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Original Article

Features of the course of measles in children in modern conditions

Angelina Alievna Karakotova[1], Malika Islamovna Batdyeva[2], Sarkis Garekinovich Petrosyan[3], Daniil Gennadievich Mikhalev[4], Kamilla Alanovna Kudzieva[3], Alina Igorevna Baturina[5], Danila Andreevich Nekrasov[6], Vladislava Sergeevna Kurakina[7*]

[1]Faculty of Pediatrics, Medical Institute, North Caucasus State Academy, Cherkessk, Republic of Karachay-Cherkessia, Russia. [2]Faculty of Medicine, Medical Institute, North Caucasus State Academy, Cherkessk, Republic of Karachay-Cherkessia, Russia. [3]Faculty of Medicine, North Ossetian State Medical Academy, Vladikavkaz, Republic of North Ossetia-Alania, Russia. [4]Faculty of Pediatrics, Stavropol State Medical University, Stavropol, Russia. [5]Faculty of Medicine and Prevention, Rostov State Medical University, Rostov-on-Don, Russia. [6]Faculty of Medicine, Kursk State Medical University, Kursk, Russia. [7]Institute of Clinical Medicine named after N.V. Sklifosovsky, First Moscow State Medical University named after I.M. Sechenov, Moscow, Russia.

Correspondence: Vladislava Sergeevna Kurakina, Institute of Clinical Medicine named after N.V. Sklifosovsky, First Moscow State Medical University named after I.M. Sechenov, Moscow, Russia. publab@bk.ru

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ABSTRACT

The article presents the results of a study of the current features of measles in children. The analysis of clinical manifestations, laboratory parameters, and the frequency of complications in vaccinated and unvaccinated patients was carried out. It has been revealed that measles remains highly contagious among the unvaccinated population, while the disease is milder in vaccinated patients. The incubation period averages 10.3 ± 1.4 days. The most common clinical symptoms are fever (98.6%), cough (89.2%), rhinitis (85.1%), and exanthema (94.6%). Laboratory tests revealed characteristic changes, including leukopenia ($3.8 \pm 1.2 \times 10^9$/l), lymphocytosis (42.5 ± 7.8%), and increased ESR (18.4 ± 6.3 mm/h). Complications such as pneumonia (12.8%) and otitis media (4.7%) mainly develop in unvaccinated patients. The study highlights the importance of vaccine prophylaxis to reduce the severity of the disease and the frequency of complications. The results can be used to optimize the therapeutic and diagnostic process and develop preventive measures.

Keywords: Measles, Vaccination, Clinical manifestations, Laboratory parameters, Complications, Collective immunity

Introduction

Measles is one of the most highly contagious viral infections in the history of mankind [1]. The first documentary evidence of this disease dates back to the 4th century AD, when the ancient Roman physician Aetius first described the characteristic clinical picture of the disease [2]. A significant breakthrough in understanding the nature of measles occurred at the beginning of the 20th century, when in 1911 D. Andersen and D. Goldberg scientifically substantiated the viral etiology of the disease [3, 4]. The most important stage in the study of measles was the isolation of the pathogen in 1954, carried out by Thomas Peebles and John Enders [5].

The history of mass vaccination against measles began in the middle of the 20th century, when, after the creation of the first vaccine in 1963, the gradual implementation of immunization programs began in various countries of the world [6, 7]. The Soviet Union was one of the first countries to introduce routine measles vaccinations into the national preventive vaccination calendar [8]. In 1968, a single vaccination of children aged 15-18 months was introduced, which significantly reduced the incidence in the country [9].

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In the developed countries of the West, the introduction of measles vaccination occurred in stages. Initially, immunization programs were aimed at the most vulnerable groups of the population, including preschool children and health workers [10, 11]. Gradually, vaccination coverage expanded, which led to a significant reduction in morbidity.

The global measles control strategy received a new impetus in the 1990s, when the World Health Organization initiated large-scale programs to expand access to vaccines in developing countries [12]. This has led to significant progress in reducing the incidence of measles on the African continent and in some regions of Asia [13]. The measles incidence statistics are shown in **Figures 1 and 2**.

In the modern period, there is a tendency to improve vaccination schemes [14]. Most developed countries have switched to double immunization, which provides more reliable protection against the disease. The first vaccination is usually carried out at the age of 12-15 months, and revaccination is carried out at the age of 6 years [15-17].

The dynamics of measles vaccination coverage demonstrate significant differences between regions of the world. In countries with a developed healthcare system, immunization rates reach 95% or higher, which makes it possible to maintain a low incidence rate [18-20]. In developing countries, these indicators are significantly lower, which creates the prerequisites for periodic outbreaks of the disease [21, 22]. The technological development of vaccine production has also had a significant impact on the effectiveness of immunization programs [23]. The advent of combined medications, including protection against measles, rubella, and mumps, has simplified the vaccination process and increased its effectiveness [24].

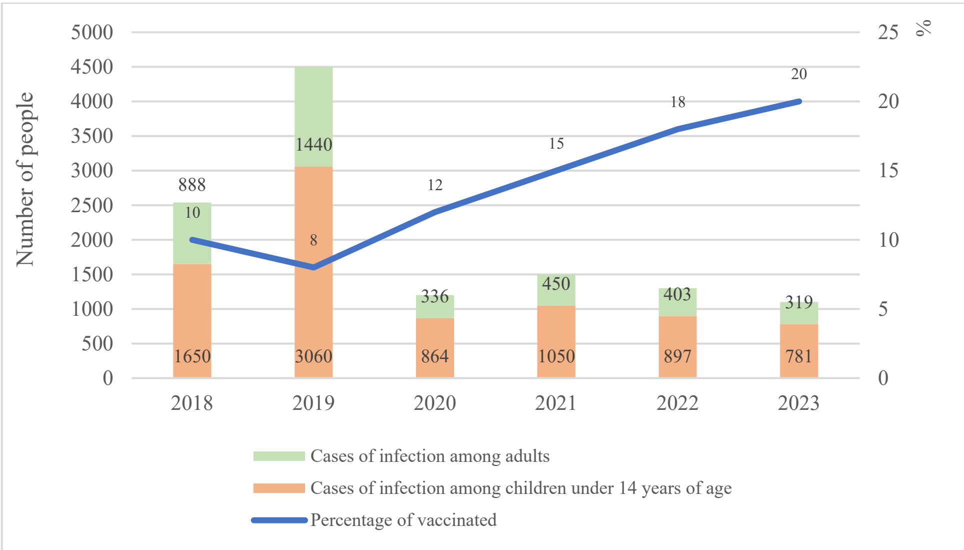

Figure 1. Measles incidence statistics in Russia

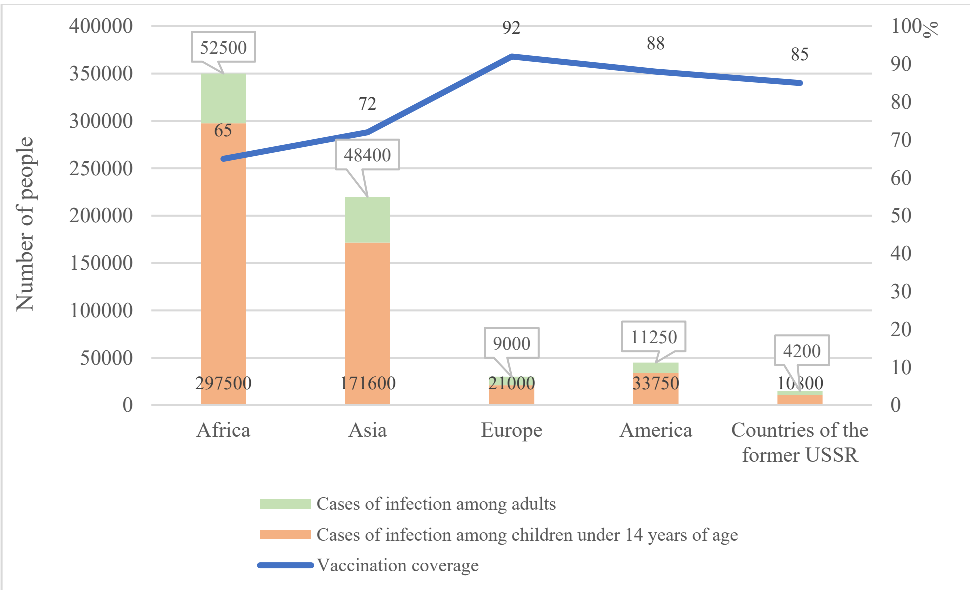

Figure 2. Global measles incidence statistics for 2023

An important stage in the development of vaccine prevention was the creation of an immunization monitoring system and evaluation of its effectiveness. Modern approaches include not only accounting for the number of vaccinated individuals but also regular analysis of antibody levels in the population, which allows timely adjustment of immunization programs [25-29].

In recent decades, special attention has been paid to maintaining a high level of collective immunity. This is due to the fact that a decrease in vaccination coverage can lead to a sharp increase in morbidity, as was observed in some countries in the early 2010s [30, 31]. International cooperation in measles vaccine prevention continues to develop, which is reflected in joint programs to strengthen immunization systems, develop new vaccines, and improve disease control strategies [31-33]. Special attention is paid to the availability of vaccines in countries with limited resources and to raising public awareness of the importance of immunization [34].

In modern conditions, the epidemiological situation of measles is characterized by a certain instability. There is a wave-like course of morbidity associated with various factors, including migration processes, changes in vaccination coverage, and the emergence of new strains of the pathogen [35-37]. Particular attention is drawn to the tendency to change the clinical picture of the disease, which requires constant monitoring and adaptation of approaches to diagnosis and treatment [38, 39].

In modern epidemiological conditions, the clinical picture of measles has undergone certain changes compared to the pre-vaccination period. The dynamics of the clinical manifestations of the disease demonstrate a tendency to modify the main symptoms and change the severity of the disease [40-42].

The incubation period of measles currently tends to shorten, which is associated with the peculiarities of the body's modern immune response [43]. Early manifestations of the disease are often blurred, which makes timely diagnosis difficult and can lead to late isolation of patients [44].

The catarrhal period in vaccinated patients often proceeds more mildly, with less pronounced symptoms of intoxication [45, 46]. Cough and rhinitis may be mild or absent, which creates certain difficulties in differential diagnosis [47].

The rash period has also changed. Filatov-Koplik spots may be less pronounced or absent, making early diagnosis difficult. The stages of rashes are sometimes disrupted, and the characteristic rash may have atypical localization [48-51].

The severity of the disease in modern conditions varies depending on the patient's immune status and the presence of concomitant diseases. Measles is more severe in unvaccinated children and people with immunodeficiency conditions, with a higher probability of complications [52, 53]. Complications of measles are less common in modern conditions, but their spectrum has changed. Secondary bacterial infections come to the fore, especially in patients with weakened immune systems [54, 55]. There is a tendency to increase the incidence of pneumonia and otitis media [56, 57].

Atypical forms of measles have become more common. Vaccinated patients may have a mitigated form of the disease with a mild course and the absence of a typical rash [58, 59]. Individuals with immunodeficiency conditions may develop a malignant form of measles with a severe course and high mortality [60, 61].

Laboratory diagnostics of measles in modern conditions has undergone significant changes. The widespread introduction of serological research methods has made it possible to increase the accuracy of diagnosis and identify atypical forms of the disease [62, 63].

The duration of the infection period in modern conditions may vary depending on the form of the disease and the state of the patient's immune system. There is a tendency for the earlier appearance of viral particles in the patient's biological fluids [64, 65]. Susceptibility to infection remains high, especially among unvaccinated individuals. However, the disease is much easier in vaccinated patients, which indicates the high effectiveness of existing vaccines [66, 67]. The prognosis of the disease in modern conditions is generally favorable, provided timely diagnosis and adequate treatment. However, in patients with concomitant diseases and immunodeficiency conditions, the risk of complications remains high.

The relevance of studying the features of the course of measles in modern conditions is due to the need to improve existing strategies for the prevention and treatment of this disease. The study of modern aspects of the pathogenesis, clinical manifestations, and outcomes of measles makes it possible to optimize approaches to patient management and develop more effective measures to control the spread of infection. Of particular importance is the analysis of the transformation of clinical manifestations of measles in the era of mass immunization. Current trends demonstrate both positive changes in the form of a decrease in the severity of the disease and the frequency of complications, as well as the emergence of new challenges associated with changes in the epidemiological situation and the appearance of atypical forms of the disease.

Materials and Methods

The clinical base of the study is represented by children's district polyclinics in the cities of Karachayevsk, Cherkessk, and Vladikavkaz. In the period from 2018 to 2024, a comprehensive examination of 148 children with a clinically confirmed diagnosis of measles was conducted **(Table 1)**.

Table 1. Characteristics of the study group

Indicator	Value
Total number of patients	148 children
Age range	from 1 year to 14 years old
Average age	5.6 ± 1.2 years
Boys	84 (56,8%)
Girls	64 (43,2%)
Vaccinated	42 (28,4%)
Unvaccinated	106 (71,6%)
The season of morbidity	mainly the winter-spring period

The seasonality of the disease demonstrated a typical pattern for measles with a predominance of cases in the winter-spring period, which corresponds to the well-known epidemiological data on the spread of this infection [68].

Clinical research methods included an integrated approach to the examination of each patient. Special attention was paid to collecting a detailed medical history of the disease, including an epidemiological history, which made it possible to identify possible sources of infection and ways of its transmission. A thorough physical examination was performed with an assessment of the general condition, thermometry, condition of the skin and mucous membranes, and examination of the lymphatic system.

Laboratory diagnostics were carried out using modern research methods. The examination program included:

- A general clinical blood test with a detailed leukocyte formula made it possible to assess the degree of the inflammatory reaction and the nature of changes in peripheral blood.
- Serological studies for the presence of specific IgM and IgG class antibodies to the measles virus were a key method of confirming the diagnosis.
- PCR diagnostics were performed to detect measles virus RNA in biological materials, which made it possible to confirm the diagnosis in the early stages of the disease.
- A biochemical blood test included an assessment of the functional state of the liver and determination of the level of C-reactive protein.
- A general urinalysis was performed to assess the general condition of the body and identify possible complications.
- Instrumental diagnostics included X-ray examination of the chest organs in case of suspected pneumonia and other complications. If necessary, an ultrasound examination of the abdominal organs was performed.

Statistical data processing was carried out using modern methods of mathematical statistics. The reliability of the differences was assessed using Student's criterion. The differences at $p < 0.05$ were considered statistically significant.

All studies were conducted in compliance with the ethical standards and principles of the Helsinki Declaration. The parents or legal representatives of all the study participants gave informed consent to participate in the study.

Results and Discussion

The clinical picture of the disease in the examined patients had several characteristic features. The incubation period averaged 10.5 ± 2.1 days, with a range from 7 to 14 days. In 15% of patients, the incubation period was shortened to 7-9 days, which may be due to the peculiarities of the modern immune response. The dynamics of clinical manifestations are represented by the following features **(Table 2)**:

Table 2. Frequency of clinical symptoms

Symptoms	Frequency of occurrence (%)
Fever	98.6
Cough	89.2
Rhinitis	85.1
Conjunctivitis	76.3
Filatov-Koplik Spots	68.9
Exanthema	94.6

The period of catarrhal events in the majority of patients (78.4%) lasted 3-4 days. Prolongation of the prodromal period to 5-6 days was noted in 21.6% of patients.

Features of the rash in the examined patients: the onset of rashes on the 4th-5th day after the onset of the disease; the stage of rash appearance was disrupted in 32.5% of patients; discharge elements were observed in 18.9% of patients; atypical forms of rash were observed in 12.2% of patients. The severity of the disease is shown in **Table 3**. Complications developed in 28 (19%) patients. The structure of complications is shown in **Table 4**. Laboratory parameters of blood and urine are presented in **Table 5**.

Table 3. Distribution by severity of the current

Form of the disease	Vaccinated (%)	Unvaccinated (%)
Easy	84.4	25.8
Medium-heavy	13.6	62.3
Heavy	2.0	11.9

Table 4. Complication rate

Complication	Frequency of occurrence (%)
Pneumonia	12.8
Otitis media	4.7
Stomatitis	1.4
Encephalitis	0.7

Table 5. Laboratory parameters of blood and urine (M ± SD)

Indicator	Measles patients	Standard
Indicators of the general blood test		
White blood cells, $\times 10^9$/l	4,2 ± 1,1	4,0-9,0
Lymphocytes, %	48,6 ± 7,2	19-37
Monocytes, %	9,4 ± 2,1	3-11
ESR, mm/hr	18,5 ± 6,3	2-10
Biochemical parameters of blood		
Total protein, g/l	68,4 ± 5,2	65-85
ALT, Unit/l	42,3 ± 15,6	up to 41
AST, Unit/l	38,5 ± 12,4	up to 38
C-reactive protein, mg/l	12,4 ± 4,5	up to 5
Indicators of general urinalysis		

Relative density	1012 ± 0,05	1005-1025
Protein, g/l	0,03 ± 0,01	no
White blood cells, in the field of vision	3-4	0-2

Laboratory parameters showed the following changes:

- Leukopenia at the onset of the disease in 76.3% of patients
- Lymphocytosis was observed in 68.9% of patients
- An increase in ESR was observed in 82.5% of patients
- Mild thrombocytopenia in 15.6% of patients

Serological parameters confirmed the diagnosis in all examined patients. Vaccinated children had a higher titer of IgG class antibodies, which correlated with a milder course of the disease. The data obtained indicate that measles retains its characteristic features in modern conditions. There is a tendency to decrease the severity of the disease in vaccinated patients.

Changes in blood tests reflect a typical body reaction to a viral infection: moderate leukopenia, lymphocytosis, increased ESR, and a slight increase in liver enzymes.

The dynamics of recovery were characterized by the following features: a decrease in temperature on an average of 7-9 days of illness, the disappearance of the rash by 10-14 days, and normalization of laboratory parameters by 3-4 weeks of illness.

A comparative analysis of the course of the disease in vaccinated and unvaccinated patients showed statistically significant differences:

- In vaccinated patients, the disease was milder
- The duration of the fever period was shorter by 2-3 days
- The complication rate was 2.5 times lower

Thus, the data obtained indicate that the measles virus remains highly contagious. There is a tendency to a milder course of the disease in vaccinated patients, which confirms the effectiveness of existing vaccines. It should be noted that severe forms of the disease were more common in unvaccinated patients; the seasonality of the disease remains pronounced; complications mainly developed in unvaccinated patients; modern diagnostic methods ensure high accuracy of diagnosis verification.

Conclusion

The conducted research allowed us to obtain significant data on the current features of measles in children and the effectiveness of vaccine prophylaxis. The main results of the study demonstrate that measles remains relevant as an infectious disease that requires the close attention of the medical community. Despite the availability of an effective vaccine, the disease continues to be reported, mainly among the unvaccinated population. The clinical picture of measles in modern conditions is characterized by a typical course with the presence of all stages of the disease. However, vaccinated patients have a milder course of the disease with fewer symptoms of intoxication and a lower incidence of complications.

Laboratory parameters confirm the viral nature of the disease and allow monitoring of the dynamics of the pathological process. Characteristic changes are leukopenia, lymphocytosis, and increased ESR.

Complications of measles remain a serious problem, especially among unvaccinated patients. The most common complications are pneumonia and otitis media, which highlights the importance of timely vaccination.

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Ethics statement: All studies were conducted in compliance with the ethical standards and principles of the Helsinki Declaration. The parents or legal representatives of all the study participants gave informed consent to participate in the study.

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