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ORIGINAL ARTICLE

Viral infections in cancer patients at the stages of antitumor treatment

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ABSTRACT

Purpose of the study. To analyze cases of viral infection in cancer patients at the stages of antitumor therapy.
Patients and methods. We conducted a retrospective analysis of the medical histories of 50 patients with acute respiratory failure (I–III st.), hospitalized in the Department of anesthesiology and intensive care in 2017–2020. Of these, 34 are children and 16 are adults. Sputum, tracheobronchial aspirate, and blood were examined for the presence of viral agents.
Results. Viral infection was confirmed in 35 (70 %) patients. During CT, it developed more often than in the early postoperative period (72.2 % vs 64.3 %, $p > 0.05$), but this situation is true only for the general group of patients. In children, viral infection was diagnosed only on CT (71.9 % of those receiving CT, $p = 0.098$, F = 0.13), and in adults it was equally common (75 % each), both during CT and after surgery. In lung cancer, viral infection was confirmed in 7 (100 %), pelvic fever in 7 (63.6 %), bones, connective and soft tissues in 6 (66.7 %), hemoblastoses in 3 (75 %), central nervous system tumors in 5 (71.4 %) patients. Herpesvirus infection (HVI) was confirmed in 15 (42.9 % of the infected), respiratory viral infection (RVI) in 13 (37.1 %), and their combination in 7 (20 %) patients. In general, we note a slight predominance of HVI over RVI (22/62.9 % vs. 20/57.1 %, $p > 0.05$). Mixed infection with a combination of two to four pathogens and mono-infection developed equally frequently: in 18 (51.4 %) and 17 (48.6 %) patients, respectively.
Conclusions. Infectious complications are an important component of modern antitumor treatment. Therefore, it is necessary to monitor the spectrum of viral infections in cancer patients with signs of respiratory dysfunction at the stages of antitumor therapy. Proper assessment of the situation will help to avoid the development of critical consequences, reduce the time of hospitalization, and improve the course and prognosis of cancer.

Keywords: viral infection, respiratory complications, antitumor therapy, respiratory failure

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Compliance with ethical standards: the ethical principles presented by the World Medical Association Declaration of Helsinki, 1964, ed. 2013 were observed in the study. Informed consent was received from all participants of the study. The study was conducted with the permission of the Ethics Committee of the National Medical Research Centre for Oncology (Protocol No. 19 dated 11/22/2021). Informed consent was obtained from all participants in the study.

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Вирусные инфекции у онкологических больных на этапах противоопухолевого лечения

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РЕЗЮМЕ

Цель исследования. Провести анализ случаев проявления вирусной инфекции у онкологических пациентов на этапах противоопухолевой терапии.

Пациенты и методы. Был проведен ретроспективный анализ историй болезни 50 больных с признаками острой дыхательной недостаточности (I–III ст.), госпитализированных в отделение анестезиологии и реанимации в 2017–2020 гг. Из них 34 ребенка и 16 взрослых. Исследовали мокроту, трахеобронхиальный аспират, кровь на наличие вирусных агентов.

Результаты. Вирусная инфекция была подтверждена у 35 (70 %) больных. При проведении химиотерапии (ХТ) она развивалась чаще, чем в раннем послеоперационном периоде (72,2 % vs 64,3 %, $p > 0,05$), однако это положение справедливо лишь для общей группы больных. Среди детей вирусная инфекция была диагностирована только у пациентов, которым проводилась ХТ (71,9 % получавших ХТ, $p = 0,098$, $F = 0,13$), а у взрослых одинаково часто (по 75 %) как в результате проводимой ХТ, так и после хирургического вмешательства. При раке легкого вирусная инфекция была подтверждена у 7 (100 %) больных, злокачественных новообразованиях малого таза – у 7 (63,6 %), костей, соединительной и мягких тканей – у 6 (66,7 %), гемобластозами – у 3 (75 %), опухолях центральной нервной системы – у 5 (71,4 %) больных. Герпесвирусная инфекция (ГВИ) была подтверждена у 15 (42,9 % от числа инфицированных), респираторно-вирусная (РВИ) – у 13 (37,1 %), а их сочетание – у 7 (20 %) больных. В целом можно отметить некоторое преобладание ГВИ над РВИ (22/62,9 % против 20/57,1 %, $p > 0,05$). Микст-инфекция с сочетанием от двух до четырех возбудителей и моноинфекция развивались одинаково часто: у 18 (51,4 %) и 17 (48,6 %) больных соответственно.

Заключение. Осложнения инфекционного характера являются важной составляющей современного противоопухолевого лечения. В этой связи необходимо проводить мониторинг спектра вирусных инфекций у онкологических пациентов с признаками развития респираторной дисфункции на этапах проведения противоопухолевой терапии. Правильная оценка ситуации позволит избежать развития критических последствий, сократить сроки госпитализации, улучшить течение и прогноз онкологического заболевания.

Ключевые слова: вирусная инфекция, респираторные осложнения, противоопухолевая терапия, дыхательная недостаточность

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Соблюдение этических стандартов: в работе соблюдались этические принципы, предъявляемые Хельсинкской декларацией Всемирной медицинской ассоциации (World Medical Association Declaration of Helsinki, 1964, ред. 2013). Исследование проведено с разрешения Комитета по Этике ФГБУ «Национальный медицинский исследовательский центр онкологии» Министерства здравоохранения Российской Федерации (протокол № 19 от 22.11.2021 г.). Информированное согласие получено от всех участников исследования.

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Конфликт интересов: все авторы заявляют об отсутствии явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи

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BACKGROUND

To date, the success of the diagnosis and therapy of malignant neoplasms has significant results. At the same time, the use of standard treatment approaches does not always lead to the expected effect, which serves as a prerequisite for the development of personalized approaches to the treatment of cancer patients [1]. Meanwhile, it is necessary to take into account the role of complications that occur against the background of antitumor treatment, which not only worsen the quality of life of patients and provoke their refusal to carry out planned therapy, but also cause serious functional disorders of the body, up to life-threatening conditions requiring timely and urgent measures [2]. In this regard, special attention should be paid to the study of risk factors for the development of negative consequences during complex antitumor treatment. It is known that cancer patients are the most vulnerable group and are more susceptible to various complications, including those of an infectious nature [3]. This is due to the fact that the defect of the immune system is provoked by the development of the tumor itself and deeper functional changes in the patient's body due to the use of aggressive courses of chemoradiotherapy, corticosteroids and antimicrobial treatment, as well as due to extended and combined surgical interventions [4]. According to Egorov AYu (2019) infectious complications are the cause of death of cancer patients in 39–43 % of cases [5]. Meanwhile, mortality from respiratory complications reaches 27 % [6, 7].

Many viral agents are involved in the occurrence of respiratory complications in these patients, such as influenza virus, parainfluenza, respiratory syncytial virus, adenovirus, rhinovirus, coronavirus, metapneumovirus and human bocavirus [6–10]. Respiratory syncytial (RS), influenza virus and rhinovirus are diagnosed with the highest frequency (60 %) [6]. Parainfluenza viruses, metapneumoviruses, bocaviruses and adenoviruses are less common: the frequency of their detection in patients ranges from 2 % to 10 % [6, 7]. Other well-known pathogens, such as cytomegalovirus (CMV), Epstein-Barr virus (EBV), herpes simplex virus types 1 and 2 (HSV 1, 2), human herpes virus type 6 (HCV6), also often cause serious diseases in cancer patients, but are not truly respiratory. CMV after hematopoietic stem cell transplantation occurred in 29 % of patients, and in 26.5 % with RS, and if pneumonia with CMV monoinfection developed in 31 %, then with coinfection with RS it was 2 times more common in 68 % of patients [11].

In this context, it is necessary to take into account the fact that the main danger of respiratory viruses lies in their ability to provoke the development of pneumonia and secondary bacterial complications. According to Katsurada N (2016), in a study of patients over 65 years of age diagnosed with pneumonia, viral pathogens were detected in 23 % of cases, while rhinoviruses (9.9 %) were the most common cause of pneumonia, the RS virus was detected in 4.1 % of cases, and influenza viruses in 3.9 % of cases [12]. A meta-analytical review of patients with pneumonia of different age groups conducted in 2017 by Korean researchers showed that any of the representatives of respiratory viruses can be the trigger of generalized bacterial infection [13].

It should be emphasized that respiratory infections in patients with a complicated premorbid background, including cancer patients with secondary immunodeficiency, are poorly predictable and do not always have a favorable prognosis [5]. As a rule, the virus, penetrating the mucous membrane of the respiratory tract, has a cytopathic effect on epithelial cells, which leads to fullness of the microcirculatory bed, swelling of the mucous layer, increased vascular permeability and excessive production of interferon. These pathological changes are the starting point of stimulation of the transient microbiota, when epithelial cell membranes are destroyed, and phospholipids are released with activation of arachidonic acid metabolism processes. There is an increased production of bradykinin, leukotrienes, and the activity of cytokines and neutrophils increases. The secondary microbial lesion is aggravated by the adhesion of several pathogenic microorganisms to the mucous membrane of the respiratory tract, which occurs as a result of a decrease in the concentration of immunoglobulin A, lactoferrin, interferon and lysozyme in the mucocellular secretion. Together, there is a decrease in antiviral and antibacterial activity with uncontrolled inflammation, impaired ventilation, and the development of hypoxia [14]. As a result, damage to the respiratory epithelium and the microcirculatory bed leads to the rapid development of acute respiratory distress syndrome (ARDS), which actually causes the death of one in three patients [15].

It is obvious that viruses are the cause of the development of a chain of pathological transformations that can later lead to the development of severe systemic complications. At the same time, it is almost impossible to assess a full-scale lesion from a viral infection, since the data on mortality from bacterial pneumonia do not actually take into account the role of the viral etiological aspect as a provocateur of the development of secondary infection [14].

The number of studies devoted to the problem of bacterial infection in various groups of patients with a variety of pathological conditions, prevention and treatment measures is increasing annually [14]. At the same time, there are practically no publications on the problem of the development and course of viral infections in cancer patients at the stages of antitumor treatment.

Purpose of the study: to analyze the cases of viral infection in cancer patients at the stages of antitumor therapy.

PATIENTS AND METHODS

The study was performed with the consent of patients or their representatives to the processing of personal information and the use of the obtained biological material for scientific purposes (Protocol No. 19 of 11/22/2021). A retrospective analysis of the medical histories of 50 patients with signs of acute respiratory failure (ARF) (Grades I–III) hospitalized in the Department of anesthesiology and intensive care at the National Medical Research Center for Oncology of the Russian Federation Ministry of Health in 2017–2020. Of these, 34 children were aged 7.0 ± 5.7 years and 16 adults aged 61 ± 15.3 years. The most represented were malignant neoplasms of the pelvis and retroperitoneal space – 11 (22 %), bones, connective and soft tissues – 9 (18 %), lungs – 7 (14 %), central nervous system (CNS) – 7 (14 %), gastrointestinal tract (GIT) – 6 (12 %), hemoblastoses – 4 (8 %). The remaining diseases are presented in isolated cases.

There were 14 (28 %) patients in the early postoperative period, 2 (4 %) received radiation therapy, and 34 (68 %) patients received chemotherapy (CT). The severity of the critical condition on the APACHE II (Acute Physiology and Chronic Health Evaluation) scale in children ranged from 10 to 28, in adults ranged from 18 to 26 points. To determine the degree of ARF, the parameters of saturation (SpO_2) and partial pressure of oxygen in arterial blood (PaO_2) were taken into account. PaO_2 of 60–79 mmHg and SpO_2 of 90–94 % corresponded to the first stage, PaO_2 of 40–59 mmHg and SpO_2 of 75–89 % corresponded to the second stage, PaO_2 of less than 40 mmHg corresponded to the third stage and SpO_2 is less than 75 %. The intensity of the initial clinical symptoms was analyzed: hyperthermia (fever to subfebrile or febrile levels), intoxication syndrome (general weakness, nausea, headache and muscle pain, seizures). Sputum, tracheobronchial aspirate, bronchoalveolar lavage, nasopharyngeal smears, and blood were examined to detect the infectious component. Biological samples were taken during the first hours of hospitalization of patients in the ICU. The isolation of viral RNA/DNA was performed using the RIBO-prep kit (FBIS CRIER). Qualitative determination of the RNA of influenza A/B virus (*Influenza virus* A/B) and influenza B, respiratory syncytial virus (RS, *hRSv*, *Orthopneumovirus hominis*), metapneumovirus (*hMPV*), parainfluenza viruses of types 1, 2, 3 and 4 (*hPiV*), coronaviruses of types OC43, E229, NL63, HKUI (*HCoV*), rhinoviruses (*hRv*), adenovirus DNA of groups B, C and E (*HAdV*), bocavirus (*HBoV*) and herpes simplex virus types 1, 2 (HSV 1, 2) were performed using reagent kits "AmpliSens® Influenza virus A/B-FL", "AmpliSens® ARVI-screen-FL", "AmpliSense® HSV I, II-FL". DNA quantification of CMV, EBV, HCV6 was performed using AmpliSens® EBV/ CMV/ HHV6A/B-screen-FL reagent kits. When CMV, EBV and HCV6 were detected in the blood, the number of more than 2 lg copies of the virus DNA/10^5 leukocytes was considered etiologically significant, in non-sterile loci-more than 2000 copies of the virus DNA/ml. The calculation was carried out in accordance with the manufacturer's instructions. Virus-specific antibodies (AT) of classes M and G to HSV 1, 2, CMV, EBV and HCV6 in blood serum were also determined in all patients by ELISA (Vector-Best AO).

Statistical analysis

Statistical data processing was carried out using Microsoft Excel 2016 and Statistica 10 (StatSoft, Inc.) programs. Statistically significant differences were considered at $p < 0.05$.

STUDY RESULTS

Viral infection (VI) was confirmed in 35 (70 %) patients. In patients undergoing CT, it developed more often than in the early postoperative period (72.2 % vs 64.3 %, the differences were not statistically significant, $p > 0.05$), however, this position is valid only for the general group of patients. Among children, VI was diagnosed only in patients who underwent CT (71.9 % of those who received CT, $p = 0.098$, F = 0.13), and in adults it was equally common (75 % each), both as a result of CT and after surgery. In lung cancer, VI was confirmed in 7 (100 %), pelvic cancer in 7 (63.6 %), bone, connective and soft tissue in 6 (66.7 %), hemoblastosis in 3 (75 %), CNS tumors in 5 (71.4 %) patients. VI was least often detected in patients with malignant neoplasms of the gastrointestinal tract – in 2 (33.3 %). Herpesvirus infection (HSV) was confirmed in 15 (42.9 % of the infected), respiratory viral infection (RVI) in 13 (37.1 %), and their combination in 7 (20 %) patients. In general, there is a slight predominance of HSV over RVI (22/62.9 % versus 20/57.1 %, the differences were not statistically significant, $p > 0.05$). Mixed infection with a combination of two to four pathogens and mono-infection developed equally frequently: in 18 (51.4 %) and 17 (48.6 %) patients, respectively. Cases of mixed infection were presented in the following combinations:

- HSV 1, 2 + EBV + *hRv* (1/18; 5.6 %);
- HSV 1, 2 + EBV (2/18; 11.1 %);
- EBC + HSV6 (2/18; 11.1 %);
- CMV + EBV + HSV6 (1/18; 5.6 %);
- HSV 1, 2 + influenza B (1/18; 5.6 %);
- *hRv* + *hCoV* (*HKU-1 / OC 42*) (1/18; 5.6 %);
- *hAdV* + *hRv* (1/18; 5.6 %);
- EBV + HSV6 + *hBv* + *hRv* (1/18; 5.6 %);
- HSV6 + *hRv* (3/18; 16.7 %);
- Influenza A + *hRSv* (1/18; 5.6 %);
- HSV 1, 2 + HCV6 (1/18; 5.6 %);
- *hRSv* + *hCoV* (*NL-63 / 229E*) (1/18; 5.6 %);
- HSV 1, 2 + CMV + EBV + HSV6 + *hRv* (1/18; 5.6 %);
- *hBv* + *hRv* (1/18; 5.6 %).

Respiratory viruses circulated in the population of cancer patients not only during the seasonal increase in the incidence of acute respiratory viral infections from October to March (61.9 %). A significant number of respiratory viruses (31.8 %) were detected in the period from April to September.

The patterns of the spread of VI differed in children and adults. Contrary to expectations, they were somewhat less common in children than in adults (23/67.6 % vs. 12/75 %, the differences were not statistically significant, $p > 0.05$). Respiratory viruses prevailed in children (16/69.6 % vs. 12/52.2 %, differences were not statistically significant, $p > 0.05$) and mixed infections (14/60.9 % vs. 9/39.1 %, differences

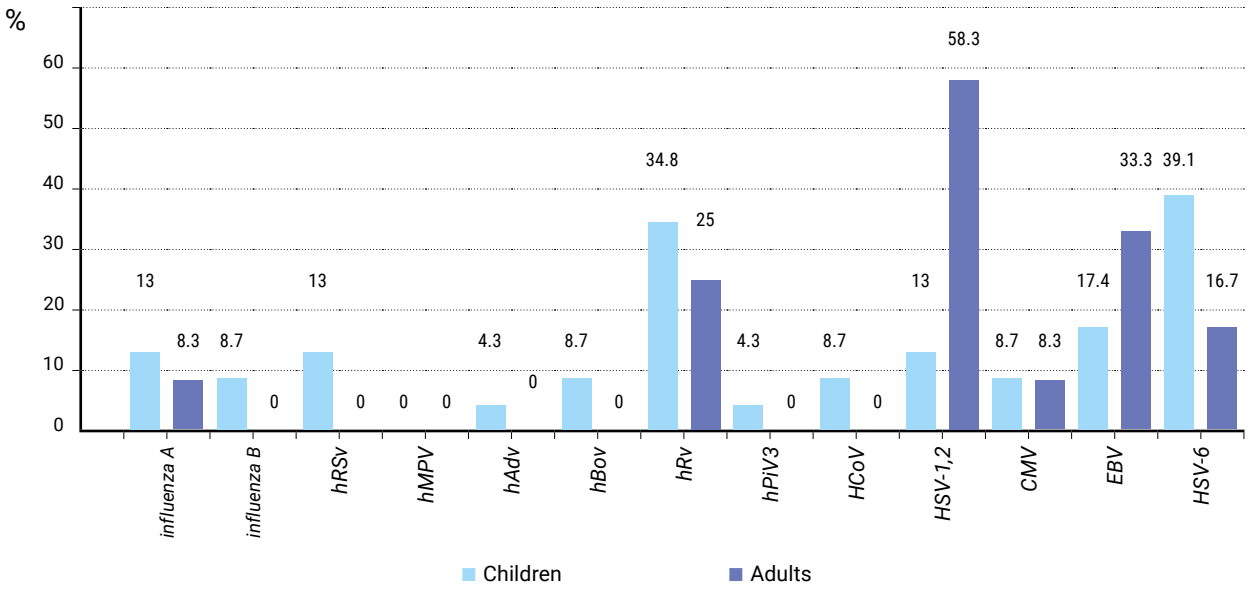

Fig. 1. Frequency of viral infection detection in cancer patients depending on age

were not statistically significant, $p > 0.05$). On the contrary, herpesviruses were more often detected in adults (10/83.3 % vs. 4/33.3 %, $p = 0.018$, F = 0.0257) and mono-infections (8/66.7 % vs. 4/33.3 %, differences were not statistically significant, $p > 0.05$). The spectrum of pathogens also differed: rhinoviruses (34.8 %) and HSV6 (39.1 %) prevailed in children, while the spectrum of respiratory viruses was quite wide (influenza A and B, RS, adenovirus, bocavirus, parainfluenza virus, seasonal coronaviruses). Rhinovirus also prevailed in adults (25 %), but apart from it, only the influenza A virus was detected from the respiratory group. A significant predominance was noted in the herpes simplex virus (58.3 %). EBV infection was the second most common infection in children (17.4 %) and adults (33.3 %) (Fig. 1).

A comparison of laboratory and clinical data revealed certain trends in the possible influence of VI on the intensity of the development of pathological symptoms. However, the results did not show statistical significance. Thus, in the general population, hyperthermia (45.7 % with VI versus 60 % without VI, the differences were not statistically significant, $p > 0.05$) and intoxication (65.7 % versus 73.3 %, the differences were not statistically significant, $p > 0.05$) were more common in patients without viral infection. On the contrary, there is a critical decrease in saturation at ARF stage III. (45.7 % vs. 33.3 %, the differences were not statistically significant, $p > 0.05$), respiratory failure of grades I–II (94.3 % vs. 33.3 %, $p = 0.058$, F = 0.087, and in children 100 % vs. 72.7 %, $p = 0.028$, F = 0.202) and pneumonia (diagnosis confirmed X-ray examination of the lungs) (20.0 % versus 13.3 %, the differences were not statistically significant, $p > 0.05$) were more common in patients with VI (Fig. 2). And if the first four parameters developed unidirectionally in children and adults, then pneumonia in adults was diagnosed only in the group with VI (33.3 % vs. 0 %, the differences were not statistically significant, $p > 0.05$), and in children, on the contrary, in the group with VI less often than without it (13.0 % vs. 18.2 %, the differences were not statistically significant, $p > 0.05$).

In addition to the DNA of the pathogen, 55.6 % of patients had serological markers of acute HVI. The determination of the serological status helped to determine that all adults developed HVI reactivation against the background of pre-existing class G immunoglobulins. Four cases of primary HVI caused by HSV6 were identified in children. In two patients, it developed as a primary mono-infection, and in two more, it was caused by the activation of another HVI.

As an example of the development of a critical respiratory complication in an oncological patient with a viral mixed infection, we present a clinical case. Patient K, 64 years old, admitted to the National Medical Research Center for Oncology with complaints of periodic rises in body temperature

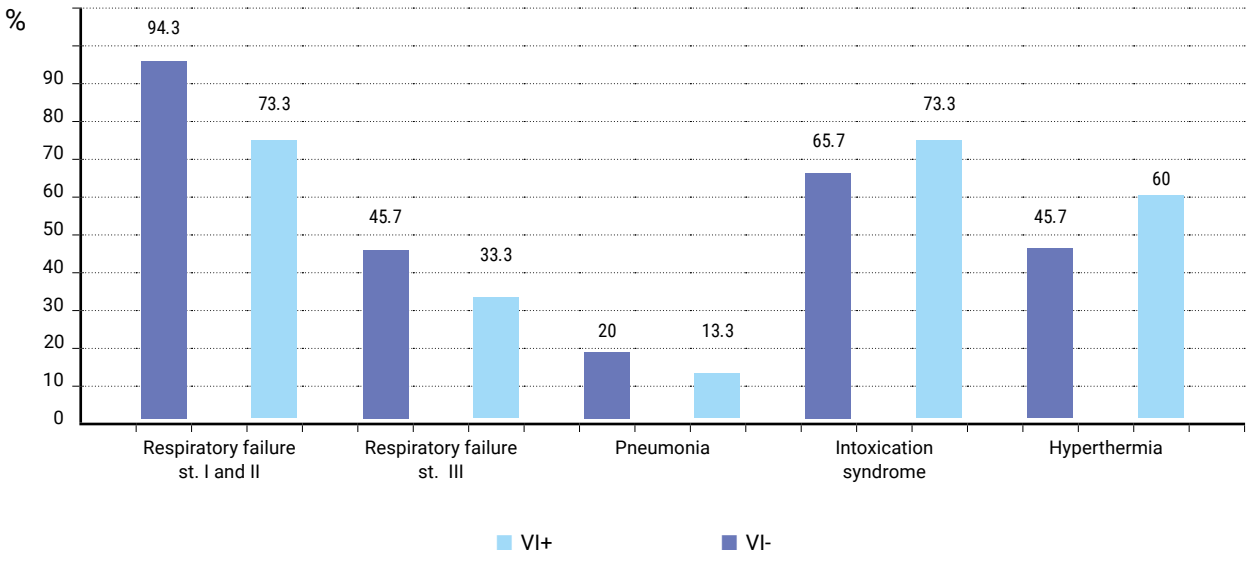

Fig. 2. Frequency of clinical symptoms of RVI/complications depending on the presence of identified pathogens in cancer patients

and cough. The diagnosis was established: (C34.1) Central cancer of the left lung with lesions of the lobar and left main bronchus pT4N2M0 stIIIb, cl.gr 2. Concomitant diagnosis: stage III COPD, severe; coronary heart disease, arrhythmic variant, rhythm disturbances of the type of normosystolic atrial fibrillation; CHF IIA, FC 2; Hypertension stage 3, risk 3. The patient underwent radical surgery – pneumonectomy on the left. The treatment was carried out without serious surgical and therapeutic complications. However, after the start of chemotherapeutic treatment on the fourth day, the patient's condition deteriorated sharply, and with clinical and laboratory signs of decompensated respiratory failure, the patient was hospitalized in the ICU. ARDS of a single lung was diagnosed against the background of progression of febrile neutropenia. The main clinical symptoms were respiratory failure, hypoxemia, and hemodynamic instability. X-ray examination revealed areas of consolidation with increased density of lung tissue. Arterial blood gas analyses revealed hypercapnic respiratory alkalosis, which demonstrated significant gas exchange disorders with an unfavorable prognosis. At the same time, laboratory examination revealed: the presence of leukocytosis up to 23×10^9/l, against the background of a significant increase in markers of systemic inflammation in the blood serum, the concentration of procalcitonin was 2.1 ng/ml (norm – up to 0.05), C-reactive protein was 87.6 mg/l (norm 0–5), the serum concentration of IL-6 was 36 pg/ml (the norm is up to 7), as well as an increase in calculated intoxication indices – the leukocyte intoxication index is 5.8 units (the norm is 1–1.6) and an increase in the neutrophil-lymphocyte ratio is 8.7 units. (norm 1–2.1), which was interpreted as the presence of endogenous intoxication of moderate severity, presumably due to the addition of bacterial agents. The patient has confirmed a respiratory viral mixed infection. Examination of the tracheobroncheal aspirate revealed rhinovirus RNA, DNA of HSV 1, 2, EBV in the amount of 119,350 copies/ml. The DNA of EBV and HCV6 was detected in the blood in the amount of 1.9 and 2.1 lg copies of DNA in terms of 10^5 leukocytes, respectively. In addition, Klebsiella pneumoniae was detected during microbiological examination. Intensive treatment of the patient was carried out within the framework of standard therapy measures. Prolonged invasive ventilation was used for respiratory support. Unfortunately, despite the incredible efforts made to save the patient, it was not possible to avoid death.

DISCUSSION

Infections are one of the most important complications in cancer patients and are often life-threatening. On the one hand, the progress of therapeutic strategies has led to an increase in the survival and recovery of cancer patients, on the other hand, the widespread use of chemotherapy and immunosuppressive therapy has further increased the risk of infection for these patients. At the same time, viral infections of the respiratory system often remain underestimated, despite the severity of the clinical picture and the associated impact on the duration of hospitalization and mortality rate. Even sadder, there is no unified approach to screening, diagnosis, and clinical management of such patients.

This study made it possible not only to establish a significant frequency of viral pathogens involved in the formation of respiratory disorders in cancer patients receiving antitumor therapy, but also to identify some differences in the spread of viral lesions of the respiratory system in children and adults. Thus, viral infections were more often detected in adults than in children; herpes viruses and mono-infections prevailed in adults, while respiratory viruses and mixed infections prevailed in children. The high detection rate of respiratory viruses in complications in children can be explained by the wide spread of their asymptomatic carriage in children (from 22.2 % to 40.9 %, on average 30.9 %), which was shown in our early study [16]. In a state of immunosuppression resulting from both the disease itself and the ongoing antitumor therapy, the initial lesion of the upper respiratory tract in the presence of the virus can progress to lower respiratory tract disease (LRT).

Just like other researchers [6, 17], we found that rhinoviruses are most common in adults and children in the group of respiratory viruses, and syncytial virus is also common in children. At the same time, this study differs from other studies in the wider range of viral agents studied, which means it provides a more complete picture of their prevalence. As a rule, either

respiratory or herpes viruses were included in the study, and only influenza, MS, and rhinoviruses from the respiratory group were studied.

During the study, HSV 1, 2 was identified in 58.3 % of adults as an etiologically significant agent. In the LRT lavage and blood, HSV 1, 2 DNA was detected 7.0 times more often than CMV, 1.8 times more often than EBV, and 3.5 times more often than HCV6. These results are fundamentally different from the data presented by Aisenberg GM and co-authors, who believe that pneumonia caused by HSV is rarely reported in patients with solid tumors, and the clinical significance of the virus in LRT samples remains unknown, since, according to the authors, it can be asymptomatic in 5 % of adults [18]. At the same time, the authors show that patients with proven HSV pneumonia were more likely to be on a ventilator (100 % versus 40 %), had a longer stay in the intensive care unit (26 days versus 12), and mortality among patients receiving antiviral therapy was lower than among those who did not (16 % versus 30 %).

In this context, when conducting antitumor therapy, it is necessary to take into account the possibility of reactivation of latent viral infections as a risk factor for the development of severe respiratory complications. Our practical efforts are aimed at providing full-fledged antitumor treatment to all patients without limiting the volume of operations and with a maximum reduction in the risk of complications. The given clinical example vividly demonstrates the situation when the pathological activity of infectious agents increases with a significant weakening of the immune barrier and a violation of the body's reserve forces against the background of a tumor disease, aggressive radical surgical and chemotherapeutic treatment. A mixture of viral agents against the background of immune-mediated processes can undoubtedly trigger critical respiratory dysfunction.

CONCLUSION

Complications of an infectious nature are an important component of modern antitumor treatment. In this regard, it is necessary to monitor the spectrum of viral infections in cancer patients with signs of respiratory dysfunction at the stages of antitumor therapy. A correct assessment of the situation will help to avoid the development of critical consequences, shorten the time of hospitalization, and improve the course and prognosis of cancer.

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Kozel Yu. Yu. – scientific editing;
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