Project 3
Containing Infectious Diseases
Reading Guide for the Smallpox Report

Read the report by Meltzer, Damon, LeDuc and Miller online at

`http://www.cdc.gov/ncidod/eid/vol7no6/meltzer.htm.`

You will not understand everything, but try to understand enough to be able to answer the questions below. As you read, keep in mind how we analyzed the schoolpox infection.

In the schoolpox problem we used a mathematical model of schoolpox to answer questions and make recommendations (there is not just one equation to describe this model, like there was with cooling objects, but if we worked hard we could come up with a group of equations that describe the model - the equations would tell us what mathematics to do at each step). The model for smallpox is more complicated, but the basic idea is the same. We follow a set of rules to keep track of how many people are in each stage of the illness and how many new people have been infected.

At the end of each question, I put the title of the section of the article where the answer can be found (in parentheses). Questions, thoughts, frustrations, can be posted on your group's Project 3 discussion board.

1. They use their mathematical model to meet four stated objectives. Did we meet these four objectives in our work? Explain. If there are any objectives we did not meet, what could we do to meet them? (Methods)

2. What are the stages of smallpox illness? (Methods)

3. They use the term "Markov Chain model". That just means that in order to determine how many people will be in each stage of illness tomorrow, we use our knowledge of how many people are in each stage today, along with their probabilities of changing stages. The probability of changing stage depends on the number of days the person has been in the stage they're in. This is different from schoolpox where we assumed that each person spent exactly 3 days in the incubation period and exactly five days in the symptomatic period and that each person was contagious for exactly two days. In smallpox, a person will spend approximately 11 days in the incubation period, but some people will spend a few more days and some people will spend a few less. The probabilities for changing stages can be deduced from Figure 2. Look carefully at Figure 2. Each graph shows the probability of remaining in a certain stage as a function of days. What is the probability of leaving the incubation stage after a week? After 10 days? After 14 days? After 18 days? What do the other two graphs tell you about the probable lengths of those stages? (Methods, Probable Durations of each Disease Stage)

4. Which assumption seems better to you: Everyone spends exactly the same number of days in each stage, or different people spend slightly different amounts of time in each stage? Which assumption is easier to deal with mathematically? If we'd had probability curves like this for our three stages of schoolpox, how would it have changed your work? (Probable Durations of each Disease Stage)

5. How did they come up with these probability curves? (Probable Durations of each Disease Stage)

6. When is a person sick with smallpox most contagious? Support your answer using the graph in Figure 3. (Likelihood of Smallpox Transmission)

7. Why do you think size of community might make a difference in transmission rates? How do the authors suggest taking that into account in their model? If you were using their model for a very densely populated area, how would you adjust the transmission rate that you use? (Existing Immunity and Community Size)

8. What transmission rate do they use? How many people are initially infected in their model? If you're using a computer to model smallpox, how easy or difficult do you think it would be to change these numbers? Why would you want to be able to change them? (Numbers Initially Infected and Rate of Transmission)

9. Why, in a vaccination-only strategy, do we need to give enough vaccines to get the transmission rate below 1? (Modeling the Effects of Potential Interventions)

10. What is one thing the researchers calculated about vaccine with no quarantine? About a combination of vaccine and quarantine? (Modeling the Effects of Potential Interventions)

11. In our model, intervention begins on Day 1. When does intervention begin in their model? Why do they not begin intervention on Day 1? (Start of Interventions)

12. What effect does doubling the transmission rate have (assuming no interventions)? You might wonder where they got the numbers in Table 1; I did. Since 30 days is only enough time for the first infected cohort to infect one more cohort, I would think the total infected would be $10 + (10)(1.5)$ which would be 25. Looking back at the graphs in Figures 2 and 3, is it possible for some of the second cohort to infect a third cohort by 30 days? (Effect of Transmission Rate and Numbers Initially Infected)

13. If we use quarantine only, what percentage of people must be quarantined in order to stop the spread of the disease? How long will it take to stop the disease in this case? How many people will get smallpox in total by the time the disease dies out? (Effect of Intervention: Quarantine Only)

14. In order to stop the disease after a year with vaccination only, how low must the transmission rate be if intervention occurs on Day 30? Do you remember how we would determine which vaccination rate this transmission rate corresponds to? (Effect of Intervention: Vaccination Only)

15. If the quarantine rate is 25% what must the transmission rate be reduced to in order to stop transmission of the disease in a year? (Effect of Intervention: Quarantine and Vaccination)

16. In which case must more people (in total) be quarantined: a 25% quarantine rate with vaccination, or a 50% quarantine rate? Why? (Effect of Intervention: Number of Infectious Persons Quarantined)

17. What are some issues the model did not take into account? (Discussion)

18. Do the researchers recommend vaccination, quarantine or a combination? What is their reasoning? (Vaccination Alone or Combined With Quarantine)

19. How many doses of vaccination do the researchers recommend the government stockpile? What is their reasoning? What are some of the issues involved with stockpiling more vaccinations? (Doses to be Stockpiled)

20. What do the researchers want the government to understand about implementing a smallpox plan? (Policy Implications)

21. Point out some places where the authors used the language of statistics to communicate facts.