Risk Factor of Hospitalization with Community-Acquired Pneumonia in Type 2 Diabetic Patients

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Abstract

Background: Many studies have reported the correlation between pneumonia and diabetes mellitus (DM). DM in pneumonia patients is associated with worsening of the patient's clinical condition. However, studies are limited on the correlation between DM and the incidence of pneumonia in Indonesia. Aims: To determine the risk factors for hospitalization due to community-acquired pneumonia (CAP) in diabetic patients. Settings and Design: A case-control study of adults patients with pulmonary disease between January and December 2018 was conducted in a teaching hospital in Central Java, Indonesia. Materials and Methods: Data were extracted from patient medical records. Statistical analysis used: Based on the chi-square analysis, we computed the odds ratio (OR) of hospitalization due to CAP and diabetes. We also assess whether age, gender, smoking, and glycemic control were related to pneumonia. Results: A total of 137 CAP patients were included, of whom 45 (32.8%) had type 2 diabetes and 77 were in the control groups (13 or 16.9% had type 2 diabetes). There was a difference in the risk of CAP between diabetic and nondiabetic patients. Diabetic patients were 2.408 times (95% confidence interval [CI] 1.202–4.824) more likely to be hospitalized due to CAP. Among patient characteristics, age, gender, and smoking were not related to CAP, whereas normal blood glucose level was a protective factor for CAP (odds ratio 0.245; 95% CI 0.102–0.590). Conclusions: Diabetic patients have a greater risk of hospitalization due to CAP than nondiabetic patients do, and normal blood glucose levels potentially reduce this risk.

Keywords: community-acquired pneumonia, diabetic patient, glucose level, risk factors

Key Messages:

A normal blood glucose level potentially reduces the risk of hospitalization due to community-acquired pneumonia.
Introduction

The prevalence of diabetes mellitus (DM) as a chronic disease remains high, especially in developing countries such as Indonesia. Indonesia was reported to be one of top 10 countries with the highest prevalence of diabetes. Known as a silent killer, DM is often not recognized by patients, which results in delayed treatment and various complications. DM can affect the function of multiple organ systems for a certain period of time, thus causing a tremendous burden on diabetic patients. DM is known to be associated with infectious diseases because of the damage to neutrophil function, depression of the antioxidant system, and humoral immunity. Uncontrolled hyperglycemia can impair innate and adaptive immunity. Some studies have reported a higher mortality rate due to infectious diseases among patients with DM. Diabetic patients potentially have a higher risk for pneumonia (1.26 [95% confidence interval (CI) 1.21–1.31] than nondiabetic individuals.

In the World Health Organization’s 2016 Global Report, lower respiratory infections, especially pneumonia, were ranked as the third-leading cause of death. Pneumonia is major killer among patients with diabetes, among whom it is associated with a mortality rate of 30–50%. Some studies have reported that diabetes is associated with a moderate (25–75%) increase in the relative risk of hospitalization with pneumonia. Uncontrolled hyperglycemia and a longer duration of diabetes increase this risk. Moreover, hyperglycemia also increases the risk of mortality rate in pneumonia patients. In Indonesia, pneumonia has been observed as a frequent cause of hospitalization. Data from the Indonesia Ministry of Health reported that the pneumonia prevalence increased 4.5% from 2013 to 2018. Pneumonia can affect all age groups, but the mortality rate is two to four times higher in patients older than 60 years as compared with those less than 50 years of age. Thus, with the increase in the number of diabetic patients, DM as a risk factor for hospitalization related to pneumonia should be considered carefully. The aim of this study was to determine the risk factors for hospitalization due to community-acquired pneumonia (CAP) in diabetic patients and other influential risk factors.

Subjects and Methods

We conducted a case-control study in a teaching hospital in Surakarta, Central Java, Indonesia. The study was approved by the Health Research Ethics Committee School of Medicine Universitas Muhammadiyah Surakarta No. 1853/C.2/KEPK-FK-UMS/I/2019. Data were extracted retrospectively from the medical records of patients with pulmonary disease between January and December 2018. Adult patients hospitalized due to CAP were eligible to be assigned to the case group, whereas patients hospitalized for other pulmonary diseases (e.g., asthma, bronchitis, bronchiectasis) were assigned to the control group. The patients’ diagnoses were confirmed via ICD-10 codes, namely,
pneumonia (J.18) and type 2 diabetes (E11). Immunocompromised patients, such as with HIV-AIDS, cancer, and chronic obstructive pulmonary disease, were excluded.

We gathered patients characteristics such as age, sex, and smoking history. Glucose level at admission was identified and categorized as normal (fasting plasma glucose [FPG] <126 mg/dL or random plasma glucose <200 mg/dL) and hyperglycemia (FPG >126 mg/dL or random plasma glucose <200 mg/dL or >200 mg/dL). Based on chi-square analysis, we computed the odds ratio (OR) of hospitalization due to CAP and type 2 diabetes. We also assess whether age, gender, smoking, and blood glucose level at admission were related to pneumonia.

Results
Risk factors for CAP

This study enrolled 214 patients, who were divided into the following two groups: 137 patients were allocated to the case group, and 77 patients were placed in the control group. Patient age was classified as older than 60 years and younger than 60 years. In Indonesia, the geriatric age category is older than 60 years.[8] Among the subjects, most were older than 60 years old, male, and non-smokers. Among all subjects, there was a nearly equal number of women and men, but there were more men in the case group. A previous study also reported that the CAP patients were predominately male. Overall, the patient characteristics did not differ significantly between the two groups. Table 1 presents the details of the subjects' characteristics.

Table 1: Characteristics of the case and control groups

<table>
<thead>
<tr>
<th>Patients characteristic</th>
<th>Pneumonia (n = 137)</th>
<th>Nonpneumonia (n = 77)</th>
<th>Total subjects (N = 214)</th>
<th>p</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60 years</td>
<td>54 (39.4%)</td>
<td>39 (50.6%)</td>
<td>93 (43.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥60 years</td>
<td>83 (60.6%)</td>
<td>38 (49.4%)</td>
<td>121 (56.5%)</td>
<td>0.112</td>
<td>0.634 (95% CI 0.361–1.113)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>73 (53.3%)</td>
<td>32 (42.6%)</td>
<td>105 (49.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>64 (46.7%)</td>
<td>45 (58.4%)</td>
<td>109 (52.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>11 (8%)</td>
<td>3 (3.9%)</td>
<td>14 (6.5%)</td>
<td></td>
<td>2.153 (95% CI 0.582–7.969)</td>
</tr>
<tr>
<td>Nonsmoker</td>
<td>126(92%)</td>
<td>74 (96.1%)</td>
<td>200 (93.5%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Association between type 2 diabetes and pneumonia

Risk factors for hospitalization related to pneumonia in diabetic and nondiabetic patients were analyzed by calculated OR (Table 2). A study have reported that diabetes was associated with pneumonia, and the study were conducted primarily in health care and hospital settings. There was a significant difference between the proportion of DM patients who were hospitalized due to pneumonia and nonpneumonia (P = 0.012; P< 0.05). This study confirmed that type 2 diabetes was associated with hospitalization related to pneumonia.
Table 2. Comparison of hospitalization related to pneumonia risk in diabetic and nondiabetic patients

<table>
<thead>
<tr>
<th>Group</th>
<th>Total subjects (N = 214)</th>
<th>Pneumonia (n = 137)</th>
<th>Nonpneumonia (n = 77)</th>
<th>Chi-squared</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
<td></td>
<td>n %</td>
<td></td>
</tr>
<tr>
<td>Type 2 DM</td>
<td>58 (27.1%)</td>
<td>45 (32.8%)</td>
<td>13 (16.9%)</td>
<td>0.012</td>
<td>2.408 (95% CI 1.202–4.824)</td>
</tr>
<tr>
<td>Non-DM</td>
<td>156 (72.9%)</td>
<td>92 (67.2%)</td>
<td>64 (83.1%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DM, diabetes mellitus.

Glucose Level at Admission

Among the 214 patients, glucose level was obtained from only 132 patients at admission. Most patients were hyperglycemic at admission. There was a significant difference in the risk of hospitalization related to pneumonia between those with hyperglycemia and normal glucose levels ($P = 0.001; P < 0.05$; Table 3).

Table 3. Patient glucose level at admission

<table>
<thead>
<tr>
<th>Glucose level at admission</th>
<th>Group</th>
<th>Total subjects</th>
<th>Pneumonia (n = 75)</th>
<th>Nonpneumonia (n = 57)</th>
<th>Chi-squared</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td>45 (32.8%)</td>
<td>49 (63.3%)</td>
<td>94</td>
<td>0.001</td>
<td>0.245 (95% CI 0.102–0.590)</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>30 (21.9%)</td>
<td>8 (10.4%)</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Risk factors for CAP

Based on the significance value of $P > 0.05$ and the OR, age, sex, and smoking history were determined to not be related to pneumonia. In another study, age alone did not affect the risk of developing pneumonia. However, in that study, possible confounding factors such as comorbid disease and lifestyles were also present.[9] In the current study, we found that most pneumonia patients were older than 60 years. This is associated with physiological changes in older people, such as reduction of mucociliary clearance, chest wall decrease due to loss of muscle strength and rib changes, elastic recoil reduction in the lung, and neurological changes.[10]

In this study, we found that sex was not associated with the risk of hospitalization related to CAP. However, in the case group, there were more men (53.3%) than women. A previous study stated that males were more susceptible than females to invasive bacterial disease.[11] Another study also reported that, statistically, more CAP patients were male than female. Moreover, diabetic males are at increased risk for CAP.[12]

Smoking is a lifestyle factor that is often associated with many diseases. Smoking can damage the epithelium of the upper airways, leading to the reduction of pathogen elimination.[12] In this study, we could not obtain details on patient smoking history or when the patient stopped smoking from the medical records. Thus, future studies should more closely examine patient smoking history as a factor.
Association between type 2 diabetes and pneumonia

In line with the findings of this study, previous research conducted in Northern Denmark reported that hospitalized patients with DM had a relative risk of pneumonia 1.26 (95% CI 1.21–1.31) as compared with patients without diabetes.\cite{5} Another study in California also reported that patients with diabetes were at increased risk for pneumonia, and the risk increased significantly with increasing HbA1c level.\cite{13} Hyperglycemia may reduce the function of the immune system as a result of impairment of neutrophils and monocytes (macrophages). In the hyperglycemic condition, phagocytic cell movement to the infection site is disturbed but improves with better glycemic control.\cite{14} According to Klekotka et al.,\cite{15} the pathophysiology of pneumonia in diabetic patients involves a decrease in T-lymphocyte response, a decrease in neutrophil function, lower secretion of inflammatory cytokines, depression of the antioxidant system, and impairment of humoral immunity. In addition, hyperglycemia escalates the virulence of microorganism infections and apoptosis of polymorphonuclear leukocytes.

Blood glucose level at admission

Several studies have suggested that blood glucose levels were associated with patients’ clinical outcomes and risk of mortality. According to a retrospective cohort study conducted in Denmark, hyperglycemia at admission increases the risk for intensive care unit admission and prolonged length of hospital stay.\cite{16} This study showed that the OR value was 0.245 (95% CI 0.102–0.590), which indicates that the patient’s glucose level on admission was a protective factor against the risk of hospitalization related to pneumonia. Another study reported that diabetic patients are at increased risk of death within 90 days. Early death in diabetic patients is associated with poor glycemic control.\cite{17}

Conclusion

Diabetic patients have a greater risk of hospitalization due to CAP than nondiabetic patients, and a normal blood glucose level potentially reduces this risk.

Acknowledgement

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Authors Contribution

All authors of this article made substantial contributions to conception and design study, and/or acquisition of data. Y.Farida, and H.D.Prahastiwi analyzed and interpreted data. Also participated in drafting the article, M.Hanafi review and revising it critically for important intellectual content; and all authors gave final approval of the version to be submitted and any revised version.

Conflict of Interest

None declared
References


