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ABSTRACT

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FEATURES OF COVID-19 IN PATIENTS WITH DIABETES MELLITUS

Introduction: Diabetes mellitus and COVID-19 are nosologies that pose new challenges in the field of medicine, and after their combination, have already outlined their importance and potentially large impact on the health of people around the world. Each of these pathologies individually has a significant impact on the lives and well-being of patients, and together they create complex conditions for medical practice and healthcare organization. The study of the mutual influence of diabetes mellitus and COVID-19 on the clinical picture, features of the course, diagnosis and treatment of patients is of great importance and relevance for both the scientific community and applied practical medicine, and its continuation and expansion is a scientific and public need.

Materials and Methods: A total of 53 patients with COVID-19 were examined. Their medical records were reviewed. To assess the clinical parameters, epidemiological data, physical and psycho-emotional state of patients, the author's own questionnaire "Form of Communication-1" was created and used. Based on the data obtained, statistical indicators were calculated: Pearson's test for qualitative indicators, Mann-Whitney U test was used as a non-parametric analysis method, Student's t-test for values that corresponded to the normality of distribution, respectively.

Results: Patients with COVID-19 were divided into two groups: with diabetes mellitus (20 patients, 37.7%) and without this pathology (comparison group) (33 patients, 62.3%). Most of those studied were women (57%), aged (59.2 ± 12.5) years. Patients were hospitalized on days 4-5 of the disease.

Among the concomitant pathologies, arterial hypertension and coronary heart disease were more frequently detected in the group of patients with diabetes mellitus (85% each), in the comparison group (55% and 52%, respectively ($p < 0.05$).

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The coronavirus disease began acutely with chills and fever up to (38.3±0.18) °C. Generalized weakness was experienced by 96 % of patients. Among the complaints in the comparison group, ague (33 %) and hoarseness of the voice (52 %) prevailed ($p < 0.05$).

Severe COVID-19 was observed in 85% of patients with diabetes mellitus, and in the comparison group - in 33% of patients. On the contrary, moderate severity prevailed in the comparison group (64 % of patients) ($p < 0.05$).

The blood glucose level in patients with COVID-19 in the setting of type 2 diabetes was (9.9 ± 6.8) mmol/L and was higher than in the comparison group (5.8 ± 1.4) mmol/L, indicating hyperglycemia due to impaired glucose tolerance ($p < 0.05$).

Conclusions: Women (57%) of middle age (59.2 years) predominate among patients. Severe COVID-19 predominates in the group of patients with diabetes mellitus. The clinical picture is not significantly different in the compared groups, but laboratory data (elevated C-reactive protein, changes in platelet size, elevated levels of alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transpeptidase, urea, creatinine), objective symptoms (changes in general condition, severe course, auscultatory abnormalities) indicate more pronounced changes in patients with COVID-19 and diabetes mellitus. SARS-CoV-2 induces changes in glucose metabolism and contributes to the severity of COVID-19, which in turn leads to hypercytokinemia, cytokine storm, tissue and airway damage.

Keywords: COVID-19, diabetes mellitus, glucose, hyperglycemia, severity, features, good health.

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ОСОБЛИВОСТІ ПЕРЕБІГУ COVID-19 У ПАЦІЄНТІВ ІЗ ЦУКРОВИМ ДІАБЕТОМ 2 ТИПУ

Актуальність: цукровий діабет і COVID-19 – нозології, що створюють нові виклики у галузі медицини, після свого поєднання, вже окреслили свою важливість та потенційно великий вплив на здоров'я людей у всьому світі. Кожна з цих патологій по окремості мають значний вплив на життя та добробут пацієнтів, у поєднанні створюють складні умови для медичної практики та організації системи охорони здоров'я. Дослідження взаємного впливу цукрового діабету та COVID-19 на клінічну картину, особливості перебігу, діагностику та лікування пацієнтів, має неабияку важливість та актуальність, як для наукового товариства, так і для прикладної практичної медицини, і його продовження та розширення є науковою та громадською потребою.

Матеріали і методи: усього обстежено 53 хворих на COVID-19. Опрацьовано їх медичні картки. Для оцінки клінічних показників, епідеміологічних даних, фізичного та психоемоційного стану хворих був створений та використаний власний опитувальник “Форма комунікації-1”. За отриманими даними були розраховані статистичні показники: критерій Пірсона – для якісних показників, U-критерій Манна-Уїтні використовувався як непараметричний метод аналізу, t-критерій Стьюдента для величин, що відповідали нормальності розподілу відповідно.

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Результати: хворі на COVID-19 були розділені на дві групи: з цукровим діабетом (20 осіб, 37.7 %) та без цієї патології (група порівняння) (33 пацієнта, 62.3 %). У дослідженні переважали жінки 57 %, віком (59.2 ± 12.5) роки. Пацієнти госпіталізувалися на 4-5 добу захворювання.

Серед супутньої патології у групі хворих з цукровим діабетом частіше визначалися артеріальна гіпертензія та ішемічна хвороба серця (по 85 %), у пацієнтів групи порівняння (55 % та 52 % відповідно ($p < 0,05$).

Коронавірусна хвороба починалася гостро з ознобу, підвищення температури тіла до (38.3±0.18) °С. Загальну слабкість відчували 96 % хворих. Серед скарг у групі порівняння переважали агевзія (33 %) та осиплість голосу (52 %) ($p < 0,05$).

Тяжкій ступінь перебігу COVID-19 спостерігався у 85 % хворих з цукровим діабетом, у групі порівняння – у 33 % хворих. Навпаки середній ступінь тяжкості переважав у групі порівняння (64 % пацієнтів) ($p < 0,05$).

Рівень глюкози у крові хворих на COVID-19 на тлі ЦД склав (9,9 ± 6,8) ммоль/л і був вищим ніж у групі порівняння (5,8 ± 1,4) ммоль/л, що свідчить про гіперглікемію внаслідок порушення толерантності до глюкози ($p < 0,05$).

Висновки: серед хворих переважають жінки (57 %) середнього віку (59.2 року). Тяжкий перебіг COVID-19 переважає у групі хворих з цукровим діабетом. Клінічна картина значно не відрізняється у порівнюваних групах, проте дані лабораторних показників (підвищений С-реактивний білок, зміни розмірів тромбоцитів, підвищений рівень аланін- та аспартат-амінотрансферази, гамма-глутамілранспептидази, сечовини, креатиніну), об'єктивна симптоматика (зміни загального стану, тяжкий перебіг, аускультативні відхилення) свідчать про виразніші зміни у пацієнтів з COVID-19 та ЦД. SARS-CoV-2 індукує зміни у метаболізмі глюкози та сприяє посиленню тяжкості COVID-19, що у свою чергу призводить до гіперцитокінемії, цитокінового шторму, пошкодження тканин і дихальних шляхів.

Ключові слова: COVID-19, цукровий діабет, глюкоза, гіперглікемія, тяжкість, особливості, міцне здоров'я.

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INTRODUCTION / ВСТУП

The coronavirus disease (COVID-19) pandemic began in 2019 and has had long-term consequences for many aspects of every citizen's life. According to the Ministry of Health of Ukraine, 5557995 people in Ukraine have confirmed COVID-19, of whom 112418 have died [1]. The adverse effects of chronic hyperglycemia on the immune system and the prevalence of type 2 diabetes mellitus (T2DM) in the population are responsible for the growing number of people with T2DM among those with COVID-19 [2].

T2DM is an endocrine disease that occurs as a result of absolute or relative insulin deficiency, insulin resistance, resulting in hyperglycemia - a persistent increase in blood glucose levels. There are several reasons why patients with diabetes may be more susceptible to the serious consequences of COVID-19: unstable blood glucose levels, reduced immune response, higher susceptibility to secondary infections, and micro- and macrovascular damage [3, 4]. Patients with diabetes are at higher risk of severe pneumonia, septic and toxic shock, acute respiratory distress syndrome, and multiple organ failure. Patients with hyperglycemia are also at increased risk of thromboembolic complications and acute respiratory failure. An increase in the number of concomitant chronic diseases in the history contributes to a significant increase in the frequency of adverse

outcomes for patients [5]. This is reflected in the high mortality rate among patients with COVID-19 with diabetes mellitus, despite full inpatient therapy [6, 7].

Research to provide a better understanding of the pathophysiological mechanisms underlying the relationship between COVID-19 and T2DM is becoming relevant to improve the level of health care services, timely diagnosis to prevent and reduce the severity of coronavirus disease in patients with T2DM.

Aim: to identify the peculiarities of COVID-19 in patients with type 2 diabetes mellitus based on the study of epidemiological, laboratory and clinical diagnostic data.

Materials and methods

The study examined 53 patients with COVID-19 who were treated in the period from 2022 to 2023 at the municipal non-profit enterprise of the Sumy Regional Council "Krasovitsky Medical Clinical Center for Infectious Diseases and Dermatology" and reviewed their medical records. All patients were examined using objective, laboratory (clinical and biochemical blood tests, coagulogram, clinical urinalysis) and hardware research methods.

To assess the patients' anamnestic, epidemiological, and clinical data, the Communication Form-1 (CF-1) questionnaire was created. The questionnaire consists of three main blocks: "Your health status today", "COVID-19 and you", "COVID-19 and diabetes". The "Your Health Status Today" section deals with the patient's health at the time of the survey. The "COVID-19 and You" section deals with past episodes of coronavirus infection. The COVID-19 and Diabetes section covers changes in indicators and therapy for patients with diabetes during the disease. In addition to assessing symptoms, the questionnaire included questions about bad habits, the number of episodes of COVID-19 in the history and the presence of Long-COVID signs. Objective and subjective symptoms typical of the disease were selected: dizziness, fever, abdominal pain, chest pain, muscle pain, sore throat, shortness of breath, cough, runny nose/runny nose, loud breathing (distant wheezing), increased heart rate, weight loss, visual impairment, voice changes nausea/vomiting, diarrhea, difficulty swallowing, tremors, postural instability, weakness/fatigue, loss of smell, loss of taste, headache, memory loss or confusion, loss (worsening) of appetite, hearing loss or tinnitus. It was also important to assess the extent to which the disease affects the psychological state, so patients were asked to determine the level of mood deterioration, sleep disorders, anxiety/anxiety, difficulty concentrating, and reduced efficiency in performing routine tasks during the disease. The questionnaire was tested on a group of patients with COVID-19 and received feedback as clear, simple, concise, easy to use, and took 7-12 minutes to complete for one patient.

The results of the data obtained (questionnaire "FC-1", medical records of patients) were formed into a database and processed using methods of variation statistics (Student's t-test, Mann-Whitney U-test, Pearson's test) in Microsoft Office Excel 2016 and IBM SPSS Statistics 27 to further study the impact of diabetes mellitus on the course of coronavirus disease. Statistical dependence between the two groups was considered to be $p < 0.05$.

All stages of the study, including data collection, processing and analysis, as well as maintaining the confidentiality of medical information, were conducted in accordance with moral and ethical standards. Participants were properly informed about the objectives and methods of the study. Consent to participate in the study was obtained in writing from each participant, as required by the Declaration of Helsinki.

Results and discussion

Patients with COVID-19 were divided into two groups: those with a history of diabetes mellitus (20 people, 37.7%) and those without diabetes mellitus (33, 62.3%) (comparison group). Most of those studied were women - 30 patients (57%), men - 23 patients (43%). The age was (59.2 ± 12.5) years. Most often, hospitalization occurred on the 4th-5th day after the onset of the disease. All patients were conscious.

Severe disease was observed in 85 % of patients with a history of diabetes mellitus, in the comparison group - in 33 % of patients ($p < 0.05$). The average severity prevailed in the comparison group - in 64 % of patients ($p < 0.05$). This is due to cellular resistance to insulin, hyperglycemia, which promotes the synthesis of proinflammatory cytokines and advanced glycation end products (AGEs), oxidative stress, production of adhesion molecules that mediate tissue inflammation and a persistent proinflammatory response. Abnormal delayed-type hypersensitivity reactions complement activation dysfunction, suppress the proliferative response of lymphocytes, and impair macrophage and neutrophil function in patients with diabetes. SARS-CoV-2 binds to ACE-2 receptors, which are expressed in cells of the pancreas, adipose tissue and intestine. Thus, SARS-CoV-2 infection causes changes in glucose metabolism and contributes to the severity of COVID-19, which in turn leads to hypercytokinemia, cytokine storm, tissue and respiratory damage [8].

During a viral load, the body is under stress, which activates the hypothalamic-pituitary-adrenal (HPA) axis. This leads to an increased release of glucocorticoids such as cortisol, which can increase

blood glucose levels by inducing gluconeogenesis and reducing insulin sensitivity. [9].

Among COVID-19 patients with diabetes, 50% increased the number of blood glucose measurements during their hospitalization, 65% detected minor changes in this indicator, and 33% changed their diabetes treatment regimen.

In all subjects, arterial hypertension (AH) and coronary heart disease (CHD) prevailed among the comorbidities. Hypertension was more common in the group of patients with T2DM (85%) compared with the group without T2DM (55%) ($p < 0.05$); CHD: in patients with T2DM - in 85%, in the comparison group - in 52% ($p < 0.05$). T2DM and COVID-19 have a mutual potentiating effect on the degree of systemic inflammation and create stress on the immune system, which leads to endothelial dysfunction and metabolic disorders that worsen the course of hypertension and coronary heart disease [10-12].

Obesity was more common in the group of patients with diabetes (50%), in the comparison group it was 3 times less common (18%): 25% each - I degree of obesity (12% in the comparison group) and II degree of obesity (3% in the comparison group) ($p < 0.05$). The established link between diabetes and obesity is insulin resistance, where glucose cannot effectively enter cells, leading to an increase in blood sugar levels [13]. The average weight in the group with diabetes was higher and amounted to (86.0 ± 18.4) kg, while in the comparison group it was (76.7 ± 14.4) ($p < 0.05$). This was confirmed by BMI in patients with diabetes mellitus - (30.6 ± 4.9), in the comparison group - (26.6 ± 4.7) ($p < 0.05$). The statistical dependence between the groups indicates that individuals with diabetes are more likely to be obese, as it is a major risk factor for the development of diabetes [14].

Among the complications, acute bronchitis was more common in the comparison group - 85% of patients, in the group with T2DM - 30%. Pneumonia was observed in 15% of subjects without T2DM and 70% in the group of patients with T2DM. Respiratory failure (RF) was prevalent in the group with T2DM: 65% of patients had grade I RF (48% in the comparison group), 15% - grade II RF ($p < 0.05$). This indicates a higher risk of severe pneumonia, septic and toxic shock, acute respiratory distress syndrome, and the development of multiple organ failure in patients with T2DM (Table 1).

Table 1 - Frequency of concomitant pathology and complications in patients

Pathology / complications	Comparison group (n = 33)	Patients with diabetes (n = 20)	p
Obesity: I degree II degree III degree	6 (18 %): I degree - 4 (12%) II degree - 1 (3%) III degree - 1 (3%)	10 (50 %): I degree - 5 (25%) II degree - 5 (25%)	0.030*
AG	18 (55 %)	17 (85 %)	0.023*
CHD	17 (52 %)	17 (85 %)	0.014*
Acute bronchitis	28 (85 %)	6 (30 %)	0.001*
Pneumonia	5 (15%)	14 (70 %)	0.001*
RF: I degree II degree	16 (48 %): I degree - 16 (48%)	16 (80 %) I degree - 13 (65%) II degree - 3 (15%)	0.017*

*Notes: * – significant difference in Pearson's test in patients with COVID-19 and T2DM compared to the group without T2DM*

Among the existing complaints in the comparison group, ague (33%) and hoarseness (52%) were 6.6 times and 2 times more common, respectively ($p < 0.05$). Generalized weakness, headache, body aches, shortness of breath, runny nose, cough, sore throat, chest pain, hoarseness, anosmia, nausea, vomiting, diarrhea did not differ significantly between the groups ($p > 0.05$) (Table 2). Such results indicate a discrepancy between the clinical manifestations and the data of objective and laboratory examination.

The acute onset of the disease with chills and fever up to 38.3°C indicates an active immune system response to the viral agent, where cytotoxic T cells contribute to the inactivation of SARS-CoV-2 and prevent further spread of the infection [15, 16].

Complaints of nausea and vomiting did not have a statistical correlation in the groups, but there is a tendency to increase in the group of patients with diabetes by 2.2 times (20% in the group with diabetes, 9% in the comparison group) ($p > 0.05$).

Table 2 - Frequency of symptoms in patients of the study groups

Symptom	Comparison group (n = 33)	Patients with diabetes (n = 20)	p
General weakness	32 (97 %)	19 (95 %)	0.444
Headache	23 (70%)	11 (55 %)	0.279
Aches and pains in the body	22 (67 %)	11 (55 %)	0.396
Shortness of breath: I - Under load; II - In peace; III - Expressed	18 (54 %): I - 11 (33 %) II - 6 (18%) III - 1 (3%)	13 (65 %): I - 10 (50 %) II - 3 (15%)	0.592
Undead	14 (42 %)	7 (35 %)	0.532
Cough	24 (73 %)	17 (85 %)	0.301
Sore throat	14 (42 %)	5 (25 %)	0.200
Pain in the chest	6 (18 %)	6 (30 %)	0.319
Huskiness of the voice	17 (52 %)	5 (25 %)	0.049*
Anosmia	12 (36 %)	4 (20 %)	0.208
Agevzia	11 (33 %)	1(5 %)	0.017*
Nausea	3 (9 %)	4 (20 %)	0.256
Vomiting.	3 (9 %)	4 (20 %)	0.256
Diarrhea	4 (12 %)	1(5 %)	0.389

*Notes: * - significant difference in Pearson's test in patients with COVID-19 and T2DM compared to the group without T2DM*

Auscultation: crepitation was more often heard in the group of patients with diabetes mellitus - in 65 % of patients, while in the comparison group - only in 12 % of patients ($p < 0.05$) (Table 3). The 5.4-fold increase in the frequency of detection indicates the presence of an increased amount of fluid in the alveoli due to inflammation, which in turn leads to a more severe course of the disease in patients with diabetes mellitus, the development of respiratory distress syndrome and pneumonia [17].

Table 3 - Severity of objective clinical signs in the subjects

Feature	Comparison group (n = 33)	Patients with diabetes (n = 20)	p
Medium severity	21 (64 %)	3 (15 %)	0.001*
Severe degree of severity	11 (33 %)	17 (85 %)	0.001*
Oxygen saturation of blood (Sp02) (%)	(96,1 ± 1,7)	(93,2 ± 7,1)	0.067
Body temperature (T) (˚C)	(37,0 ± 0,6)	(37,2 ± 0,6)	0.379
T, in anamnesis (˚C)	(38,1 ± 0,8)	(38,3 ± 0,9)	0.328
Duration T (days since hospitalization)	(2,8 ± 4,1)	(2,8 ± 4,0)	0.773
Heart rate (HR) (beats per minute)	(89,4 ± 16,6)	(80,6 ± 16,6)	0.352
Blood pressure (mm Hg): systolic diastolic	(129,5 ± 17,4) (82,4 ± 7,5)	(130,8 ± 18,3) (78,5± 13,7)	0.697 0.479
Weight (kg)	(76,7 ± 14,4)	(86,0 ± 18,4)	0.046*
Body mass index (BMI)	(26,6 ± 4,7)	(30,6 ± 4,9)	0.005*
Hyperemic mucous membrane of the oropharynx	9 (27 %)	5 (20 %)	0.831
Difficulty breathing through the nose	7 (21 %)	1 (5 %)	0.135
Auscultatory: shortness of breath harsh breathing crepitation	 20 (61 %) 19 (58 %) 4 (12 %)	 12 (60 %) 10 (50 %) 13 (65 %)	 0.145 0.591 0.001*

Notes: * - significant difference in Pearson's test in patients with COVID-19 and T2DM compared to the group without T2DM

Table 4 - Laboratory parameters in patients depending on the presence of diabetes mellitus

Indicator	Comparison group (n = 33) (M±m)	Patients with diabetes (n = 20) (M±m)	p
Clinical blood test			
White blood cells (WBC) (*10 /l)^9	7,6 ± 7,0	8,7 ± 6,4	0.313
Red blood cells (RBC) (*10 /l)^{12}	4,2 ± 0,7	4,4 ± 0,6	0.135
Hemoglobin (HGB) (g/l)	126,7 ± 19,7	126,5 ±15,8	0.862
Hematocrit (HCT) (%)	0,3 ± 0,05	0,3	0.491
Mean corpuscular volume (MCV) (fh)	77,1 ± 6,05	76,3 ± 5,8	0.258
Mean corpuscular hemoglobin (MCH) (pg)	31,0 ± 4,8	29,4 ± 2,2	0.054
MCHC (g/l)	399,6 ± 38,4	384,5 ± 11	0.01*
Platelets (PLT) (*10 /L)^9	205,7 ± 89,4	198,4 ± 68	0.757
PDW (fl)	10,4 ± 1,7	13,9 ± 2,3	0.001*
Rods of neutrophils (%)	5,2 ± 3,9	7,6 ± 6	0.226
Segmented neutrophils (%)	59,1 ± 19,2	66,7 ± 10,4	0.209
Eosonophiles (%)	0,9 ± 1,5	0,9 ± 1,4	0.617
Basophils (%)	0,0 ± 0,2	0,0	-
Lymphocytes (%)	30,3 ± 20,8	20,2 ± 10,3	0.093
Monocytes (%)	4,4 ± 2,5	5,1 ± 2,9	0.488
ESR (mm/h)	17,8 ± 13,5	22,5 ± 16,6	0.373
Biochemical blood test			
Total protein (g/l)	72,5 ± 6,7	74,2 ± 7,9	0.407
Albumin (g/l)	44,0 ± 6	38,9 ± 3,2	0.001*
Creatinine (μmol/L)	89,5 ± 26,5	111,4 ± 54,8	0.044*
Urea (mmol/l)	6,9 ± 3,9	8,5 ± 2,7	0.047*
Total bilirubin (μmol/L)	12,9 ± 5,4	16,1 ± 8,6	0.191
ALT (IU/l)	22,6 ± 18,9	29,3 ± 9,9	0.022*
AST (IU/L)	25,8 ± 11,6	34,7 ± 22,2	0.016*
Alkaline phosphatase (ALP) (U/l)	64,5 ± 24,3	77,1 ± 25	0.08
GHT (U/l)	27,2 ± 19,2	43,0 ± 35,3	0.04*
Glucose (mmol/L)	5,8 ± 1,4	9,9 ± 6,8	0.011*
D-dimer (μg/ml)	0,7 ± 0,7	0,7 ± 0,6	0.806
CRP (mg/l)	12,5 ± 13,1	32,7 ± 28,2	0.007*
Coagulogram			
Fibrinogen (g/l)	3,4 ± 0,6	4,0 ± 0,4	0.001*
Prothrombin time (sec.)	10,8 ± 2,7	12,3 ± 1,8	0.017*
INR	0,9 ± 0,2	1,0 ± 0,1	0.037*
Thrombin time (sec.)	9,0 ± 3,1	9,6 ± 0,8	0.602
Activated partial thromboplastin time (APTT) (sec)	32,0 ± 6,8	29,5 ± 2,2	0.943
Thrombotest (degree)	4,3 ± 0,5	4,3 ± 0,6	0.854
Clinical urine analysis			
Protein (g/l)	0,2 ± 0,5	0,2 ± 0,7	0.447
White blood cells (cells in the field of view)	5,2 ± 5,1	10,6 ± 17,3	0.087
Red blood cells (unchanged) (cells in the field of view)	3,0 ± 4,2	0,8 ± 1,2	0.002*
Red blood cells (variable) (cells in the field of view)	2,2 ± 2,1	1,6 ± 2,2	0.101
Glucose (mmol/L)	2,1 ± 9,8	13,5 ± 20,9	0.001*
Ketone bodies (mg/dL)	0	2,0 ± 4,5	-

*Notes: * - significant difference in Pearson's test in patients with COVID-19 and T2DM compared to the group without T2DM*

In the group of patients with diabetes mellitus, there is a tendency to leukocytosis, an increase in segmented and rod-shaped neutrophils, while in the comparison group there is a tendency to increase lymphocytes ($p > 0.05$).

Elevated C-reactive protein (CRP) (2.62 times) and Platelet Distribution Width (PDW) in the group of patients with diabetes (1.34 times), in contrast to the comparison group, are an indicator of the acute phase of inflammation associated with SARS-CoV-2 infection ($p < 0.05$).

Elevated levels of alanine aminotransferase (ALT) (1.30-fold), aspartate aminotransferase (AST) (1.34-fold) and gamma-glutamyl transpeptidase (GGT) (1.58-fold) in the group with diabetes indicate hepatocyte cytolysis and increased liver detoxification function ($p < 0.05$).

A reduced value of albumin in the blood of patients with diabetes mellitus (1.13 times) may indicate a systemic inflammatory response in the body, such as a cytokine storm. A pronounced immune response can affect liver function, primarily protein synthesis, by indirectly reducing blood albumin levels. Renal dysfunction can cause loss of proteins in the urine, including albumin. Renal dysfunction is also indicated by elevated urea (1.23 times) and creatinine (1.24 times) in patients with diabetes ($p < 0.05$).

High blood glucose levels in the group of patients with T2DM (9.9 ± 6.8) indicate hyperglycemia due to impaired glucose tolerance ($p < 0.05$). This condition is dangerous because of the possibility of developing diabetic ketoacidosis, polyuria polydipsia, arterial hypertension and coronary heart disease, myocardial infarction, stroke, and cytokine storm [18].

Coagulogram parameters (fibrinogen, prothrombin time, international normalized ratio (INR)) were higher in the group with T2DM ($p < 0.05$). The appearance of glucose in the clinical urine test (13.5 ± 20.9) in patients with T2DM indicates a decrease in the renal threshold for glucose ($p < 0.05$) (Table 4).

CONCLUSIONS / ВИСНОВКИ

Women (57%) of middle age (59.2 years) predominate among patients with COVID-19.

Among the concomitant pathologies in the group of COVID-19 patients with diabetes mellitus, arterial hypertension and coronary heart disease are more commonly diagnosed.

The severe course prevails in patients with concomitant diabetes mellitus, who are at higher risk of developing severe pneumonia, septic and toxic shock, acute respiratory distress syndrome, and multiple organ failure.

Patients with concomitant diabetes mellitus are more likely to be obese, as it is a major risk factor for the development of diabetes.

The complaints of patients with concomitant diabetes mellitus are dominated by generalized weakness, headache, body aches, and cough. The clinical picture does not differ significantly in the compared groups, but the data of laboratory parameters (elevated C-reactive protein, changes in platelet size, elevated levels of alanine aminotransferase, aspartate aminotransferase gamma-glutamyl transpeptidase, urea, creatinine), objective abnormalities (changes in general condition, severe course, auscultatory abnormalities) indicate more pronounced changes in patients with COVID-19 and concomitant diabetes mellitus.

SARS-CoV-2 causes changes in glucose metabolism and contributes to the severity of COVID-19, which in turn leads to hypercytokinemia, cytokine storm, tissue and respiratory damage.

AUTHOR CONTRIBUTIONS / ВКЛАД АВТОРІВ

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CONFLICT OF INTEREST / КОНФЛІКТ ІНТЕРЕСІВ

The authors declare no conflict of interest.

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