

EPIDEMIOLOGICAL SIGNIFICANCE OF EARLY DETECTION OF INFECTIOUS DISEASES PRESENTING WITH EXANTHEM IN CHILDREN

Khodjaeva Inobat Bekpulatovna

*Assistant, Department of Infectious Diseases and Phthisiology, Urgench State Medical
Institute*

Infectious disease physician, Family Polyclinic No. 3, Urgench, Uzbekistan

Abstract. *Infectious diseases accompanied by exanthem remain one of the most common reasons for paediatric consultations and an important source of outbreaks in preschool and school collectives. Several of them – measles, rubella, varicella, scarlet fever and meningococcal infection – combine high communicability or high lethality with the fact that the patient is infectious before the rash appears or before the diagnosis is confirmed. This narrative review, based on international guidelines and peer-reviewed publications, summarises the epidemiological characteristics of the main exanthematous infections of childhood and substantiates why detection at the prodromal or earliest rash stage changes the course of an epidemic process. The components of an early detection system at the primary care level – standardised case definitions, immediate notification, laboratory confirmation, isolation, contact tracing, post-exposure prophylaxis and immunisation status review – are discussed, together with current threats such as declining vaccination coverage and atypical presentations in partially immune children.*

Keywords: exanthem, children, early detection, epidemiological surveillance, measles, rubella, varicella, scarlet fever, primary health care.

1. Introduction

Rash is one of the most frequent presenting signs of febrile illness in childhood. In everyday outpatient practice a family physician or paediatrician sees many children with fever and skin eruption, and only a minority of these cases require urgent action. However, the group of exanthematous infections includes diseases with fundamentally different epidemiological weight: from benign self-limiting conditions such as roseola to measles, which remains one of the most contagious human infections, and meningococcaemia, which can kill a previously healthy child within hours [1, 2].

From the epidemiological point of view, the main problem is the timing of infectiousness. A child with measles, rubella or varicella is already able to transmit the pathogen for several days before a characteristic rash appears, when the clinical picture is still indistinguishable from an ordinary acute respiratory infection [3]. Consequently, the first contacts in a family, a kindergarten group or a waiting

room may occur before anyone suspects a notifiable disease. The earlier a case is recognised, the smaller the number of exposed susceptible persons and the more effective the protective measures that can be applied to them.

The aim of this article is to analyse the epidemiological significance of early detection of exanthematous infectious diseases in children and to define the practical elements of an early detection system at the level of primary health care.

2. Materials and methods

The article is a narrative review. It is based on the analysis of international clinical and public health guidance (World Health Organization position papers, recommendations of the American Academy of Pediatrics and of the Advisory Committee on Immunization Practices), leading paediatric infectious disease textbooks and peer-reviewed review articles on measles, rubella, varicella, streptococcal infection, parvovirus B19 infection, enteroviral and meningococcal disease published in major international journals. Data were compared with respect to incubation period, period of communicability, complications and measures of epidemic control, and then systematised in the form of a table and thematic sections.

3. Epidemiological characteristics of the main exanthematous infections

The infections that most often present with rash in children differ in the route of transmission, the duration of the incubation period and, most importantly, in the period of communicability relative to the appearance of the rash (Table 1). Airborne transmission dominates in measles, rubella and varicella; droplet and contact transmission in scarlet fever, erythema infectiosum and enteroviral exanthems; and respiratory droplets via carriers or ill contacts in meningococcal disease [1, 3].

Table 1. Epidemiological characteristics of selected exanthematous infections in children

Disease	Main route of transmission	Incubation period	Period of communicability	Principal epidemiological risk
Measles	Airborne (aerosol)	7–21 days	About 4 days before to 4 days after rash onset	Extreme contagiousness; outbreaks in unvaccinated groups
Rubella	Droplet	12–23 days	About 7 days before to 7 days after rash onset	Congenital rubella syndrome after infection of pregnant women
Varicella	Airborne, contact with vesicle fluid	10–21 days	1–2 days before rash until all lesions are crusted	Nosocomial and kindergarten outbreaks; risk for newborns and immunocompromised persons

Disease	Main route of transmission	Incubation period	Period of communicability	Principal epidemiological risk
Scarlet fever (group A streptococcus)	Droplet, contact	1–4 days	Until 24 hours after start of effective antibiotic therapy	Rheumatic fever and glomerulonephritis in untreated cases
Erythema infectiosum (parvovirus B19)	Droplet, blood-borne	4–14 days, up to 21 days	Mainly before rash; low after rash appears	Exposure of pregnant women and persons with haemolytic anaemia
Enteroviral exanthems (hand, foot and mouth disease)	Faecal–oral, droplet	3–6 days	Several weeks of faecal shedding	Summer–autumn outbreaks in preschool institutions
Meningococcal infection	Droplet	2–10 days (usually 3–4)	Until 24 hours after effective therapy	Rapid progression; secondary cases among close contacts

The data in Table 1 show that for most of the infections listed the child is capable of spreading the agent before the diagnostic rash is seen. This is the principal reason why surveillance based only on "classic" rash cannot prevent transmission and why attention must be directed to the prodromal syndrome and to the epidemiological context.

4. Why early detection changes the epidemic process

Contagiousness and herd immunity.

The basic reproduction number of measles is usually estimated at 12–18, which means that one infectious person may infect that many susceptible contacts in a fully susceptible population. Maintaining the proportion of immune persons at about 95% with two doses of vaccine is therefore necessary to interrupt sustained transmission [4, 5, 6]. Even small clusters of susceptible children – for example in a single kindergarten group or in a community with vaccine refusal – are sufficient to maintain an outbreak. Early recognition of the index case shortens the interval during which such clusters are exposed.

Prevention of severe outcomes in vulnerable groups.

The epidemiological importance of rubella lies mainly in congenital rubella syndrome. Infection in the first 12 weeks of pregnancy leads to fetal damage in up to 85% of cases, including deafness, cataract, congenital heart disease and neurological impairment [7, 8]. Parvovirus B19 infection of a pregnant woman may cause fetal anaemia and hydrops [9], while varicella in a newborn whose mother developed the disease around delivery, or in an immunocompromised child, can be life-threatening [10]. A rapid identification of the source allows pregnant contacts to be assessed serologically and managed in time.

Time-critical post-exposure measures.

Several effective post-exposure interventions have strict time limits. Measles vaccine given within 72 hours after first contact, or immunoglobulin within six days, can prevent or attenuate disease in susceptible contacts; varicella vaccine is recommended within 3–5 days after exposure and varicella-zoster immunoglobulin for high-risk persons within 10 days; chemoprophylaxis for close contacts of a patient with meningococcal disease should be given as soon as possible, ideally within 24 hours [3, 11, 12]. These windows can only be used if the case is recognised and reported promptly.

Reduction of morbidity and mortality in the patient.

Early identification is also clinically significant. In scarlet fever, timely antibiotic treatment eliminates the infectious state within 24 hours and prevents suppurative and non-suppurative sequelae [13, 14]. In meningococcaemia, antibiotic administration at the first suspicion – before laboratory confirmation – is the most important determinant of survival, since the disease can progress from a non-specific febrile illness to septic shock within hours [12, 15]. In measles, vitamin A supplementation and supportive care reduce complications in children in whom the diagnosis is made early [5].

5. Components of an early detection system at the primary care level

The family polyclinic is the first point of contact for most children with exanthem and therefore the most important sensor of the epidemiological surveillance system. An effective system includes the following elements.

Standardised case definitions. For measles the World Health Organization case definition – fever and generalised maculopapular rash accompanied by cough, coryza or conjunctivitis – is deliberately sensitive, and its use at the first contact allows suspected cases to be flagged before laboratory confirmation [4, 6]. Equally important is recognition of prodromal features such as Koplik spots, postauricular and occipital lymphadenopathy in rubella, or perioral pallor with a "strawberry" tongue in scarlet fever.

Epidemiological history. A routine question about vaccination status, contact with a rash illness during the preceding 2–3 weeks, attendance at a preschool institution, recent travel and contact with a pregnant woman should be a part of the examination of every febrile child with rash. A negative or unknown vaccination history substantially increases the pre-test probability of vaccine-preventable diseases.

Immediate notification and laboratory confirmation. A suspected case of measles, rubella, meningococcal infection or an outbreak of any exanthematous infection should be reported to the

sanitary-epidemiological service without waiting for confirmation. Specimens (serum for specific IgM, throat or nasopharyngeal swab and urine for RT-PCR) should be taken at the first contact, because the sensitivity of IgM testing is lower in the first days after rash onset and viral RNA detection falls with time [6, 8].

Isolation and contact management. A suspected patient should be isolated at home or in an infectious disease hospital, depending on severity and on the home situation; all contacts should be identified, their immune status verified from vaccination records, and susceptible contacts offered post-exposure prophylaxis or excluded from collectives for the maximum incubation period [3].

Feedback and review of immunisation coverage. Every confirmed case should initiate an assessment of vaccination coverage in the catchment area and in the affected institution, followed by catch-up immunisation where gaps are found.

6. A practical syndromic approach to early recognition

In routine practice the physician rarely has laboratory confirmation at the first visit; the decision about isolation, notification and protection of contacts must therefore be based on a syndromic assessment. The morphology of the rash, its timing relative to fever and the accompanying enanthem and lymphadenopathy allow children to be sorted into several groups, each linked to a specific epidemiological action (Table 2). This approach does not replace differential diagnosis but defines what must be done on the same day, before a final diagnosis is available [1, 2].

Table 2. Syndromic groups of exanthem and immediate epidemiological actions

Syndromic group	Conditions to be considered	Immediate action at first contact
Fever, cough, coryza, conjunctivitis, then descending maculopapular rash	Measles; rubella and enteroviral or adenoviral infection less likely	Isolate; notify; take serum and swab/urine; list contacts and check their vaccination records
Mild fever, postauricular lymphadenopathy, fine pink rash	Rubella; parvovirus B19; enteroviral rash	Isolate; ask about pregnant contacts; send serology; inform the obstetric service if exposure is confirmed
Vesicles appearing in crops at different stages	Varicella; less often enteroviral or herpetic infection	Isolate until all lesions are crusted; identify susceptible, pregnant and immunocompromised contacts; consider post-exposure prophylaxis
Sore throat, fine "sandpaper" rash, perioral pallor, strawberry tongue	Scarlet fever (group A streptococcus)	Rapid antigen test or culture; start antibiotic; exclude from the collective for at least 24 hours of therapy
Fever with petechial or purpuric rash that spreads quickly, ill appearance	Meningococcaemia; other bacterial sepsis	Emergency: parenteral antibiotic at once, urgent hospital transfer, notification, contact chemoprophylaxis
Prolonged fever with polymorphous rash, conjunctival injection, mucosal changes	Kawasaki disease; MIS-C; measles; scarlet fever	Urgent referral to a paediatric hospital; do not delay because of uncertainty about the infectious nature

Two principles make this approach safe. First, any child with fever and a non-blanching rash is managed as a possible case of meningococcal disease until proven otherwise, because the cost of delayed antibiotic therapy is very high. Second, a child with a rash whose vaccination history is incomplete or unknown is treated as a possible vaccine-preventable infection, and the notification and contact tracing procedure is started in parallel with diagnostic work-up. The epidemiological cost of a false alarm – a short isolation and several laboratory tests – is small compared with the cost of an unrecognised measles case in a polyclinic waiting room or a kindergarten.

It is also important to keep a record of the time of each step. In outbreak investigations the interval between rash onset, first medical contact, notification, laboratory confirmation and the start of control measures is a measurable indicator of surveillance quality. Local analysis of these intervals identifies delays – for example at the stage of specimen transport or reporting – and directs training and organisational changes where they are most needed.

7. Preschool institutions and communities as sites of amplification

Children in preschool institutions have frequent close contact, limited hygiene skills and, in the youngest groups, incomplete vaccination. These conditions favour rapid spread of varicella, hand, foot and mouth disease, scarlet fever and erythema infectiosum. Daily morning screening by a nurse, immediate exclusion of a child with fever and rash, notification of the polyclinic, and a register of children with contraindications to vaccination are practical measures that improve early detection. A close cooperation between the preschool institution, the family polyclinic and the epidemiological service is essential, because the educator or nurse is usually the first person to observe a rash and the polyclinic physician the first to interpret it.

8. Current challenges

Several trends complicate early detection. First, global measles incidence increased after routine immunisation was disrupted during the COVID-19 pandemic, and elimination targets in many regions have not been achieved; accumulation of susceptible cohorts is the principal driver of resurgence [16]. Second, in partially immune children, measles and rubella may present with mild, modified or atypical disease, which reduces the sensitivity of purely clinical surveillance. Third, limited clinical experience with diseases that have become uncommon leads to delayed recognition. Fourth, new conditions such as multisystem inflammatory syndrome in children and Kawasaki disease, although not infectious, resemble exanthematous infections and may delay or confuse the epidemiological assessment [17, 18].

The response to these challenges includes regular training of primary care staff in the recognition of rash illnesses, use of simple algorithms based on rash morphology and prodromal signs, strengthening of laboratory capacity for IgM and PCR testing, high-quality immunisation records, and active communication with parents about vaccine safety and the risks of the diseases.

9. Conclusion

Early detection of exanthematous infections in children is not only a clinical task but also a key element of epidemic control. Because many of these diseases are transmissible before the typical rash appears, the effectiveness of control depends on the ability of the primary care physician to suspect the infection at the prodromal stage, to obtain epidemiological history, to notify immediately and to start time-limited post-exposure measures. Strengthening the surveillance function of the family polyclinic, together with high immunisation coverage and cooperation with preschool institutions, reduces the number of secondary cases, protects pregnant women and immunocompromised children and prevents severe outcomes in patients.

REFERENCES

1. Nelson Textbook of Pediatrics / ed. by R.M. Kliegman, J.W. St. Geme, N.J. Blum et al. – 21st ed. – Philadelphia: Elsevier, 2020.
2. Feigin and Cherry's Textbook of Pediatric Infectious Diseases / ed. by J.D. Cherry, G.J. Harrison, S.L. Kaplan et al. – 8th ed. – Philadelphia: Elsevier, 2019.
3. Red Book: 2021–2024 Report of the Committee on Infectious Diseases / ed. by D.W. Kimberlin, M.T. Brady, M.A. Jackson, S.S. Long. – 32nd ed. – Itasca, IL: American Academy of Pediatrics, 2021.
4. Moss W.J. Measles // Lancet. – 2017. – Vol. 390. – P. 2490–2502.
5. Strebel P.M., Orenstein W.A. Measles // N. Engl. J. Med. – 2019. – Vol. 381. – P. 349–357.
6. Measles vaccines: WHO position paper – April 2017 // Wkly. Epidemiol. Rec. – 2017. – Vol. 92, № 17. – P. 205–227.
7. Lambert N., Strebel P., Orenstein W., Icenogle J., Poland G.A. Rubella // Lancet. – 2015. – Vol. 385. – P. 2297–2307.
8. Rubella vaccines: WHO position paper – July 2020 // Wkly. Epidemiol. Rec. – 2020. – Vol. 95, № 27. – P. 306–324.
9. Young N.S., Brown K.E. Parvovirus B19 // N. Engl. J. Med. – 2004. – Vol. 350. – P. 586–597.
10. Heininger U., Seward J.F. Varicella // Lancet. – 2006. – Vol. 368. – P. 1365–1376.

11. Marin M., Güris D., Chaves S.S., Schmid S., Seward J.F. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP) // MMWR Recomm. Rep. – 2007. – Vol. 56, № RR-4. – P. 1–40.
12. Rosenstein N.E., Perkins B.A., Stephens D.S., Popovic T., Hughes J.M. Meningococcal disease // N. Engl. J. Med. – 2001. – Vol. 344. – P. 1378–1388.
13. Shulman S.T., Bisno A.L., Clegg H.W. et al. Clinical practice guideline for the diagnosis and management of group A streptococcal pharyngitis: 2012 update by the Infectious Diseases Society of America // Clin. Infect. Dis. – 2012. – Vol. 55. – P. e86–e102.
14. Wessels M.R. Streptococcal pharyngitis // N. Engl. J. Med. – 2011. – Vol. 364. – P. 648–655.
15. Weiss S.L., Peters M.J., Alhazzani W. et al. Surviving Sepsis Campaign international guidelines for the management of septic shock and sepsis-associated organ dysfunction in children // Pediatr. Crit. Care Med. – 2020. – Vol. 21, № 2. – P. e52–e106.
16. Patel M.K., Goodson J.L., Alexander J.P. et al. Progress toward regional measles elimination — worldwide, 2000–2019 // MMWR Morb. Mortal. Wkly. Rep. – 2020. – Vol. 69, № 45. – P. 1700–1705.
17. Feldstein L.R., Rose E.B., Horwitz S.M. et al. Multisystem inflammatory syndrome in U.S. children and adolescents // N. Engl. J. Med. – 2020. – Vol. 383. – P. 334–346.
18. McCrindle B.W., Rowley A.H., Newburger J.W. et al. Diagnosis, treatment, and long-term management of Kawasaki disease: a scientific statement for health professionals from the American Heart Association // Circulation. – 2017. – Vol. 135. – P. e927–e999.