Advanced Molecular Detection: An Overview

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Today's Agenda

- ❑ AMD Overview at CDC – Greg Armstrong, CDC
- ❑ AMD Application in Three Domains
  - • Enhancing Influenza Surveillance with AMD – John Barnes, CDC
  - • GHOSTing Hepatitis C Outbreaks—Yury Khudyakov, CDC
  - • Evaluation of whole genome sequencing for genotyping of Mycobacterium tuberculosis – CDC
- ❑ AMD technology in the public health laboratory: Opportunities and challenges – Pete Shult, Wisconsin State Laboratory of Hygiene
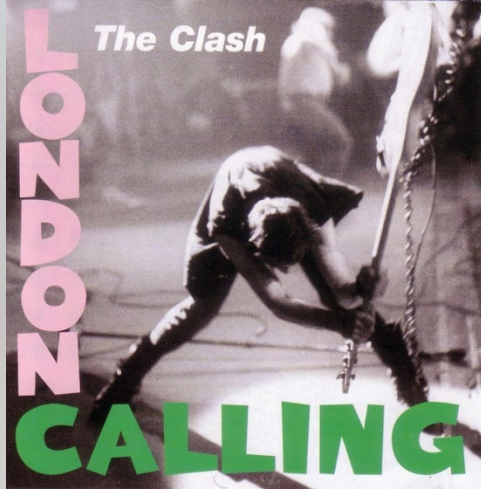- ❑ Discussion

Cost per Raw Megabase of DNA Sequence

Source: NCBI (https://www.genome.gov/sequencingcosts/)
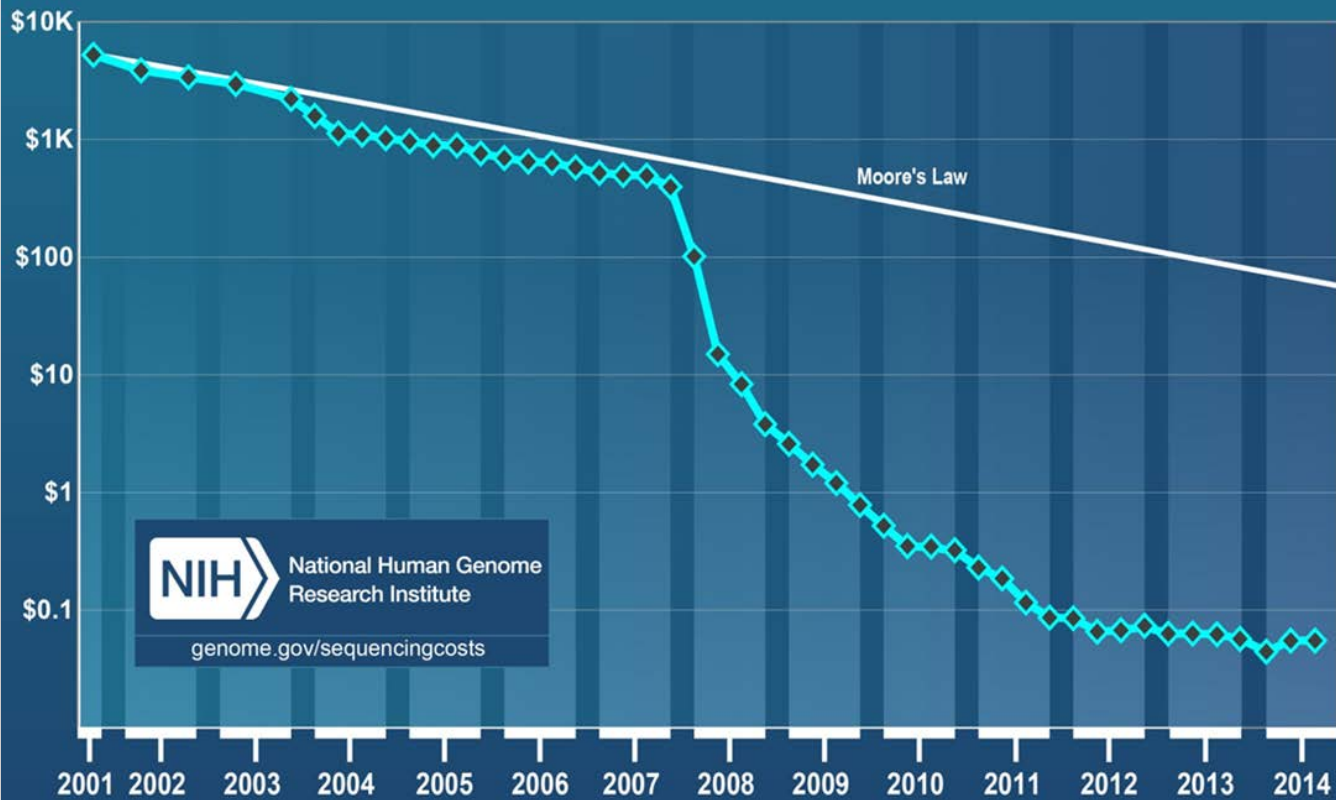
Future of Sequencing?

Evolution of AMD

2011: Bioinformatics Blue Ribbon Panel

In order to keep up with technologies that have revolutionized the science that is so critical to public health, CDC must develop a bioinformatics program, otherwise we will become obsolete, and then irrelevant.

Evolution of AMD

2014: Advanced Molecular Detection and Response to Infectious Disease Outbreaks (AMD) initiative approved by Congress

- 5-year, $30m-per-year program to modernize genomics and bioinformatics
- Core goals:
  - Improve **pathogen detection and characterization**
  - Develop **new diagnostics** to meet public health needs
  - Support genomic and **bioinformatics** needs in state and local health departments
  - Implement enhanced, sustainable, **integrated information systems**
  - Develop tools for prediction, modeling and **early recognition of emerging infectious threats**

What is AMD?

❑ Next-generation sequencing (NGS)

❑ Bioinformatics and high performance computing

❑ Application to public health
- Integration with epidemiologic data
- Effective use of this data
- Providing open access when possible
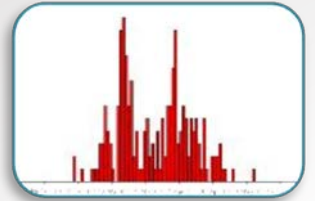
AMD Impact on Public Health

❑ Improved surveillance

❑ Improved outbreak detection and response
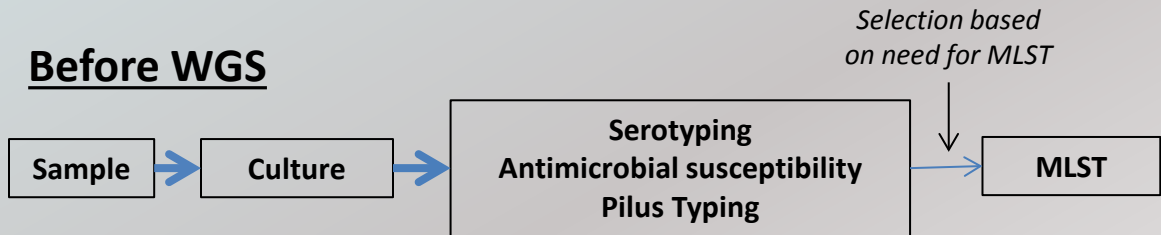
❑ Improved vaccines

AMD Impact: Surveillance

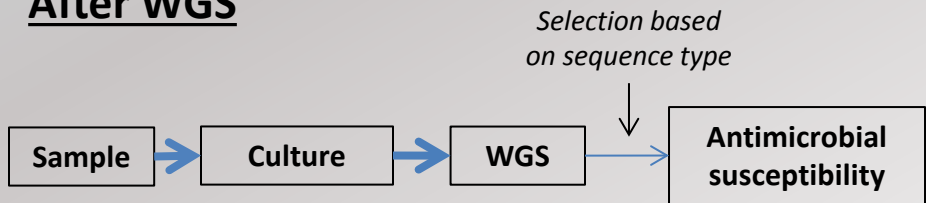| Model	Examples	Challenges
50 states+	PulseNet	• 80+ different jurisdictions • CDC/FDA coordination • Information management
Reference Labs	Flu, TB, GC, Hepatitis, URDO	• Defining model for each
Sequencing mostly at CDC (for now)	Malaria, Cyclospora, Meningococcus, Pneumococcus, Hib, Anthrax, Brucella, Burkholderia, Filoviruses, Arboviruses, Pertussis, Legionella, Respiratory Viruses, Coccidioides, Tick-Borne Pathogens, Dengue	• Less direct impact on day-to-day operations at state and local level

Impact on Efficiency
Pneumococcal Isolate Processing Pipeline

Before WGS

Selection based on need for MLST

Sample → Culture → **Serotyping Antimicrobial susceptibility Pilus Typing** → MLST

After WGS

Selection based on sequence type

Sample → Culture → WGS → **Antimicrobial susceptibility**

Advantages
- *Faster*
- *Cheaper*
- *Less labor-intensive (i.e., less prone to human error)*
- *More data*
- *Better data*
- *More public data*
- *More easily exportable*

AMD – Innovate * Transform * Protect

Impact of AMD: Vaccine Preventable Diseases

❑ Examples

- Influenza

- Invasive pneumococcal disease
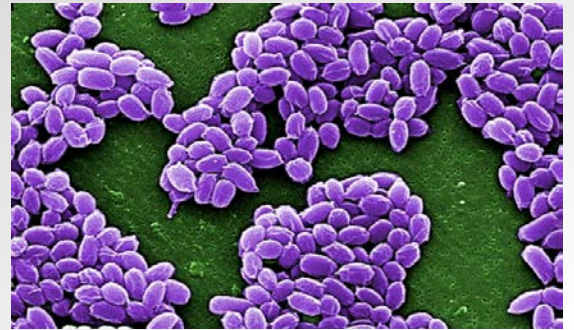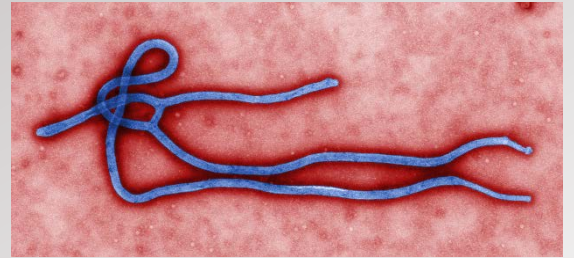
- Others: pertussis, measles, rubella, rotavirus, polio

Impact of AMD:
Outbreak Detection and Response

❑ Examples

- PulseNet

- TB

- Hepatitis C

- HIV

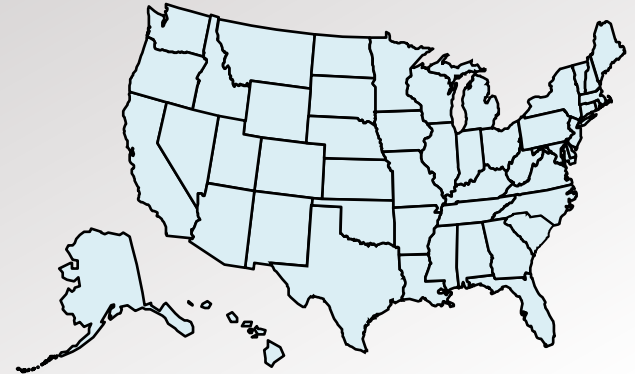- Unexplained respiratory diseases

Other Areas Supported by AMD

- MicrobeNet
- Reference services
  - Uncommon infections
  - Certain select agents
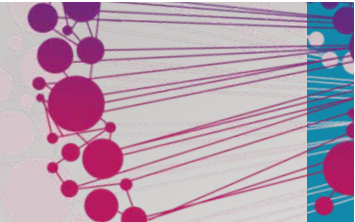- Metagenomics
  - Microbiome
  - CIDT

AMD: Next 3 Years

❑ CDC

- Complete transition to NGS in high priority areas
- Continue transition in medium priority areas
- Further push data integration

❑ State and local health departments

- PulseNet
- NGS capacity in other areas
- Standardization
  - Sample prep
  - Bioinformatics tools

www.cdc.gov/amd

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