urea, respiratory rate, blood pressure and age>65), pneumonia severity index (PSI), nursing home acquired pneumonia (NHAP) index, SMART-COP (systolic blood pressure, multilobar involvement, albumin, respiratory rate, tachycardia, confusion, oxygen, arterial pH) and SOAR (systolic blood pressure, oxygen, age>65 and respiratory rate) scoring systems to predict inpatients mortality from NHAP

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Table 1. Demographic and clinical characteristics of 87 subjects enrolled in the study

	Group A (n=58)	**Group B (n=29)**	**P**
Age, (years, mean ± SD)	79.6 ± 15.36	79.8 ± 6.3	0.95
Male/Female	35/23	19/10	-
Comorbidities (n)	• Congestive heart failure (26) • Chronic respiratory diseases(9) • Chronic renal failure (6) • Psychiatric disease (10) • Cognitive impairment (41) • Gastrostomy (4) • Tracheostomy (3)	• Congestive heart failure (15) • Chronic respiratory diseases (18) • Chronic renal failure (6) • Cognitive impairment (10)	-
Diagnoses (n)	NHAP (58)[a] • *Streptococcus pneumoniae* (8) • *Staphulococcus aureus* (4) • *Haemophilus influenzae* (4) • *Pseudomonas aeruginosa* (5) • Other (8) • Mixted infection (2) • No kown pathogen (31)	• Lung cancer (3) • Pulmonary embolism (4) • Congestive heart failure (7) • Bronchial asthma exacerbation (2) • COPD exacerbation (10) • Usual interstitial pneumonia(2)	-
Fever (>37.8°C) (n/%)	38 / 65.5%	10 / 34.4%	0.006
Fever, shortness of breathing, cough (n/%)	25/ 42.3%	7/ 24.1%	0.0837
PS (mean ± SD)[b]	3.57±0.77	2.86±1.026	0.002
PO_2/FiO_2 (mean ± SD)	221.6 ± 77.07	250.33 ± 59.13	0.06
CPIS (mean ±SD)[c]	5.4 ± 1.2	2.3 ± 1.5	<0.001
CPIS 48h(mean ±SD)	6.16 ± 1.7	2.3 ± 1.5	<0.001
White blood cell (mean ± SD)	15480.75 ± 6299/mm^3	11131 ± 4944/mm^3	0.002
PCT (ng/ml, mean±SD)[d]	1.52 ± 2.75	0.24 ± 0.21	0.001
CRP (mg/dl, mean ±SD)	16.38 ± 8.6	5.2 ± 5.6	<0.001

[a] NHAP (nursing home acquired pneumonia), [b] PS (performance status)
[c] CPIS (clinical pulmonary infection score), [d] PCT (procalcitonin)

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Table 2. CRP, procalcitonin (PCT) and the pneumonia severity scores of 58 subjects with nursing home acquired pneumonia; patients are divided into two groups; survivors and non-survivors

	Survivors	Non survivors	p
CRP(mean ± SD)	15.63 ± 7.9	19.96 ± 10.9	0.14
PCT (mean ± SD)	0.86 ± 0.9	4.67± 5.4	<0.001
CURB65 (mean ± SD)[a]	3.25 ± 0.9	3.8 ± 0.63	0.034
PSI (mean ± SD)[b]	157.6 ± 30.6	173.2 ± 20.9	0.067
NHAP Index (mean ± SD)[c]	3.25 ± 0.95	3.6 ± 0.51	0.115
SMART-COP (mean ± SD)[d]	4.7 ± 1.65	5.6 ± 2.5	0.195
SOAR(mean ± SD)[e]	2.58 ± 0.82	3 ± 0.81	0.15

[a] CURB-65 (confusion, urea, respiratory rate, blood pressure and age>65), [b] PSI (pneumonia severity index), [c] NHAP (nursing home acquired pneumonia) index, [d] SMART-COP (systolic blood pressure, multilobar involvement, albumin, respiratory rate, tachycardia, confusion, oxygen, arterial pH), [e] SOAR (systolic blood pressure, oxygen, age>65 and respiratory rate)

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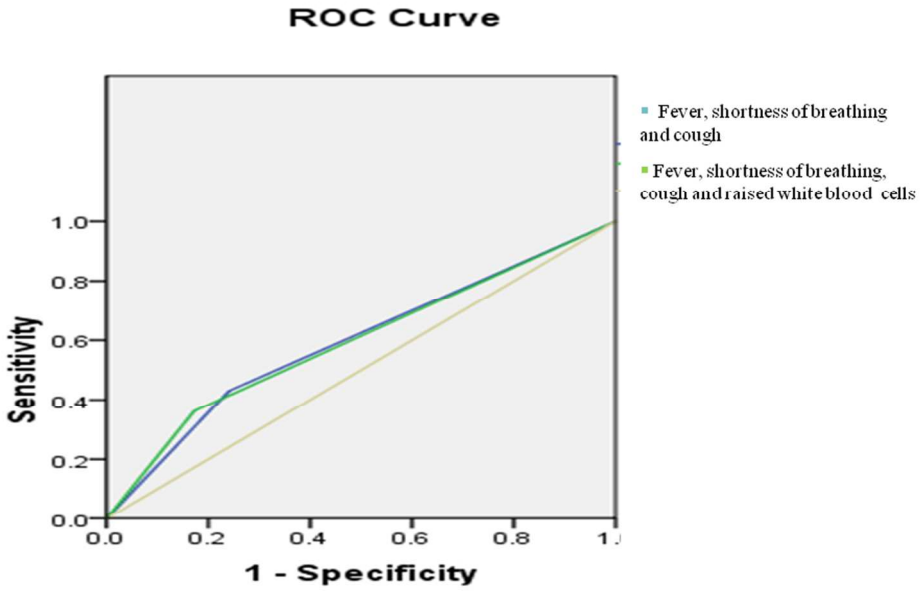

Receiver operator characteristic (ROC) curves of the following clinical characteristics at presentation: fever, shortness of breathing and cough and of fever, shortness of breathing, cough and raised white blood cells for the diagnosis of nursing home acquired pneumonia (NHAP)
254x190mm (96 x 96 DPI)

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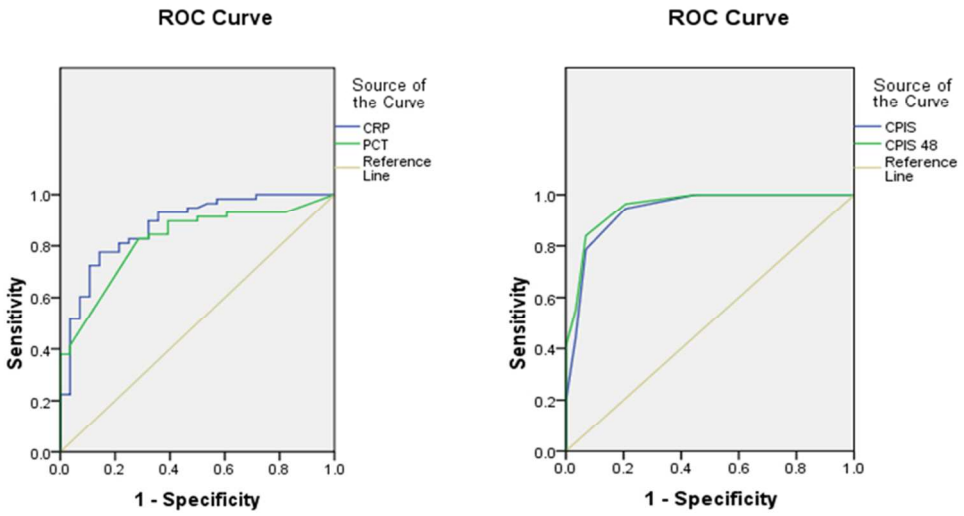

Receiver operator characteristic (ROC) curves of CRP, procalcitonin (PCT), clinical pulmonary infection score (CPIS) in admission and CPIS after 48h for the diagnosis of nursing home acquired pneumonia (NHAP)
254x190mm (96 x 96 DPI)

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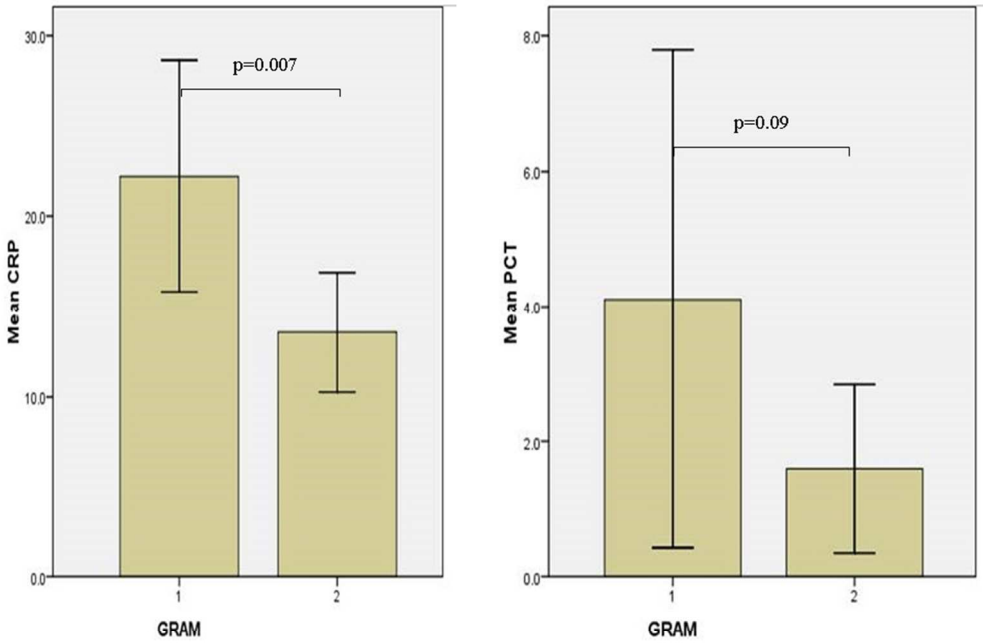

Serum levels of CRP and procalcitonin (PCT) among subjects with nursing home acquired pneumonia (NHAP). Subjects are divided into two groups: 1=Gram (+) and 2=Gram (-)
254x190mm (96 x 96 DPI)

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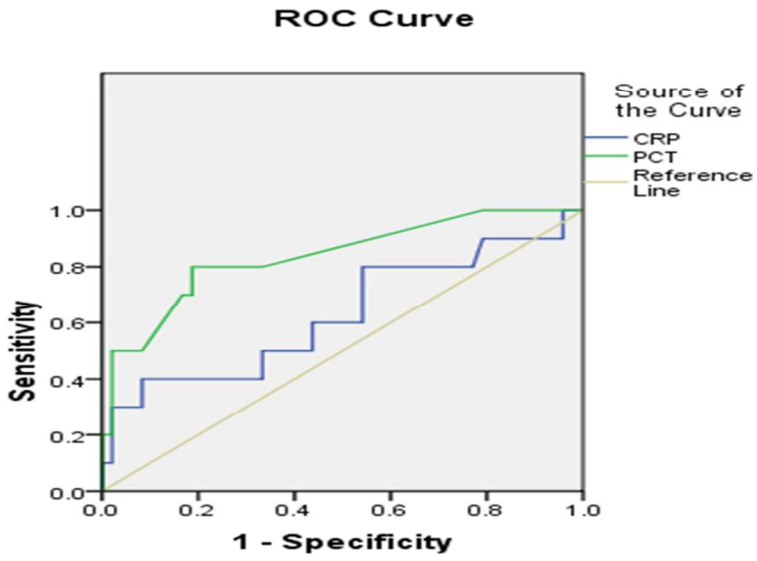

Receiver operator characteristic (ROC) curve of CRP and procalcitonin (PCT) to predict inpatient mortality from nursing home acquired pneumonia (NHAP)
254x190mm (96 x 96 DPI)

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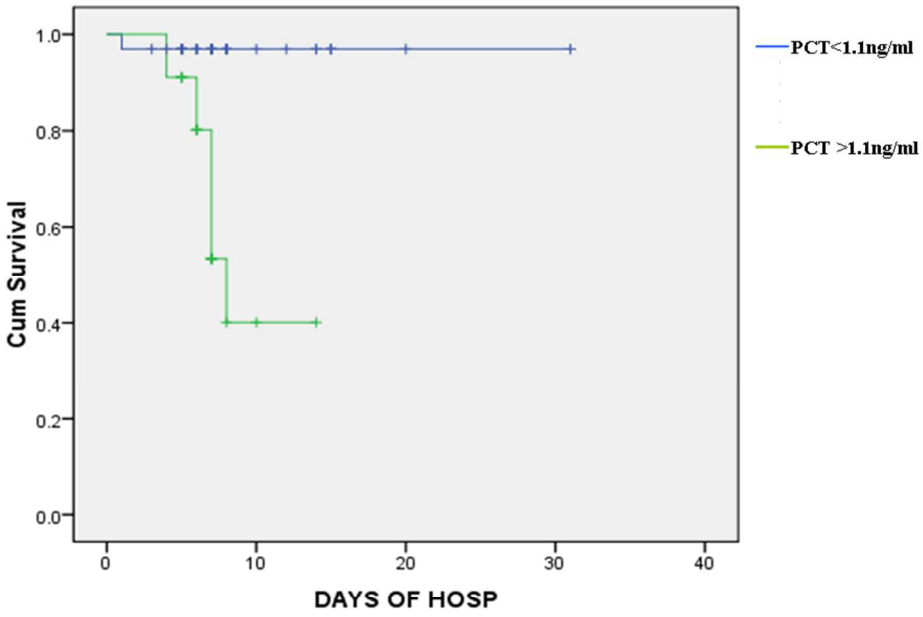

Kaplan-Meier analysis of subjects with nursing home acquired pneumonia (NHAP) and procalcitonin (PCT) levels >1.1ng/ml (n=24) and <1.1ng/ml (n =34). There was a significant difference between the two curves (log-rank test, p<0.001)
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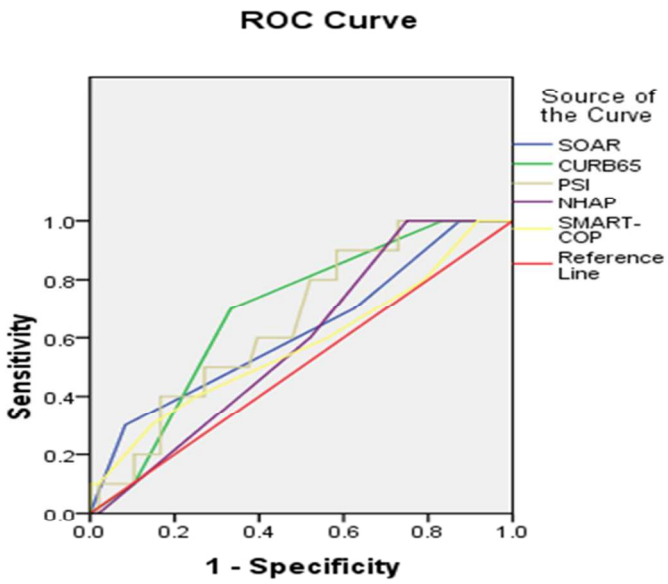

Receiver operator characteristic (ROC) curve of CURB-65 (confusion, urea, respiratory rate, blood pressure and age>65), pneumonia severity index (PSI), nursing home acquired pneumonia (NHAP) index, SMART-COP (systolic blood pressure, multilobar involvement, albumin, respiratory rate, tachycardia, confusion, oxygen, arterial pH) and SOAR (systolic blood pressure, oxygen, age>65 and respiratory rate) scoring systems to predict inpatients mortality from NHAP
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