Chapter 9: *Mumps*

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I. Disease Description

Mumps is an acute viral illness caused by a paramyxovirus. The classic symptom of mumps is parotitis (i.e., acute onset of unilateral or bilateral tender, self-limited swelling of the parotid or other salivary gland(s)), lasting at least two days, but may persist longer than ten days.[1] The mumps incubation period ranges from 12–25 days, but parotitis typically develops 16 to 18 days after exposure to mumps virus.[2] Nonspecific prodromal symptoms may precede parotitis by several days, including low-grade fever which may last three to four days, myalgia, anorexia, malaise, and headache. However, mumps infection may present only with nonspecific or primarily respiratory symptoms or may be a subclinical infection.[3]

Clinical manifestations

In the prevaccine era, rates of classical parotitis among all age groups typically ranged from 31% to 65%, but in specific age groups could be as low as 9% or as high as 94% depending on the age and immunity of the group.[4–7] Several articles discuss mumps symptoms as nonspecific or primarily respiratory, however, findings in these articles were based on serologies taken every six months or a year, so it is difficult to prove that the respiratory symptoms were because of mumps or that the symptoms occurred at the same time as the mumps infection.[6, 7] In the prevaccine era, 15% to 27% of infections were asymptomatic.[4–6] In the post-vaccine era, it is difficult to estimate the number of asymptomatic infections, because it is unclear how vaccine modifies clinical presentation. Serious complications can occur in the absence of parotitis.[8, 9]

Prevaccine era complications

In the prevaccine era, mumps gained notoriety as an illness that substantially affected armies during mobilization.[1] The average annual rate of hospitalization resulting from mumps during World War I was 55.8 per 1,000, which was exceeded only by the rates for influenza and gonorrhea.[1] Mumps caused transient deafness in 4.1% of infected adult males in a military population.[10] Permanent unilateral deafness caused by mumps occurred in 1 of 20,000 infected persons;[11] bilateral, severe hearing loss was very rare.[11] Before the introduction of the live attenuated mumps vaccine in 1967, mumps accounted for approximately 10% of cases of aseptic meningitis in the United States with men afflicted three times as often as women.[12] Mumps encephalitis accounted for 35.9% of all reported encephalitis cases in the United States in 1967.[13] The incidence of mumps encephalitis is reported to range from 1 in 6000 mumps cases (0.02%)[14] to 1 in 300 mumps cases (0.3%).[13] Orchitis has been reported in 11.6% to 66% of postpubertal males infected with mumps.[15, 16] In 60% to 83% of males with mumps orchitis, only one testis was affected.[4, 9] Sterility from mumps orchitis, even bilateral orchitis, occurred infrequently.[15] Oophoritis was reported in approximately 5% of postpubertal females affected with mumps[17, 18] Mastitis was reported in a few case reports[19, 20] but was also described in an outbreak in 1956–1957 affecting 31% of postpubertal females.[4] Pancreatitis was reported in 3.5% of persons infected with mumps in one community during a two year period[6] and was described in case reports.[21, 22] Permanent sequelae such as paralysis, seizures, cranial nerve palsies, and hydrocephalus occurred very rarely.[23] Death due to mumps is exceedingly rare, and is primarily caused by mumps-associated encephalitis.[13] In the United States during 1966–1971, there were two deaths per 10,000 reported mumps cases.[13]

Post-vaccine era complications

Results from a recent outbreak showed that complications are lower in vaccinated case-patients compared to unvaccinated case-patients;[24] however, in another recent outbreak, vaccination status was not significantly associated with complications.[25] Among vaccinated persons, severe complications of mumps are uncommon but occur more frequently among adults than children. In recent U.S. outbreaks in 2006 and 2009–2010, rates of orchitis among postpubertal males have ranged from 3.3% to 10%;[25–27] among postpubertal females, mastitis rates have ranged

from <1% to 1%[25–27] and oophoritis rates have ranged from <1% to 1%.[25–27] Among all persons infected with mumps, reported rates of pancreatitis, deafness, meningitis, and encephalitis were all <1%.[25–27] No mumps-related deaths have been reported in recent U.S. outbreaks.

Mumps during pregnancy

An association between maternal mumps infection during the first trimester of pregnancy and an increase in the rate of spontaneous abortion or intrauterine fetal death has been reported in a large prospective controlled cohort study,[28] but this association was not found in another study.[29] One study with methodological flaws showed that congenital malformations may occur from mumps during pregnancy, but because the author did not compare rates with infants born to women not affected with mumps, these findings must be interpreted with caution;[30] other papers have not reported similar findings.[4, 31]

Infectious period

Although mumps virus has been isolated from seven days before, through 11–14 days after parotitis onset,[7, 32, 33] the highest percentage of positive isolations and the highest virus loads occur closest to parotitis onset and decrease rapidly thereafter. Mumps is therefore most infectious in the several days before and after parotitis onset. Most transmission likely occurs before and within five days of parotitis onset.[32] Transmission also likely occurs from persons with asymptomatic infections and from persons with prodromal symptoms.[34] In 2008, the period of isolation for mumps patients was changed from nine days to five days.[32, 33] The recommended period for contact tracing for mumps is two days before through five days after parotitis onset.

Other etiologies of parotitis

Not all cases of parotitis—especially sporadic ones—are due to mumps infection. Parotitis can be caused by parainfluenza virus types 1 and 3, Epstein Barr virus, influenza A virus, Coxsackie A virus, echovirus, lymphocytic choriomeningitis virus, human immunodeficiency virus, and noninfectious causes such as drugs, tumors, immunologic diseases, and obstruction of the salivary duct. However, other causes do not produce parotitis on an epidemic scale.[35, 36]

II. Background

Mumps vaccine was licensed in the United States in 1967. The Advisory Committee on Immunization Practices (ACIP) made an official recommendation for one dose of mumps vaccine for all children at any age after 12 months in 1977.[37] In 1989, children began receiving two doses of mumps vaccine because of the implementation of a two-dose measles vaccination policy using the combined measles, mumps, and rubella vaccine (MMR) vaccine.[38] In 2006, a two-dose mumps vaccine policy was recommended for school-aged children, students at post high school educational institutions, healthcare personnel, and international travelers.[39]

Following mumps vaccine licensure, reported mumps decreased steadily from more than 152,000 cases reported in 1968 to 2,982 in 1985.[40] During 1986–1987, a resurgence occurred with more than 20,000 reported mumps cases. The primary cause of this resurgence was low vaccination levels among adolescents and young adults.[40] In the late 1980s and early 1990s, outbreaks were reported among primary and secondary school children who had previously received one dose of mumps-containing vaccine.[41, 42] By 2003, only 231 mumps cases were reported, the lowest annual number since reporting began. However, in 2006, another resurgence occurred, with 6,584 reported cases.[25] The incidence was highest among persons aged 18–24 years, many of whom were college students. Approximately 63% of all case-patients with known vaccination status in the main outbreak states had received two doses of MMR vaccine.[25] In 2007 and 2008, the number of annual cases declined to 800 and 454 cases, respectively.

Between June 28, 2009, and June 27, 2010, another large outbreak (3,502 mumps cases) occurred in Orthodox Jewish communities in the Northeast. The source case was an 11-year-old U.S. resident with a history of two doses of MMR vaccine who developed parotitis while

attending a summer camp in New York after traveling to the United Kingdom. The median age of persons with mumps was 15 years (range: 3 months to 90 years), 2,479 (71%) were male, and of the 2,519 (72%) for whom vaccination status was reported, 76% had received two doses, 14% had received one dose, and 10% had received no doses.[26]

From December 9, 2009, through December 31, 2010, the U.S. Territory of Guam also experienced an outbreak, with 505 mumps cases reported; 48% of cases were male, and the median age was 12 years with a range of 2 months to 79 years.[27] Of the 287 school-aged children aged 6–18 years with reported mumps, 270 (94%) had received at least two doses of MMR vaccine, 8 (3%) had received one dose, 2 (1%) were unvaccinated, and 7 (2%) had unknown vaccination status. Two-dose MMR vaccine coverage in the most highly affected schools ranged from 99.3%–100%.[27]

In the Northeast and Guam mumps outbreaks, third doses of MMR vaccine were administered under Institutional Review Board protocols to the most affected populations.[27, 43] In both studies, there were declines in attack rates that were more pronounced in the age groups targeted for the intervention, but due to the late timing of the intervention and other factors, the results are inconclusive as to whether the decrease was due to the intervention. Other locations that were experiencing mumps outbreaks during the same time frame among similar populations also showed a decline in attack rates without the third dose intervention (New York City, unpublished data). There is currently no recommendation for a third dose of mumps-containing vaccine for mumps outbreaks in highly vaccinated populations, but ACIP is considering a permissive recommendation for such situations. Catch-up vaccination efforts to ensure that populations at risk are up to date with the recommended number of vaccine doses, as well as reducing opportunities for close contact, remain the recommended strategies for mumps outbreak control.

Cases of mumps will continue to be imported into the United States as long as mumps continues to be endemic globally. Mumps vaccine is routinely used in 61% of countries in the world.[44]

III. Disease Reduction Goals

The 338 reported cases of mumps in 2000 met the *Healthy People 2000* reduction goal of fewer than 500 cases. Subsequently, a goal of elimination of indigenous mumps by the year 2010 was made.[45] However, major resurgences in mumps during 2006, 2009, and 2010 highlighted the challenges of obtaining this goal with currently available vaccines and the existing vaccination policy and resulted in re-evaluation of the mumps program goal in the U.S. Mumps is endemic throughout the world, and achieving elimination was considered difficult in the context of ongoing mumps virus importations and the current two-dose vaccination program. Subsequently, the *Healthy People 2020* goal for mumps is a disease reduction goal (i.e., to have fewer than 500 reported cases of mumps annually), rather than an elimination goal.[46]

Vaccination

Live attenuated mumps virus vaccine is incorporated into combined MMR vaccine. Monovalent mumps vaccine is no longer produced in the United States. For prevention of mumps, two doses of MMR vaccine are recommended routinely for children with the first dose at 12–15 months of age and the second dose at 4–6 years of age (school entry).[47]

For prevention of mumps, two doses of MMR vaccine are also recommended for adults at high risk, including international travelers, college and other post high school students, and healthcare personnel born during or after 1957.[39, 47] All other adults born during or after 1957 without other evidence of mumps immunity should be vaccinated with one dose of MMR vaccine[39, 47] Vaccination recommendations for an outbreak setting are discussed in the "Outbreak Control" section later in this chapter.

The mumps vaccine component of the MMR vaccine has a lower effectiveness compared to the measles and rubella components. Mumps vaccine effectiveness has been estimated at a median of 78% (range: 49%−91%) for one dose[1, 42, 48–51] and a median of 88% (range: 66%−95%) for two doses.[34, 50–53]

Mumps vaccine can also be administered as a combined vaccine with measles, rubella, and varicella vaccines (MMRV); however, MMRV vaccine is currently available in limited supply.[54] MMRV vaccine can be used for children aged 12 months through 12 years who need a first dose of MMR and varicella vaccine, or who need a second dose of MMR and either a first or second dose (as indicated) of varicella vaccine.[55]

For the first dose of measles, mumps, rubella, and varicella vaccines at age 12–47 months, either MMR vaccine and varicella vaccine or MMRV vaccine may be used. Providers who are considering administering MMRV vaccine should discuss the benefits and risks of both vaccination options with the parents or caregivers. Compared with use of MMR and varicella vaccines given separately at the same visit, use of MMRV vaccine results in one fewer injection but is associated with a higher risk for fever and febrile seizures 5 through 12 days after the first dose among children aged 12 through 23 months (about one extra febrile seizure for every 2,300–2,600 MMRV vaccine doses). Unless the parent or caregiver expresses a preference for MMRV vaccine, CDC recommends that MMR vaccine and varicella vaccine should be administered for the first dose in this age group.[55] For the first dose of measles, mumps, rubella, and varicella vaccines at ages 48 months and older and for dose two at any age (15 months through 12 years), use of MMRV vaccine generally is preferred over separate injections of its equivalent component vaccines (i.e., MMR and varicella vaccines).

IV. Presumptive Evidence of Mumps Immunity

According to ACIP recommendations published in 2006,[39] acceptable presumptive evidence of mumps immunity includes at least one of the following:

(a) written documentation of receipt of one or more doses of a mumps-containing vaccine administered on or after the first birthday for preschool-aged children and adults not at high risk, and two doses of mumps-containing vaccine for school-aged children and adults at high risk (i.e., healthcare personnel, international travelers, and students at post high school educational institutions);

(b) laboratory evidence of immunity;

(c) birth before 1957; or

(d) documentation of physician-diagnosed mumps.

Persons who do not meet the above criteria are considered susceptible.[39] Healthcare settings have slightly different criteria for acceptable presumptive evidence of immunity, and these criteria are detailed in the 'Healthcare Personnel: Presumptive Evidence of Immunity' section below.

V. Case Definition

The following case definition for mumps was updated and approved by the Council of State and Territorial Epidemiologists (CSTE) in 2011.[56]

Disease specific data elements:

Disease-specific data elements to be included in the initial report are listed below.

Clinical presentation

- parotitis or swelling of sublingual or submandibular salivary glands for two or more days
- onset date of symptoms
- mumps-associated complications (describe)

Epidemiological evidence

- contact (or in a chain of contacts) of a laboratory-confirmed mumps case
- contact of a person with parotitis
- contact of a person with a mumps-associated complication
- member of a risk group defined by public health authorities during an outbreak

- return from international travel within 25 days of symptom onset
  - Travel location
  - Date of return to U.S.

Immunization history

- number of doses of mumps-containing vaccine received
- date of all doses of mumps-containing vaccine received

Case definition for case classification

Suspect:

- parotitis, acute salivary gland swelling, orchitis, or oophoritis unexplained by another more likely diagnosis,

or

- a positive lab result with no mumps clinical symptoms (with or without epidemiological linkage to a confirmed or probable case).

Probable:

- Acute parotitis or other salivary gland swelling lasting at least 2 days, or orchitis or oophoritis unexplained by another more likely diagnosis, in:
  - a person with a positive test for serum anti-mumps IgM antibody, or
  - a person with epidemiologic linkage to another probable or confirmed case or linkage to a group/community defined by public health during an outbreak of mumps.

Confirmed:

- A positive mumps laboratory confirmation for mumps virus with RT-PCR or culture in a patient with an acute illness characterized by any of the following:
  - Acute parotitis or other salivary gland swelling, lasting at least 2 days
  - Aseptic meningitis
  - Encephalitis
  - Hearing loss
  - Orchitis
  - Oophoritis
  - Mastitis
  - Pancreatitis

Case classification for import status

Internationally imported case: An internationally imported case is defined as a case in which mumps results from exposure to mumps virus outside the United States as evidenced by at least some of the exposure period (12–25 days before onset of parotitis or other mumps-associated complications) occurring outside the United States and the onset of parotitis or other mumps-associated complications within 25 days of entering the United States and no known exposure to mumps in the U.S. during that time. All other cases are considered U.S.-acquired cases.

U.S.-acquired case: A U.S.-acquired case is defined as a case in which the patient had not been outside the United States during the 25 days before onset of parotitis or other mumps-associated complications or was known to have been exposed to mumps within the United States.

U.S.-acquired cases are sub-classified into four mutually exclusive groups:

- **Import-linked case:** Any case in a chain of transmission that is epidemiologically linked to an internationally imported case.
- **Imported-virus case:** A case for which an epidemiologic link to an internationally imported case was not identified but for which viral genetic evidence indicates an imported mumps genotype (i.e., a genotype that is not occurring within the United States in a pattern indicative

of endemic transmission). An endemic genotype is the genotype of any mumps virus that occurs in an endemic chain of transmission (i.e., lasting ≥12 months). Any genotype that is found repeatedly in U.S.-acquired cases should be thoroughly investigated as a potential endemic genotype, especially if the cases are closely related in time or location.

- **Endemic case:** A case for which epidemiological or virological evidence indicates an endemic chain of transmission. Endemic transmission is defined as a chain of mumps virus transmission continuous for ≥12 months within the United States.
- **Unknown source case:** A case for which an epidemiological or virological link to importation or to endemic transmission within the U.S. cannot be established after a thorough investigation. These cases must be carefully assessed epidemiologically to assure that they do not represent a sustained U.S.-acquired chain of transmission or an endemic chain of transmission within the U.S.

Note: *Internationally imported, import-linked, and imported-virus cases are considered collectively to be import-associated cases.*

States may also choose to classify cases as "out-of-state-imported" when imported from another state in the United States. For national reporting, however, cases will be classified as either internationally imported or U.S.-acquired.

VI. Laboratory Testing

If mumps is suspected, laboratory testing should be performed. Acute mumps infection can be detected by the presence of serum mumps IgM, a significant rise in IgG antibody titer in acute- and convalescent-phase serum specimens, IgG seroconversion, positive mumps virus culture, or detection of virus by real-time reverse transcriptase polymerase chain reaction (rRT-PCR). However, in both unvaccinated and vaccinated persons, false positive results can occur because assays may be affected by other diagnostic entities that cause parotitis. In addition, laboratory-confirming the diagnosis of mumps in highly vaccinated populations may be challenging, and serologic tests should be interpreted with caution because false negative results in vaccinated persons (i.e., a negative serologic test in a person with true mumps) are common. With previous contact with mumps virus either through vaccination (particularly with two doses) or natural infection, serum mumps IgM test results may be negative; IgG test results may be positive at the initial blood draw; and viral detection in RT-PCR or culture may have low yield if the buccal swab is collected more than three days after parotitis onset. Therefore, mumps cases should not be ruled out by negative laboratory results. These challenges are discussed in more detail below.

Virus detection (real-time RT-PCR and culture)

Mumps virus can be detected from fluid collected from the parotid duct, other affected salivary gland ducts, the throat, from urine, and from cerebrospinal fluid (CSF). Parotid duct swabs yield the best viral sample. This is particularly true when the salivary gland area is massaged approximately 30 seconds prior to swabbing the buccal/parotid duct, so that the specimen contains the secretions from the parotid or other salivary duct glands. Efforts should be made to obtain the specimen as soon as possible after onset of parotitis or meningitis. Clinical specimens should ideally be obtained within three days and not more than eight days after parotitis onset.

Successful virus isolation should always be confirmed by immunofluorescence with a mumps-specific monoclonal antibody or by molecular techniques. Molecular techniques such as real-time RT-PCR can also be used to detect mumps RNA directly for mumps confirmation in appropriately collected specimens.

Urine samples are less likely than oral specimens to contain sufficient virus copies or virus-infected cells for culture or detection by molecular methods, and therefore are not preferred.

Molecular typing is recommended because it provides important epidemiologic information. Molecular epidemiologic surveillance, (i.e., virus genotyping) allows the building of a sequence database that will help track transmission pathways of mumps strains circulating in the United

States. In addition, genotyping methods are available to distinguish wild-type mumps virus from vaccine virus.

- **Unvaccinated persons:** Virus may be isolated from the buccal mucosa until 11–14 days after salivary enlargement; however, viral isolation is most likely to be successful just prior to and within the first three days of parotitis onset.
- **Vaccinated persons:** In order to optimize virus yield, emphasis should be placed on obtaining mumps clinical specimens from buccal mucosa within 1 to 3 days after onset of symptoms (usually parotitis).

In the case of specimens for virus culture or PCR assay, immediately place specimens in a cold storage container and transport to the laboratory.

Serologic testing

The serologic tests available for laboratory confirmation of mumps acute infection and confirmation of previous exposure to mumps vary among laboratories. The State health department can provide guidance regarding available laboratory services. At the direction of the State health department, healthcare providers and State and local health departments may send serum specimens from suspected mumps cases to the CDC Measles, Mumps, Rubella, and Herpes Laboratory Branch for IgM detection by EIA. See "Specimen collection and management" section below.

- At the initial visit, a serum specimen should be obtained to test for mumps IgM antibodies.
  - If the acute-phase specimen is positive for IgM, a second specimen is not necessary.
  - A second negative IgM does not rule out mumps unless the IgG result is also negative.
- Paired serum specimens may also be used to demonstrate seroconversion from negative to positive from acute to convalescent, which is considered a positive diagnostic result for mumps. In unvaccinated individuals, a four-fold increase in IgG titers is also considered a positive diagnostic result for mumps, but these are rarely done.

Tests for IgM antibody

Enzyme immunoassay (EIA): a highly specific test for diagnosing acute mumps infection. The use of the IgM capture EIA is preferred over the Immunofluorescence assay (IFA).

Immunofluorescence assay (IFA): a test that is relatively inexpensive and simple, but the IFA format is particularly susceptible to interference by high levels of mumps-specific IgG. Reading the test requires considerable skill and experience since this nonspecific staining may cause false positive readings if the serum is not treated with an agent to remove human IgG antibody.

Note: *Commercially available EIA kits and IFA antibody assays for detection of mumps IgM are not currently FDA-approved. Therefore, each laboratory must validate these tests independently.*

Serum collection and timing of the mumps IgM response

- **Unvaccinated persons:** IgM antibody is detectable within 5 days after onset of symptoms, reaches a maximum level about a week after onset, and remains elevated for several weeks or months.[57, 58] If an acute-phase serum sample collected ≤3 days after parotitis onset is negative for IgM, testing a second sample collected 5–7 days after symptom onset is recommended since the IgM response may require more time to develop.
- **Vaccinated persons:** Patients that mount a secondary immune response to mumps, as seen in most previously vaccinated persons, may not have an IgM response or it may be transient and not detected depending on the timing of specimen collection.[57] Because of this, a high number of false negative results may occur in previously vaccinated individuals. False positive IgM results may also occur and appear to be more prevalent with certain IgM test formats, such as the IFA. There is some evidence that serum collected ≥10 days after parotitis onset may improve the ability to detect IgM among persons who have received one or two doses of MMR vaccine[59] (CDC, unpublished data). However, persons with a history of mumps vaccination may not have detectable mumps IgM antibody regardless of the timing of specimen collection.

Tests for IgG antibody

Tests for IgG antibody may be used for mumps diagnosis or for testing mumps immunity. A variety of tests for IgG antibodies to mumps are available and include EIA, IFA, and plaque reduction neutralization. The specific criteria for documenting an increase in titer depend on the test.

Diagnosis of Mumps with IgG

IgG testing for laboratory confirmation of mumps requires the demonstration of seroconversion from negative to positive by EIA or a four-fold rise in the titer of antibody against mumps as measured in plaque-reduction neutralization assays or similar quantitative assays. The tests for IgG antibody should be conducted on both acute- and convalescent-phase specimens at the same time. The same type of test should be used on both specimens. EIA values are not titers, and increases in EIA values do not directly correspond to titer rises.

- **Unvaccinated persons:** In unvaccinated persons, IgG antibody increases rapidly after onset of symptoms and is long lasting.
- **Vaccinated persons:** In vaccinated persons, the IgG may already be quite elevated in the acute-phase blood sample which frequently prevents detection of a four-fold rise in IgG titer in the convalescent serum specimen.

Testing Mumps Immunity with IgG

A single serum sample tested for mumps-specific IgG is not useful for diagnosing acute mumps infections. The presence of mumps-specific IgG, as detected using a serologic assay (EIA or IFA), is considered evidence of mumps immunity but does not necessarily predict the presence of neutralizing antibodies or protection from mumps disease.

Specimen collection and management

Specific instructions for specimen collection and shipping may be obtained from the CDC mumps website at: http://www.cdc.gov/mumps/lab/specimen-collect.html[60] or by contacting the CDC MMR and Herpes Virus Laboratory Branch at 404-639-1156 or 404-639-3512. Specimens for virus isolation and genotyping should be sent to CDC as directed by the State health department.

For additional information on use of laboratory testing for surveillance of vaccine-preventable diseases, see Chapter 22, "Laboratory Support for the Surveillance of Vaccine-Preventable Diseases."

VII. Reporting

Each state and U.S. territory has regulations or laws governing the reporting of diseases and conditions of public health importance.[61] These regulations and laws list the diseases that are to be reported and describe those persons or groups responsible for reporting, such as healthcare providers, hospitals, schools, laboratories, daycare and childcare facilities, and other institutions. Persons reporting these conditions should contact their State health department for state-specific reporting requirements.

Reporting to CDC

A provisional report of all probable and confirmed mumps cases should be sent by the State health department to CDC via the National Notifiable Diseases Surveillance System (NNDSS). Electronic reporting of case records should not be delayed because of incomplete information or lack of confirmation. Following completion of case investigations, case records should be updated with any new information and resubmitted to CDC. Final laboratory results may not be available for the initial report but should be submitted via NNDSS when available.

Information to collect

The following data should be collected in the course of the case investigation. Additional information may be collected at the direction of the State health department.

- Demographic information
  - Name
  - Address
  - Date of birth
  - Age
  - Sex
  - Ethnicity
  - Race
  - Country of birth
  - Length of time in United States
  - Reporting source
  - County
  - Earliest date reported
- Clinical
  - Date of illness onset (note: this may be earlier than parotitis onset due to prodromal symptoms)
  - Parotitis or other salivary gland involvement (pain, tenderness, swelling)
  - Date of parotitis (or other salivary gland swelling) onset
  - Duration of parotitis (or other salivary gland swelling)
  - Other symptoms (e.g., headache, anorexia, fatigue, fever, body aches, stiff neck, difficulty in swallowing, nasal congestion, cough, earache, sore throat, nausea, abdominal pain)
  - Complications
    - Deafness (transient or permanent; unilateral or bilateral)
    - Encephalitis
    - Mastitis
    - Meningitis
    - Oophoritis
    - Orchitis (unilateral or bilateral)
    - Pancreatitis
    - Other
  - Hospitalization, reason/association to mumps, duration of stay
  - Outcome (patient survived or died)
  - Date of death
  - Postmortem examination results
  - Death certificate diagnoses
- Treatment
  - Medications given
  - Duration person was on each medication
- Laboratory
  - Serology (IgM, IgG)
  - Virus detection (PCR, culture)
  - Specimen collection date(s)
- Vaccine information
  - Number of doses of vaccine given
  - Type of vaccine administered (i.e., MMR, MMRV, or single antigen mumps vaccine)
  - Dates of mumps vaccination for each dose
  - Manufacturer of vaccine

- Vaccine lot number
- If not vaccinated, reason

- Epidemiologic
  - Epidemiologic linkages
  - Transmission setting (e.g., college, school, doctor's office)
  - Import status (e.g., internationally imported or U.S.-acquired). See "Case classification for import status" section above.
  - Location of exposure (country, if international import; state, if out-of-state import)
  - Travel history

VIII. Case Investigation

The Mumps Surveillance Worksheet (Appendix 10) may be used as a guideline to collect case information during a case investigation; the details are discussed below.

Case identification

Identification of suspected or confirmed cases of mumps is important in the initiation of control measures to prevent the spread of the disease among persons who do not have presumptive evidence of immunity. Once a sporadic case has been identified, several factors should be taken into consideration before initiating a public health response, such as epidemiological risk factors, vaccination status, and other etiologies. However, in transmission settings with high risk, such as households, schools, and camps, health departments may want to be a little more aggressive. In these settings, health departments should consider conducting case investigations and assessing immune status of close contacts before laboratory results are known or before additional cases are identified. Nonetheless, control measures are unlikely to be implemented until either the laboratory results are back or until at least two infected persons have a confirmed epidemiological link.

Establishing a diagnosis of mumps

Clinical diagnosis of mumps may be unreliable. Cases of suspected mumps should be laboratory confirmed; however, negative laboratory results among vaccinated persons do not necessarily rule out the diagnosis of mumps, particularly if there is an outbreak of parotitis.

Efforts should be made to obtain clinical specimens (buccal cavity/parotid duct fluids, throat swabs, urine, or CSF) for viral isolation for all sporadic cases and at least some cases in each outbreak at the time of the initial investigation.

Obtaining accurate, complete immunization histories

Mumps case investigations should include complete immunization histories that are verified by documentation of administration of all doses. Verbal history of receipt of mumps vaccine is not considered adequate proof of vaccination. Some case-patients or their caregivers may have personal copies of immunization records available that include dates of administration; these are acceptable for reporting purposes.

Identifying the source of infection

Efforts should be made to identify the source of infection for every confirmed case of mumps (i.e., case-patients should be asked about contact with other known patients). However, this is not always possible, especially with sporadic cases, and this should not occur at the expense of higher public health priorities. If it can be determined when and where transmission likely occurred, investigative efforts should be directed to these locations.

Assessing potential transmission and identifying contacts

The potential for further transmission should be assessed. Contacts of the case-patient during the two days prior through five days after onset of parotitis should be identified, assessed for immunity, offered vaccine as appropriate, and educated about signs and symptoms.

CDC recommends a five-day period after onset of parotitis for: 1) isolation of persons with mumps in the community and for 2) use of droplet precautions, in addition to standard precautions in healthcare settings.[32]

IX. Enhancing Surveillance

Importance of surveillance

Information obtained through surveillance is used to follow disease trends in the population, to assess progress towards disease reduction goals, and to characterize populations requiring additional disease control measures.

Monitoring surveillance indicators

Regular monitoring of surveillance indicators can help identify specific areas of the surveillance and reporting system that need improvement. The following indicators should be monitored.

- The proportion of confirmed cases reported to NNDSS with complete information (e.g., date of birth, onset date, clinical case definition, hospitalization, laboratory testing, vaccine history, date reported to health department, transmission setting, outbreak-related, and epidemiologic linkage)
- The interval between date of symptom onset and date of public health notification
- The proportion of cases that are laboratory confirmed
- The proportion of cases that have an imported source

The activities listed below can help increase the number of suspected mumps cases that are reported and improve the comprehensiveness and quality of reports that are received. Additional guidelines for enhancing surveillance are given in Chapter 19, "Enhancing Surveillance."

Promoting awareness

In the event of an outbreak, surveillance should be enhanced by promoting awareness in the public affected by the outbreak and healthcare personnel. Healthcare personnel should be aware that mumps outbreaks have occurred in highly vaccinated populations in high transmission settings, including school settings (e.g., elementary school, middle school, high school, and college students). Therefore, mumps should not be ruled out on the assumption that individuals have evidence of mumps immunity because of vaccination.

X. Outbreak Investigation

A mumps outbreak is defined as three or more cases linked by time and place. In recent years, mumps outbreaks have occurred in highly vaccinated populations in high transmission settings, including elementary, middle, and high schools, colleges, and camps. Especially in these settings, rapid detection and investigation of cases, and implementation of control measures may reduce the magnitude of outbreaks.[50] The following are general guidelines for an outbreak investigation.

Collecting tracking information

During an outbreak, a line listing of cases on a spreadsheet allows for quick identification of known and unknown data and ensures that complete case investigations are done.

Identifying the population affected by the outbreak

During an outbreak, every suspected case should be investigated thoroughly, as described above. In very large outbreaks, it may not be possible to thoroughly investigate each reported case.

Based on the findings of individual case investigations, the population affected by the outbreak should be characterized in terms of:

- person (who is becoming infected with mumps, what is their vaccination status),
- place (where are the cases), and
- time (when did the outbreak start, and is it still going on).

These essential data elements allow public health officials to determine the population at risk of infection (e.g., unvaccinated persons, students who have only received one dose of mumps vaccine, persons who visited the emergency department of Hospital A on a certain day, and highly vaccinated populations in high transmission settings); to determine where transmission is occurring (e.g., schools, colleges, healthcare settings); and to identify individuals who are at potential risk of infection (e.g., other unvaccinated persons, students attending other schools).

Obtaining accurate and complete immunization histories

Vaccination histories may be obtained from schools (generally available for children attending licensed childcare centers or kindergarten through high school, as well as many universities), medical providers, or immunization records provided by the case-patient. Immunization registries, if available, can also readily provide vaccination histories.

Investigating contacts

Identifying contacts (e.g., household, school/college, and other close contacts) and following up with persons without evidence of mumps immunity may reveal previously undiagnosed and unreported cases.

Enhancing surveillance for mumps

Local or State health departments should contact healthcare providers in outbreak areas to inform them of the outbreak and request reporting of any suspected cases. During outbreaks, active surveillance for mumps should be conducted for every confirmed and probable mumps case. Active surveillance should be maintained for at least two incubation periods (50 days) following parotitis onset in the last case. Two incubation periods allow for the identification of transmission from subclinical infections or unrecognized cases. Previously unreported cases may be identified by reviewing laboratory records.

XI. Outbreak Control

Initial preparation for control activities may need to be started before laboratory results are known, but are unlikely to be implemented until either the laboratory results are back or until at least two infected persons have a confirmed epidemiological link.

The main strategy for controlling a mumps outbreak is to define the population(s) at risk and transmission setting(s), and to rapidly identify and vaccinate persons without presumptive evidence of immunity; or, if a contraindication exists, to exclude persons without presumptive evidence of immunity from the setting to prevent exposure and transmission.

Mumps-containing vaccine should be administered to persons without evidence of immunity and everyone should be brought up to date with age appropriate vaccination (one or two doses). Although mumps-containing vaccination has not been shown to be effective in preventing mumps in persons already infected, it will prevent infection in those persons who are not yet exposed or infected. If persons without evidence of immunity can be vaccinated early in the course of an outbreak, they can be protected prior to exposure. However, because of the long incubation period for mumps, cases are expected to continue to occur for at least 25 days among newly vaccinated persons who may have been infected before vaccination.[62] As with all vaccines, some individuals will not develop protective immunity after receipt of mumps vaccine. Depending on the epidemiology of the outbreak (e.g., the age groups and/or institutions involved), a second dose of mumps-containing vaccine should be considered for children aged 1–4 years and adults who have received one dose previously.[39]

To assist with control of mumps outbreaks in schools and colleges, students with zero doses of MMR vaccine and with no other evidence of mumps immunity should be excluded from schools/colleges affected by a mumps outbreak or other schools that are unaffected but deemed by local public health authorities to be at risk for transmission of disease.[47] Excluded students can be readmitted immediately after they are vaccinated. Students who have a history of one dose of MMR vaccination should receive their second vaccine dose and be allowed to remain in school. Students who have been exempted from mumps vaccination for medical, religious,

or other reasons should be excluded until the 26th day after the onset of parotitis in the last person with mumps in the affected school.[47]

Currently, data are insufficient to recommend for or against the use of a third dose of MMR vaccine for mumps outbreak control. CDC has issued guidance for considerations for use of a third dose in specifically identified target populations along with criteria for public health departments to consider for decision making.

During mumps outbreaks, public health authorities may administer a third dose of MMR vaccine for specifically identified target populations.

Criteria to consider prior to administering a third dose in a target population for mumps outbreak control include:

- high two-dose vaccination coverage (i.e., vaccination coverage >90%);
- intense exposure settings likely to facilitate transmission (e.g., schools, colleges, correctional facilities, congregate living facilities) or healthcare settings;
- high attack rates (i.e., >5 cases per 1,000 population); and evidence of ongoing transmission for at least two weeks in the target population (i.e., population with the high attack rates)

Additional data on the effectiveness and impact of a third dose of MMR vaccine for mumps outbreak control are needed to guide control strategies in future outbreaks. Authorities who decide to administer a third dose as part of mumps outbreak control are encouraged to collect data to evaluate the impact of the intervention. The following data should be collected:

- incidence of mumps in target population (before and after the intervention, by vaccination status),
- incidence of adverse events following vaccination with a third dose, and
- costs associated with the intervention (vaccine, personnel)

Catch-up vaccination efforts to ensure that populations at risk are up to date with the recommended number of vaccine doses, as well as reducing opportunities for close contact, remain the recommended strategies for mumps outbreak control.

XII. Healthcare Settings

Prevention and control strategies in healthcare settings

Prevention and control strategies should be applied in all healthcare settings, including outpatient and long-term care facilities. These measures include:

1. assessment of presumptive evidence of immunity of healthcare personnel, including documented administration of two doses of live mumps virus vaccine, laboratory evidence of immunity or laboratory confirmation of disease, or birth before 1957 (refer to next section, "Healthcare personnel presumptive evidence of immunity" for footnotes),
2. vaccination of those without evidence of immunity,
3. exclusion of healthcare personnel with active mumps illness, as well as healthcare personnel who do not have presumptive evidence of immunity who are exposed to persons with mumps,
4. isolation of patients in whom mumps is suspected, and
5. implementation of droplet precautions, in addition to standard precautions.

An effective vaccination program is the best approach to prevent healthcare-associated mumps transmission. Healthcare Infection Control Practices Advisory Committee (HICPAC) and CDC have recommended that secure, preferably computerized, systems should be used to manage vaccination records for healthcare personnel so records can be easily retrieved as needed.[63] Facilities are also encouraged to review employee evidence of immunity status for mumps and other vaccine preventable infections. Healthcare facilities should provide MMR vaccine to all personnel without evidence of mumps immunity at no charge.

Healthcare personnel: presumptive evidence of immunity

The presumptive evidence of immunity criteria for healthcare personnel differs slightly from the criteria for community settings. The following criteria should be followed to assess presumptive evidence of immunity among healthcare personnel.[64]

- Written documentation of vaccination with two doses of live mumps or MMR vaccine administered at least 28 days apart*
- Laboratory evidence of immunity†
- Laboratory confirmation of disease
- Birth before 1957‡§¶#

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* *The first dose of mumps-containing vaccine should be administered on or after the first birthday; the second dose should be administered no earlier than 28 days after the first dose.*

† *Mumps immunoglobulin (IgG) in the serum; equivocal results should be considered negative.*

‡ *Most persons born before 1957 are likely to have been infected naturally between birth and 1977— the year mumps vaccination was recommended for routine use— and may be presumed immune, even if they have not had clinically recognizable mumps disease.*

§ *May vary depending on current state or local requirements.*

¶ *For unvaccinated personnel born before 1957 who lack laboratory evidence of mumps immunity or laboratory confirmation of disease, healthcare facilities should consider vaccinating personnel with two doses of MMR vaccine at the appropriate interval.*

\# *For unvaccinated personnel born before 1957 who lack laboratory evidence of mumps immunity or laboratory confirmation of disease, healthcare facilities should recommend two doses of MMR vaccine during an outbreak of mumps.*

In the event that a nosocomial outbreak occurs, healthcare facilities should have a plan in place for the implementation of the two-dose recommendation for all healthcare personnel, including those who were born before 1957 and lack laboratory evidence of immunity or laboratory confirmation of disease. Healthcare facilities may choose to proceed with appropriate assessment and vaccination of personnel born before 1957 before an outbreak occurs.

Although there are no data that correlate levels of serum antibody with protection from disease, presence of mumps-specific IgG antibodies is considered evidence of mumps immunity. For healthcare personnel who do not have adequate presumptive evidence of mumps immunity, prevaccination antibody screening before MMR vaccination is not necessary.

Results of serum antibody tests in vaccinated persons are difficult to interpret. In vaccinated persons, antibody levels are often lower than following natural infection, and commercially available tests may not detect such low levels of antibody. As a result, postvaccination serologic testing to verify an immune response to MMR or its component vaccines is not recommended. There are no data on the effect of additional (greater than two) doses of mumps vaccine on antibody levels or protection from disease.

Healthcare personnel exclusion

Healthcare personnel with active mumps illness and those who lack evidence of immunity and have had unprotected exposures to mumps should be excluded from work from the 12th day after the first unprotected exposure to mumps through the 25th day after the last exposure. Unprotected exposures are defined as being within three feet of a patient with a diagnosis of mumps without the use of proper personal protective equipment. Irrespective of their immune status, all exposed healthcare personnel should report any signs or symptoms of illness during the incubation period, from 12 through 25 days after exposure.

Management of healthcare personnel with illness due to mumps

- A diagnosis of mumps should be considered in exposed healthcare personnel who develop non-specific respiratory infection symptoms during the incubation period after unprotected exposures to mumps, even in the absence of parotitis.
- Healthcare personnel with mumps illness should be excluded for five days after the onset of parotitis.

Management of healthcare personnel who are exposed to persons with mumps

For healthcare personnel who do not have acceptable presumptive evidence of immunity

- Healthcare personnel without evidence of immunity should be excluded from the 12th day after the first unprotected exposure to mumps through the 25th day after the last exposure. Previously unvaccinated healthcare personnel who receive a first dose of vaccine after an exposure are considered non-immune and should be excluded from the 12th day after the first exposure to mumps through the 25th day after the last exposure. The mumps vaccine cannot be used to prevent the development of mumps after exposure.

For healthcare personnel with partial vaccination

- Healthcare personnel who had been previously vaccinated for mumps, but received only one dose of mumps vaccine may continue working following an unprotected exposure to mumps. Such personnel should receive a second dose as soon as possible, but no sooner than 28 days after the first dose. They should be educated about symptoms of mumps, including non-specific presentations, and should notify occupational health if they develop these symptoms.

For healthcare personnel who have presumptive evidence of immunity

- Healthcare personnel with evidence of immunity do not need to be excluded from work following an unprotected exposure. However, two doses of MMR vaccine do not provide 100% protection from mumps. Some vaccinated personnel may remain at risk for mumps. Therefore, healthcare personnel should be educated about symptoms of mumps, including nonspecific presentations, and should notify occupational health if they develop these symptoms.

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