Antibiotics and Antibiotic Resistance: Risk Assessment Challenges for Human Health

Felicia Wu, PhD
John A. Hannah Distinguished Professor
Department of Food Science & Human Nutrition
Department of Agricultural, Food, & Resource Economics
Michigan State University

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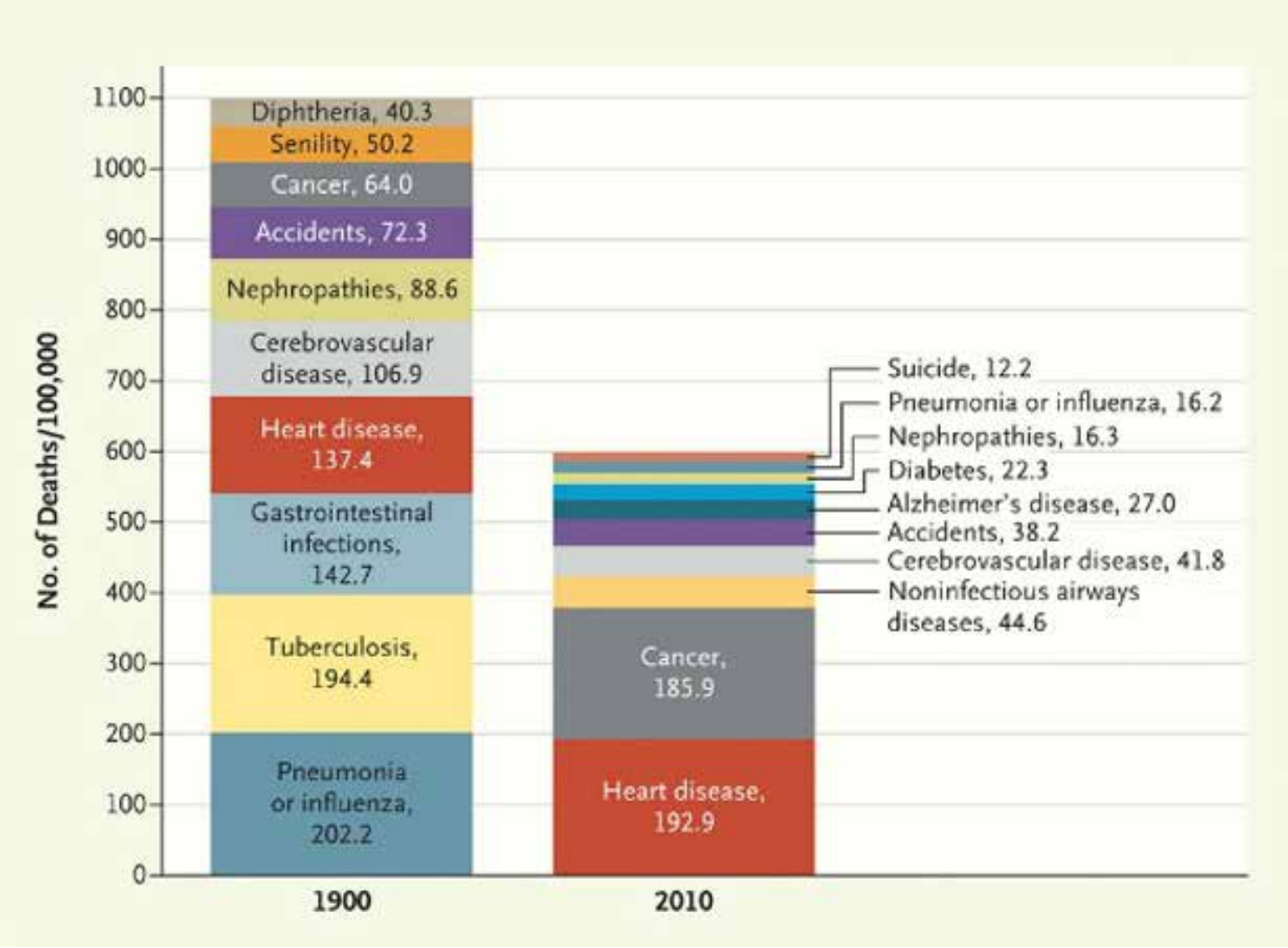
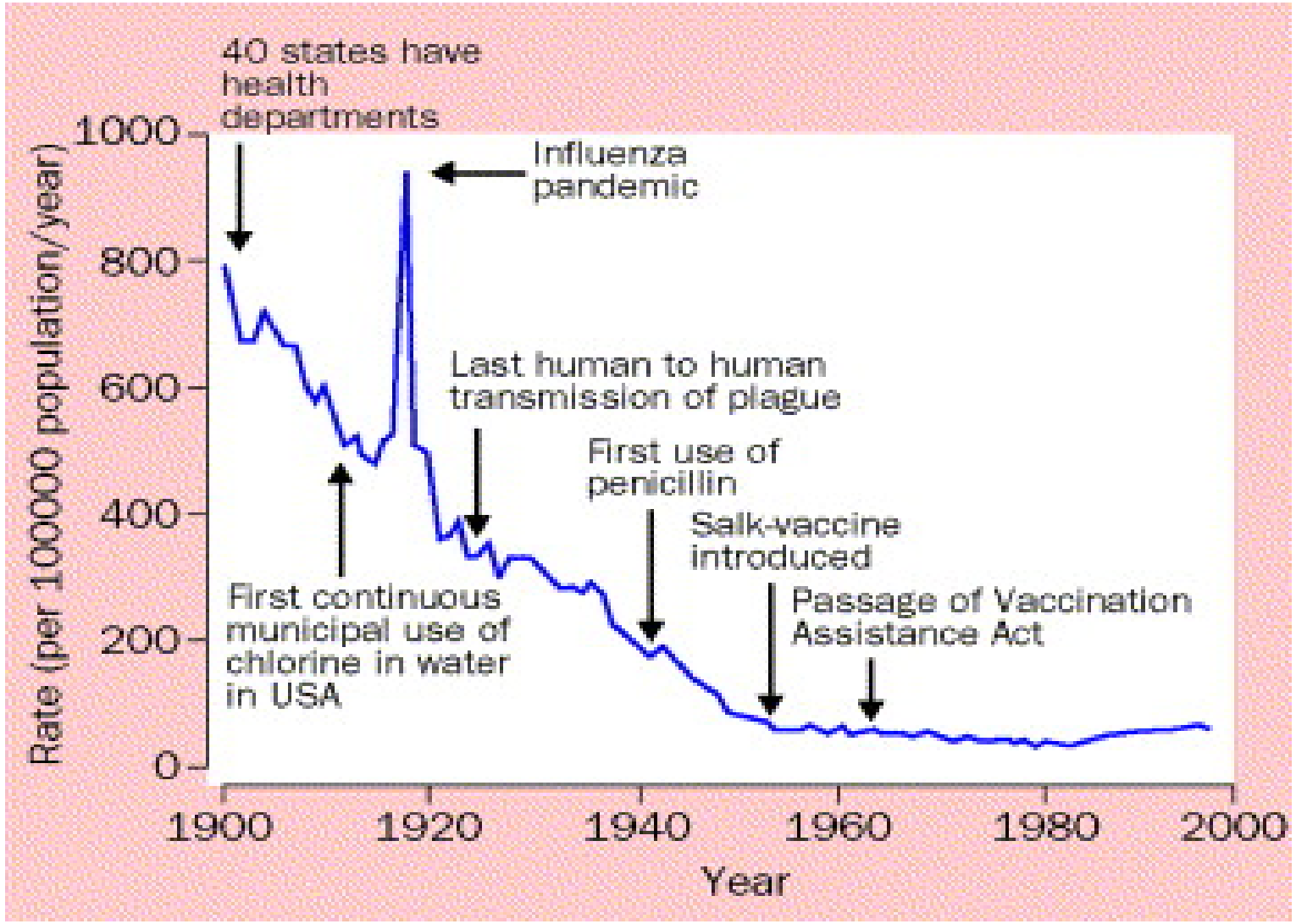
Presentation outline

- A (very) brief history of antibiotics
- Antibiotic resistance
- Antibiotic resistance risk assessment: Why it is so difficult
- Steps forward

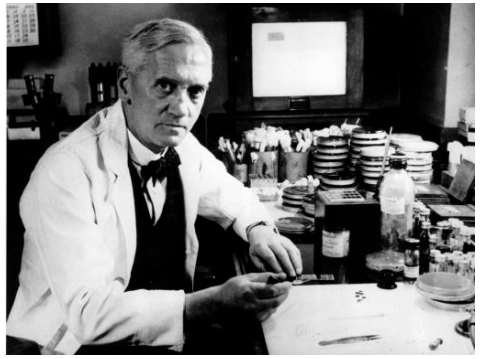
Top 10 causes of death in US were caused much more by bacteria in 1900 than in 2010 (CDC National Vital Statistics Report 2010)



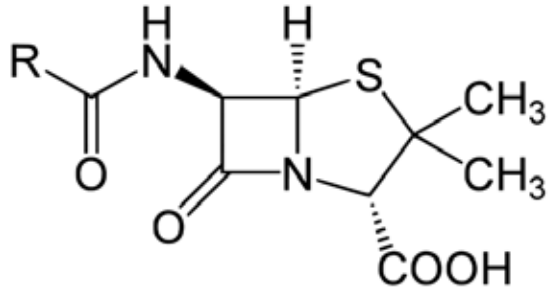
In US, infectious disease death risk has dropped dramatically since 1900.



Aiello AE, Larson EL (2002). *Lancet Infectious Dis*. 2:103-110.



Antibiotics



Compounds that kill bacteria or slow their growth

- 1928: Alexander Fleming's staphylococcus cultures in lab
  - *Penicillium* in one dish destroyed bacteria
- "Mould juice" (penicillin) found to be effective against scarlet fever, pneumonia, meningitis, diphtheria, gonorrhea, syphilis, etc.

Today: >150 antibiotics developed for humans & animals

- Before antibiotics, infections caused >33% all deaths in US
- >200M lives saved by penicillin (Roberts & Ingram 2001)

Risks of overuse

- Adverse gastrointestinal effects, including life-threatening *C. difficile*
- **Antibiotic-resistant bacteria**

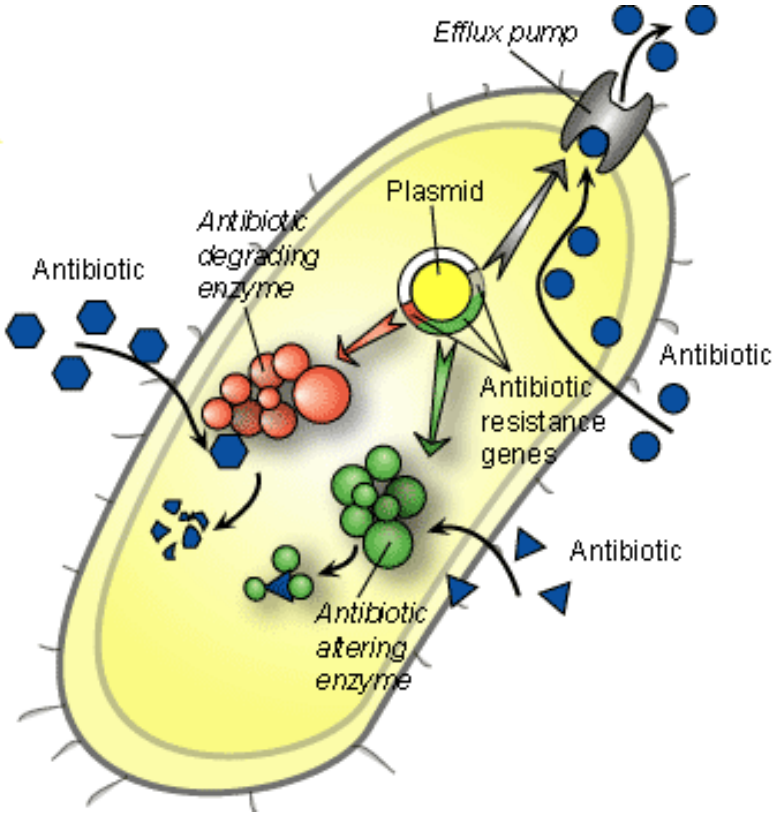
Antibiotic resistance recognized as national and global threat

- US government (PCAST), CDC and WHO have identified antibiotic resistance as one of greatest public health threats today
  - http://www.cdc.gov/narms/
  - http://www.who.int/mediacentre/factsheets/fs194/en/

- Although ***clinical*** use/misuse is identified as the major cause, uses in animal agriculture may play role

How bacteria evolve resistance to antibiotics, & consequences

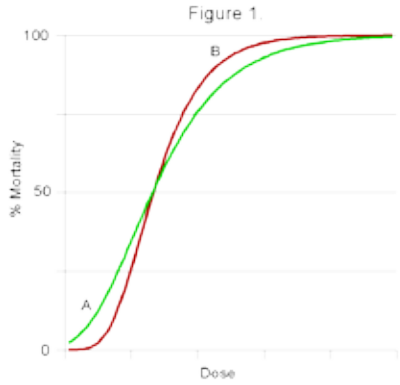
- Strong selection pressure in environment
  - **Environment** is reservoir for antibiotic resistance genes
    - Hospitals, soil, lagoons, etc.
  - As our practices put more and more antibiotics into environment, bacteria face pressure to evolve resistance, or die
  - Mechanisms:
    - Exclusion of antibiotic from cell
    - Antibiotic degradation or structural modification (Topp 2015)
- à Loss of antibiotic efficacy in vet & human medicine, IV vs. oral treatment, greater health care costs, greater **risk** to medical procedures once thought routine



How could antibiotic use in animal/dairy production affect humans? Risk assessment

WE NEED TO ASSESS RISKS OF 3 THINGS

- Antibiotics
- Antibiotic-resistant bacteria
- Antibiotic resistance genes
  - In all cases, **dose** & **exposure** matter



WHAT WE STILL DON'T KNOW

- To what extent does antibiotic use in dairy production affect antibiotic resistance in **humans**?
  - B/c of careful stewardship over decades, antibiotic use in dairy has not led to widespread pathogen resistance; however, does contribute to antimicrobial resistance (Oliver et al. 2011)
- Can bacteria evolve resistance to multiple antibiotics at once?
  - If so, then it wouldn't matter that vet medicine uses different antibiotics than human medicine
- What is the **time** scale of evolving resistance?

Steps forward

- Continue careful stewardship of antibiotic use in vet & human medicine
- Monitor for emerging antibiotic-resistant pathogens
- Continue research on whether bacteria develop cross-resistance or co-evolution to antibiotics across vet-human medicine
- Consider alternatives to antibiotics that are as safe and effective