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Hospital malnutrition – important health and economic problem

Niedożywienie szpitalne – ważny problem zdrowotny i ekonomiczny

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S u m m a r y

Nutritional status of patients in hospitals has a significant impact on the effectiveness of treatment, the incidence of complications, length of hospital stay and cost of treatment. Therefore an appropriate assessment of the nutritional status of patients admitted to hospitals is extremely important as well as a suitable diet applied on the basis of this assessment.

This procedure reduces wound healing time, decreases the risk of hospital-acquired pneumonia, reduces the period of hospitalization and reduces the total costs of treatment by 30-50%. However, as the anthropometric and biochemical studies show, symptoms of malnutrition are found in approximately 40-50% of patients admitted to hospitals. Moreover, symptoms of malnutrition develop or intensify during hospital stay in a large proportion of patients.

Key words: malnutrition, hospital stay, health complications, treatment effectiveness

S t r e s z c z e n i e

Stan odżywienia pacjentów w szpitalach ma istotny wpływ na skuteczność leczenia, występowanie powikłań, długość hospitalizacji i koszty leczenia. Dlatego też niezmiernie ważna jest właściwa ocena stanu odżywienia pacjentów przyjmowanych do szpitali i na jej podstawie zastosowanie odpowiedniego sposobu żywienia. Pozwala to na skrócenie czasu gojenia się ran, zmniejszenie ryzyka rozwoju szpitalnego zapalenia płuc, zmniejszenie okresu hospitalizacji oraz zmniejszenie nawet o 30-50% całkowitych kosztów leczenia. Tymczasem, jak wskazują wyniki badań antropometrycznych oraz biochemicznych, objawy niedożywienia występują u 40-50% pacjentów przyjmowanych do szpitali. Co więcej, u dużego odsetka chorych objawy niedożywienia rozwijają się lub pogłębiają w czasie pobytu w szpitalu.

Słowa kluczowe: niedożywienie, hospitalizacja, powikłania, skuteczność leczenia

HOSPITAL MALNUTRITION – SCALE OF THE PHENOMENON

In the past decades hospital malnutrition has become a subject of numerous epidemiological and clinical studies. This is due to the fact that a considerable part of patients admitted to hospitals manifest clinical or biochemical symptoms of malnutrition (1, 2). In many patients the symptoms of malnutrition, ascertained while being admitted to hospital, become intensified in the hospitalisation period. Besides as the stay in hospital increases, the occurrence frequency of malnutrition tends to grow as well (3, 4). It was found that malnutrition in patients tends to increase the morbidity, prolongs the required stay in hospital, and also increases treatment costs (5, 6).

In Poland tests of the nutritional status of the patients staying in hospitals were undertaken under a Commissioned Research Project Development of the scientific basis for nutrition in hospitals, which was oriented at evaluating the hospitalisation influence on the nutritional status (2, 7). The research was of a multi-centred, prospective and randomised nature. It was performed in 16 Polish hospitals, in clinics or internal medicine, general surgery, otolaryngological, gynaecology, ophthalmology and neurology wards.

The tests were performed on each tenth patient admitted to particular clinics or wards in the period from 01.01.1999 to 31.12.2000 (2, 7). The tests comprised 3256 patients aged 16 to 100, including 1368 males (average age: 54 years) and 1888 females (average

age: 53 years). For each patient qualified for testing, in the first 24 hours after admission an assessment was carried out of the nutritional status, and with regard to persons after surgery – also on the date of discharge from the hospital. On the other hand, as regards persons who did not undergo surgery the nutritional status testing was carried out during discharge only if they stayed in the hospital longer than 10 days. The evaluation of the nutritional status at discharge from hospital was carried out on 2673 patients. The nutritional status was evaluated with the use of anthropometric methods (Body Mass Index – BMI (kg/m^2); arm circumference (cm)) and biochemical methods (red cells count (million/mm^3), haemoglobin concentration (g/dl), white cells count ($x10^3/mm^3$), lymphocyte count in peripheral blood ($x10^3/mm^3$), and albumin concentration in blood serum (g/dl)). In in-depth tests on the nutritional status several biochemical tests were carried out, which comprised the determination of levels of antioxidant vitamins (A, E, C), B_{12} vitamin and folic acid in blood serum.

In patients for which the tests were carried out twice, it was found that during the stay in hospital a weight loss took place and consequently also the reduction of BMI, and arm circumference was reduced (2). In the tested blood the concentration of haemoglobin and albumins was reduced, and also the red cells count. Changes in the average lymphocyte count were not significant statistically.

The existence of a correlation was proven between the lengh of hospital stay and a change of certain nutritional indices (2, 7). As the number of days spent in hospital increased, a reduction of weight, BMI and arm circumference was noted ($p < 0.05$).

In a part of the patients the malnutrition risk was ascertained already during admittance to the hospital (tab. 1) (2). The value of BMI suggesting the possibility of protein-energy malnutrition was recorded in 4.2% of males and 4.4% of females. A decrease of lymphocytes count was recorded in the blood of 20% of males and 21.7% of females, and a deficient albumin concentration in the blood serum was noted in 23.1% of males and 18.6% of females. At discharge the percentage of persons with underweight was slightly higher, especially among males, nevertheless the differences were not of statistical significance. **On the other hand, the percentage of patients, in which deficient albumin concentration was recorded, was significantly higher.**

The percentage of persons, in which at least one of the above parameters pointed to the risk of malnutrition, amounted to 39.5% among males and 37.9% among females at admittance to hospital and to 43.9% and 44.1% respectively at discharge (2).

Weight loss during hospital stay was recorded in 60.9% of patients (2). On average it equalled to 2.1% of weight measured at the time of admittance. This reduction also concerned other persons characterised by underweight, and tended to intensify during hospitalisation. This concerned 42.6% of patients from this subgroup, and their weight decreased on average by 2.6%.

In the majority of cases the risk of vitamin malnutrition concerned vitamin C and folic acid (2). At admittance to hospital the deficit concentrations of those vitamins were recorded in 51.8% and 32% respectively of patients qualified for in-depth study. At discharge from hospital those percentages grew insignificantly (lack of statistical significance): for vitamin C to 67.7% and for folic acid to 40%.

The BMI correlates relatively well with other health state indices. In the analysed tests the interpretation proposed by WHO was adopted, according to which values of BMI < 18.5 kg/m^2 point to the risk of malnutrition (8). In the tested patient group BMI was clearly lower at discharge from hospital (2). Moreover, a strong interdependency was found to exist between the lengh of hospital stay and BMI reduction. The percentage of underweight persons already during admittance to hospital was higher in the general population, especially in older age groups (2, 9). During hospitalisation it even increased slightly (2).

During hospital stay arm circumference, another indicator of the protein-energy nutritional status decreased (2). The longer was the hospitalisation, the greater was the decrease in arm circumference.

The haemoglobin concentration is considered to be the most useful indicator in screening used to allow an evaluation of iron deficiency anaemia and an assessment of the nutritional status (7, 8). However, its values depend on the age of the tested persons, their gender and race and tend to change clearly dur-

Table 1. Percentage of patients in which values of selected indices at admittance and discharge from hospital pointed to the risk of malnutrition.

Tested index	Males				Females			
	At admittance		At discharge		At admittance		At discharge	
	N	%	N	%	N	%	N	%
BMI (< 18.5 kg/m^2)	1368	4.2	1064	5.5	1888	4.4	1594	4.5
lymphocyte count (< 1.5 x $10^3/mm^3$)	1365	20.0	715	19.0	1867	21.7	910	22.4
albumin concentration (< 3.5 g/dl)	1348	23.1	684	30.6*	1865	18.6	894	27.1*

N – number of patients in which the given indicator was tested.
*Statistically significant differences in patients tested at admittance to and discharge from hospital ($p < 0.05$; test of difference between two structure indices).

ing pregnancy. The haemoglobin concentration among tested patients during their stay in hospital clearly decreased (2).

In malnutrition the lymphocyte count in peripheral blood decreases (7, 8). The total lymphocyte count equalling to 1.5 x 10^3/mm^3 is considered to be correct. Values ranging between 0.9-1.5 x 10^3/mm^3 may indicate moderate nutritional disorders, while values below 0.9 x 10^3/mm^3 – severe malnutrition. However, the number of lymphocytes depends on numerous factors, such as septic states, stress, the administration of adrenal steroids, as well as coexistent infections. The evaluation of the total count of lymphocytes is a good measure of the immunity of the body and may only be used as an indirect measure of the nutrition status. A considerable part (ca. 20%) of tested patients was characterised by an insufficient lymphocyte count (2). Neither the average number of lymphocytes nor the percentage of patients in which it remained below the recommended values underwent substantial changes during the stay in hospital.

A frequently used index of the protein nutritional status are blood albumins (7, 8). There are many factors that affect the concentration of albumins in the blood serum, such as hepatic diseases, hypothyroidism (impaired production), diseases of the gastrointestinal tract and the kidneys (intensified albumins loss), injuries, stress, infections (change in the distribution of white cells in particular sections of the body), pregnancy (by dilution), in dehydration states (haemoconcentration). The albumin concentration of 3.5 g/dl was found to be the lowest admissible one, which can be accepted as being correct, while values ranging between 2.8-3.5 g/dl indicate to the possibility of protein malnutrition, and below 2.8 g/dl point to severe protein malnutrition. During hospitalisation the average concentration of albumins in the blood serum of the patients decreased considerably, and simultaneously quite a clear increase was recorded (by ca. 8 percentage points) of the percentage of patients, in whom this concentration was deficit (2).

Similar observations concerning the anthropometric indices of the nutritional status were made in patients admitted to one of the university hospitals in Scotland at the beginning of the nineties (3). The studied persons were characterised by an inferior nutritional status already at their admittance to the hospital as compared to the general population. Moreover, at the time of admission 39% of the group of patients with a correct weight had a lower weight during discharge, while in the group of underweight patients it became reduced in as much as 75%.

Among patients of 9 Swedish hospitals, who were studied in 2007, the risk of malnutrition (defined on the basis of low BMI, weight loss and improper nutrition) occurred in 22-34% of patients, and was the highest in the largest facilities (10).

Tests performed in 2006 in one of the Brazilian hospitals pointed to an extremely difficult situation (11). On the basis of the "Mini Nutritional Assessment" (MNA) malnutrition was recorded in 29.1% of elderly persons, and the risk of malnutrition in 37.1%.

In research related to the nutritional status of patients in Polish hospitals studies extended by biochemical indices were carried out, the objective of which was to allow discovering specific states of malnutrition (2). Very low vitamin concentration (with the exception of vitamin E) occurred with a similar frequency both in underweight patients, as well as with the normal weight, overweight and obesity. This implies that the risk of deficiency of many vitamins and minerals concerns not only underweight patients, but in many cases also those with the normal weight or overweight. The high percentage of patients with lower vitamin concentrations in the blood serum in hospitals than values considered to be correct may be connected not only with the disease, but may also reflect the relatively low intake of those vitamins.

A characteristic phenomenon for Polish hospitals is additional alimentation of patients by their families, as a large part of the patients declared supplementary alimentation apart from the hospital meals. However, in both patient groups, i.e. one obtaining additional food and the one that obtained no additional food, a similar trend was recorded of a reduction taking place of the tested indices of the nutritional status during the stay in hospital (2, 7).

The conducted research has shown that in Poland in more than 4% of patients admitted to various rank hospitals underweight was recorded (2). Reduced values of biochemical indices, indicating the impaired nutritional status (the concentration of albumins in the blood serum, the lymphocyte count in peripheral blood), occur in ca. 20% of persons admitted to hospitals. On the other hand, taking into consideration the above analysed parameters, it was found that at least one of them occurs in almost 40% of patients admitted to hospitals. The percentage of patients characterised by the risk of malnutrition becomes considerably intensified if one takes into account results of in-depth studies. The risk of vitamin malnutrition is recorded in more than half the patients admitted to hospitals, and the most frequent deficiencies concern vitamin C and folic acid.

MALNOURISHMENT COMPLICATIONS

A particularly disadvantageous impact of malnutrition is on the functioning of the immunological system. In such a case the cellular immunity appears to be most impaired, as well as phagocytic functions, cytokines production and the production of IgA antibodies and functioning of the complement system (12, 13).

The deficiencies of some vitamins have an adverse impact on the functioning of the immunological system (12, 13). The vitamin A deficiency frequently is associated with the protein deficiency and is connected with an increased infection risk. This arises most probably from epithelial changes and/or reduced humoral and cellular immunity. Studies carried out on animals proved that the vitamin A deficiency has an adverse

impact on the number and functioning of lymphocytes T, and reduced the possibility of antibody production by lymphocytes B. On the other hand, the deficiency of vitamin E impairs both the cellular and humoral immunity. Reduced energy intake from fat below 20% of energy requirement leads to a significant reduction in the absorption of fat-soluble vitamins, including vitamin E. As regards water-soluble vitamins the adverse impact of the deficiency of vitamin B_6 was proven, as well as pantothenic acid and folic acid on both types of immunity – both cellular and humoral.

The deficiency of energy, proteins, fats, vitamins and minerals leads to several different complications: they include a reduction in the muscular force, decreased immunity, hypochromic anaemia, and reduction of protein concentration in the blood serum, reduced intestinal mass, and atrophy of the mucous membrane, digestion and absorption disorders, weakened peristalsis, bacterial colonisation of the small intestine (5).

A severe protein deficiency leads to impairment of the cellular immunity – atrophy of the thymus and of thymus dependent areas of lymphatic nodes takes place, as well as a spleen atrophy (13, 14). The cause of this phenomenon is the inhibition of protein and DNA synthesis. The count of circulating lymphocytes T becomes reduced. Also the humoral immunity is impaired, which is manifested by a reduced concentration of IgA antibodies in the mucous membrane in the rhinopharyngeal passage and is conducive to infections of the chest. The concentration of IgA antibodies in the serum may become elevated, while lymphocytes B, antibodies class IgG and IgM tend to remain on standard levels. Frequently if the protein supply is insufficient, also deficiencies are recorded of numerous components of the complement system. As an effect with the total leukocyte count being correct, the immunity of the body to bacterial and fungal infections can be impaired.

Among minerals of particular importance are iron ions (14). Both the deficiency and their surplus entail the risks of a dysfunction of the immunological system. Iron is necessary for the correct functioning of the human immune system and to allow the bacterial proliferation. It is supposed that theoretically it may lead to the development of latent bacterial or parasitic infections, and so it is recommended that for persons with severe malnutrition or on-going infection iron supplementing be administered with caution. As regards healthy persons, supplementation of iron shortages was not found to affect the immune system. The zinc shortage is primarily connected with the disturbed cellular and humoral immunity. In many cases it coexists with the deficiency of protein, especially in children and adults with parenteral nutrition (15).

The immunodeficiency caused by malnutrition concerns a much larger proportion of humans than AIDS (12-14). It was found that malnutrition is an independent risk factor for the development of numerous diseases and treatment complications and mortality, in proportion to the intensity degree and the most severe one apart from organ failure. It turned out to be a much more acute risk factor than the coexistent diseases. The nutritional status has a great impact on the course of several infectious diseases, such as tuberculosis, pneumonia, the measles or bacterial and viral diarrhoeas. **Patients with malnutrition are characterised by apathy, and have a reduced muscular strength. Weakening of the respiratory muscles and impaired immunity increase the susceptibility to infections of the respiratory system.** Malnutrition caused by discontinuation of oral nutrition has a particularly disadvantageous impact on the intestines, which form a part of the immune system, as they contain ca. 50% immune cells of the body and generate considerable amounts of immunoglobulin. During chronic starvation, especially in the presence of an injury or disease, changes take place to the structure and functioning of the intestines, disorders of immune functions and the permeation of bacteria and endotoxins through the damaged intestinal walls. In such a way sepsis may take place, and later a multiple organ dysfunction syndrome, which is one of the main causes of deaths in patients after surgeries performed on abdominal cavity organs. The application of the nutritional treatment in the perioperative period reduces the risk of complications and hastens the healing of wounds. What is more, enteral nutrition is a stronger stimulus of the immune system than parenteral nutrition (16).

Many studies pointed to the positive impact of various nutrients on the immune system (14, 17). An important role is played here by the appropriate intake of energy, amino acids, nucleotides and lipids. If a high protein diet is applied, a significant increase is recorded in the concentration of proteins in the serum, transferrin, component C3 of the complement and IgG immunoglobulin, and leukocytes indicated a much higher opsonic index. Arginine supplementation stimulates lymphocytes B and T and promotes the collagen synthesis.

Provision of nourishment treatment in malnourished patients reduces significantly the occurrence of infectious complications during hospitalisation (16). This takes place both thanks to enhanced functioning of the immune system, and by shortening the exposure time of the patient to the hospital bacterial flora. If the hospitalisation is shorter, the risk of colonisation of the skin and of the mucous membrane as well as infections with bacterial strains resistant to antibiotics also becomes considerably reduced (18).

In the study carried out in Brazil among more than 700 hospitalised adults, the recorded mortality was almost three-fold higher and the hospitalisation time needed for malnourished patients was longer as compared to correctly nourished persons (tab. 2) (5). The study also pointed to a significantly more frequent occurrence of sepsis and abscesses within the abdominal cavity and a bigger risk of catching hospital pneumonia in malnourished persons. Moreover, treatment costs of patients with malnutrition were higher by 30% than those correctly nourished.

Table 2. The impact of malnutrition on complications, mortality and length of hospitalisation (709 patients).

Group	Complications (%)	Mortality (%)	Hospitalisation (days)
Malnourished	27	12.4	16
Correctly nourished	16.8	4.7	10

Preventing hospital malnutrition and its effective treatment allows an advantageous effect on the functioning of the immunological system, and consequently also on reducing the risk of infections and their course in hospitalised patients (18). In practice it is recommended that hospital nourishment be consistent with rational nourishment rules. Consequently wherever possible prior to the planned hospitalisation the nourishing deficiencies of the patients should be supplemented, and patients with the poroper nutritional status should be correctly nourished. This would allow reducing the number of complications, shortening the hospitalisation lengh and reducing costs of treatment.

HOSPITAL MALNUTRITION AND THE EFFICACY OF TREATMENT

The nutritional status also affects results both of preventive and of surgical treatment (19). Among others the nutritional status has a clear influence on the course of the Chronic Obstructive Pulmonary Disease (COPD). Patients characterised by low fat-free body mass or BMI below 20 kg/m^2, admitted to hospital owing to exacerbation of COPD, require longer treatment in hospital than patients with correct values of those parameters. There is also a bigger risk that they would require hospitalisation once again due to exacerbation of COPD symptoms within a period of 3 months since discharge from the hospital. Among patients with COPD treated by surgery by the lung volume reduction surgery (LVRS) 26% persons with a low BMI required longer administering of supported respiration (over 24 hours) as compared to 4% with the proper BMI (20-22).

Another disease, the course of which affects the nutritional status, is the stroke. Research results imply that patients, who were found to have symptoms of malnutrition at the time of their admittance to hospital due to a stroke, were more intensely exposed to the occurrence of complications (among others pneumonia, heart infarction, deep vein thrombosis), as well as a more acute course of the stroke as such, expressed in deeper damage to the central nervous system (22-24).

The nutritional status also influences to a large extent the results of surgical treatment, independently on the type of surgery (16). Based on the available test results it may be presumed that the total frequency of complications following surgeries is twice higher in malnourished persons, and severe complications occur in them three times more frequently than in persons in a proper nutritional status.

IMPACT OF THE NUTRITIONAL STATUS ON THE LENGTH OF HOSPITALISATION

The nutritional status is one of the crucial factors that affect the length of hospitalisation, which is a good indcator of the treatment efficacy and costs. One of the studies comprised an analysis of interdependencies that take place between the contents of adipose tissue and fat-free body mass on the one hand and the length of required hospitalisation on the other (25). It was found that the hospitalisation period of patients both with high adipose and a low fat-free body mass was longer than of persons with correct values of those parameters (20, 26). It was also found that the body composition of the hospitalised patients significantly differed from the one ascertained in healthy persons, despite slight differences in BMI. Persons admitted to the hospital much more frequently had excessively low fat-free body mass or excessively fat body mass than healthy volunteers. Furthermore, a conclusion was drawn that the body composition tends to be a more useful indicator for assessing the nutritional status than BMI. According BMI malnutrition was discovered in 13%, and overweight in 44% of patients, while results of the body composition testing equalled to 38% and 63%.

Other research suggested that patients whose nutritional status evaluation during admittance indicated malnutrition, had a risk of extended hospitalisation (7-22 days) of 65% as compared to correctly nourished persons, the average stay in hospital of which ranged from 4 to 13 days (27).

A lot of research has shown that Subjective Global Assessment (SGA) proves to be an expedient tool for evaluation of nutritional status of patients admitted to the hospital and an appropriate predictive factor for the length of hospitalisation. One of the studies evaluated the impact of the nutritional status assessed based on SGA of patients admitted to the gastroenterological ward on the hospitalisation period. It was found that persons qualified to category SGA C (severe malnutrition) had to be hospitalised much longer than persons categorised to SGA A (good nutritional status) and SGA B (moderately advanced malnutrition) (28, 29).

SUMMARY

A stay in hospital leads to an increased risk of occurrence of disorders to the nutritional status of patients. Furthermore, a strict correlation exists between the number of days of stay in hospital and the impairment of such indices of malnutrition risk, as: weight, BMI, and arm circumference. In the case of some patients this could potentially lead to serious health related consequences and may significantly reduce the efficacy of treatment.

The problem of hospital malnutrition was discussed during sessions of the European Commission in Strasburg in 2001. At the time it was emphasised that there was a shortage of programmes that comprise the identification and treatment of malnutrition, and the prevention of its occurrence after admittance to the hospital.

Consequently it was recommended that teams responsible for nutrition of the patients be appointed in hospitals and that the science of nutrition be introduced to education programmes of physicians and nurses.

On the one hand the above presented data confirm the importance of prevention and treatment of obesity to allow reducing risks to the development and intensification of civilizational diseases, which in many cases are a cause for hospitalisation, and on the other hand – the significance of assessing the nutritional status of persons admitted to the hospital. It should be emphasised that the mere determination of BMI and the concentration of albumins in the blood serum at admittance to hospital may allow the discerning of malnourished patients, who require special nutritional supervision and treatment, and may consequently contribute to enhancing the efficacy of treatment, lower its costs and as an effect reduce the required hospitalisation time.

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received/otrzymano: 26.09.2012
accepted/zaakceptowano: 31.10.2012

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