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Contents

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Expert panel
Dale Fisher (co-chair, Global Outbreak Alert and Response Network [GOARN] chair); Srinivas Murthy (co-chair, University of British Columbia, Canada); Kulkanya Chokephaibulkit (Mahidol University, Thailand); Dianne Crellin (University of Melbourne, Australia); Vu Quoc Dat (Hanoi Medical University, Viet Nam); Nicola Gini (Starship Children's Hospital, Auckland, New Zealand); Timothy Gray (Concord Repatriation General Hospital, New South Wales, Australia); Richard Kojan (The Alliance for International Medical Action [ALIMA], Senegal); Hans-Joerg Lang (University of Witten/Herdecke, Germany); Paula Lister (Sunshine Coast University Hospital, Australia); Peter Prager (University of Queensland, Australia); Helena Rabie (Stellenbosch University, South Africa); Naoki Shimizu (St Marianna University School of Medicine, Japan).

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Médecins Sans Frontières: Tanja Ducomble.

United Nations Children's Fund: Maria Otelia Costales, Imran Mirza, Yodit Sahlemariam.

United States Centers for Disease Control and Prevention: Jeffrey McFarland, Mark Papania, Robert Perry.

WHO: April Baller, Diana Chang Blanc, Janet Diaz, Santosh Gurung, Jose Hagan, Lee Lee Ho, Dragan Jankovic, Sudhir Khanal, Katrina Kretsinger, Margaret Lamunu, Ann Lindstrand, Laura Nic Lochlainn, Balcha Girma Masresha, Mick Mulders, Susan Norris, Katherine O'Brien, Maria Clara Padoveze, Desiree Pastor, Minal Patel, Lisa Rogers, Alex Rosewell, Wilson Milton Were, Nasrin Musa Widaa.

Abbreviations

AIIR	airborne infection isolation room
ARDS	acute respiratory distress syndrome
BP	blood pressure
bpm	beats per minute
CLIA	Clinical Laboratory Improvement Amendments
CPAP	continuous positive airway pressure
CRT	capillary refill time
HCW	health care worker
HEPA	high-efficiency particulate air
HIV	human immunodeficiency virus
HR	heart rate
IO	intraosseous
IPC	infection prevention and control
ISO	International Organization for Standardization
IV	intravenous
NS	normal saline
ORS	oral rehydration salts
PEP	post-exposure prophylaxis
PPE	personal protective equipment
RL	Ringer's lactate
RR	respiratory rate
SOP	standard operating procedure
SpO_2	peripheral oxygen saturation
SSPE	subacute sclerosing pan encephalitis
WHO	World Health Organization

1 Introduction

This guide has been developed to reduce the high morbidity and mortality seen in some of the current outbreaks of measles. This short guide outlines practical clinical care interventions and is derived from previously published WHO documents, including the WHO *Pocket book of hospital care for children* (1), WHO *Paediatric emergency triage, assessment and treatment* (2), and other international guidelines such as the *Surviving Sepsis Campaign: international guidelines for the management of sepsis and septic shock: 2016* (3).

1.1 Target audience

This guide is intended for front-line clinicians and health care workers (HCWs) who care for clinically suspected or confirmed measles in any health care setting. This guide will also aid policy-makers and hospital managers to ensure policies are in place to safely provide necessary life-saving care to measles patients.

1.2 Key recommendations

1. All suspected cases of measles should be reported to public health authorities as mandated. Public health authorities in many countries request reporting of all patients with fever and maculopapular (non-vesicular) rash as suspected measles cases, whereas clinicians may form a differential diagnosis which includes clinically suspected measles based on their experience, clinical suspicion and the epidemiological country context. This guide applies to clinically suspected or confirmed measles cases.

2. Hospitals and public health authorities should update the existing infection prevention and control (IPC) guidelines to include specific IPC measures and airborne precautions for measles.

3. Ensure that all HCWs have presumptive evidence of measles immunity. Two doses of measles virus-containing vaccine are recommended if no evidence of measles immunity exists.

4. Prioritize the hospitalization of and airborne precautions required for patients with clinical warning signs. Non-severe measles cases should receive outpatient treatment and be isolated at home, with limited exposure to non-immune people, and be administered vitamin A as recommended.

5. Patients with clinically suspected measles or other clinical warning signs should be admitted to a treatment facility with isolation capacity – a single room is preferred. If this is not possible, then safeguard cohort patients in confined areas, separating clinically suspected and confirmed cases.

6. For all suspected measles cases among children under 5 years of age, administer one dose of vitamin A immediately on diagnosis and administer a second dose the next day, according to the age-specific dosing guidelines (Table 5.2). A third dose should be given 4–6 weeks later if any clinical signs of vitamin A deficiency, such as xerophthalmia, including Bitot's spots and corneal ulceration, present themselves.

7. In adults with measles, vitamin A may be of value, particularly in specific populations in which patients may have vitamin A deficiency. Women of reproductive age in whom vitamin A deficiency is suspected should only be treated with lower, but more frequent, doses.

8. Patients with measles are at high risk for complications, and thus careful care of eyes, mouth and skin is necessary to prevent secondary infections. Ensuring adequate nutrition is essential.

9. Severe manifestations or complications of measles should be managed using the same standards used in non-measles patients. When available, use local or national patient care guidelines, including antibiotic guidelines.

10. Administering prophylactic antibiotics is not recommended in adults and children with measles. However, early empiric antibiotics should be considered for suspected secondary bacterial infections.

11. There is insufficient evidence to make a recommendation for the routine use of antivirals (ribavirin) in adults and children with measles.

12. It is important to work with public health authorities to evaluate exposed HCWs, patients and visitors for presumptive evidence of measles immunity and take necessary actions including administration of post-exposure prophylaxis (PEP).

2 Objectives

During an outbreak, early and adequate treatment and clinical case management of clinically suspected measles patients is essential to reducing measles morbidity and mortality. The implementation of infection prevention and control (IPC) measures is important to prevent HCW infections, reduce transmission in health care settings, and reduce the risk of spread to vulnerable populations. Clinical management and infection control measures should not be delayed while waiting for laboratory confirmation of measles.

This short guide aims to improve the care of patients with clinically suspected or confirmed measles and to prevent health care-associated infections nosocomial transmission.

3 Background

3.1 Disease

Measles is one of the most contagious diseases in humans. It is caused by a paramyxovirus virus, genus *Morbillivirus*. Measles transmission is primarily person to person via large respiratory droplets. Airborne transmission via aerosolized droplet nuclei has been documented in closed areas for up to 2 hours after a person with measles occupied the area *(4)*.

3.2 Clinical presentation

The incubation period for measles is usually 10–14 days (range 7–23 days), measured from exposure to onset of fever. The disease is characterized by prodromal fever, rash, cough, red inflamed eyes (conjunctivitis), or runny nose (coryza), and the presence of Koplik's spots (reddish spots with a white centre) on the buccal mucosa. The characteristic erythematous maculopapular rash appears 2–4 days after onset of the prodrome, beginning on the face and becoming generalized and lasting 4–7 days. Skin peeling is common after resolution of the rash.

3.3 Complications

Complications associated with measles most commonly involve the respiratory and/or digestive tracts: otitis media, pneumonia, laryngotracheobronchitis (croup), diarrhoea and stomatitis. Dehydration can result from either reduced oral intake from stomatitis, increased losses from diarrhoea, or both. Measles can also be complicated by febrile seizures, especially in older children and adults, and post-infectious encephalitis. Vitamin A levels fall significantly during measles, and in children with pre-existing deficiency or malnutrition, measles can result in xerophthalmia, including inflammation of the cornea (keratitis), Bitot's spots and keratomalacia. Subacute sclerosing pan encephalitis (SSPE), a progressive degenerative disease due to persistent measles virus infection of the brain, occurs in five to ten cases per million reported measles cases an average of 7 years after acute measles (range 1 month to 27 years). Many case series of adult measles patients also report hepatitis as a complication. Measles infection during pregnancy is associated with an increased risk of complications, including miscarriage, preterm birth, neonatal low birth weight and maternal death. In populations with malnutrition, overcrowding and lack of access to health care, measles mortality can be as high as 2–15%.

4 Public health surveillance case definitions and classifications

Table 4.1. Case definitions to be used for public health surveillance *(5)*

Suspected measles case	A suspected case is one in which a patient with fever and maculopapular (non-vesicular) rash, or in whom a health care worker suspects measles.
Laboratory-confirmed measles	A suspected case of measles that has been confirmed positive by testing in a proficient laboratory,[1] and vaccine-associated illness has been ruled out.
Epidemiologically linked measles	A suspected case of measles that has not been confirmed by a laboratory, but was geographically and temporally related with dates of rash onset occurring 7–23 days apart from a laboratory-confirmed case or another epidemiologically linked measles case.
Clinically compatible measles	A suspected case with fever and maculopapular rash and at least one of cough, coryza or conjunctivitis, but no adequate clinical specimen was taken, and the case has not been linked epidemiologically to a laboratory-confirmed case of measles or other communicable disease.
Non-measles discarded case	A suspected measles case that has been investigated and discarded as non-measles through: • negative laboratory testing in a proficient laboratory on an adequate specimen collected during the proper time after rash onset; • epidemiological linkage to a laboratory-confirmed outbreak of another communicable disease that is not measles, i.e. confirmation of another etiology; • failure to meet the clinically compatible measles case definition.
Measles outbreak	A single laboratory-confirmed measles case should trigger an aggressive public health investigation and response in an elimination setting. An outbreak is defined as two or more laboratory-confirmed cases that are temporally related (with dates of rash onset occurring 7–23 days apart) and epidemiologically or virologically linked, or both.[2]

[1] A proficient laboratory is one that is WHO-accredited or has established a recognized quality assurance programme, such as International Organization for Standardization (ISO) or Clinical Laboratory Improvement Amendments (CLIA) certification.

[2] Criteria for epidemiological linkage include being a known contact, being in the same physical setting as the case during their infectious period for any length of time (shared enclosed air space such as at home, school, health facility waiting room, transport or workplace). Note, the virus remains contagious in the air or on infected surfaces for up to 2 hours; this should be considered when conducting contact tracing as transmission can occur even if the contact was not in the same room at the exact same time as the case. In some investigations, contacts are considered those sharing an enclosed air space with a case within 2 hours of when the case was there.

Box 1. Clinical medicine and public health surveillance: they're not the same thing!

Public health surveillance is done for a variety of reasons: for example, to identify an outbreak or to understand if the intervention (e.g. vaccine) is working. As measles can range from mild to severe illness, public health authorities in many countries request that all cases with fever and rash are reported. This helps to ensure that every case of measles is identified – even atypical ones. However, clinicians form a differential diagnosis based on their experience and the country context. They might or might not think a case which meets the public health suspected case definition of measles is truly measles. That's acceptable – but those cases must still be reported to public health authorities.

Most health facilities cannot nor should not implement measles treatment and IPC protocols for every case of fever and rash. Instead, it is more reasonable for health facilities to screen for clinically suspected measles, such as someone who presents with fever, rash and either cough, conjunctivitis or coryza. If someone meets this clinical definition, then they should be isolated from other patients, and clinical judgement should be used to decide if the likely cause of illness is measles. In that situation, the guidance provided in this document should be used for case management and IPC.

5 Clinical management and infection prevention and control measures

Topics

- **Early recognition/triage of patients with clinical suspected measles or severe illness**
- **Early infection prevention and control: apply standard and airborne precautions**
  - Update existing IPC guidelines
  - Health care worker immunization
  - Health care worker training
  - Administrative controls
  - Ensure early recognition, notification and source control
  - Single room or cohort with clinically suspected or confirmed cases
  - Environmental cleaning and waste management
- **Immediate administration of vitamin A**
  - Children
  - Adults
- **Symptomatic treatments for prevention of complications**
- **Early supportive care for sepsis/severe illness**
  - Assessment and re-assessment: interpret and respond
  - Diarrhoea and severe dehydration
  - Use of prophylactic antibiotics
  - Severe pneumonia and acute respiratory distress syndrome
  - Sepsis and shock
  - Croup/upper airway obstruction
  - Antiviral treatments

5.1 Early recognition/triage of patients with clinically suspected measles or severe illness

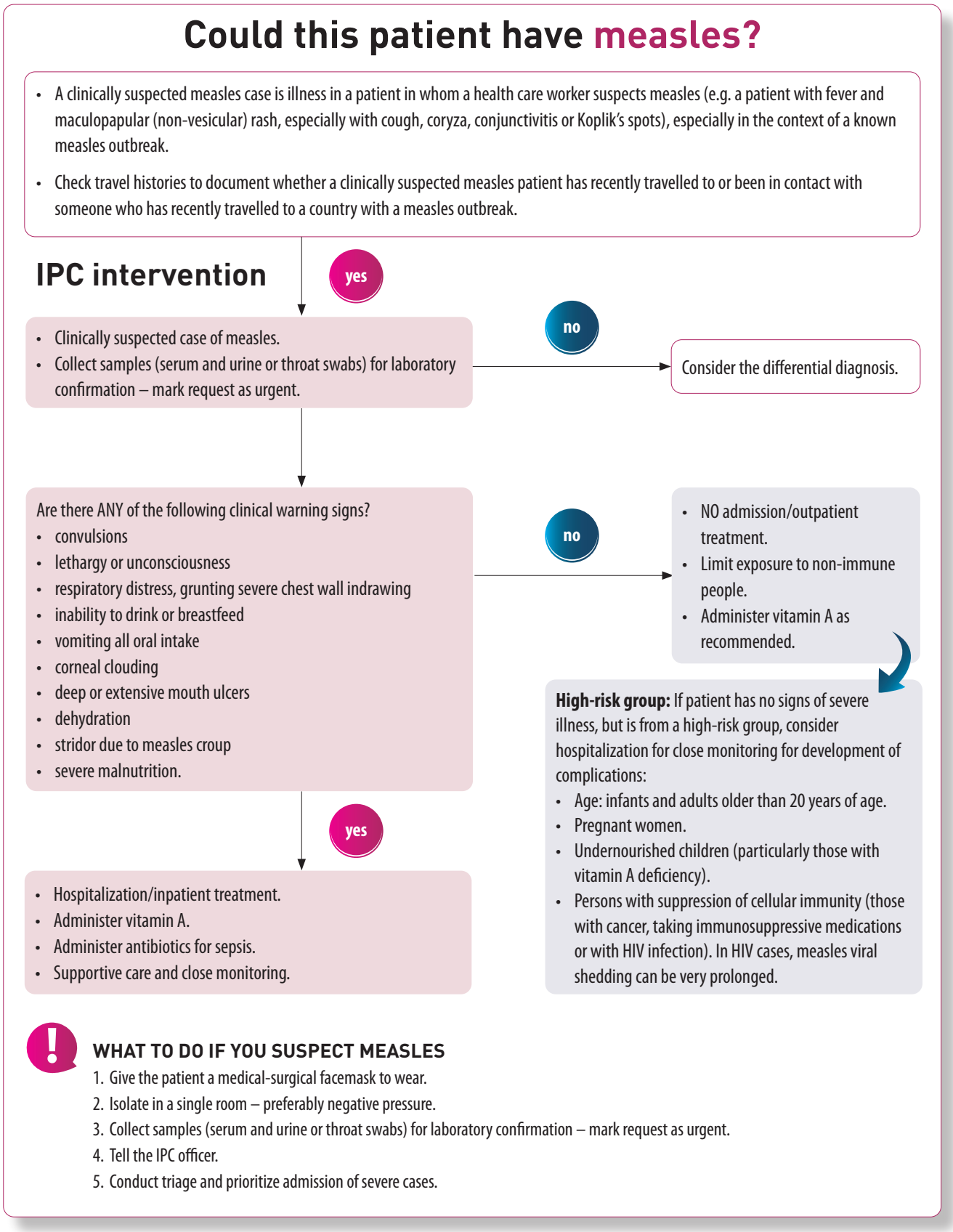

Fig. 5.1. Screening and triage for measles during outbreak

5.2 Early infection prevention and control: apply standard and airborne precautions

Update existing IPC guidelines

Hospitals and public health authorities should update the existing IPC guidelines to include specific IPC measures and airborne precautions for measles *(6,7)*.

Health care worker immunization

Ensure that all HCWs have presumptive evidence of measles immunity, which may include written documentation of two doses of measles-containing vaccine, laboratory evidence of immunity or previous disease (i.e. measles IgG positive in serum); equivocal results are considered negative. Two doses of measles virus containing vaccine are recommended if no evidence of measles immunity.

Health care worker training

Provide all HCWs with job-specific training on basic concepts of measles transmission, case management, including early recognition of clinical suspected cases and IPC measures on prevention of measles transmission. Ensure HCWs are educated and can demonstrate use of personal protective equipment (PPE) appropriately, according to risk evaluation, prior to caring for measles cases. Train all HCWs after receiving medical clearance on the use of tight-fitting respirators (N95 or equivalent), which must be fit tested.[3]

Administrative controls

Place visual aids (signs, posters) about respiratory etiquette (cover nose and mouth when coughing/sneezing with tissue or medical-surgical facemask, dispose of used tissues and masks, and perform hand hygiene after contact with respiratory secretions) and medical-surgical masks at the facility entrance and in common areas (e.g. waiting rooms). Provide supplies to perform hand hygiene and make available to all persons in the facility. Ensure standard operating procedures (SOPs) for infection control in hospitals and health settings are available. Perform routine audits and feedbacks on isolation practices to ensure HCWs are performing them correctly. Develop plans for safely receiving measles cases, either sporadic or in outbreaks. Where possible, facilities may plan for providing dedicated entrances, examination rooms and exits for clinically suspected cases, or even separate dedicated buildings.

Ensure early recognition, notification and source control

Where possible, while scheduling appointments for clinically suspected measles cases by phone, provide instructions for arrival, including which entrance/facility to use and what precautions to take (e.g. how to notify hospital staff, don a medical-surgical facemask upon entry, follow triage procedures). It is important to check travel histories to establish whether patients with clinically suspected measles have recently travelled to or been in contact with someone who has recently travelled to a country with a measles outbreak. In low-resource setting, the health centre staff should immediately notify the next administration level up, for example, district or province, using the quickest available means of communication in accordance with local procedures. The notification form should include available information on name, age, sex, clinical symptoms, date of rash onset, date of specimen collection, vaccination status, travel history and residence. If cases are reported along border areas, health officials in the adjoining areas should be notified and efforts should be made to share information. Notify the receiving facility in advance when transporting clinically suspected cases. Use dedicated triage stations; clinically suspected cases should be immediately isolated upon identification. In areas where isolation rooms are not available, a separate area or structure for clinically suspected measles patients should be used. Isolation should continue until the case is discharged, or for 4 days after rash onset, whichever is first.

[3] Fit testing is one of the most important parts of the respirator programme because it is the only recognized tool to assess the fit of a specific respirator model and size to the user's face.

Prioritize the hospitalization and airborne precautions of patients with clinical warning signs as indicated in Fig. 5.1. Non-severe measles cases should receive outpatient treatment and be isolated at home, although in some settings where isolation areas are available, the patients can be under observation for 24 hours. Limit exposure to non-immune people. Ensure that patients with confirmed or clinically suspected measles do not remain in outpatient departments and other areas where they may infect vulnerable individuals (infants, immune-compromised etc.). Provide patients with confirmed or clinically suspected measles with a medical-surgical facemask and separate these individuals from non-measles patients prior to or as soon as possible upon entering a health care facility. Limit transport of patients with clinically suspected and confirmed measles to essential reasons only, and if movement is unavoidable then use all necessary precautions (medical-surgical facemask on patient).

Single room or cohort with clinically suspected or confirmed cases

Immediately place patients with known or clinically suspected measles in a separate area until examined or in an airborne infection isolation room (AIIR), where available. Patients with clinically suspected measles or other clinical warning signs should be admitted to a treatment facility with isolation capacity – a single room is preferred. If this is not possible, then cohort patients in confined areas, separating clinically suspected and confirmed cases. Keep the isolation area segregated from other patient care areas.

Consult infection control staff before patient placement to determine the safety of alternative rooms (or locations) that do not meet engineering requirements for isolating patients with airborne diseases. Create a negative pressure environment in the converted area of the facility to create ad hoc patient isolation rooms (fans, open windows for external ventilation). Where resources allow, discharge air directly to the outside, away from people and air intakes, or direct all air through high-efficiency particulate air (HEPA) filters before it is introduced to other air spaces. Immune-compromised persons with measles infection should remain in airborne precautions for the duration of the illness due to prolonged virus shedding. Manage visitor access and movement within the facility. Ensure that only persons (HCWs, other staff, family, visitors) with presumptive evidence of measles immunity enter the room of a clinically suspected or confirmed measles patient or have contact with these patients in other areas of the facility.

Table 5.1. Isolation practices

Room/ward type	Suggested isolation practices
Single rooms	• Single rooms reduce the risk of contact transmission from a source patient. • Suitable types of single room isolation (in order of preference): – AIIR (single-patient room with negative pressure capabilities); – single room with air conditioning and an exhaust system (or external ventilation) to direct air outside of the building (preferably to an area without patient/visitor traffic); – single room with a fan (where available) placed to direct airflow towards an open window (window should face an area without patient/visitor traffic); – single room with no air circulation or window(s). • In all cases, any door(s) to the room should remain closed to prevent circulation of potentially contaminated air into the interior of the building. Also, any return air vents capable of circulating air into other areas of the hospital should be closed or occluded.
Cohorting	• If single rooms are unavailable, patients with **confirmed** measles can be cohorted together, segregated from other patient care areas. • As patients with clinically suspected measles may have another infection, they should never be placed with patients with confirmed measles as this will lead to transmission. • Rooms or wards used for cohorting patients should be in a designated area, clearly marked and separated from other patient care areas. • Cohort areas should be well-defined areas (designated rooms or wards), which can be clearly segregated from other patient care areas in the health care facility. • Suitable types, requirements and preferences of isolation rooms for cohort areas are the same as those listed above for single room isolation.

Environmental cleaning and waste management

Use standard cleaning and disinfection procedures as these are adequate for measles virus environmental control in all health care settings. Standard precautions are recommended for dealing with PPE and medical waste items from measles patients.

5.3 Immediate administration of vitamin A

Children

Vitamin A should be administered to all acute measles patients under 5 years of age, irrespective of the timing of previous doses of vitamin A.

Most patients with measles, even in developed countries, have laboratory or clinical evidence of vitamin A deficiency. Reduced blood levels of vitamin A may be partially due to the acute phase response that occurs during infection *(8)*. However, low blood levels of vitamin A are associated with more severe measles illness and complications, especially ophthalmologic disease.

Two doses of vitamin A are recommended for all suspected measles cases in children under 5 years of age, immediately on diagnosis and repeated the next day, according to the dosing indicated in Table 5.2 *(9)*. This treatment has been shown to reduce overall mortality in children *(10,11)* and pneumonia-specific mortality in children with measles under 2 years of age *(10)*. If a patient has any clinical signs of vitamin A deficiency, such as xerophthalmia, including Bitot's spots and corneal ulceration, then a third same age-specific dose should be given 4–6 weeks later.

Table 5.2. Vitamin A dose for paediatric patients

Age	Vitamin A dose
Infants aged < 6 months	50 000 IU
Infants aged 6–11 months	100 000 IU
Children aged 12–59 months	200 000 IU

Every effort should be made to ensure all health facilities have adequate supplies of vitamin A and that HCWs have guidance on this mortality reduction strategy.

Adults

Based on evidence in children and the theory surrounding the benefits of vitamin A supplementation, it is possible that it may be of value in adults with measles, particularly in specific populations in which patients may have vitamin A deficiency *(12)*. Women of reproductive age in whom vitamin A deficiency is suspected should only be treated with lower, but more frequent, doses of vitamin A (e.g. daily oral dose of 5000–10000 IU vitamin A for at least 4 weeks) due to possible teratogenic effects *(9)*.

5.4 Symptomatic treatments for prevention of complications

Patients with measles are at high risk for complications, and thus careful care of eyes, mouth and skin are necessary to prevent secondary infections. Ensuring adequate nutrition is essential.

Table 5.3. Symptomatic treatments

Symptom	Treatment
Fever	• Treat fever with paracetamol.
Nutrition	• Monitor child's weight daily and their intake. • Encourage breastfeeding for infants and small frequent meals for children. • Consult dietician. • Treat malnutrition if present.
Mouth ulcers	• Wash mouth with clean, salted water at least four times a day. Avoid giving child spicy foods. If mouth ulcers appear superinfected with bacteria, treat with antibiotics.
Eye care	• For mild conjunctivitis, clear and watery discharge, no treatment is necessary. Monitor for change in discharge quality, if pus present, then treat for bacterial conjunctivitis. • If eye has more than just clear watery discharge, such as pus or cloudy discharge, then treat for superinfection with bacteria with bacterial ointment, such as tetracycline ointment, applied three times a day for 7 days. Clean the eye carefully using clean cloth dipped in clean water or sterile gauzes. Consult with eye specialist as needed. Do not use steroid ointment on infected eyes.
Skin care	• Ensure skin is kept clean and dry. Monitor for signs of infection, such as cellulitis or other more severe soft tissue infections.

5.5 Early supportive care for sepsis/severe illness

Severe manifestations or complications of measles should be managed using the same standards used in non-measles patients. When available, use local or national patient care guidelines, including antibiotic guidelines. Discussion of some complications follows. For others, such as otitis media and meningoencephalitis, please refer to the *Pocket book of hospital care for children (1)*.

Assessment and re-assessment: interpret and respond

Patients at high risk of complications or already showing signs of severe illness or sepsis should be closely monitored and assessed at least every hour. Ideally, these patients should be admitted to an intensive care ward, or equivalent area, with sufficient staffing ratios and appropriate equipment. For patients not at high risk of complications and those with mild illness, perform an assessment at least every 8 hours. Refer to local hospital admission policies and protocols, if they already exist, for certain co-morbidities, such as severe acute malnutrition.

Assessments should include the following:

- Vital signs, including temperature, heart rate (HR), respiratory rate (RR), blood pressure (BP), peripheral oxygen saturation (SpO_2), mental status and urine output; and targeted physical examination (see Annex 1: Key criteria to assess nutrition and vital signs in children).
- Observations should be recorded on an observation chart to show trends over time.
- If vital signs and physical examination fall within the normal range for age then the patient can be monitored again in 3–4 hours, unless there is a clinical change.
- Any clinical change must prompt recording of another full set of observations. Abnormal observations should prompt a clinical review and formulation of a treatment plan with re-evaluation after any clinical intervention to assess response.
- Early warning scoring systems can be used to detect deteriorating patients and trigger a call for assistance by the most experienced clinicians and for evaluation for escalation of care *(13)*.

Diarrhoea and severe dehydration

Children with measles should be evaluated on admission and during their hospitalization for signs of dehydration and treated accordingly with oral or intravenous (IV) fluid based on severity *(1)*. See plans A, B and C, to treat none, some or severe dehydration in children. Also see Annex 2: Classification of dehydration.

Plan A: Treatment of patient with no dehydration

Children with diarrhoea but no dehydration should receive extra fluids at home to prevent dehydration. They should continue to receive an appropriate diet for their age, including continued breastfeeding.

Plan B: Treatment of patient with some dehydration using oral rehydration salts

WHO oral rehydration salts (ORS) contain: glucose 13.5 g/L, sodium chloride 2.6 g/L, potassium chloride 1.5 g/L, trisodium citrate dihydrate 2.9 g/L (total osmolarity of 245 mOsm/L).

Counsel the patient:

- drink extra water or ORS
- continue feeding
- provide assistance with drinking if needed.

1. Determine amount of ORS to give during first 4 hours

To determine the approximate amount of ORS required (in mL), multiply the patient's weight (kg) by 75.

Recommended volume of ORS within the first 4 hours to treat dehydration						
Weight of patient	< 5 kg	5–8 kg	8–11 kg	11–16 kg	16–30 kg	> 30 kg
ORS (mL)	200–400 mL	400–600 mL	600–800 mL	800–1200 mL	1200–2200 mL	2200–4000 mL

- Use the patient's age if you do not know their weight: estimated weight (kg)1–10 years = (age in years + 4) × 2.
- If the patient wants more ORS, give more.
- Give the recommended amount of ORS over a 4-hour period.
- If the patient is weak or vomits, give frequent small sips from a cup.
- After vomiting, wait 10 minutes then continue ORS but more slowly.
- Consider treating with an anti-emetic and continuing with ORS.
- The volume of oral ORS in the timeframe recommended above is often challenging and patients with moderate volume depletion/dehydration often require supplemental IV fluids.

2. After 4 hours or each clinical round

- Re-assess the patient and classify for dehydration.
- Select the appropriate plan to continue treatment.
- Begin feeding the patient in the clinic.
- Start zinc supplementation as part of home treatment.

Plan C: Treatment of patient with severe dehydration

Start IV fluid therapy with 0.9% normal saline (NS) with dextrose or Ringer's lactate (RL) with dextrose.

If patient can drink, give ORS by sips while IV line is being set up. Check the weight of the child or adult.

1. Determine amount of IV fluid to be given: 100 mL/kg
2. Determine rate of fluid to be given based on age: infant < 1 year; or child > 1 year

Recommended volume of IV fluid and type to treat severe dehydration

Age	First fluid bolus, 30 mL/kg	Second fluid bolus, 70 mL/kg	Fluid composition
Infants < 12 months	1 hour*	5 hours	RL with 10% dextrose or NS with 10% dextrose
12 months – 5 years	30 minutes*	2.5 hours	RL with 5% dextrose or NS with 10% dextrose

* Repeat once if weak radial pulse.

- Re-assess child every 15–30 minutes. If hydration status not improving, give fluids more rapidly.
- Give child ORS as soon as the child can drink.
- If the patient is weak or vomits give frequent small sips from a cup.
- Re-classify dehydration at each evaluation and select the appropriate plan to continue treatment.

Use of prophylactic antibiotics

Prophylactic antibiotics are not recommended in adults and children with measles. Early empiric antibiotics should be considered for severe disease associated with suspected secondary bacterial infections. Distinguishing viral from bacterial infection is often not clinically possible, therefore it is important to administer empiric antibiotics when secondary bacterial infection is considered in patients with complicated measles, e.g. lower respiratory tract infection, sepsis or septic shock. Severe disease in measles is often related to secondary bacterial infections, and early empiric antibiotics in patients with suspected superinfections should be administered aggressively, before the secondary bacterial infection is confirmed. The choice of antibiotic should be based on local experience and include therapy for gram positive bacteria including *Staphylococcus aureus*.

However, administering universal antibiotics to all patients as a preventative measure is not recommended.

Severe pneumonia and acute respiratory distress syndrome

Paediatric and adult patients with clinically suspected or confirmed measles should be evaluated on admission and during hospitalization for progressive signs of severe pneumonia and treated with oxygen therapy *(14)* and antibiotics for bacterial co-infection *(3)*.

Severe pneumonia in a child: defined with cough or difficulty breathing AND signs of pneumonia AND either:

- a general danger sign, such as lethargy, convulsions or unconsciousness; or
- inability to breastfeed, or central cyanosis (SpO_2 < 90%); or
- sign of severe distress, such as grunting or very severe chest indrawing.

Severe pneumonia in an adult: defined with cough or difficult breathing and severe respiratory distress, SpO_2 < 90%.

Antibiotics should be administered as soon as possible and based on local guidelines and local antibiograms, when available. If these data are not available, international guidelines can be adapted for local use. The following recommendations give options for community-acquired pathogens for children. If pneumonia develops while in hospital, then hospital-acquired, multidrug-resistant pathogens, such as *Pseudomonas* or methicillin-resistant *Staphylococcous aureus*, should be considered and appropriate antibiotics administered.

Recommendations for antibiotic treatment for severe pneumonia in children

WHO *Pocket book of hospital care for children (1)* recommendations for severe pneumonia:

- Start with ampicillin or penicillin G + gentamicin.
- If no signs of improvement within 48 hours, switch to third generation cephalosporin (e.g. cefotaxime or ceftriaxone).
- If no improvement in 48 hours and suspect community-acquired *S. aureus*, switch to cloxacillin and gentamicin.

The Infectious Diseases Society of America guidelines' suggestions for severe pneumonia in children more than 3 months of age *(15)*:

- Ampicillin or penicillin G for fully immunized child if local epidemiology documents lack of substantial high-level penicillin-resistance for invasive *S. pneumoniae* OR third generation cephalosporin (e.g. cefotaxime or ceftriaxone) for non-fully immunized child, known high-level penicillin-resistance for invasive *S. pneumoniae* or life-threatening infection.
- AND antibiotic against atypical pneumonia (i.e. macrolide).
- If community-acquired *S. aureus* suspected: add vancomycin or clindamycin based on local susceptibility data.

Oxygen therapy is also life-saving in children with severe pneumonia and should be administered as soon as possible.

Oxygen therapy in children

- Titrate to lowest flow rate necessary to reach target SpO_2 > 94% if in shock or > 90% if no shock.
- Nasal cannula is preferred in children as it may be easier to tolerate.
- Medical-surgical facemask with reservoir bag at 15 L/minute can be used for adults and children in an emergency.

Age	< 1 month	1–12 months	Pre-school age	School age
Oxygen flow rate	0.5–1.0 L/min	1–2 L/min	1–4 L/min	1–6 L/min

Some children may progress to acute respiratory distress syndrome (ARDS) that is unresponsive to oxygen therapy, and in those situations, clinicians should consult an intensive care team for more advanced intensive support, such as continuous positive airway pressure (CPAP), high-flow oxygen and/or intubation and invasive mechanical ventilation. If intubated, the use of a lung protective ventilation strategy to reduce ventilator induced injury is suggested *(16)*.

Sepsis and shock

Children and adults with clinically suspected or confirmed measles should be evaluated on admission and during hospitalization for signs of sepsis and shock and treated accordingly with appropriate antibiotics and fluid therapy. Sepsis represents a dysregulated immune response to an infection associated with organ dysfunction and requires both volume resuscitation and pathogen-specific therapy such as antibiotics or antivirals, when available.

Antibiotics for clinically suspected patients with measles who develop sepsis should be administered as soon as possible (less than 1 hour) and guided by the clinical syndrome (i.e. pneumonia, cellulitis, etc.), local epidemiology and include one or more effective drugs likely to kill the pathogen. See above for suggestions for antimicrobial therapy in clinically suspected measles patients with signs of severe pneumonia.

Septic shock is a subset of sepsis, which is complicated by hypotension refractory to fluid resuscitation and requires the use of vasopressor medication to maintain organ perfusion in addition to volume resuscitation and pathogenic-specific therapy *(17)*.

General principles for management of shock in children

1. Recognize child with shock:
   - Presence of all three: delayed capillary refill time (CRT) > 3 seconds; cold extremities; weak rapid pulse OR hypotension for age (systolic BP < 70 + [age in years × 2]).
   - Hypotension is a late finding in children.
2. In emergency situations, parenteral fluids can be given via an intraosseous (IO) line to deliver fluids for patient with shock or severe dehydration.
3. Start oxygen therapy to maintain SpO_2 > 94% while child in shock.
4. Use isotonic crystalloid fluid for fluid resuscitation: NS (0.9% NaCl) or RL solution (also called Hartmann's Solution for Injection).
   - Hypotonic fluids should not be used for resuscitation; these include 5% glucose (dextrose) solution or 0.18% saline with 5% dextrose solution, as they increase the risk for hyponatraemia, which can cause cerebral oedema.
   - Dextrose-containing fluids should not be delivered as a bolus as they are hypotonic and can also cause spikes and drops in glucose level.

General principles for management of shock in children (continued)

4. In well-nourished children, bolus 10–20 mL/kg as initial bolus over 30–60 minutes (use lower dose for malnourished children). The child should be re-assessed at the completion of infusion and during subsequent hours to check for any deterioration. If the child is still in shock, consider giving a further infusion of 10 mL/kg body weight over 30 minutes. If shock has resolved, provide fluids to maintain normal hydration status only (maintenance fluids).
6. If shock persists, despite fluid loading, then vasopressors may be added to maintain perfusion.
   - Adrenaline 1 mg = 1 mL of 1:1000 (or noradrenaline 1 mg = 1 mL 1:1000 if hypotensive).
     - add 1 mL to 49 mL of G5% to obtain 50 mL;
     - 1 mcg/kg/kg/min at initial flow rate for adrenaline and norepinephrine.
   - Close haemodynamic monitoring with adequate staffing; watch for extravasation.
7. If, at any time, there are signs of fluid overload, cardiac failure, hepatomegaly or neurological deterioration (in children), the infusion of fluids should be stopped, and no further IV infusion of fluids should be given until the signs resolve.

For children with severe anaemia or severe malnutrition:

- Rapid fluid therapy may also be harmful. Thus, use alternate resuscitation protocols found in the WHO *Pocket book of hospital care for children (1)*.

In children, markers of good perfusion include:

- CRT ≤ 2 seconds, skin exam: absence of skin mottling, well felt peripheral pulses, warm and dry extremities, urine output > 1 mL/kg/hour (< 12 years of age).
- Heart rate thresholds: up to 1 year: 120–180 bpm; up to 2 years: 120–160 bpm; up to 7 years: 100–140 bpm; up to 15 years: 90–140 bpm.
- Age-appropriate BP.

Croup/upper airway obstruction

Children may develop upper airway obstruction as a local complication of severe measles. Care must be taken to avoid complete airway collapse and asphyxiation *(3)*. Symptomatic treatment with nebulized adrenaline can be given; but do not give steroids for risk of further immunosuppression. Urgent consultation with an intensive care anaesthetist and surgeon early is suggested, in case emergency intubation or tracheostomy is necessary.

Antiviral treatments

There is insufficient evidence to make a recommendation for the routine use of antivirals (ribavirin) in adults and children with measles. Due to the lack of published evidence, there is a potentially valuable opportunity to study the use of antivirals such as ribavirin in the context of research trials to identify therapeutic options for the future. Trials could be in severe disease or at-risk groups with early disease.

6 Managing measles exposures

6.1 Health care workers

As previously discussed, ensure that all HCWs have presumptive evidence of measles immunity. Work with public health authorities to evaluate exposed HCWs, patients and visitors for presumptive evidence of measles immunity and take necessary actions including administration of post-exposure prophylaxis (PEP) *(7)*.[4]

- For HCWs with presumptive evidence of immunity, PEP and work restrictions are not necessary. However, the HCW should be monitored for 21 days after the last exposure.
- For HCWs without presumptive evidence immunity PEP should be administered and HCWs should be excluded from work from the fifth day after the first exposure until the 21st day after the last exposure (regardless of receipt of PEP).
- HCWs with known or suspected measles should be excluded from work for 4 days after the rash onset (with rash onset considered as Day 0), or for the duration of illness if immune-compromised.

6.2 Patients

Patients exposed to measles without presumptive evidence of measles immunity should be placed in airborne precautions for 21 days after the last exposure, or until discharge, and should be administered with PEP. The hospital should inform the public health authorities when discharging exposed patients within their possible incubation period.

Exercise active screening with two doses of measles-containing vaccine and vitamin A status in all children coming to hospitals/health centres for curative or preventive services and provide any missed measles vaccination as early as possible and supplemental doses of vitamin A.

[4] In unimmunized or insufficiently immunized individuals, measles vaccine may be administered within 72 hours of exposure to the measles virus to protect against disease. For susceptible individuals for whom the measles-containing vaccine is contraindicated, human immune globulin may be given after measles virus exposure and if administered within 6 days of exposure can prevent illness or reduce its severity.

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ANNEX 1 Key criteria to assess nutrition and vital signs in children

Age	< 1 month	1 month – year	1–5 years	5–12 years	> 12 years
Normal RR/min	30–40	30–40	20–30	20–25	12–20
RR/min in severe distress	> 60 or < 20	> 50 or < 10	> 40	> 40	> 40
Normal HR/min	120–180	120–180	100–140	90–140	90–140
Normal systolic BP (mm Hg)	60	80	90 + (2 × age)		120
Lower limit systolic BP (mm Hg)	50	70	70 + (2 × age)		90
Normal urine output	1–2 mL/kg/hour		1 mL/kg/hour		0.5–1 mL/kg/hour

Key tips for assessing a sick child

Blood pressure measurement in children

- Cuff should cover two thirds to three quarters of the upper arm, calf or thigh.
- Cuffs that are too small give falsely high readings.
- Cuffs that are too large give falsely low readings.
- Child should be at rest and not distressed as this will falsely elevate the reading.

To perform capillary refill assessment

- Press the nail bed of finger or thumb (peripheral capillary refill) or over the sternum (central capillary refill) for 3 seconds.
- Release and count in seconds the time taken for the return of colour (perfusion).

Weight estimates in children

It is always best to weigh children rather than estimate their weight. In an emergency, weight can be estimated in visibly well-nourished children:

- term infants: 2.5–4.5 kg
- estimate at 6 months of age: 5–7 kg
- estimate after 1 year of age: (age in years + 4) x 2 kg.

Criteria to define severe malnutrition

- Clinical signs of severe malnutrition: visible ribs and no fat on buttocks, thighs, arms or shoulders.
- Mid-upper arm circumference < 11.5 cm.
- Bilateral pedal oedema.
- Severe wasting: < 70% weight-for-length or -3 SD (see charts in the WHO *Pocket book of hospital care for children*) *(1)*.

Signs of respiratory distress

- Fast RR (normal ranges in table above).
- Nasal flaring, grunting.
- Intercostal recession and tracheal tug.
- Indrawing of the lower chest wall (very severe).
- Central cyanosis of the lips and tongue (very severe).
- Inability to breastfeed, drink (very severe).
- Lethargy (very severe).

ANNEX 2

Classification of dehydration

	Mild (3–5% volume depletion)	Moderate (6–9% volume depletion)	Severe (> 10% volume depletion)
Pulse	Normal	Rapid	Rapid and weak or thready
Systolic BP	Normal	Normal to low	Low
Buccal mucosa	Slightly dry	Dry	Parched
Skin turgor	Normal		Reduced
Urine output	Normal (> 0.5 mL/kg/hour adult; > 1 mL/kg/hour child)	At or below (< 0.5 mL/kg/hour or < 1 mL/kg/hour child × 3 hours)	Markedly reduced to anuric (< 0.5 mL/kg/hour × 3 hours)
Respiratory rate	No change	Increased	Increased
Ins and outs	Outs ≥ ins	Outs > ins	Outs >> ins
Other	Increased thirst	Increased thirst	In infant, depressed fontanelle Cold skin

Note: A child with severe dehydration and shock should have all three clinical signs present: delayed CRT > 3 seconds; cold extremities; and weak rapid pulse or hypotension for age: systolic BP < 70 + (age in years × 2). These children should be treated with the shock algorithm.

Contact:

Essential Programme on Immunization
Department of Immunization, Vaccines and Biologicals
World Health Organization
20 Avenue Appia
CH-1211 Geneva
Switzerland
www.who.int/immunization/en

9789240002876