Khartoum Textbook of PAEDIATRICS

First Edition Volume One

Edited by
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Khartoum Textbook of Paediatrics

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Dedication

This book is dedicated, in Heaven, to the soul of the late Professor Salah Ahmed Ibrahim, whom we lost last year, and to our predecessors who founded this department.

It is also dedicated to all medical students in the recent diaspora— without their ambition and enthusiasm, we would not have had the momentum to write this work.

Above all, this book is dedicated to our little ones, and to parents everywhere, in their ongoing odyssey toward health and well-being.

Dr. Ibrahim Gamareldawla

Foreword

Since its inception, the Department of Paediatrics and Child Health has maintained a commitment to delivering an excellent level of teaching in general paediatrics and Child Health to undergraduate students.

The curriculum lays the foundations of Paediatrics and Child Health through the childhood and adolescence period, including perinatal, neonatal, infancy, childhood, and adolescence.

It addresses priority areas, including growth and development, nutrition, preventive public health interventions, priority childhood diseases, caring for special needs and disadvantaged children

Changing Context: National:

With the changing political and social context for the last three years since the start of the internal war and unrest in many Sudanese states, and its impact on population dynamics through internal and external migration, increasing poverty. impact on the health system and social services

The weak and inadequate national health system was further weakened by the increasing migration of medical and health workers and university teachers, and graduates to the Gulf and other neighbouring Countries

The medical schools and other health workers training institutes are destroyed or non-functional in many states.

The internet connectivity coverage was interrupted and unavailable for distant learning programs. Unaffordability of the cost of the internet.

Regional and international:

The diminished regional and international funding for education and training.

All these factors mandate a scholarly effort for local input.

The contributors:

The contributors to this book are seasoned scholars with excellent resumes and international and regional experiences. They have admirable teaching and training experiences and leadership roles in UN health agencies locally and internationally.

I am quite convinced and committed to this effort by the Department of Paediatrics and Child Health and its leadership.

Prof Zein A. Karrar

Preface

Paediatrics at the University of Khartoum has a history that reflects both growth and vision.

Until 1967, paediatrics was taught as part of internal medicine. That year, the specialty found its own home with the establishment of the Department of Paediatrics under the leadership of the late Professor Hafiz Elshazali, the department's first head.

For more than three decades, the idea of writing a book that speaks directly to the realities of paediatrics in our part of the world has been alive among us. Many generations of students have asked for a resource that bridges the gap between international standard textbooks and the daily challenges they encounter in our context. Today, it gives us great pride and privilege to see that vision finally take shape in this book.

Our aim is simple yet important: to provide students with knowledge that is relevant, practical, and rooted in the context of child health in a low-income country. This book is not meant to replace standard paediatrics textbooks, which remain indispensable for a broad medical education. Rather, it is intended to supplement them by focusing on issues that are central to paediatric practice in Sudan, including tropical infestations, infectious diseases, vaccination, and nutritional disorders.

We recognise that this is only the beginning. In future editions, we intend to expand the scope to include system-based diseases and other aspects of paediatrics. For now, however, we believe this first step will provide students with a resource that is closer to their reality and more responsive to their needs.

We dedicate this book to our students, who have inspired us to keep this idea alive for so long, and to our teachers and colleagues, whose support and guidance continue to shape our work.

Dr Osama Hafiz Elshazali.

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Chapter 1: Immunisation In Children

Introduction

Immunisation saves millions of lives each year, as well as preventing morbidity and disability from infectious diseases. It is one of the most cost-effective measures for preventing disease. The most notable success of immunisation has been the global eradication of smallpox in 1980. Poliomyelitis, neonatal and maternal tetanus have been eliminated in most countries.

Definition

Vaccines are defined as whole or part of microorganisms administered to prevent an infectious disease.

Vaccines can be introduced by stimulating humoral (antibody production), cellular immunity or both. It is initially by IgM production in the first week, then by IgG for months or years. Protection induced by most vaccines is thought to be mediated preliminary by B lymphocytes, which produce antibodies that protect the host by inactivating toxins, neutralising viruses, and killing bacteria by phagocytosis. Most B lymphocytes require the assistance of CD4 helper T lymphocytes.

Immunisation is the process of introducing immunity against a specific disease. It can be either passive or passive immunity.

Passive Immunity

Rather than producing antibodies through the body's own immune system, passive immunity is achieved by administration of preformed antibodies. Protection is immediate, yet transient, lasting weeks to months.

Products include:

During pregnancy, transplacental immunoglobulin IgG from the mother to the foetus offers the infant protection of approximately 6 months against infection. Another antibody, IgA, is transmitted to the infant through breast milk. Immunoglobulins (normal or specific), Antisera such as Diphtheria and Botulin antitoxin, Monoclonal antibodies used in respiratory syncytial virus (RSV)

Major indications for inducing passive immunity are immunodeficiency in children with B lymphocyte defects who are unable to produce antibodies (Hypogammaglobulinemia). Other indications include Guillain-Barré syndrome, Idiopathic Thrombocytopenic Purpura (ITP), and Hepatitis B.

Active Immunity

It is achieved through administering a vaccine or toxoid to stimulate the immune system to produce a prolonged humoral or cellular immune response, and it is also achieved by following infection with a certain microorganism.

Vaccines can consist of

- live attenuated microorganisms, e.g. Measles, Rotavirus, Mumps and Rubella.
- Whole inactivated (acellular Pertussis, hepatitis B)
- Polysaccharide capsules (Pneumococcal, Meningococcal)
- Polysaccharide capsules conjugated to protein carrier Haemophilus Influenzae (Hib), Pneumococcal, Meningococcal conjugate vaccine)
- Toxoid (Diphtheria, tetanus). Toxoid is a bacterial toxin modified to be non-toxic but still capable of inducing an active immune response against the toxin.

Vaccines can contain a variety of constituents besides the immunising agent, i.e., saline, water, proteins, preservatives, stabilisers, and microbial agents.

Herd Immunity

It is the concept in which active vaccination in a community will increase immunity in contacts and households and decrease infection in susceptible individuals (if > 85% of the population vaccinated), e.g., oral polio vaccine

Initially, host bodies respond to the vaccine by generating IgM, which, over time, creates a long-term IgG response and induces immunological memory that leads to enhanced responses on booster doses.

Live attenuated vaccine tends to induce long-term responses. Most live vaccines are administered in a one or two-dose schedule. Inactivated vaccines tend to require multiple doses to induce response and are more likely than live attenuated vaccines to need booster doses to maintain immunity.

It is especially important to maintain routine immunisations to prevent a disease outbreak, public health emergency, or future pandemic.

In Sudan Expanded Program of Immunisation (EPI) established in 1978 recommended 13 vaccines (12 for children, Tetanus toxoid for mothers). After the introduction of the vaccine program, there was a marked reduction in childhood infectious diseases and an increase in coverage rates. Sudan has witnessed a remarkable improvement in routine vaccination coverage during the last few years. The coverage rate for the Penta vaccine 3rd dose reached 93%, and the measles coverage rate was 87%.

Bacillus Calmette Guerin (BCG)

Although it's of a limited protective value against Tuberculosis, it prevents disseminated disease and Tuberculous Meningitis. It is a Bovine live attenuated vaccine. It is a heat-stable, light-sensitive, freeze-dried vaccine (Figure 1).

It is given at birth or on the first visit to the health facility.

Site: Intradermal lateral upper aspect of left forearm

Dose: 0.05 ml to neonate, 0.10 ml to infants

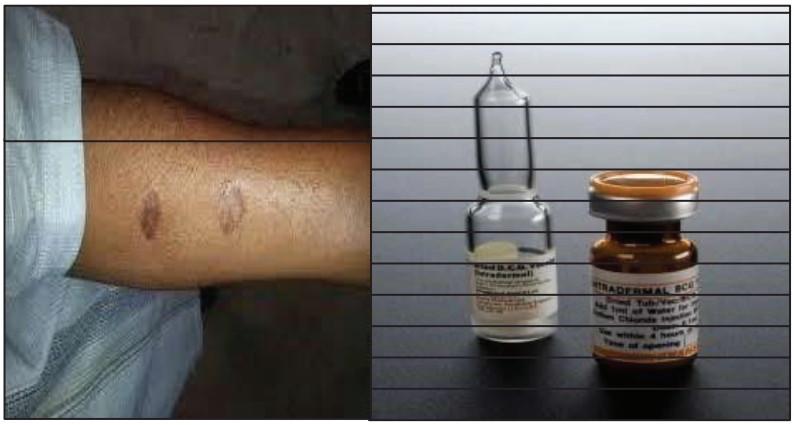

Figure 1 BCG vaccine

Two weeks after administration, a small papule develops, which, after six weeks, might ulcerate. It heals with a scar. Axillary lymph nodes might enlarge (BCGiosis).

Most times ulcer heals by itself and forms a scar. It rarely needs antibiotics or isoniazid.

Because it is a life attenuated vaccine so it should not be given to immunocompromised individuals. After vaccination, if no papule develops no need to repeat or to do the Mantoux skin test.

Oral Polio Vaccine (OPV) (Sabin):

Figure 2 Oral Polio Vaccine

Live attenuated vaccine containing the 3 Polio viruses 1, 2, 3. Given a 0 (zero) dose at birth in the form of 2 to 3 drops. Then at the ages of 6, 10, and 14 weeks, simultaneously with other vaccines (Figure 2). Not to be given to immunodeficient individuals. Its advantages are that it is cheap and easy to administer. As it is secreted in the stools, this will increase herd immunity. Very rarely causes paralytic polio.

Inactivated Polio Vaccine (IPV)(Salk)

It is a killed vaccine containing 3 Polio viruses: 1, 2, 3 (Figure 3).

Given IM injection in the anterolateral aspect of the thigh.

Dose: 0.5 ml at the age of 10, 14 weeks, simultaneously with other vaccines. There is no risk of paralysis, but it is expensive and does not promote herd immunity.

Figure 3: Inactivated Polio Vaccine (IPV)

Rota Virus Vaccine:

Live attenuated bovine rotavirus (Figure 4).

It is given orally, 1.5 ml at 6 and 10 weeks. It should not be given after 14 weeks

Figure 4 Rota Virus Vaccine

Live attenuated bovine Rota virus.

It is given orally 1.50 ml in each dose at 6 and 10 weeks. should not be given after 14 weeks.

Figure 4 Rota Virus vaccine

Penta-Valet Vaccine

It is a combination of 5 antigens in one vial (Diphtheria, Pertussis, Tetanus, Hepatitis B, Haemophilus influenzae (HIB)(Figure 5))

Given IM injection in the anterolateral aspect of the thigh, a dose of 0.5 ml at 6, 10, and 14 weeks simultaneously with other vaccines.

There are two types of Pertussis vaccine. Whole cell Pertussis vaccine (wP), which is used in Sudan, is cheap but with some side effects, e.g., pain, fever and convulsions. The other type is the acellular Pertussis vaccine (aP), which has minimal side effects, but is expensive.

Figure 5 Penta-valent vaccine

Pneumococcal Conjugate Vaccine (PCV 13)

It is a polysaccharide protein conjugate, protects against 13 serotypes (Figure 6). It has a higher immune response. Administered IM injection 0.5 ml in the anterolateral upper thigh at 6, 10, 14 weeks simultaneously with other vaccines. Particularly important for immunodeficient individuals, i.e. Sickle cell disease, Asplenia, HIV.

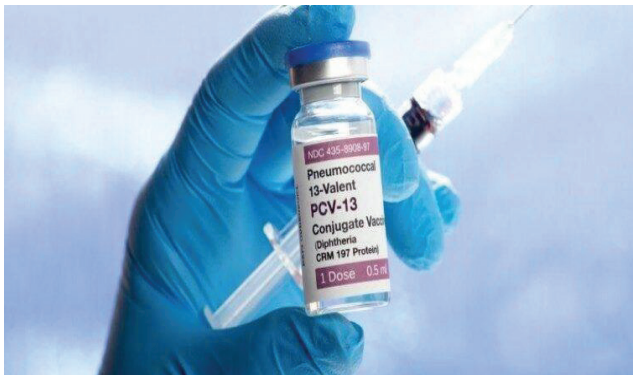

Figure 6 Pneumococcal conjugate vaccine (PCV 13)

Measles Vaccine

Live attenuated vaccine (Figure 7). Given I.M injection of 0.5 ml in the anterolateral aspect of the thigh at 9 months. Successful immunisation gives long-term immunity.

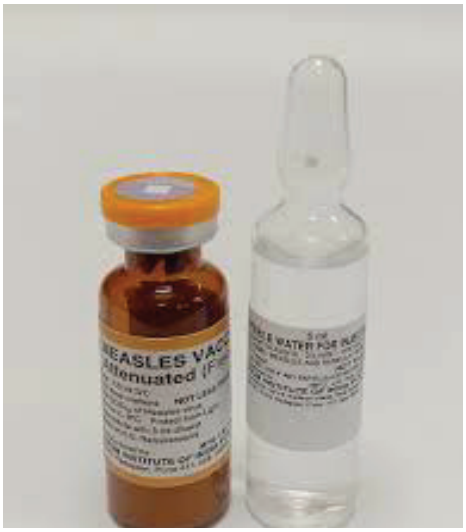

Figure 7 Measles vaccine

Meningococcal Vaccine

It is a polysaccharide serotype A (Figure 8). Given I.M injection at the anterolateral aspect of the thigh at 9 months. Immunity lasts for 2 to 3 years.

Figure 8 Meningococcal vaccine

Yellow Fever Vaccine

Live attenuated vaccine (Figure 9), given as a subcutaneous (SC) injection at the age of 9 months. Should not be administered in pregnancy.

Figure 9 Yellow fever vaccine

Tetanus Toxoid (TT)

Inactivated tetanus toxoid (Figure 10) is stable at 37 °C. Administered to females of childbearing age, a total of five doses should be given, each as an IM injection of 0.5 mL. It prevents neonatal tetanus.

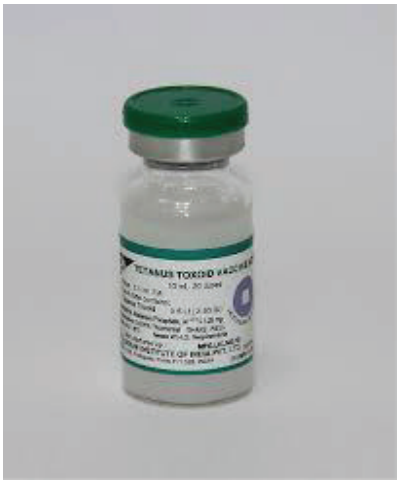

Figure 10 Tetanus Toxoid vaccine (TT)

Vaccine Storage and Delivery (Cold Chain)

Most vaccines must be preserved at a temperature of 2 to 8 °C.

Sudan is a vast country, and most of the population lives in rural areas, which is further complicated by high temperatures and limited financial resources. All of these factors make it a huge challenge to deliver a valid vaccine under these circumstances. The cold chain is the backbone of a successful vaccination program. It needs a lot of financial support, trained personnel and logistics such as transport, electric generators, and deep freezers. No Cold chain, no vaccine (Figure 11).

Vaccine delivery needs fixed or mobile stations, efficient cars equipped with deep freezers, ice-packed bottles, tight cold boxes, vaccine monitors, and auto-disposable syringes (Figures 12,13,14,15).

In each vaccine vial, there is a sensitive temperature label square with a white circle inside. It works as a temperature monitor; if the colour of the circle changes to deep blue, it means that the vaccine is not valid and may be discarded.

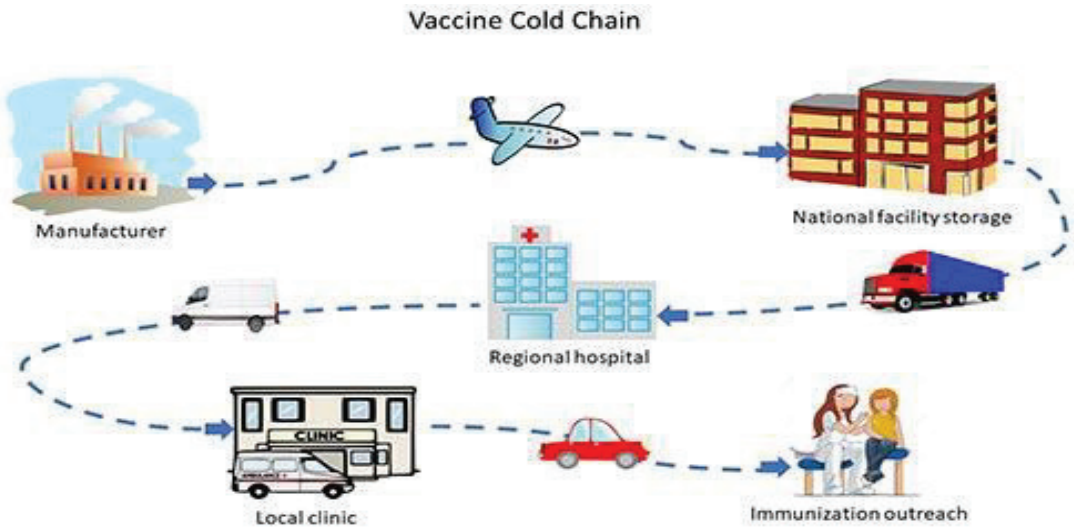

Figure 11 Cold Chain, storage and delivery)

Figure 12

Figure 13 Vaccine delivery with cold boxes

Figure 14 Vaccine box with temperature monitor

Figure 15 Vaccination check

Vaccine safety

All available vaccines are safe when given to preterm or low birthweight babies.

Malnourished children can receive vaccination safely and can develop adequate immune responses.

Breastfeeding does not affect orally administered vaccines.

Immunodeficient individuals should not receive live attenuated viral or bacterial vaccines.

Missed Doses and Defaulters

The immunologic response will not be affected if the interval between vaccination doses exceeds the recommended schedule. In children who missed vaccination doses, they should complete the missed doses; no need to restart the immunisation series or give additional doses.

Complications

Possible local complications from IM injections include fever, red induration and tenderness, loud crying, cellulitis, lymphadenitis and abscess formation.

Contraindications

Vaccination personnel should consider the benefits and the risks of the vaccine which is going to be administered.

Mild illnesses with no fever are not a contraindication for vaccination, such as the flu and cough. Children with cerebral palsy, Down syndrome, family history of epilepsy can receive vaccination.

If the child developed a severe reaction or anaphylaxis following a vaccination, the next dose of this vaccine should not be given.

vaccine	Birth	6 weeks	10 weeks	14 weeks	9 month
BCG	√				
OPV	√	√	√	√	
PENTA		√	√	√	
PCV		√	√	√	
ROTA		√	√		
IPV		√		√	
MEASLES					√
MENINGO					√
YELLOW F.					√

Figure 16: Sudan Immunisation schedule

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Chapter 2: Infectious Diseases.

Exanthemata's Illnesses

Measles

Measles is highly contagious; widespread vaccination has reduced endemic transmission significantly. In developing countries, Measles remains a major cause of morbidity and mortality in children.

Aetiology

The measles virus is a negative-sense single-stranded, lipid-encapsulated RNA virus in the family Paramyxoviridae and genus Morbillivirus. Other members of the genus Morbillivirus affect a variety of mammals, but humans are the only host of the measles virus.

Epidemiology

The measles vaccine has changed the epidemiology of measles dramatically. Once worldwide in distribution, endemic transmission of measles has been interrupted in many countries where there is widespread vaccine coverage. Historically, measles caused universal infection in childhood, particularly in developing countries, where geopolitical, environmental, and climate catastrophes, pandemics, wars, and famine have a significant negative impact on immunisation coverage. This renders children vulnerable to epidemics of most childhood vaccination-protected infections. Children are usually protected by maternal antibodies for the first six months of life.

The portal of entry of the measles virus is through the respiratory tract or conjunctivae following contact with large droplets or small-droplet aerosols in which the virus is suspended. Individuals are infectious from 3 days before to up to 4to6 days after the onset of rash.

Pathology

Measles infection causes necrosis of the respiratory tract epithelium and an accompanying lymphocytic infiltrate. Measles produces a small-vessel vasculitis on the skin and on the oral mucous membranes. With the formation of epidermal syncytial giant cells.

Pathogenesis

Measles infection has four phases:

incubation period, prodromal illness, exanthematous phase, and recovery. During incubation, the measles virus migrates to the regional lymph nodes. A primary viremia ensues. that disseminates the virus to the reticuloendothelial system. A secondary viremia spreads the virus to the body surfaces. With the onset of the rash, antibody production begins, and viral replication and symptoms begin to subside. The measles virus also infects CD4+ T cells, resulting in suppression of the Th1 immune response

Clinical Manifestations

Measles is a serious infection characterised by high fever, an enanthem, cough, coryza, conjunctivitis, and a prominent exanthema (Figure 17). After an incubation period of 8 to 12 days, the prodromal phase begins with a mild fever followed by the onset of conjunctivitis with photophobia, coryza, a prominent cough, and increasing fever.

Koplik's spots (**Error! Reference source not found.**) represent the enanthem and are the pathognomonic sign of measles, appearing 1 to 4 days before the onset of the rash. They first appear as discrete red lesions with bluish-white spots in the centre on the inner aspects of the cheeks at the level of the premolars. They may spread to involve the lips, hard palate, and gingiva. Kolpik spots have been reported in the great majority. Symptoms increase in intensity for 2 to 4 days until the first day of the rash. The rash begins on the forehead around the hairline, behind the ears, and on the upper neck as a red maculopapular eruption. It then spreads downward to the trunk and extremities, reaching the palms and soles in up to 50% of cases. The exanthem frequently becomes confluent on the face and upper trunk (Figure 19). With the onset of the rash, symptoms begin to subside. The rash fades over about 7 days in the same progression as it evolved, often leaving a fine desquamation of skin in its wake. Of the major symptoms of measles, the cough lasts the longest, often up to 10 days. In more severe cases, generalised lymphadenopathy may be present, with cervical and occipital lymph nodes especially prominent.

Complications

Complications of measles are largely attributable to the pathogenic effects of the virus on the respiratory tract and immune system. Several factors make complications more likely. Morbidity and mortality from measles are greatest in individuals younger than 5 years of age. In resource-poor countries, higher case fatality rates have been associated with crowding, severe malnutrition in children results in a suboptimal immune response and higher morbidity and mortality with measles infection. Low serum retinol levels in children with measles are associated with higher measles morbidity and mortality in developing countries and lead to
blindness due to Vitamin A deficiency (Figure 20).

Measles infection in immunocompromised persons is associated with increased morbidity and mortality. Pneumonia is the most common cause of death in measles. It may manifest as giant cell pneumonia caused directly by the viral infection or as a superimposed bacterial infection. Measles infection is known to suppress skin test responsiveness to purified tuberculin antigen. There may be a higher rate of activation of pulmonary tuberculosis in individuals.

Diarrhoea and vomiting are common symptoms associated with acute measles. Dehydration is a common consequence. Appendicitis or abdominal pain may occur from obstruction of the appendiceal lumen by lymphoid hyperplasia. Febrile seizures occur in<3%children with measles. Encephalitis following measles is a long-associated complication, often with an unfavourable outcome. the second encephalitis is a postinfectious, subacute, immunologically mediated process, and the third type of encephalitis is subacute sclerosing panencephalitis. (SSPE) delayed chronic complication of measles with a delayed onset and an outcome that is nearly always fatal. It appears to result from a persistent infection with an altered measles virus that is harboured intracellularly in the central nervous system for several years. After 7 to 10 years, the virus apparently regains virulence and attacks the cells in the central nervous system. This “slow virus infection” results in inflammation and cell death, leading to an inexorable neurodegenerative process. demyelinated disease with a nearly always fatal outcome.

A severe form of measles rarely seen nowadays is haemorrhagic measles or black measles. It manifested as a haemorrhagic skin eruption and was often fatal. Keratitis, appearing as multiple punctate epithelial foci, resolved with recovery from the infection. Myocarditis is a rare complication of measles.

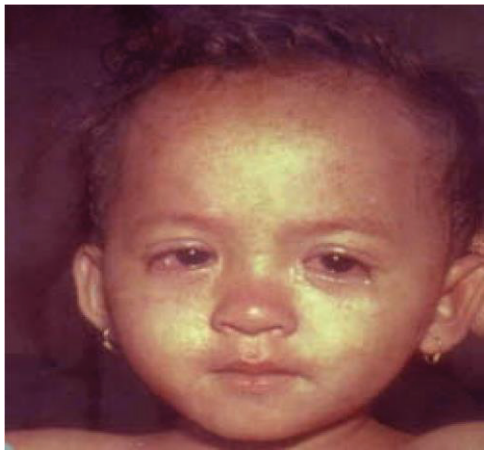

Figure 17

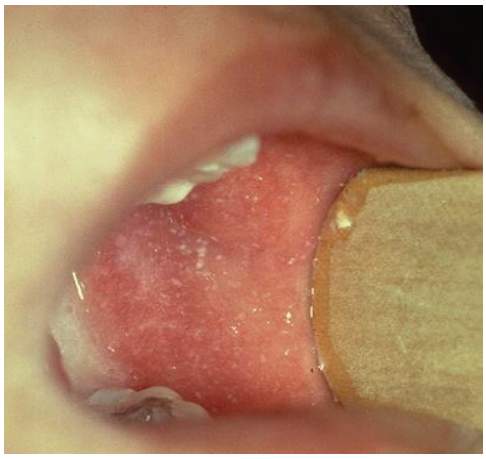

Figure 18

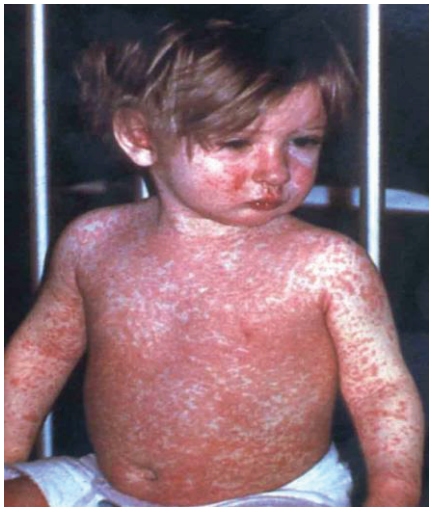

Figure 19

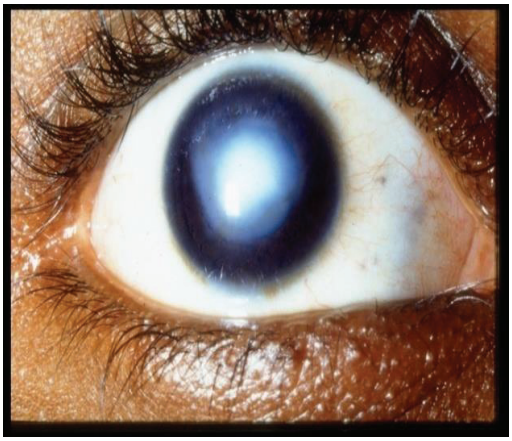

Figure 20

Diagnosis and Laboratory Findings

The diagnosis of measles is almost always based on clinical and epidemiologic findings. Laboratory findings in the acute phase include a reduction in the total white blood cell count, with lymphocytes decreased more than neutrophils. However, absolute neutropenia has been known to occur. In measles not complicated by bacterial infection, the erythrocyte sedimentation rate and C-reactive protein level are usually normal. Isolation of the measles virus from blood, urine, or respiratory secretions can be accomplished by culture. Molecular detection by polymerase chain reaction (PCR), Serologic confirmation is most conveniently made by identification Ig M antibody in serum.

Differential Diagnosis

Typical measles is unlikely to be confused with other illnesses, especially if Koplik spots, pathognomonic, are observed. Measles in the later stages or modified or atypical infections may be confused with some other exanthemata's immune-mediated illnesses and infections, including Rubella, Adenovirus infection, Enterovirus infection, and Epstein-Barr virus infection. Exanthem subitum (in infants) and Erythema Infectiosum (in older children) may also be confused with measles. Mycoplasma pneumoniae and group A Streptococcus may also produce rashes similar to those of measles. Kawasaki syndrome can cause many of the same findings as measles, but lacks the discrete intraoral lesions of Koplik spots and a severe prodromal cough, and typically leads to elevations of neutrophils and acute-phase reactants. In addition, the characteristic thrombocytosis of Kawasaki syndrome is absent in measles. Drug eruption can mimic measles.

Management

Management of measles is supportive because there is no specific antiviral therapy approved for the treatment of measles. however, Ribavrin may be given to immunocompromised children. Maintenance of hydration, oxygenation, and comfort is the goal of therapy. Antipyretics for comfort and fever control are useful. For patients with respiratory tract involvement, airway humidification and supplemental oxygen may be of benefit. Respiratory failure from croup or pneumonia may require ventilatory support. Oral rehydration is effective in most cases, but severe dehydration may require intravenous therapy. Prophylactic antimicrobial therapy to prevent bacterial infection is not indicated.

Vitamin A

Vitamin A deficiency in children in resource-poor countries has long been known to be associated with increased mortality from a variety of infectious diseases, including measles. WHO and the CDC recommend that vitamin A be administered to all children with acute measles, even in countries where measles is not usually severe. Vitamin A should be administered once daily for 2 days at doses of 200,000 IU for children 12 months of age or older;100,000 IU for infants 6 to 11 months of age; and 50,000 IU for infants younger than 6 months of age.

Prevention

Patients shed measles virus from 7 days after exposure to 4 to 6 days after the onset of rash. In hospitals, standard and airborne precautions should be observed for this period.

Postexposure Prophylaxis

Susceptible individuals exposed to measles may be protected from infection either by vaccine administration or with immunoglobulin. The vaccine is effective in preventing or modifying measles if given within 72 hours of exposure. Ig may be given up to 6 days after exposure to prevent or modify infection.

Immunocompetent children should receive 0.5 ml/kg intramuscularly. For severely immunocompromised children, particularly infants under 6 months, and pregnant women lacking measles immunity, administer intravenous immunoglobulin.

(IGIV) The recommended dose is 400 mg/kg.

Rubella

Rubella (German measles or 3-day measles) is a mild, often exanthematous disease of childhood that is typically more severe and associated with more complications in adults. Its major clinical significance is transplacental infection and foetal damage as part of the Congenital Rubella Syndrome (CRS).

Aetiology

Rubella virus is a member of the family Togaviridae and is the only species of the genus Rubivirus. It is a positive-sense single-stranded RNA virus. The virus is sensitive to heat, ultraviolet light, and extremes of pH but is relatively stable at cold temperatures. Humans are the only known reservoir.

Epidemiology

Rubella is found worldwide and circulates predominantly in late winter and early spring. There has been a considerable decline in congenital rubella syndrome since the introduction of the rubella vaccine.

Pathogenesis

The viral mechanisms for cell injury and death in postnatal or congenital rubella are not well delineated. The main mechanisms of transmission are respiratory for postnatal infection and transplacental in CRS (congenital rubella syndrome). days, with a range from 12 to 23 days. After infection, the virus replicates in the respiratory epithelium and then spreads to regional lymph nodes.17 days after infection. Viral shedding from the nasopharynx begins approximately 10 days after infection and may be detected up to 2 weeks. Congenital infection occurs during maternal viremia. The first trimester carries a high risk of foetal infection.

The most distinctive feature of congenital rubella is chronicity. Once the foetus is infected early in gestation, the virus persists in foetal tissue until well beyond delivery. Persistence suggests the possibility of ongoing tissue damage and reactivation, most notably in the brain.

Clinical Manifestations

Postnatal infection with rubella is typically a mild disease not easily discernible from other viral infections, especially in children. After an incubation period of 12 to 23 days, a prodrome consisting of low-grade fever, sore throat, red eyes with or without eye pain, headache, malaise, anorexia, and lymphadenopathy begins. Suboccipital, postauricular, and anterior cervical lymph nodes are most prominent. In children, the first manifestation of rubella is usually the rash, which is variable and not distinctive, often more prominent with heat. It begins on the face and neck as small, (Figure 21) irregular pink macules that coalesce, and it spreads centrifugally to involve the trunk and extremities, where it tends to occur as discrete macules (Figure 22).

About the time of onset of the rash, examination of the oropharynx may reveal tiny, rose-coloured lesions (Forchheimer spots) or petechial haemorrhages on the soft

palate. The rash fades from the face as it extends to the rest of the body, so that the whole body may not be involved at any one time. The duration of the rash is generally 3 days, and it usually resolves without desquamation. Subclinical infections are common, and 25–40% of children may not have a rash. Teenagers and adults tend to be more symptomatic and have systemic manifestations, with up to 70% of females demonstrating arthralgia and arthritis.

Figure 21

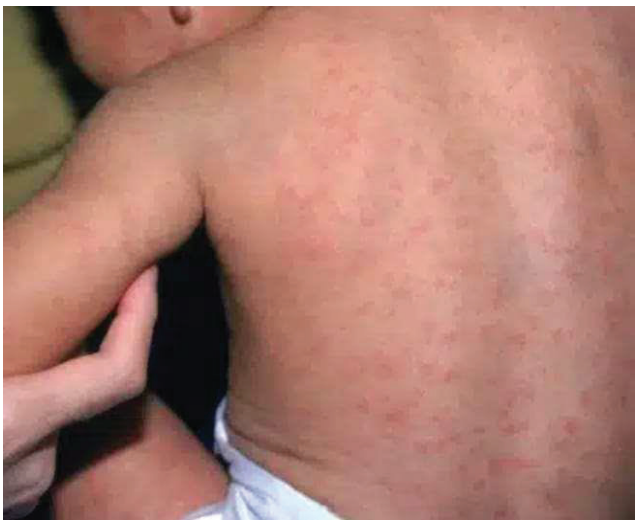

Figure 22

Laboratory Findings

Leukopenia, neutropenia, and mild thrombocytopenia have been described during postnatal rubella.

Diagnosis

A specific diagnosis of rubella is important for epidemiologic reasons, for the diagnosis of infection in pregnant women, and for the confirmation of the diagnosis of congenital rubella. The most common diagnostic test is rubella immunoglobulin (Ig) M enzyme immunosorbent assay, which is typically present ~4 days after the appearance of the rash. Such patients, an IgM capture assay, reverse transcriptase polymerase chain reaction

(PCR) test or viral culture should be performed for confirmation.

Differential Diagnoses

Rubella may manifest as distinctive features suggesting the diagnosis. It is frequently confused with other infections because it is uncommon, is similar to other viral exanthemata's diseases, and demonstrates variability in the presence of typical findings. In severe cases, it may resemble measles. The absence of Koplik spots, a severe prodrome, and a shorter course allow for differentiation from measles. Other diseases frequently confused with Rubella include infections caused by Adenoviruses, Parvovirus B19 (Erythema Infectiosum), Epstein-Barr virus, Enteroviruses, Roseola, and Mycoplasma pneumoniae.

Complications

Complications following postnatal infection with rubella are infrequent and generally not life-threatening. Postinfectious thrombocytopenia is frequently among children. It manifests about 2 weeks after the onset of the rash as petechiae, epistaxis, gastrointestinal bleeding, and haematuria, and is usually self-limited.

Arthritis following rubella occurs more commonly among adults, especially women. It begins within one week of the onset of the exanthema and classically involves the small joints of the hands. It is self-limited and resolves without sequelae. Encephalitis is the most serious complication of postnatal rubella, but it is extremely rare.

Treatment and Supportive Care

There is no specific treatment available for either acquired rubella or CRS.

Postnatal rubella is generally a mild illness that requires no care beyond antipyretics and analgesics. Intravenous immunoglobulin or corticosteroids can be considered for severe, unremitting thrombocytopenia

Prognosis

Rubella postnatal infection has an excellent prognosis.

Prevention

Patients with postnatal infection should be isolated from susceptible individuals for 7 days after the onset of the rash. Standard plus droplet precautions is recommended for hospitalised patients. Children with CRS may excrete the virus in respiratory secretions up to 1 year of age, so contact precautions should be maintained for them until 1 year of age to susceptible pregnant women.

Vaccination

usually administered in combination with measles and mumps (MMR) two-dose regimen according to the national vaccination schedule.12 to15 months and 4 to 6 years of age. Vaccines should not be administered to severely immunocompromised patients and be administered during pregnancy.

Scarlet Fever

Aetiology

This is caused by an infection with pyrogenic exotoxin erythrogenic toxin-producing GAS. Scarlet fever is group A streptococcal (GAS) pharyngitis associated with a characteristic rash in individuals who do not have antitoxin antibodies.

Epidemiology

It is now encountered less often and is less virulent than in the past, but the incidence is cyclic, depending on the prevalence of toxin-producing strains and the immune status of the population. The modes of transmission, age distribution, and other epidemiologic features are otherwise similar to those for GAS pharyngitis.

Clinical Features and Diagnosis

The scarlet fever rash appears within 24 to 48 hours after the onset of symptoms, although it may appear with the first signs of illness (figure 23)). It often begins around the neck and spreads over the trunk and extremities.

The rash is a diffuse, finely papular, erythematous eruption producing bright-red discolouration of the skin, which blanches on pressure. It is often accentuated in the creases of the elbows, axillae, and groin. The skin has a goose-pimple appearance and feels rough (Figure 24).

The cheeks are often erythematous with perioral pallor. After 3 to 4 days, the rash begins to fade and is followed by desquamation, initially on the face, progressing caudally, and often resembling mild sunburn. Occasionally, sheet-like desquamation may occur around the free margins of the fingernails, the palms, and the soles. Examination of the pharynx of a patient with scarlet fever reveals essentially the same findings as with GAS pharyngitis. In addition, the tongue is usually coated, and the papillae are swollen. After desquamation, the reddened papillae are prominent, giving the tongue a strawberry appearance (Figure 25).

Differential Diagnosis

Typical scarlet fever is not difficult to diagnose; the milder form with equivocal pharyngeal findings can be confused with viral exanthems, Kawasaki disease, and drug eruptions. Identification of GAS in the pharynx confirms the diagnosis.

Treatment.

Penicillin is given for 10 10-day course at least to eradicate GAS and guard against rheumatic fever and poststreptococcal nephritis.

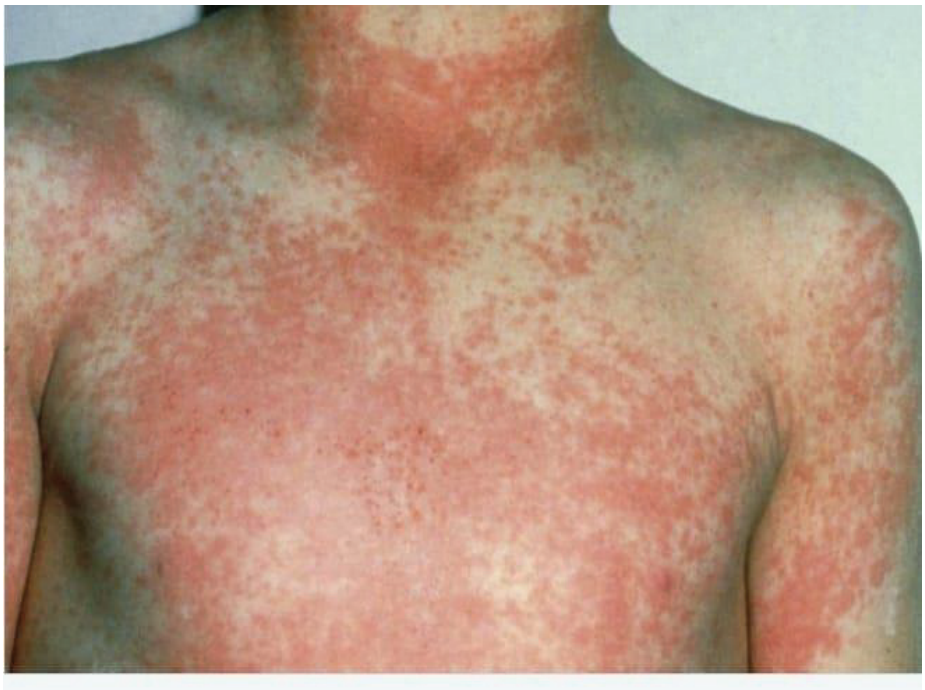

Figure 23

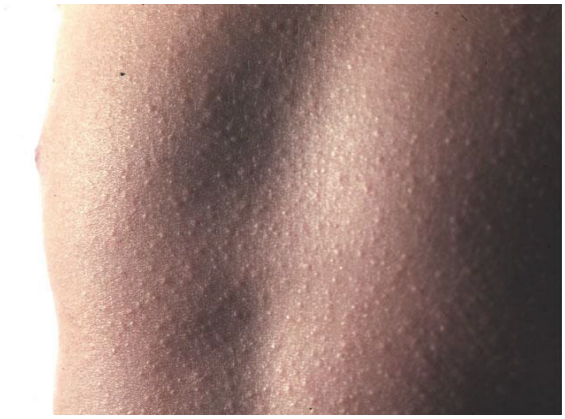

Figure 24

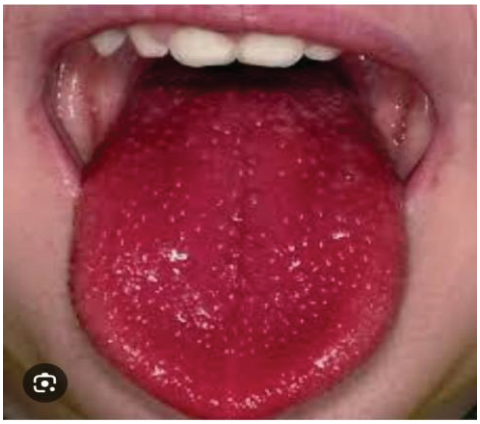

Figure 25

Kawasaki Disease

Kawasaki disease (KD) is a systemic vasculitis. Although uncommon, it is important to establish the diagnosis early because artery damage may cause morbidity and occasional mortality.

Aetiology

No cause has been found. KD mainly affects children of 6 months to 4 years of age, boys are more affected than girls, and it is not contagious. It is a rare disease except in Japan, where the incidence is relatively higher.

Clinical Features

Usually present with fever, like most common childhood exanthemata's febrile illness, high fever difficult to control, miserable and irritable, skin rash, mucocutaneous involvement, cervical lymphadenopathy, no purulent conjunctivitis, followed by skin desquamation after about two weeks (Figure 26 A-E). Classical clinical features may not present in infants less than six months old, so you need to have a high index of suspicion for early diagnosis of KD to guard against the development of coronary artery complications.

Laboratory And Radiology Findings

There is no diagnostic test for KD, but patients usually have characteristic laboratory findings. The leukocyte count is often elevated, with a predominance of neutrophils and immature forms. Normocytic, normochromic anaemia is common. The platelet count is generally normal in the first week of illness and rapidly increases by the second to third week of illness, sometimes exceeding 1 million/mm3. An elevated ESR or CRP value is universally present in the acute phase of illness. The ESR may remain elevated for weeks, in part from the effect of IVIG. Sterile pyuria, mild elevations of the hepatic transaminases, hyperbilirubinemia, and cerebrospinal fluid pleocytosis may also be present. KD is unlikely if the ESR, CRP, and platelet counts are normal after 7 days of fever. Echocardiography should be performed at diagnosis and again after 12 weeks of illness. If the results are normal, a repeat study should be performed 6 to 8 weeks after the onset of illness. If the results of either of the initial studies are abnormal or the patient has recurrent fever or symptoms, more frequent echocardiography or other studies may be necessary. In patients in whom a coronary artery aneurysm has not developed in the first 4 to 6 Weeks of illness, the patient may be discharged from cardiology care, although follow-up through 12 months may be considered.

D E

Differential Diagnosis

Adenovirus, measles, and scarlet fever lead the list of common childhood infections that mimic KD. Children with adenovirus typically have exudative pharyngitis and exudative conjunctivitis, allowing differentiation from KD. A common clinical

problem is the differentiation of scarlet fever from KD in a child who is a group A streptococcal carrier. Patients with scarlet fever typically have a rapid clinical response to appropriate antibiotic therapy. Such treatment for 24 -48 hours with clinical reassessment generally clarifies the diagnosis. Furthermore, ocular findings are quite rare in group A streptococcal pharyngitis and may assist in the diagnosis of KD. Features of measles that distinguish it from KD include exudative conjunctivitis, Koplik's spots, rash that begins on the face and hairline and behind the ears, and leukopenia. Cervical lymphadenitis can be the initial diagnosis in children who are ultimately recognised to have KD. Drug hypersensitivity reactions, including Stevens-Johnson syndrome, share some characteristics with KD. Drug reaction features such as the presence of oral ulcerations and a normal or minimally elevated ESR are not seen in KD. Systemic juvenile idiopathic arthritis (SJIA) is also characterised by fever and rash, but physical findings include diffuse lymphadenopathy and hepatosplenomegaly. Arthritis may or may not be present in the initial illness. Fevers typically show a quotidian or double quotidian pattern, in contrast to the unremitting fevers seen in KD.

Diagnosis

Diagnosis of Kawasaki disease must be made within 10 days of the onset of fever to guard against cardiac complications. The diagnosis is clinically based on the clinical criteria. Presence of fever for at least 5 days with at least four of the five following clinical features:

1. Bilateral bulbar conjunctival injection without exudate.
2. Erythema and cracking of lips, strawberry tongue, and/or erythema of oral and pharyngeal mucosa.
3. Cervical lymphadenopathy (≥1.5 cm diameter), usually unilateral.
4. Rash: maculopapular, diffuse erythroderma, or erythema multiforme-like.
5. Erythema and oedema of the hands and feet in the acute phase and/or desquamation around the nails in the subacute phase.

Complications

Acute KD is complicated in 1–2% of patients by Macrophage Activation Syndrome (MAS), a syndrome of life-threatening hyperinflammation on the spectrum of hemophagocytic lympho-histiocytosis. These patients may present with Hyperferritinemia, coagulopathy, thrombocytopenia, and shock, warranting more aggressive immunosuppressive therapy. In all phases of KD, patients with giant coronary aneurysms may experience myocardial infarction, angina, and sudden death due to thrombosis. For this reason, aspirin is continued indefinitely in children with coronary aneurysms.

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Treatment

Acute stage:

Intravenous immunoglobulin 2 g/kg over 10 to 12 hrs and Aspirin

30 to 50 mg/kg/day divided every 6 hr orally until the patient is afebrile for at least 48 hr.

High risk* for coronary artery abnormalities:(age less than 6 months, presence of coronary artery abnormalities). Intravenous immune globulin and aspirin as above, plus methylprednisolone 2 mg/kg/d IV divided q12hr until a febrile, then prednisolone orally until CRP normalised, then taper over 2 to 3 weeks.

Convalescent stage:

Aspirin 3 to 5 mg/kg once daily orally until 6 weeks after illness onset, if normal coronary findings throughout the course, otherwise aspirin is given for life if any abnormal coronary findings.

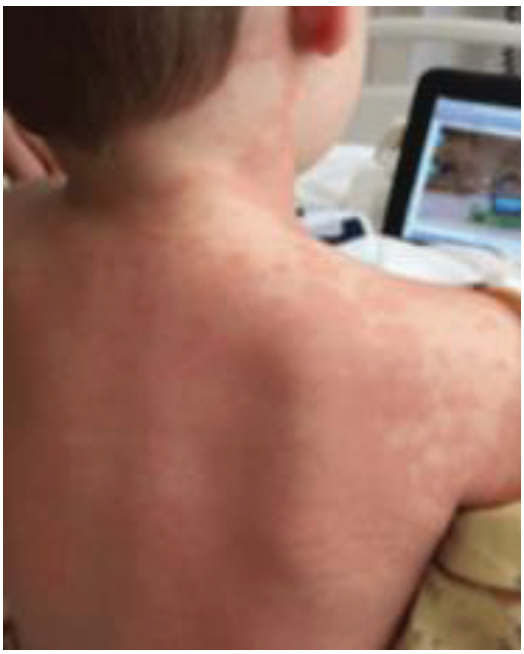

Figure 26 A

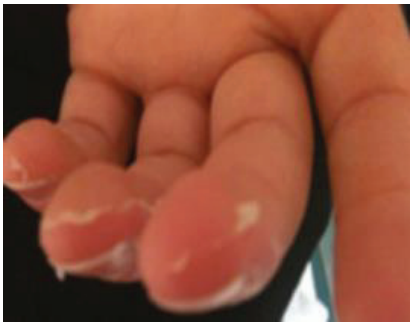

Figure 26 B

Figure 26 C

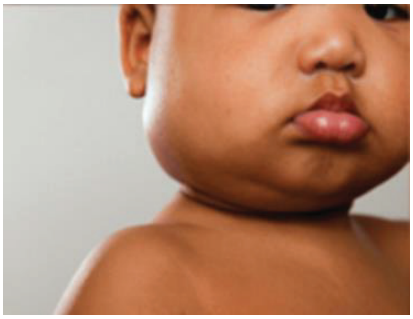

Figure 26 D

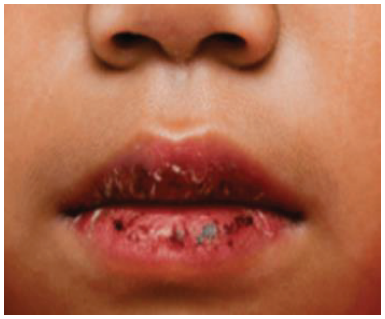

Figure 26 E

Roseolainfantum (exanthem subitum or sixth disease)

Aetiology

Human herpesvirus 6 (HHV-6A and HHV-6B) and human herpesvirus 7 (HHV-7) cause ubiquitous infection in infancy and early childhood. HHV-6B is responsible for the majority of cases of roseola infantum (exanthem subitum or sixth disease) and is associated with other diseases, including encephalitis, especially in immunocompromised hosts.

HHV-6 and HHV-7are the sole members of the Roseolovirus genus in the Betaherpesvirinae subfamily of human herpesviruses. Morphologically, within the nucleocapsid, both contain large, linear, double-stranded DNA Genomes.

Epidemiology

Primary infection with HHV-6 is acquired rapidly by essentially all children after the loss of maternal antibodies in the first few months of infancy, with 95% of children being infected by 2 years of age. The peak age of primary HHV-6 infection is 6 to9 months of life, with infections occurring sporadically and without seasonal predilection or contact with infected individuals.

Clinical Manifestations

Roseola infantum (exanthem subitum, or sixth disease) is an acute, self-limited disease of infancy and early childhood. It is characterised by the abrupt onset of high fever, which may be accompanied by fussiness. The fever usually resolves acutely after 72 hours (crisis) but may gradually fade over a day (lysis) coincident with the appearance of a faint pink or rose-coloured, nonpruritic, 2 to 3mm morbilliform rash on the trunk **(**Figure 27).

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The rash usually lasts 1to3 days but is often described as evanescent and may be visible only for hours, spreading from the trunk to the face and extremities. Because the rash is variable in appearance, location, and duration, it is not distinctive and may be missed. Associated other signs are few but can include mild injection of the pharynx, or tympanic membranes and enlarged suboccipital nodes. The mean duration of illness is 6 days.

Laboratory Findings

The most characteristic laboratory findings noted in children with primary HHV-6B infection are low total white blood cells (8,900/μL), lymphocytes (3,400/μL), and neutrophils (4,500/μL). Atypical lymphocytes have also been noted sporadically. And thrombocytopenia, as well.

Diagnosis

Although roseola is generally a benign self-limited disease, its diagnosis can exclude other, more serious disorders that cause fever and rash. A history of 3 days of high fever in an otherwise nontoxic 10-month-old infant with a blanching maculopapular rash on the trunk suggests a diagnosis of roseola. A specific diagnosis of HHV-6 is not usually necessary except in situations in which the manifestations of the infection are severe or unusual and might benefit from antiviral therapy. The diagnosis of primary infection with either HHV-6 or HHV-7 is confirmed by demonstrating the presence of actively replicating virus in the patient's blood sample, coupled with seroconversion.

Differential Diagnosis

Primary infection with either HHV-6 or HHV-7usually causes an undifferentiated febrile illness that may be very difficult to distinguish from other common viral infections of childhood. This difficulty also applies to the early stages of roseola, before the rash develops. Once the rash is present, roseola may be confused with other childhood exanthemata, especially measles and rubella. Children with Rubella often have a prodrome characterised by mild illness with low-grade fever, sore throat, arthralgia, and gastrointestinal complaints, unlike those with Roseola. Physical shows, suboccipital and posterior auricular lymph nodes are prominent before the rash of rubella is evident and persist during the exanthemata. Additionally, the rash of rubella usually begins on the face and spreads to the chest, like that in measles.

The associated symptoms of Measles virus infection include cough, coryza, and conjunctivitis, with high fever coincident with the development of rash, unlike in roseola. Roseola may also be confused with Scarlet fever, although the latter is rare in children younger than 2 years of age and causes a characteristic sandpaper-like rash concurrent with fever. Roseola may be confused with illnesses caused by enterovirus infections. Drug hypersensitivity reactions may also be difficult to distinguish from Roseola. Antibiotics are frequently prescribed for children with fever from roseola before the appearance of the rash. A child who then demonstrates rash after the resolution of fever may erroneously be labelled as being drug allergic

Complications

Convulsions are the most common complication of Roseola and are recognized in up to one-third of patients. Seizures are also the most common complication of children with documented primary HHV-6 infection, occurring in approximately 15%, with a peak age of 12 to 15 months.

Treatment

Supportive care is usually only what is needed for infants with Roseola. Parents should be advised to maintain hydration and may use antipyretics with the fever. Specific antiviral therapy is not recommended for routine cases of primary HHV-6 or HHV-7 infection.

Prognosis

It is generally a self-limited illness associated with complete recovery. Most children with primary infections recover uneventfully without sequelae.

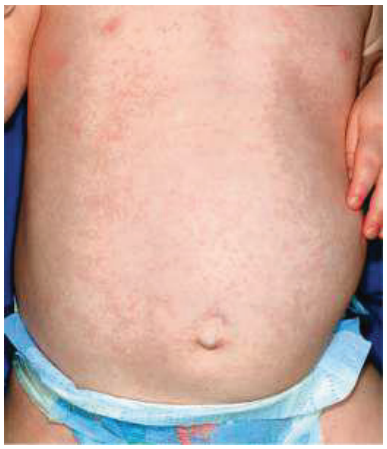

Figure 27

Erythema Infectiosum (Fifth Disease)

Aetiology

The most common manifestation of parvovirus B19V is erythema infectiosum, also known as fifth disease, which is a benign, self-limited exanthemata's illness of childhood.

Clinical Manifestation

The incubation period for Erythema infectiosum is 4 to 28 days (average:16 to17 days). The prodromal phase is mild and consists of low-grade fever in 15–30% of cases, headache, and symptoms of mild upper respiratory tract infection. The hallmark of erythema infectiosum is the characteristic rash, which occurs in three stages that are not always distinguishable.

The initial stage is an erythematous facial flushing, often described as a slapped cheek appearance (Figure 28)

The rash spreads rapidly or concurrently to the trunk and proximal extremities as a diffuse macular erythema in the second stage. Central clearing of macular lesions occurs promptly, giving the rash a lacy, reticulated appearance (Figure 29).

The rash tends to be more prominent on extensor surfaces, sparing the palms and soles. Affected children are afebrile and do not appear ill. Some have petechiae. Older children and adults often complain of mild pruritus. The rash resolves spontaneously without desquamation but tends to wax and wane over 1 to 3 weeks. It can recur with exposure to sunlight, heat, exercise, and stress.

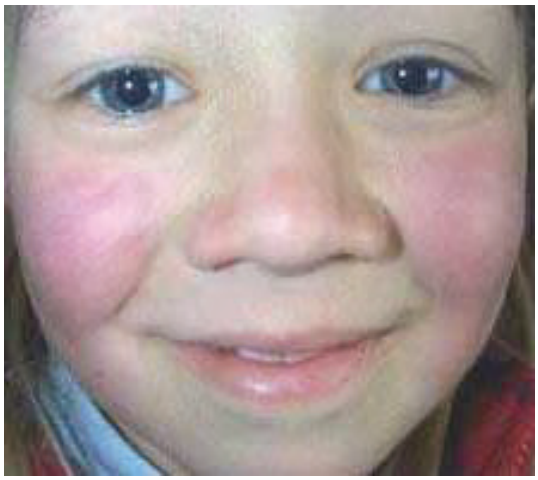

Figure 28

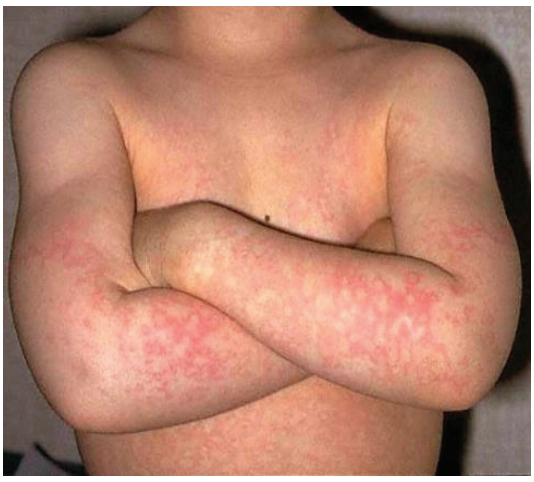

Figure 29

Hand-Foot-And-Mouth Disease

Aetiology

Hand-foot-and-mouth disease, one of the more distinctive rash syndromes, is most frequently caused by Coxsackie virus A16, sometimes in large outbreaks, and can also be caused by another enterovirus.

Clinical Manifestation

It is usually a mild illness, with or without low-grade fever. Maculopapular, vesicular, and/or pustular lesions may occur on the hands and fingers, feet, and buttocks and groin. Hand and foot lesions (Figure 30 A&B). are usually tender, 3 to 7 mm vesicles that resolve in about 1 week. When the mouth is involved, then oropharynx is inflamed and often contains scattered, painful vesicles on the tongue, buccal mucosa, posterior pharynx, palate, gingiva, and/or lips (Figure 31). These lesions may ulcerate. Buttock lesions do not usually progress to vesiculation. Management is symptomatic and supportive.

Herpangina

Herpangina is usually caused by Coxsackie A virus, characterised by a sudden onset of fever, sore throat, dysphagia, and painful lesions in the posterior pharynx. Temperatures range from normal to 41°C; fever tends to be higher in younger patients. Headache and backache may occur in older children, and vomiting and abdominal pain occur in 25% of cases. Characteristic lesions, present on the anterior tonsillar pillars, soft palate (Figure 32), uvula, tonsils, posterior pharyngeal wall, and, occasionally, the posterior buccal mucosa surfaces, are discrete 1to 2mm vesicles and ulcers that enlarge over 2- 3 days to 3- 4 mm and are surrounded by erythematous rings that vary in size up to 10 mm.

The remainder of the pharynx appears normal or minimally erythematous. Most cases are mild and have no complications. However, dehydration because of decreased oral intake may occur with more severe illness; meningitis can also sometimes occur. Fever generally lasts 1 to 4 days, and resolution of symptoms occurs in 3 to 7days. A variety of enteroviruses cause herpangina, including enterovirus A71, but Coxsackie A viruses are implicated most often.

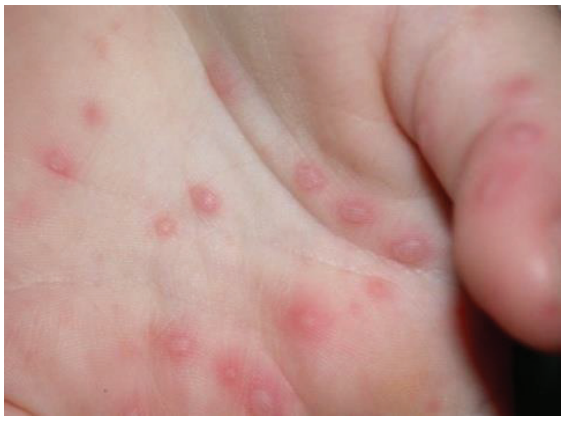

Figure 30 A

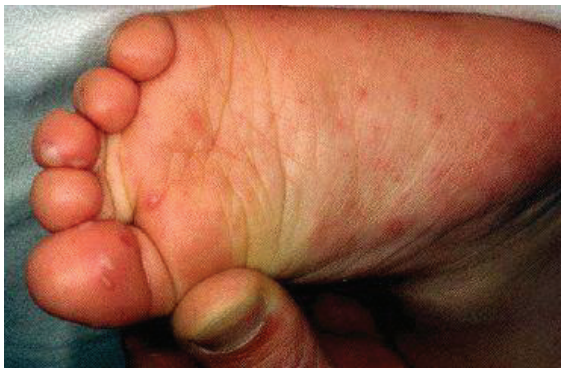

Figure 30 B

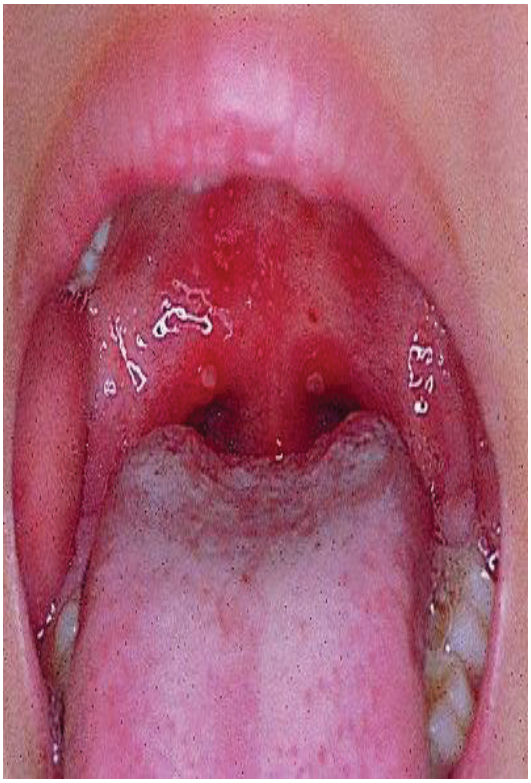

Figure 31

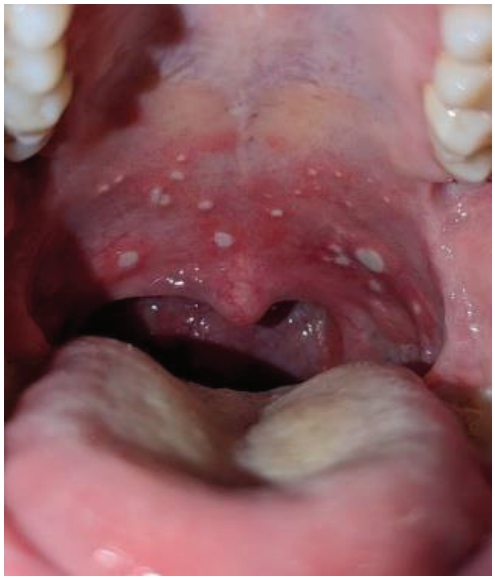

Figure 32

Varicella (Chicken Pox)

Aetiology

Varicella-zoster virus (VZV) causes primary, latent, and reactivation infections. The primary infection manifests as varicella (chickenpox) and results in the establishment of a lifelong latent infection of sensory ganglionic neurons. Reactivation of the latent infection causes herpes zoster (shingles). Although often a mild illness of childhood, varicella can cause substantial morbidity and mortality in otherwise healthy children.

Varicella predisposes to severe group A Streptococcus and Staphylococcus infections. Primary clinical disease can be prevented by immunisation with live-attenuated varicella vaccine; in special circumstances, VZV can be treated with antiviral drugs.

VZV is a neurotropic human herpesvirus with similarities to herpes simplex virus. VZV enveloped viruses contain double-stranded DNA genomes that encode 71 proteins, including proteins that are targets of cellular and humoral immunity.

Epidemiology

Before the introduction of the varicella vaccine in 1995, varicella was an almost universal communicable infection of childhood. Annual varicella epidemics occurred in winter and spring.

Most children were infected by 10 years of age. By contrast, in tropical areas, children acquire varicella at older ages and in young adults. Varicella is a more serious disease in young infants, adults, and immunocompromised persons. Persons with varicella may be contagious 24to 48 hours before the rash is evident and until vesicles are crusted, usually 4 to 7 days after onset of rash. Vaccination has made a great impact in the reduction of morbidity and mortality in countries where the varicella vaccine is given.

Herpes zoster is caused by the reactivation of latent VZV. It is not common in childhood and shows no seasonal variation in incidence. Zoster is not caused by exposure to a patient with varicella, but varicella is caused by exposure to Zoster in unimmunized persons.

Pathogenesis

Primary infection (varicella) results from inoculation of the virus onto the mucosa of the upper respiratory tract and tonsillar lymphoid tissue. During the early part of the 10 to 21-day incubation period, the virus replicates in the local lymphoid tissue and spreads to T lymphocytes, causing a viremia that delivers the virus to the skin, where innate immunity controls VZV replication for several days.

After innate immunity is overcome in the skin, widespread cutaneous lesions develop as the incubation period ends. Adaptive host immune responses, especially cellular immunity, limit viral replication and lead to recovery from infection.

Clinical Manifestations

Varicella is an acute febrile rash illness that is common in children. It has variable severity but is usually self-limited. It may be associated with severe complications, including bacterial superinfection, especially with staphylococci and group A streptococci, pneumonia, encephalitis, bleeding disorders, congenital infection, and life-threatening perinatal infection. Herpes zoster is not common in children and typically causes localised cutaneous symptoms, but may disseminate in immunocompromised patients and varicella in unvaccinated individuals.

The illness usually begins about 14 days after exposure, although the incubation period can range from 10 to 21days. Almost all exposed, susceptible persons experience a rash, although so mild in some cases that it may go unnoticed. Prodromal symptoms may be present, particularly in older children and adults. Fever, malaise, anorexia, headache, and occasionally mild abdominal pain may occur 24to 48 hours before the rash appears. Temperature elevation is usually 37.8–38.9°C but may be as high as 41.1°C; fever and other systemic symptoms usually resolve within 2to4 days after the onset of the rash.

Varicella lesions often appear first on the scalp, face, or trunk. The initial exanthem consists of intensely pruritic erythematous macules that evolve through the papular stage to form clear, fluid-filled vesicles. Clouding and umbilication of the lesions begin in 24to48 hours. While the initial lesions are crusting, new crops form on the trunk and then the extremities; the simultaneous presence of lesions in various stages of evolution is characteristic of varicella (Figure 33).

The distribution of the rash is predominantly central or centripetal, lesions involving the mucosa of the oropharynx and vagina and eyes are also common; The exanthem may be much more extensive in children with skin disorders, such as eczema. Hypopigmentation or hyperpigmentation of lesion sites persists for days to weeks in some children, but severe scarring is unusual unless they were secondarily infected. The differential diagnosis of varicella includes vesicular rashes caused by other infectious agents, such as Herpes simplex virus, Enterovirus, Monkey pox (mpox), Rickettsial pox, and Staphylococcus aureus; drug reactions and contact dermatitis. Severe varicella was the most common illness confused with smallpox before the eradication of smallpox.

Neonatal Varicella

Mortality is particularly high in neonates born to susceptible mothers who contract varicella around the time of delivery (Figure 34). Infants whose mother demonstrates varicella in the period from 5 days before delivery to 2 days afterwards are at high risk for severe varicella; they should receive human Varicella-Zoster Immunoglobulin (VZIG) as soon as possible.

Complications

The complications of VZV infection (varicella or zoster) are more common in immunocompromised patients. In the otherwise healthy child, asymptomatic transient varicella hepatitis is relatively common. Other complications of varicella, some of them rare, include acute cerebellar ataxia, encephalitis, and pneumonia

.

Bacterial Infections

Secondary bacterial infections of the skin, usually caused by **Group A Streptococcus** or **Staph aureus,** may occur in children with varicella. These range from impetigo to cellulitis, lymphadenitis, and subcutaneous abscesses. An early manifestation of secondary bacterial infection is erythema of the base of a new vesicle. Recrudescence of fever 3 to 4 days after the initial exanthema may also herald a secondary bacterial infection.

Encephalitis and Cerebellar Ataxia

Encephalitis and acute cerebellar ataxia (1 per 4,000 cases of varicella in unvaccinated children) are well-described neurologic complications of varicella; morbidity from central nervous system complications is highest among patients younger than five years and older than 20 years old.

Clinical recovery is typically rapid, occurring within 24 to 72 hours, and is usually complete.

Pneumonia

Varicella pneumonia (viral, due to VZV) is a severe complication that accounts for most the increased morbidity and mortality from varicella in adults and other high-risk populations, but viral pneumonia may also complicate varicella in young children.

Herpes Zoster (shingles)

Herpes zoster manifests as vesicular lesions clustered within one or, less commonly, two adjacent dermatomes (**Error! Reference source not found.**. In the elderly, herpes z oster typically begins with burning pain or itching followed by clusters of skin lesions in a dermatomal pattern. Almost half of the elderly with herpes zoster experience complications; the most frequent complication is postherpetic neuralgia, a painful condition that affects the nerves despite resolution of the skin lesion. Unlike herpes zoster in adults, zoster in children is infrequently associated with localised pain, hyperesthesia, pruritus, low-grade fever, or complications. In children, the rash is mild, with new lesions appearing for a few days; symptoms of acute neuritis are minimal, and complete resolution usually occurs within 1 to 2 weeks. Unlike in adults, postherpetic neuralgia is unusual in children.

Diagnosis

Varicella and herpes zoster are usually diagnosed primarily by their clinical appearance. Laboratory evaluation has not been considered necessary for diagnosis or management. However, in exceptional situations, VZV can be identified quickly by PCR amplification testing (vesicular fluid, crusts).

Treatment

Antiviral treatment with acyclovir or valacyclovir modifies the course of both varicella and herpes zoster. Given the safety profile of acyclovir and valacyclovir, and their demonstrated efficacy in the treatment of varicella, treatment of all children, adolescents, and adults with varicella is acceptable. Oral therapy with acyclovir (20 mg/kg/dose; maximum: 800 mg/dose) given as four doses/day for 5 days, preferably within 24 hours of the onset of the exanthem.

There is less clinical benefit if treatment is initiated more than 72 hours after the onset of the exanthem. Intravenous therapy is indicated for severe disease and for varicella in immunocompromised patients. Intravenous acyclovir therapy (10 mg/kg or 500 mg/m^2 every 8 hours) (even if begun more than 72 hours after onset of rash) for 7 to 10 days.

Herpes Zoster

Antiviral drugs are effective for the treatment of herpes zoster. In healthy adults, reduce the duration of the illness but do not prevent the development of postherpetic neuralgia. In otherwise healthy children, herpes zoster is a less-severe disease, and postherpetic neuralgia usually does not occur. Therefore, treatment of uncomplicated herpes zoster in the child with an antiviral agent may not always be necessary; in contrast, herpes zoster in immunocompromised children can be severe, and disseminated disease may be life-threatening. should receive intravenous acyclovir (500 mg/m^2 or 10 mg/kg every 8 hours).

Postexposure Prophylaxis

Vaccine given to healthy children within 3 and up to 5 days after exposure (as soon as possible is preferred) is effective in preventing or modifying varicella. anti-VZV immune globulin as postexposure prophylaxis is recommended for immunocompromised children, pregnant women, and newborns who were exposed to varicella. In situations in which administration of VZIG is not possible, IVIG can be administered (400 mg/ kg as a single dose once within 10 days.

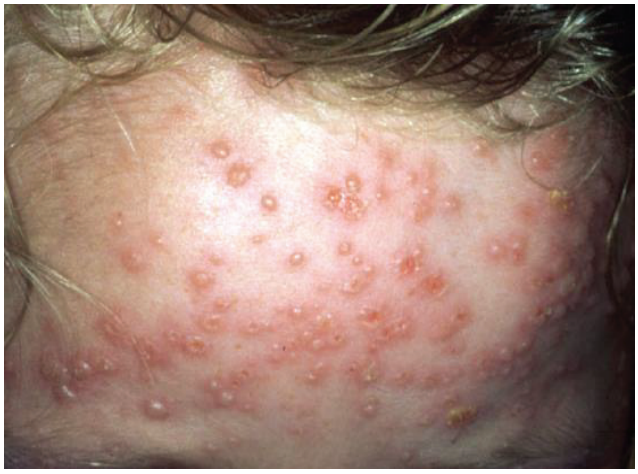

Figure 33

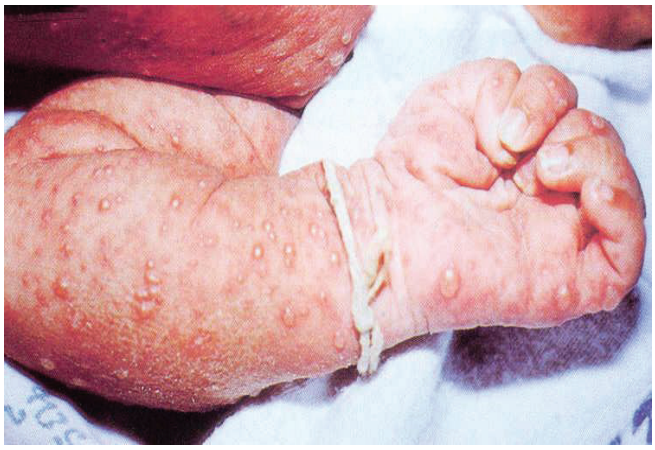

Figure 34

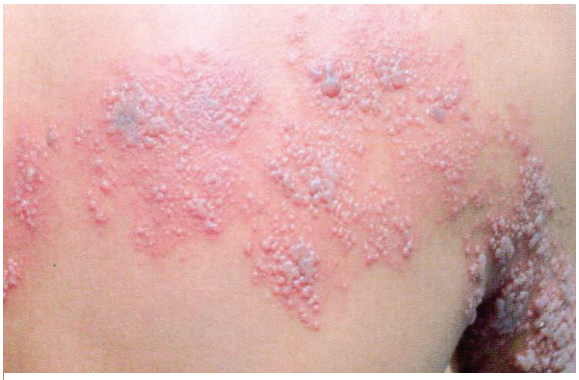

Figure 35

Mumps

Mumps is an acute self-limited infection that was once commonplace but is now uncommon in countries with widespread use of vaccination. It is characterised by fever, bilateral or unilateral parotid swelling and tenderness, and the frequent occurrence of meningoencephalitis and orchitis. Although infrequent in countries with extensive vaccination programs, mumps remains endemic in the rest of the world, warranting continued vaccine protection.

Aetiology

Mumps virus is in the family Paramyxoviridae and the genus Rubula virus. It is a negative-sense single-stranded nonsegmented RNA virus encapsulated in a lipoprotein envelope. Mumps virus exists as a single serotype with up to 12 known genotypes, and humans are the only natural host.

Epidemiology

In the pre-vaccine era, mumps occurred primarily in young children, 5 and 9 years. Mumps infection occurred more often in the winter and spring. Following the recommendation for routine use of the mumps vaccine, it fell dramatically in young children and shifted instead to older children, adolescents, and young adults. Mumps is spread from person to person by respiratory droplets. Virus appears in the saliva from up to 7 days before to as long as 7 days after the onset of parotid swelling. Viral shedding before the onset of symptoms and in asymptomatic infected individuals impairs efforts to contain the infection in susceptible populations. recommend an isolation period of 5 days after the onset of parotitis.

Clinical Manifestations

The incubation period for mumps ranges from 2 to 3 weeks. Mumps virus infection may result in a clinical presentation ranging from asymptomatic or nonspecific symptoms to the typical illness associated with parotitis with or without complications involving several body systems. The typical patient presents with a prodrome lasting 12 days consisting of fever, headache, vomiting, malaise, and myalgias. Parotitis follows and may be unilateral initially but becomes bilateral in approximately 70% of cases (Figure 36).

The parotid gland is tender, and parotitis may be preceded or accompanied by ear pain on the ipsilateral side. Ingestion of sour or acidic foods or liquids may enhance pain in the parotid area. As swelling progresses, the angle of the jaw is obscured, and the ear lobe may be lifted upward and outward. The opening of the parotid duct may be red and oedematous. The parotid swelling peaks in approximately 3 days and then gradually subsides over 7 days. Fever and the other systemic symptoms resolve in 3 to5 days. Submandibular salivary glands may also be involved or may be enlarged without parotid swelling.

Diagnosis

When Mumps was highly prevalent, the diagnosis could be made based on a history of exposure to mumps infection, an appropriate incubation period, and development of typical clinical findings. Confirmation of the presence of parotitis could be made with the demonstration of an elevated serum amylase value. Leukopenia with a relative lymphocytosis was a common finding. Currently, in highly immunised populations, patients with parotitis lasting longer than 2 days and of unknown cause, a specific diagnosis of Mumps should be confirmed or ruled out by virologic or serologic examination (viral culture and PCR, IgG)

Differential Diagnosis

Parotid swelling may be caused by many other infectious and non-infectious conditions, especially in sporadic cases. Viruses that cause parotitis include HIV, parainfluenza viruses, cytomegalovirus, Epstein-Barr virus, and enteroviruses. Purulent parotitis, usually caused by Staphylococcus aureus, is unilateral, extremely tender, associated with an elevated white blood cell count, and may involve purulent drainage from the parotid duct. Submandibular or anterior cervical adenitis from a variety of pathogens may also be confused with parotitis. Other non-infectious causes of parotid swelling include obstruction of the parotid duct, collagen vascular diseases, tumour, and drugs.

Complications

The most common complications of mumps are meningitis, with or without encephalitis, and gonadal (orchitis, oophoritis) involvement. Uncommon complications include myocarditis, nephritis, pancreatitis, and thrombocytopenia. Overall, complication rates in immunised individuals are lower than in unimmunized individuals.

Treatment

No specific antiviral therapy is available for mumps.

Management should be aimed at reducing the pain associated with meningitis or orchitis and maintaining adequate hydration. Antipyretics may be given for fever.

Prognosis

The outcome of mumps is nearly always excellent, even when the disease is complicated by encephalitis, although fatal cases from CNS involvement or myocarditis have been reported.

Prevention

Immunisation with the live mumps vaccine is the primary mode of prevention. It is given as part of the MMR.

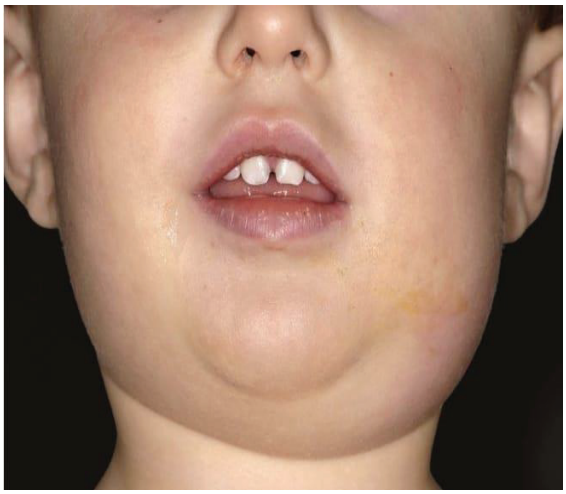

Figure 36

Pertussis

Pertussis is an acute respiratory tract infection; the term pertussis means "intense cough" and is preferable to whooping cough, because most infected individuals do not whoop.

Aetiology

Bordetella pertussis is the cause of epidemic pertussis and the usual cause of sporadic pertussis. Bordetella parapertussis is an occasional cause of sporadic pertussis that contributes significantly to total cases of pertussis. Protracted coughing (which in some cases can be paroxysmal) is attributable sporadically to Mycoplasma, or adenoviruses and other viruses.

Epidemiology

A recent modelling study estimated that in 2014, 24.1 million cases of pertussis and 160,700 deaths caused by pertussis occurred worldwide in children <5 years, reflecting significantly higher numbers than actual case counts. Before vaccination was available, pertussis was the leading cause of death from communicable disease among children <14 years. Widespread use of the pertussis vaccine (DTP) led to a >99% decline in cases, decreasing morbidity and mortality worldwide.

Pathogenesis

Bordetella organisms are small, fastidious, gram-negative coccobacilli that colonise only ciliated epithelium. The exact mechanism of disease symptomatology remains unknown. Bordetella species share a high degree of DNA homology among virulence genes. Only B. pertussis expresses pertussis toxin (PT), the major virulence protein. PT has numerous proven biological activities, leukocyte dysfunction activities (e.g. Histamine sensitivity, insulin secretion, and leukocyte dysfunction) PT appears to have a central, but not a singular, role in pathogenesis.

Clinical Manifestations

Classically, pertussis is a prolonged disease, divided into catarrhal, paroxysmal, and convalescent stages. The catarrhal stage (1 to 2 weeks) begins insidiously after an incubation period ranging from 3 to 12 days with nondistinctive symptoms of congestion and rhinorrhoea variably accompanied by low-grade fever, sneezing, lacrimation, and conjunctival suffusion. As initial symptoms wane, coughing marks the onset of the paroxysmal stage (2to 6 weeks). The cough begins as a dry, intermittent, irritative hack and evolves into the inexorable paroxysms that are the hallmark of pertussis. A well appearing, playful toddler with insignificant provocation suddenly begins a machinegun burst of uninterrupted cough on a single exhalation, chin and chest held forward, tongue protruding maximally, eyes bulging

and watering, face purple, until coughing ceases and a loud whoop follows as inspired air traverses the still partially closed airway. Post-tussive emesis is common. The number and severity of paroxysms escalate over days to a week and remain at that plateau for days to weeks. As the paroxysmal stage fades into the convalescent stage (≥2 weeks), the number, severity, and duration of episodes diminish.

Infants less than 3 Months-old do not display the classic stages. The catarrhal phase lasts only a few days or is unnoticed; a well-appearing young infant begins to choke, gasp, gag, and flail the extremities, with the face reddened. Cough may not be prominent, especially in the early phase, and whoop is infrequent. Apnoea and cyanosis can follow a coughing paroxysm, or apnoea can occur as the only symptom.

Adolescents and previously immunised children have foreshortening of all stages of pertussis. Findings on physical examination are generally uninformative. Signs of lower respiratory tract disease are not expected unless complicating secondary bacterial pneumonia is present. Conjunctival haemorrhages and petechiae on the upper body are common.

Diagnosis

Diagnosis is usually clinical; a history of contact is highly supportive. Pertussis should be suspected in any individual who has a pure or predominant complaint of cough, especially if the following features are absent: fever, malaise or myalgia, exanthem or enanthem, sore throat, hoarseness, tachypnoea, wheezes, and rales. For sporadic cases, a clinical case definition of cough of ≥14 days' duration with at least one associated symptom of paroxysms, whoop, or post-tussive vomiting has a high sensitivity and specificity for diagnosis of pertussis.

Pertussis should be suspected in infants younger than 3 months old with gagging, gasping, apnoea, cyanosis, or Sudden infant death. Adenoviral infections are usually distinguishable by associated features, such as fever, sore throat, and conjunctivitis. Mycoplasma causes protracted episodic coughing, but patients usually have systemic symptoms and chest findings. Leucocytosis caused by absolute lymphocytosis is characteristic in the catarrhal stage. Lymphocytes are normal small cells, rather than the large, atypical lymphocytes seen with viral infections. Adults, partially immune children, and occasionally infants may have less impressive lymphocytosis and thrombocytosis may occur. Chest radiographic findings are usually normal in older children, only mildly abnormal in most hospitalised infants, showing perihilar infiltrate and variable atelectasis. Parenchymal consolidation suggests secondary bacterial infection. Pneumothorax, pneumomediastinum, and subcutaneous emphysema can be seen occasionally.

Methods for confirmation of infection by B. pertussis (culture, polymerase chain reaction [PCR], serology) have limitations in sensitivity, specificity, or practicality. PCR testing on nasopharyngeal wash specimens is the laboratory test of choice for B. pertussis identification.

Treatment

Most older children and adolescents are managed in outpatient clinics. Infants with suspected pertussis usually are hospitalised, and patients of any age with significant complications. Prematurely born young infants have a high risk for severe, potentially fatal disease, and children with underlying cardiac, pulmonary, muscular, or neurologic disorders have an increased risk of poor outcome beyond infancy. The specific, limited goals of hospitalisation are to (1) assess progression of disease and likelihood of life-threatening events at the peak of disease, (2) maximise nutrition, (3) prevent or treat complications, and (4) educate parents in the natural history of the disease and in care that will be given at home. Heart rate, respiratory rate, and pulse oximetry are monitored continuously with alarm settings so that paroxysms can be witnessed and managed. Feeding children with pertussis is challenging. The risk of precipitating cough by nipple feeding does not warrant nasogastric or parenteral alimentation in most infants. The thickness of the formula does not affect the quality of secretions or cough.

Antibiotics

An antimicrobial agent is always given when pertussis is suspected or confirmed to decrease contagiousness and to afford possible clinical benefit. Azithromycin is the drug of choice in all age groups, either for treatment or postexposure prophylaxis. Azithromycin 10 mg/kg/day for 5 days or Clarithromycin 15 mg/ kg/day for 7 days, or Erythromycin 50 mg/kg/day for 10 days.

Trimethoprim-sulfamethoxazole (TMP-SMX) is an alternative to azithromycin for infants >2 months old and children unable to receive azithromycin. The treatment of B. parapertussis is based on clinical judgment and is considered in high-risk populations. Agents are the same as for B. Pertussis.

Adjunct Therapies

Stimulants such as Salbutamol and fussing associated with aerosol treatment trigger paroxysms. and the usefulness of corticosteroids in the management of pertussis; their clinical use is not warranted. Pertussis immunoglobulin (IGIV) has not been studied and should not be used for treatment or prophylaxis.

Isolation

Patients suspected of pertussis should be isolated with droplet precautions to minimize close respiratory or mucous membrane contact with respiratory secretions until 5 days after starting azithromycin treatment. Children and staff with pertussis in childcare facilities or schools should be excluded until they have completed 5 days of therapy.

Care of Household and Other Close Contacts

Azithromycin should be given promptly to all household contacts, and immunisation, age-related, of DTaP. DTaP should be given to complete the recommended series. Children <7 years old who received a third Diphtheria Tetanus and acellular Pertussis

(DTaP) dose >6 months before exposure, or a fourth dose ≥3 years before exposure, should be given a booster dose. Individuals ≥9 years old should be given Tetanus, Diphtheria and Pertussis (Tdap).

Complications

Infants <4 months old have the highest reported rates of pertussis-associated hospitalisation, pneumonia, seizures, encephalopathy, and death. Infants <4 months old account for 90% of cases of fatal pertussis. The principal complications of pertussis are apnoea, secondary infections (otitis media, pneumonia), and physical sequelae of forceful coughing, pneumonia, which is a main cause of death. Increased intrathoracic and intra-abdominal pressure during coughing can result in conjunctival and scleral haemorrhage (**Error! Reference source not found.**), petechiae on the upper body, e pistaxis, pneumothorax and subcutaneous emphysema, umbilical or inguinal hernia, and, rarely, haemorrhage in the central nervous system or retina. Laceration of the lingual frenulum occurs occasionally. Progressive pulmonary hypertension in very young infants has been reported. Acute neurologic events during pertussis are almost always the result of hypoxemia or haemorrhage associated with coughing or apnoea in young infants. Apnoea or bradycardia or both may result from apparent laryngospasm or vagal stimulation just before a coughing episode. Seizures usually result from hypoxemia, hypocalcaemia tetany due to respiratory alkalosis and cerebral haemorrhage. Bronchiectasis has been reported rarely after Pertussis.

Prevention

Universal immunisation of children with pertussis vaccine, beginning in infancy with reinforcing dose(s) through adolescence and adulthood. Prevention of pertussis mortality in young infants depends on universal maternal immunisation during each pregnancy and focused full immunisation of contacts, both children and adults of all ages.

Figure 9

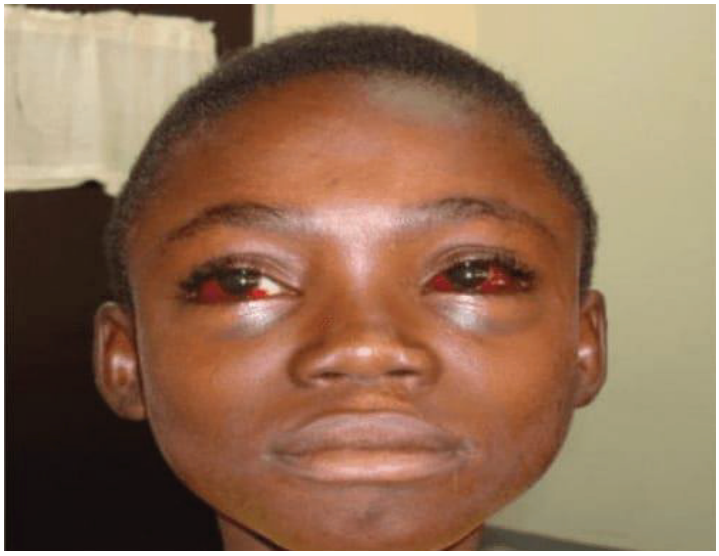

Figure 37

Diphtheria

Diphtheria is an acute toxic infection caused by toxin-producing strains of Corynebacterium diphtheriae and, less often, by toxin-producing strains of Corynebacterium ulcerans. Nontoxin-producing C. diphtheriae can also cause disease, although less severely. Although respiratory and cutaneous presentations of diphtheria are the most common, mortality is substantially higher with respiratory diphtheria. Classic respiratory diphtheria caused by toxigenic Corynebacterium species is the focus of the World Health Organisation (WHO) case surveillance.

Aetiology

Corynebacteria are aerobic, nonencapsulated, non-spore-forming, mostly nonmotile, pleomorphic, gram-positive bacilli. C. diphtheria. Differentiation of C. diphtheriae from C. ulcerans is based on urease activity; C. ulcerans is urease-positive.

Four C. diphtheriae biotypes (mitis, intermedius, belfanti, gravis) are capable of causing diphtheria. The ability of either C. diphtheriae or C. ulcerans to produce diphtheritic toxin results from the acquisition of a lysogenic corynebacteriophage, which encodes the diphtheritic toxin gene and confers diphtheria-producing potential in these strains.

Epidemiology

Unlike other diphtheroids (coryneform bacteria), which are prevalent in nature, C. diphtheriae is an exclusive inhabitant of human mucous membranes and skin. Spread is primarily by respiratory droplets, direct contact with respiratory secretions of symptomatic individuals, or exudate from infected skin lesions. Asymptomatic respiratory tract carriage is important in transmission. Skin infection and skin carriage are silent reservoirs of C. diphtheriae, and organisms can remain viable in dust or on fomites for up to 6 months. Diphtheria remains endemic in many developing countries with poor immunisation rates against diphtheria. Improving surveillance, vaccination coverage, and public awareness of the disease are key to controlling disease outbreaks.

Pathogenesis

Both toxigenic and nontoxigenic strains of C. diphtheriae cause skin and mucosal infection and can rarely cause invasive disease, including endocarditis and bacteraemia. The organism usually remains in the superficial layers of skin lesions or respiratory tract mucosa, inducing a local inflammatory reaction. The major virulence of the organism lies in its ability to produce a potent polypeptide exotoxin, the diphtheritic toxin, which inhibits protein synthesis and causes local tissue necrosis. and the resultant local inflammatory response. This leads to a Gray brown, leather-like, adherent pseudo membrane (diphtheria is Greek for leather). Removal is difficult and reveals a bleeding, oedematous submucosa. Paralysis of the palate and hypopharynx is an early local effect of diphtheritic toxin. Toxin absorption can lead to

systemic manifestations. kidney tubule necrosis, thrombocytopenia, cardiomyopathy, and demyelination of nerves. Because the latter two complications can occur 2 to 10 weeks after mucocutaneous infection, the pathophysiology in some cases is suspected to be immunologically mediated.

Clinical Manifestations

The manifestations of C. diphtheriae infection are influenced by the anatomic site of infection, the immune status of the host, and the production and systemic distribution of toxin. Although 98% of infections occur in the respiratory tract, other sites include the skin.

Respiratory Tract Diphtheria

The pharynx or tonsils are the most common location of infection in the respiratory tract (75–94%), followed by the larynx (25%). Although the incubation period has traditionally been regarded to be 2 to 5 days, 80% of untreated symptomatic cases progress to membranous diphtheria in an average of 2 to 3 days after symptom onset. In tonsillar and pharyngeal diphtheria, sore throat is the universal early symptom. Only half of the patients have fever, and fewer have dysphagia, hoarseness, malaise, or headache.

Mild pharyngeal injection is followed by unilateral or bilateral tonsillar membrane formation, which can extend to involve the uvula (which may cause toxin-mediated paralysis), soft palate, posterior oropharynx, hypopharynx, or glottic areas (Figure 38). Underlying soft tissue oedema and enlarged lymph nodes can cause a bull-neck appearance (Figure 39). The degree of local extension correlates directly with profound prostration, bullneck appearance and fatality caused by airway compromise or toxin-mediated complications.

The characteristic adherent pseudo-membrane, extension beyond the facial area, dysphagia, and relative lack of fever help differentiate diphtheria from exudative pharyngitis caused by Streptococcus pyogenes, Epstein-Barr virus, and Vincent angina. Laryngeal infection, laryngeal diphtheria, can be primary or a secondary extension from the pharyngeal infection, presenting with hoarseness, stridor, dyspnoea, and croupy cough. Differentiation from bacterial epiglottitis, severe viral laryngotracheobronchitis, and staphylococcal or streptococcal tracheitis. History, clinical examination, and the presence of a membrane at laryngoscopy and intubation all help in the diagnosis.

Cutaneous Diphtheria

Classic cutaneous diphtheria is an indolent, nonprogressive infection characterised by a superficial, ecthyma-like, nonhealing ulcer with a grey brown membrane (Figure 40). Diphtheria skin infections cannot always be differentiated from streptococcal or staphylococcal impetigo. Extremities are more affected than the trunk or head.

Respiratory tract colonisation or symptomatic infection with toxic complications occurs in the minority of patients with cutaneous diphtheria.

Diagnosis

Specimens for culture should be obtained from the nose and throat and any other mucocutaneous lesion. A portion of the membrane should be removed and submitted for culture along with the underlying exudate. The laboratory must be notified to use the selective medium. C. diphtheria direct smear using Gram stain or specific fluorescent antibody is unreliable. Culture isolates of coryneform organisms should be identified to the species level, and toxigenicity and antimicrobial susceptibility tests should be performed for C. diphtheriae isolates. It is recommended that all isolates be sent to a **reference** laboratory and subtyping of C. diphtheriae and C. ulcerans.

Complications

Respiratory tract obstruction by pseudomembranes may require bronchoscopy or intubation and mechanical ventilation. Two other tissues remote from sites of C. diphtheriae infection can be significantly affected by diphtheritic toxin: the heart and the nervous system.

Toxic Cardiomyopathy

Toxic cardiomyopathy occurs in 10–25% of patients with respiratory diphtheria, resulting in death in 35–60% of cases with this complication, and is responsible for 20–25% of deaths overall. Subtle signs of myocarditis can be detected in most patients, especially the elderly, but the risk for significant complications correlates directly with the extent and severity of exudative local oropharyngeal disease, along with a delay in administration of antitoxin. The first evidence of cardiac toxicity characteristically occurs 7 to 14 days after the onset of respiratory symptoms but can appear acutely as early as the first week of illness, a poor prognostic sign, or as late as the sixth week. Tachycardia disproportionate to fever is common and may be evidence of cardiac toxicity or autonomic nervous system dysfunction. A prolonged P-R interval and changes in the ST-T wave on an electrocardiographic tracing are relatively frequent findings; dilated and hypertrophic cardiomyopathy detected by echocardiogram has been described. Single or progressive cardiac dysrhythmias can occur, including heart block. Heart failure may appear insidiously or acutely. Elevation of the serum aspartate transaminase concentration closely parallels the severity of myonecrosis. Severe dysrhythmia can lead to death.

Toxic Neuropathy

Neurologic complications occur in 20–25% of untreated cases, resulting in death in 50% of cases that develop them and are responsible for 15% of deaths overall. They parallel the severity of primary infection and are multiphasic in onset. Acutely or 2 -3 weeks after the onset of oropharyngeal inflammation, hyperesthesia and local paralysis of the soft palate typically occur. Weakness of the posterior pharyngeal,

laryngeal, and facial nerves may follow, causing a nasal quality in the voice, difficulty in swallowing, and risk for aspiration. Cranial neuropathies characteristically occur in the fifth week, leading to oculomotor and ciliary paralysis, which can cause strabismus, blurred vision, or difficulty with accommodation. Symmetric demyelinating polyneuropathy has an onset of 10 days to 3 months after oropharyngeal infection and causes principally motor deficits with diminished deep tendon reflexes, acute flaccid paralysis. Nerve conduction velocity studies and cerebrospinal fluid findings in diphtheritic polyneuropathy are indistinguishable from those of Guillain-Barré syndrome. Paralysis of the diaphragm may ensue. Complete neurologic recovery is likely, but rarely, vasomotor centre dysfunction 2 -3 weeks after onset of illness can cause hypotension or cardiac failure. Recovery from myocarditis and neuritis is often slow but usually complete. Corticosteroids do not diminish these complications and are not recommended.

Treatment

Specific Diphtheria antitoxin is the mainstay of therapy and should be administered as soon as possible, without delay based on clinical diagnosis. Because it neutralises only free toxin, antitoxin efficacy diminishes with elapsed time after the onset of mucocutaneous symptoms. Antitoxin is administered as a single empirical dose of 20,000- 100,000 units based on the degree of severity, site, and duration of illness. Skin testing for hypersensitivity must be performed before administration of antitoxin. Patients with positive sensitivity testing or with a history of hypersensitivity reaction to horse, equine protein, should be desensitised. Antitoxin is probably of no value for local manifestations of cutaneous diphtheria, but its use is prudent because toxic sequelae can occur.

The role of antimicrobial therapy is to halt toxin production, treat localised infection, and prevent transmission of the organism to contacts. Although C. diphtheriae is usually susceptible to various agents in vitro, only Erythromycin or Penicillin is recommended for treatment.

Erythromycin is marginally superior to penicillin for the eradication of nasopharyngeal carriage. Appropriate therapy is Erythromycin (40- 50 mg/kg/day divided every 6 hours by mouth [PO] or intravenously [IV]; maximum 2 g/day), aqueous crystalline penicillin G (150,000 - 250,000 units/kg/day divided every 6 hr IV or intramuscularly [IM], up to 2- 3 million units/ day), or procaine penicillin (300,000 units every 12 hr IM for those ≤10 kg in weight; 600,000 units every 12 hr IM for those >10 kg in weight) for 14 days. Once oral medications are tolerated, oral erythromycin (see dosing above) or penicillin V (50 mg/kg/ day, divided every 6 hr, maximum 2 g per day) may be used for the remaining duration of therapy. Antibiotic therapy is not a substitute for antitoxin therapy. Some patients with cutaneous diphtheria have been treated for 7- 10 days. Elimination of the organism should be documented by negative results of at least two successive cultures of specimens from the nose and throat (or skin).

Supportive Care

Droplet precautions are instituted for patients with pharyngeal Diphtheria; are observed until the results of specimen cultures taken after cessation of therapy are negative. Bed rest is essential during the acute phase of disease, usually for ≥2 weeks until the risk for symptomatic cardiac damage has passed, with return to physical activity guided by the degree of toxicity and cardiac involvement.

Prognosis

The prognosis for patients with diphtheria depends on the virulence of the organism (subspecies gravis has the highest fatality rate), patient age, immunization status, site of infection, and speed of administration of the antitoxin. Mechanical obstruction from laryngeal diphtheria or bull-neck diphtheria and the complications of myocarditis account for most diphtheria-related deaths. The case fatality ratio for untreated, never vaccinated cases is 29%, improving to 10% with antitoxin treatment. Mortality is higher in the younger age group than in the older age group and adults.

Asymptomatic Case Contacts

All household contacts and people who have had intimate respiratory or habitual physical contact with a patient are closely monitored for illness for 7 days. Cultures of the nose, throat, and any cutaneous lesions are performed. Antimicrobial prophylaxis is presumed effective and is administered regardless of immunisation status, using a single injection of Benzathine Penicillin or Erythromycin PO for 7 to 10 days. Diphtheria toxoid vaccine, in age-appropriate form, is given to immunised individuals who have not received a booster dose within 5 years. other children to be evaluated according to their immunisation status and immunised with an age-appropriate preparation on a primary schedule.

Asymptomatic Carriers

When an asymptomatic carrier is identified, antimicrobial prophylaxis, erythromycin, is given for 10 to 14 days, and an age-appropriate preparation of Diphtheria toxoid vaccination is administered immediately if a booster has not been given within one year. Follow-up is needed till the culture is negative

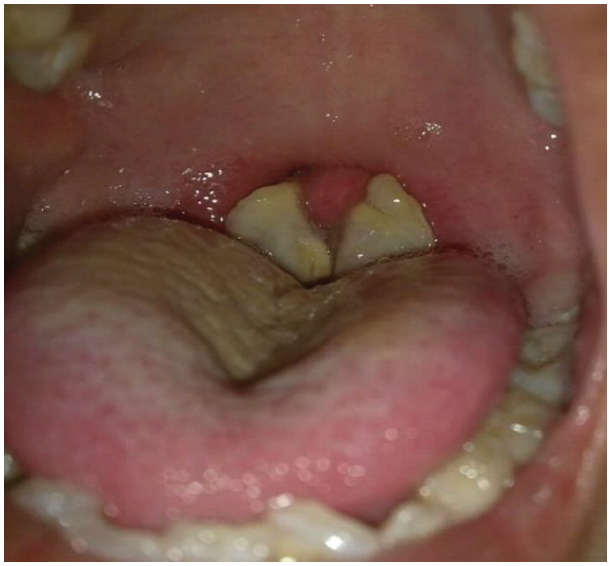

Figure 38

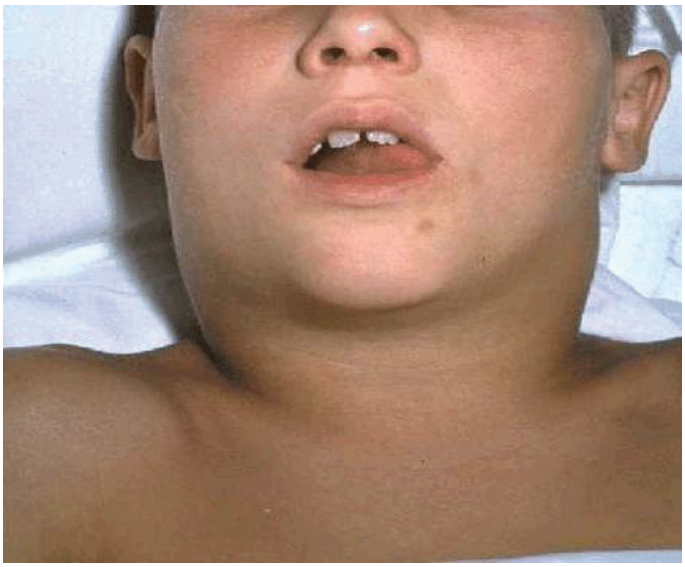

Figure 39

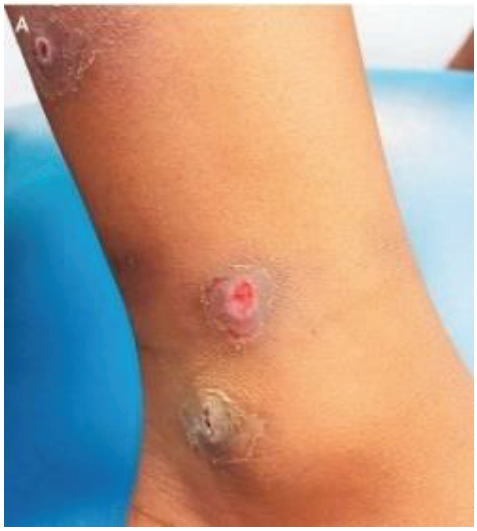

Figure 40

Tetanus

Aetiology

The clinical syndrome of tetanus involves an acute spastic paralytic illness caused by a neurotoxin produced by Clostridium tetani. Thus, tetanus can be considered a toxin-mediated process more than an acute infectious process per se. Unlike other pathogenic clostridia species, C. tetani is not a tissue-invasive organism. Instead, it causes illness through the toxin. tetanospasmin, more commonly referred to as tetanus toxin. Tetanospasmin is the second most poisonous substance known, surpassed in potency only by botulinum toxin. C. tetani is a motile, gram-positive, spore-forming obligate anaerobe. The organism's natural habitat worldwide is soil, dust, and the alimentary tracts of various animals. C. tetani forms spores terminally, with a classic morphologic appearance resembling a drumstick viewed microscopically.

Epidemiology

Tetanus occurs worldwide and is endemic in many developing countries, although its incidence varies considerably. Public health efforts in recent years have had an impressive impact on tetanus-associated mortality, but many challenges remain. Global mortality in adults is largely driven by maternal tetanus, which results from postpartum, postabortion, or postsurgical wound infection with C. tetani. Most mortality related to neonatal tetanus (also referred to as umbilical tetanus) occurs in South Asia and sub-Saharan Africa. The mortality of neonatal tetanus has been substantially reduced globally, driven by increased rates of maternal tetanus vaccination. Tetanus is not contagious.

Pathogenesis

Tetanus typically occurs after spores germinate, multiply, and produce tetanus toxin. Toxin is produced only by the vegetative cell, not the spore. It is released after the vegetative phase of replication, with replication occurring under anaerobic conditions. therefore, provides an ideal environment for transition from the spore to the vegetative stage of growth. After bacterial cell death and lysis, tetanospasmin is produced. Tetanus toxin binds at the neuromuscular junction and enters the motor nerve in the spinal cord, and next enters adjacent spinal inhibitory interneurons, where it prevents the release of the neurotransmitters glycine and Gamma-aminobutyric acid (GABA).

Tetanus toxin thus blocks the normal inhibition of antagonistic muscles on which voluntary coordinated movement depends; consequently, affected muscles sustain maximal contraction and cannot relax. This aspect of pathogenesis leads to the term lockjaw, classically applied to the clinical manifestations of tetanus in the affected individual.

Neurotransmission at neuromuscular junctions in the autonomic nervous system is also rendered unstable in tetanus, producing "autonomic storm" Because C. tetani is not an invasive organism, and its toxin-producing vegetative cells remain where

introduced into the wound, which may display local inflammatory changes and a mixed bacterial flora.

Clinical Manifestations

Tetanus is most often generalised but may also be localised. The incubation period typically is 2 -14 days after the injury. In generalised tetanus, the presenting symptom in about half of cases is trismus (masseter muscle spasm, or lockjaw). Headache, restlessness, and irritability are early symptoms, often followed by stiffness, difficulty chewing, dysphagia, and neck muscle spasm. The so-called sardonic smile of tetanus (Risus Sardonicus) (Figure 41) results from intractable spasms of facial and buccal muscles. When the paralysis extends to abdominal, lumbar, hip, and thigh muscles, the patient may assume an arched posture of extreme hyperextension of the body, or opisthotonos (Figure 42).

Laryngeal and respiratory muscle spasm can lead to airway obstruction and asphyxiation. Because tetanus toxin does not affect sensory nerves or cortical function, the patient unfortunately remains conscious. The seizures are characterised by sudden, severe tonic contractions of the muscles, with fist clenching, flexion, and adduction of the arms and hyperextension of the legs. Without treatment, the duration of these seizures may range from a few seconds to a few minutes in length with intervening respite periods. As the illness progresses, the spasms become sustained and exhausting.

The smallest disturbance by light, sound, or touch may trigger a titanic spasm. Fever, occasionally as high as 40°C, is common and is caused by the substantial metabolic energy consumed by spastic muscles. Notable autonomic effects include tachycardia, labile hypertension, and sweating.

The tetanic paralysis usually becomes more severe in the first week after onset, stabilises in the second week, and ameliorates gradually over the ensuing 1 -4 weeks. Neonatal tetanus, the infantile form of generalised tetanus, typically manifests within 3 to 12 days of birth. It presents as progressive difficulty in feeding (sucking and

swallowing), associated hunger, and crying. Paralysis or diminished movement, stiffness and rigidity to the touch, and spasms, with or without opisthotonos, are characteristic. The umbilical stump, which is typically the portal of entry for the microorganism, is usually contaminated or infected (Figure 43) Localised tetanus results in painful spasms of the muscles adjacent to the wound site and may precede generalised tetanus.

Cephalic tetanus is a rare form of localised tetanus involving the bulbar musculature and cranial nerves (particularly cranial nerve VII) that occurs with wounds in the head or face.

Diagnosis

The picture of tetanus is one of the most dramatic in medicine, and the diagnosis is usually established clinically. The typical setting is an unimmunized patient (and/or mother) who was injured or born within the preceding 2 weeks, who presents with trismus, dysphagia, generalised muscle rigidity and spasm, and a clear sensorium. Results of routine laboratory studies are usually normal. A peripheral leucocytosis may result from a secondary bacterial infection of the wound. The cerebrospinal fluid analysis is normal. although the. Serum muscle enzymes (creatine kinase, aldolase) may be elevated. Neither the electroencephalogram (EEG) nor the electromyogram (EMG) shows a characteristic pattern. C. tetani is not always visible on a Gram stain of wound material and is isolated by culture.

Differential Diagnosis

Florid and generalised tetanus is typically not mistaken for any other disease; locked jaw and sardonic smile are diagnostic features. However, trismus (locked jaw) may result from parapharyngeal, retropharyngeal, or dental abscesses. Either rabies or tetanus may follow an animal bite, and rabies may manifest as trismus with seizures. Rabies may be distinguished from tetanus by hydrophobia, marked dysphagia, and predominantly colonic seizures. Although strychnine poisoning may result in tonic muscle spasms and generalised seizure activity, it seldom produces trismus, and, unlike in tetanus, general relaxation usually occurs between spasms. Hypocalcaemia may produce tetany that is characterised by laryngeal and carpopedal spasms, but trismus is absent.

Treatment

Management of tetanus requires eradication of C. tetani, correction of wound environment conditions conducive to its anaerobic replication, neutralisation of all accessible tetanus toxin, control of seizures and respiration, palliation, provision of meticulous supportive care, and, finally, prevention of recurrences. Surgical wound excision and debridement are often needed. Surgery should be performed promptly after administration of human tetanus immunoglobulin (TIG) and antibiotics. TIG should be given as soon as possible to neutralise the toxin that diffuses from the wound into the circulation before the toxin can bind to distant muscle groups. The optimal dose of TIG has not been determined. Most experts recommend that a single intramuscular (IM) injection of 500 units of TIG is sufficient to neutralise systemic tetanus toxin. Infiltration of part of the dose of TIG into the wound is no longer recommended, and the entire dose can be administered IM. If TIG is unavailable, use of human intravenous immunoglobulin (at a dose of 200 to 400 mg/kg) can be considered. another alternative may be horse-derived tetanus antitoxin (TAT). A dose of 1,500 to 3,000 U is recommended and should be administered after appropriate testing for sensitivity and desensitisation. The human-derived immunoglobulins are much preferred. for their longer half-lives (30 days) and the virtual absence of allergic and serum sickness adverse effects.

Oral (or intravenous) metronidazole (30 mg/kg per day, given at 6-hour intervals; maximum dose, 4 g/day) decreases the number of vegetative forms of C. tetani and is currently considered the antibiotic of choice. Parenteral penicillin G (100,000 U/kg per day, administered at 4-to 6-hour intervals, with a daily maximum of 12 million U) is an alternative treatment. Antimicrobial therapy for a total duration of 7- 10 days. Tetanic spasms are of critical importance in the management of tetanus. In light of this goal, all patients with generalised tetanus should receive muscle relaxants. Diazepam provides both relaxation and seizure control. For neonatal tetanus, an initial dose of 0.1 0.2mg/kg every 3- 6 hours given intravenously is subsequently titrated to control the tonic spasms (continuous IV infusion doses of 15- 40 mg/kg/day have been recommended, titrated to control the spasm). After 5 -7 days, the dosage can be decreased by 5- 10 mg/day, with the drug given orally or by the nasogastric route, after which the effective dose is sustained for 2 -6 weeks before a tapered withdrawal. Magnesium sulphate may be useful in controlling autonomic dysfunction. In addition to diazepam, other benzodiazepines (midazolam) and baclofen are also used.

Supportive Care

Meticulous supportive care in a quiet, dark, secluded setting is most desirable. Because tetanic spasms may be triggered by minor stimuli, the patient should be sedated and protected from all unnecessary sounds, sights, and touch, and all therapeutic and other manipulations must be carefully scheduled and coordinated. Endotracheal intubation and tracheostomy may be needed in severe cases that have failed to respond to pharmacological treatment in an ICU set-up. Cardiorespiratory monitoring, frequent suctioning, and maintenance of the patient's substantial fluid, electrolyte, and caloric needs are fundamental and meticulous nursing care.

Complications

The seizures and the severe, sustained, rigid paralysis of tetanus predispose the patient to many complications. Aspiration of secretions with attendant pneumonia is an important complication to consider and may be present at the time of the initial diagnosis. Maintaining airway patency often mandates endotracheal intubation and mechanical. The seizures may result in lacerations of the mouth or tongue, in intramuscular hematomas or rhabdomyolysis with myoglobinuria and renal failure, or in long bone or spinal fractures. Venous thrombosis, pulmonary embolism, gastric ulceration with or without haemorrhage, paralytic ileus, and decubitus ulceration are described as complications. Cardiac arrhythmias, including asystole, unstable blood pressure, and labile temperature regulation, reflect disordered autonomic nervous system control.

Prognosis

Recovery in tetanus occurs through regeneration of synapses within the spinal cord that results in restoration of muscle relaxation, with no long-term neurological sequelae. Interestingly, an episode of tetanus does not confer immunity to tetanus. Therefore, active immunisation with tetanus toxoid should follow. The most important factor that influences outcome is the quality of supportive care. Mortality is highest in the very young.

Prevention

Tetanus is an entirely and easily preventable disease. Active immunization should begin in early infancy with combined diphtheria toxoid–tetanus toxoid–acellular pertussis (DTaP) vaccine according to the national vaccination schedule. Recovery from tetanus does not confer permanent protective immunity, so immunisation is recommended. Immunisation of women with tetanus toxoid prevents neonatal tetanus, and pregnant women should receive one dose of reduced diphtheria and pertussis toxoids (Tdap)during each pregnancy, preferably at 27 -36 weeks of gestation.

Wound Management

Tetanus prevention measures after trauma consist of inducing active Immunity to tetanus toxin and of passively providing antitoxin antibody. Tetanus prophylaxis is an essential part of all wound management, but specific measures depend on the nature of the injury and the immunisation status of the patient.

Tetanus toxoid should always be given after a dog or other animal bite.

Non-minor wounds require human TIG except those in a fully immunised patient (i.e., ≥3 doses of adsorbed tetanus toxoid). In any other circumstance (e.g., patients with an unknown or incomplete immunisation history; of contaminated wound, animal bite, TIG 250 units should be administered intramuscularly, regardless of the patient's age or weight. If TIG is unavailable, use of human intravenous immunoglobulin may be

considered. If neither of these products is available, then 3,000- 5,000 units of equine-TAT (in regions of the world where it is available) may be given intramuscularly after testing for hypersensitivity. A tetanus toxoid booster (preferably Tdap) is administered to all persons with any wound if the tetanus immunisation status is unknown or incomplete. A booster is administered to injured persons who have completed the primary immunisation series if (1) the wound is clean and minor, but 10 or more years have passed since the last booster, or (2) the wound is more serious, and 5 or more years have passed since the last booster.

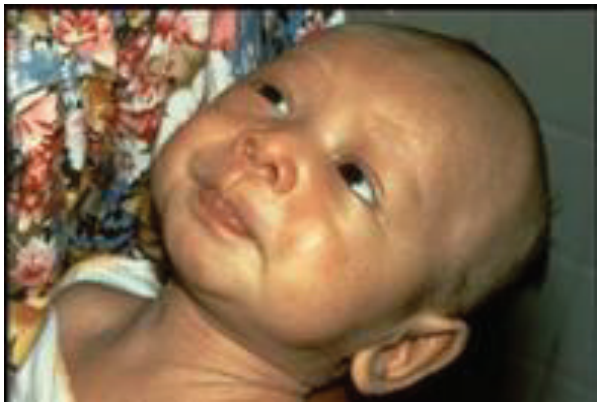

Figure 41

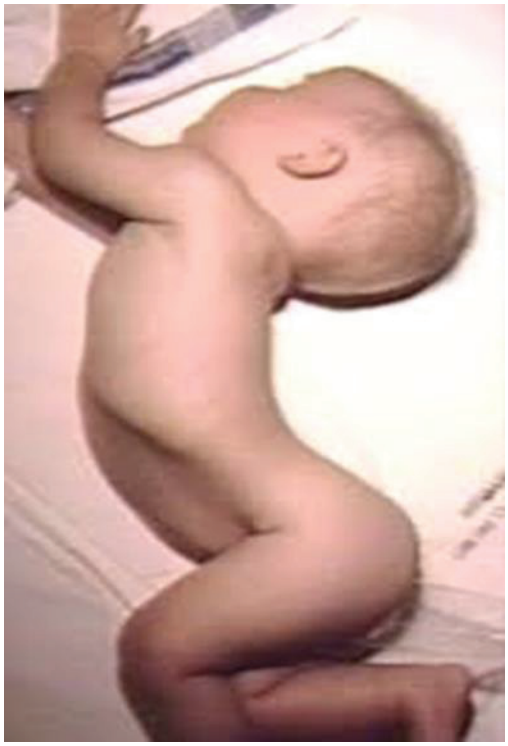

Figure 42

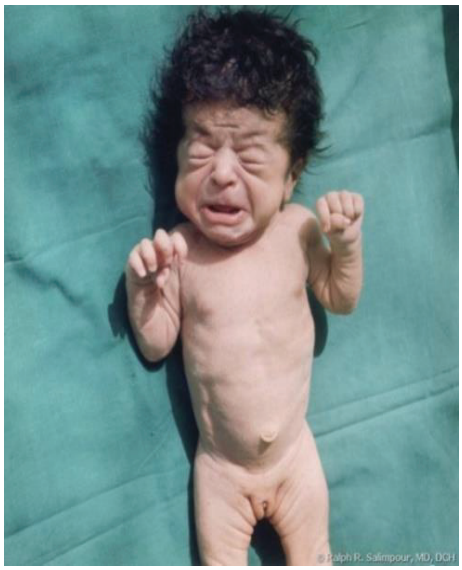

Figure 43

Poliomyelitis

Aetiology

The polioviruses are nonenveloped, positive-stranded RNA viruses belonging to the **Picornaviridae** family, in the genus **Enterovirus,** species enterovirus C, and consist of three antigenically distinct serotypes (types 1, 2, and 3). Polioviruses spread from the intestinal tract to the central nervous system (CNS), where they cause aseptic meningitis and poliomyelitis. The polioviruses are extremely hardy and can retain infectivity for several days at room temperature.

Epidemiology

The most devastating result of poliovirus infection is paralysis, although 90–95% of infections are inapparent, which induce protective immunity, with paralytic polio occurring in approximately 1 in 1,000 infections among infants. in developing countries with poor sanitation, infection early in life results in infantile paralysis. Improved sanitation and vaccination explain the virtual eradication of polio from many countries.

Transmission

Humans are the only known reservoir for the polioviruses, which are spread by the faecal-oral route. Poliovirus has been isolated from faeces for longer than 2 weeks before paralysis, to several weeks after the onset of symptoms

Pathogenesis

Polioviruses infect cells by adsorbing to the genetically determined poliovirus receptor (CD155). The virus penetrates the cell, is uncoated, and releases viral RNA. The RNA is translated to produce proteins responsible for replication of the RNA, shutdown of host cell protein synthesis, and synthesis of structural elements that compose the capsid. The poliovirus primarily infects motor neuron cells in the spinal cord (the anterior horn cells) and the medulla oblongata (the cranial nerve nuclei). Because of the overlap in muscle innervations by two to three adjacent segments of the spinal cord, clinical signs of weakness in the limbs develop when more than 50% of motor neurons are destroyed. In the medulla, less extensive lesions cause paralysis, and involvement of the reticular formation that contains the vital centres controlling respiration and circulation may have a catastrophic outcome. And rarely are other brain centres involved to some extent. Infants acquire immunity trans placentally from their mothers. This gives babies protection for the first 4 -6 months of life.

Clinical Manifestations

The incubation period of poliovirus from contact to initial clinical symptoms is usually considered to be 8- 12 days, with a range of 5- 35 days. Poliovirus infections with wild-type virus may follow one of several courses: inapparent infection, which occurs in 90–95% of cases and causes no disease and no sequelae; abortive poliomyelitis; nonparalytic poliomyelitis; or paralytic poliomyelitis. Paralysis, if it occurs, appears 3 to 8 days after the initial symptoms.

Abortive Poliomyelitis

In approximately 5% of patients, a nonspecific influenza-like Syndrome occurs 1 -2 weeks after infection, which is termed abortive poliomyelitis. Fever, malaise, anorexia, and headache are prominent features, and there may be a sore throat and abdominal or muscular pain. The illness is short-lived, lasting up to 2 -3 days. The physical examination may be normal or may reveal nonspecific pharyngitis, abdominal or muscular tenderness, and weakness. Recovery is complete, and no neurologic signs or sequelae develop.

Non paralytic Poliomyelitis

In approximately 1% of patients infected with wild-type poliovirus, signs of abortive poliomyelitis are present, plus signs and symptoms of aseptic meningitis, as more intense headache, nausea, and vomiting, and stiffness of the posterior muscles of the neck, trunk, and limbs. Nuchal rigidity and spinal rigidity are the basis for the diagnosis of nonparalytic poliomyelitis. Physical examination reveals nuchal-spinal signs and changes in superficial and deep reflexes. True nuchal with head drop sign, rigidity, the anterior fontanel may be tense or bulging, and paresis of the extremities. Tendon reflexes are absent with paralysis. Sensory defects do not occur in poliomyelitis.

Paralytic Poliomyelitis

Paralytic poliomyelitis develops in approximately 0.1% of persons infected with poliovirus, causing three clinically recognisable syndromes that represent a continuum of infection differentiated only by the portions of the CNS most severely affected. These are (1) spinal paralytic poliomyelitis, (2) bulbar poliomyelitis, and (3) polio encephalitis.

Spinal paralytic poliomyelitis may occur as the second phase of a biphasic illness, the first phase of which corresponds to abortive poliomyelitis. The patient then appears to recover and feels better for 2 to 5 days, after which severe headache and fever occur with exacerbation of the previous systemic symptoms. Severe muscle pain is present, and sensory and motor phenomena (e.g., paraesthesia, hyperesthesia, fasciculations, and spasms) may develop. On physical examination, the distribution of paralysis is characteristically spotty. Single muscles, or groups of muscles, may be involved. Within 1- 2 days, asymmetric flaccid paralysis or paresis occurs. Involvement of one leg is most common. The proximal areas of the extremities tend to be involved to a

greater extent than the distal areas. with intact sensation and no sensory disturbances. The paralytic phase is extremely variable; some patients progress to paralysis, whereas others recover. Bowel and bladder dysfunction may occur due to weakness of abdominal and pelvic muscles.

The onset and course of paralysis are variable in developing countries. typically, the disease manifests in a single phase in which prodromal symptoms and paralysis occur in a continuous fashion. With a history of intramuscular injections preceding paralytic poliomyelitis in approximately 50–60% of patients, patients may present initially with fever and paralysis (provocation paralysis). Whereas in most patients, flaccid paralysis occurs abruptly. Little recovery from paralysis is noted in the first days or weeks, but, if it is to occur, it is usually evident within 6 months. Atrophy of the limb, failure of growth, and deformity are common.

Bulbar poliomyelitis

may occur as a clinical entity without apparent disease, as bulbar implies only dominance of the clinical manifestations by dysfunctions of the cranial nerves and medullary centres. The clinical findings seen with bulbar poliomyelitis include respiratory difficulty, dysphonia, drooling and dysphagia, and complications that supervene, such as vocal cord paralysis and aspiration and choking. The course of bulbar disease is variable; some patients die as a result of extensive, severe involvement of the various centres in the medulla; others recover partially but require ongoing respiratory support, and others recover completely. Cranial nerve involvement is seldom permanent.

Polio encephalitis is a rare form of the disease in which higher centres of the brain are severely involved. Presenting with Seizures, coma, and spastic paralysis.

Diagnosis

Poliomyelitis should be considered in any unimmunized or incompletely immunised child with paralytic disease. This guideline is applicable in poliomyelitis endemic countries and nonendemic countries due to the spread of the virus to the latter recently from endemic countries. The World Health Organisation (WHO) recommends that the laboratory diagnosis of poliomyelitis be confirmed by isolation and identification of poliovirus in the stool. Two stool specimens should be collected 24- 48 hours apart as soon as possible. Isolates should be sent to one of the WHO-certified poliomyelitis laboratories where DNA sequence analysis can be performed. Serologic testing demonstrates seroconversion or a fourfold or greater increase in antibody titres from the acute phase of illness to 3 t o6 weeks later.

Differential Diagnosis

Poliomyelitis should be considered in the differential diagnosis of any case of paralysis

and is only one of many causes of acute flaccid paralysis (AFP) in children and adults. There are numerous other causes of acute flaccid paralysis. In our practice in Sudan, the common causes of AFP are Guillain-Barré Syndrome, transverse myelitis, and traumatic paralysis, and in the past, diphtheritic neuropathy. In most common conditions, the history, clinical features are usually sufficient to differentiate between these various causes, but in some cases, nerve conduction studies and electromyograms, neuroimaging, and CSF analysis may be of help.

The possibility of polio should be considered in any case of acute flaccid paralysis. In Guillain-Barré syndrome, it is distinguished from poliomyelitis as the paralysis is characteristically symmetric, ascending paralysis, and contrasts with poliomyelitis. Fever, headache, and meningeal signs are less notable, and the CSF has few cells but an elevated protein content. Transverse myelitis progresses rapidly over hours to days, causing an acute symmetric paralysis of the lower limbs with concomitant anaesthesia and diminished sensory perception, and there is bladder dysfunction. The CSF is usually normal. Traumatic neuritis occurs from a few hours to a few days after the traumatic event, usually follows a gluteal I.M. injection, sciatic nerve injury, given by an unskilled person. It is usually asymmetric, acute, and affects only one limb. Muscle tone and deep tendon reflexes are reduced or absent in the affected limb, with pain in the gluteus.

Treatment

There is no specific antiviral treatment for polio. The management is supportive and aimed at limiting progression of disease, preventing ensuing skeletal deformities, and preparing the child and family for the prolonged treatment required and for permanent disability if this seems likely. Patients with the nonparalytic and mildly paralytic forms of poliomyelitis may be treated at home. All intramuscular injections and surgical procedures are contraindicated during the acute phase of the illness, because they might result in progression of the disease. Abortive and Nonparalytic Poliomyelitis, Supportive treatment with analgesics, sedatives, and bed rest until the child's temperature is normal for several days is usually sufficient. Avoidance of exertion for the ensuing 2 weeks is desirable, and careful neurologic and musculoskeletal examinations should be performed 2 months later to detect any minor involvement.

Paralytic Poliomyelitis

Most patients with the paralytic form of poliomyelitis require hospitalisation with complete physical rest in a calm atmosphere for the first 2 -3 weeks. Suitable body alignment is necessary for comfort. The position should be changed every 3- 6 hours. Active and passive movements are indicated as soon as the pain has disappeared; orthopaedists and physiatrists should see patients as early in the course of the illness and should assume responsibility for their care before fixed deformities.

Complications

Paralytic poliomyelitis may be associated with numerous complications. Acute gastric dilation may occur abruptly during the acute or convalescent stage. Melena may result from superficial intestinal erosions; Mild hypertension for days or weeks is common in the acute stage and probably related to lesions of the Vascular regulatory centres in the medulla. In the later stages, because of immobilisation, hypertension may occur along with hypercalcemia and nephrocalcinosis. High fluid intake is the only effective prophylactic measure.

Prevention

Poliomyelitis is a lifelong disability (Figure 44). Vaccination is the only effective method of preventing poliomyelitis. Hygienic measures help to limit the spread of the infection. Both the inactivated polio vaccine (IPV), which is currently produced using better methods than those for the original vaccine and is sometimes referred to as enhanced IPV, and the live-attenuated OPV have established efficacy in preventing poliovirus infection and paralytic poliomyelitis. Both vaccines induce the production of antibodies against the three strains of poliovirus. IPV elicits higher serum IgG antibody titres, but the OPV also induces significantly greater mucosal IgA immunity in the oropharynx and gastrointestinal tract, which limits replication of the wild poliovirus at these sites.

Figure 44

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Chapter 3: Tropical Diseases.

Malaria

Aetiology

The genus Plasmodium includes species of intraerythrocytic parasites that infect a wide range of mammals, birds, and reptiles. The 5 species that infect humans are P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi. Coinfection with multiple species has been documented.

Epidemiology

Malaria is endemic throughout tropical areas of the world and is acquired primarily from the bite of the female Anopheles genus of mosquito. Half of the world's population lives in areas where transmission occurs. Worldwide, 247 million cases and 619,000 deaths were reported in 2021. Approximately 10% of cases are severe malaria. Most deaths occur in children younger than 5 years. Uncommon modes of malaria transmission are congenital, through transfusion or transplant, or using contaminated needles or syringes. Asymptomatic parasitaemia can occur in individuals with partial immunity. Drug resistance in both P. falciparum and P. vivax has been evolving throughout areas with endemic malaria.

Clinical Manifestations

The classic symptoms of malaria, which may be paroxysmal, are high fever with chills, rigors, sweats, and headache. Young children often present only with fever and nonspecific symptoms, which may include nausea, vomiting, diarrhoea, cough, tachypnoea, arthralgia, myalgia, and abdominal and back pain. Anaemia and thrombocytopenia are common. Hepatosplenomegaly is frequently present in infected children in areas with endemic malaria. Severe disease occurs more frequently in children without immunity acquired because of previous infection, young children, especially those who are immunocompromised. Infection with Plasmodium falciparum, one of the 5 Plasmodium species that naturally infect humans, most commonly manifests as a nonspecific febrile illness, often without localising signs.

Severe disease is caused mostly by P. falciparum. Severe P. falciparum malaria: may manifest as one of the following clinical syndromes, many of which also may be seen with other malaria species, and all of which are medical emergencies and may be fatal unless treated promptly:

Impaired consciousness, characterised by altered mental status, which may progress to cerebral malaria, defined by the presence of coma (Blantyre coma scale ≤2) and often accompanied by multiple seizures; cerebral malaria has a mortality rate of 15% to 20%.

Multiple seizures (2 or more in 24 hours), which, in the absence of coma, have a low mortality rate.

Severe anaemia (haemoglobin of ≤5 g/dL, secondary to haemolysis of infected blood cells, coagulopathy, and/or hepatic dysfunction. Hyper-parasitaemia, sequestration of infected erythrocytes & treatment with artemisinin derivatives.

Metabolic acidosis: base deficit > 8mEq/L or bicarbonate <15mmol/L

Hypoglycaemia, which can present with metabolic acidosis and hypotension associated with hyper-parasitaemia (parasitaemia >5%). and is associated with increased mortality; it can also be a consequence of quinine or quinidine-induced hyperinsulinemia.

Acute kidney injury, which is likely multifactorial, is common in severe malaria in children and associated with increased mortality; acute renal failure, caused by acute tubular necrosis, is more common in adults than in children.

Pulmonary oedema and acute respiratory distress syndrome are more common in adults than in children.

Prostration, in which a child is unable to sit, stand, or walk without assistance. Significant bleeding, including recurrent or prolonged bleeding from the nose, gums, venepuncture sites, haematemesis, or melena.

Vascular collapse and shock or impaired perfusion, associated with concurrent bacteraemia, hypothermia, or adrenal insufficiency.

Jaundice secondary to haemolysis of infected blood cells, coagulopathy, and/or hepatic dysfunction.

Plasmodium vivax and Plasmodium ovale

Anaemia attributable to acute parasitaemia, leading to haemolysis.

Hypersplenism with risk of splenic rupture.

Thrombocytopenia, which may be severe with P vivax.

Pulmonary oedema, which may occur after initial treatment of P. ovale.

Relapse of infection, for as long as 3 to 5 years after the primary infection, is attributable to latent hepatic stages (hypnozoites).

Plasmodium malariae

Chronic asymptomatic parasitaemia can persist for decades.

Nephrotic syndrome is due deposition of immune complexes in the kidney.

Plasmodium knowlesi

A non-human primate malaria parasite misdiagnosed as P malariae infection.

causes a more benign infection.

characterized by very rapid replication, hyper parasitaemia &severe disease.

P. knowlesi infection should be treated aggressively, because hepatorenal failure and subsequent death have been documented.

Congenital Malaria

defined as the presence of asexual forms of the Plasmodium parasite in the peripheral blood within the first 7 days of life.

Increased risk among the newborns of primigravidae in areas with endemic infection.

Most cases have been caused by P vivax and P falciparum; P malariae and P. ovale account for fewer than 20% of such cases. Manifestations can resemble those of neonatal sepsis, including fever and nonspecific symptoms of poor appetite, irritability, and Lethargy.

Clinical features of congenital malaria are fever, anaemia, and splenomegaly. Less common features include hepatosplenomegaly, jaundice, regurgitation, loose stools, and poor feeding.Fever in the first 3 weeks of life is mostly due to bacterial infection, but congenital malaria should be considered as a differential diagnosis in endemic areas.

The treatment of choice for congenital malaria is IV Artesunate.

Diagnostic Tests

Definitive parasitological diagnosis is by the identification of Plasmodium parasites microscopically on stained blood films by Giemsa stain.

Thick film: to find parasites that may be present at low density.

Thin film: for species identification and determination of the density of red blood cells infected with parasites. Confirmation and identification of the species of malaria parasites on the blood smear is essential in guiding therapy

Rapid diagnostic test: detects specific malaria antigens in blood.

Serologic testing: generally, it is not helpful except in epidemiologic surveys.

The nucleic acid amplification test (NAAT) is available in reference laboratories.

Treatment

Choice of malaria treatment is based on the infecting species, possible drug resistance, and severity of disease.

Treatment for malaria should not be delayed if malaria is suspected and rapid diagnosis is not available. Patients with severe malaria require intensive care and parenteral treatment with intravenous (IV) Artesunate or IV Quinine. Use of Artesunate without laboratory confirmation of malaria should be reserved for cases in which there is a strong clinical suspicion of severe malaria and prompt laboratory diagnosis is not available. Sequential blood smears to determine the percentage of erythrocytes infected with parasites can be used to assess therapeutic efficacy. A review of available literature suggests that exchange transfusion for severe disease is not efficacious in patients with end-organ involvement.

Treatment of uncomplicated malaria in children

As young children are more likely to vomit or regurgitate treatment than older children or adults, mothers should be advised on the technique of drug administration and the importance of administering the drug again if it is regurgitated within one hour of administration.

First-line treatment

The first-line treatment for uncomplicated malaria in Sudan is Artemether-Lumefantrine (AL) in the form of tablets. AL is a highly effective fixed-dose combination antimalarial treatment. Each tablet contains both Artemether and Lumefantrine. It has high clinical and parasitological cure rates.

Formulations available

in Sudan, AL is currently available as dispersible or standard tablets containing 20 mg Artemether and 120 mg lumefantrine (AL 20/120), and standard tablets containing 80 mg Artemether and 480 mg Lumefantrine (AL 80/480) in fixed dose combinations.

Dosage regimen:

- AL is given twice a day for three days (the total is six doses).
- The second dose should be taken 8 hours after the first dose.
- The 3rd dose should be taken 24 hours after the first dose.
- The remaining doses should be taken every 12 hours.
- To maximise absorption, AL should be taken with fatty food or milk.
- The dose should be repeated if the drug is vomited within 30 minutes.

Side effects

AL is generally well-tolerated. Reported adverse effects include gastrointestinal upset, headache, dizziness and muscle pain. Contraindications: Hypersensitivity to Artemether or lumefantrine.

Drug interactions

Decreased exposure to lumefantrine has been documented in young children, pregnant women, large adults, smokers and patients taking rifampicin. As these target groups may be at increased risk for treatment failure, their responses to treatment should be monitored more closely, and their adherence ensured.

Treatment failure

Treatment failure is considered when fever and parasitaemia persist or recur within 4 weeks after initial treatment.

Treatment failure is not always due to parasite resistance. Other causes include sub-optimal dosing, poor adherence, vomiting, unusual pharmacokinetics in an individual or substandard medicines.

Revisit the history to determine whether the patient vomited the previous treatment or did not complete a full course of treatment.

Treatment failure must be confirmed by parasitological examination; the use of rapid detection test (RDT) is not appropriate in suspected treatment failure, as they remain positive for weeks after initial infection, even with effective treatment. After exclusion of alternative causes, the second-line treatment should be used.

Recurrence of fever and parasitaemia more than 4 weeks after treatment should be considered a new infection and treated with first-line treatment (AL).

Second-line treatment

Indicated in the case of treatment failure or when the first-line treatment is contraindicated or unavailable. Dihydroartemisinin + Piperaquine (DHAP) is the second-line treatment. DHAP is a highly effective fixed-dose combination antimalarial treatment.

Formulations available

Two strengths are currently available as fixed-dose combination tablets: (20/160) DHAP (20 mg DHA + 160 mg P) for paediatric cases, and (40/320) DHAP (40 mg DHA + 320 mg P) for adults.

Dosage regimen

DHAP is given once daily for three consecutive days (a total of three doses). The dose should be taken at the same time every day.

Additional considerations: High-fat meals should be avoided with DHAP as they alter the absorption of Piperaquine.

Side effects

Side effects are uncommon.

Gastrointestinal upset and dizziness may occur in a minority of patients.

Contraindications

Hypersensitivity to dihydroartemisinic or piperaquine. Patients with congenital or acquired QT prolongation.

Drug interactions: Malnourished children are at an increased risk of DHAP treatment failure. Their response to treatment should be monitored closely.

Drug interactions

Malnourished children are at an increased risk of DHAP treatment failure. Their response to treatment should be monitored closely.

Specific treatment of severe malaria

Intravenous Artesunate is the treatment of choice for severe malaria.

Drug formulations

The drug is available as artesunate powder in three strengths: 30, 60, and 120 mg vials. The drug is packed together with sodium bicarbonate for reconstitution and normal saline for dilution.

Dose and regimen

Artesunate 2.4 mg/kg body weight (or 3.0mg/ kg in children less than 20 kg) is given by intravenous injection on admission (time = 0), repeated at 12 hours and 24 hours, then once a day until the patient can tolerate oral medication. After at least 24 hours of parenteral treatment and if the patient can tolerate oral medication, complete the treatment with a full course of artemether-lumefantrine.

At least 3 doses of parenteral artesunate should be given within the first 24 hours of treatment. These should be given irrespective of the patient's ability to tolerate oral medication.

If intravenous access is unavailable, artesunate may be administered intramuscularly.

Side effects

Artesunate is generally well-tolerated and has a better safety profile than quinine. Artesunate side effects include hypersensitivity reactions, gastrointestinal disturbances, cough, rash, arthralgia, and dizziness. Clinically, the most significant side effect is haemolysis, which has been reported up to weeks after treatment.

Contraindications

Hypersensitivity to artesunate or artemisinin derivatives.

Treatment with Quinine

IV Quinine is used for treating severe malaria when Artesunate is not available or contraindicated.

Formulations available

Intravenous Quinine is available as 300 mg/ml (or 600 mg/2ml) vials.

Dose and regimen

Rapid intravenous administration of quinine is dangerous. Each dose (10 mg/kg) of parenteral quinine must be diluted in 5% dextrose and administered as a slow infusion over 4 hours. The dose is administered at 8-hour intervals. IV quinine should be continued for at least 24 hours and until the patient can take oral medication. A full course of oral artemether lumefantrine should be prescribed as soon as the patient can tolerate oral medication. If Artemisinin derivatives are contraindicated, a 7-day course of oral quinine can be used instead.

If the IV route is not possible, IM quinine can be given in the same dosage as IV quinine. Intramuscular injection must be diluted with sterile normal saline or distilled water to 60 mg/ml, split into halves, and administered into the anterior upper aspect of each thigh.

Side effects

Hypoglycaemia is the most serious and frequent adverse effect. Other side effects include hypotension and cinchonism

Specific treatment of severe P. vivax malaria

P. vivax malaria is considered benign with a very low case-fatality rate, but occasionally it can cause severe disease. Prompt and effective treatment and case management should be the same as for severe and complicated P. falciparum malaria. Parenteral treatment should be followed by full courses of Artemether Lumefantrine and Primaquine.

Adjustment of dosing in renal failure or hepatic dysfunction

The dosage of artesunate does not have to be adjusted for patients with vital organ dysfunction. However, quinine accumulates in severe vital organ dysfunction. If a patient with severe malaria has persisting acute kidney injury or there is no clinical improvement by 48 h, the dose of interval quinine should be increased to 12 hourly rather than 8 hourly

. Dosage adjustments are not necessary if patients are receiving either haemodialysis or hemofiltration.

General management of patients with severe malaria

1. .Start resuscitation, particularly maintenance of the Airway, Breathing, and Circulation (ABCs)
2. Make a thick blood smear for immediate malaria parasite.
3. Establish the patient's hydration status, assess the patient's fluid requirements, and replace accordingly.
4. Control fever if the axillary temperature is 38.5ºC or above: Tepid sponge, fanning, and IV, oral or rectal paracetamol.
5. Control convulsions: Maintain airway, treat with rectal diazepam (0.5mg/kg) or slow IV diazepam (0.3mg/kg, maximum 10mg in an adult). Correct hypoglycaemia if it is present.
6. Detect and treat hypoglycaemia: If blood glucose ≤ 2.2 mmol/l (or ≤ 3 mmol/L for children < 5 years); give 5 ml/kg of 10% dextrose IV slowly over 3 -5 minutes. Follow with 10% dextrose infusion at 5ml/kg/hr. If there is no test for blood glucose, treat as if the patient is hypoglycaemic.
7. Start intravenous Artesunate.
8. If suspecting sepsis, get blood culture and start antibiotics.
9. Blood transfusion if anaemic, consider the general condition

Management of Complicated Severe Malaria

Management of Algid malaria and shock

ABC approach, if systolic BP <50mmHg in children 1 -5 yrs. or <80 mmHg in >5yrs, suspect Gram-negative septicaemia. In such cases, take blood samples for culture. Give parenteral broad-spectrum antimicrobials. Correct hemodynamic disturbances. Treat with 30ml/kg 0.9% Saline IV in 1 hour, then reassess. Give oxygen if possible.

Consider the need for blood transfusion: Assess the degree of pallor (no pallor, some pallor, or severe pallor). Look for signs of severe anaemia such as very pale mucous membranes, respiratory distress, and a rapid pulse. Note: The decision to transfuse with blood should not only be based on low laboratory values.

Transfuse blood if there is:

A. Cardio-respiratory symptoms, e.g., cardiac failure or decompensation.
B. PCV<15% or Hb <5g/dL.

Management of metabolic acidosis

Exclude and treat hypoglycaemia, hypovolemia, and septicaemia. Give isotonic saline 20 ml/Kg of body weight rapidly or screened. If severe, add hemofiltration or haemodialysis.

If there is spontaneous bleeding and coagulation disorder: Transfuse screened fresh whole blood or clotting factors; give vitamin K 10 mg IV per day for adults, 1 mg/day for infants, 2 -3 mg/day for children, and 5 -10 mg/day for adolescents. Vitamin K should be given SC or IV.

Acute renal failure: Exclude dehydration; maintain strict fluid balance; carry out dialysis if indicated.

Malarial haemoglobinuria (black-water fever)

Continue with suitable anti-malarial treatment; transfuse screened fresh blood if needed.

Acute pulmonary oedema

Prevention is by avoiding excessive IV fluids

Treatment

Raise the bed to an angle of 45 degrees; give oxygen. If pulmonary oedema is due to overhydration, stop intravenous fluids, and give a diuretic (furosemide I.V. in a dose of 40 mg for adults and 0.5 -1 mg/Kg/dose for children).

In life-threatening hypoxemia, intubate and ventilate the patient.

Exclude common infections/conditions that present like severe malaria:

Perform urinalysis for urinary tract infection.

A diagnostic lumbar puncture should be performed (unless contraindicated) for unconscious patients. Coma and fever may be due to meningoencephalitis or malaria. Cerebral malaria is not associated with signs of meningeal irritation (neck stiffness, photophobia, or Kernig's sign)

White blood cell count for other infections and chest x-ray for bronchopneumonia.

PCR for Covid-19, or antigen-sensitive ICT for Covid-19

Monitor considering the following points:

1. Level of consciousness: If there is an altered level of consciousness, use Glasgow or Blantyre coma scales to assess progress every 6 hours until the patient regains full consciousness.
2. Fluid input/output: Detect dehydration and avoid fluid overload. Prevent pulmonary oedema.
3. Vital signs: Monitor vital signs every 6 hours to detect complications of severe malaria. If pulmonary oedema develops (rapid respiratory rate and deep laboured breathing), stop all IV fluids except quinine and call the medical officer/ clinical officer for management

4. Level of parasitaemia: Determine the parasite count daily to monitor the therapeutic effect of treatment. Stop when there is no detectable parasitaemia.

The patient and relatives should be educated about compliance with a full course of treatment, home prevention of malaria, and the sequelae of severe malaria. Wait for the patient with severe malaria to recover before counselling.

Pre-referral treatment at peripheral units

In many rural settings in Sudan, it is usual to see patients with severe malaria seeking care at primary healthcare units. The health personnel in these units should refer the patients to the nearest hospital. Pre-referral treatment, if available, should be given. The choice is IV artesunate. If IV artesunate is not available, rectal artesunate should be used for children less than 6 years of age.

Artesunate suppositories

Artesunate should be given rectally at 10 mg/kg once the diagnosis of malaria is made. If the rectal capsule is expelled within 30 minutes of insertion, another rectal capsule should be inserted, and the buttocks held together for 10 minutes to ensure retention. Artesunate rectal capsules are recommended only for children under six years.

If, after 24 hours, the patient has not been referred to a hospital and is still unable to take oral medication, a second dose should be administered.

Treatment of P. vivax and P. ovale

The eradication of P. vivax or P. ovale hypnozoites using primaquine is contraindicated in children under 6 months

Infection Prevention And Control Measures In Health Care Settings:

Standard precautions are recommended.

Control Measures

The RTS, S vaccine for malaria is used for malaria control in children living in endemic areas and is not available for travellers. Effective measures to reduce the risk of acquiring malaria include control of Anopheles mosquito populations, protection against mosquito bites, treatment of infected people, and chemoprophylaxis. Measures to prevent contact with mosquitoes, especially from dusk to dawn (because of the nocturnal biting habits of most female Anopheles mosquitoes), include the use of bed nets impregnated with insecticide, mosquito repellents and protective clothing.

Prevention of Relapses

There is no test to determine the potential for relapses of P vivax or P ovale infection. Anti-relapse therapy can be provided along with treatment of symptomatic infection or after leaving an endemic area following a prolonged stay. Presumptive anti-relapse therapy, also known as terminal prophylaxis, uses a medication toward the end of the

exposure period or immediately thereafter to prevent relapses or delayed onset clinical presentations of malaria caused by hypnozoites. Primaquine and tafenoquine (Krintafel, in patients 16 years and older, and only if co-administered with chloroquine or hydroxychloroquine) are approved for use to prevent relapses of P vivax. Both can be used to prevent P. ovale relapse, but tafenoquine is not approved by the FDA for this use. Screening for G6PD deficiency using a quantitative test must be performed before using primaquine and tafenoquine, because both drugs can cause haemolysis in patients with G6PD deficiency.

Personal Protective Measures.

All travellers to areas where malaria is endemic should be advised to use personal protective measures, including the following: insecticide-impregnated mosquito nets while sleeping; remaining in well-screened or air-conditioned areas at dusk and at night; protective clothing, preferably permethrin-treated; and mosquito repellents.

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Visceral Leishmaniasis In Children

Introduction

Visceral leishmaniasis (VL), also known as kala-azar (black fever in Hindi), is a disease primarily caused by Leishmania donovani and L. infantum (synonym L. Chagas) , which is transmitted by phlebotomine sandflies. Rarely, visceral disease has been reported in patients infected with leishmanial species usually associated with cutaneous disease, in particular, L. mexicana . The major clinical manifestations caused by L. donovani and L. infantum are not generally distinguishable, and specialised techniques are needed to identify the species. However, treatment decisions for VL usually do not require species identification since they are based on disease severity, geographic origin, and the presence of HIV and other coinfections.

Pathophysiology

Leishmania invade and replicate within host macrophages, evading innate and cell-mediated immune responses. Infection generally appears to persist after clinical cure of the primary infection. Evasion and persistence are achieved through a combination of strategies, including neutralisation of complement components, preventing release of macrophage superoxide and nitric oxide, and suppressing induction of antigen-specific CD4+ T helper lymphocytes. Spontaneous recovery is rare.

Clinical Manifestations

Many leishmaniasis infections are asymptomatic, reflecting the ability of the host immune system to control the parasite. The ratio of asymptomatic infection to clinically manifest disease varies widely from >30:1 in Europe to 6:1 in Brazilian children and 4:1 in Bangladesh. This may reflect differences in parasite virulence, human genetic predisposition, nutritional status, the sensitivity and durability of positive results by the assay used to detect infection, and other factors. Most patients with subclinical infection harbour viable parasites lifelong and can develop reactivation disease in the setting of immunosuppression.

Visceral Leishmaniasis

The most important clinical manifestation of VL is the syndrome known as kala-azar (Hindi for «black fever»). The incubation period is usually two to six months but can range from a few weeks to several years. Onset of symptoms is usually insidious or subacute, with slow progression of malaise, fever, weight loss, and splenomegaly (with or without hepatomegaly) over a period of weeks to months. In rare cases, acute febrile illness can occur with rapidly progressive symptoms. Patients may complain of abdominal discomfort and fullness that may be localised to the left upper quadrant. The spleen is usually firm and minimally tender, but in some patients, palpation is quite painful, presumably due to capsular pressure from rapid enlargement. Hepatomegaly is usually less marked than splenomegaly. Lymphadenopathy may be observed in East African (including Sudan) VL but is rare outside this region.

Since parasites replicate in the reticuloendothelial system, very high parasite loads accumulate in the spleen, liver, and bone marrow. Severe anaemia can occur due to bone marrow suppression, haemolysis, and splenic sequestration. Advanced Kala azar is associated with marked cachexia, hypoalbuminemia, and oedema. Late in the course of the disease, hepatic dysfunction, jaundice, and ascites can occur.

Thrombocytopenia and hepatic dysfunction contribute to haemorrhagic complications. Patients may have spontaneous bleeding from the gingiva, nasal mucosa, or other sites. Rarely, chronic diarrhoea and malabsorption can occur because of parasitic invasion of the intestine.

Disseminated intravascular coagulation is a rare but potentially lethal complication of VL. The condition may occur with or without hemophagocytic lymph-histiocytosis. Laboratory findings: Nonspecific laboratory findings of VL include anaemia, neutropenia, eosinopenia, and thrombocytopenia. The anaemia is normocytic and normochromic unless iron deficiency is also present.

The aetiology of anaemia is thought to be multifactorial, including bone marrow suppression, haemolysis, and hypersplenism. An elevated neutrophil count is uncharacteristic of VL and should prompt a search for secondary bacterial infection. Elevated liver enzymes and bilirubin are also seen.

Hypergammaglobulinemia results from polyclonal B-cell activation. Severe anaemia and frank jaundice are associated with a poor prognosis.

Diagnosis

Definitive diagnosis requires demonstration of the parasite by either histopathology or culture of material obtained by needle aspiration or biopsy from affected organs (usually bone marrow or spleen). Aspirated material should be inoculated into culture, and the remainder used to prepare a Giemsa-stained smear. Biopsy specimens should be prepared with tissue sections as well as touch preparation. Histopathologic diagnosis requires visualisation of amastigotes; culture can be performed in Novy-McNeal-Nicolle or other parasitic growth media. Molecular methods (i.e., polymerase chain reaction) can also be used to detect parasites in tissue or peripheral blood.

Serologic tests

Indirect fluorescent antibody tests(IFA) and enzyme-linked immunosorbent assays (ELISAs) are useful diagnostic tools. The direct agglutination test (DAT) requires less equipment than ELISA, so it is useful in developing settings. The recombinant kinesin antigen (rK39) is a useful antigen in ELISA assays as well as in immunochromatographic strip format as a rapid test.

Post-kala-azar dermal leishmaniasis (PKDL)

PKDL is a chronic skin rash typically observed following clinical response to treatment for VL. PKDL occurs in up to 60 per cent of VL patients in East Africa. PKDL is rare in areas with L. infantum VL. It usually presents with erythematous or

hypopigmented macules, which sometimes progress to plaques or nodules. The diagnosis is made by evaluation of skin biopsies or slit skin specimens.

Coinfection with HIV

Patients with HIV-VL coinfection may have a lower incidence of splenomegaly. Among patients with profound immunosuppression, parasitic infection of atypical sites may occur, including the gastrointestinal tract, peritoneal space, lung, pleural space, and skin. HIVVL coinfected patients tend to have relatively low antibody titres, but molecular techniques have good sensitivity, given generally high levels of parasitaemia in peripheral blood specimens. Histopathologic or molecular confirmation is warranted for definitive diagnostic microscopy, culture, and/or molecular methods (3,4).

Treatment

The recommendation by the WHO is a combination treatment with Stibogluconate 20 mg/kg/day IM and Paromomycin 15 to 20 mg/kg/ day IM, both for 17 days.

Treatment of VL in patients with HIV

Primary treatment â Patients with VL should be evaluated for HIV coinfection; if found, HIV-VL coinfection should be treated aggressively with antiparasitic therapy and antiretroviral therapy.

For patients with HIV-VL coinfection in East Africa, Liposomal Amphotericin B (5 mg/kg intravenously administered on days 1, 3, 5, 7, 9, and 11) with Miltefosine (100 mg orally daily for 28 days). If Miltefosine is not available, monotherapy with Liposomal Amphotericin B (5 mg/kg intravenously on days 1,5.10,17, and 24) is an appropriate alternative.

Assessing response to treatment

- Clinically, based on resolution of fever, decrease in spleen size, and weight gain. Serologic tests are not useful tests of cure, as they remain positive for months to years after treatment.
- Post-kala-azar dermal leishmaniasis requires prolonged treatment; the optimal approach is uncertain clinical trial data are limited.

Therapeutic agents

Liposomal Amphotericin has the highest therapeutic efficacy and the most favourable safety profile for treatment of VL. Other agents with activity against VL include Pentavalent antimonial drugs, Paromomycin (a parenteral aminoglycoside), and Miltefosine (the first oral drug for treatment of VL).

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Chapter 4: Gastroenteritis And Diarrheal Diseases

Introduction

Diarrhoea is one of the most common clinical problems encountered in paediatric practice. It remains a leading cause of morbidity and mortality in children under five years of age, particularly in low- and middle-income countries. Despite advancements in child health, diarrhoeal diseases still account for approximately 500,000 child deaths annually, most of which are preventable with timely and appropriate management.

Definition

Diarrhoea is defined as the passage of three or more loose or watery stools within 24 hours, or an increase in frequency and liquidity compared to the child's usual pattern. In neonates and breastfed infants, the definition must be applied carefully, as frequent loose stools can be normal.

Global Significance

According to the World Health Organisation (WHO), diarrhoeal disease ranks among the top five causes of death in children under five. The burden is highest in Africa and South Asia, where poor sanitation, unsafe drinking water, and limited access to healthcare services persist. The illness contributes not only to acute mortality but also to long-term malnutrition, stunted growth, impaired cognitive development, and increased vulnerability to future infections.

Significance of Diarrhoeal Diseases in Paediatrics

Diarrhoea affects fluid and electrolyte balance, which can rapidly become life-threatening in young children due to their smaller fluid reserves and immature renal compensation mechanisms.

Dehydration, electrolyte imbalances (particularly sodium and potassium disturbances), and associated complications such as hypovolemic shock and acute kidney injury are key clinical concerns.

In addition, diarrhoea often disrupts feeding and nutrient absorption, contributing to the vicious cycle of malnutrition and infection—a major public health issue known as the "malnutrition-infection cycle."

Pathophysiology of Diarrhoea in Children

Diarrhoea occurs when the balance between absorption and secretion in the gastrointestinal tract is disrupted, leading to excessive loss of water and electrolytes in the stool. Understanding the pathophysiological mechanisms is crucial for diagnosing the underlying cause and selecting the appropriate therapeutic strategy.

Normal Physiology of Intestinal Fluid Balance

The small intestine normally absorbs about 8–9 litres of fluid per day, composed of ingested liquids and gastrointestinal secretions (saliva, gastric, pancreatic, and biliary fluids). Water movement is passive and follows osmotic gradients established by electrolyte transport, especially sodium and chloride. The colon reabsorbs about 1–1.5 litres of fluid, resulting in a normal stool volume of 100–200 mL/day.

Main Pathophysiological Mechanisms of Diarrhoea

Osmotic Diarrhoea

Occurs when non-absorbable solutes remain in the intestinal lumen, drawing water into the gut by osmosis. Common in carbohydrate malabsorption (e.g., lactose intolerance) and some laxative use (e.g., magnesium-containing antacids).

Key features:

- Stops with fasting
- Acidic stool pH (<6.0)
- High stool osmotic gap (>100 mOsm/kg)

Secretory Diarrhoea

Results from increased active secretion or inhibition of absorption of water and electrolytes. Often caused by enterotoxins (e.g., cholera, ETEC) that stimulate cyclic AMP or cyclic GMP pathways in enterocytes.

Key features**:**

- **Large-volume, watery diarrhoea**
- **Persists during fasting**
- **Low stool osmotic gap (<50 mOsm/kg)**

Inflammatory (Exudative) Diarrhoea

Caused by mucosal damage and inflammation, leading to secretion of mucus, blood, and proteins into the gut lumen. Occurs in invasive bacterial infections (e.g., Shigella, Salmonella, Entamoeba histolytica) or IBD.

Key features:

- Bloody diarrhoea (dysentery)
- Tenesmus, fever, abdominal pain - Positive stool leukocytes

Motility-related Diarrhoea

Occurs when transit time is decreased, reducing the contact time for nutrient and fluid absorption. Seen in hyperthyroidism, IBS, or post-gastroenteritis syndrome.

Key features:

- Variable presentation
- May coexist with other mechanisms

Malabsorptive Diarrhoea

Occurs due to damage to the absorptive surface of the small intestine. Seen in celiac disease, chronic giardiasis, and short bowel syndrome.

Key features:

- Bulky, foul-smelling, greasy stools - Weight loss, micronutrient deficiencies

Age-Specific Considerations in Children

Neonates and infants are more vulnerable due to:

- Immature intestinal mucosa.
- Reduced immune defence.
- Higher baseline intestinal permeability.
- Increased risk of dehydration.
- Rotavirus and norovirus are common in infants, leading to both osmotic and secretory diarrhoea.
- Summary Table: Mechanisms of Diarrhoea.
- Osmotic – non-absorbed solutes, e.g., lactose.
- Secretory – Toxin-mediated, e.g., cholera.
- Inflammatory – Mucosal damage, e.g., Shigella.
- Motility – Reduced transit time, e.g., IBS.
- Malabsorptive – Damage to the surface, e.g., Giardia.

Clinical Implications

Understanding the underlying mechanism helps differentiate between self-limiting and serious causes of diarrhoea. Management is tailored accordingly:

- Osmotic dietary change.
- Secretory rehydration and antimicrobials.
- Inflammatory antibiotics and supportive care.
- Malabsorptive nutritional rehabilitation.

Classification of Diarrhoea In Children

Accurate classification of diarrhoea is essential to guide clinical decision-making, determine urgency, tailor management, and anticipate complications. Diarrhoea can be classified based on duration, underlying pathophysiology, stool characteristics, and clinical severity.

Classification by duration

- Acute diarrhoea: Lasts <14 days – e.g., Viral gastroenteritis (rotavirus)
- Persistent diarrhoea: Lasts ≥14 days – e.g., Giardia, post-infectious enteropathy
- Chronic diarrhoea: Lasts ≥30 days – e.g., Celiac disease, IBD, cystic fibrosis.

Classification by Pathophysiological Mechanism

- Osmotic – Lactose intolerance, sorbitol ingestion
- Secretory – Cholera, ETEC, VIPoma
- Inflammatory – Shigella, Salmonella, IBD
- Motility-related – IBS, hyperthyroidism. Malabsorptive – Giardia, celiac disease

Classification By Stool Characteristics

- Watery diarrhoea – Viral (rotavirus), cholera
- Mucoid diarrhoea – Bacterial (Campylobacter)
- Bloody diarrhoea – Shigella, Salmonella, Entamoeba histolytica

- Fatty (steatorrheic) diarrhoea – Cystic fibrosis, celiac disease, giardiasis

WHO Clinical classification

No dehydration – Normal eyes and thirst – Home care with ORS
Some dehydration – Thirsty, sunken eyes – ORS
Severe dehydration – Lethargy, sunken eyes, not drinking – IV fluids

Classification by Aetiology

- Viral – Rotavirus, norovirus – Watery, self-limited
- Bacterial – Shigella, E. coli – Fever, bloody stool
- Parasitic – Giardia, Entamoeba – Chronic, foul-smelling stools
- Non-infectious – Celiac, food allergy, drug-induced – Chronic or relapsing pattern

Diarrhoea in children can result from a wide range of infectious and non-infectious causes. Infectious causes are the most common, especially in developing countries, and may be viral, bacterial, or parasitic. Accurate identification of aetiology is important to guide management, particularly when deciding whether antibiotics or further investigations are needed.

Infectious Causes

A. Viral
   - Rotavirus: Most common cause of severe diarrhoea in infants and young children globally.
   - Norovirus: Affects all ages; common in outbreaks and winter season.
   - Adenovirus (types 4041/): Associated with diarrhoea in young children.
   - Astrovirus: Mild, self-limiting diarrhoea in children under 5.

B. Bacterial
   - Escherichia coli (ETEC, EHEC, EPEC): Causes watery or bloody diarrhoea; EHEC may cause HUS.
   - Shigella: Causes dysentery (bloody diarrhoea), high fever, seizures.
   - Salmonella spp.: Non-typhoidal strains cause gastroenteritis; typhoidal strains cause systemic illness.
   - Campylobacter jejuni: Common bacterial cause; often from contaminated poultry.
   - Vibrio cholerae: Profuse watery diarrhoea (<rice water stools>) with severe dehydration.

C. Parasitic
   - Giardia lamblia: Chronic, foul-smelling, greasy stools with bloating.
   - Entamoeba histolytica: Invasive amoebiasis; causes dysentery and liver abscess.
   - Cryptosporidium: Common in immunocompromised children
   - (e.g., HIV).

- Ascaris and Strongyloides: Occasionally cause diarrhoea as part of systemic infection.

Non-Infectious Causes

- Celiac disease: Immune reaction to gluten, causing malabsorption.
- Lactose intolerance: Osmotic diarrhoea due to lactase deficiency.
- Inflammatory bowel disease: Crohn's disease and ulcerative colitis in older children. - Cystic fibrosis: Steatorrhea and failure to thrive.
- Food allergy/intolerance: Often associated with eczema, vomiting, or blood in stool.
- Antibiotic-associated diarrhoea: Disruption of gut flora; may lead to C. difficile infection.

Risk Factors for Infectious Diarrhoea in Children

- Poor sanitation and hygiene.
- Use of contaminated water or food
- Malnutrition
- Lack of exclusive breastfeeding
- Recent antibiotic use
- Exposure in childcare centres or during outbreaks

Summary

Infectious causes dominate in acute diarrhoea, especially viral agents in infants. Bacterial and parasitic infections are more likely in cases of bloody diarrhoea or prolonged symptoms. Non-infectious causes should be considered in chronic or recurrent cases, particularly in well-nourished children or those with systemic signs.

Clinical Features and Assessment Of Diarrhoea In Children

Thorough clinical assessment is essential for determining the severity of diarrhoea, identifying complications such as dehydration, and guiding appropriate treatment. The presentation can vary depending on the cause, duration, and presence of comorbidities.

General Clinical Features

- Increased frequency of stool passage (≥3 times per 24 hours)
- Loose, watery, or unformed stools
- Abdominal cramping or discomfort
- Nausea and/or vomiting
- Fever (especially with bacterial causes)
- Loss of appetite
- Weight loss (in prolonged or recurrent cases)
- Dehydration signs

Dehydration Assessment (WHO Guidelines)

Assessment is based on physical signs and used to classify dehydration into three categories:

A. No Dehydration
   - Alert, well, and drinking normally
   - No sunken eyes
   - Moist mucous membranes
   - Normal skin turgor.

B. Some Dehydration
   - Restless or irritable.
   - Thirsty, drinks eagerly.
   - Sunken eyes.
   - Decreased skin turgor (skin pinch goes back slowly).

C. Severe Dehydration
   - Lethargy or unconsciousness
   - Unable to drink or drinking poorly
   - Very sunken eyes
   - Skin pinch goes back very slowly (≥2 seconds)
   - Weak or absent peripheral pulses

Red Flags Requiring Urgent Evaluation

- Blood in stool (dysentery)
- Persistent vomiting
- Signs of shock (cold extremities, weak pulse, delayed capillary refill)
- Inability to tolerate fluids orally
- Severe malnutrition or underlying chronic illness
- Infants <6 months with any signs of dehydration

Nutritional Status Assessment

- Measure weight-for-height and MUAC.
- Look for bilateral pedal oedema (suggestive of severe acute malnutrition) .
- Assess for visible wasting and poor appetite.
- Consider growth faltering in prolonged diarrhoea**.**

Focused History

- Onset, duration, and frequency of diarrhoea.
- Stool characteristics (watery, bloody, mucous, fatty).
- Associated symptoms: vomiting, fever, abdominal pain.
- Recent food intake, antibiotic use, travel, and water source.
- Feeding history, breastfeeding, and complementary foods.
- Vaccination status (especially rotavirus vaccine).
- Any similar illness in the family or the community.

Physical Examination Checklist

- General appearance and activity level
- Vital signs: temperature, heart rate, respiratory rate, capillary refill
- Hydration signs: eyes, mucosa, turgor, fontanelle (infants)
- Abdominal examination: tenderness, distension, bowel sounds
- Skin and eyes for signs of micronutrient deficiency (e.g., vitamin A, zinc)
- Weight measurement and comparison with prior records

Summary

The cornerstone of clinical management is rapid recognition of dehydration and red flag symptoms. A detailed history and physical examination should be performed in all cases to guide classification, management, and decisions on referral or admission.

Diagnosis and Laboratory Investigations in Diarrhoea

The diagnosis of diarrhoea in children is primarily clinical. Laboratory tests are reserved for moderate to severe cases, those with complications, persistent or chronic diarrhoea, or when specific pathogens are suspected. Investigations help identify the cause, assess the severity, and detect complications such as electrolyte imbalance or malnutrition.

Clinical Diagnosis

- Based on history and physical examination.
- Assess stool frequency, volume, appearance, and associated symptoms.
- Identify signs of dehydration and malnutrition.
- Determine possible exposure (e.g., contaminated water, recent travel, family outbreaks).

Indications for Laboratory Testing

- Bloody diarrhoea (dysentery)
- Persistent diarrhoea (>14 days)
- Severe dehydration or shock
- Suspicion of cholera or outbreak investigation
- Suspected parasitic infection
- Severe malnutrition
- Children not improving with standard treatment - Neonates and immunocompromised children

Stool Tests

- Stool microscopy: Detects ova, parasites, pus cells, and red blood cells. –
- Stool culture: Identifies bacterial pathogens such as Shigella, Salmonella, and Campylobacter.
- Stool antigen tests: For Rotavirus, Giardia, Cryptosporidium.
- Occult blood test: Detects hidden blood in stool.
- Stool pH and reducing substances: Helps in suspected carbohydrate malabsorption.

Blood Tests

- Serum electrolytes: Detects hyponatremia, hypernatremia, hypokalaemia.
- Urea and creatinine: Assess renal function, especially in dehydration.
- Complete blood count (CBC): May show leucocytosis in infection.
- C-reactive protein (CRP) or ESR: Elevated in systemic infection or inflammation.

Special Investigations for Chronic Diarrhoea

- Endoscopy with biopsy: For suspected IBD or celiac disease.
- Sweat chloride test: For suspected cystic fibrosis.
- Thyroid function tests: If hyperthyroidism is suspected.
- HIV test: For immunocompromised children with chronic diarrhoea.

Imaging (if needed)

- Abdominal X-ray or ultrasound: May be used to evaluate distension, obstruction, or systemic complications.
- Rarely indicated unless atypical symptoms present (e.g., abdominal mass, intussusception, hepatomegaly).

Summary

Laboratory investigations are not routinely required in every child with diarrhoea. They should be used selectively based on clinical findings, duration of illness, and severity. A good clinical assessment remains the most important tool for early diagnosis and management.

Management and Treatment of Diarrhoea in Children

The primary goals in managing diarrhoea in children are to prevent and correct dehydration, maintain adequate nutrition, treat the underlying cause when appropriate, and prevent complications. Most cases are self-limited and can be managed with supportive care.

Rehydration Therapy

Oral Rehydration (ORS)

First-line treatment for children with some dehydration.

WHO-recommended low-osmolarity ORS contains 75 mEq/L of sodium and 75 mmol/L of glucose.

Dosage: 75 ml/kg over 4 hours for some dehydration.

Continue breastfeeding and feeding during rehydration.

Intravenous Fluids (IVF)

Indicated for children with severe dehydration or those unable to tolerate ORS.

Use Ringer's Lactate or Normal Saline.

100 ml/kg over 3–6 hours (30 ml/kg in the first hour, then 70 ml/kg over 5 hours).

Zinc Supplementation

- Reduces duration and severity of diarrhoeal episodes.
- Children 6 months and older: 20 mg/day for 10–14 days. - Infants under 6 months: 10 mg/day for 10–14 days.

Nutritional Management

- Continue breastfeeding throughout illness.
- Encourage age-appropriate, nutrient-dense foods.
- Avoid starvation or restricting food during diarrhoea.
- Offer small, frequent meals and encourage oral intake.

Antibiotic Use

- Most cases do not require antibiotics.
- Indications include:
- Bloody diarrhoea (Shigella)
- Cholera with severe dehydration
- Suspected giardiasis or amoebiasis
- Typhoid fever or systemic bacterial infection

Always choose antibiotics based on local resistance patterns and laboratory confirmation when available.

Management of Severe Acute Malnutrition (SAM)

- Use ReSoMal (Rehydration Solution for Malnutrition) if available.
- Monitor closely for overhydration.
- Begin F-75 therapeutic feeds once stabilised.
- Treat underlying infections empirically if needed.

Supportive Measures and Symptomatic Care

- Antiemetics may be considered for persistent vomiting (e.g., ondansetron).
- Antipyretics for fever (e.g., paracetamol).
- Avoid anti-motility drugs (e.g., loperamide) in children. - Educate caregivers on signs of dehydration and when to return to the clinic.

Indications for Hospitalisation

- Severe dehydration requiring IV therapy
- Inability to retain ORS due to persistent vomiting
- Infants <6 months with moderate/severe dehydration
- Signs of systemic infection or shock
- Malnutrition with complications
- Suspected surgical abdomen or unclear diagnosis

Summary

Management of childhood diarrhoea involves prompt rehydration, nutritional support, targeted therapy when necessary, and ongoing caregiver education. Most children can be treated at home or in outpatient settings with ORS and zinc.

Complications of Diarrhoea in Children

Complications can arise when diarrhoea is severe, prolonged, or improperly managed. Young children and malnourished individuals are at greatest risk. Early recognition and intervention can prevent most of these outcomes.

1. Dehydration and Shock

Hypovolemic shock is a life-threatening complication.

Signs include cold extremities, weak pulse, prolonged capillary refill, and hypotension.

Requires urgent IV fluid resuscitation.

2. Electrolyte Imbalances

Hyponatremia: May cause seizures, altered mental status.

Hypernatremia: Risk of cerebral bleeding or oedema if corrected too fast.

Hypokalaemia: Can lead to muscle weakness, arrhythmias.

3. Acute Kidney Injury (AKI)

Results from severe dehydration and reduced perfusion.

Requires fluid resuscitation and careful monitoring.

May progress to the need for dialysis in rare cases.

4. Malnutrition and Growth Faltering

Prolonged diarrhoea leads to poor nutrient absorption.

Loss of appetite and nutrient depletion contribute to weight loss and stunting.

5. Sepsis and Secondary Infections

Especially in immunocompromised or malnourished children.

May present with fever, altered consciousness, and lethargy.

6. Neurological Complications

Febrile seizures in infants with high fever.

Electrolyte disturbances (Na^+ , Ca^{2+}) may lead to convulsions.

Prevention of Diarrhoeal Disease in Children

Prevention strategies focus on improving hygiene, nutrition, water safety, and vaccination. Public health measures are crucial in reducing incidence and severity, especially in high-risk populations.

Exclusive Breastfeeding

Recommended for the first 6 months of life.

Protects against enteric infections through antibodies and antimicrobial factors.

Safe Complementary Feeding Practices

Begin at 6 months while continuing breastfeeding.

Use clean utensils and properly prepared food.

Educate caregivers on hand hygiene and food handling.

Clean Water and Sanitation

Promote access to clean drinking water.

Encourage the use of latrines and safe disposal of faeces.

Handwashing with soap after defecation and before meals.

Rotavirus Vaccination

Significantly reduces severity and hospitalisation due to viral gastroenteritis.

Recommended in national immunisation programs.

Zinc and Vitamin A Supplementation

Reduces incidence, duration, and severity of diarrhoea. Especially important in malnourished and vulnerable populations.

Key Learning Points

- Diarrhoea is a leading cause of child morbidity and mortality, especially under 5 years.
- Prompt assessment of dehydration and proper rehydration is lifesaving.
- ORS and zinc are essential first-line therapies.
- Antibiotics should be used judiciously and only when indicated.
- Continued feeding and breastfeeding are critical.
- Prevention is possible through vaccination, hygiene, and caregiver education.

Diarrhoea in Special Situations: Newborns and Malnutrition

Diarrhoea in Newborns

Diarrhoea in neonates (first 28 days of life) must be approached with caution, as they are highly vulnerable to rapid fluid and electrolyte loss. Newborns also have immature immune and renal systems, and their presentation can be subtle.

Common Causes in Newborns

- Early-onset sepsis (especially if associated with feeding intolerance, fever, or lethargy)
- Formula contamination or preparation errors
- Cow's milk protein allergy (non-IgE mediated colitis)
- Congenital infections (e.g., CMV, syphilis)
- Hirschsprung-associated enterocolitis
- Necrotising enterocolitis (NEC) in preterm infants

Clinical Features

- Increased stool frequency or watery stools
- Abdominal distension, vomiting
- Poor feeding, lethargy, irritability
- Signs of sepsis: temperature instability, apnoea, bradycardia
- Blood or mucus in stool may suggest infection or allergy

Management Principles

- Admit all neonates with diarrhoea for evaluation
- Start empiric antibiotics in suspected sepsis
- Rehydrate carefully (avoid rapid IV correction)
- Use expressed breast milk (EBM) or hydrolysed formula if cow's milk protein allergy is suspected
- Monitor weight, hydration status, and electrolytes closely
- Screen for NEC in preterm or ill infants with abdominal signs

Diarrhoea in Malnourished Children

Malnourished children are at high risk of prolonged and recurrent diarrhoea. They often present with atypical or masked signs of dehydration, electrolyte imbalances, and immune dysfunction. Mortality is significantly higher in this group if diarrhoea is not managed appropriately.

Features of Diarrhoea in Malnutrition

- Watery diarrhoea may be persistent (>14 days)
- Associated with skin changes, hair changes, and bilateral pedal oedema
- Anorexia and vomiting are common
- May be afebrile even with severe infection

Management Principles

- Use ReSoMal (Rehydration Solution for Malnutrition); if not available, modify ORS (diluted + added sugar and potassium)
- Avoid rapid IV fluids unless in shock
- Start antibiotics empirically: amoxicillin or ceftriaxone (local guidelines)
- Begin therapeutic feeding with F-75, progressing to F-100
- Supplement with zinc, vitamin A, folate, and iron (after stabilisation)
- Treat associated infections (e.g., pneumonia, UTI, parasitic diseases)
- Provide psychosocial support and caregiver education.

Summary

Newborns and malnourished children require special attention when presenting with diarrhoea. Rapid fluid shifts, atypical signs, and increased risk of complications demand early recognition, cautious rehydration, targeted therapy, and close monitoring. These groups should be managed at higher-level facilities when possible.

Chapter 5: Protein Energy Malnutrition

Overview of Malnutrition

It is important when treating acute malnutrition to understand the underlying medical and social causes so that, once cured, the child does not relapse in the future with further episodes of acute malnutrition.

In Sudan, Protein Energy Malnutrition (PEM) has always been one of the priority health problems among under-5 children and a major background cause of mortality caused by pneumonia and other infectious diseases due to its impact on weakening the immune system.

This contribution gives a brief overview of the underlying factors contributing to the development of malnutrition and of the physiological consequences of it. The classification of acute malnutrition and the protocols for treating it are based on this abnormal physiology. The section ends with an overview of how the abnormal physiology and classification of acute malnutrition are translated into the services provided.

Consequences of PEM:

Increased morbidity and mortality in childhood

Impaired cognitive, motor, social, and emotional development

Impaired school performance and learning capacity

Reduced adult stature

Impaired work capacity and productivity

increased development of non-communicable diseases in adult life.

The inadequacy

of the diet and the development of disease may occur due to other underlying factors such as inadequate access to food, inadequate care for women and children or lack of access to health services or living in an unclean environment.

These underlying causes may occur due to a lack of knowledge, for example, regarding proper age-appropriate feeding practices for infants and young children, good hygiene and sanitation practices essential for safe food preparation/or due to a lack of knowledge regarding appropriate preventative care, such as immunisation and growth monitoring for children or antenatal visits for pregnant women. If the deficiency is severe, weight loss is greater, and cellular and organ functions are severely affected. Every organ in the body is affected by these changes (**Figure 45)**.

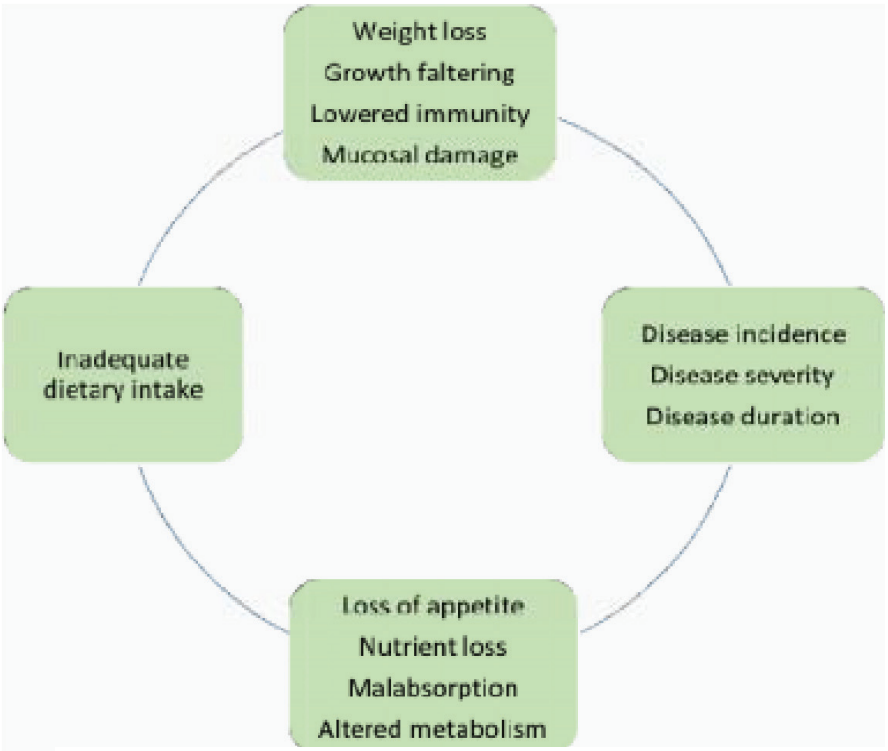

Figure 45

In severe disease

- The liver loses its capacity to metabolise and detoxify protein.
- Reduction in transferrin synthesis resulting in increased free iron.
- The heart loses its ability to respond to increased fluid load.
- The kidney loses its ability to regulate urine production.
- The stomach has reduced acidity, and the intestine has reduced motility.
- The immune system is impaired and less able to respond to infection.

Types of Malnutrition

Malnutrition is a general term that includes 'overnutrition' and 'undernutrition'.

It is important in childhood and adulthood, as it is a cause of obesity and consequent non-communicable diseases. These guidelines are primarily concerned with undernutrition and particularly with the identification and treatment of acute malnutrition. Starting to eat again after a period of prolonged starvation appears to precipitate cardiac failure.

Chronic malnutrition

Chronic malnutrition is called 'chronic' because it is measured over a longer time frame than acute malnutrition. Forms of chronic malnutrition include stunting and underweight.

Stunting is a measure of linear growth and is measured by 'height for age'. The height of the child is measured and compared to a chart of normal growth in height for children according to age. The growth charts are based on international standards for growth produced by the World Health Organisation (WHO).

Underweight is a measure of ponderal growth (related to weight) and is measured by 'weight for age'. The weight of the child is measured and compared to a chart of normal growth in children based on WHO standards. A child may be underweight for their age because they are too short for their age or are too thin. It is therefore a 'composite index'.

Acute Malnutrition

Acute malnutrition is seen in 2 different forms: wasting and oedema. Wasting is assessed by measuring either the mid-upper arm circumference (MUAC) or by measuring the child's weight and height, then comparing those measurements to a chart of normal weight according to the height or length of the child. This is referred to as the weight for height (WFH) (used for older children) or weight for length (WFL) (used for younger children). WFL and WFH are expressed in z-scores, which are a measure of the 'normality' of growth. Moderate wasting is defined as a MUAC less than 12.5 cm or a WFL or WFH less than -2 z-scores.

Severe wasting is defined as a MUAC < 11.5 cm or a WFL or WFH less than -3 z-scores.

An older term for wasting is 'marasmus', which is still referred to in some textbooks but is falling into disuse.

Bilateral Pitting Oedema is a form of acute malnutrition. Oedema resulting from malnutrition is always bilateral (on both sides of the body) and is always seen in the feet first. In more severe forms, the oedema spreads to the lower legs and hands on both sides.

In the most severe form of oedema, there is swelling around the eyes (periorbital oedema) and face.

When the oedema in the feet, legs, or hands is pressed firmly but gently with the thumbs for 3 Seconds, small pits are left behind when the thumb is taken away. This is referred to as bilateral pitting oedema. An older term for the oedema seen in malnutrition is 'kwashiorkor'. Kwashiorkor is sometimes still used in some textbooks, but it is a term that describes a syndrome, in which oedema is one of the signs. Bilateral pitting oedema is the sign that defines acute malnutrition (other signs of kwashiorkor are not definitive) and is the preferred term for classifying malnutrition.

A combination of wasting and oedema is sometimes seen and is a very poor prognostic indicator. An older term for this combination of forms of acute malnutrition is 'marasmic-kwashiorkor'.

The term 'protein energy malnutrition' is sometimes seen in textbooks and refers to acute malnutrition. It is a term that is falling out of use since acute malnutrition is not only the result of a deficiency of protein or energy.

Classification of Acute Malnutrition

Acute malnutrition is classified based on both anthropometric status and clinical condition.

Based on anthropometry, acute malnutrition is classified as 'moderate' or 'severe'. If there are no other medical complications that require hospital treatment, this is referred to as 'uncomplicated acute malnutrition'.

If clinical complications or a lack of appetite are present, this is called 'complicated acute malnutrition'.

Complications or a lack of appetite, which need hospital treatment, are normally only seen in severe acute malnutrition. The classification of acute malnutrition is a functional one and describes where the treatment may be given.

Uncomplicated acute malnutrition can be treated at the Primary Health Care (PHC)setting, while complicated acute malnutrition requires transfer to the hospital or specialised treatment.

Overview of the Identification and Treatment of Acute Malnutrition

The early identification and treatment of acute malnutrition is composed of 4 main components of care:

1. Screening and referral services.
2. Outpatient treatment of moderate acute malnutrition at the PHC
3. Outpatient treatment of uncomplicated severe acute malnutrition at the PHC
4. Inpatient treatment of complicated severe acute malnutrition at the hospital

Screening and referral services

The early identification and treatment of acute malnutrition means the malnutrition is easier to treat, the development of complications is much less likely, and treatment is more cost-effective.

The primary point of contact for screening services is the PHC. Every child aged less than 5 years and pregnant or breastfeeding woman with an infant aged less than 6 months undergoes screening for acute malnutrition at every visit to the PHC. Some PHC centres will offer screening services only, and when a case of acute malnutrition is identified, the woman or child is referred to a Treatment PHC.

Screening for acute malnutrition for women and children should be integrated whenever possible into outreach activities that are conducted by the PHC. When conducting public health awareness campaigns, Screening and Treatment PHC centres should include messages that raise the public's awareness of acute malnutrition and where treatment services are located. An example of a simple message is given in the annex

Treatment of moderate acute malnutrition at PHC

If the acute malnutrition is identified at an early stage, when it is only 'moderately acute', the routine treatment includes the giving of a supplementary food, which supplements the usual diet of the child or pregnant or lactating woman (PLW) who are the primary targets for this treatment. The treatment may include medicines if the physician diagnoses any other illnesses. Typically, the woman or child will attend every 2 weeks for a check-up to see that treatment is progressing well.

Treatment may last for a period of approximately 4to6 weeks, sometimes longer.

Treatment is always supported by counselling on appropriate child feeding practices, immunisation, dietary practices for adults, and general health advice as appropriate.

Treatment of uncomplicated severe acute malnutrition at the PHC

Children aged less than 5 years are the most vulnerable to nutritional deficiencies and acute malnutrition. For this reason, they are the primary target group for the treatment of Severe Acute Malnutrition (SAM). Most children diagnosed with SAM do not have complications and can be treated as an outpatient at a Treatment PHC. Routine care includes a therapeutic food that contains the specific balance of nutrients required for recovery (the amount given is based on the weight of the child), along with routine antibiotics and other medicines as needed for the treatment of the underlying disease. Antibiotics are given routinely because illnesses may be present, which may not always be symptomatic in the severely malnourished child. Typically, the child will attend weekly for a check-up to determine if the treatment is progressing well. Treatment may last for 48 weeks, sometimes longer, depending on the severity of the acute malnutrition. A child with a very low MUAC or a very low WFH or WFL may receive treatment for 3to4 months before full recovery.

Treatment of complicated severe acute malnutrition at the hospital

Children with complicated severe acute malnutrition are treated initially at the hospital. Hospital-based treatment may also be given to children who have been receiving treatment at the PHC but who are either not getting any better, not gaining weight, or whose condition is deteriorating.

Hospital-based treatment involves the use of specialised therapeutic milks 4 and routine intravenous or intramuscular antibiotics for complicated cases. Typically, the child remains in the hospital until the condition is stabilised and they are well enough to be discharged back to the PHC to continue nutritional rehabilitation until full recovery. This stabilisation phase may last from 2 to 4 days, with a further period of 'transition' when the child is prepared for discharge back to the PHC for 1 to 3 days.

The child may require longer treatment before discharge to the PHC, depending on the severity of their clinical condition.

Various types of therapeutic milk with differing nutritional compositions may be prescribed according to the age and severity of the medical condition of the child.

Early diagnosis

The early diagnosis of acute malnutrition results in lower mortality risk for the individual child and more cost-effective service delivery. Adequate human and equipment resources should be supplied for systematic screening to be integrated into routine service delivery in every department that comes into contact with children aged less than 5 years and PLW. As a minimum, this requires at least one member of staff trained in the use of a MUAC tape and the provision of child and adult MUAC tapes.

Compliance with treatment

Compliance with treatment is important from the point of view of the patient and of the health care providers delivering the service. Complying with the protocols should ensure that the patient can remain in treatment until cure and prevent or reduce the risk of possible relapse in the future.

Many of the protocols for the treatment of acute malnutrition differ from those for normally nourished individuals, and health care workers should be encouraged to adhere to the guidelines to ensure safe care delivery.

The treatment of acute malnutrition sometimes requires transfer between health facilities and requires the giving of medicines and nutritional treatments at home for several weeks or sometimes months. There may often be circumstances that make compliance with treatment by the caregiver difficult. This may be due to the cost of treatment, the distances they need to travel, or psycho-social issues. The healthcare provider must understand the individual circumstances of the caregiver by conducting a thorough assessment when they or their child is enrolled for treatment. Whenever possible, the healthcare provider should discuss any difficulties that may be faced at the beginning of treatment so that the caregiver has the best chance of complying with the treatment until discharged as a cure.

References

World Health Organization WHO guideline on the prevention and management of wasting and nutritional oedema (acute malnutrition) in infants and children under 5 years. 2023. https://app.magicapp.org/#/guideline/noPQkE

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