

9. Epidemic Models: Yellow Fever in Senegal in 2002

Yellow fever is a viral hemorrhagic fever transmitted by infected mosquitoes. Yellow fever is spread into human populations in three stages:

- (1) Sylvatic (or jungle). Yellow fever occurs in tropical rain forests where mosquitoes, which feed on infected monkeys, pass the virus to humans who work in the forest.
- (2) Intermediate. Yellow fever occurs as infected individuals bring the disease into rural villages, where it is spread by mosquitoes among humans (and also monkeys).
- (3) Urban. Yellow fever occurs as soon as an infected individual enters urban areas. This can lead to an explosive epidemic in densely inhabited regions. Domestic mosquitoes carry the virus from person to person.

The epidemic can be controlled by vaccination. The yellow fever vaccine is safe and effective, and provides immunity within one week in 95% of those vaccinated.

The table below shows a data set of yellow fever cases and yellow fever deaths during an outbreak in Senegal in 2002, collected from the Internet archives of the World Health Organization (WHO). As soon as the virus was identified, a vaccination program was started (Oct. 1, 2002). On Oct. 11, 2002, the disease was reported in Touba, a city of 800,000 residents. More information can be found on the WHO website – <http://www.who.int/research/en/> .

Report date	Cases (total)	Deaths (total)
Jan. 18 th	18	0
Oct. 4 th	12	0
Oct. 11 th	15	2
Oct. 17 th	18	2
Oct. 24 th	41	4
Oct. 31 st	45	4
Nov. 20 th	57	10
Nov. 28 th	60	11

Yellow Fever in Senegal, 2002 (data from the disease outbreak news archives of the WHO)

- a) Develop a model for the three stages of yellow fever as outlined above.
- b) Include a fourth stage which describes vaccination in urban areas.
- c) Fit your model to the data.
- d) What would have happened without vaccination?
- e) Would you expect the disease to die out, or to become persistent?