

# The impact of admission blood glucose level on patients with community-acquired pneumonia

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**Background** Pneumonia is one of the most common diseases with a high hospitalization rate. Many studies have suggested that there is a correlation between pre-existing diabetes and the alterations in serum glucose levels in patients with community-acquired pneumonia (CAP) and high death rate.

**Aim** To study the impact of admission blood glucose level on patients' outcomes with CAP.

**Patients and methods** Sixty (30 nondiabetic and 30 diabetic patients) consecutive hospitalized adult patients with CAP were recruited over a 1-year period. Data on patients' outcomes including duration of hospital stay, duration of antibiotic treatment, increase in oxygen requirements, increase in antibiotics coverage, ICU admission, mechanical ventilation, and in-hospital mortality were collected.

**Results** Admission blood glucose level was elevated in diabetic patients (the mean plasma glucose level was  $258.86 \pm 116.15$  mg/dl in diabetics and  $151.13 \pm 51.23$  mg/dl in nondiabetics). There were statistically significant increases in the duration of hospital stay ( $7.633 \pm 3.567$  nondiabetic vs.  $11.267 \pm 4.291$  diabetic patients in days), duration of antibiotic treatment ( $7.633 \pm 3.567$  nondiabetic vs.  $11.267 \pm 4.291$  diabetic patients in days), increase in O<sub>2</sub> requirements (33.33

vs.70%), increase in antibiotics coverage (16.67 vs. 63.33%), and ICU admission (30 vs. 63.33%) in the diabetic group on comparing nondiabetic versus diabetic patients with CAP. Also, the previously mentioned outcomes increased significantly with increasing blood glucose levels among the entire study population.

**Conclusion** On admission, CAP patients with increased blood glucose level, either diabetic or nondiabetic, are expected to have poor outcomes.

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## Introduction

Community-acquired pneumonia (CAP) is a common disease that leads to significant morbidity and mortality, and its annual incidence varies from 5 to 11/1000 population; 20% of these patients require hospitalization, which places a significant economic burden on the society [1].

Hyperglycemia has a major influence on the function of the immune system; it combines in-vitro with ingredients of the innate immune system [2] and also combines with the adaptive immune system, causing direct inhibition of T-lymphocyte, immunoglobulin, and complement functions [3].

Hyperglycemia can occur because of diabetes mellitus or stress. Stress induced by hyperglycemia resulted from increase in catecholamine, growth hormone, glucagon, proinflammatory cytokines [4].

Hyperglycemia on admission is considered an absolute risk factor for higher complication rates and higher mortality in patients with CAP with or without diabetes [5]. Most studies have found that there is an association between hyperglycemia and long-term mortality after each CAP episode [6]. Thus, it is crucial

to study the impact of admission blood glucose levels on outcomes in patients with CAP in our hospital.

## Patients and methods

### Study design and setting

This prospective study was carried out at the Chest Department, Ain Shams University Hospitals from January 2018 to January 2019 after approval by the Ethics Committee of the Chest Department and on obtaining verbal informed consent from all patients.

### Study sample

Sixty consecutive adult patients (>18 years) admitted for at least 24 h in the ward during the study with CAP (symptoms of cough, purulent expectoration, fever, a new abnormality on chest radiograph with no recent hospital admission) were recruited by convenience sampling. The diagnosis of CAP was made on the basis of ATS/IDSA guidelines [7]; the patients were

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divided according to information collected about diabetes into 30 nondiabetic patients and 30 diabetic patients (diabetes was defined as a doctor's diagnosis that had been made before the current pneumonia episode, and verified from the patient files, or if the patient was receiving medication for diabetes).

Patients with aspiration pneumonia, those who had already received antibiotic treatment before admission, patients with recent tuberculosis infection, patients under treatment with corticosteroids ( $\geq 20$  mg prednisolone-equivalent/day  $> 14$  days), immunocompromised patients (HIV infection, receiving chemotherapy in the last month before inclusion in the study), pregnant women, and patients admitted in the ward less than 24 h were excluded.

### Study tool

All patients selected in the study were subjected to a full assessment of medical history (age, sex, smoking status, comorbidities, and history of recent hospital admission and history of drug intake), complete clinical examination, radiological investigations [chest x ray (CXR) posterior anterior (PA) view and computed tomography (CT) chest whenever needed], laboratory investigations, arterial blood gases on room air, and bacteriological investigations (sputum culture, sputum Ziehl-Neelsen); the CURB-65 score on admission was used to assess CAP severity as stated previously in the literature [8].

Blood glucose level on admission was measured in both groups using an Accu-chek blood glucose meter model (Accu-chek Active) manufactured by Roche Diabetes Care (Basel, Switzerland) (after washing our hands, the test strip was inserted into the device and we placed the

device on the side of the patient's fingertip to obtain the blood sample; then touching and holding the edge of the test strip to the drop of blood then the result appeared) [9].

Data related to hospitalization were collected, included duration of hospital stay, duration of antibiotic coverage, and complications such as increase in oxygen ( $O_2$ ) requirement, increase antibiotic coverage (defined as increase the dose and/or the number of antibiotics than that prescribed on admission), sepsis, admission to the ICU with or without mechanical ventilation, and in-hospital mortality.

### Statistical analysis

Quantitative variables were presented as mean and SD, comparison between two means was performed using the independent *t*-test. Categorical data were presented as count and percentages. Comparison between proportions was performed using the  $\chi^2$ -test. The analysis of variance (ANOVA) test was used to compare more than two groups as regard quantitative variables. *P* values equal to or less than 0.05 were considered statistically significant. SPSS version 20 (IBM, American Multinational Information Technology Company, Armonk, New York) was used for data analysis.

### Results

The majority of the studied population included men; 73.33 and 53.33% of the patients in the nondiabetic and the diabetic group, respectively, were men, with a mean age 60 years among nondiabetics and 62 years among diabetics. There were no statistically significant differences between nondiabetic and diabetic patients in the sociodemographic data and comorbidities in Table 1.

**Table 1 Demographic data and comorbidities in both nondiabetic and diabetic patients**

	Groups		<i>t</i> -Test or $\chi^2$ <i>P</i> value
	Nondiabetic	Diabetic	
Age (mean $\pm$ SD) (years)	60.300 $\pm$ 18.859	62.067 $\pm$ 12.868	0.673
Sex [ <i>n</i> (%)]			
Male	22 (73.33)	16 (53.33)	0.108
Female	8 (26.67)	14 (46.67)	
Pack/year (mean $\pm$ SD)	32.737 $\pm$ 15.726	30.000 $\pm$ 19.640	0.655
Comorbidities [ <i>n</i> (%)]			
Pulmonary disease	6 (20)	11 (36.67)	0.152
Cardiac disease	6 (20)	9 (30)	0.371
Liver disease	3 (10)	0	0.076
Malignancy	2 (6.67)	3 (10)	0.640
Chronic renal disease	2 (6.67)	5 (16.67)	0.228
Neurological disease	3 (10)	5 (16.67)	0.448

In Table 2, the mean plasma glucose level on admission was elevated in diabetics in comparison with nondiabetics as the mean blood glucose level was  $258.867 \pm 116.154$  mg/dl in diabetics and  $151.133 \pm 51.235$  mg/dl in nondiabetics. Also, on classifying blood glucose, it was found that the majority of nondiabetics (76.6%) had blood glucose levels ranging from 110 to 199 mg/dl, whereas in more than half the diabetic patients, the blood glucose level was above 250 mg/dl; thus, there was a statistically significant difference between nondiabetic and diabetic patients.

There was no statistically significant difference between both groups in the different parameters of the CURB-65 score (Table 3).

There was no statistically significant difference between nondiabetics and diabetics in the arterial blood gas parameters [potential hydrogen (PH), PaO<sub>2</sub>: partial pressure of oxygen in arterial blood

and oxygen saturation; *P* values were 0.434, 0.878, and 0.896, respectively].

There were statistically significant increases in the duration of hospital stay ( $7.633 \pm 3.567$  nondiabetic vs.  $11.267 \pm 4.291$  diabetic patients in days), duration of antibiotic treatment ( $7.633 \pm 3.567$  nondiabetic vs.  $11.267 \pm 4.291$  diabetic patients in days), increase in O<sub>2</sub> requirements (33.33 vs. 70%), increase antibiotics coverage (16.67 vs. 63.33%), and ICU admission (30 vs. 63.33%) among the diabetic group on comparing nondiabetic versus diabetic patients with CAP. However, there was no statistically significant difference between nondiabetic and diabetic patients with CAP in terms of sepsis, mechanical ventilation, and in-hospital mortality (Table 4).

On comparing between the different admission blood glucose levels in the entire study population (nondiabetic and diabetic patients) and outcomes of CAP patients, there was a statistically significant increase in the duration of hospital stay ( $13.211 \pm 3.614$  days),

**Table 2 Glucose levels at admission in nondiabetic and diabetic patients**

	Groups		<i>t</i> -Test or $\chi^2$ <i>P</i> value
	Nondiabetic	Diabetic	
Glucose level at admission			
Mean $\pm$ SD	151.133 $\pm$ 51.235	258.867 $\pm$ 116.154	<0.001**
<110 mg/dl	1 (3.33)	3 (10.00)	<0.001**
110–199 mg/dl	23 (76.67)	8 (26.67)	
200–250 mg/dl	4 (13.33)	2 (6.67)	
>250 mg/dl	2 (6.67)	17 (56.67)	

\*\**P*<0.01, highly significant.

**Table 3 CURB-65 score in nondiabetic and diabetic patients**

	Groups		$\chi^2$ <i>P</i> value
	Nondiabetic	Diabetic	
Confusion	6 (20.00)	7 (23.33)	0.754
Urea>7 mmol/l	13 (43.33)	14 (46.67)	0.795
RR $\geq$ 30	9 (30.00)	14 (46.67)	0.184
SBP<90 mmHg or DBP $\leq$ 60 mmHg	0	0	0.00
Age $\geq$ 65 years	14 (46.67)	16 (53.33)	0.606

DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

**Table 4 Outcomes in nondiabetic and diabetic patients with community-acquired pneumonia**

	Groups		<i>t</i> -Test or $\chi^2$ <i>P</i> value
	Nondiabetic	Diabetic	
Duration of hospital stay (mean $\pm$ SD) (days)	7.633 $\pm$ 3.567	11.267 $\pm$ 4.291	0.001*
Duration of antibiotic treatment (mean $\pm$ SD) (days)	7.633 $\pm$ 3.567	11.267 $\pm$ 4.291	0.001*
Increase O <sub>2</sub> requirements	10 (33.33)	21 (70)	0.004*
Increase antibiotics coverage	5 (16.67)	19 (63.33)	<0.001**
Sepsis	1 (3.33)	1 (3.33)	1.000
ICU admission	9 (30)	19 (63.33)	0.010*
Mechanical ventilation	7 (23.33)	12 (40)	0.165
In-hospital mortality	1 (3.33)	2 (6.67)	0.554

O<sub>2</sub>, oxygen. \**P*≤0.05, significant. \*\**P*<0.01, highly significant.

**Table 5 Comparison between different levels of admission blood glucose and community-acquired pneumonia patients' outcomes**

	Different levels of admission blood glucose				ANOVA or $\chi^2$
	<110 mg/dl (N=4)	110–199 mg/dl (N=31)	200–250 mg/dl (N=6)	>250 mg/dl (N=19)	P value
Duration of hospital stay (mean±SD) (days)	6.613±2.076	6.613±2.076	10.667±4.967	13.211±3.614	<0.001**
Duration of antibiotic treatment (mean±SD) (days)	6.613±2.076	6.613±2.076	10.667±4.967	13.211±3.614	<0.001**
Increase in O <sub>2</sub> requirements	0	11 (35.48)	3 (50.00)	17 (89.47)	<0.001**
Increase antibiotics coverage	0	3 (9.68)	4 (66.67)	17 (89.47)	<0.001**
Sepsis	0	1 (3.23)	0	1 (5.26)	0.904
ICU admission	0	10 (32.25)	3 (50.00)	15 (78.95)	0.001*
Mechanical ventilation	0	6 (19.35)	3 (50.00)	10 (52.63)	0.945
In-hospital mortality	0	0	1 (16.67)	2 (10.53)	0.188

ANOVA, analysis of variance; O<sub>2</sub>, oxygen. \* $P \leq 0.05$ , significant. \*\* $P < 0.01$ , highly significant.

duration of antibiotic treatment (13.211±3.614 days), increase in O<sub>2</sub> requirements, increase antibiotic coverage, and ICU admission with an increase in CAP patients' blood glucose levels as shown in Table 5.

## Discussion

Diabetes mellitus is a highly prevalent chronic metabolic disorder that is present in ~5–10% of the elderly population, and it may be considered a risk factor for pneumonia [10]. Several investigations have found that CAP leads to an increase in the mortality rate among patients with diabetes more than that in patients without diabetes [11], whereas others have shown no association [12]. Thus, some studies have found that hyperglycemia on admission predicts poor outcomes in CAP [13], whereas others have not [14].

On the basis of the results of this study, on admission, CAP patients with increased blood glucose levels, either diabetic or nondiabetic, have adverse outcomes (Tables 4 and 5) even after adjusting for the other associated factors that may affect the prognosis for CAP such as age, sex, smoking habit, comorbidities (Table 1), and CURB-65 (Table 3).

Jensen *et al.* [15] studied the impact of admission blood glucose levels on the outcome of CAP in a hospital in their retrospective study, which was carried out on 1320 patients, and they found that that duration of hospital stay and antibiotic duration for diabetic patients were longer (6 days in diabetic patients and 5 days in nondiabetic patients), which was consistent with this study, as the duration of hospital stay and antibiotic duration for diabetic patients was 11 versus 7 days in nondiabetic patients.

Jensen *et al.* [15] also reported that the clinical course was more severe in nondiabetics and they explained that because diabetic patients were more adapted to have blood glucose levels elevated so they had less severe clinical course than nondiabetic patients, but this was not in agreement with this study and other previous studies [13,16,17], which found that the increase in admission blood glucose was associated with a severe clinical course in diabetics.

McAlister *et al.* [5] also found that hyperglycemia on admission in patients with CAP mostly predicts adverse outcomes as for each 1-mmol/l increase in the blood glucose level, there was a 3% increase in the risk of in-hospital complications, and this finding was in agreement with ours.

Hyperglycemia on admission has been associated with increased mortality in various studies [5,13,17], but this was not in agreement with this study as the in-hospital mortality was insignificant (only two diabetic patients and one nondiabetic patient), and this can be explained by the small sample size and assessment of in-hospital mortality only without follow-up of the patients after discharge.

This study has its limitations. The sample was too small and hence we could not detect the difference in the mortality rate between diabetic and nondiabetic patients and we did not follow-up the patients after discharge to detect long-term mortality as we focused on in-hospital mortality.

## Conclusion

On admission, CAP patients with increased blood glucose levels, either diabetic or nondiabetic, are expected to have poor outcomes.

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**Conflicts of interest**

There are no conflicts of interest.

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