
Escalating Infectious Disease Threat
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Dramatic changes in society and environment . .

Explosive population growth, spreading poverty, global warming, and urban migration

– new pathogens, old pathogens in new places

Dramatic changes in society and environment . .

Increased international travel and trade: we live in a global village

- rapid spread of disease

Dramatic changes in society and environment . .

Loss of control of national borders

– ineffective quarantine laws

Dramatic changes in society and environment . .

Rise of antibiotic resistant pathogens

1946 Penicillin became available

- Strep and staph (strep throat, pneaumonia, septicemia, skin infections, wound infections, scarlet fever, toxic shock syndrome)

Today, 80 % of all strains of staph are resistant to penicillin

1950 Streptomycin, chloramphenicol, tetracycline

- Multiple infections

1953 Shigella outbreak in Japan resulted in the appearance of a strain of dysentery bacillus with multiple drug resistances

1982 Last new class of antibiotics – quinolones

- Resistance rising

1998 Vancomycin is antibiotic of last resort for staph and other gram positive pathogens

We are now seeing emergence of vancomycin resistance!

Why Antibiotic Resistance is Growing Rapidly

- **Antibiotics in animal feed and in aerosols for fruits and vegetables**
  - **Of the 50-million lbs of antibiotics produced annually in the U.S., 40% go to livestock**

Why Antibiotic Resistance is Growing Rapidly

- **Growing numbers of immuno-compromised people**
  - **Chemotherapy Patients**
  - **Transplant patients**
  - **AIDS patients**
  - **Aging population**

Why Antibiotic Resistance is Growing Rapidly

- **Excessive use of antibiotics**
  - **Over prescription**
  - **Unregulated over-the-counter sales**

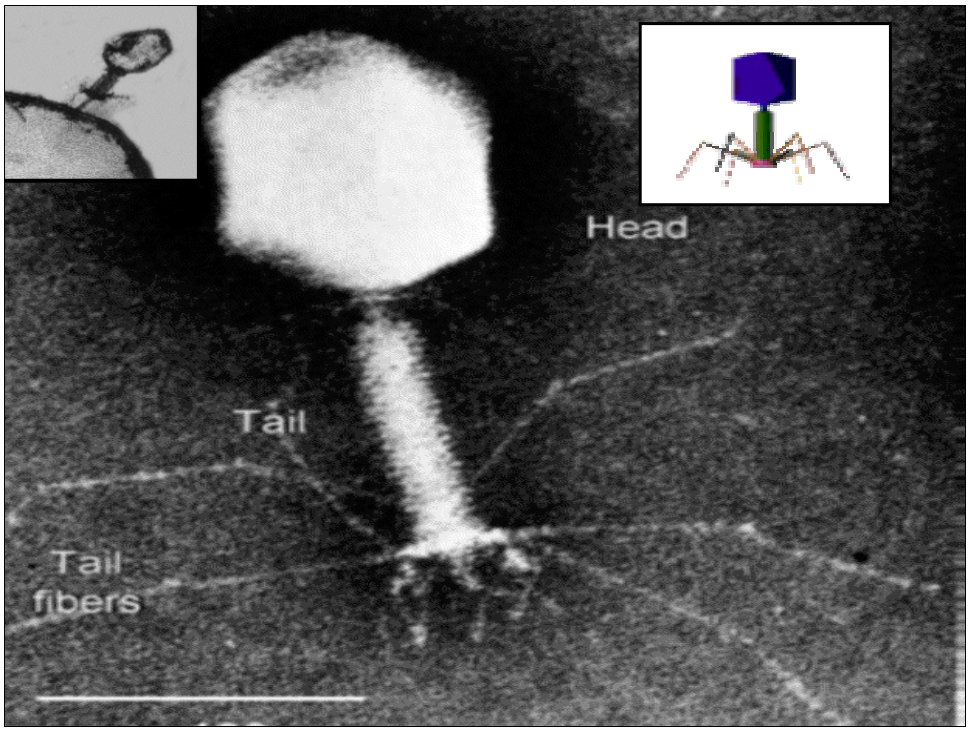
Why Antibiotic Resistance is Growing Rapidly

- **International travel**
  - **Multidrug-resistant streptomycin:**

    Rapid spread: Spain → UK → US → So. Africa

E. Coli 0157: H7
Where did this come from?

- **A new and pervasive pathogen**
- **A food contaminant that is now the leading cause of kidney failure in children**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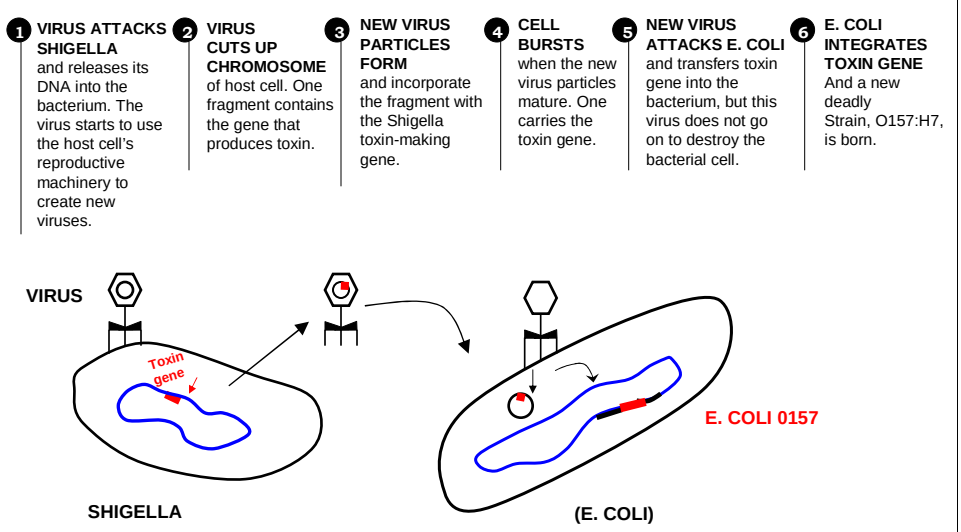


Source: Uniformed Services University of the Health Science,
F. Edward Hebert School of Medicine, Dr. Alison O'Brien and Dr. Angela Melton-Celsa

West Nile Virus

SARs

Severe Acute Respiratory Syndrome

- **Corona Virus – the same type of virus that causes the common cold**

- **High potential for natural evolution**

Influenza

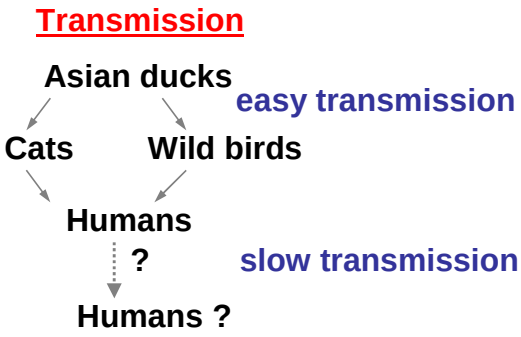
Asian Bird Flu H5N1

- **No strong evidence of human to human transmission, yet**
- **The concern is that H5N1 mutates rapidly**

Flu virus H5N1

- **Single strand of RNA containing 8 genes, each encoding a single protein**
- **High mutagenicity rate due to:**
  - **Reassortment of the genes**
  - **Single base mutations**

Flu virus H5N1



Influenza viruses

H = haemaglutinin

- binds to host cells to aid virus entry

N = Neuraminidase

- allows newly formed viruses to escape and infect other cells (Tamiflu & Relenza target)

Influenza viruses

1918 flu (H1 N1) Killed ~40 million people

1957 flu (H2 N2) Killed ~2 million people

1968 flu (H3 N2) Killed ~1 million people

Current Asian bird flu (H5 N1) 50% death rate

Humans have no immunity against H5, only against H1, H2, H3

What Needs to be Done?

- **Increase basic research to understand viral and bacterial pathogens**
  - **Identify genes essential for pathogen's survival**
  - **Sequence and compare viral and bacterial genomes**
  - **Identify "virulence" and "resistance" genes and how they work**
- **Design and stockpile new vaccine strategies and "combination" antibiotics**

What Needs to be Done?

•For epidemic control:

- **Develop techniques for fast (hours, not days) identification of causative agents**
  - **Exploit viral and bacterial DNA sequence-based technologies**
- **Increased network of surveillance and reporting protocols**
- **Return to historical use of quarantine**
  - **For resistant and virulent infections it is the only effective containment strategy**