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Influence of malnutrition on the risk of hospital-acquired pneumonia

Wpływ niedożywienia na ryzyko rozwoju szpitalnego zapalenia płuc

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Summary

Introduction. Hospital-acquired pneumonia (HAP) is a dangerous complication in hospitalized patients which involves the inherent risk of death.

Aim. The aim of this study was to check whether malnutrition has an influence on the risk of HAP.

Material and methods. Two groups of patients were examined: group I (the control group) comprised 166 randomly chosen patients (86 women and 80 men; mean age: 72; age range: 32-88 years); group II comprised 138 patients (50 women and 78 men; mean age: 74; age range: 39-86 years), suffering from hospital-acquired pneumonia.

Results. Anthropometric measurements and biochemical tests showed that malnutrition occurred definitely more often ($p = 0.001$) in the group II (with hospital-acquired pneumonia) than in the control group (66.7% vs 22.9%). The average length of hospital stay for patients was significantly longer (4.5 times longer; on average it was 22 days longer) in the group II than in the control group. The death rate in the group of patients with hospital-acquired pneumonia was significantly higher ($p = 0.001$) than in the control group (28.2% vs 4.2%).

Conclusions. Thus, malnutrition could be one of the possible risk factor for hospital-acquired pneumonia and increased death rate, as well as could be related to longer patient's hospital stay. Every patient admitted to hospital should have his/her nutritional status assessed and, in the case of having malnutrition diagnosed, he/she should undergo clinical medical nutrition.

Key words: malnutrition, overweight, obesity, hospital-acquired pneumonia

Streszczenie

Wstęp. Szpitalne zapalenie płuc (SzZP) jest groźnym, obciążonym dużym ryzykiem zgonu, powikłaniem u chorych hospitalizowanych.

Cel. W pracy zbadano, czy niedożywienie ma wpływ na zwiększenie ryzyka rozwoju SzZP.

Materiał i metody. Zbadano 2 grupy pacjentów: grupa I (kontrolna) obejmowała 166 losowo wybranych chorych (86 kobiet i 80 mężczyzn; średnia wieku: 72 lata; rozpiętość: 32-88 lat); grupa II 138 chorych (50 kobiet i 78 mężczyzn; średnia wieku: 74 lata; rozpiętość: 39-86 lat), u których rozwinęło się SzZP.

Wyniki. Na podstawie pomiarów antropometrycznych i badań biochemicznych wykazano, że niedożywienie występowało istotnie częściej ($p = 0,001$) w grupie II (ze SzZP) niż w grupie kontrolnej (66,7% vs 22,9%). Średni okres hospitalizacji również był istotnie dłuższy (4,5-krotnie; średnio o 22 dni) w grupie II niż w grupie kontrolnej. Odsetek zgonów w grupie chorych z SzZP był istotnie większy ($p = 0,001$) niż u osób z grupy kontrolnej (28,2% vs 4,2%).

Wnioski. Niedożywienie może być jednym z potencjalnych czynników ryzyka rozwoju SzZP, ryzyka zgonu, oraz może wiązać się z wydłużeniem okresu hospitalizacji. Każdy chory przyjmowany do szpitala powinien mieć wykonaną ocenę stanu odżywienia, a w przypadku rozpoznania niedożywienia – zastosowane odpowiednie leczenie żywieniowe.

Słowa kluczowe: niedożywienie, nadwaga, otyłość, szpitalne zapalenie płuc

INTRODUCTION

Hospital-acquired pneumonia (HAP) is a dangerous complication in patients hospitalized on various hospital wards (1-3).

Hospital-acquired pneumonia is defined as pneumonia which occurs 48 hours after admitting to hospital in a patient who was not intubated at the moment of his/her admission. The incidence of pneumonia fluctuates

between 5 and 15 per 1000 cases of hospitalization (4, 5). HAP is most often the result of nasopharyngeal bacterial colonization, after which the bacteria are aspirated to the lower respiratory tract (4, 6, 7). Hospital-acquired pneumonia significantly worsens the prognosis for recovery and increases the cost of treating patients in hospitals, especially in the case of elderly people, over the age of 65 (5). Pneumonia causes death more often than other nosocomial infections (5, 8).

The most important pathogens causing hospital-acquired pneumonia during the first days of hospitalization are *S. pneumoniae*, *H. influenzae*, methicillin-resistant *Staphylococcus aureus*, and sometimes HAP is caused by Gram-negative bacteria: *E. coli*, *K. pneumoniae*, *Enterobacter*, *Proteus*, *S. marcescens*. From the fifth day of hospitalization, Gram-negative bacteria dominate, *K. pneumoniae*, *Proteus*, *Serratia*, *P. aeruginosa*, *E. coli*, *Acinetobacter* sp. and *L. Pneumophila*, as well as Gram-positive ones: *P. aeruginosa*, *S. aureus*. The source of the bacteria causing hospital-acquired pneumonia are devices used on wards, environment (the air, water, equipment, clothes). Bacteria are also transmitted from one patient to another, as well as from healthcare personnel to patients.

The development of hospital complications, including hospital-acquired pneumonia in hospitalized patients, is favoured by various diseases (diabetes, cirrhosis, chemotherapy performed earlier) which disturb immune balance or diseases in which invasive examination of respiratory system (bronchoscopy) or urinary system was performed (9). There is little data available on the influence of one's nutritional status on the development of HAP in hospitalized patients (4, 5, 10). Pilot studies have shown that malnutrition can be a risk factor for hospital-acquired pneumonia (11). They are, however, difficult to carry out, because many factors can cause the development of this disease. Moreover, in such studies a very accurate assessment of one's nutrition state ought to be performed, as well as patients should be appropriately selected for the study.

The problem is quite serious, because many studies have shown that from 30% to 70% hospitalized patients suffer from protein-energy malnutrition, as well as vitamin or mineral malnutrition (8, 12-15). Studies carried out in Poland have shown that the symptoms of malnutrition can be observed in almost half of hospitalized patients (16, 17). The most serious causes of hospital malnutrition are: disease, hospital diet – especially low-protein – and low-energy diet, a lack of appropriate interest of doctors and nurses in this problem, as well as the fact that hospital dietitians cannot influence feeding arrangements in hospital (18-20). Moreover, hospitalized patients very often suffer nutrients loss as a result of hyper-catabolism (21, 22).

MATERIAL AND METHODS

Patients selected to participate in the study were hospitalized in the Clinic of Metabolic Diseases and Gastroenterology in the Mazowiecki Bródnowski Hospital.

They suffered from: ischemic heart disease, myocardial infarction, hypertension, cardiac dysrhythmia, atherosclerotic psychoorganic syndrome, gallstone, functional bowel disorders, chronic and acute pancreatitis, peptic ulcer, gastroesophageal reflux disease and neoplasm (patients who had not undergone chemotherapy).

The patients who were not selected for this study were admitted to hospital for bacterial infections and other illnesses which could become a risk factor of nosocomial infections, as well as patients who had undergone invasive examinations of respiratory system. The reasons for excluding patients from the study were as follows: the patient's hospital stay shorter than 2 days or longer than 14 days, non-HAP, chronic obstructive pulmonary disease, urinary tract infections, cholecystitis, ascending cholangitis, diabetes, cirrhosis, gastrointestinal bleeding, AIDS, coma, stroke, tracheal intubation, invasive examination of respiratory system (e.g. bronchoscopy), ear, nose and throat examination.

The (control) group I comprised randomly selected patients, who were admitted to the Clinic and who fulfilled all requirements. There were 166 people in this group (86 women and 80 men), mean age: 72 (age range: 32-88 years). The group II comprised patients who within 14 days of their hospital stay developed so called hospital-acquired pneumonia that is at least after 48 hours of their stay in hospital there were clinical and radiological symptoms of pneumonia observed. The following criteria for the detection of HAP were applied: new pulmonary infiltrates and worsening of existing infiltrates; 2 or 3 clinical symptoms present – body temperature $\geq 38^{\circ}\text{C}$, leukocytosis or leukopenia, pus in bronchi (23). Blood and/or sputum culture was done in order to identify bacteria that caused pneumonia (1). Group II comprised 138 patients (50 women and 78 men); mean age: 74 (age range: 39-86 years).

The assessment of nutritional status in all patients selected for the study was performed. The assessment covered: anthropometric measurements (BMI – Body Mass Index) (21, 24) as well as laboratory analyses (RBC count, haemoglobin concentration, peripheral blood lymphocyte count and serum albumin) (21, 22, 25). The following criteria to detect malnutrition were applied: BMI $< 18.5 \text{ kg/m}^2$, haemoglobin concentration (g/dl) in men $< 14 \text{ g/dl}$, in women $< 12 \text{ g/dl}$, peripheral blood lymphocyte count $< 1500/\text{mm}^3$, serum albumin $< 3.5 \text{ g/dl}$ (21, 24, 25). The statistical analysis was performed with the use of chi-square test.

RESULTS

The analysis of results showed that when the symptoms of hospital-acquired pneumonia occurred, most patients had abnormalities of nutritional status of various stages (anthropometric and biochemical abnormalities) suggesting malnutrition (tab. 1). The abnormalities were observed in 92 out of 138 patients (66.7%) with HAP (group II), whereas in the control group (group I) malnutrition symptoms were observed

in 38 out of 166 patients (22.9%). Worth noticing is the fact that in the group II in other 46 patients (33.3%) with hospital-acquired pneumonia overweight and obesity was observed. This proves that the development of HAP may be caused not only by malnutrition but also by overweight and obesity.

The patients with hospital-acquired pneumonia stayed in hospital longer (on average 22 days longer) than the patients in the control group (tab. 2). **The death rate among the patients with HAP was significantly higher** ($p = 0.001$) than among patients in the control group (28.2% vs 4.2%) (tab. 2).

Among patients with hospital-acquired pneumonia (group II) there were statistically ($p = 0.001$) more

deaths than in the control group (group I) (28.3% vs 4.2%). In patients with overweight and obesity more frequently ($p = 0.001$) the cause of death was myocardial infarction, ventricular fibrillation and pulmonary oedema. In malnourished patients more frequently ($p = 0.001$) the cause of death was focal cerebromalacia damage to circulation and respiration centres (tab. 3).

The analysis of blood and/or sputum cultures showed that most often pneumonia was caused by the following bacteria: *Streptococcus pneumoniae*, *Enterobacter species* and *Pseudomonas aeruginosa* (tab. 4). In both subgroups with hospital-acquired pneumonia there were no significant differences in the frequency of particular pathogens in those infections.

Table 1. Abnormalities of nutritional status (anthropometric and biochemical) suggesting malnutrition in the groups: group I (controls, $n = 166$) and group II (with HAP, $n = 138$).

Parameter studied		Group I, control group $n = 166$	%	Group II $n = 138$	%
Anthropometric data					
Underweight (malnutrition risk) BMI	< 18.5 kg/m ²	38	22.9	92*	66.7*
Normal BMI	18.5-24.9 kg/m ²	32	19.3	–	–
Overweight and obesity BMI	> 25.0 kg/m ²	96	57.8	46*	33.3
Laboratory analysis					
RBC count K K (F) < 4 200 000 M (M) < 4 600 000		26	15.7	58*	42
Haemoglobin concentration K (F) < 12 g/dl M (M) < 14 g/dl		38	22.9	89*	64.5
Peripheral blood lymphocytes count	< 1500/mm ³	34	20.5	72*	52.2
Serum albumin	< 3.5 g/dl	34	20.5	90*	65.2
Malnutrition markers					
Anthropometric and/or biochemical		38	22.9*	92*	66.7*

*Chi-square test $p = 0.001$ (vs group I)

Table 2. Duration of hospital stay and death rate in group I (control) and group II (patients with HAP).

Stay in hospital	Group I $n = 166$	Group II $n = 138$	Group IIa ¹ $n = 92$	Group IIb ² $n = 46$
Stay duration days				
Mean	6	28*	29*	22*
Range	4-22	15-49	17-49	15-39
Deaths	7 (4.2%)	39 (28.2%)*	26 (28.3%)*	13 (23.2%)*

¹Group IIa – malnourished patients with HAP

²Group IIb – overweight or obese patients with HAP

*Chi-square test $p = 0.001$ (II, IIa, IIb vs group I)

Table 3. Causes of death in patients with HAP (group II, number of deaths – 27).

Cause of death	Group II $n = 39$	Group IIa ¹ $n = 26$	Group IIb ² $n = 13$
Focal cerebromalacia damage to circulation and respiration centres	11 (28.2%)	11 (42.3%)	1* (7.7%)
Pulmonary artery embolism	13 (33.3%)	9 (34.6%)	4 (90.7%)
Lung oedema	2 (5.1%)	1 (3.8%)	1 (7.7%)*
Myocardial infarction	9 (23.1%)	4 (15.4%)	4 (30.7%)*
Ventricular fibrillation	4 (10.3%)	1 (3.8%)	3 (23.1%)*

¹Group IIa – malnourished NP patients

²Group IIb – NP patients with overweight or obesity

*Chi-square test $p = 0.001$ (group IIa vs group IIb)

Table 4. Analysis of blood and/or sputum cultures in 138 patients in group II (with HAP).

Bacterial species	Group II n = 138	%	Group IIa ¹ n = 92	%	Group IIb ² n = 46	%
<i>Streptococcus pneumoniae</i>	30	21.7	22	23.9	8	17.4
<i>Enterobacter species</i>	24	17.4	14	15.2	10	21.7
<i>Pseudomonas aeruginosa</i>	23	16.7	17	18.5	6	13.0
<i>Klebsiella pneumoniae</i>	18	13.0	12	13.0	5	10.9
<i>Acitenobacter species</i>	15	10.59	10	10.9	5	10.9
<i>Haemophilus influenzae</i>	8	5.8	5	5.4	3	6.5
<i>Escherichia coli</i>	2	1.4	1	1.1	2	4.3
(No bacteria were cultured from biological material)	18	13.0	11	12.0	7	15.2

¹Group IIa – malnourished patients with HAP

²Group IIb – HAP patients with overweight or obesity

DISCUSSION

The conducted study showed that malnutrition is related to the development of hospital-acquired pneumonia in hospitalized patients. Malnutrition symptoms were observed in 92 out of 138 patients with HAP (66.7%) selected for the study (tab. 1). A fact worth noticing is that there were no patients with proper nutritional status in this group. However, in the group there were 46 overweight and obese patients (that is 33.3%). Malnutrition occurred more often in patients with hospital-acquired pneumonia ($p = 0.001$) than in the control group (tab. 1). It was observed in 38 (22.9%) randomly selected hospital patients who made the control group (group I) (tab. 1).

Hospital-acquired pneumonia in malnourished patients probably develops as a result of immune systems disorders, which explains why such patients are more prone to infections (5). The occurrence of HAP in overweight and obese patients is probably also connected with nutrition disorders. Earlier published studies showed that vitamin and mineral deficiencies occurred in about 50% of overweight and obese patients who were admitted to Polish hospitals (17).

Too low protein and energy intake in obese patients may result in the development of kwashiorkor, which often accompanies such diseases as acute pancreatitis, or it may result in Crohn's disease (26).

Hospital-acquired pneumonia in malnourished patients closely correlated with longer hospital stay. In this group of patients it was on average 28 days (range: 15-49 days). The stay was even 4.5 times longer ($p = 0.001$) than the average hospital stay in the control group, which was on average 6 days (range: 4-22 days) (tab. 2). Moreover, suffering from hospital-acquired pneumonia was related to the worse prognosis for recovery. 39 out of 92 patients with HAP died (28.2%), while in the control group 7 patients died (that

is 4.2%) ($p = 0.001$) (tab. 2). A similar percentage of deaths was in both malnourished patients and patients with overweight or obesity.

A direct cause of death in malnourished patients with HAP pneumonia (group IIa) was: focal cerebromalacia damage to circulation and respiration centres, pulmonary artery embolism, lung oedema, myocardial infarction and ventricular fibrillation. Hospital-acquired pneumonia was connected with an increased risk of death in those patients, probably due to a range of mechanisms, such as an increased body temperature, dehydration, hypoxia, being bedridden, an increased risk of deep vein thrombosis, taking medicines (antibiotics, bronchodilators). These factors, especially in elderly people, lead to inadequate blood supply to brain and cerebral hypoxia (focal cerebromalacia damage to circulation and respiration centres), an increased risk of pulmonary artery embolism, myocardial infarction and ventricular fibrillation.

CONCLUSIONS

The conducted study showed that malnutrition could be one of the important factors behind the development of hospital-acquired pneumonia in patients hospitalized on internal medicine wards. Hospital-acquired pneumonia in malnourished patients probably increases the risk of death, whose direct causes are most often focal cerebromalacia damage to circulation and respiration centres, pulmonary artery embolism, lung oedema and myocardial infarction. Moreover, HAP in malnourished patients can affect longer hospital stay (the hospital stay is even 4.5 times longer) and it probably increases treatment costs. The study shows that all patients admitted to hospital should have their nutritional status assessed and in the case of having malnutrition diagnosed, they ought to undergo appropriate clinical nutrition.

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