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# Cardiac dysfunction in patients with community-acquired pneumonia

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## Abstract

### Background

Community-acquired pneumonia (CAP) is still an important cause of morbidity and mortality worldwide especially in the elderly. Evidence shows a high correlation between acute respiratory infections and increased risk of cardiovascular events (CVEs). The occurrence of CVE in hospitalized patients with CAP may significantly affect the clinical status, and a severe CVE could be the primary cause of clinical failure.

### Aim

To study the incidence of cardiac complications in patients with CAP.

### Patients and methods

This clinical study was carried out on 120 patients (63 males and 57 females) hospitalized with a primary diagnosis of CAP. Patients with the presence of an alternative diagnosis that likely explained the pulmonary symptoms and radiographic infiltrate (e.g. lung carcinoma, pulmonary edema, or pulmonary embolus) were excluded. All patients were subjected to complete medical history, general and local chest examination, laboratory investigations, complete blood count, liver function tests, serum electrolytes, blood glucose, arterial blood gases, and serum troponin I. For microbial etiology, at least two sets of separate blood and sputum samples of each patient were gram stained and cultured. Radiological investigations (plain radiography and computed tomography on the chest), ECG, and echocardiography were also done.

### Results

Among the studied 120 patients, 30 (25%) patients had a cardiac complication, such as new or worsening heart failure (12.5%), new arrhythmia (9.2%), and acute myocardial infarction in 3.3%. Patients who developed cardiac complication had significantly higher percentage of blood urea nitrogen (more than or equal to 30 mg/dl), hematocrit less than 30%, sodium less than 130 mm/l, pH less than 7.35, and PaO<sub>2</sub> less than 60 and/or O<sub>2</sub> saturation less than 90 mmHg than patients without cardiac complication. Regarding the outcome of the studied patients, patients who developed cardiac complication had a significantly higher percentage of patients who needed mechanical ventilation, needed inotropes and vasopressors, had higher occurrence of an acute renal failure, had prolonged hospital stays, and had higher mortality than patients without cardiac complication.

### Conclusion

Incident cardiac complications are common in patients with CAP and are associated with increased mortality, acute renal failure, prolonged hospital stay, and need for mechanical ventilation. Further studies are required to test risk stratification and prevention and treatment strategies for cardiac complications in this population.

**Keywords:** arrhythmia, heart failure, myocardial infarction, pneumonia

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## INTRODUCTION

Community-acquired pneumonia (CAP) is still an important cause of morbidity and mortality worldwide especially in the elderly [1]. Since decades, mortality rates have not changed despite advances in diagnostic and supportive methods [2].

Evidence shows a high correlation between acute respiratory infections and increased risk of cardiovascular events (CVE). The occurrence of CVE in hospitalized patients with CAP may significantly affect the clinical status, and a severe CVE could be the primary cause of clinical failure [3].

The occurrence of acute myocardial infarction (AMI) or unstable angina is reported to be 5% among patients with pneumonia [4]. Mechanisms causing myocardial ischemia (plaque rupture and in-situ thrombus formation) are triggered or worsened during acute pneumonia [5]. A multicenter prospective observational study published in 2015 found that AMI had a prevalence of 2.3 versus 11.7% of other CVEs, but it was associated with significantly higher severity of the disease on admission and a significantly higher in-hospital mortality, with 43% [6]. In addition, this study showed that female sex, severe sepsis, and previous history of liver disease are independent risk factors for the occurrence of AMI.

Regarding arrhythmia, several explanations have been proposed to justify the association between acute respiratory infections and risk of arrhythmia; some studies refer to the increased levels of inflammatory cytokines in serious infection [7] or disturbed hemodynamic homeostasis, prothrombotic conditions, and increased catecholamine release [8]. Other studies describe a direct inflammatory effect on a coronary artery, myocardium, and pericardium as well as direct infection of cardiomyocytes as a provocative mechanism of acute arrhythmia [9]. Finally, acute disturbances such as hypo/hyperthermia, electrolyte abnormalities, and hypoxemia may cause arrhythmia.

A study by Kuiken T, *et al.* [10] found new-onset arrhythmia in 12% of cases among a large number of patients with pneumonia, especially in severe elderly patients. In addition, the authors found that arrhythmias were associated with an increased 30- and 90-day mortality. Old age, congested heart failure (CHF) and septic shock were independently associated with the onset of arrhythmia. On the contrary, use of beta-blockers before admission seemed to prevent arrhythmias [11].

Heart failure, the incidence of new or worsening CHF, is the most frequent cardiac complication among patients with pneumonia. A meta-analysis by Corrales-Medina *et al.* [4] reported an incidence of CHF of 14 versus 5.3% of the acute coronary syndrome and 4.7% of arrhythmia. Results also show an association between CHF and female sex, older age, and preexisting coronary artery disease [4]. Studies with a high prevalence of chronic obstructive pulmonary disease and pneumonia found a higher incidence of CHF.

## PATIENTS AND METHODS

This clinical study was carried out on 120 patients (63 males and 57 females) hospitalized with a primary diagnosis of CAP in the period between September 2017 and September 2018 after taking informed consent. Patients with the presence of an alternative diagnosis that likely explained the pulmonary symptoms and radiographic infiltrate (e.g. lung carcinoma, pulmonary edema, or pulmonary embolus) were excluded.

All patients were subjected to complete medical history, general and local chest examination, laboratory investigations, complete blood count, liver function tests, serum electrolytes, blood glucose, arterial blood gases, and serum troponin I. For microbial etiology, at least two sets of separate blood and sputum samples of each patient were gram stained and cultured. Radiological investigations (plain radiography and computed tomography on the chest), ECG, and echocardiography were also done.

CAP was defined as the presence of consolidation or pulmonary infiltrates on chest radiograph at the time of hospital admission, with cough, with or without sputum production, abnormal temperature ( $<35.6$  or  $>37.8^{\circ}\text{C}$ ), or an abnormal serum leukocyte count (leukocytosis or left shift, or leukopenia).

An acute cardiac event was defined as an increase of biochemical markers of myocardial necrosis along with ischemic symptoms, development of Q wave on ECG, ECG changes indicative of myocardial infarction or ischemia (i.e. ST-segment elevation or depression), and arrhythmia.

### Statistical analysis

Statistical analysis was performed using IBM Corp. Released 2010, IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp, software package, which was used for analyses by Chi-square test and Student *t* test. *P* value less than 0.05 was accepted as significant.

## RESULTS

Table 1 shows that patients who developed cardiac complication had significantly higher percentages of patients with preexisting cardiovascular disease (history of ischemic heart disease, arterial hypertension, heart failure, and past history of cardiac arrhythmia) (43.3 vs. 6.7%;  $P < 0.05$ ). Moreover, patients who developed cardiac complication had no significant difference regarding the history of smoking, diabetes, chronic obstructive pulmonary disease, cerebrovascular disease, and chronic renal failure compared with patients without cardiac complication.

Table 2 shows distribution of cardiac complication among patients who developed cardiac complication; new or worsening heart failure (12.5%), new arrhythmia (9.2%), and AMI (3.3%).

Table 3 shows the initial clinical manifestation of studied patients. Patients who developed cardiac complication had a significantly higher percentage of altered mental status, pulse

more than or equal to 125 bpm, systolic blood pressure less than 90 mmHg, and respiratory rate of more than or equal to 30 breaths/min than patients without cardiac complication.

Table 4 shows patients who developed cardiac complication had significantly higher percentage of blood urea nitrogen more than or equal to 30 mg/dl, hematocrit less than 30%, sodium less than 130 mm/l, PH less than 7.35, and PaO<sub>2</sub> less than 60 and/or O<sub>2</sub> saturation less than 90 mmHg than patients without cardiac complication.

Table 5 shows initial radiological finding of the studied patients. Patients who developed cardiac complications had

a significantly higher percentage of pleural effusion and interstitial radiographic pattern than patients without cardiac complication.

Table 6 shows the outcome of the studied patients. Patients who developed cardiac complication had a significantly higher percentage of patients who needed mechanical ventilation, needed inotropes and vasopressors, had higher occurrence of an acute renal failure, had higher hospital stays, and had greater mortality than patients without cardiac complication.

## DISCUSSION

In this study, 30 of 120 (25%) patients admitted with a primary diagnosis of pneumonia had a cardiac complication: new-onset or worsening heart failure in 15 (12.5%), new arrhythmia in 11 (9.2%) patients, and AMI in four (3.3%) patients. Eman Shebl and Salah[12] reported that major cardiac complication occurs in 24.6% of patients with CAP, including the incidence of heart failure (12.3%), AMI (3.1%), and arrhythmia (9.2%). Several mechanisms, related largely to the systemic response to infection, can account for the development of incident cardiac complication in patients with CAP. Acute systemic inflammation can directly depress myocardial function and increase left ventricular afterload [13]. Hypoxemia decreased myocardial oxygen delivery and raised pulmonary arterial pressure and right ventricular afterload [13]. Tachycardia increased myocardial oxygen needs and shortened diastole (when coronary perfusion occurs) [14]. The net effect is a negative shift of the cardiac metabolic supply to demand ratio and further myocardial dysfunction. Myocarditis may also play a role [15]. Acute infections can promote inflammatory activity within coronary atherosclerotic plaques and induce prothrombotic changes in the blood and endothelium, resulting in plaque instability and facilitating coronary thrombosis [15]. Mucher *et al.*[16] reported that incidence of new-onset or worsening congestive heart failure (14%) and incidence of

**Table 1: Demographic characteristic and comorbidities in the studied patients**

Patients characteristic	With cardiac complication [n=30 (25%)]	Without cardiac complication [n=90 (75%)]	P
Age (mean±SD)	70±18.4	48±19.7	<0.05
Sex (male/female)	16/14	47/43	>0.05
Smoking [n (%)]	8 (26.7)	21 (23.3)	>0.05
Cardiovascular disease [n (%)]	13 (43.3)	6 (6.7)	<0.05
Diabetes [n (%)]	6 (20)	17 (18.9)	>0.05
COPD [n (%)]	5 (16.7)	16 (17.8)	>0.05
Cerebrovascular disease [n (%)]	2 (6.1)	8 (8.1)	>0.05
Chronic renal failure [n (%)]	3 (10)	11 (12.2)	>0.05

COPD, chronic obstructive pulmonary disease.

**Table 2: Cardiac complications of studied patients**

Cardiac complications	Number of patients (n=120) [n (%)]
New or worsening heart failure	15 (12.5)
New arrhythmias	11 (9.2)
Acute myocardial infarction	4 (3.3)

**Table 3: Initial clinical manifestation of studied patients**

Clinical manifestation	With cardiac complication (n=30) [n (%)]	Without cardiac complication (n=90) [n (%)]	P
Altered mental status	11 (36.7)	6 (6.7)	<0.05
Pulse ≥125 bpm	9 (30)	12 (13.3)	<0.05
Systolic blood pressure <90 mmHg	12 (40)	13 (14.4)	<0.05
Respiratory rate of ≥30 breaths/min	17 (56.7)	15 (16.7)	<0.05

**Table 4: Initial laboratory investigations of the studied patients**

Laboratory investigations	With cardiac complications (n=30) [n (%)]	Without cardiac complications (n=90) [n (%)]	P
Hematocrit <30%	10 (33.3)	5 (5.6)	<0.05
Blood urea nitrogen ≥30 mg/dl	18 (60)	19 (21.1)	<0.05
Sodium <130 mm/l	10 (33.3)	6 (6.7)	<0.05
pH <7.35	22 (73.3)	8 (8.9)	<0.05
PaO <sub>2</sub> <60 and/or O <sub>2</sub> sat <90 mmHg	23 (76.7)	29 (32.2)	<0.05
Glucose ≥250 mg/dl	9 (30)	5 (5.6)	<0.05
Increased troponin I	13 (43.3)	10 (11.1)	<0.05

**Table 5: The initial radiological finding of the studied patients**

Radiological finding	With cardiac complication (n=30) [n (%)]	Without cardiac complication (n=90) [n (%)]	P
Lobar pattern	5 (16.7)	51 (56.7)	<0.05
Interstitial pattern	16 (53.3)	23 (25.6)	<0.05
Segmental pattern	3 (10)	10 (11.1)	>0.05
Bronchopneumonia	3 (10)	9 (10)	>0.05
Presence of pleural effusion	11 (36.7)	12 (13.3)	<0.05

**Table 6: The outcome of the studied patients with and without cardiac complication**

Outcome	With cardiac complications (n=30) [n (%)]	Without cardiac complications (n=90) [n (%)]	P
Need for mechanical ventilation	14 (46.7)	7 (7.8)	<0.05
Need for inotropes and vasopressors	15 (50)	8 (8.9)	<0.05
Acute renal failure	14 (46.7)	5 (5.6)	<0.05
Hospital stay in days	21±6.8	8±5.2	<0.05
Mortality	8 (26.7)	7 (7.8)	<0.05

new-onset arrhythmia (5.8%) and AMI was found in 7%. Many factors including increased myocardial demand may explain the occurrence of CHF in pneumonia, such as lowered blood oxygen levels, suppression of ventricular function by elevated levels of cytokines [12], biventricular impairment of intrinsic myocardial contractility, which may be present in 50% of patients with severe sepsis or septic shock [17], and arrhythmia. Several explanations have been proposed to justify the association between acute respiratory infections and risk of arrhythmia. Some studies refer to the increased levels of inflammatory cytokines in serious infection or disturbed hemodynamic homeostasis, prothrombotic conditions, and increased catecholamine release [18].

This study identifies specific factors associated with the occurrence of cardiac complication in admitted patients with pneumonia; these factors include old age, past history of cardiovascular diseases, and severity of pneumonia at presentation (blood urea nitrogen  $\geq 30$  mg/dl, pH  $< 7.35$ , respiratory rate  $\geq 30$  breaths/min, sodium  $< 130$  mmol/l, and hematocrit  $< 30\%$ ), which agrees with previous studies [12].

This study showed that increased troponin I was present in 43.3% in a patient with cardiac complication versus 11.1%, in patients without cardiac complication which agrees with a previous study [12]. Our study showed significant increased need for mechanical ventilation, increased need for inotropes and vasopressors, increased development of acute renal failure, prolonged hospital stay, and increased mortality in studied patients with cardiac complications versus patients without cardiac complications. This finding agrees with the study of Eman Shebl and Salah [12].

## CONCLUSION

Incident cardiac complications are common in patients with CAP and are associated with increased mortality, acute renal failure, prolonged hospital stay, and need for mechanical ventilation. Further studies are required to test

risk stratification and prevention and treatment strategies for cardiac complications in this population.

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## Conflicts of interest

There are no conflicts of interest.

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