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## Changes seen in the body of an elderly patient suffering from diabetes

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### Abstract:

**Background:** Diabetes is a foreign disease today. This is a chronic, metabolic disease that is characterized by elevated blood glucose levels. There are many types of disease. Each of them has different characteristics. The key in the fight against the disease is to perform appropriate laboratory tests to diagnose diabetes and to introduce appropriate treatment to prevent many complications, e.g. impairment of: vision, kidneys, cardiovascular system or hearing.

**Material and methods:** A proper review of the literature was used, which identifies risk factors, complications and proper management in diagnosing diabetes.

**Results:** The growing problem of diabetes forces us to find the most accurate way to treat the disease. Performing reliable diagnostics is crucial. The reference method (IDMS) and

methods used in routine diagnostics, oxidase hexokinase are the basic and necessary laboratory tests used in the diagnosis of diabetes.

**Conclusions:** In the coming years, the number of patients suffering from diabetes will continue to grow. Diagnosis and treatment of this disease is extremely important, because neglecting the disease can have many serious consequences for healthy physical and mental functioning. The basis is the performance of correct tests, which allows for proper treatment.

**Key words:** diabetes, hyperglycaemia, atherosclerosis, cardiovascular, sight complications, hearing complications, kidney complications

## **Introduction**

Diabetes is a chronic metabolic disease characterized by elevated blood glucose levels - above 7.0 mmol / l. It is also referred to as a metabolic syndrome, which is associated with abnormal carbohydrate metabolism (primary diabetes). To diagnose diabetes, the ADA and WHO criteria are used, which include the finding of elevated fasting blood glucose and glucose load testing. The number of people with diabetes around the world is around 170 million people, and the incidence is still increasing. Forecasts suggest that by 2030, the number of people with diabetes will amount to 360 million [1, 2, 3].

Diabetes is an important clinical problem in older people - affects up to 25-30% of seniors. The body's aging itself is associated with specific disorders of carbohydrate metabolism, and risk factors such as reduced physical activity, obesity, decreased muscle mass, changes in diet, use of drugs, co-existing diseases or genetic predisposition favor the occurrence of diabetes [2, 4, 5].

Depending on the pathomechanism, type 1 diabetes mellitus and type 2 diabetes are distinguished. Type 1 diabetes is caused by the disorder or destruction of the  $\beta$ -islets of Langerhans pancreas, which are responsible for the production and secretion of insulin. It develops rapidly, manifests itself in increased thirst, frequent urination, weight loss, and general feeling of fatigue and weakness. Lack of treatment may lead to exhaustion of the body's compensation and even death. It is most common in young people and children, and

the incidence in comparison with type 2 diabetes is 5-10%. The basic treatment method is insulin substitution and proper nutrition or moderate physical exercise [2].

Type 2 diabetes is caused by abnormal secretion and / or action of insulin in the body (reduced sensitivity of tissues to insulin). It is characterized by gradual and secretive development. In the early phase of the disease, patients are accompanied by polyphagia. As a result of exceeding the threshold blood glucose levels, glycosuria, polydipsia and polyuria occur. Non-typical symptoms of type 2 diabetes include fatigue and reduced mental and physical performance. This type of diabetes occurs primarily in people over 30 years of age, and is most often accompanied by obesity and hypertension. The incidence of type 2 diabetes is 90-95% compared to type 1 diabetes and increases with age. In Poland, about 1.6 million people suffer from this disease. The basic method of treatment is to adjust the right diet, exercise or use of hypoglycemic agents [2, 6].

In addition to type 1 and type 2 diabetes, other types of diabetes are also distinguished, including gestational type diabetes, type MODY and type LADA [1].

### **Laboratory tests to diagnose diabetes**

Hyperglycemia occurs naturally in all types of diabetes, regardless of their etiopathogenesis and clinical course. Determination of blood glucose is the basic and indispensable laboratory test used in the diagnosis of diabetes, as well as within the self-control of patients. Due to the increasing prevalence of diabetes and the need to prevent and monitor the disease, the determination of glycaemia is the most commonly performed biochemical examination in the diagnostic laboratory. Currently, there are two methods used to determine glucose in blood in laboratories: 1. reference method - mass spectrometry with isotope dilution (IDMS), 2. methods used in routine laboratory diagnostics, hexokinase or oxidase [7, 8].

Preparing the patient for the study of fasting blood glucose should look like this: the test should be performed in the morning after an overnight rest, and the patient must necessarily be fasting and 24 hours before the test should not perform intense physical exercise, or change their diet. The patient should not report for a period of acute infectious or inflammatory disease and strictly give up alcoholic beverages that may affect glucose levels. If all of the

above conditions have been met, we recognize diabetes when the blood glucose is  $\geq 7$  mmol / L [9].

When the patient has an abnormal fasting blood glucose (5.6-6.9 mmol / L) to diagnose diabetes, an Oral Glucose Tolerance Test (OGTT) should be performed. Other indications for the OGTT test are: 1. Features of the metabolic syndrome with normal fasting glycemia, 2. Glucoseuria with normal fasting glycemia, 3. When there is a reasonable suspicion of glucose insufficiency (in elderly people without overweight, with other co-existing risk factors for diabetes) . The patient should prepare for OGTT in the same way as for testing fasting blood glucose. When all conditions are met, blood is drawn from the patient (in the morning, after an overnight rest). The patient is then given 75 g of anhydrous glucose dissolved in 200-300ml of water and must be consumed within 5 minutes. After drinking the solution, the patient can not do any physical exertion for 2 hours, ideally he should remain at rest. After 2 hours, the blood should be collected again. We recognize diabetes when after 2 hours in the OGTT test the blood glucose level is  $> 200$  mg / dl (11.1 mmol / l) [1, 10].

Diabetes can't be diagnosed by glucometeres. They are used to monitor the level of glucose in the blood that can be done at home. If two patient tests for the diagnosis of diabetes gave conflicting results, confirm the test, the result of which exceeds the diagnostic point. In risk groups, screening for diabetes is necessary because more than half of the patients do not have symptoms of hyperglycaemia [1, 8].

A test for diabetes mellitus should be done once every 3 years for every person over 45 years of age. In addition, regardless of age, this test should be performed annually in people who have risk groups: 1. People who are overweight or obese, 2. If diabetes affects the closest family, 3. People who are not physically active, 4. People who had a pre-diabetic status in a previous study, 5. In women with gestational diabetes, 6. People with hypertension, 7. People with dyslipidemia, 8. Women with polycystic ovary syndrome, 9. People with cardiovascular disease [1, 11].

Another test in the diagnosis of diabetes is the determination of glycated hemoglobin (HbA1c). It is used to monitor the treatment of diabetes, whose determination should be done depending on the stability of the patient's disease. If the patient has a stable course of diabetes, HbA1c should be done once a year, whereas if the patient does not achieve the goals of

treatment, HbA1c should be done at least once a quarter. Blood for this test is taken to an EDTA tube or heparin. This study distinguishes the fact that the patient does not need to be prepared for the test (does not have to be fasted). The HbA1c value reflects the average blood glucose concentration in the period of about 3 months preceding the determination. It is a retrospective glycemc index and a risk factor for the development of chronic diabetic complications. Determination of HbA1c should be performed in all diabetic patients. The result > 6.5% suggests diabetes [8, 9].

The next parameter used in the diagnosis of diabetes is the determination of fructosamine concentration. In diabetic patients, the elevated fructosamine concentration correlates with elevated glucose and is directly proportional to the concentration of blood proteins. Fructosamine reflects daily average glycemia over the last 2 weeks (albumin survival period) prior to the test to control the effectiveness of diabetes treatment during this time. Due to large fluctuations in the results (the impact of non-abortion factors, diet, albumin loss, liver disease) is not as popular in diagnostics as HbA1c, but due to the short half-life is useful in monitoring diabetes in pregnant and in closed care [8].

## **Clinical changes in a person with diabetes**

### **1. Visual impairment**

In the course of diabetes, there are changes in capillaries that have a basal membrane. Increased blood sugar levels damage the blood vessels (capillaries) in the retina. Changes in photosensitive tissue, or retina, caused by functional and specific microangiopathy complications for diabetes are called diabetic retinopathy. This clinical syndrome according to WHO data in the diabetic population ranges from 20-60%. Of the 2 million people in the Polish population suffering from diabetes, up to 600,000 people suffer from diabetic retinopathy [12, 13].

Eye complications due to diabetes may also be extravascular changes occurring in the eye organs, such as: cataract, glaucoma, inflammation or atrophy of the optic nerve, paralysis of other nerves of the eyeball. In the initial stage of diabetes in the examination of the eye organ, the oculomotor nerve palsy innervating the eyeballs is rarely detected. In the later

period, symptoms that appear in vision disorders and even loss of sight are often intensified [12, 14, 15, 16, 17].

In patients with diabetes, two types of cataracts may occur: metabolic (diabetic) and senile which is more common and usually among geriatric patients with type 2 diabetes. The prolonged exposure to hyperglycemia undoubtedly contributes to the development and maturation of cataracts, which is confirmed by epidemiological studies indicating a greater percentage of patients with cataracts among people with diabetes mellitus from people in the same age group with normal blood sugar levels [12, 14, 16, 17].

There are two types of changes in the eye organ of the nature of retinopathy. Non-threatening loss of vision is retinopathy non-proliferative in which the formation of microaneurysms and venous congestion (angiopatia diabetica retinae) or minor patches in the eye bottom resulting from retinal ischemia (retinopathy diabetica angiogens) is characteristic. Vascular lesions that lead to retinal degeneration and marked deterioration of vision are termed proliferative retinopathy. New blood vessels are formed that under the influence of increased pressure in the capillaries burst and cause blood loss to the retina resulting in loss of vision. Only retinal angiopathy is specific for those with diabetes. Other sets of symptoms in the course of retinopathy also occur in other diseases [12, 17].

The course and development of retinopathy depends on: the type of diabetes, the duration of the disease and the degree of carbohydrate disorder. More often, retinal disease affects people diagnosed with type 1 diabetes. Pregnancy affects the clinical picture of retinopathy. More frequent widening of the retina veins is observed which is dependent on the level of progesterone and estrogens. In the course of proliferative retinopathy, retinal hemorrhages occur more frequently, which poses a threat to the organ of vision. Diabetic nephropathy, autonomic neuropathy, liver parenchymal disease and hypertension also have an impact on the progression of diabetic retinopathy. Elevated intraocular pressure and the presence of other eye defects increase the progression of the disease [12, 13, 15, 16].

Retinopathy rate is quite high, therefore it requires early diagnosis of the disease and the use of appropriate treatment. Due to the possibility of vision loss good diabetes control and frequent follow-up ophthalmologic examinations are necessary. Onset and progression of non-proliferative retinopathy depend primarily on hyperglycaemia and can be significantly

delayed through intensive insulin therapy. However, in the course of diagnosed proliferative retinopathy, laser photocoagulation is used. Using this treatment in a timely manner reduces the risk of blindness by half [13, 16, 17].

## **2. Cardiovascular disorders**

Cardiovascular disorders are a frequent cause of death in diabetics. In patients the incidence of cardiovascular events is higher than in healthy people. Inappropriately treated diabetes is the cause of macroangiopathic complications (damage to large vessels) and microangiopathic (small vessel damage) [18, 19].

Microangiopathic changes in diabetics result from long-term exposure of tissues to hyperglycaemia. These changes occur as a result of summation of many factors - endothelium damage, oxidative stress. As a consequence, we observe disturbed blood flow, deposition of protein deposits outside the vessels - this leads to changes in tissues and insulin-dependent organs (eg kidneys) [20].

In the case of macrovascular complications, atherosclerosis plays an important role. The initial step of progression of atherosclerosis is the adhesion of monocytes to endothelial cells, their subsequent migration to the intimal membrane, where monocytes are transformed into macrophages. Foam cells are formed. As a result of subsequent changes in the vessel, atherosclerotic plaque is formed. In a person with type 2 diabetes, the process of thickening the walls of the vessel is faster. Hyperglycemia in these patients also leads to increased LDL cholesterol, triglycerides, and reduced HDL cholesterol. In patients with type 1 diabetes, there is also a greater risk of atherosclerosis through elevated blood sugar [18, 19]

Atherosclerosis in diabetics (also in cerebral arteries) increases the risk of stroke (2-3 times more often than in healthy people). Another consequence of atherosclerosis is impaired collateral circulation, which adversely affects the blood supply to the lower limbs [21].

Insulin resistance and hyperinsulinaemia play a significant role in the pathogenesis of type 2 diabetes. The absorption of sodium in the kidneys, thickening of the vessel wall and the

retention of sodium and calcium in the vessel occurs. All this, together with stimulation of the sympathetic system, leads to increased blood pressure [21].

It is estimated that the risk of cardiovascular death in diabetic patients is almost 3 times more frequent compared to healthy people. Appropriate treatment and constant patient control are the key to reducing the cardiovascular risk associated with diabetes [18, 21].

### **3. Disorders in the functioning of the kidneys**

Nearly 30% of patients with type 2 diabetes develop diabetic kidney disease. In Poland, as in many other countries, this complication of diabetes is one of the most common reasons for the use of renal replacement therapy. Diabetic kidney disease is transformed into a chronic kidney disease. This, along with diabetes, is one of the risk factors for the emergence of cardiovascular complications. Both of these diseases also increase the risk of death. Due to the prevalence and impact on the further life of patients, diabetic kidney disease is therefore a very important problem [22, 23].

A characteristic feature of kidney disease is their abnormal functioning and/or structural changes occurring in them - tissue fibrosis, caused by inflammation and haemodynamic effects. Genetic factors are also important. All this ultimately leads to irreparable damage to the organ. The fibrosis of the glomerulus and tubules very often leads to chronic kidney disease. However, progressive chronic kidney disease leads to end-stage renal failure requiring dialysis or renal transplantation to save lives [24].

Inflammation plays an important role in the pathomechanism of developing diabetic kidney disease. It can be activated by hyperglycemia, the renin-angiotensin system and oxidative stress. Obesity appearing in diabetics is also important. The negative effect is caused by the increased production of chemokine, kidney infiltration by monocytes and lymphocytes, as well as the production of pro-inflammatory cytokine and reactive oxygen. The activity of inflammatory cells enhances the inflammatory response, cell damage and the development of fibrosis in the organ. [25, 26].

The first symptoms of changes that occur in the kidneys's diabetic patients is glomerular hyperfiltration occurring in the early stages of diabetes in the majority of people. The glomerular permeability deficiency causes an increased amount of protein in the urine. Already at the moment of diagnosis (diabetes) 1/3 of people have microalbuminuria - the first biochemical determinant of diabetic kidney disease. Microalbuminuria is transformed into macroalbuminuria in nearly 3% of patients within one year [22, 26].

All diabetic patients should have a test for detection of diabetic kidney disease at least once a year. The screening tests include: urinalysis and GFR estimation. In the case of persistent albuminuria or the appearance of protein in the urine and co-existing diabetic retinopathy, diabetic nephropathy is diagnosed. Exclude other kidney diseases that could be the cause of similar symptoms is necessary before making a diagnosis.

The basic therapeutic actions in the case of chronic kidney disease and slowing down its progression is glycemic control. The latest guidelines emphasize the importance of maintaining the target percentage of glycosylated hemoglobin below 7%. With albuminuria it is also important to maintain a pressure below 130/80 mm Hg. The drugs of choice in this case should be angiotensin converting enzyme inhibitors and angiotensin II receptor antagonists. Lipid disorders should also be under control. In the metabolism of many drugs used to treat diabetes, the kidneys play an important role. Therefore, it is important to properly use and modify medicaments having regard to the presence of both diseases - diabetes and diabetic nephropathy [22, 23].

### **Difficulties in contacting a patient with diabetes**

Nervous system disorder is one of the most discussed topic in diabetes, but cognitive disorders are an equally important aspect. Many studies indicate that cognitive impairment is much more common in diabetic patients than in healthy people of the same age. This aspect is extremely important because problems in the cognitive sphere significantly impede contact between the doctor and the patient. Patients often do not understand treatment instructions Niven by the doctor, and cannot use them. This limits their independence by the necessity of third parties during their daily activities [27, 28].

According to psychologists, cognitive functions are mental activities that are used to obtain information about yourselves, analyze the situation, formulate conclusions, make decisions and act. Among them are: perception, attention, memory, learning, thought processes, executive functions, and language processes [29].

Type I diabetes weakens cognitive skills, but these changes are short-lived and reversible. Type II diabetes has much greater difficulties in this matter. Patients suffer from verbal and spatial memory impairment, the efficiency of attention processes, verbal fluency, functions related to the frontal lobe (mating functions), psychomotor performance and are associated with an increased risk of intellectual disorders [29].

In addition, diabetes doubles the risk of vascular dementia and dementia that develops as a result of Alzheimer's disease. Tali Cukierman has even suggested placing a reduction in cognitive performance in the group of chronic diabetic complications [28].

Aging processes take place much faster in patients with diabetes than in healthy peers. Both the disease and the physiological aging of the organism significantly affect the deterioration of cognitive functions or even lead to dementia [27].

In case of any problems with communication, the treatment team and the speech therapist need to be co-operated. Speech therapist role is to support the patient in improving communication skills and implementing the doctor's recommendations. In addition, correct communication significantly affects the quality of life of the patient and his / her mental state, which may favorably affect the success of the whole treatment process [30].

## **Discussion**

An elderly person with diabetes is at risk of developing many complications associated with changes in the body, the listing and description of which significantly exceeds the scope of a single scientific publication. Considering the most frequent changes and considered the most important from the point of view of clinical practice, special attention should be paid to the high risk of amputation of the lower limb, due to the high mortality associated with it. Given the great importance of this issue for elderly patients with diabetes,

Carmona et al. conducted a 10-year observation of people from the Geneva area (Switzerland) for the occurrence, etiology and prognosis of lower limb amputation. According to the results of their observation, the risk of amputation of the said limb increases by a factor of 10 in elderly people who have diabetes. The forecasts turned out to be pessimistic, because as many as 47% of the respondents died after amputation. This demonstrates the need for further research into the management of patients after lower limb removal and the introduction of specialized care methods, consisting of rehabilitation, pharmacotherapy, and psychological care to reduce mortality [31, 32].

The results of the article describe the impact of diabetes on cardiovascular changes. These changes can often be recognized already on the basis of the clinical picture, which is of great importance in practice due to the high speed of diagnosis at virtually zero financial input. An example is the possibility of diagnosing asymptomatic coronary artery disease based on erectile dysfunction in older men with diabetes. Research carried out in Italy by Gazzaruso et al. confirms the importance of erectile dysfunction as a predictor in the aforementioned disease, however, indicating that its usefulness decreases in people over 66 and should be used in younger patients. Because of the great importance in clinical practice, activities should be carried out to detect and describe subsequent predictors in other diseases [33].

The changes in the kidneys in people with diabetes described in the article are not the only urinary tract disorders. The effect of diabetes on the increased development of urinary incontinence in the elderly is also known and significant in clinical practice. However, the exact mechanism by which this phenomenon occurs remains unsolved. To increase knowledge about this issue, 322 patients with diabetes over 60 years of age, treated at the National Geriatric Hospital in Hanoi (Vietnam), have been examined. The results of the study include advanced age, long duration of diabetes, high levels of FPG and HbA1c, taking a large amount of drugs, and the presence of cognitive impairment as factors that increase the development of urinary incontinence in people with diabetes. The multitude of factors that may increase the risk of the disorder in question suggests the need for further research on this topic in the future [34].

## Conclusions

Diabetes is a metabolic disease with hyperglycaemia due to various causes. This disease often affects older people. Due to its increasing occurrence, rapid diagnostics and the introduction of patient-specific treatment play a major role. Blood glucose is determined using mass spectrometry with isotope dilution (IDMS) and hexokinase or oxidase. Diabetes is diagnosed when blood glucose is  $\geq 7$  mmol / L. Diabetes cannot be diagnosed with a meter. An important test in the diagnosis of diabetes is the determination of glycated hemoglobin (HbA1c) and the concentration of fructosamine. It is important to remember about eye damage in the course of diabetes, especially in seniors. The risk of developing diabetic retinopathy is increasing, which affects 20% to 60% of patients. Metabolic and senile cataracts, glaucoma, optic neuritis or atrophy are further problems affecting senior citizens with diabetes. Proliferative retinopathy is a threat to blindness. Its development is affected by the type of diabetes, the duration of the disease and the degree of carbohydrate disorders. Diabetic nephropathy, autonomic neuropathy, liver parenchyma disease and hypertension as well as elevated intraocular pressure and the presence of other eye defects are also important factors. Cardiovascular disorders are a common cause of death in diabetics. Prolonged exposure of tissues to hyperglycemia results in impaired blood flow and protein deposition outside the vessels. This type of patient is also at risk for atherosclerosis. Atherosclerosis increases the risk of stroke and affects the blood supply to the lower extremities. Insulin resistance and hyperinsulinemia, on the other hand, play an important role in the pathogenesis of type 2 diabetes. Cardiovascular diseases significantly increase the risk of death in patients with diabetes compared to a healthy person. Almost half of the patients suffer from kidney disease, which results in the use of renal replacement therapy. Diabetic kidney disease and cardiovascular disease are the most common complications of diabetes. Kidney damage results from inflammatory processes and vascular changes. Glomerular filtration is reduced, which increases the amount of protein in the urine. Everyone with diabetes should be screened for diabetic kidney disease once a year. During diabetes, the nervous system and cognitive functions are damaged. In most cases these are reversible changes. There are memory disorders, problems with concentration, psychomotor and intellectual skills. The risk of Alzheimer's disease increases. Patients need the help of specialists who help them with developing dementia.

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