Case Study
In
Assurance

Measles Outbreak in Speckle County

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A. Title: Measles Outbreak in Speckle County

B. Functional Area Focus: Assurance

C. Major Subjects Involved:

Religious exemption of vaccination

Community collaboration to address a public health concern

D. Setting the Case:

1. Key Participants:

- Cari Concern, MPH, Public Health Administrator, Speckle County Health Department (SCHD)
- Patty Prevention, RN, Communicable Disease Coordinator, SCHD
- Irene Immunity, RN, Staff Nurse, SCHD
- Mr. IgG, RN, Staff Nurse SCHD
- Sam Shots, Spotsylvania State Department of Public Health, Immunization Section
- Penny Candy, Spotsylvania State Department of Public Health, Region 14, Immun Section
- Olden Outbreak, President, No Shots College
- Heidi Rash, No Shots College "Nurse" (a title given by the Avaccinationists, not medically trained)
- Dr. Knozit, Medical Director, Infectiapolis County Health Dept.
- The Avaccinationists: A religious organization that generally does not accept vaccination and medical intervention. They are a self-contained community with schools in Speckle County and Infectiana

2. Relevant Geographic and Demographic Information:

Speckle County is a small rural county in Spotsylvania. The 1990 census listed the population at 20,539. Of this number, 99.2% were Caucasian, 0.5% were African American, and 0.4% were other races. The median age was 33.2 years.

Farming is the main occupation for county residents. The majority of the workforce commutes outside of the county. Local employment is mainly service-based part-time with little to no benefits. Unemployment was 9.1% in September, 1993. During the same period, approximately 9.2% of the county population was receiving state public assistance and 30% of the population lived below 200% of the poverty level as compared to 27.1% of state. Twenty-eight percent of county residents over 25 had not graduated from high school. The county is also a rural medically underserved area. Because the majority of the population is rural, there is difficulty with transportation to health care services.
The most interesting aspect of the demographics of Speckle County is the presence of an Avaccinationist community, church, and college comprising over 700 students, staff, and faculty. This population claims religious exemption from vaccination leading to the potential for outbreaks of vaccine preventable diseases.

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Introduction
This case study demonstrates the successful strategies developed between public health and a community for management of a susceptible population during a disease outbreak of measles. In addition to controlling the disease outbreak itself, the public health officials had to work with the culture and restrictions of the religious community.

The measles outbreak in Speckle County is an important example for the assurance function in public health. There is a definite acceptance of risk in the community of inevitable outbreaks in a religious community that objects to vaccination. The capacity of the local public health system, including preparedness of its workforce, collaboration with the state authorities, and relationship to the local community, to handle the outbreak is key to assurance. There is also the necessity of assuring adequate medical care to the population once members are ill with a disease that is not often seen today. Measles has not yet been successfully eliminated in the world. Until it is, there is a risk of outbreaks in unvaccinated populations. Many in the workforce have not had experience with measles, and in rural areas, experience with disease outbreaks. (For more information on measles, see attachments.)

The assurance function in public health requires the ability to respond to a critical situation, such as a disease outbreak. In a religious community with vaccine exemption, such a disease outbreak should be expected and policies and procedures in place. Issues include containment of the outbreak, medical treatment of the ill, and prevention of future outbreaks. Local health departments are responsible for serving as catalysts to the community to coordinate and organize the needs of the community and work with the state in emergency responses. This case demonstrates the cooperation of state, local, and religious community officials. Core functions were also designed as a strategy to develop an integrated public health system and healthy community. The public health agency must be capable of working with all entities, including those that are not health related. The function of assessment also needs to be considered, including the extent of the outbreak and how it started. The policy development function can include the
procedures used to deal with the outbreak in a situation where valid exemptions to the law increase the likelihood of outbreaks.

Case Chronology:
The description of the time line may seem extensive and detailed, but it is necessary to see the day by day tracking of the outbreak which resulted in the successful containment of the disease.

4/18/94
Speckle County Health Department (SCHD) received a call from the No Shots College "nurse,” Heidi Rash, reporting a rash in a 20-year-old college student. On further questioning two other rashes were reported from within the same family. There was report of a previous rash 12 days prior in the 14-year-old sibling (the probable index case) and a 4/16/94 rash onset in an 11-year-old sibling. Religious "nurses” were instructed to report any future rashes and isolate anyone with a rash. Also, they were instructed to inform the family that nurses must visit to observe and investigate the rashes. Heidi Rash also reported that No Shots Lower School in Infectiapolis had 3 cases of rash in children and 5 not feeling well, and this had been reported to Infectiana officials. Contacts were made to Regional and State official contacts at the Spotsylvania Department of Public Health. Officials planned to visit SCHD the following morning.

CDC staff nurses, Patty Prevention, Irene Immunity, Mr. IgG, and Speckle County Health Department Administrator Cari Concern met to discuss the possibility of a measles or other outbreak. Two of the nurses were sent to the town of Rashville in Speckle County, to view the rashes. Rash investigation forms were taken to be completed on the current rashes as well as the prior rash case, date onset of 4/4/94.

Current rashes verified case definition of measles: Generalized rash, fever of 101 or greater, Koplik spots, cough, coryza, conjunctivitis, photophobia, and/or lymphadenopathy. CDC nurses were not successful in obtaining serum drawn from any involved. All refuse. Thermometers to assess temperature were also refused, but those with rashes finally agreed to the use of the ear-thermometer. Travel history examination revealed that the family of the 14-year-old had traveled to a vacation site in Primary, Old Indexico on March 18 through 24, 1994, during a spring break. Vaccination history revealed no current vaccination on any of the rash cases due to religious exemption. Measles update review of MMWR revealed probable measles outbreak in Primary, Old Indexico, with 15 probable cases 4/1 through 4/7/94.

State Health Department officials were notified immediately and prepared to accompany local public health official to the No Shots campus to discuss outbreak measures if measles is confirmed. Regional CDC officials also planned to accompany the group. The visit was arranged with college officials for the morning of 4/19/94.

Late 4/18/94 an additional report of a rash in an 8-year-old (non-relative) was received. The rash investigation was also conclusive of possible measles and had a link to the first rash onset of the 14-year-old through church and also bus riding to a lower school in the nearby state of Infectiana. A list of school bus riders was requested. A list of school enrollment was also requested from the college.
4/19/94

State, regional and local public health officials met prior to campus visit to review strategy in dealing with the Avaccinationist community. Officials stressed the importance of respecting their beliefs. It was agreed that working with them in a positive, respectful and lawful way, would prompt early reporting and cooperation. A review of the 1985 outbreak of measles indicated a need for changes. In particular three deaths in 1985 may have been related to having already ill persons in Reflection House (a healing area for the students on campus) and placing those with rashes in with the others that were ill. It was decided that the college would be asked to keep ill persons with rash separate from those with other symptoms.

It was also discussed that the Avaccinationists under reported symptoms and did not recognize illness. This was most likely due to their religious thinking. In 1985, 30 persons were ill with rashes before it was finally reported. It had been noted that some students totally denied feeling ill, or seeing a rash when they were obviously extremely ill with high fevers, cough, rash, etc. Immunization clinics were therefore set up late in the outbreak in 1985. It was agreed that one key measure of outbreak control would be prompt immunization clinic set-up.

Only one of the public health officials present was directly involved in the 1985 outbreak, the state official, Sam Shots. This official noted the students in 1985 did eventually accept vaccination but only to be able to continue on with their normal routine. For the best response to the Avaccinationist group, it was decided that Sam Shots would take the lead in discussion with campus officials.

It was noted that the Spotsylvania campus had an advantage to vaccination—most students on campus were age 18 and did not require parental permission for vaccination. It was also noted that Spotsylvania had an advantage in preventing the spread to the outside community, because they had instituted the 2-dose MMR requirement. Infants who had not been vaccinated yet with the MMR would remain vulnerable. It was decided that infants as young as 6 months of age would be given the MMR during this outbreak and would later receive additional age appropriate doses of MMR. A major media campaign was implemented to ensure area citizens were up to date with immunizations.

State, local and regional health official representatives (Sam Shots and Penny Candy) met with college president, Olden Outbreak, and other officials. Reference was made to a 1985 outbreak of measles in Speckle County, which resulted in 136 cases and three deaths and much publicity. Public health officials secured the cooperation of the campus officials, but who were also quite certain that the college was not affected, as there was only one 20-year-old college student with a rash.

The laws were reviewed, as well as a plan in the event more rashes occurred among the campus students. The goals of public health officials were to prevent deaths, assure any need for health care to those affected, and quickly contain and resolve any outbreak. The goals of college officials were to follow the law, not disrupt their campus and to ensure graduation at end of May.
Concern was expressed by public health officials not to put those with rashes in the same place as those who may be in Reflection House, an area where students recuperated from illness, but not expressed as such. Permission was also received to view anyone with rashes, or illness. Immunization clinics were set up to begin, but Olden Outbreak would not allow them on campus. They were allowed to begin in the town hall of Rashville.

Five additional rash onsets developed and were reported to the health department. Four were children age 9 through 13 who rode the bus to lower school in Infectiana. One report was of a 19-year-old college student, who attended No Shots College and was a friend of the other 20-year-old student with a rash. The 19-year-old allowed serum to be drawn.

Infectiana Department of Public Health Administrator, Dr. Knozit, was asked if there were any other cases of rashes in the lower school in their state. Infectiana had three initial rash cases and now an additional five. They began a measles outbreak investigation as well. They were able to obtain blood specimens on three children with rashes, and expected results by the end of the day. All eight of the Infectiana cases were linked to the 14-year-old probable index case in Speckle County. All of the Spotsylvania rashes had a link to her as well. Infectiana was home to a lower school and high school with No Shots students, many of whom commuted by bus from Speckle County, Spotsylvania, and many of whom lived in dormitory settings in Infectiana. A meeting was arranged for Infectiana and Spotsylvania public health officials to meet in Infectiapolis on 4/20/94.

All area MD’s and hospital ER’s were put on alert that there were probable measles cases in non-vaccinated population. They were requested to report all suspect rash-like illnesses. Emergency room logs were checked for rash reports through ER after 4/14/94. Also all medical personnel were informed of free serology for all suspect cases. Public and private nurses and superintendents were notified and asked to verify immunization status, and identify those who are exempt from vaccination due to medical or religious reasons.

4/20/94
Received word from Infectiana officials that first serum drawn was confirmed IgM positive for measles. State regional officials were notified. College officials were notified. Spotsylvania also received confirmation of IgM positive serum drawn on probable cases. Immunization clinics were set up in Rashville. College officials voluntarily closed campus. Only those students who could show proof of immunity were allowed to leave campus. Only persons who could show proof of immunity could go back onto campus, i.e. employees. This prompted many students into becoming vaccinated. Vaccination was offered for MMR (Measles, mumps, and rubella) not the single measles vaccination, as local officials only had immediate availability of the MMR vaccine. This was an opportunity to immunize for other diseases. News releases were reviewed with college officials before they were finalized and distributed. Health Department administrator, Cari Concern, was assigned to handle all media calls, questions, and interviews. Ms. Concern was very understanding and respectful of religious community’s beliefs during all media contact.

Infectiana and Spotsylvania public health officials met and reviewed strategy and travel histories of cases. Basic action strategies were 1) Isolation, 2) Immunization, and 3) Reporting.
Communication contacts were named among bi-state officials to share outbreak information. More information was received about a carnival held on campus one weekend that was attended by students from many other states.

Letters were sent to all MD’s that measles cases were confirmed. All cases were epidemiologically and symptomatically linked to a blood confirmed case of measles. Letters from Speckle County Health Department were sent to all parents of 10 schools in the county, per school district and private school personnel.

No Shots College officials were asked for proof of measles documentation for campus faculty and student population. There were 530 students enrolled, 508 were on campus. There were 235 employees including faculty and staff. Records showed 511 of student population claimed religious exemption to vaccination. Those born prior to 1957 were considered immune. School officials requested vaccination status on many who were involved in the 1985 outbreak to show proof they received measles vaccination.

Spotsylvania State and local health department officials decided for purposes of this outbreak proof of one measles vaccination for Avaccinationists would be sufficient. A two-dose requirement would deter the Avaccinationists community from receiving the vaccine. Public health officials believed that if the vaccination was given within 72 hours of measles exposure, the disease could be prevented. Spotsylvania State officials reported there was only one case of measles in a person who was vaccinated during the 1985 outbreak. The measles was contagious 3 to 4 days prior to rash onset and for 4 days after rash onset. This period of being communicable prior to rash onset helps the disease spread quickly. Another issue of concern was allowing persons vaccinated to return to normal duties. Once vaccinated, Spotsylvania officials allowed students to return to normal activity. Infectiana officials made students wait 3 days after vaccination, which also deterred students from vaccination in Infectiana.

Religious community took the immunizations, but they refused to receive the Vaccine information forms. On 4/20/94, 100 were vaccinated. On 04/21/94, 177 students were vaccinated. By 4/25/94, 394 of the 530 students or 74.3% could show proof and were able to leave campus. Students went to both states to visit sporting events, restaurants, etc. Infectiana had 39 cases thus far. Spotsylvania still had 10 cases. Those students who refused to be vaccinated remained on campus. The number was 82.

By 04/27/94, there were 436 students who could show proof of immunity. Twelve were traveling in other parts of the world and had not been on campus, leaving 82 or 15% unvaccinated. Health Department CDC nurses continued to go to campus each day.

4/28/94
Health Department CDC nurses found a 19-year-old with a 101.7 degree fever, swollen glands, with MMR vaccination history on 4/20/94. They also found a 21-year-old with sore throat, 99.6 temp, MMR on 4/20/94.
4/30/94
Two more cases of measles were found in age 5 and 11-year-olds with MMR histories 4/21 and 4/22.

5/1/94
Three more cases were found, all with recent MMR vaccinations.

5/2/94
Received telephone call from Olden Outbreak reporting 3 more persons in Reflection House with rashes. All had the vaccination recently. President confused as to why. Cari Concern explained that the two college students were exposed to students on 4/14, 15, 16, 17, 18, and 19. Vaccinations did not start until 4/20, 21, 22. Many could have been exposed before the 72-hour mark prior to vaccination. She also explained that the 1985 outbreak showed we should vaccinate, as only one person who was vaccinated during the outbreak developed the disease. President made an unusual request. Could all that were not immune go to their homes in seclusion? This would involve many states. State and local public health officials began a plan to help the college accomplish this goal, contain the outbreak, and assure all involved had access to care it they needed it.

Additional students were vaccinated, reducing the total susceptible population to 70.

4/29 through 5/7/94
The second generation of measles cases occurred. Ages ranged from three to 25. Twenty-eight cases were confirmed. Unfortunately, 22 had received the MMR vaccination, but evidently too late to prevent the disease. Only five of the second-generation cases had no vaccination.

5/3/94
A teleconference with Centers for Disease Control, Infectiana and Spotsylvania officials took place. CDC requested that a team scientist visit No Shots campus during the outbreak. Spotsylvania officials requested that it be a well-spoken senior person, who would be sympathetic to the religious community. CDC was very complimentary to Spotsylvania regarding vaccination efforts.

Days were filled with rash investigations on others in the general community. No rashes outside the religious community met case definition of measles. Two cases were confirmed outside the religious community in Infectiana. One case outside the religious community attended a sporting event. The other was an infant who was in a restaurant when the No Shots College student, who had played in the sports tournament, visited the restaurant. This student had been vaccinated but later developed the disease.

5/12/94 to 5/19/94
The third generation of measles cases began. The third generation involved 9 cases as of 5/19/94. Total cases in Spotsylvania numbered 52.
5/24/94 to 6/2/94
Five additional cases occurred between 5/24 and 6/2/94. One was a 19-year-old with a proven history of measles vaccination in 1976, representing a vaccine failure, but only after repeated exposure to the measles. Another was a rash onset on 6/3/94 with vaccination received on final day offered, 5/19/94. The final case was a susceptible student who was in isolation because of no vaccine history.

6/5/94
Strategies to assist accomplishing the goal of containing the outbreak and allowing graduation services to take place included the following: 57 susceptibles wishing to graduate on June 5, 1994 gave proof of immunity through blood tests or were vaccinated. Two students were isolated for 21 days before graduation so they would not be exposed to anyone with measles. Three students were “encapsulated” to travel to their homes in Spotsylvania, Down South State, and Old State. Four students who could possibly have been incubating the disease were isolated during graduation. They remained in isolation until 21 days after the last rash onset.

Note: A major decision was made to halt giving the MMR vaccination as of May 19, 1994. This was done to stop any possible spread through travel by those who were recently vaccinated, and who might develop the disease regardless of the vaccination. This would prevent confusion that immunity was certain due to recent vaccination. It was noted through this outbreak that some vaccinated persons developed the disease even fourteen days after vaccination, one case was 15 days after vaccination. The campus was opened for graduation on 6/2/94, with commencement exercises being completed 6/5/94. Parents and relatives safely came from nearly every state to enjoy the graduation ceremonies.

Chronology Summary:
By the end of the outbreak, 52 cases of measles had occurred in Speckle County. Twenty-three cases were children, ages 3 through 14. Twenty-nine were from the college: 28 students, and one staff member, ages 18 through 25. Four hundred-fifty-one MMR vaccinations were given, including 319 to on campus persons, 104 off campus in Nashville area, and 28 from surrounding counties. There were no deaths. The Vaccinationist community had allowed health department nurses to check on cases every day, preventing any major complications or deaths, and assuring their access to care, as well as continued spread of the disease outside the community.

Departmental History
The Speckle County Health Department (SCHD) was formed by resolution on July 1, 1966. A Public Health Administrator (PHA) was hired and held that position until his retirement in 1992. Since then, Cari Concern has held the PHA position. SCHD employs 50 part-time and full-time employees. SCHD’s major program and funding comes from the Medicare home health to reach rural underserved populations. The Communication Disease Coordinator, Patty Prevention, is responsible for immunizations. Her team of staff nurses, Irene Immunity and Mr. IgG, regularly hosts clinics to ensure proper immunization of county residents.
There have been two (2) measles outbreaks in the history of the Department: in 1985, 3 persons died and, in 1994, there were no deaths. It is suspected that a measles outbreak will happen every 5-9 years. Currently, the Department is working on two goals: 90% or higher immunization compliance rates and prevention education from vaccine preventable diseases.

**Religious/Political Concerns**
The cases in the measles outbreak were members of the Avaccinationist religious group. Avaccinationists used prayer as treatment for physical problems and believed that only God could heal and therefore usually avoided medical care. Members of this church generally claimed religious exemption from immunizations but obeyed legal requirements (e.g., reported infectious diseases and obeyed public health quarantines). However, physical maladies were not viewed as disease symptoms, but rather from a spiritual viewpoint, and vital signs were not measured by church “nurses.” Because of this religious perspective, infectious disease might not be recognized and therefore not reported. If an infectious disease was reported, it might be very late in the illness.

**The Human Element**
Since the focus of the outbreak was at No Shots, an Avaccinationist College, communication between Speckle County Health Department Administrator, Cari Concern, and No Shots President, Olden Outbreak, was vital to control.

In a crisis, group members turn to their leader for guidance. As college president, Olden Outbreak was in a position to influence members of the religious community. His positions on vaccination, quarantines, and reporting were vital to the outcome. Prior to becoming president of No Shots College, Mr. Outbreak had a distinguished career as an international diplomat, author, and public speaker.

In a prior measles outbreak at No Shots, reporting had been late and deaths had occurred. A key event in this latest outbreak was the upcoming college graduation ceremonies.

At the field level, a cooperative relationship was also important between Irene Immunity, RN, Speckle County Health Department Staff Nurse, and Heidi Rash, the Avaccinationist “nurse” on the college campus. Since the outbreak extended into Infectiapolis County Health Department, in the bordering state of Infectiana, cooperation was also needed between Cari Concern, Speckle County Public Health Administrator; Sam Shots and Penny Candy, Spotsylvania Department of Public Health (SDPH); and Dr. Knozit, Infectiapolis County Health Department.

**Public Relations/Communications**
Public relations played a role in helping to contain the outbreak. When the first cases of measles were identified, health officials launched a major media campaign to ensure citizens were up to date with their immunizations. Such a campaign helped increase the number of measles vaccinations in the target areas.

The way in which public relations efforts were handled helped ease tensions between the health officials and the Avaccinationist community. Health officials placed precedence on working with
the religious community in a positive and respectful manor. Ms. Cari Concern, the administrator assigned to handle media calls, made this a priority. As a result, the ensuing newspaper articles were not focused on criticism of Avaccinationist beliefs. The coverage of the outbreak for the most part was balanced and fair, which helped increase cooperation between health officials and the Avaccinationist community as a whole.

In general, there was a substantial difference between communications activities during the 1994 outbreak, which led to no deaths, and the 1985 outbreak, which led to three deaths. In 1985, immunization clinics were set up late due to poor communications and distrust between the religious community and health officials. Many students at No Shots College denied being sick. Once deaths occurred, the Avaccinationist community had to handle an onslaught of negative publicity. In 1994, the relationship between the Avaccinationist community and health officials was stronger, which led to quicker action. Health officials were immediately notified of potential measles cases. Immunization clinics were set up almost immediately, and more No Shots College students received vaccinations.

Financial Concerns
The 1994 budget of the Speckle County Health Department was approximately $1.4 million. However, most of the budget was earmarked for home health. Only 40 percent was designated for public health functions, and there was no extra funding to cover the outbreak. Since the Health Department was formed by resolution and not by referendum, the department had no authority to tax the public for additional funds. Thus, it was required to handle the outbreak, but had no funding to do so.

Cari Concern handled the situation by placing a number of her staff on over-time. While she could never pay them for their extra hours, she gave them compensation time once the outbreak was over.

In Speckle County, as well as other counties with populations opposed to immunizations, there is always the chance of a new measles outbreak. Health departments in these areas must be creative in how they manage finances in the event of an emergency, and should consider developing preparedness plans.

Conclusion
The resulting public health outcome was successful in having a minimal impact on disease and containment within a limited geographic area, including zero deaths. Therefore, the assurance function was met.

This case reminds us that it is not possible to assure 100% vaccinations, even with legislative and practical intent. Given that reality, it is important to balance the rights of a select group against the public health safety of a larger population. It is not possible to force disclosure of all of the ill from an outbreak in a closed community. Therefore it is extremely important to develop a good relationship with the religious community while respecting their culture. The goals of public health and the religious community were very different, yet the outcome was positive.
This is an example of a type of situation that can be beyond the control of traditional regulation. The risk of inevitable outbreak will always be present with religious exemptions. An expansion of this scenario with philosophical exemptions could only greatly complicate any risks. The leadership challenge is to work with the realities of the community, such as encouraging the effectiveness of prevention, controlling the spread of disease, and how to handle the medical complications. The key is to maintain high public health standards, while fostering a good working relationship with the religious community. It requires the important human component of balancing cooperation and control.

QUESTIONS

1. Which of the 5 fundamental practices of exemplary leadership would be most important in assuring that a future measles outbreak in Speckle County would have minimal negative impact on the community’s health?

2. Give several examples of how collaboration can be fostered between the key players.

3. With the reality of policies of religious exemption, and possibly philosophical exemptions, what would be some issues for assurance that local health departments can be adequately prepared to deal with the inevitable disease outbreaks?

4. How did the health department history assist in making effective public health leadership decisions?

5. Based on the environment, what were the barriers of assurance?

6. What assurances were not met or could not be met due to religious exemption?

7. In light of the fact that many developed the measles despite being vaccinated, what barriers might the Speckle County Health Department face in future outbreaks and how can they deal with these barriers?

8. In the event there is another measles outbreak in Speckle County, are there any new strategies health officials and Avaccinationist community officials could use to improve the response?
Case Study Attachments
Relationship to Healthy People 2000, etc:
According to the CDC, of 895 cases of measles reported in 1994, 209 (23.4%) were among religiously exempt persons. Together, the fictional Speckle County and the neighboring state of Infectiana in this case study reflect the largest measles outbreak in the US in 1994. (Immunization Action News, Vol 1 (3), p. 1, June 15, 1994). MMWR Dec 17, 1999 indicates that data for 1998 suggests that routine measles vaccination coverage has declined, and that "measles continues to be an important cause of morbidity and mortality." It does not address the complications of the religious exemption, which continues to provide a vulnerable population for infection.

Measles has been identified as a top target for global eradication as a public health strategy. Healthy People 2000 (Section 20.1) indicated that there was a targeted goal of zero indigenous cases of measles by 2000 since 1978. The baseline number of cases in 1988 (3058) dropped to a record low of 135 in 1997. Although significant progress was made, the goal was reset in Healthy People 2010 (section 22-7). The reported cases, confirmed by epidemiologic and virologic data, have reached record lows due to high vaccine coverage and demonstrate the interruption of indigenous transmission levels in 1993, 1996, and 1997. The disease is recognized as a challenge for eradication due to its highly contagious nature, especially with air travel providing an easy avenue for importations and spread. This is especially true from less developed countries, where limited resources may not be focused on measles eradication. CDC workgroups research into developing "adequate indicators for evaluating surveillance and documenting the impact of intervention" (MMWR, Vol. 49, Supplement, December 31, 1999, p. 129).

Measles
Measles (Rubeola), not to be confused with Rubella (German Measles), is an acute viral disease characterized by a rash, fever, and respiratory symptoms. The virus belongs to the genus Morbilli virus. Other members of the genus are the distemper virus in dogs and the rinderpest virus of cattle. The virus enters the victim through the respiratory tract, soon spreads to the local lymph nodes and begins to multiply there, during an incubation period of about 10 days. Virus secretion can start as early as day nine of the incubation period, at which time the patient is already infectious.

The course of the disease is in three stages. The earliest stage (the prodrome) is characterized by symptoms similar to an upper respiratory tract infection with sneezing, "runny" nose, cough, and fever. Redness of the eyes and light sensitivity are also early signs. At this time the virus is still present in the patient in sufficient quantity to be spread by the aerosols created by coughing and sneezing.

The fever continues as the virus multiplies to a great enough level (Viremia) for the second stage to be expressed. It is characterized by red spots and a red raised rash (Macular or Maculopapular exanthema). The other hallmark symptom is bumps in the mouth called Koplik's spots. The fever and cough subside in 1-2 days after the onset of the rash. The next 2-4 days the rash covers the entire body.

In the third stage, the rash turns from red to brown and the symptoms become less acute until the
rash is gone. The virus is still excreted during this time. If there are no complications, the disease should disappear one to two weeks after the onset of the rash.

Complications include bronchitis, pneumonia, and otitis caused by increased susceptibility during the disease (15% of cases). Pneumonia accounts for 60% of measles deaths. Encephalomyelitis appears in 1:1000 cases, after the onset of the rash. There is no correlation between the severity of the case of measles and the incidence of encephalomyelitis. This causes a second round of fever with drowsiness or convulsions. Encephalomyelitis has a mortality of 10 to 30%. Survivors may show permanent mental disorders (psychosis or personality changes), physical disabilities, and seizure disorders. These changes are suspected to be caused by autoimmune reactions. Measles during pregnancy may cause low birth weight, premature labor, and spontaneous abortion. Birth defects caused by measles have not been clearly established.

Persistent measles virus can lead to other complications. Subacute sclerosing panencephalitis (SSPE; Dawson's inclusion body encephalitis) is thought to be caused by the Measles virus in five to ten cases per million. The onset can be one month to 27 years after the case of measles. It affects children and young adults with a slow progressive mental deterioration ending in death. Other chronic autoimmune diseases suspected are multiple sclerosis and systemic lupus erythematosus.

**Modified Measles**
This syndrome occurs in persons who have received immune globulin (IG) after exposure or in young infants (usually less than six months old). The result is a course with a mild prodrome or first stage and rash of short duration.
Measles Laboratory Tests

Direct Detection by Tissue Culture

The presence of the measles virus (MV) can be ascertained directly by culture. The virus can be isolated from urine, blood, and nasal and throat swabs collected within three days of the rash onset. Viruses, must be grown in live cell cultures, and cannot be grown on agar plates or in nutrient broths like bacteria. Monkey kidney cells, which can be grown in a culture media, are used to grow MV cell cultures, and are commercially available for this purpose. Vials with a thin layer of monkey kidney cells grown in them are inoculated with the specimen. These cell cultures are incubated and observed at intervals, for up to two weeks. MV is detected when changes in the monkey kidney cell cultures characteristic of MV infection are observed by the laboratory technologist. Viral isolation is difficult, very dependent on the quality of the specimen, and should only be used in epidemiologic studies or in cases of chronic infection.

Direct Detection by Direct Fluorescence Antibody (DFA)

Cells infected with MV can be recovered from nasopharyngeal secretions. MV in these cells can be "stained" with antibodies chemically bonded (Conjugated) with a fluorescent chemical.

A nasopharyngeal secretion specimen is collected, refrigerated, and is sent to the laboratory. The collected mucous is swabbed on a glass slide and heated to attach any cells to the slide. The slide is "stained" for cells containing the virus, by covering it with a solution of antibody that targets MV. The antibody has a fluorescent dye (called Fluorescein Isothiocyanate or FITC) conjugated to it. The slide is then incubated for a time to allow the antibody time to attach to the viruses in the cells. Next the slide is searched for cells under a microscope equipped with an ultraviolet light source, cells that are infected with MV can be observed when the antibody-FITC "stained" MV glows apple green. If there is no MV present, no fluorescence is observed.

Indirect Detection by Indirect Fluorescence Antibody (IFA)

Indirect Fluorescence Antibody (IFA) of MV establishes infection by finding antibody to MV in the blood. In the first step of this method, cells infected with MV that are attached to a microscope slide, are exposed to the patient's serum that may or may not contain antibodies to the MV. In the second step, antibody to human antibody present and "conjugated" with FITC is used to detect the patient's "Anti-MV antibody." This is the classic sandwich antibody technique of the Indirect Fluorescent Antibody (IFA) test.

In this method, blood is collected and allowed to coagulate. The clear liquid serum is separated from the clotted blood in a centrifuge. The serum is drawn off the top of the clot and is transferred to another test tube for the analysis. The serum is diluted in a 0.9% salt solution with the pH usually at 7.2. (This solution is "buffered" with phosphate. This solution is referred to as phosphate buffered saline or "PBS.") A small amount of the serum is diluted in PBS in a test tube
(0.1cc serum to 0.7cc PBS; a 1:8 dilution). The diluted serum is transferred to a glass slide with wells containing MV infected cells, and the slide is incubated. The slide is then rinsed with PBS to remove antibodies that are not specific for MV. Next the slide is covered with anti-human antibody-antibody conjugated with FITC, and is incubated. After this incubation, the slide is examined as in DFA for apple green fluorescence. If the patient has antibody to MV the apple green color is seen on the virus in the prepared cells.

Indirect Detection by Enzyme Immuno-Antibody (EIA)

In EIA the same antibody sandwich is created as in IFA, but the detection is made by an enzyme activated color change.

As in the IFA a serum specimen is collected and diluted. The diluted specimen is transferred to a test tube with MV infected cells attached to walls. The diluted serum/prepared test tube is incubated. After the incubation the test tube is rinsed with PBS. The test tube is filled with anti-human antibody-antibody conjugated with an enzyme, and is incubated. The test tube is rinsed again with PBS. A solution with a chemical that is acted on by the enzyme is put in the test tube. If the patient has antibodies to MV the color (yellow) is seen in the test tube.

* Other testing methods exist, but are outside the scope of this discussion.

IgM, IgG, and Titer

Careful interpretation of antibody detection is important in evaluating the "Immune" status of the patient. In IFA or EIA the presence and amount ("titer") of antibody either IgM or IgG can be measured. (In IFA and EIA Anti-Human IgM or Anti-Human IgG antibodies are utilized as the secondary antibody respectively.)

Titer

A titer is established by the use of a series of increasingly less concentrated dilutions of the patient's serum (serial dilution) in a PBS solution. For example to find a measles titer, a series of ten dilutions could be prepared as follows:

1) A 1:8 dilution is prepared (see "IFA"). 2) Nine test tubes are filled with 0.5cc of PBS solution. 3) 0.5cc of the 1:8 dilution is transferred to the first of the series of test tubes and mixed resulting in a 1:16 dilution. 4) next 0.5cc on the 1:16 dilution is transferred to the next in the series yielding a 1:32 dilution. 5) this process is continued until the serum is diluted to the 10th tube. (The resulting dilutions in the test tubes would be: Tube #2- 1:16; Tube #3- 1:32; Tube #4- 1:64; Tube #5- 1:128; Tube #6- 1:256; Tube #7- 1:512; Tube #8- 1:1024; Tube #9- 1:2048; Tube #10- 1:4096. (*This is called a "2-fold dilution" because serum is diluted by a factor of two with each tube.) 6) Finally, a small quantity (depending on the assay used) of each one of these dilutions is transferred to the slide (IFA) or test tube(EIA) used in the test and the test procedure is run. The "Titer" is the "highest" dilution (least concentration) of the serum that results in the display of the desired reaction in the test. (i.e. the apple green fluorescence in IFA or
the enzyme color change in EIA.) *Note: Any other dilution factor can be used that is compatible with a test. This is an example to illustrate the preparation of a “serial dilution.”

**IgG and IgM**

In humans, there are five classes of antibodies or immunoglobulins (Ig). They are called IgG, IgA, IgM, IgD, and IgE. Immunoglobulins are produced in a small group of white blood cells called "plasma cells." (IgA is associated with immunity in the lymph nodes, and in the digestive, respiratory, and urinary systems. IgD and IgE are associated with the function of white blood cells in their role in destroying invading germs.)

IgM is the antibody of first response. In the event of an infection in healthy individuals, IgM is produced in the first few days. The IgM helps to initiate the immune response in the white blood cells. In a few days, the level of IgM declines and it is replaced by IgG. IgG initiates a more powerful immune response, which in most cases finishes off the invading organisms. After the infection is vanquished, the immune system "memory" continues to produce this exact IgG antibody to protect against another infection of the same organism. To properly assess a patient's stage of infection, paired serum specimens, taken seven to 10 days apart, should be tested.

In Measles IgM can be detected (using Antibody to IgM in the serum test) at the onset of the rash and may last for four weeks to four months. Its presence usually indicates a person who has never been exposed to MV. The results of paired specimens, may show no IgM in the earlier specimen and the presence of IgM in the later specimen as the immune response proceeds. Also possible is detectable IgM in the early specimen and a higher "titer" IgM (a jump of four dilutions in "acute measles" is possible) in the second specimen.

The stimulation of IgG production, either naturally or by vaccination, against MV is the secondary immune response. The presence of IgG to MV may indicate immunity, but does not ensure it. Paired specimen testing should show a dramatic increase in the IgG "titer" (a four dilution increase is also possible).
References:


Peter M.D., Ph.D., J.B. Use and Interpretation of Tests in Infectious Disease, Fourth Edition. Santa Monica, CA, Specialty Laboratories, 1996.

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SPECKLE COUNTY EPIDEMIC PROPAGATION TREE

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LEGEND

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- Age
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Measles outbreak unbroken

By IMA NEWSIE
Staff Reporter

RASHVILLE -- Speckle County health officials say they are worried about a new outbreak of measles after three more students have become infected.

"We anticipate that the disease will spread to more people this week," Speckle County Health Department Administrator Miss Concerned said Monday.

Two students at No Shots College, a school for anti-vaccinationists, came down with measles over the weekend, Concerned said.

On Thursday, the measles rash appeared on an 11-year-old Infectiapolis boy who attended the No Shots Lower School, an elementary and secondary school for anti-vaccinationist students in Infectiapolis County, Infectiana.

Many anti-vaccinationists believe that vaccination against measles is unnecessary because prayer can heal better than medicine.

The three new measles infections raised the total to 38 cases, 16 college students and 22 children in Spotsylvania and Infectiana since the outbreak started April 18, Concerned said.

An estimated 65 of the 620 No Shots College students have not been vaccinated against measles, Concerned said. "We're expecting another outbreak this week around Rashville and the college."

Six college students with measles remained in a quarantined building on the campus Monday, Concerned said.

"Our nurses visit the campus every day to monitor the measles cases," she said.

The college and the No Shots Lower School are closed until the measles outbreak has run its course.

"People can't enter or leave the two campuses unless they have proof of vaccination or immunity to measles," Concerned said.

The measles outbreak has spread to 176 people in six states since an infected skier in the State of Snowmass came in contact with vacationers in March, including a 14 year old anti-vaccinationist girl from Rashville.

Five children from Maine, New York, California and Washington visited the No Shots school in mid-April and have developed measles.

Approximately 150 of the measles cases are in Speckle and Infectiapolis Counties, and were spread from communities associated with the two anti-vaccinationist schools, authorities said.

Approximately 229 No Shots College students and 102 residents in Rashville and Speckle County have been vaccinated since April 15, Concerned said.

Anyone who wants to be vaccinated against measles can contact the Speckle County Health Department, Concerned said.

Measles' first symptoms include a fever of more than 101 degrees, coughing, sneezing, a runny nose and watery eyes.

May 10, 19xx