Mumps in Colorado
Overview of Mumps Epidemiology and the 2017 Outbreak

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Background

• Paramyxovirus
• Pre-Vaccine Era
  ~186,000 cases reported/year (mostly school-aged)
• 99% decrease in mumps cases in the US since vaccine
• Increases over the past year, including outbreaks

I’m going to start with some basic background information on mumps so that we’re all on the same page.

Mumps is a contagious, viral disease caused by a paramyxovirus (para-mike-so-virus) that is preventable by the MMR vaccine

Prior to a vaccine being available, approximately 186,000 cases were reported a year, mostly among school-aged children

Since the MMR vaccine was licensed in it’s current form in 1971, the US has seen a 99% decrease in mumps cases
However, outbreaks continue and in the past year, mumps cases have been on the rise.
Humans are the only known natural hosts

The virus is spread through direct contact with respiratory droplets or saliva from infected person

It can spread rapidly among individuals in close settings

The average incubation period is 16-18 days, though can range from 12-25 days

Persons with mumps are infectious for 2 days before onset of parotitis to 5 days after onset

There is no treatment for mumps, only symptom relief.

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<td><strong>Incubation Period</strong></td>
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The classic clinical feature of mumps is parotitis, or swelling of that parotid glands, which causes the tell-tale chipmunk-like look associated with mumps. Parotitis may be unilateral or bilateral, or absent. CDC estimates that only 30-40% of persons infected with mumps experience parotitis.

Mumps is typically preceded by a prodrome that may include myalgia, malaise, lack of appetite, headache, and low grade fever.

Complications of mumps are rare and occur more frequently among adults than children.

In recent U.S. mumps outbreaks (2006, 2009 to 2010), orchitis occurred in 3.3 to 10% of adolescent and adult males.

Among adolescent and adult females in recent outbreaks, mastitis and oophoritis rates have been ≤1%.

Other rare complications of mumps include pancreatitis, deafness, meningitis, and encephalitis, which have occurred in less than 1% of cases in recent U.S. outbreaks.

There have been no mumps related deaths reported in the United States during recent mumps outbreaks.
Here are some pictures of parotitis.

It can sometimes be confused with lymph node swelling. Parotid swelling is first visible in front of the lower part of the ear. It then extends downward and forward. Swelling usually peaks in 1 to 3 days and then subsides during the next week.

The swollen tissue pushes the angle of the ear up and out and the angle of the jawbone below the ear is no longer visible.

Often, the jawbone cannot be felt because of swelling of the parotid.

There are several other causes of parotitis, such as flu, coxsackie, and Epstein barr, but mumps is the only known cause of epidemic parotitis.
The mumps virus isolated in 1945 and the first mumps vaccine was developed in 1948 and included an inactivated vaccine. This was discontinued in the 1970s and a live attenuated vaccine was licensed in 1971, combined with measles and rubella.

Mumps vaccine combined with measles, rubella and varicella, or MMRV, was licensed in 2005.

Single-antigen vaccine not available in the US

The vaccine is routinely given in 2 doses with the first dose at age 12-15 months and the second at 4-6 years but that second dose may be given sooner in certain outbreak situations.

The vaccine is also recommended for infants 6-12 months of age who plan to travel internationally. This is mostly for measles protection but is also useful against mumps exposures one may encounter while traveling.
There are a few options to test for mumps – PCR, serology, and culture, though we find that all of these options have their challenges.

In Colorado, PCR is not widely available from commercial labs so it’s mostly only done at state lab. The specimen needed, a buccal swab, is unfamiliar any many providers needs guidance on how to collect this specimen, where to send it, and what materials are needed.

Serology

IgM may be delayed or absent in vaccinated people.
A single serum sample tested for mumps-specific IgG is not useful for diagnosing acute mumps.

Viral Culture
Can take several days to several weeks, not clinically valuable.
This graph from CDC shows the percent of positive mumps specimens from PCR and IgM. You can see the positivity for PCR is greatest in the first 3 days after symptom onset whereas IgM is greater after 3 days.

We recommend physicians order PCR and IgM.

PCR is the preferred because the results are easier to interpret and the quick turn around allows for public health intervention, but IgM is valuable if it’s been over 3 days since symptom onset or if the practice is unable to get a specimen to our state lab.

https://www.cdc.gov/mumps/lab/qa-lab-test-infect.html
U.S. Mumps Trends
This shows mumps cases in the US from 2000 through June of 2017.

In 2006 there was an increase in cases following a multi-state that predominantly affected college-aged students living in the Midwest, with outbreaks occurring on many different Midwestern college campuses.

5833 cases were reported during 2016, with many cases associated with a large outbreak in Arkansas that largely affected the state’s community of Marshall Islanders.

Outbreaks have continued into 2017. As of June 17, about 3500 cases have been reported in the US.
*AK, AR, CA, CO, FL, IL, IN, IA, KS, KY, MA, MI, MO, NV, NH, NY, NC, ND, OH, OK, OR, PA, TN, TX, VA, WA, and WI

**Preliminary data reported to CDC. Mumps outbreaks are not reportable.

https://www.cdc.gov/mumps/outbreaks.html

This shows states that have reported outbreaks during 2017. Colorado is not alone, in fact, our outbreak is much smaller than outbreaks in other states, including, Texas, Washington, Missouri, Arkansas. And many of these outbreaks have been reported among communities with high vaccination coverage.
So why are vaccinated people getting mumps?

There are several reasons.
Person may not develop an immune response, either related to the vaccine or the host 
Protection from the vaccine may wan over the years 
Mumps component in MMR has relatively lower effectiveness than the measles and rubella component. 1 dose is estimated to be about 78% effective in preventing disease, 2 doses are about 88%

Congregating in close settings such as college dormitories, sports teams, and large households intensifies exposure

However, it’s important to remember that though mumps outbreaks may occur in highly vaccinated communities, this should not be interpreted as meaning that the vaccine is not effective.

The effectiveness of the vaccine is assessed by comparing the attack rate in people who are vaccinated with the attack rate in those who have not been vaccinated. In
outbreaks in highly vaccinated populations, people who have not been vaccinated against mumps usually have a much greater mumps attack rate than those who have been fully vaccinated.
Colorado Mumps Trends
We experienced similar trends in Colorado.

During 2006, we had an increase in cases following the outbreak in the Midwest US. Our numbers also increased in 2016.

So far in 2017, we’ve had 72 cases reported, which brings me to our next slide...
Colorado Mumps Outbreak, 2017
On 1/9/2017, CDPHE received a report on a 4 year old who was PCR positive for mumps, and had onset of unilateral parotid swelling on 1/2/2017.

Parent thought the child was given 2 doses of MMR in another state, but immunization records did not have any documented MMR.

Thinks he might have acquired infection while in her church's daycare room.

Not very forthcoming with information, reluctant to identify her church further.

Mom had similar symptoms and was included as an epi-linked case.

On 1/9/2017, CDPHE received a report on a 4 year old who was PCR positive for mumps, and had onset of unilateral parotid swelling on 1/2/2017.

Our local health department assigned to the case, Denver Public Health, interviewed the mother of the child who thought the child was given 2 doses of MMR while the family was living in another state, though out of state immunization records we received did not have any documented MMR.

The child didn’t attend childcare or preschool.

The mom said she though the child acquired infection while in her church’s daycare room, and identified a vague location of the church but we could not locate a church near the intersection she mentioned and the mom was not very forthcoming with additional information. She was very reluctant to identify her church further.

Mom had similar symptoms and was included as an epi-linked case. No further investigation was done at that time.
11 days after those cases were reported, on 1/20/2017, we received a report of an unvaccinated male who was PCR positive for mumps. He had a 2 day history of parotitis with low grade fever.

The case reported that his adult daughter was also seen in a local ED and suspected of having mumps

The family was advised by hospital physicians to stay home, but were unable to comply.

The case reported attending a church with a congregation of about 100 people, mostly Marshallese, and that several people at church had similar symptoms.

The daughter shared the name and location of her church, which we realized was likely the same church and the previous cases.

Considering we had 4 confirmed cases with a known connection to a community at had experienced an outbreak in another state, and reports of other community members with similar symptoms, we were concerned that the outbreak may be more extensive.

On Friday, January 20, we notified the local health department where the church was located, Tri-County Health Department, of 4 possibly related mumps cases within the greater Denver metropolitan area, all of Marshallese descent and reporting a common association with a local Marshallese church.
The Marshallese are a group of people originating from the Marshall Islands, a small island group near the equator in the Pacific Ocean, as shown by the red dot on this map.

A 1986 compact gave the United States continued military access, while the Marshallese got the right to work and live in the United States indefinitely without visas. More than a third of the Marshallese, or about 20,000, have seized the opportunity with the largest concentration Marshall Islanders having relocated to Springdale, Arkansas, to work for Tyson Foods.

The majority of Marshallese are practicing Christians, with the church often representing the primary community center and social hub.

It is estimated that there are about 400 Marshallese persons living in the greater Denver metropolitan area.

MMR is not given routinely in the Marshall Islands during childhood and is not required upon entry to the US, though the CDC reports that they achieved a 94% MMR vaccination rate following a massive vaccination campaign in response to a measles outbreak in 2003.

On January 20, we had a conference call with relevant public health agencies to discuss a course of action.

Based on our knowledge of the critical function of the church in this community, Tri County Health Department decided to reach out directly to the church leaders.

On January 22, Tri-County Health Department staff visited the Marshallese church which had been identified as a common link between all 4 known mumps cases.

They explained that we were concerned about additional, unidentified cases in the church and that we wanted to contact church members and find out if they were sick.

The church pastor agreed to provide a list of all households from the congregation.

On Monday, January 23, we received a list of 21 households that attended the church.

On Wednesday, January 25, we initiated active surveillance with in-depth household-
level phone interviews from the provided church roster. This effort was a joint collaboration with three public health agencies, informed by prior work done by the CDC and Arkansas public health officials who had been experiencing a mumps outbreak among their Marshallese community.

We really wanted to understand the scope of the outbreak as we felt that cases were probably being under reported due to lack of access to health care.
Using the CSTE case definition for mumps, we defined an outbreak case as a probable or confirmed case with an epidemiologic link to the Marshallese community in the Denver metropolitan area with symptom onset on or after November 1, 2016.

We decided to include cases as far back as November 1st because of reports that people in the church had been symptomatic for several months and because they may have gotten sick around the holiday travel season.
This is an epi curve of our outbreak.

Outbreak mumps cases were identified through a combination of passive and active surveillance. 47 cases were identified with symptom onset during November 1, 2016 and April 1, 2017.

The last case onset was 3/28/2017, which we were unable to fit on the slide. Prior to that case, the last case onset was 2/25.

As mentioned, the outbreak was identified on January 20 but active case surveillance detected a number of cases retrospectively.

As part of the outbreak response, Tri-County Health Department asked permission from church leaders to hold MMR vaccination clinics at the churches with a goal of bringing the population up to date with the recommended number of vaccine doses.

Permission was granted from leader of each of the churches, enabling 4 vaccination clinics to be held at each of the local Marshallese churches, on January 29, February 12, February 26, and March 5.
This is a zoomed-in map showing the greater Denver metropolitan area that included all of the Marshallese outbreak cases. The location of the four Marshallese churches where the vaccination clinics were held are represented by the blue church steeples.

Here you can see a heat map illustrating the tight geographic clustering where outbreak patients resided. The red dot represents the centroid of the outbreak cases with symptom onset through December 2016. The colors indicate the relative number of cases within a specific geographic area, with red indicating the greatest density and blue, the lowest density. The 2.5, 5 and 10 mile radii are shown by the dotted red lines.

This shows the geographic spread of the outbreak during January and February.

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NOTES:
The density surface is calculated by a kernel density function using the geocoded residential addresses of confirmed Mumps cases cumulatively for each month.
At these clinics, vaccination status of each person was checked in the Colorado Immunization Information System prior to offering the MMR vaccine.

The vaccine was offered to any person who was not up-to-date, according to the national Advisory Committee on Immunization Practices.

There was much discussion about vaccination strategies – should we focus on those who were unvaccinated? Should we offer a third dose? We landed on having an end goal of covering everyone in the community who showed up to the clinic with 2 doses of MMR.

A total of 164 MMR doses were administered, covering an estimated 35% of the local Marshallese population, and an estimated 75% of the largest and most affected church congregation.

Church leaders consistently estimated that there are about 400 Marshallese persons living in the greater Denver metropolitan area. The 35% MMR vaccination clinic coverage was calculated by dividing the total number of unique individuals receiving at least 1 MMR vaccine at one of these clinics by the total estimated population.
The estimated church size of church #1 (“Assembly of God”) was 150 persons. At vaccine clinics #1 and #3 (both for this church body but at two separate locations), 113 unique individuals received at least 1 MMR (26 received 2 MMR). This covered 75% of the estimated church body (113 / 150).
In addition to increasing the vaccination coverage among community members affected by the mumps outbreak, one of our goals was to limit the spread of mumps beyond this community.

Communication efforts were implemented to urge the public to get vaccinated if they weren’t already and for physicians to consider a mumps diagnosis when patient present with parotitis, to collect specimens for testing, and to instruct suspect cases to self-isolate.

To get this message out, we sent out a health alert via our health alert network and a letter to schools.

The school letter was intended to be distributed to parents by school nurses and had some language that cautioned parents that unvaccinated children could be excluded from school if their school was affected by a mumps outbreak.

The letter to schools was unexpectedly controversial, as many school districts required school board approval before sending out any sort of letter and some school boards were populated with people opposed to mandatory vaccinations.
The messaging to health care providers seemed to have been effective, as 25 non-outbreak cases were reported from Jan – June of 2017. We attribute some of these cases to the increase in awareness and increased testing for mumps.

Though we had an increase in non-outbreak cases, these cases were sporadic. The outbreak did not spread beyond the Marshallese community.
Describing the Outbreak
Cases were split fairly evenly among male and female – 49% female and 51% male.

98% of the cases reported race as “native Hawaiian/other pacific islander”
Cases ranged in age from 4 months to 44 years. The average was 20 years. Most cases were in the younger adult range.
As we know there are challenges with mumps testing, the outbreak gave us an opportunity to examine what tests were helpful to provide laboratory confirmation for our cases.

We were successful with getting PCR results from our cases, as 85% of the 20 cases tested by PCR were positive. Serology was not often used and was of little value.

The average time from symptom onset to specimen collection was 2.23 days with a range of 0-6 days, which is likely why PCR was so successful.

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Confirmed = 17, prob = 30
This table shows the percent of cases that self-reported having the following symptoms at the time of interview.

In addition to parotidis, the most common symptom was jaw pain, followed by malaise, fever, and submandibular swelling. Though it is important to note there is likely some recall bias as many of the cases were discovered retrospectively.

Parotid swelling lasted an average of 5 days, with a range of 1-14 days and was about equally unilateral and bilateral.

None of the outbreak cases experienced complications such as meningitis, deafness, or orchitis. 1 case was hospitalized.
Most of the cases listed their home or place of worship as the transmission setting.

Some cases listed “work” or “school” but as members of this community tend to attend the same schools and work in the same locations, we think the transmission was still within the community and not widespread within these settings.
This shows the outbreak cases by the number of vaccine doses and as you can see, 53% of our cases were unvaccinated.

This is in contrast to outbreaks that have occurred elsewhere in the US among vaccination populations and one of the reasons our interventions were so successful.

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<th>MMR Doses</th>
<th>Cases N (%)</th>
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<td>0</td>
<td>25 (53%)</td>
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<tr>
<td>1</td>
<td>2 (4%)</td>
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<tr>
<td>2</td>
<td>9 (19%)</td>
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<tr>
<td>3</td>
<td>1 (2%)</td>
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<tr>
<td>4</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>9 (19%)</td>
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We also looked at the number of vaccine doses by age group.

While about half of the cases age 6-17 had at least 1 dose of MMR, only 4 of the 27 cases over 18 had a dose.

63% of cases over 18 were unvaccinated.

I think it’s important to note that the local health department who investigated these cases did not find them to be against vaccination, but they did seem to lack a medical home where they could receive routine preventative care. Most of the cases were treated at a hospital ED, not at a primary care office.

When offered vaccination, the community was very willing.
An outbreak of mumps was identified in an generally unvaccinated Marshallese community in Colorado.

Lack of access to health care among this community made case ascertainment difficult.

Mumps can be difficult to distinguish from other respiratory illnesses before an outbreak is detected.

Early and culturally sensitive contact with Marshallese church leaders was critical.

Early implementation of active case finding identified need for vaccination as a control measure.

Rapid implementation of church-based MMR vaccination clinics might have helped to contain the outbreak.
Thank you to all my colleagues at the Colorado Dept of Health who helped gather data and coordinate this investigation,

To my colleagues at Tri County Health Dept and Denver Public Health who conducted the investigations and executed the vaccine clinics,

And to my colleagues at CDC who provided guidance throughout the process.
Questions?

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