Public health, epidemiology and modeling

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Goals

- Define public health
  - Compare and contrast with medicine
- Define epidemiology
- Discuss the role of dynamical modeling

1 What is public health?

- The science of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts...
- *Winslow 1920* *https://zenodo.org/record/1448241*
- *https://www.youtube.com/watch?v=t_eWESXTnic*
- Works at the population level
- *Prevention* comes first

Examples

- What are some public health interventions?

Public-health intervention framework

- Define the problem
- Determine risk factors
- Develop interventions
- Implementation
- Maintenance

Barriers

- Economic
- Moral/religious
- Individual freedom
- Political

1.1 Public health vs. medicine

- Medicine
  - individual focus
  - diagnosis
  - treatment
- Public health
  - community focus
  - investigation (epidemiology)
  - intervention (policy)

Medical interventions

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  -
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Joint interventions

- Vaccinations
- Treatment as prevention

Conflicts

- Do the individual and population perspectives ever conflict?

Antibiotics

- For most patients the safer choice is aggressive, broad-spectrum treatment
- What's the problem?
  -
  -

HIV treatment beliefs

- 1980s: treating with AZT is better for the patient but might be worse for the community
- 2000s: Early treatment with highly active combination therapy is better for the community but might be worse for the patient
- Now: Ever-improving treatments are better for everyone

COVID testing

- Public-health people like widely deployed, low-accuracy fast tests
  - They provide useful population-level information for policy and response
- Many medical people disllike them
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Clinical trials

- Randomized clinical trials are good for society
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Health care

- Health care $\neq$ medical care
- Health care = medical care + public health
- Public health and economic improvements dominate health progress

2 What is epidemiology?

- The study of the
  - distribution and
  - determinants
  - of health-related states or events
  - in specified populations
- and the application of this study to control health problems
- *J. Last, Dictionary of Epidemiology* `https://academic.oup.com/aje/article/154/1/93/117432`

Getting answers

- Classic epidemiology
  - Who, what, when, where?
- Analytic epidemiology
  - Why and how?
- of disease patterns at the population level

Determinants of disease

More partners → greater likelihood of HIV

Observational studies

Is it OK to use observational studies to shape policy?

Classical epidemiology

When do we need to know why?

- Many interventions were implemented long before they were understood
- *R. Bertollini, Policy Implications of Our Understanding of the East-West Life Expectancy Gap (DOI broken!)*

Testing interventions

Circumcision reduces male HIV incidence by 60%

3 Where does modeling come in?

Risk factors for heart disease

- Fatty diet
- Poor exercise
- Genetics
- Stress

Risk factors for tuberculosis

- Poor nutrition
- Crowded living conditions
- Stress
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Risk factors for measles

- Poor nutrition
- Crowded living conditions
- Stress
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Dynamics

- You are at risk if your neighbors have the disease
- Your neighbors are at risk if *their* neighbors have the disease
- Their neighbors are at risk ...
- Dynamical models are the tool for understanding this

Thresholds for control

- Ronald Ross: if we reduce the number of mosquitoes beyond a critical level, yellow fever should not be able to persist

Predicting dynamical impacts

- Studied universal testing and treatment for HIV
- Direct benefits
- Indirect benefits
- *Granich et al., 2009* `https://pubmed.ncbi.nlm.nih.gov/19038438/`

Summary

- Public health
  - Population level view; the complement of medicine
  - Prevention first!
- Epidemiology
  - the cornerstone of public health
  - distribution and determinants of disease
- Models
  - Understand dynamical disease processes
  - Investigate dynamical effects of changes