Concepts in infectious disease epidemiology II

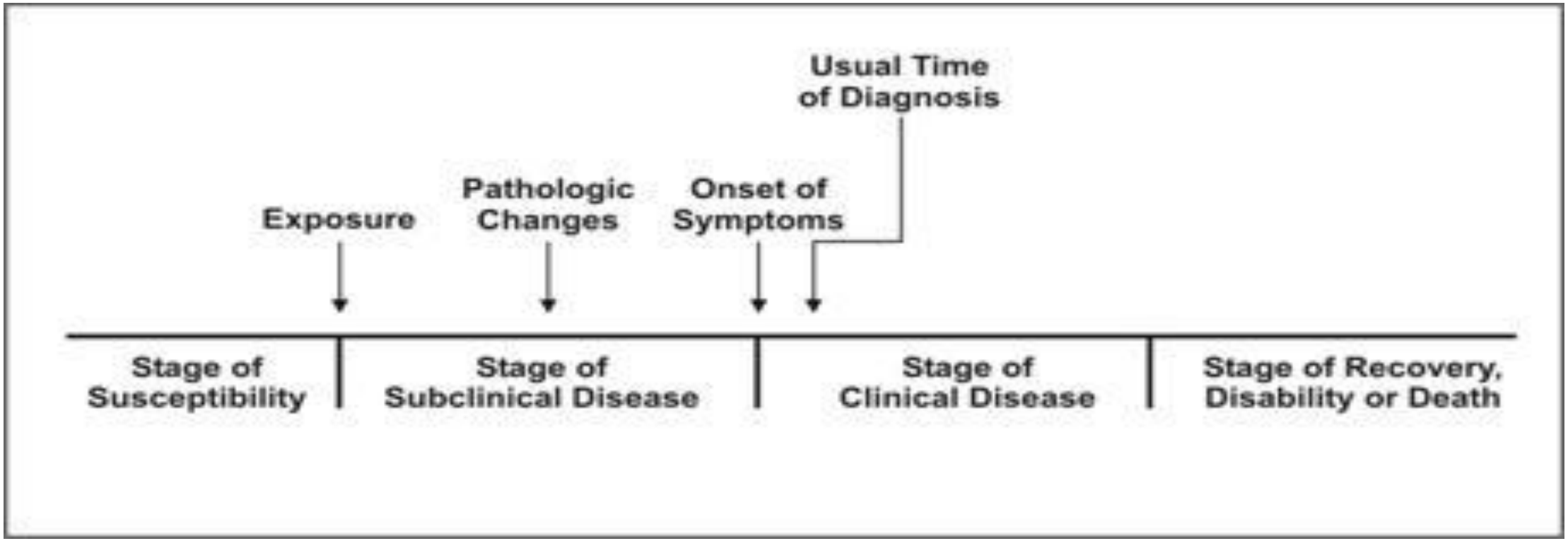
MATHEMATICAL MODELING FOR INFECTIOUS DISEASE PLANNING IN AFRICA

30 minutes

Learning objectives

- Understand the natural history of an infectious disease
- Understand how the burden of infectious disease can be measured
- Define contact rate and super spreading events

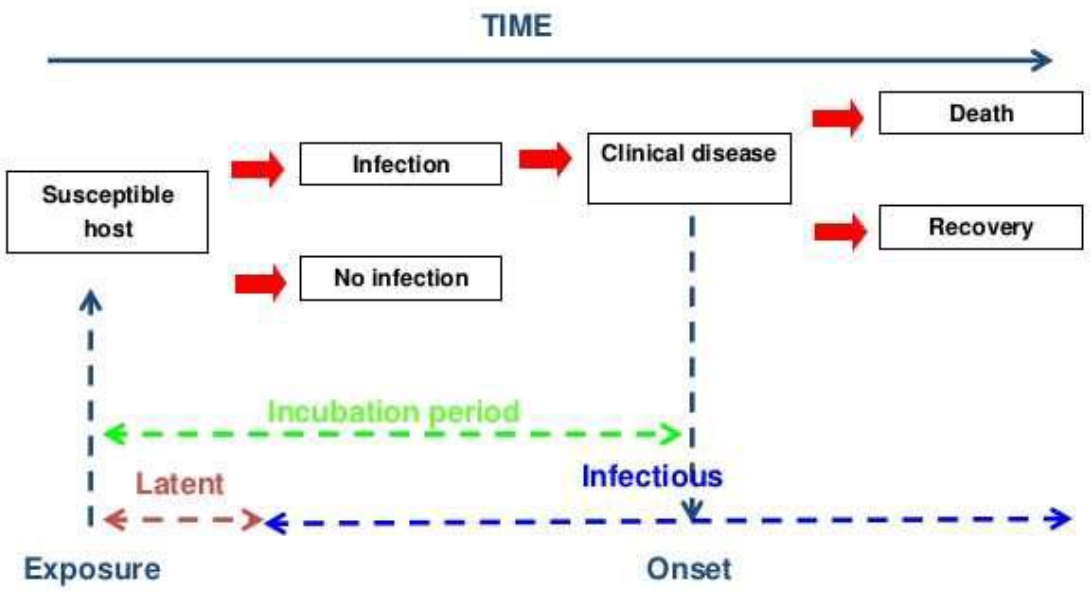
Natural history of a disease



Source: Centers for Disease Control and Prevention. Principles of epidemiology, 2nd ed. Atlanta: U.S. Department of Health and Human Services;1992.

- What is the latency period?
- What is the incubation period?

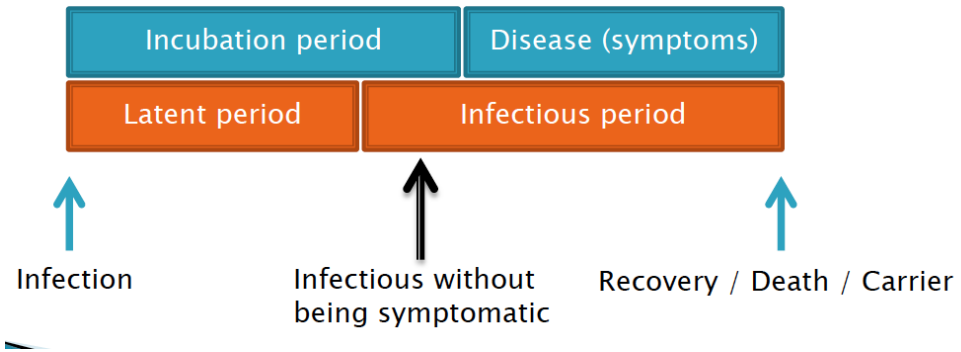
Natural history



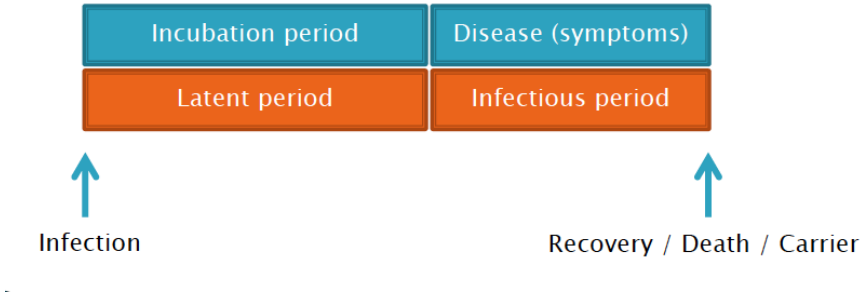
Source: *Nguyen Thi Ngoc Mai*

Latent period

- Latent period → infectious period
  - E.g. influenza



- An infected individual only becomes infectious when symptomatic
  - E.g., SARS



- What about carriers?

Source: Dr. Fung's lecture notes6

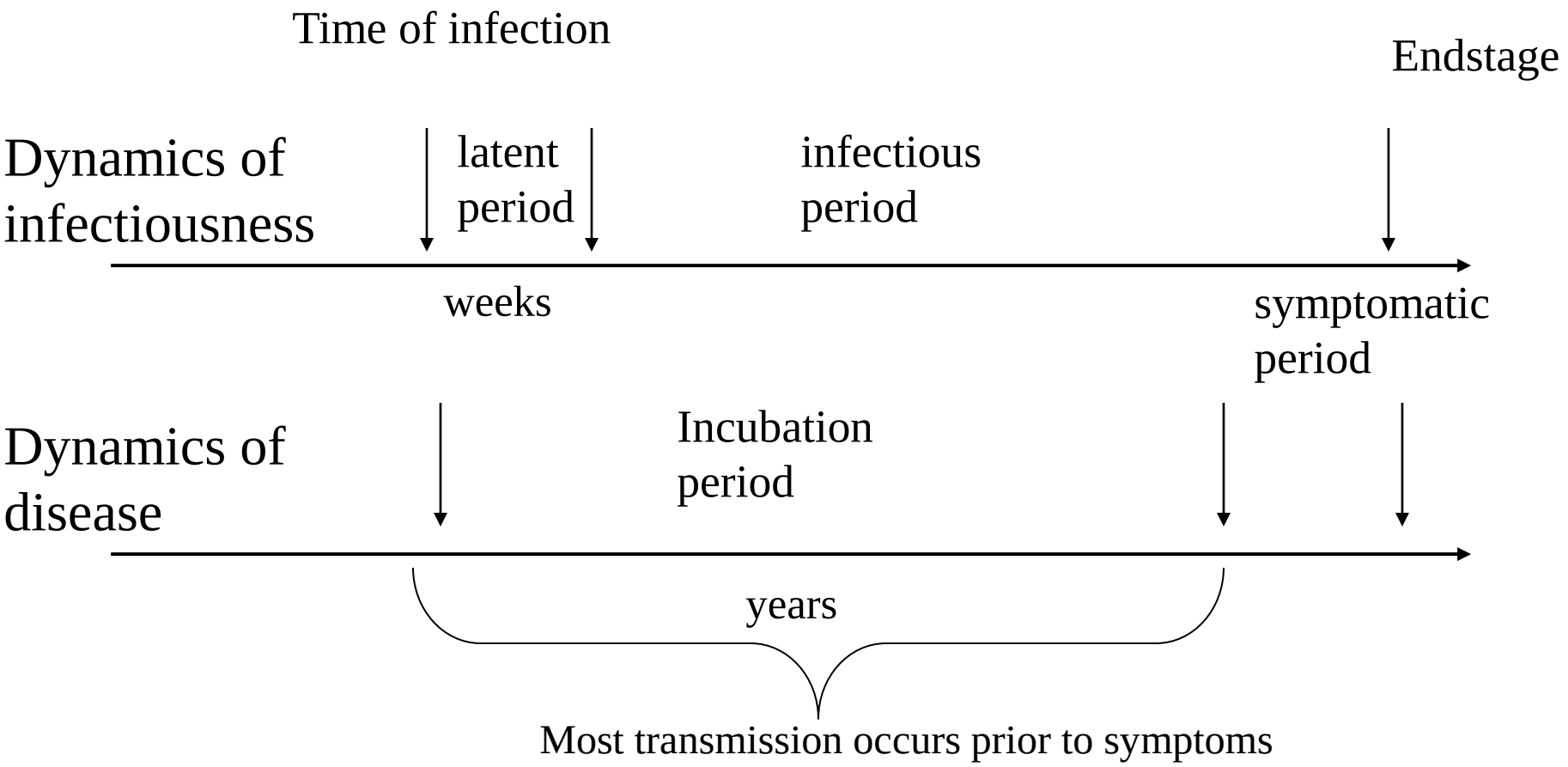
Incubation period

- Factors influencing the incubation period
  - Generation time
  - Infective dose
  - Portal of entry
  - Individual susceptibility

Questions

- Is the incubation period for a specific disease the same for everyone?
- Compare the incubation and latent period for:
  - Cholera
  - Chicken pox
  - Measles
- Why is it important to know the incubation period?

Natural history for HIV

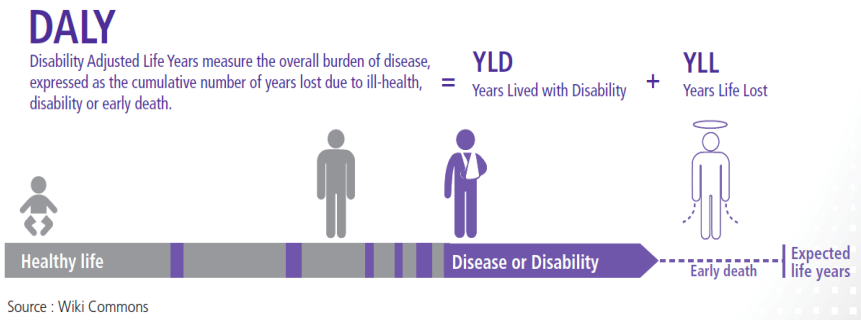


How do we measure the “burden” of infectious diseases?

- How many (and which) people die each year?
- How many people live with the disease?
- How debilitating is the disease?
- What is the economic burden?
- What type of epidemiology? (Epidemic? Endemic?)

Other measures of disease burden

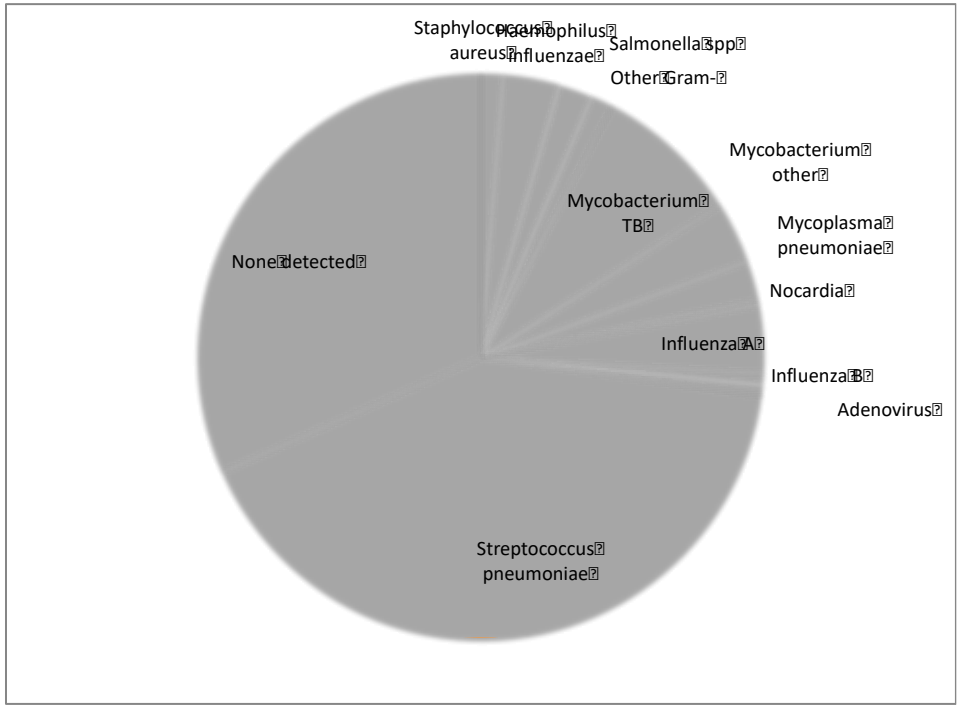
- **Disability-Adjusted Life Years (DALYs)**: measures lost healthy life years.



- **Quality-Adjusted Life Years (QALYs)**: measures how many years lived in good health.
- Others?

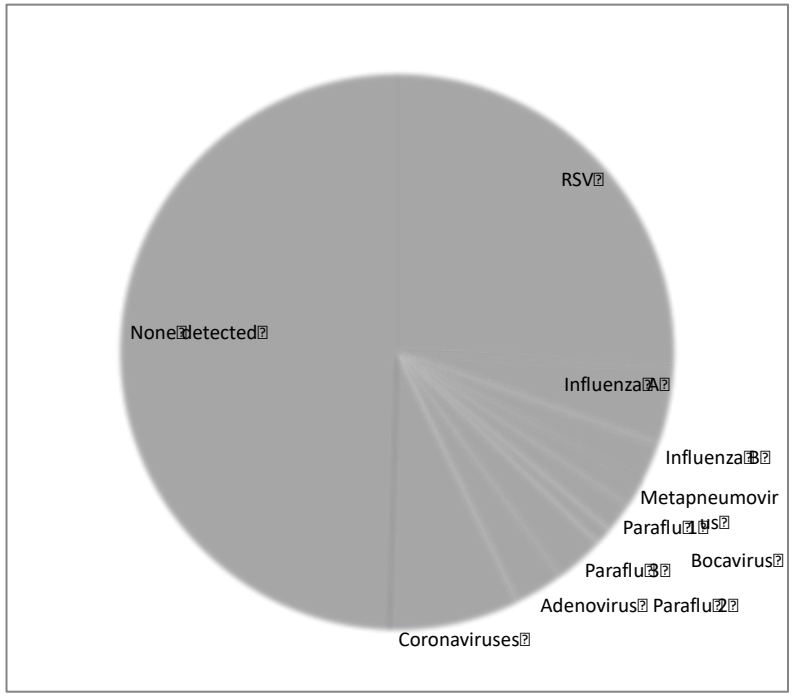
Multiple etiologies: Pneumonia, meningitis, diarrhea

Pneumonia, Adults, Kenya



JA Scott et al. *Lancet* 2000

Severe pneumonia, infants and children, Kenya (viruses only)



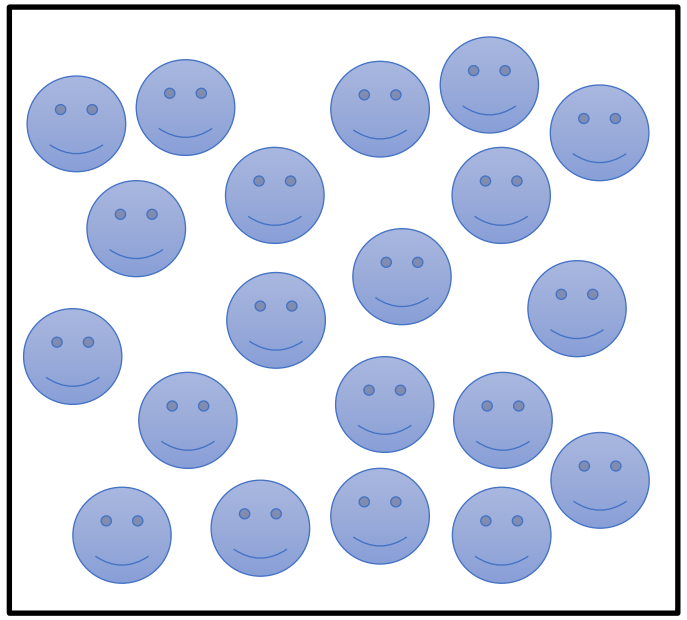
JA Berkley et al. *JAMA* 2010

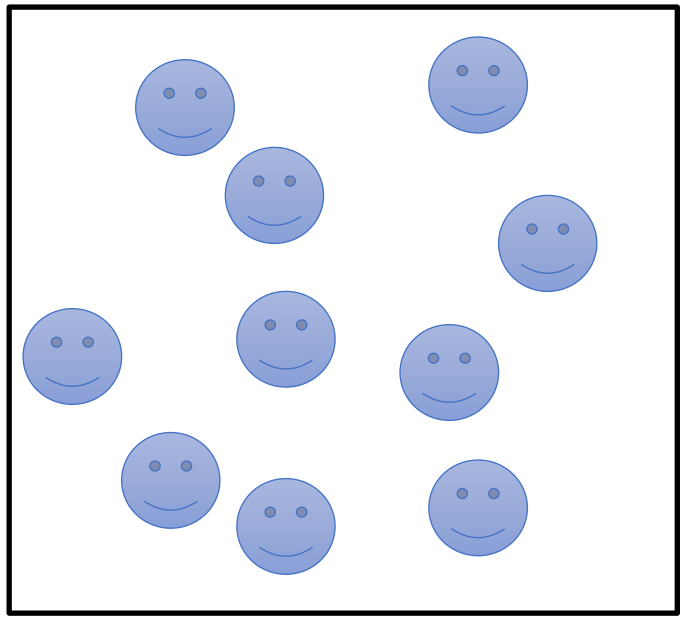
What are superspreading events?

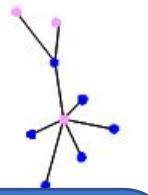
- May be events where a large number of people are infected over a relatively short period.
- Usually associated with explosive growth early in the outbreak and sustained transmission later.

Frieden et al., 2020

Population at risk: how to think about the contact rate







How does a superspreading event influence the transmission dynamics?

For a nice explanation see: https://parasiteecology.wordpress.com/2013/10/17/density-dependent-vs-frequency-dependent-disease-transmission/

References

- Dr. Isaac Fung's lecture on overview of infectious disease epidemiology: an overview
- Dr. Caroline Buckee's lecture on why we need mathematical models