1. DISEASE REPORTING

1.1 Purpose of Reporting and Surveillance

1. To identify measles cases.
2. To prevent the spread of measles.
3. To identify groups of unimmunized children and adults.

1.2 Laboratory and Physician Reporting Requirements

Physicians are required to report all cases (including suspected cases) immediately. Labs are required to report all measles IgM antibody-positive test results immediately.

1.3 Local Health Department Reporting and Follow-Up Responsibilities

1. Report all confirmed and presumptive cases (see definitions below) to the Acute and Communicable Disease Prevention Program within 24 hours.
2. Begin follow-up investigation within 24 hours. Submit all case data electronically within 7 days of initial report. If measles is suspected, facilitate collection and transport of specimens immediately to Washington State Public Health Laboratories (WSPHL). Collect data that must accompany all specimens sent to WSPHL (see §3.4).
3. Initiate special control measures within 24 hours of initial report (see §5, Controlling Further Spread).
   a. Identify contacts of the case during the period of communicability.
   b. Alert physicians, hospital emergency rooms, and other sites visited by the case during the period of communicability.
   c. Alert physicians, hospital emergency rooms, student infirmaries, and local officials of the potential for additional cases; encourage them to consider measles in persons with a rash illness. This includes making special arrangements for patient flow to minimize contact between cases and susceptibles. Healthcare workers should be advised to immediately report any suspected case. For more information on infection precautions see §6.2.
   d. Set up special clinics as needed to immunize susceptible persons at risk of infection.
   e. If indicated, prepare and distribute a press release in conjunction with the Immunization Program staff.
   f. Identify and exclude susceptibles when measles has been identified in a school or day care facility (see §§5 and 6). For more information on susceptibles in a medical setting see §6.2.

2. EPIDEMIOLOGY

2.1 Etiologic Agent

The measles virus—a single-stranded, RNA-encoded paramyxovirus.

2.2 Description of Illness

Measles is characterized by a generalized maculopapular rash, fever, and one or more of the following: cough, coryza, conjunctivitis, or Koplik’s spots. There are three stages of illness.

1. Prodrome

Measles has a distinct prodromal stage that begins with a mild to moderate fever and malaise. Usually within 24 hours there is an onset of conjunctivitis, photophobia, coryza (sneezing, nasal congestion, and
nasal discharge), an increasingly severe cough, swollen lymph nodes (occipital, postauricular and cervical at the angle of the jaw), and Koplik’s spots (seen only for a day or two before and after onset of rash). These spots are seen as bluish-white specks on a rose-red background appearing on the buccal and labial mucosa usually opposite the molars.

2. **Rash**
   The rash begins with flat, faint eruptions of upper lateral parts of the neck, behind the ears, along the hairline and on the posterior parts of the cheeks. The rash may appear from 1–7 days after the onset of the prodromal symptoms, but usually appears within 3–4 days. Individual lesions become more raised as the rash rapidly spreads over the entire face, neck, upper arms and chest. In severe cases, the lesions may become confluent. In mild cases, the rash may be macular and more nearly pinpoint, resembling that of scarlet fever.

3. **Fever**
   Fever is mild to moderate early in the prodrome, and goes up when the rash appears. Temperatures may exceed 40°C (104°F), and usually fall 2–3 days after rash onset. High fever persisting beyond the third day of the rash suggests that a complication (e.g., otitis media) may have occurred.

2.3 **Reservoirs**
   Other acutely infected humans.

2.4 **Modes of Transmission**
   Virus is spread directly from person to person by inhalation of suspended droplet nuclei or by contact with infective nasopharyngeal secretions. It can also be transmitted indirectly by objects (fomites) contaminated with nasopharyngeal secretions. Measles virus is labile. Half the infectivity is lost every 2 hr. at 37 C. So it depends on the initial number of viral particles in the droplet. It does not survive drying on a surface, so it has a short survival time on contaminated fomites. It is effectively spread as an aerosol. The virus survives drying in microdroplets in the air relatively well, as opposed to drying on a flat surface. Measles is one of the most contagious of all infectious diseases, with >90% attack rates among susceptible close contacts.

2.5 **Incubation Period**
   The incubation period ranges from 7–18 days (average 10–12 days) from exposure to the onset of prodromal symptoms. The interval from exposure to rash onset is usually 14 days (range 7–18 days), rarely as long as 19–21 days. The administration of IG early in the incubation period may extend this period to 28 days.

2.6 **Period of Communicability**
   Persons infected with measles are infectious 4 days before rash onset through 4 days after rash onset. Immunosuppressed persons might have a longer period of communicability.

2.7 **Treatment**
   No specific treatment.

### 3. CASE DEFINITIONS, DIAGNOSIS, AND LABORATORY SERVICES

3.1 **Confirmed Case Definition**
   Absent measles immunization or receipt of antibody-containing blood products within the previous 45 days:
   • Positive “confirmatory” lab results (measles virus isolation, detection of virus by PCR, or >4-fold rise in antibody titer), or
   • Positive IgM serology with compatible illness, defined as:
     • acute onset generalized maculopapular rash lasting ≥3 days and
     • temperature ≥38.3°C (101°F) and
     • cough, coryza, or conjunctivitis

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1 Note that up to 10% of vaccinated individuals may remain IgM-positive even 3 months post vaccination.
3.2 Presumptive Case Definition

A person who is epi-linked to a confirmed case and who has all of the following:
1. acute onset generalized maculopapular rash lasting ≥3 days and
2. temperature ≥38.3°C (101°F) and
3. cough, coryza, or conjunctivitis

3.3 Suspected (Clinical Diagnosis)

Any person with a generalized rash and fever of unknown etiology.

3.4 Services Available (or not) at the Oregon State Public Health Laboratory

Currently OSPHL performs no test for measles. WSPHL perform testing for measles-specific IgM and IgG antibodies. In addition, WSPHL can perform RT-PCR and viral culture for measles on clinical specimens. If measles is considered a real possibility, please contact ACDP epidemiologists to arrange testing at WSPHL. After the request has been approved, please collect the following information required by WSPHL: submitter, method of transport, expected specimen arrival date, tracking number, patient initials, DOB, rash onset date, specimen collection date, immunization history, specimen type(s), and test(s) requested.

Persons suspected to have measles should have serum drawn and specimens collected for RT-PCR and viral isolation (throat or nasopharyngeal swab preferred) at the time of the first health care visit. Urine samples may also contain virus, collection of both respiratory and urine samples can increase the likelihood of detecting virus. For additional information regarding collection, storage and shipping of specimens, see: http://public.health.oregon.gov/LaboratoryServices/CommunicableDiseaseTesting/Documents/measlesub.pdf.

The laboratory diagnosis of measles is most often made by detection of IgM antibody in a single serum specimen. In most instances, a serum sample should be collected for measles IgM at the first clinical encounter. However, 30% of serum samples obtained in the first 72 hours after rash onset give false-negative results. Negative results from serum collected in the first 72 hours after rash onset should be confirmed with a second serum obtained 72 hours or longer after rash onset! (Any positive test is OK.) IgM is detectable for at least 30 days after rash onset and frequently longer.

False positive IgM results for measles may be due to the presence of rheumatoid factor in serum specimens. Serum specimens from patients with other rash illness, such as parvovirus B19, rubella, roseola and dengue have been observed to result in false positive reactions in some IgM tests for measles. In these situations, confirmatory tests may be done at CDC. Because tests for IgG require two specimens and because a confirmed diagnosis cannot be made until the second specimen is obtained, IgM tests are generally preferred. However, if the IgM tests remain inconclusive, a second (convalescent) serum specimen, collected 14–30 days after the first (acute) specimen, can be used to test for an increase in the IgG titer.

The diagnosis can also be made by detection of measles RNA by RT-PCR or by isolation of measles virus in culture. A negative PCR or a negative culture does not rule out measles because both methods are much affected by the timing of specimen collection and the quality and handling of the clinical specimens. Clinical specimens for virus isolation should be collected at the same time as samples taken for serologic testing. Measles virus isolation and RNA detection are more likely to be successful when samples are collected on the first day of rash through 3 days following onset of rash; however, it is possible to detect virus up to day 10 following rash onset.

Among persons with a recent MMR vaccination, determination of the measles genotype is necessary to distinguish between wild-type virus infection and a rash caused from measles vaccination.

4. ROUTINE INVESTIGATION

4.1 Identify the Source of Infection

Identify people who may have been exposed to the case during the 7–18 days prior to onset of fever (especially the 3-day window that is 13-15 days before rash onset). Ask about:

1. names, addresses and phone numbers of any householder, playmate, or other contact who was sick or had a rash;
2. any indoor group activities attended, such as churches, theaters, tourist locations, air travel, parties, athletic events, family gatherings, and the like;
3. any visit to a doctor's office, clinic, or hospital (find out exact time and date);
4. any health care employment;
5. attendance or work at a school, day care, college, prison, etc.;
6. any travel outside of Oregon; and
7. any visitors from outside the U.S.

4.2 Identify Potentially Exposed Persons (Contacts)
Identify persons who may have been exposed to the case during the period from 4 days before through 4 days after onset of rash.

Measles is spread by the airborne route and is potentially transmissible after only brief exposure and at distances as great as 30 meters. The virus can remain airborne for up to 2 hours. That said, the fact is that transmission of measles in the United States is now the exception, rather than the rule, because of high levels of vaccine-induced immunity in the population. Therefore, an attempt to identify and interview every person who was within 30 meters of a case at any time during the case's 8-day period of potential contagion could represent an enormous amount of work for minimal public-health benefit.

There is no accepted, data-based definition of measles “exposure” that demands public-health follow-up. For practical reasons during a case investigation, some lines must nonetheless be drawn. In typical circumstances, “exposure” may be defined as
- any period of time spent indoors
- within 10 meters of a case's location
- within 20 minutes of the case's having been there.

These are operational guidelines only, and a more aggressive definition may be called for in some circumstances — e.g., a case who is coughing vigorously, a case in an under immunized population or in a school with high exemption rates. Conversely, cases are less contagious after the rash breaks out — which is when most of them seek medical attention — lessening the risk of transmission in health care settings. In hospital setting, the hospital infection practitioner might choose to use a broader time interval to define measles “exposure”.

Of those exposed, determine which have no evidence of immunity (as in §4.3) and implement appropriate prevention measures (§5.4).

4.3 Determine Measles Immune Status of Exposed Contacts
Nothing is foolproof, but any of the following are considered acceptable evidence of immunity:
- Birth before 1957 (but see §6.2)
- Laboratory -confirmed disease
- Laboratory evidence of immunity (protective antibody titers); or
- Documentation of adequate vaccination, as follows.
  - Pre-school children: 1 dose
  - Children in grades K-12: 2 doses
  - Women of childbearing age: 1 dose
  - Healthcare personnel born during or after 1957: 2 doses
  - Students at post-high-school educational institutions: 2 doses
  - International travelers ≥12 months of age: 2 doses
  - Children 6–11 months who plan to travel internationally: 1 dose
  - All other adults: 1 dose

A child receiving a measles-containing vaccine dose at this age should get a normal 2-dose MMR vaccine series starting at age 12 months. This child would receive a total of 3 MMR doses.
Measles

4.4 Environmental Evaluation

None.

5. CONTROLLING FURTHER SPREAD

5.1 General Comments

An outbreak is defined as three or more cases linked by time and place. However, outbreaks are now rare in Oregon where two doses of measles vaccination have been required since 1998. In 2014, >93% of Oregon kindergartners had received two doses of measles-containing vaccine. Such high vaccination rates have interrupted the endemic transmission of measles in the United States. Despite repeated introduction of measles into Oregon, we have seen no more than 14 cases in any given year since 1991. As long as vaccination rates remain high, aggressive measures are not needed to control measles. In addition, consider asking the reporting provider questions like "might the rash be due to antibiotics? Have you tested for other viruses?"
5.2 **Education**

Advise cases to avoid contact with susceptible children (particularly infants), pregnant women, and immunosuppressed individuals for 4 days after the rash appears. Instruct contacts or parents to look for signs and symptoms of measles 7-21 days after the first day of contact with the ill person during the communicable period. If suggestive symptoms develop, they must call the local health department ASAP. It is important to avoid exposing people who may coincidentally be present at a health care facility or doctor's office. Persons with possible measles should call ahead first to alert staff at such facilities so that special arrangements can be made to prevent contact with other patients or employees, pending an evaluation.

5.3 **Isolation of cases**

Keep hospitalized patients under airborne precautions for 4 days after rash onset. Exclude cases with confirmed and presumptive measles from day care, school or work as long as they could be contagious (ORS 433.106; OAR 333 019 0010). Advise cases to stay home and avoid contact with others.

5.4 **Protection of Contacts**

1. **Active Immunization with Measles Vaccine**

There is limited data regarding the effectiveness of MMR vaccine and immunoglobulin (IG) postexposure prophylaxis against disease prevention. The MMR vaccine, if administered within 72 hours may provide some protection or modify the clinical course of disease. Vaccine induced immunity to measles varies from person to person, but usually develops by 14 days. Contraindications include: pregnancy; anaphylactic allergy to neomycin or gelatin; untreated active TB; or compromised immunity (including HIV infection). Immune globulin may interfere with the desired response to measles vaccine if given less than 5 months before or 2 weeks after the measles vaccine. Any measles immunization given in that window should be repeated at least 5 months after the IG was given (see table page 5). If repeating the vaccine is not practical, serologic testing to determine if antibodies were produced is indicated.

2. **Passive Immunization with Immune Globulin**

Immune globulin can prevent or attenuate infection with measles, and should be considered for susceptible persons at increased risk of severe infection (e.g. pregnant women and children <1 year old) and those for whom vaccine is contraindicated. Patients should be warned that IG may only modify measles infection and may increase the incubation period to 28 days. IG should never be used as an outbreak control measure. To be effective, IG (see table page 5) must be administered ASAP but not more than 6 days after exposure.

Recommended dosages and routes of administration of IG for measles postexposure prophylaxis are as follows:

- **Infants <12 months of age**: 0.5 ml/kg of body weight, given intramuscularly; (IGIM; maximum dose = 15 ml). For infants aged 6-11 months, MMR vaccine is an acceptable alternative to IG, if given within 72 hours of exposure.

- **Pregnant women without evidence of measles immunity**: 400 mg/kg of body weight, given intravenously.

- **Severely immunocompromised‡ persons, irrespective of evidence of measles immunity**: 400 mg/kg of body weight, given intravenously.

- **IGIM (0.5 ml/kg of body weight; maximum dose = 15 ml)** can be given to other persons who lack evidence of measles immunity, but priority should be given to persons exposed in settings with intense, prolonged, close contact (e.g., household, child care, classroom, etc.).

‡Severely immunocompromised patients include patients with severe primary immunodeficiency; patients who have received a bone marrow or stem cell transplant until at least 12 months after finishing all immunosuppressive treatment, or longer where the patient has developed graft-versus-host disease; patients on treatment for ALL and until at least six months after completion of immunosuppressive chemotherapy; and patients with a diagnosis of AIDS or HIV-infected persons with CD4 percent <15% (all ages) or CD4 <200 lymphocytes /mm3 (age >5 years) and those who have not received MMR vaccine since receiving effective ART; some experts would include HIV-infected persons who lack recent confirmation of immunologic status or measles immunity.

3. **Follow-up for Contacts**

Susceptible contacts who received high-dose IG for measles prophylaxis should be immunized against
Measles

measles 5 or 8 months after IG was given (see table page 5) if the vaccine is no longer contraindicated.

5.5 Quarantine

Broad, mandatory quarantine is not generally indicated to control measles outbreaks. However, targeted (most commonly voluntary) quarantine maybe implemented especially where unvaccinated or populations at risk are affected. In such situations, susceptible persons who have been exposed to measles should be advised to stay home during days 5–21 after exposure. Under special circumstances, such as during outbreaks in schools attended by large numbers of persons who refuse vaccination, restriction of an event or other quarantine measures might be warranted (see §6).

6. MANAGING SPECIAL SITUATIONS

6.1 Case Among Employees or Attendees at School/Day Care Facility

1. Establish symptom watch for all identified school or daycare contacts, requesting a call to the local health department for any prodromal signs, symptoms or rash illnesses compatible with measles occurring within 21 days from the last date of attendance by any measles case. Active surveillance, with periodic check-ins, is recommended for susceptible contacts and those who received postexposure prophylaxis because of the measles exposure.

2. Encourage those with suspected infections to stay home while symptomatic so as not to expose susceptibles. To prevent healthcare-associated transmission, parents should call their children's healthcare provider about the possibility of measles prior to arriving at the doctor's office. The parents should also be instructed to call the health department at the first signs and symptoms of illness to help facilitate provider evaluation if needed. Such suspected patients should be met outside and masked before entering any building. A negative pressure room should be used if at all possible. If a negative pressure room is not available, an exam room close to an exit/entrance with its own ventilation system can be used. If such a room is used, the room shouldn't be used for 2 hours after the suspect patient leaves. Ideally this evaluation would take place at the end of the day to minimize exposures to staff/other patients.

3. Exclude all unimmunized children and staff without evidence of natural immunity (including susceptible siblings of a case attending other schools). Susceptible children and staff attending school (including susceptible siblings of a case attending other schools) at the time the case was communicable should be excluded for 21 days after the last date of attendance of the last measles case. However these individuals should be monitored for signs and symptoms of measles. At the health officer's discretion, these persons can be readmitted once vaccinated.

6.2 Case in a Medical Setting

Control efforts in medical settings should focus on reviewing existing immunization policies, employee immunization records and patient isolation practices.

Health care workers (volunteers, trainees, nurses, physicians, technicians, receptionists and other clinical support staff) should be immunized before exposure, ideally as a condition of employment. Documentation of immunity should be easily and readily available.

When a person who is suspected of having measles visits a healthcare facility, airborne infection-control precautions should be followed stringently. The patient should be asked immediately to wear a medical mask and should be placed in an airborne-infection isolation room (i.e., a negative air-pressure room) as soon as possible. If an airborne-infection isolation room is not available, the patient should be placed in a private room with the door closed and be asked to wear a mask. Only staff with presumptive evidence of immunity should enter the room of a person with suspect or confirmed measles. There is no recommendation for face protection for immune health care workers.

If a case with measles in any stage of communicability was treated at a healthcare facility, identify potentially exposed healthcare workers (see §4.2 above) and assess their documented immune status to confirm that they are immune. As harsh as this is, susceptible personnel who have been exposed to measles should be relieved from patient contact and excluded from the facility from the 5th to the 21st day after exposure, regardless of whether they have received vaccine or immune globulin after the exposure. Personnel who become ill should be relieved from all patient contact and excluded from the facility for 4 days after
they develop rash. This means physicians, too. The desirability of a priori immunity is obvious. If immune globulin is administered to an exposed person, observations should continue for signs and symptoms of measles for 28 days after exposure since immune globulin may prolong the incubation period.

Case-patient contacts should likewise have their immune status assessed and be given vaccine if they are not immune; school and work restrictions for exposed, susceptible contacts apply. Obtain a line list of patients exposed from the infection control nurses at the hospital. This line list should include all necessary information to be able to contact such patients – name, DOB, address, phone #s, etc.

When calling exposed patients, inquire about any visitors who may have visited these patients during their stay in the hospital and who, consequently, were also exposed.

During an outbreak of measles, healthcare facilities should recommend 2 doses of MMR vaccine for unvaccinated personnel, including those born before 1957 who lack laboratory evidence of measles immunity or laboratory confirmation of disease.

We occasionally get questions about potential risk to persons in distant locations, but which share an air supply – e.g., via ventilation ducts. Priority in contact tracing and management should first be given to immediate close contacts of ill patients or healthcare workers. Subsequently, contact identification may proceed at the discretion of the infection preventionist at the facility for those who may have been exposed via the air flow in other areas of the hospital, if the nature of the HVAC system suggests true potential for exposure.

6.3 Case on an Aircraft

Although measles transmission has been documented during air travel, it is uncommon.

Notify the ACDP epidemiologist on-call if the case has traveled while infectious. Please collect the following information: name and DOB of patient, names and DOB of travel companions, travel dates (include airline name, flight number), seat number and any information about whether the index case plans to continue travel while infectious.

An admittedly arbitrary definition has been devised to cover who may have been sufficiently exposed to warrant notification. The figures show 4 examples on a hypothetically configured jumbo jet. Unfortunately, not all planes are configured this way, and sometimes we are not given the seat assignment information for a given event. So this is only a general indication of what we would likely recommend; this is not an exact science.

Potential Exposures on Airplanes

Consider bulkheads as barriers.
6.4 **Going Public**

Consult with ACDP/Immunization staff before going public. They will help you draft your press release and can assist with contacting media representatives who are outside your local area (e.g., Portland TV stations, the Oregonian), as well as public health officials in other counties and neighboring states.

**UPDATE LOG**

July 2006. The confirmed case definition was modified from "IgM antibody to measles virus" to "positive IgM serology to measles." Several people had misinterpreted the older language to mean that the presence of any IgM antibody was indicative of a confirmed case. Recommendations concerning follow-up to potential airborne exposures were revised to recommend a 2-hour cutoff (down from 4 hours). Longer periods are certainly possible, but the risk beyond 2 hours is apparently low enough that the juice isn’t worth the squeeze. Not coincidentally this makes our recommendations more consistent with CDC’s. (Juventila Liko)

October 2007. Case definitions revised to require symptoms. This is more in line with the national definition, and acknowledges the fact that with our incidence of disease being so low, IgM has a poor positive predictive value. (Juventila Liko)

April 2008. Revised 2.4, 3.4, 4.2, 4.3, 5.1, 5.4, 5.5, 6.2, 6.3 to reflect a concerted approach to the control of measles in Oregon based on high levels of measles vaccination in the community, national recommendations, and a focused attack on measles outbreak. Recommendations concerning identification of contacts were revised to recommend “20 minutes-10 meters rule” (down from 2 hours cutoff). (Paul Cieslak, Juventila Liko)

April 2010. Services available at OSPHL updated. (Juventila Liko)

March 2011. Minor wordsmithing of case definitions. (Juventila Liko)

September 2011. Minor wordsmithing of case definitions and the acceptable evidence of immunity. Reporting responsibilities revised. Also, revised the lab section adding testing availability at WSPHL for cases when disease is considered a possibility. Section 6.4 “Going Public” was added. (Juventila Liko)

January 2012. Typo corrected in section 6.2 Healthcare workers should be excluded for 4 days after rash onset, not 7. (Paul Cieslak)

December 2012. Clarified LHD responsibilities regarding measles testing at WSPHL. (Juventila Liko)

March 2013. The acceptable evidence of immunity is updated. Dosage of the immune globulin for measles post exposure prophylaxis is increased since IG levels have been going down in the donor population in the vaccine era and available evidence suggests that the dose of 0.25ml/kg may not provide adequate protection. (Juventila Liko)

August 2013. Outbreak definition revised to be more in line with the national definition. (Juventila Liko)

March 2014. Urine specimen recommended in addition to NP swab; passive surveillance for UTD contacts and language clarified in several places. (Juventila Liko)

September 2014. Added clarification about other potential diagnosis for measles-like illnesses. (Juventila Liko)

February 2015. The lab section was updated to reflect the most recent OSPHL guidelines. (Juventila Liko)

March 2015. Added flowchart for testing criteria. (Juventila Liko)
Testing criteria for measles, mumps and rubella

- Concern about risk for measles, mumps or rubella
- Clinical symptoms compatible with disease* Yes → Test at Washington State Public Health Lab (WSPHL)
  - Yes → Have a nice day
  - No → Have a nice day
- Epi-linked to another case? Yes → Test at WSPHL
  - No → Have a nice day
- Test at Washington State Public Health Lab (WSPHL)
  - Yes → Test at WSPHL
  - No → Have a nice day
- High-risk individuals potentially exposed? Yes → Test at WSPHL
  - No → Have a nice day
- Travel to areas where disease known to be circulating?† Yes → Test at WSPHL
  - No → Have a nice day
- Evidence of immunity?‡ Yes → Test at commercial lab
  - No → Have a nice day
- Cases in the area? Yes → Test at WSPHL
  - No → Have a nice day

*Measles:
An acute illness characterized by:
Generalized maculopapular rash and temperature ≥38.3°C (101°F) and cough, coryza, or conjunctivitis.

*Rubella:
An acute illness characterized by:
Generalized maculopapular rash and temperature ≥37.2°C (99°F) and arthralgia, arthritis, lymphadenopathy, or conjunctivitis.

*Mumps:
An acute illness characterized by:
Parotitis, acute salivary gland swelling, orchitis, or oophoritis unexplained by another more likely diagnosis.

† During exposure period
‡ See Section 4.3 in Investigative Guideline for applicable disease

Oregon Health Authority, March 2015