

Smallpox Containment: Surveillance and Vaccination Strategies

Post-Event Operational Issues



- This presentation discusses strategies for surveillance and vaccination in the setting of a smallpox outbreak (post-event), and the operational issues associated with planning for and establishing these activities.

Getting Started

- Human resources (Local and National)
- Identify communication infrastructure
- Stockpiles
- Transport:
 - Supplies
 - People
 - Lab Specimens



- How you respond to a public health emergency will depend on the resources available.
- As authorities develop their emergency smallpox response plans, the extent of the activities they're able to do will depend on these factors.

Post-Event Response

- Investigation of cases and outbreak
- Surveillance
- Contact identification, tracing, vaccination and surveillance for health status and vaccine take
- Assessment of control strategies



- Public health response to a smallpox outbreak will require that all suspected cases be investigated for their likelihood of being a case, their likely source of infection (which may lead to the identification of other cases), and the contacts that they may have exposed
- This information will assist with determining the origin and potential scope of the outbreak and will also help formulate the type and level of control strategies that are required (e.g. focused vaccination vs. larger-scale vaccination)
- Surveillance activities include finding potential cases, monitoring contacts for symptoms, and monitoring vaccine effectiveness and adverse event rates
- These surveillance activities will assist in assessing how well the control strategies are working and if they need to be modified during the course of the outbreak

Smallpox Surveillance Clinical Case Definition

- An illness with acute onset of fever \geq 101° F (38.3° C) followed by a rash characterized by vesicles or firm pustules in the same stage of development without other apparent cause



- The clinical case definition for smallpox is shown here.
- It describes the most typical clinical presentation of the disease

Case Classification

- **Confirmed:** A case of smallpox that is laboratory confirmed OR a case that meets the clinical case definition that is epidemiologically linked to a lab confirmed case
- **Probable:** A case that meets the clinical case definition OR a case that has an atypical presentation that is epi-linked to a confirmed case of smallpox
- **Suspect:** A case with a febrile rash illness with fever preceding development of rash by 1 to 4 days



- Case classifications for smallpox are:
- Confirmed: case with lab confirmation or meets the clinical case definition and is epi linked to another lab confirmed case
- Probable: meets the clinical case definition or has an atypical presentation but is epi-linked to confirmed case
- Suspect: febrile rash illness with fever preceding rash

Laboratory Criteria for Diagnosis of Smallpox

- PCR identification of Variola DNA in a clinical specimen, or
- Isolation of smallpox virus from a clinical specimen followed by PCR confirmation (BSL 4 Lab with variola diagnostic capabilities)

Note: Orthopoxvirus generic PCR tests and negative stain Electron Microscopy identification of a pox virus in a clinical specimen indicate an orthopox virus infection but are not diagnostic for smallpox



Because smallpox is no longer naturally occurring, the likelihood that a person with fever and a rash has smallpox is very low. Therefore, laboratory confirmation of the initial outbreak of the disease is critical.

- It is also important that variola specific diagnostics be utilized to confirm the first cases of smallpox.
- Modern day techniques that would be utilized to confirm variola virus infection include polymerase chain reaction (PCR) amplification and identification of DNA from a clinical specimen or,
- Viral isolation of variola virus from a clinical specimen that was confirmed by PCR methods
- It is important to note that attempted culture of variola virus at this time should be done in a laboratory that has the appropriate containment and diagnostic capabilities
- Electron microscopy can differentiate orthopoxviruses from other viruses, but would not tell you which specific orthopoxvirus was present

Variola Major: Clinical Types

- **Ordinary (classic) type:** raised, pustular lesions
 - Confluent: confluent rash on face and forearms
 - Semi-confluent: confluent rash on face, discrete elsewhere
 - Discrete: areas of normal skin between pustules, even on face
- **Modified type:** like ordinary type but with an accelerated and less severe course



- There are several clinical types of smallpox that are generally differentiated based on the rash characteristics
- The rash of ordinary type smallpox can be confluent, semi-confluent, or discrete depending upon the distance between lesions on the face and body.
- Modified smallpox can be seen in individuals that were previously vaccinated but not still fully protected from vaccination and generally presents with less lesions that progress more quickly to resolution. These individuals are usually less ill also.

Variola Major: Clinical Types (cont.)

- **Variola sine eruptione**: fever without rash caused by variola virus, serological confirmation required
- **Flat type**: pustules remain flat, usually confluent or semi-confluent
- **Hemorrhagic type**: widespread hemorrhages in skin and mucous membranes
 - Early: with purpuric rash
 - Late: with hemorrhage into base of lesions



- The remaining clinical types include:
 - Variola sine eruptione – occurs in vaccinated individuals that probably have enough immunity to blunt the development of the full clinical illness and is evident by a significant rise in neutralizing antibody titer
 - Flat type and hemorrhagic type smallpox are the most severe clinical forms of smallpox and are associated with a very high mortality rate.

Smallpox Outbreak

- Defined as a single laboratory confirmed case



- Since smallpox no longer exists naturally, a single case of smallpox would be considered an outbreak

Criteria for Implementation of a Smallpox Response Plan

- Confirmation of smallpox virus, antigen or nucleic acid in a clinical specimen
- Large outbreak of clinically compatible illness pending etiologic confirmation
- Reports of suspected or probable cases once an outbreak has been identified elsewhere
- Confirmation of smallpox virus in environmental sample, package or device associated with potential human exposure



- Smallpox response plans should be activated if smallpox is confirmed in a patient of an area/country or if a clinically compatible outbreak were to occur in a new area/country after smallpox had already been confirmed in a different area/country
- Plans may be partially or fully activated if smallpox virus were confirmed in an environmental sample, package or device that was associated with potential human exposure or if a large outbreak of a clinically compatible illness were to occur although confirmation was pending.

Public Health Response to a Confirmed Smallpox Case

- Make smallpox reportable
- Make varicella reportable
- Initiate active and enhanced passive surveillance for additional suspect, probable and confirmed cases
- Investigate and report all cases
 - Detailed in early phases (epi investigation)
 - Simplified once ongoing transmission is occurring (surveillance)
 - Contact identification, tracing, vaccination and surveillance



- Immediate public health surveillance actions that should be taken in response to a confirmed smallpox case are shown here
- Requiring that all suspected smallpox cases be immediately reportable to public health authorities will assist with more rapid implementation of control measures required for that case and their contacts and will help define the scope of the outbreak
- Mandatory varicella case reporting will help prevent confusion that can occur with simultaneous outbreaks of these two febrile rash illnesses and may help identify smallpox cases that were initially believed to be varicella cases.
- Investigation of cases will be very detailed in the early phases of the outbreak to help define the mode of exposure and the population at immediate risk but may become more simplified and targeted towards assisting with contact identification and tracing later if ongoing transmission is occurring.

Active Smallpox Surveillance

- Distribute case definitions and case classifications to:
 - Public health staff involved in surveillance
 - Hospitals
 - Clinics
 - Health care providers
 - Other reporting sources
- Distribute forms for case investigation/surveillance and contact identification, tracing, vaccination and surveillance



- Active smallpox surveillance would entail distributing the case definitions to places that medically evaluate and treat patients
- Other sources, such as medical examiners or schools, may also be targeted for active surveillance
- It is also important to make sure that all the public health and medical authorities involved in the response have a standard set of data collection tools that have been developed for use in surveillance, contact tracing and monitoring, and vaccination record keeping

Active Smallpox Surveillance

- Daily contact with major reporting sources
- Review deaths over last month especially from all rash illnesses including hemorrhagic rashes
- Daily reporting of case counts to state and national levels
- Report out of jurisdiction contacts to the National coordinating authorities or through identified jurisdiction to jurisdiction mechanisms



- In active surveillance, there is active solicitation of cases
- The frequency of reporting would be established by local public health authorities and may be daily in the initial stages of the outbreak
- Some retrospective surveillance will also be required at the recognition of the outbreak to determine if cases occurred earlier than the first confirmed case
- Mechanisms for reporting identified contacts that have left a health jurisdiction must also be in place (e.g. state to state, providence to providence, or country to country)

Surveillance (cont)

- Lab confirm other causes of rash illness if feasible
- Review reported varicella cases (some will be smallpox)



- Other important surveillance activities would include the confirmation of non-smallpox causes of rash illnesses with laboratory testing when possible in order to provide the appropriate treatment for the illness and more accurately reflect the number of true smallpox cases
- Review of reported varicella cases will also be important to make sure they weren't misdiagnosed smallpox cases

Epi/Surv/Summary

- Case interview:
 - Contact identification
 - Contact households, other sites, travel modes
 - Contact risk category for prioritization
 - Assignment of contacts to tracing teams
 - Contact and contact household member interviews
 - Vaccination of contact and household members
 - Contact surveillance for fever/rash follow-up
 - Reporting of contacts with fever and rash for isolation
- Vaccine take and severe adverse event surveillance
Reporting of severe adverse vaccination events
- Maintaining forms and data files
- Data reporting



- There will be an extensive amount of data coming in.
- Each smallpox case should be interviewed to determine who they have come into contact with, where they have traveled, etc.
- Each contact to that case should be interviewed to determine the nature of their exposure to the case (time, length, etc.) and their current state of health
- Contacts should be vaccinated and monitored for symptoms of smallpox. There are no contraindications to vaccination for those exposed to a smallpox case.
- Household members of the contacts should be interviewed to determine if they have risk factors for the vaccine and vaccinated if they do not. If they do have risk factors, they should consider staying outside of the household during the contact surveillance period, avoiding any exposure to the contact while they are under surveillance, so that they won't be exposed if the contact develops smallpox.
- In addition, vaccine takes and adverse events monitoring will be critical. Authorities should be prepared to deal with a large amount of data and be ready to analyze the data quickly so that it can be useful in assessing the effectiveness of the containment strategy.

Case Reporting Form

- Demographic.
- Medical and vaccination history.
- Clinical presentation and initial case classification.
- Exposure and source of transmission.
- Contact identification module.
- Laboratory data.
- Outcome.
- Final case classification including not smallpox.



•Case reporting forms that are developed should, at a minimum, capture:

- demographic information
- Medical and vaccination history
- Clinical presentation of the case and its initial classification
- Exposure and source of transmission
- Contacts
- Laboratory data
- Final outcome
- And final case classification.

Epidemiological Investigation Purpose – Initial Phase

- To establish the diagnosis and case classification.
- To identify contacts for tracing, vaccination and surveillance.
- To identify source of initial exposure.
- To describe clinical presentations and outcome, unusual features of outbreak.



•During the initial phases of an outbreak, the goal of your investigations will be to establish the diagnosis, identify contacts, identify the source of the initial exposure, and ascertain if there are any unusual features of the outbreak.

Smallpox Surveillance Purpose – Ongoing Phase

- To monitor outbreak by person, place and time characteristics:
 - Mortality, morbidity, transmission settings etc.
- To identify contacts for tracing, vaccination and surveillance.



- If transmission is ongoing, the goal will be to monitor and describe the outbreak and to continue to identify contacts in order to intervene with the appropriate public health measures.

Epidemiology Investigation and Surveillance

Maintain Flexibility:

- Scenarios may differ from what we may have predicted
- 1 or few case scenarios rather than mass exposure e.g, at a large event?
- Virus strain not vaccine preventable
- May need to revise outbreak investigation approaches and ongoing surveillance depending on circumstances and characteristics of the outbreak



- It will be important for public health and medical authorities/responders to remain flexible and ready to alter strategies quickly.
- Scenarios may turn out different from what is predicted by early investigation data
- Prior to a smallpox bioterrorism event, we have no way of knowing whether we would see a few cases or a large scale event.
- There is also the theoretical possibility that the virus strain was altered to make it more virulent or less affected by vaccine-induced immunity.
- Planners should be prepared to analyze the data for any unusual characteristics of the outbreak in order to adjust response strategies appropriately

Vaccination Strategies to Contain an Outbreak



- I will now talk about vaccination strategies that may be utilized to assist in containing a smallpox outbreak

- When deciding on how to focus smallpox response efforts, several factors should be considered
 - First is the vaccine supply. The number of available doses could make the difference between focusing only on the high-risk ring of direct contacts and their close contacts, or expanding the focus to include an entire community or population
 - The extent of the outbreak is also important.
 - Is the outbreak confined to one small area?
 - Or are there multiple areas in various places around the country?
 - Localized cases may allow vaccination to be focused on a smaller number of people. Multiple initial cases in several areas of a country could indicate a that multiple intentional introductions of the virus has occurred and lead to an early decision to immunize the entire population.

Eradication Strategy of the 1970s

- Vaccination of close contacts of cases
- Occasionally supplemented with broader campaigns
- Vaccine was readily available



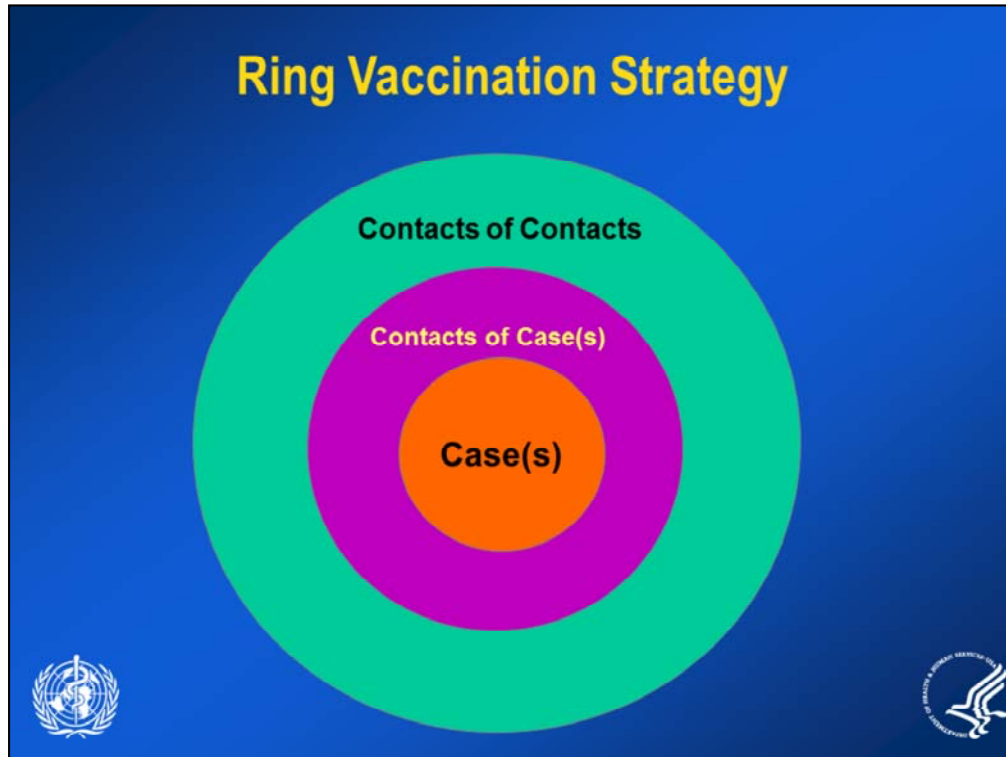
- During the eradication program conducted in the 1970s, it was determined that vaccination focused primarily on the close contacts to smallpox cases was very effective in halting outbreaks, even in areas where there was a low percentage of previous vaccination.
- Occasionally, depending on the makeup of the area, number of contacts, or contact tracing resources, broader vaccination was added to help break a chain of transmission.
- Broader vaccination was possible because vaccine was readily available, giving options to public health planners that they may not have currently.

Smallpox Realities Today

- No cases of smallpox
- Threat unknown
- Susceptible population
- Many people at risk for adverse events from vaccination
- Limited vaccine supplies in majority of world



- How do you go about defining a vaccination strategy?
- Current Realities:
 - At this time, there are no known cases of smallpox.
 - It is unclear if there are individuals, groups, or governments that have smallpox for use as a weapon.
 - Since regular vaccination with smallpox was stopped worldwide over 20 years ago, there are entire populations who are vulnerable to infection with smallpox virus
 - There are many more people at risk from adverse events from vaccination than there were 20 years ago (e.g. more people with immune system disorders, transplants, and cancer treatment)
 - There are limited vaccine supplies worldwide. Even if we wanted to immunize everyone in the world today, we couldn't do it with the supplies of vaccine we have



- The “Ring Vaccination” strategy has been used successfully in the past to stop smallpox outbreaks. It was the only strategy used for control of smallpox in Australia
- This strategy involves vaccinating the contacts of the case, and their own close contacts in order to interrupt the chain of transmission.
- Vaccinating the close contacts of the contact (e.g. household members of contact) provides protection to individuals who are likely to be exposed if the contact develops the disease while under surveillance at home
- The strategy provides a “ring” of vaccinated/protected individuals around the case and their contacts to prevent further transmission. After a case and their contacts are identified, anyone coming into contact with them while they are potentially infectious would be vaccinated and protected.
- This has been so useful because we know that most transmission of smallpox occurs from close contact

Contacts

- Primary contact:
 - Person with contact to a confirmed, probable, or suspected case of smallpox during the infectious period
 - Primary contacts include both household and non-household contacts
- Secondary contact (contact of contact):
 - Household members of primary contacts and persons who work in the household of a primary contact



- A primary contact is a person in contact to a confirmed, probable or suspected cases of smallpox during the infectious period.
- A secondary contact (or contact of contact) is a household contact of a primary contact or a person who works in the household of a primary contact

Ring Vaccination Strategy

- Primary strategy to stop transmission
- Depends upon prompt identification of contacts
- Judicious use of vaccine supply
- Minimizes risks of adverse events



- While the ring vaccination strategy is our primary means of stopping the immediate chain of transmission, we know that it depends on the prompt identification of contacts, which means having trained personnel who can do this
- This strategy allows us to maximize the effectiveness of a limited vaccine supply by targeting vaccination to those at highest risk while minimizing the risks of adverse events by vaccinating only those who really must be vaccinated because of their high risk of infection

Contact Vaccination

- Face-to-face contact (2 meters or \leq 6 feet) and household members at greatest risk
- May prevent or lessen severity of disease (4-day window)
- Followed by monitoring for fever for at least 18 days



•Reviewing the ring vaccination strategy:

- High-risk contacts are defined as people having close, face-to-face contact with a smallpox case, usually within 2 meters or 6.5 feet, and/or household members of a smallpox case.
- If we can immunize these contacts within 3 days of exposure, we might be able to prevent a case completely, or at least lessen the severity of the disease if they do develop the disease
- These close contacts should be monitored for fever, the first indication of possible smallpox infection, for at least 18 days from their last exposure to the smallpox case

Contraindications for Vaccination of Contacts

NONE

In general, the risk of developing smallpox for face-to face contacts **outweighs** the risk of developing vaccine complications for those contacts with contraindications to vaccination.



- For the close contacts of a smallpox case, there are no contraindications for the use of vaccine because they are at high risk for developing the disease.
 - Development of smallpox would present a greater risk to the contact than adverse events.
 - Adverse events may be treatable with vaccinia immune globulin (VIG) or newer antiviral medications (cidofovir), while there is no known treatment for smallpox

Vaccination of Contacts of Contacts

- Household members of a contact without contraindications
- Household members of a contact with contraindications, who are not vaccinated, must avoid the contact (18 days)



- Contacts of contacts who do not have contraindications should be vaccinated
- Contacts to contacts who have vaccine contraindications (e.g. immune suppression, eczema/atopic dermatitis), should not be vaccinated and should stay elsewhere and avoid seeing the contact until the contact is no longer under surveillance for the development of smallpox
 - Unlike direct close contacts of smallpox cases, the contact's household members are not at risk of developing smallpox unless they are exposed through the contact developing the disease while being monitored at home.

High-Risk Priority Groups for Vaccination

- Close contacts of smallpox cases
- Exposure to initial virus release
- Public health, medical, and transportation personnel
- Laboratory personnel
- Laundry, housekeeping, and waste management staff
- Support of response: law, military, emergency workers



In addition to contacts of smallpox cases, other groups to identify for priority vaccination include:

- Anyone else potentially exposed to the initial virus release that doesn't have symptoms of smallpox (vaccinate if ill but unsure of cause or if isolating patients together)
- Public health, medical, and transportation personnel who will be potentially exposed to smallpox patients during their work activities
- Laboratory personnel who would potentially handle specimens from smallpox cases
- Support staff in the hospital who have exposure to the linens, clothes and waste from smallpox patients
- Other groups to consider vaccinating, even though they may not have direct patient care or evaluation responsibilities would include the other response support personnel, and other essential service personnel who must be maintained at full staffing

Vaccine Administration Support

- Establish vaccination sites and procedures for contacts
- Establish vaccination sites and procedures for response personnel
- Establish adverse events reporting and tracking system



- To vaccinated contacts and personnel, vaccination sites and procedures should be established
- Establishing central designated clinic sites will minimize vaccine wastage.
- If personnel and vaccine supplies are adequate, it may be possible to consider the option of vaccinating contacts wherever they are located (home, work, etc.)
- No matter what strategy for vaccination is chosen, establishing an adverse events reporting system is important
- Establishing a system to ensure all those exposed are either vaccinated or managed appropriately with isolation is also essential.

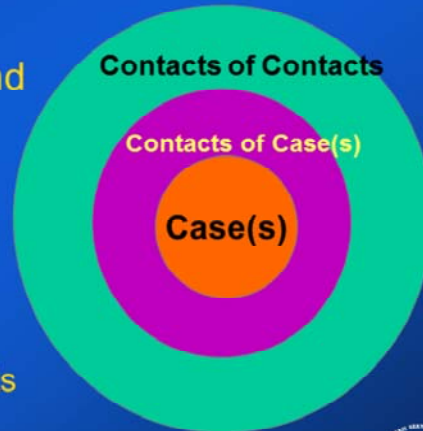
Contact Tracing and Follow-Up



- The identification and timely follow-up and vaccination of contacts to smallpox cases is an essential outbreak response activity

Ring Vaccination Search and Containment

- Search for cases
- Vaccinate to provide a “ring of immunity” around each case
- Ring Strategy during Eradication:
 - helped control disease even with ‘routine immunization’
 - minimizes adverse events
 - most efficient use of vaccine supplies



- Since smallpox is a contagious disease, once a case is confirmed, the highest priorities for public health officials are to reduce the risk of ongoing transmission by isolating the case to prevent exposure of others and identifying and vaccinating close contacts of the case
- Any vaccination strategy for containing a smallpox outbreak should still utilize this concept. Vaccinating and monitoring a “ring” of people around each case and contact will help to protect those at the greatest risk of contracting the disease, as well as form a buffer of immune individuals to prevent the spread of disease.

This strategy is more desirable for the following reasons:

1. Focused contact tracing and vaccination, combined with extensive surveillance and isolation of cases, was successful in stopping outbreaks in the eradication program and was the only strategy used for smallpox control in Australia
2. Adverse events would be expected to be higher in an indiscriminate vaccination campaign due to vaccination of persons with unrecognized contraindications.
3. Current supplies of smallpox vaccine would be exhausted

quickly if an indiscriminate campaign was utilized.

Ring Vaccination

Biologic Basis for Contact Tracing and Follow-up

- Smallpox spreads from infected patients to susceptible individuals:
 - Predominant transmission by “droplets.”
 - Droplet travel “range” approximately 6 feet/2 meters.
 - Usual transmission “situation” is time spent close together.
- Interrupt “Chains of transmission.”



- It is important to remember that smallpox is a contagious disease that spreads among susceptible individuals.
- Transmitted predominately by droplets at relatively close range
- Individuals who have had close, prolonged contact with a smallpox patient are at the highest risk for developing infection.
- By priority vaccinating and monitoring these people, we can stop the chain of susceptible people who pass on the disease.

Ring Vaccination

Biologic Basis for Contact Tracing and Follow-up

- Exposure and risk of transmission are **NOT** uniform
- Exposure predicts the next generation of new cases
- Focusing smallpox control efforts based on risk is the best use of limited resources



- Since the length of time and closeness of exposure increases risk for contacts to become infected, the main tracing and vaccination efforts should be focused on contacts we know are the most at risk (e.g. household contacts), to make the most efficient use of limited resources and staff to more efficiently stop the outbreak.
- It is important to remember that even if resources aren't limited and/or a broader vaccination approach is implemented, it is still imperative that close contacts and their household contacts are identified, vaccinated, and monitored for the development of disease

Ring Vaccination Containment Methods

- Early interruption of chains of transmission.
- Effective interruption/containment relies on:
 - **Early** diagnosis and isolation of the patient(s)
 - **Prompt** contact identification, tracing, and vaccination
 - **Prompt** vaccination of household and other face-to-face contacts of known smallpox patients
 - **Frequent** surveillance of contacts
 - Critical part of search and containment

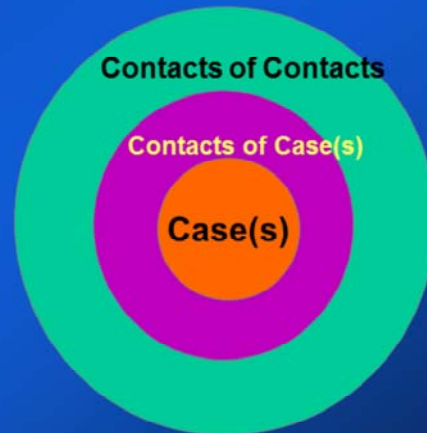


- In order to quickly interrupt the chain of transmission, there are several actions that must be taken:
 1. Diagnose and isolate patients early in the course of illness.
 2. Quickly identify and vaccinate those individuals who've had close contact with the patient.
 3. Vaccinate the people in close contact to the primary contact to the smallpox patient to provide a ring of protected people around that persons if they develop smallpox
 4. Monitor the primary contacts for development of disease in order to quickly isolate them and begin the process of containment for them if needed.

Ring Vaccination Types of Contacts

Types of contacts:

- **Contacts of Case/s:**
 - Household – usually highest risk
 - Other face-to-face
- **Contacts of Contacts:**
 - Less extensive contact
- **Contact risk category for prioritization**



- What contacts should be identified first?
- All who've had direct, face-to-face contact with the patient. Household members are usually at the highest risk because of the closeness and extended length of contact.
- Other face-to-face contacts after the onset of fever in the smallpox patient
- The close contacts to the primary contacts (or contacts of contacts) should also be identified

We also need to vaccinate the contacts of those contacts who may have had less extensive contact with the case and who can provide an additional buffer from the patient, in the event the contact becomes ill.

Ring Vaccination Factors Determining Risk of Transmission

Factors determining risk of transmission:

- Duration of contact(s) time together
- Distance/separation:
 - Distance: Face-to-face contact (~6 feet)
- Patient status (type of smallpox, day of illness, presence of cough, vaccination status)



- How to determine who's at the highest risk?
 - People who spent more time with the patient.
 - People who had face-to-face contact of around six feet or less with the patient.
 - Other factors that may be considered include characteristics of the smallpox case including clinical type, day of illness (infectiousness is highest in the first several days of rash onset), whether or not the patient had a cough etc.

Contact Management Overview

- Detailed interview of contact(s) households, other sites, travel modes.
- Contact risk category for prioritization.
- Assignment of contacts to tracing teams.
- Establish an ongoing relationship with the contact.
- Follow-up visits (at least daily) for fever/rash follow-up.
- Assure vaccination of the contact and household members.
- Update record: forms, database.
- Report contacts with fever and rash for isolation.



- Must conduct a detailed interview of smallpox patient to establish known contacts and potential contacts. Determine contacts since onset of fever. Also determine activities and movement of case in the 3 week period before onset of fever. This may help identify where index case exposed as well as additional cases if more people exposed at same time.
- Conduct detailed interview of identified contacts. This will help establish the level of risk for the contact, and provide additional clues as to the source of exposure for the case patient.
- Interview also allows you to establish a relationship with the contact, who you will need to visit or contact at least daily during their monitoring period to ascertain their status (ill or not ill). Should also use this opportunity to assure that the contact and their contacts are vaccinated.

To monitor outbreak control efforts, a database should be established to track all cases and contacts. This will allow the outbreak to be better monitored, will put in some controls to assure appropriate case management, refine outbreak control strategies and might provide clues as to the source of the outbreak.

Contact Management Interview and Risk Determination

- Detailed interview of contact(s):
 - Determine the fever/illness/rash status of the contact.
 - Obtain detailed day-by-day history of contact's activities since onset of fever of "index" case.
 - Ask if contact knows of any other persons with fever, rash, smallpox.
 - Probe for unrecognized contacts.
 - Contacts of case:
 - Household (HH) contacts; non-HH contacts.
 - Close, non-HH contact sites (workplace, school, travel modes).
- Report data on contact/contact sites to supervisor.



- When interviewing the contact, determine the health status of the contact. Do they have a fever? Any signs of illness? Any signs of rash that could indicate they are already developing smallpox?
- Obtain a day-by-day history of the contact's activities since the smallpox case developed their fever. If this correlates to some of the smallpox case's activities, it could supply other contacts to the index case who haven't been recognized for follow-up.
- Identify a list of contacts to the contact. They should explore household contacts, and other close, non-household contacts, in places outside of the house, such as work, school, etc.
- Household contacts of contacts should be vaccinated. May consider expanding vaccination to contacts outside of home if contact not confined to home during monitoring period for symptoms
- This data should be maintained in a database for evaluation of the larger outbreak.

Contact Tracing Forms

- Contact Tracing/Follow-Up:
 - Demographics
 - Vaccination Status
 - Vaccination History
 - Health Status – Development of Smallpox?
 - Adverse Reactions



Other questions that should be asked of the Contacts and their close contacts:

- Demographics (name, age, address, etc.)
- Vaccination Status and History (previously smallpox vaccination, date, etc.)
- Health Status – (any current symptoms that may indicate developing smallpox?)
- Adverse Reactions to previous smallpox vaccines?

Contact Management Vaccination of Contacts

- Screen contact household members for vaccine contraindications:
 - eczema, immunosuppressive disease or medications, etc.
- Arrange/Assure vaccination of contact and contact household members (options):
 - Assure transport to fixed vaccination site
 - Vaccinate in home
 - Mobile vaccination teams – neighborhood, subdivision, school, business, etc.



- The highest priority for vaccination are contacts of cases and after that, their close contacts.
- Household members of contact should be screened thoroughly for contraindications to smallpox vaccine.
- Check for history of conditions such as eczema, immunosuppressive diseases or medications
- If household contact with serious contraindication to vaccination and is not vaccinated, they should stay outside of home for duration of monitoring period so that they won't be exposed (and require urgent vaccination) if the primary contact develops smallpox in the home
- If vaccine is brought to the contact home, the contact and their household contacts should be vaccinated. Otherwise, the interviewer should assure that the contact and their household members are taken to an established vaccination site to receive vaccination

What If the Smallpox Patient Went to Work/School While Infectious?

- **Vaccinate everyone in the building?** Yes, probably easiest!
- Risk of transmission is NOT uniform, homogeneous
- Interview patients, contacts, etc., identify the people in the office building who are at substantially higher risk
 - The co-workers whose work locations are close to the patient's
 - Staff who worked directly with the patient
- These higher risk contacts need more follow-up



- If a smallpox patient went to work or school after the onset of fever, it may be difficult to identify all the people that had face-to-face contact so should vaccinate everyone in the building during the time the patient present.
- However, you could also consider limiting your contact management to those whose work locations are close to the patient's and those who worked directly with the patient if there was limited movement of the patient in the building

Contact Management Follow-Up and Surveillance

- Surveillance of contact for fever/rash (18 days):
 - Provide temperature monitoring chart
 - At least daily follow-up (in person visit better than phone call).
 - Fever x 2 or rash = SUSPECT CASE → **REPORT**
→ **ISOLATE**
- Surveillance of contact and household contacts for vaccine “take” and severe adverse events:
 - No “take” → repeat vaccination
 - Severe adverse event → **REPORT**



- Contacts who do not have fever or rash at the time of interview must remain under active surveillance for 18 days after their last contact.
- Contacts must monitor and record their temperature in the morning and early evening of each day.
- Each day before 8pm, they must call or be called by a designated person (or staff at a designated phone number) to report their daily temperatures, health status, and any severe reactions following vaccination.
- During surveillance/monitoring period, health officials may elect to allow them to continue their usual daily activities as long as no temperatures of more than 101F (38C) are measured.
- They should not, however, travel away from their city of residence. If they have a temperature, they must remain in or immediately return to their own home.
- If they have two successive temperature readings of 101F (38C) or higher, they must contact health department personnel immediately, remain at home, and have contact only with vaccinated household members until they can be further evaluated.
- On day 7 following vaccination, must confirm s

- Vaccine take for contacts and their household members and other vaccinated close contacts. Persons with no take should be revaccinated.
- Vaccination should be repeated if vaccine take not evident

Organizing Contact Tracing & Follow-up

- Team: at least two public health workers/team and driver (possibly security)
- May require numerous teams (20 or more).
- Need supervisory structure to manage the contact tracing and follow-up activities.
- Supervisor prioritizes and assigns contacts by risk category.



- Contact tracing teams (or 2 or more) preferable to individuals if possible. Allows for more efficient follow-up and could help improve security for teams
- Given the number of daily contacts any one person can have, public health authorities should be prepared to field numerous teams in order to quickly manage the contacts.
- Supervisory structure should be established in order to monitor activity and provide quality assurance.
- If the outbreak grows too large for the number of case management teams, the supervisory structure can prioritize team contact tracing activities according to the level of risk for different groups of contacts (e.g. focus only on household contacts)

Organizing Contact Tracing & Follow-up

- Link contacts with case.
- If possible, track in database:
 - Easier to determine spread and attack rates.
 - Can generate lists of contacts still open.
 - Help to determine staffing needs.
 - Monitoring performance.
 - Will require data entry staff to support teams.



- A database should be established to record all contact information.
- A database would make it easier to determine spread and attack rates in order to improve epidemiologic response. This can help supervisors ensure that all known contacts receive follow-up. This can also help public health authorities better define their staffing needs
- Databases will require data entry staff to support the teams, or technology that will allow the case managers to enter data while onsite (e.g. handheld PDAs, laptops, etc.)

Managing Large Case Counts

- **Few cases** allows intensive follow-up of high, medium, and lower risk contacts and contacts of contacts, etc.
- **Many cases** contact tracing concentrates on the highest risk contacts:
 - Assumption is that contact tracing/surveillance containment will reduce spread and in several generations the many cases will be reduced to few cases. (Attrition)
- Large release – mass vaccination, plus ring strategy around known cases
- Multi-focal Release – same strategy, as possible



- With fewer cases, all contacts can be followed by case managers.
- If the case and contact count becomes large, concentrating on the highest risk contacts will allow for the best use of limited personnel or vaccine resources and best chance at containment.
- If enough vaccine is available, larger-scale community vaccination could be done in addition to high-risk contact identification and vaccination. This activity would increase the chances of achieving vaccination of contacts that weren't previously identified, as well as decrease the number of people in the community at risk of disease if unidentified contacts develop smallpox.
- However, even if larger scale community vaccination is offered, contact tracing, vaccination and surveillance activities should continue as new cases are identified.

Contact Tracing and Follow-up Will Not Work Without Public Confidence

- The intuitive strategy for smallpox outbreak control is widespread vaccination (including me and my family)
- The public must understand and believe in:
 - Why contacts will be interviewed.
 - Priority vaccination of higher risk individuals.
 - Follow-up surveillance of high risk contacts.
 - Isolation of persons with possible or confirmed smallpox.
- Social Mobilization – Consider a large scale ***pre-event*** public education and communication program on smallpox and search and containment



- The general public may not understand the potential effectiveness of the ring vaccination strategy
- They may also not understand why it should always be used, no matter what other vaccination strategies are employed
- Most will expect and demand widespread vaccination, even if the outbreak is small.
- If population-wide vaccination is not possible or will not be used in an area in response to a smallpox outbreak, then public health authorities must conduct extensive pre-outbreak education programs to inform about the effectiveness and need for this strategy to prepare the community before the panic of a smallpox outbreak

Conclusions

- Contact identification, tracing, and vaccination and surveillance of contacts are CRITICAL to interrupting smallpox transmission
- Must be continued throughout the entire outbreak
- Inadequate response due to insufficient personnel or delays in fielding personnel increases the likelihood of failure to interrupt chains of transmission AND leads to more cases, more vaccine needed, and a longer lasting outbreak.
- Public understanding of the need for and effectiveness of containment activities will be essential



In conclusion:

- Contact identification, tracing, and vaccination and surveillance of contacts are CRITICAL to interrupting smallpox transmission, even if larger-scale vaccination is implemented.
- Must be continued throughout the entire outbreak.
- Inadequate response due to insufficient personnel or delays in fielding personnel increases the likelihood of failure to interrupt chains of transmission AND leads to more cases, more vaccine needed, and a longer lasting outbreak.
- Public understanding of the effectiveness of containment will be essential.