2020; 10(1): e11. https://doi.org/10.5415/apallergy.2020.10.e11
7. Basharat Z., Yasmin A. Energy landscape of a GSTP1 polymorph linked with cytological function decay in response to chemical stressors. Gene. 2017; 609: 19-27. https://doi.org/10.1016/j.gene.2017.01.034
8. Breiteneder H., [et al.]. Biomarkers for diagnosis and prediction of therapy responses in allergic diseases and asthma. Allergy. 2020; 75(12): 3039-3068. https://doi.org/10.1111/all.14582
9. Dai X., Dharmage S.C., Lodge C.J. Interactions between glutathione S-transferase genes and household air pollution on asthma and lung function. Front. Mol. Biosci. 2022; 9: 955193. https://doi.org/10.3389/fmolb.2022.955193
10. Dai X., [et al.]. Do glutathione S-transferase genes modify the link between indoor air pollution and asthma, allergies, and lung function? A systematic review. Curr. Allergy Asthma Rep. 2018;18: 20. https://doi.org/10.1007/s11882-018-0771-0
11. Bowatte G., [et al.]. Do variants in GSTs modify the association between traffic air pollution and asthma in adolescence? Int. J. Mol. Sci. 2016; 17(4): 485. https://doi.org/10.3390/ijms17040485
12. Bowatte G., [et al.]. Interactions of GST polymorphisms in air pollution exposure and respiratory diseases and allergies. Curr. Allergy Asthma Rep. 2016; 16(12): 85. https://doi.org/10.1007/s11882-016-0664-z
13. Kelchtermans J., Hakonarson H. The role of gene-ambient air pollution interactions in paediatric asthma. Eur. Respir. Rev. 2022; 31: 220094 https://doi.org/10.1183/16000617.0094-2022.
14. Wei Choo C. Y., [et al.] Oxidative stress is associated with atopic indices in relation to childhood rhinitis and asthma. J. Microbiol. Immunol. Infect. 2021; 54(3): 466-473. https://doi.org/10.1016/j.jmii.2020.01.009
15. Takano H., Inoue K.I. Environmental pollution and allergies. J. Toxicol. Pathol. 2017; 30(3):193-199. https://doi.org/10.1293/tox.2017-0028.
16. Mazari A.M.A., [et al.]. The multifaceted role of glutathione S-transferases in health and disease. Biomolecules. 2023; 13(4): 688. https://doi.org/10.3390/biom13040688
17. Xiao J., [et al.]. The relevance analysis of GSTP1 rs1695 and lung cancer in the Chinese Han population. Int. J. Biol. Markers. 2021; 36(3): 48-54. https://doi.org/10.1177/17246008211039236
18. Zarth A.T., Murphy S.E., Hecht S.S. Benzene oxide is a substrate for glutathione S-transferases. Chem. Biol. Interact. 2015; 242; 390-395. https://doi.org/10.1016/j.cbi.2015.11.005

S.N. Ionov, I.S. Zakaryan, A.D.Salimgareev, E.R.Kuzmina

EPIDEMIOLOGICAL PREVALENCE OF MEASLES IN THE RUSSIAN FEDERATION, NEIGHBOURING AND FOREIGN STATES

DOI 10.25789/YMJ.2024.86.13

UDC 616. 972

This article analyzes the statistical studies results of the epidemiological prevalence of measles infection in Russia, neighboring and foreign countries for the period from 2017 to 2023. A comparative characteristic of the measles incidence has been carried out in the Russian Federation, Ukraine, Georgia, Kazakhstan, and the USA. The effect of immunization results on morbidity is shown. The increasing risks of outbreaks of morbidity associated with migrations and import processes during the import of the causative agent of measles infection have been identified.

The reasons for the lack of vaccination against measles among the entire population are considered. Data on vaccination coverage among residents of the Russian Federation are provided. Social groups that are less resistant to outbreaks of the disease due to the lack of immunization have been identified. All risks and possible complications due to high morbidity among the entire population are reflected. The restrictive measures influence related to the unfavorable epidemiological situation of COVID-19 was noted. The relationship is presented between the introduced restrictive measures related to the new coronavirus infection and the reduction of measles outbreaks among different countries, as well as the general incidence. The prevention importance is shown among children and adults, as well as the importance of timely detection of new measles infection outbreaks.

Keywords: measles; morbidity; epidemiological situation, vaccination.

Introduction. Measles is a highly contagious acute viral disease that is transmitted by airborne droplets and can lead to serious complications and death.

The incubation period of measles infection ranges from 9 to 17 days. Infected people are contagious from 4 days before the appearance of the rash and up to 4 days after the appearance of the rash in vaccinated people.

Measles virus is transmitted by airborne droplets through aerosolised secretions, as a part of the contents of the nasopharynx, secretions from coughing, sneezing, talking, breathing. The pathogen can spread considerable distances with airflow.

The disease begins with fever and usually at least one of three symptoms: cough, rhinitis and conjunctivitis. Filatov-Koplik spots are small whitish-gray dots surrounded by a corolla of hyperemia. They are located on the mucous membrane of the cheeks opposite the second molars and make it possible to clinically diagnose measles a day or two before the rash appears.

The rash appears in 3-4 days after the onset of fever, first on the face and behind the ears. Then it spreads to the trunk and extremities, coinciding with the development of the adaptive immune response. Fever and catarrhal symptoms usually peak along with the rash, which persists for 3-4 days. Measles in vaccinated patients occurs in a mild form, there is no stage in the manifestation of infection.

Diagnostic studies of measles consist of the collection of anamnesis, examination, assessment of the manifestation of the main symptoms of the disease, as well as laboratory and instrumental methods of investigation.

Specific prevention. The main method of protecting the population from measles, rubella and mumps is vaccination.

Immunization of the population against measles, rubella, and mumps is carried out within the framework of the National Calendar of Preventive Vaccinations and the Epidemic Indications Preventive Vaccination Calendar.

Children and adults who received vaccinations under the National Preventive

IONOV Stanislav Nikolaevich – Doctor in Biology, PhD in Medical sciences, **ZAKARYAN Ivan Stanislavovich –** 5-year student of the educational institution Reaviz Medical University, medical nurse in the Oncology Department of Antitumour Drug Therapy. Zakaryanivan321@mail.ru 89858928527; **SALIMGAREEV Aleksandr Dmitrievich –** 5-year student of the educational institution: Reaviz Medical University, alexsalimgareev@gmail.com; **KUZMINA Ekaterina Romanovna –** 5-year student of the educational institution Reaviz Medical University, ekaterina299@bk.ru

Vaccination Schedule and whose blood serum did not detect antibodies to the relevant pathogens in standard serology tests receive additional vaccinations against measles and rubella (or) mumps according to the instructions for immunobiological drug use (hereafter referred to as "ILP").

For immunization, ILPS is used, registered and approved for use on the territory of the Russian Federation in accordance with instructions for its use.

In order to maximize coverage of vaccinations for measles, rubella and mumps in the population of the Russian Federation, efforts are being made to identify people who have not had these infections and have not received vaccinations among hard-to-reach groups (migrants, refugees, internally displaced people, nomadic populations) and to immunize them in accordance with the National Immunization Schedule.

To ensure population immunity to measles, rubella, and mumps, sufficient to prevent the spread of infection among the population, vaccination coverage of the population in the territory of the municipality should be:

- vaccination and revaccination against measles, rubella, mumps in children at decreed ages - at least 95%;
- vaccination against rubella in women aged 18-25 years - at least 90%;
- vaccination against measles in adults aged 18-35 years - at least 90%;
- vaccination against measles of persons of decreed professions aged 18-55 years - at least 90%. [8].

Materials and Methods. In the analysis of the epidemiological situation, materials from the official websites of the US and European health care organisations, WHO, as well as data from Rospotrebnadzor were used. Statistical processing of the material was carried out by using the MS EXCEL software package for the Microsoft Office 2020 operating system.

Objectives:

- to summarise the results of the spread of the epidemic process in Russia, neighbouring and foreign countries;
- to determine the main difficulties in conducting vaccine prophylaxis of measles infection, cite the reasons preventing its elimination in the country and modern conditions, as well as possible ways to eliminate them;
- to analyse the level of prevalence of measles infection on the territory of the Russian Federation and assess the vaccination coverage rate;
- to analyse the reasons for late vaccination.

Results and discussion. The epidemiological situation of measles in the Russian Federation

Considering the epidemiological situation of measles in the Russian Federation and other countries of the world since the 1990s, it can be noted that the level of morbidity is characterized by dynamic wave-like rises with a periodicity of 7-10 years and subsequent declines after the introduction of anti-epidemic measures [5].

Between 2017 and 2023, new wave-like outbreaks of infection can be observed both in the Russian Federation and in other countries [2, 3, 4, 5, 6, 7]. All this is happening for various reasons that can include increased migration between neighboring countries, increased parallel imports, and weakened anti-epidemiological measures related to the new coronavirus infection. All this requires a direct analysis of the incidence and its spread associated with new outbreaks of measles. Data on cases in the period 2017-2023 are presented in Fig.1 and Table 1.

Analyzing the reported data from 2017 to 2019, there is an increase in incidence. Between 2019 and 2021, on the contrary, there is a sharp number decrease of infections due to the epidemiological situation connected with the new coronovirus infection (COVID-19) in the world and in the country. All this was accompanied by the imposition of measures such as restrictions on the movement of citizens, self-isolation, mask regime, bans on mass events, closure of borders, and restrictions on trade with neighboring countries [5, 6, 7]. All of these restrictions slowed the spread of the new infection and also reduced the risks associated with the spread of measles.

According to the data for the period from 2022 to 2023, there is an increase in the incidence of the disease. There is a tendency to "restore" the indicators of the "pre-COVID" period.

Specific prophylaxis is one of the effective measures to protect the population from measles and other infections. However, its effectiveness will depend on the immune coverage of the population, which should be at least 75% of the country's population. And in the case of measles it should be 95%. Indicators of immunization of the RF personnel are presented in Table 2.

Analyzing the data from 2017 to 2023, overall vaccination coverage among under 24 months and 6 years old children, and 18-35 years old adults exceeded the regulated level (at least 95%) nationwide. Nevertheless, measles outbreaks continued to be observed. The epidemic process of measles was supported by people who were not vaccinated and those with an unknown vaccination history, accounting for 82.4% of cases. Those who had been vaccinated once and twice participated in the epidemic process equally, at 8.8% each, indicating the effectiveness of vaccination [7]. Imported cases of measles are shown in Figure 2.

A pronounced upward trend in imported measles cases was observed in the periods from 2017 to 2019, and from 2020 to 2022 there was a sharp decrease. The deterioration of the epidemiological situation of measles is facilitated by an increase in the number of children and adults in many territories who have not been vaccinated with HCV, mainly due to refusals of vaccination, including during vaccination according to epidemiological indications [3]. The largest number of cases, as well as imported cases of measles, occurred in 2019. According to the Federal State Budgetary Institution "MNIIEM named after G.N. Gabrichevsky" Rospotrebnadzor imported 231 cases of measles from 41 countries on the territory of 40 subjects of the Russian Federation. Measles was most often imported from Ukraine (49), Azerbaijan (24), Thailand (24), Georgia (21), Turkey (16), Uzbekistan (17), Kyrgyzstan (12) [4]. The decline in morbidity is caused by a reduction in tourism, the closure of borders with neighboring countries, as well as a decrease in imports [5].

Due to the closure of borders due to the COVID-19 pandemic in 2020, the long-term trend of increasing the number of imported cases did not persist, but the import of measles cases from neighboring countries still prevailed (in 2020 - about 70% of all imported cases) [5].

However, from 2022 to 2023, an increase in imported measles cases was observed again, due to the cancellation of anti-epidemic measures aimed at preventing the spread of the new coronavirus infection and an increase in parallel imports and tourism.

Kazakhstan. In recent years, there has been an increase in the number of measles cases in the Republic of Kazakhstan. For example, from 2018 to 2019, the number of cases increased from 576 to 13326 [10].

One of the main reasons for the aggravation of the epidemiological situation was insufficient immunisation of the population due to refusals and medical contraindications to preventive vaccinations.

The main share of morbidity that made up 58.3 per cent (7,775 cases) was noted among unvaccinated children, who accounted for, of whom 3,703 (47.6%) were under one year old and

4,072 (52.4%) due to medical withdrawals and refusals.

Among those who fell ill, 2,405 people (18 %) were vaccinated against measles, 1,273 (52.9 %) of them received one dose of vaccine and 1,132 (47.1 %) of them received two doses.

Analysing the morbidity of different population groups, the main share of infections was in children from 1 to 4 years old, which corresponded to 4257 (31.9%) and children under 1 year were corresponded to 3879 (29.1 %).

Smaller proportion of patients was observed in the age group of 20-29 years (14.7 %.), 30 years and older (11.9%).

At the end of 2019, 21 cases of measles-related deaths were reported, 19 (90.4 %) of them were children.

According to the US Centers for Disease Control and Prevention (CDC), 12,985 cases of measles were recorded in Kazakhstan from May to October 2023 [18].

In a study by Yerdesov et al., 2023, the cyclical nature of measles outbreaks in Kazakhstan is noted, often correlating with a drop in vaccination rates and aggravated by seasonal factors [11].

Thus, the number of new measles outbreaks in the Republic of Kazakhstan has increased in recent years. Unvaccinated children accounted for the bulk of the cases. Mostly children under 1 year of age were ill due to not reaching the vaccination age and medical refusals, as well as unvaccinated adults.

Ukraine. Ukraine is one of the most endemic territories with measles infection. This is a serious public health problem that needs to be continuously monitored.

The largest recent outbreak occurred between 2017 and 2019. More than 115,000 people were infected in Ukraine during this period, and 41 of those who became ill died. The incidence peaked in 2018 and 2019 with up to 53219 cases of infected people. In 2019, this figure increased even further to 57282. The increase in infections was due to people who were not vaccinated or did not complete the immunisation course. According to the latest data, 65-67 per cent of those who fell ill were children and 33-35 % were adults in Ukraine.

Ukraine has risks of new measles outbreaks due to low vaccination coverage, which implies increased susceptibility to the virus in the country.

At the beginning of the outbreak of 2017-2019, the coverage of the population with measles vaccinations in Ukraine was 42%, which is two times less than the 95% regulated by WHO [19]. In 2021,

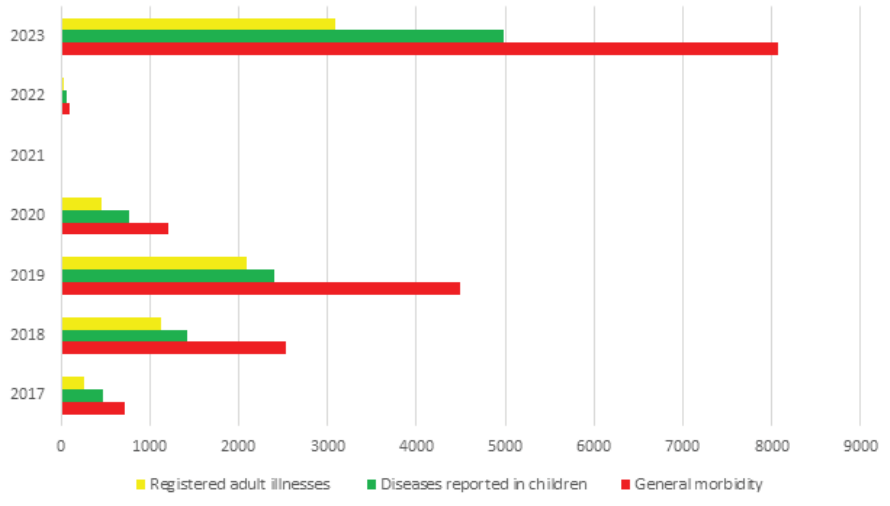

Fig. 1. Dynamics of measles incidence in the Russian Federation in 2017-2023 abs.units

Table 1

Results of measles outbreaks in the Russian Federation in 2017-2023 abs.units

Number of patients	2017	2018	2019	2020	2021	2022	2023
Recorded cases	721	2539	4491	1214	1	102	8073
Diseases reported in children	464	1414	2395	763	0	65	4989
Reported illnesses in adults	257	1125	2096	451	1	37	3084

Table 2

Indicators of vaccination coverage of the population of the Russian Federation for 2017-2023

Index	2017	2018	2019	2020	2021	2022-2023
Vaccination coverage of children at 24 months, %	97.69	97.1	97.66	97.28	97.34	97.44
Revaccination coverage of children at 6 years of age, %	97.05	97.02	96.62	96.09	96.4	96.52
Measles vaccination coverage of adults 18-35 years old, %	99.08	97.82	97.99	97.71	97.83	97.97

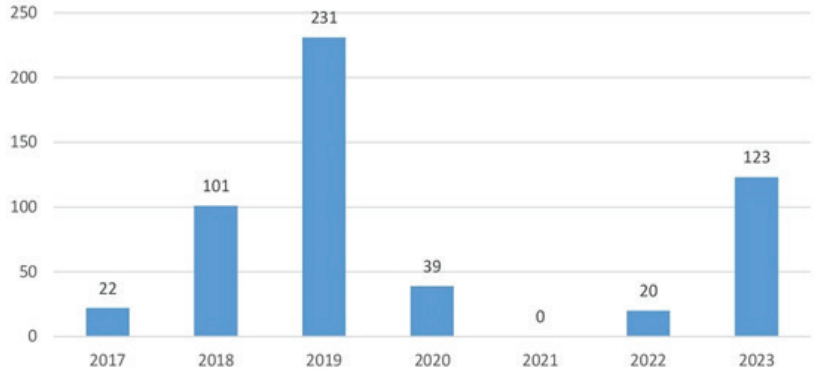

Fig. 2. Imported measles cases in the Russian Federation in 2017-2023

the vaccination coverage rate increased to 88%, and in 2022 it was only 74%, which led to a decrease in the immune layer and, accordingly, to an increase in the number of vulnerable populations [20].

Thus, new cases of measles occur periodically in Ukraine, which is the reason for insufficient vaccination rates among all segments of the population. Thus, due to the current situation, military actions and migration to other countries, there is an additional risk of outbreaks of measles infection outside the territory of Ukraine.

The U.S.A. Thanks to universal vaccination in the United States, measles was officially declared eliminated in 2000. According to the Centers for Disease Control and Prevention (CDC), 31 states reported 1,282 confirmed measles cases and 128 hospitalisations from January to December 2019, that is the highest reported number since 1992 [12].

Severe cases of measles require hospitalisation of patients. Based on historical data, CDC estimates that about 1 in 4 infected cases in the U.S. requires hospitalisation, and 1 in 1,000 cases is fatal. The number of hospitalisations fell sharply following widespread measles vaccination [12].

The 2019 measles outbreak in the U.S. was imported, and most of those who became ill were unvaccinated.

In light of increased mobility in this century, any under-immunized region is at risk of a measles outbreak due to social migration.

During the COVID-19 pandemic, routine immunisation rates are reported to have decreased in various parts of the world, including in the USA. Epidemiologists estimate that more than 27 million children worldwide missed their first dose of measles vaccine in 2020. A decrease in the level of routine vaccination is likely to lead to an upsurge in highly contagious diseases, including such as measles.

Measles in Europe. Despite the introduction of vaccination programmes in European countries, the increase in vaccination refusals and the lack of mandatory immunization strategies in a number of countries have led to various outbreaks throughout Europe [14].

In particular, in 2017, measles epidemics were observed in 28 European countries with 37 reported deaths. They were mainly detected in Romania (5,608 cases), Italy (5,098), Greece (967) and Germany (929 cases). Measles infections were also reported in European countries in 2018 (17,822 cases) and 2019 (13,199 cases).

In 2020, measles incidence decreased by 2,043 cases in all European countries due to restrictions implemented during the COVID-19 pandemic [14].

In 2022, 123 measles cases were registered in the EU/EEA countries, of which 75 (61%) were laboratory confirmed, 41 cases were registered as "possible" (33%), 5 cases as "probable" (4%) and 2 cases as "unknown" (<2%) [16].

In 2023, 2,361 cases of measles were reported in the EU/EEA countries, of which 1,607 (68%) were laboratory confirmed. The remaining 754 cases were registered as "probable" (29%), "possible" (3%) and "unknown" (<1 %) [16].

Twenty-three countries reported measles cases in 2023, while seven countries (Bulgaria, Greece, Iceland, Cyprus, Luxembourg, Malta, Slovenia) did not report any cases during this period, indicating a favorable epidemiological situation [16].

One country (Romania) accounted for 74% of all reported cases.

The spread of measles in Europe indicates that the eradication of infection has not yet been achieved.

In Europe, the persistent presence of measles each year highlights that eradication has not yet been achieved. This emphasizes the need to continue expanding vaccination efforts to control the disease and prevent future outbreaks.

Until March 2020, surveillance data confirm the classic cyclical pattern of measles prevalence.

Since March 2020, many European countries didn't report any cases of measles virus infection [15].

In Europe the average number of measles cases has a maximum value in 2019 (37.51 cases per million inhabitants) and a minimum value in 2020 (4.24 cases per million inhabitants) [15].

Based on WHO data, it can be assumed that COVID-19 containment measures have largely prevented the spread of other airborne diseases, as the epidemic trend that is usually observed has not been confirmed in 2020-2021 [15].

The resurgence of measles incidence is paradoxical in Europe in the last few years. Although national immunisation programmes offer an affordable and effective vaccine, but the results of epidemiological situation analysis show that more than 47000 people have contracted measles in WHO countries. Serbia, France, Greece and Italy were the most affected countries were [15].

Recent outbreaks, that are often transmitted nasocomialy and infect healthcare workers, were reported in several European countries, such as Ireland, Portugal, France, Sweden and Ireland, in which the virus has been eradicated according to WHO [15].

Transmission from unvaccinated patients from measles-endemic countries is the most common cause of outbreaks.

Lack of awareness of the infection, as well as the late appearance of the typical maculopapular rash characteristic of measles, 3-4 days after the onset of fever, increases the risk of disease with nasocomial and household transmission.

Between January and July 2018, measles caused 63 deaths in Europe, a rate of one to two cases per 1,000 cases. During the outbreak in France from October 2017 to July 2018, there were two deaths per 1,101 infected people. These figures appear to have been underestimated because of possible unconfirmed data, without virological laboratory results, and a higher prevalence of susceptible patients with risk factors for severe measles [15].

Migration of unvaccinated populations from the war zones increased the risk of the infection transmission with underdeveloped primary health care systems such as Syria and Pakistan in the Middle East. Other reasons are poor vaccination of hard-to-reach populations and national minority groups living in European countries [15].

Conclusion. The occurrence of measles outbreaks in the near abroad indicates the need to maintain vigilance against this infection [7]. And the constant annual detection of measles cases in Europe indicates that eradication has not yet been achieved, and underlines the need to further increase the number of vaccinations necessary to control the disease and prevent new outbreaks [14].

WHO information resources and the European Center for Disease Prevention and Control provided data to assess the solution to the problem of vaccination refusal and recommended evidence-based responses to increase and maintain the level of the immune stratum of the population.

There are good reasons to focus on the risk of measles in children who are unprotected or not immunized yet, as even newborns can be at risk when they are exposed to the virus. Infants born to vaccinated women have significantly lower antibody concentrations than those born to naturally immune women and may have no protection until the first MMR vaccination. In addition, under one year old children are seven times more likely to die than older children due to post-infectious complications such as pneumonia.

The current outbreaks in Europe affect both adult and pediatric populations. A large proportion of cases in the analysis of European measles outbreaks involved health care workers, and most were associated with the refusal to be vaccinated.

The of two doses of MMR vaccine is about 95%. Immunity to the measles pathogen acquired from immunization with live attenuated vaccine is much lower than the protection afforded by natural infection. A 2018 study reported that immunity wanes over time regardless of how it was acquired.

The route of transmission may be important because health care workers who are in close contact with primary measles patients and are exposed to high doses of virus appear to have a greater risk of infection.

Vaccination is the only way to prevent measles and eliminate the disease, and a great effort must be made to restore public confidence in vaccination. Currently, mandatory measles vaccination is included in national immunization programs in nine of the 28 European Union countries, but Italy has recently decided to opt out of mandatory MMR measles vaccination. The European Commission proposed to increase the cooperation between countries in the fight against diseases that can be prevented by vaccination against infections such as measles, whooping cough and seasonal influenza. The European Union proposals emphasize the importance of joint action to increase vaccination coverage and provide reliable and understandable information about vaccines to the public [14].

Since 2017, there has been a rise in measles incidence in the Russian Federation through 2019. The main reason was the decrease in attention to immunization against measles and, as a consequence, the formation of susceptible to the pathogen persons among the population shares.

The decline in morbidity occurred from 2020 to 2022, which is the result of anti-epidemic measures carried out in the country related to isolation in connection with COVID-19.

In 2023, there was a tendency for the incidence of measles to rise. Many domestic researchers have noted an increase in vaccination refusals over the past few years, which has contributed to a significant decline in the immune layer of the population prior to the 2017-2019 COVID-19 pandemic [9].

Another problem is the large influx of migrants from neighboring countries. Cultural and language barriers prevent the timely seeking of health care, which ultimately creates large groups of unvaccinated citizens. It contributes to the spread of infections among the local population [9].

Based on the epidemiological analysis of neighboring countries for the years 2017-2023, it can be seen that the rise in incidence and its cyclical nature is characteristic of many states, so the problem of measles virus is a worldwide problem. Maintaining vaccination rates for all segments of the population is the top priority in measles prevention and requires a coverage rate of at least 95%.

Imported cases with migration flows remain relevant in the Russian Federation and neighboring countries. This requires special attention from health authorities to take additional measures, including even such as checking certificates for measles vaccination.

References

1. Yunasova T. N. Gorenkov D. V. Rukavishnikov A. V. Movsesyants A. A. Merkulov V. A. Analiz zabolevaemosti kor'yu v Rossii i problemy profilaktiki kori na etape eliminatsii [Analysis of the painfulness of peptic ulcers in Russia and problems of prevention of peptic ulcers at the elimination stage]. BIO preparaty. Profilaktika, diagnostika, lechenie. [Organic preparations. Prophylaxis, diagnostics, treatment 2019; 154-160 (In Russ.).] https://doi.org/10.30895/2221-996X-2019-19-3-154-160

2. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2017 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2017']. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being. 2018; 268 (In Russ.).]

3. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2018 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2018'.]. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being. 2019; 254 (In Russ.).]

4. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2019 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2019']. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being]. 2020; 299 (In Russ.).]

5. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2020 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2020'.]. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being. 2021; 340 (In Russ.).]

6. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2021 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2021']. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being. 2022; 340 (In Russ.).]

7. Gosudarstvennyj doklad «O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v RF v 2022 g [State report 'On the state of sanitary and epidemiological well-being of the population in the Russian Federation in 2022']. Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelej i blagopoluchiya cheloveka [Federal Service for Surveillance on Consumer Rights Protection and Human Well-being. 2023; 368 (In Russ.).]

8. Sanitarnye pravila i normy SanPiN 3.3686-21 "Sanitarno-ehpidemiologicheskie trebovaniya po profilaktike infektsionnykh boleznei" [Sanitary Rules and Regulations of SanPin 3.3686-21 'Sanitary and epidemiological requirements for the prevention of infectious diseases' (In Russ.).]

9. Semenenko T.A. Nozdracheva A.V. Analiz i perspektivy razvitiya epidemiologicheskoi situatsii po kori v usloviyakh pandemii COVID-19 [Analysis and prospects for the development of the measles epidemiological situation in the context of the COVID-19 pandemic]. Epidemiologiya i vaktsinoprofilaktika [Epidemiology and Vaccine Prophylaxis. 21-31p. (In Russ.).] https://doi.org/10.31631/2073-3046-2021-20-5-21-31

10. Gabasova M.K. Daniyarova A.B. Alekesheva L.ZH. Kasabekova L.K. Arynova G.A. Epidemiologicheskaya situatsiya po kori v respublike Kazakhstan po dannym retrospektivnogo analiza [Epidemiological analysis of morbidity in Kazakhstan population by HIV infection (literature review). Vestnik KazNMU. 2020; 1:388-393 (In Russ.).]

11. Akilbekova D, Yerdessov S, Gaipov A. Urgent health update: rising measles cases in Kazakhstan. Lancet Reg Health Eur. 2023 Dec 20;37:100828. doi: 10.1016/j.lanepe.2023.100828.

12. Chovatiya R, Silverberg JI. Inpatient morbidity and mortality of measles in the United States. PLoS One. 2020 Apr 28;15(4):e0231329. doi: 10.1371/journal.pone.0231329.

13. Thakur M, Zhou R, Mohan M, Marathe A, Chen J, Hoops S, Machi D, Lewis B, Vullikanti A. COVID's collateral damage: likelihood of measles resurgence in the United States. BMC Infect Dis. 2022 Sep 20;22(1):743. doi: 10.1186/s12879-022-07703-w.

14. De Francesco MA. Measles Resurgence in Europe: An Open Breakthrough in the Field of Vaccine-PrevenTable Diseases. Pathogens. 2023 Sep 25;12(10):1192. doi:10.3390/pathogens12101192.

15. Dotevall L. The return of measles to Europe highlights the need to regain confidence in immunisation. Acta Paediatr. 2019 Jan;108(1):8-9. doi: 10.1111/apa.14621.

16. European Centre for Disease Prevention and Control. Measles. In: ECDC. Annual Epidemiological Report for 2023. Stockholm: ECDC; 2024.

17. Gianfredi V, Santangelo OE, Provenzano S. The effects of COVID-19 pandemic on the trend of measles and influenza in Europe.

Acta Biomed. 2021 Sep 2;92(4):e2021318. doi: 10.23750/abm.v92i4.11558.

18. Global Measles Outbreaks. CDC report from December 8; 2023. Available from: https://www.cdc.gov/globalhealth/measles/data/ global-measles-outbreaks.html. Accessed December 10, 2023

19. Holt E. War in Ukraine impacts immunisation. Lancet Microbe. 2024 Feb;5(2):e108. doi: 10.1016/S2666-5247(23)00337-3. Epub 2023 Oct 17.

20. Orsini D, Martini M. Measles: a new danger for Ukraine's children! The need for an effective and timely vaccination prevention campaign for an insidious disease that comes from afar. J. Prev Med Hyg. 2023 Jun 1; 64(2):E204-E208. doi: 10.15167/2421-4248/jpmh2023.64.2.2996.

21. Paules CI, Marston HD, Fauci AS. Measles in 2019 - Going Backward. N Engl J Med. 2019 Jun 6;380(23):2185-2187. doi: 10.1056/NEJMp1905099.

TOPICAL ISSUE

DOI 10.25789/YMJ.2024.86.14

UDC 618.3-06:616.98:834.1+615.357

L.S. Ishchenko, E.E. Voropaeva, E.A. Kazachkova, E.L. Kazachkov, T.N. Shamaeva, Y.S. Ishchenko

ERYTHROPOETIN AS A PREDICTOR OF EXTREMELY SEVERE COURSE OF NEW CORONAVIRUS INFECTION COVID-19 IN PREGNANT WOMEN

A comparative analysis of medical, social, clinical and laboratory parameters in pregnant women with a new coronavirus infection (NCI) COVID-19 of varying severity was carried out. For the first time, the level of serum erythropoietin was studied in this category of patients; for the first time, a statistically significantly lower level of erythropoietin was detected in pregnant women with extremely severe COVID-19. The threshold value of serum erythropoietin level was determined to predict the development of extremely severe COVID-19 in pregnant women.

Keywords: new coronavirus infection, COVID-19, pregnancy, extremely severe course, serum erythropoietin/

ISHCHENKO Lyudmila Stanislavovna – PhD in Medical Sciences, Associate Professor of the Department of obstetrics and gynecology of South Ural State Medical University of the Ministry of Health of the Russian Federation (MH RF), obstetrician-gynecologist Regional Clinical Hospital No. 2, e-mail: lyudalyn@mail.ru, ORCID: 0000-0002-9405-0134; **VOROPAEVA Ekaterina Evgenievna** – MD, Professor, Professor of the Department of pathological anatomy and forensic medicine of South Ural State Medical University MH RF, Deputy Chief Physician for Obstetrics and Gynecology, Regional Clinical Hospital No. 2, e-mail: katya_voropaeva@mail.ru, ORCID: 0000-0002-9055-102X; **KAZACHKOVA Ella Alekseevna** – MD, Professor, Professor of the Department of Obstetrics and Gynecology of the South Ural State Medical University MH RF, e-mail: doctorkel@narod.ru, ORCID: 0000-0002-1672-7058; **KAZACHKOV Evgeny Leonidovich** – MD, Professor, Head of the Department of Pathological Anatomy and Forensic Medicine of the Federal State Budgetary Educational Institution of the South Ural State Medical University MH RF, e-mail: doctorkel@narod.ru, ORCID: 0000-0002-4512-3421; **SHAMAEVA Tatiana Nikolaevna** – PhD in Pedagogical Sciences, Associate Professor of the Department of Mathematics, Medical Informatics, Computer Science and Statistics, Physics of South Ural State Medical University MH RF, e-mail: shamtan@rambler.ru, ORCID: 0000-0001-6327-2685; **ISHCHENKO Yulia Sergeevna** – 4rd year student, Faculty of Pediatrics, South Ural State Medical University MH RF, e-mail: ischenkous0407@mail.ru, ORCID: 0000-0003-1642-6607

Introduction. On 5th May, 2023 World Health Organization officially announced that Novel Coronavirus Infection (NCI) COVID-19 pandemic **no longer constitutes a public health emergency of international concern.** However, there is still a wide circulation of various SARS-CoV-2 virus variants [4]. NCI COVID-19 is a predominately respiratory disease with multisystem damage, especially in case of extremely severe disease course, accompanied by pronounced hypoxic effect on all the tissues and organs with the development of multiple organ dysfunction with potential early damage to the kidney parenchyma [9]. The decrease in oxygen saturation of the tissues stimulates the synthesis of erythropoietin (EPO) a glycoprotein hormone. Up to 90% of EPO in the body of an adult person is produced by peritubular fibroblasts of renal interstitium [5]. EPO activates the production of nitrogen oxide in the endothelium, thus effecting the lung vasoconstriction and improving the oxygen supply to the brain, heart and other organs and tissues [12]. Under physiological regulation EPO is capable of reacting against the pro-inflammatory cytokines TNFα and IL-1β, producing an anti-inflammatory effect [3, 13, 14]. Numerous studies have presented the data on adverse pregnancy outcomes in patients with NCI of various severity. Against the background of steady NCI course pregnant women may have sudden development of critical state. The majority of studies testify to a high risk of fetus distress in pregnant women with severe COVID-19, which is associated with the necessity of preterm labor, premature fetus birth, or potential prenatal/intrapartum fetus death [1, 10, 11, 15, 19]. That is why the studies devoted to the analysis of the NCI effect on pregnancy remain highly relevant. The determination of early predictors of the progression of the COVID-19 severity during gestation is of utmost importance.

The aim of the study: to assess the level of blood serum erythropoietin in pregnant women with novel coronavirus infection COVID-19 of various severity; determine its threshold value to predict extremely severe course of COVID-19 during gestation.

Materials and methods. A comparative prospective cohort study has been performed with subsequent retrospective analysis of the data from medical records (labor and delivery record, health card of