Future pandemics might be caused by bacteria and not viruses

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Outline

• Characteristics of a pathogen of pandemic potential
• Antimicrobial resistance
• Global estimates of mortality
• Local observations
• What next
HISTORY OF PANDEMICS

Throughout history, as humans spread across the world, infectious diseases have been a constant companion. Even in this modern era, outbreaks are nearly constant.

Here are some of history’s most deadly pandemics, from the Antonine Plague to COVID-19.

- Antonine Plague: 155–160
- Plague of Justinian: 541-542
- Japanese Smallpox Epidemic: 735-737
- Black Death (Bubonic Plague): 1347–1351
- Smallpox: 1729
- 17th Century Great Plagues: 1600
- 18th Century Great Plagues: 1700
- Cholera 6 outbreak: 1851-1853
- The Third Plague: 1855
- Yellow Fever: 1700-1702
- Spanish Flu: 1918-1919
- Russian Flu: 1944-1954
- HIV/AIDS: 1981-Present
- Asian Flu: 1957-1958
- Hong Kong Flu: 1968-1969
- SARS: 2002-2003
- MERS: 2012-Present
- Swine Flu: 1976
- COVID-19: 2019- (Ongoing)

DEATH TOLL

[HiHEST TO LOWEST]

It is hard to calculate and forecast the impact of COVID-19 because the disease is new to medicine, and data is still coming in.

*Johns Hopkins University estimates
Characteristics of pathogens with potential to cause pandemic

• Appreciable case fatality rate

• Ongoing risks

• Efficient human-to-human transmissibility

• Absence of an effective or widely available treatment/therapeutics/vaccines

• Immunologically naïve population

• Ability to evade the immune system

• Routes of spread - respiratory>contact
Appreciable mortality

Deaths attributable to AMR every year by 2050

- North America: 317,000
- Europe: 390,000
- Africa: 4,150,000
- Latin America: 392,000
- Asia: 4,730,000
- Oceania: 22,000

Source: Review on Antimicrobial Resistance
An estimated 4.95 million (3.62–6.57) deaths associated with bacterial AMR in 2019

1.27 million (95% UI 0.911–1.71) deaths attributable to bacterial AMR.

The six leading pathogens - Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, Streptococcus pneumoniae, Acinetobacter baumannii, and Pseudomonas aeruginosa

cf 6,481,600 COVID-19 deaths (cumulative over close to 3 years)
Figure 2: All-age rate of deaths attributable to and associated with bacterial antimicrobial resistance by GBD region, 2019

Estimates were aggregated across drugs, accounting for the co-occurrence of resistance to multiple drugs. Error bars show 95% uncertainty intervals. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.
On-going risks - antibiotic use
Types of antibiotics

Figure 2 Common antibiotics used in Kenyatta National hospital
Community antibiotic use

• Self-medication with antibiotics is widespread, often for viral or non-infectious illnesses

• In one study, self-prescription was found to be widespread in resource-limited countries - in Vietnam (55.2%), Bangladesh (45.7%), and Ghana (36.1%)

• This is replicated in many parts of the world

Absence of effective and widely available therapy

Klebsiella pneumoniae BSI (%S)

- Amikacin: 90%
- Meropenem: 86%
- Ciprofloxacin: 80%
- Aminoglycoside: 74%
- Piptaz: 74%
- Cefepime: 67%
- Ceftazidime: 28%
- Gentamicin: 18%
- Cefotaxime: 8%
- Ceftriaxone: 7%
- Cefuroxime: 7%

Acinetobacter baumannii BSI

- Meropenem: 28%
- Ciprofloxacin: 35%
- Piptaz: 22%
- Ceftazidime: 25%
- Gentamicin: 39%
Staph aureus in Blood

![Graph showing the percentage of Staphylococcus aureus BSI in different antibiotics]

- **LINEZOLID**: 100%
- **TEICOPHANIN**: 100%
- **VANCOMYCIN**: 100%
- **GENTAMICIN**: 92%
- **LEVOFLOXACIN**: 77%
- **TETRACYCLINE**: 68%
- **OXACILLIN**: 48%
- **PENICILLIN**: 1%
• Pathogenic GN cultured in 76.8% (175 of 228) of neonates.

• Klebsiella spp (41.7%; 115 of 276) and Escherichia coli (26.4%; 73 of 276)

• Klebsiella spp, 75.6% (87 of 115) phenotypically expressed ESBL

• 15.6% expressed carbapenemase and harbored bla-OXA-181 and bla-CTX-M-15.

• 7.0% (16 of 228) of neonates developed GN bloodstream infection.
Deaths Due to Nosocomial Sepsis NBU, 2018-2019

Number of Deaths and % Deaths due to Nosocomial Sepsis, KNH NBU, 2018-2019
AMR in the community
Outbreak Reports: Extensively Drug-Resistant (XDR) *Salmonella* Typhi Outbreak by Waterborne Infection — Beijing Municipality, China, January–February 2022

Yu Wang; Dan Lu; Yingying Jin; Huanxin Wang; Bing Lu; Xin Zhang; Ying Huang; Gaolin Shu; Baiwei Liu; Changying Lin; Hao Zhao; Mingqiang Zhao; Lingyu Shen; Zhiyong Gao; Daitao Zhang; Quanyi Wang; Mei Qu; Lei Jin.
Next steps

• Strengthening of infection control and prevention initiatives

• Hygiene and sanitation

• Vaccination

• Improving microbiology laboratory capacity

• Antimicrobial stewardship (AWaRe categorisation)

• Therapeutics - development, access and cost. Access to newer antimicrobials particularly in LMICs which bear the largest burden of AMR

• Keep in mind that pandemics may drive pandemics
Summary

• Antimicrobial resistance is a clear and present danger to global health and urgent steps must be taken NOW to contain and prevent further emergence and spread of AMR

• A pandemic anywhere is a pandemic everywhere.