The Politics of Smallpox Modeling
Rice University - November 2004

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Smallpox Basics
- Pox virus
  - Stable as an aerosol
  - Infectious at low doses
- Human to human transmission through coughing and contaminated items (fomites)
- 10 to 12 day incubation period
- High mortality rate (30%)

Co-Evolution
- Smallpox infects humans only
- Could not survive until agriculture
- No non-human reservoir
- If at any point no one in the world is infected, then the disease is eradicated
- Infected persons who survive are immune, allowing communities to rebuild after epidemics

Eradication
- Driven by the development of a heat stable vaccine
  - 1947 – last cases in the US
  - Smallpox vaccine was given to everyone in the US until 1972
  - Worldwide eradication campaign in the 1970s

Eradication Ended Vaccinations
- Cost Benefit Analysis
  - Vaccine was Very Cheap
  - Program Administration was Expensive
  - Risks of Vaccine Were Seen as Outweighing Benefits
  - Stopped in the 1970s
Complications of Vaccination
- Local Lesion
- Progressive/Disseminated Vaccinia
  - Deadly
- Encephalitis
- Most common in the immunosuppressed

How Have the Risks of Vaccination Changed Since 1970?
- 1970
  - 1/1,000,000 deaths
  - 5/1,000,000 serious complications
  - Immunosuppression was rare in 1970
- 2004
  - Immunosuppression is common
  - HIV, Chemotherapy, Arthritis Drugs
  - Tolerance for risk is much lower

Post Eradication
- 50%+ in the US have not been vaccinated
- Many fewer have been vaccinated in Africa
- Immunity fades over time
  - Everyone is probably susceptible
  - Perhaps enough protection to reduce the severity of the disease

The Danger of Synchronous Infection
- The whole world may be like Hawaii before the first sailors
- If everyone gets sick at the same time, even non-fatal diseases such as measles become fatal
- A massive smallpox epidemic would be a national security threat
- Is a massive epidemic possible?

The Dark Winter Model
- Johns Hopkins Model - 2001
- Simulation for high level government officials
- Assumed terrorists infected 1000 persons in several cities
- Within a few simulated months, all vaccine was gone, 1,000,000 people where dead, and the epidemic was raging out of control

Response to the Dark Winter Model
- Koopman – worked in the eradication campaign
  - “Smallpox is a barely contagious and slow-spreading infection.”
- Lane – ex-CDC smallpox unit director
  - Dark Winter was “silly.” “There's no way that's going to happen.”
Decomposing the Models – Common Factors

- Population at risk
- Initial seed
- Transmission rate
- Control measures under study

Population at Risk

- Total number of people
  - Compartments - how much mixing?
- Immunization status
  - Most assume 100% are susceptible
  - Increasing the % of persons immune to smallpox
    - Reduces the number of susceptibles
    - Dilutes the pool, reducing rate of spread

Transmission Rate

- Mixing Coefficient X Contact Efficiency
- Mixing Coefficient
  - The number of susceptible persons an index case comes in contact with
- Contact Efficiency (Infectivity)
  - Probably of transmission from a given contact
  - Can be varied based on the type of contact

Where do the Models Differ?

Transmission Rate is the Key

- < 1 - epidemic dies out on its own
- 1 - 3 - moves slowly and can be controlled without major disruption
- > 5 - fast moving, massive intervention needed for control
- > 10 - overwhelms the system - Dark Winter

What is the Data on Transmission Rate?

- Appendix I
  - This is all the data that exists
  - The data is limited because of control efforts
  - This data supports any choice between 1 and 10
What are the Policy Implications of the Transmission Rate?

- Can only be prevented by the reinstituting routine smallpox immunization
- Terrible parameters for policy making
  - Huge risk if there is an outbreak
  - Low probability of an outbreak

Kaplan - 5
- Mass immunization on case detection
- Best to pre-immunize health care workers

Metzler/CDC - 2-3
- Contact tracing and ring immunization
  - Trace each case and immunize contacts
  - Immunize contacts of contacts
  - Takes a long time to get the last case

What are the Politics?

- Reinstituting Routine Vaccinations
  - We cannot even get people to get flu shots, which is perfectly safe
  - No chance that any significant number of people will get the smallpox vaccine after the failure of the campaign to vaccinate health care workers
  - Would require a massive federal vaccine compensation program
Mass Vaccinations Post-Outbreak

**Pros**
- Limits the duration of the outbreak to the time necessary to do the immunizations, could be two weeks with good organization
- Eliminates the chance of breakout

**Cons**
- Lots of complications and deaths from the vaccine
- Requires massive changes in federal vaccine plans

Contract Tracing and Ring Immunizations

**Pros**
- Limits the vaccine complications
- Does not require hard policy choice to immunize everyone

**Cons**
- Requires lots of staff
- Requires quarantine
- Requires lots of time
- Chance of breakout

Political Choices are Hidden in the Models

- Federal policy is based on a low transmission rate
  - Is that justified by the data?
  - Is the potential upside risk too great with this assumption?
- Dark Winter is based on a high rate
  - Do anything and pay anything to avoid bioterrorism
  - Convenient for bioterrorism industries

Which Model Do You Want to Rely On?
Appendix I

Table 23.4 Europe: smallpox outbreaks by generation

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<th>Importing country</th>
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* Infections said to have been transmitted on a carpet.

References


