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## Epidemic to Endemic or Pandemic Infectious Diseases: Commonalities and Distinctions between Malaria, Ebola and COVID19

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# Epidemic to Endemic or Pandemic Infectious Diseases: Commonalities and Distinctions between Malaria, Ebola and COVID19

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March 30, 2020

# Outline

- Definition of terms
- Examples of diseases, transmission and health impact
- Diagnostics versus presumptive diagnosis – how to make strategic decisions with limited resources and specific context
- How strategies are modified by what we learn – how fast can we adapt?
- Control, elimination, eradication – modeling the end game

# “Pop-up” Quiz time!

(Zoom poll) – sorry, maybe next time?

Q1. What is an epidemic disease?

Q2. What is an endemic disease?

Q3. What is a pandemic?

**Q1. What is an epidemic disease? ( Single Choice)**

Answer 1: A disease of the skin

Answer 2: A disease that rapidly affect a lot of people over a short period of time

**Q2. What is an endemic disease? (Single Choice)**

Answer 1: A common disease you don't have to worry about

Answer 2: A disease that persists in a population

**Q3. What is a pandemic? (Single Choice)**

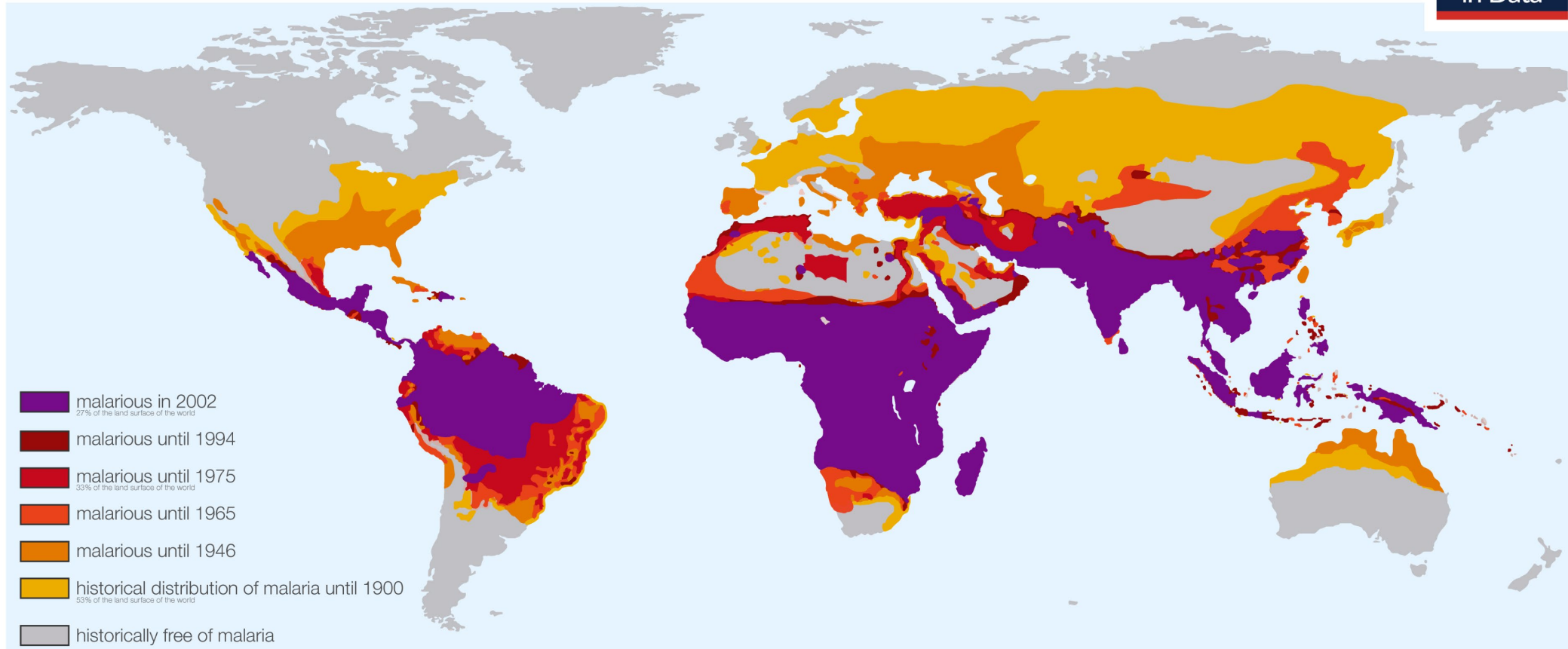
Answer 1: A disease of pandas

Answer 2: A disease that spreads rapidly across continents and poses a threat to people all over the world

# Did you know malaria used to be endemic in the USA?

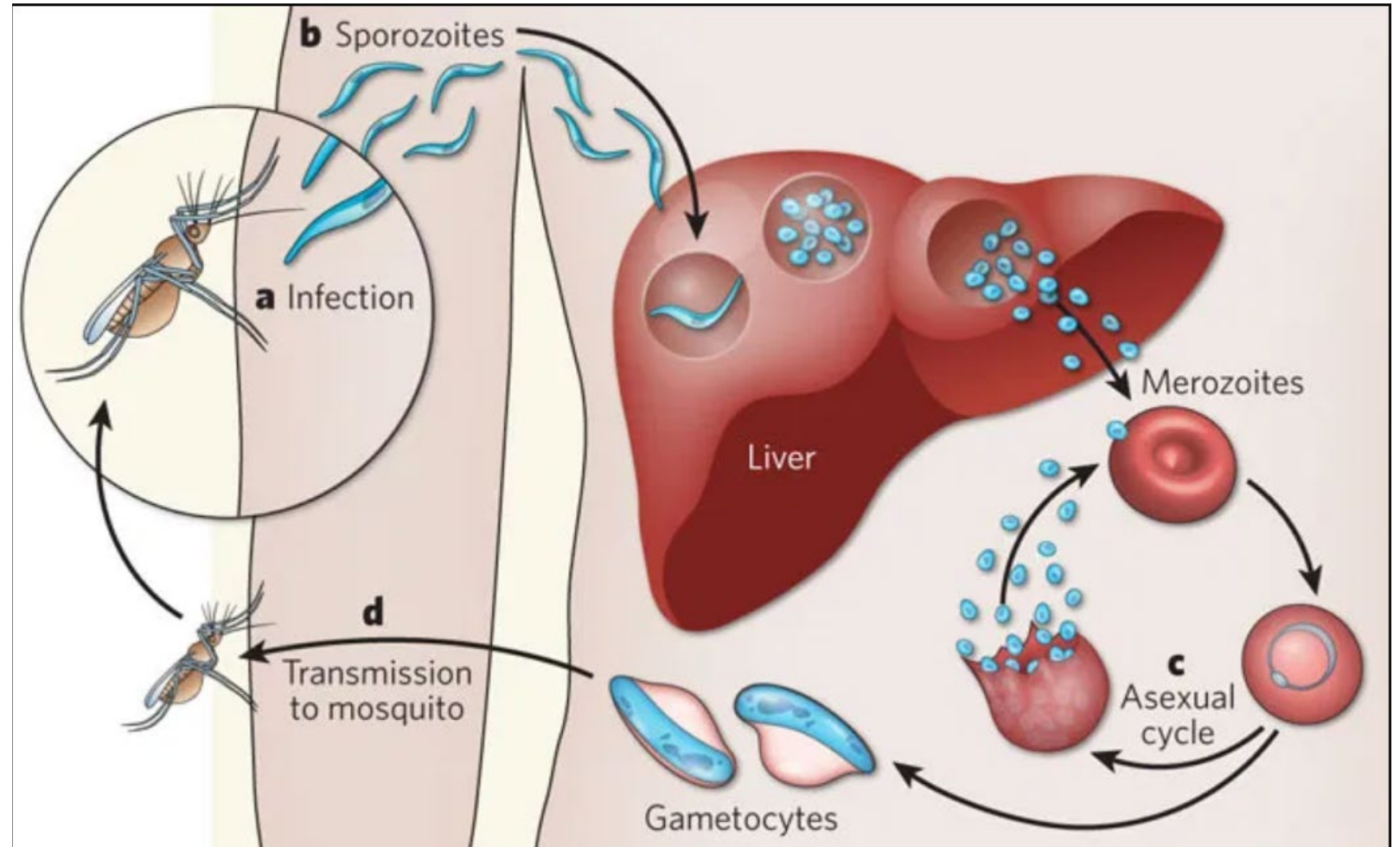
Malaria was prevalent in many parts of the world that are free of malaria today

Our World  
in Data



# How to Block Malaria Transmission

- Prevent mosquitoes from biting humans
  - Bednet
  - Bug spray
  - larvicides
  - change human behavior
- Cure infected humans so they are no longer infectious to mosquitoes
  - Anti-malarial drugs

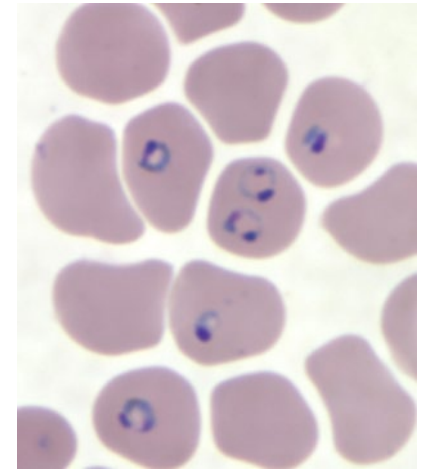


# The Winged Scourge (1942)

- <https://www.youtube.com/watch?v=y68F8YwLWdg&t=5s>



# Malaria diagnosis and surveillance



- Microscopy for blood stage parasites
- Rapid diagnostic tests (RDTs) – point-of-care (POC) diagnostics
- Presumptive diagnosis
  - based on symptoms: shaking chills, high fever, headache, night sweats, diarrhea, vomiting, fast heart rate, -- severe anemia, coma (Blantyre score) , enlarged spleen
  - travel history or residence based on the epidemiology of malaria
- Antibody testing – mainly used in sero-surveys to determine if malaria control measures are working and how many people still getting infected.

# Strategies to rid humans of infectious diseases

- **Control** measures aim to reduce disease incidence, prevalence, morbidity, or mortality to a locally acceptable level as a result of deliberate efforts. Continued intervention is required to sustain control.
- **Elimination** is the interruption of local transmission (that is, reducing the rate of cases to zero) in a defined geographic area (period of time depends on disease). Continued measures are required to prevent the re-establishment of transmission and resurgence of disease.
- **Eradication** is a permanent reduction to zero of the worldwide incidence of infection as a result of deliberate efforts. Once eradication has been achieved, intervention measures would no longer be needed. Countries can achieve eradication status but intervention measures needed until eradication is global.
- **Extinction** is the specific infectious agent no longer exists in nature or in the laboratory.

Global malaria statistics for 2019:  
228 million cases per year and 405,000 deaths  
(0.18% mortality)  
\*\*10-years ago was >2 million deaths per year

**Q4. What strategies are currently in use to control malaria?**

**Q5. What strategies are needed to achieve malaria elimination?**

**Q4. What strategies are currently in use to control malaria? (Select all that apply Choice)**

Answer 1: Sleeping under a bednet

Answer 2: Killing mosquitoes one way or another

Answer 3: Rapid diagnosis and treatment of infected patients

Answer 4: Hiring the seven dwarves at the WHO

**Q5. What strategies are needed to achieve malaria elimination? (Single Choice)**

Answer 1: A safe, efficacious and easy to administer vaccine

Answer 2: New anti-malaria drugs to combat drug resistant parasites

Answer 3: All of the currently practiced control strategies in conjunction with a vaccine and effective anti-malarial drugs.

Q6. Which infectious diseases are currently endemic in the USA?

**What criteria are used to determine when an epidemic has become an endemic disease?**

Raise your zoom-hand or type in the zoom-chat answer or questions

**Q6. Which infectious diseases are currently endemic in the USA? (Select all that apply)**

Answer 1: HIV/AIDS

Answer 2: Salmonella

Answer 3: Lyme Disease

Answer 4: Tuberculosis

Answer 5: All of the above

# Examples of epidemic diseases in the USA

- Measles – declared eliminated in the USA in 2000 (outbreaks have recently occurred due to changes in human behavior)
- Influenza – ‘seasonal flu’ Flu: 18-26 million medical visits, 400-730k hospitalizations, 24-62,000 deaths
- HIV prevalence 1.1 million, 38,000 new infections per year in the USA (global deaths <770,000 per year) – or is this endemic now?
- What others epidemic diseases are there in the USA?
  - Raise your zoom-hand or type in the zoom-chat answer or questions

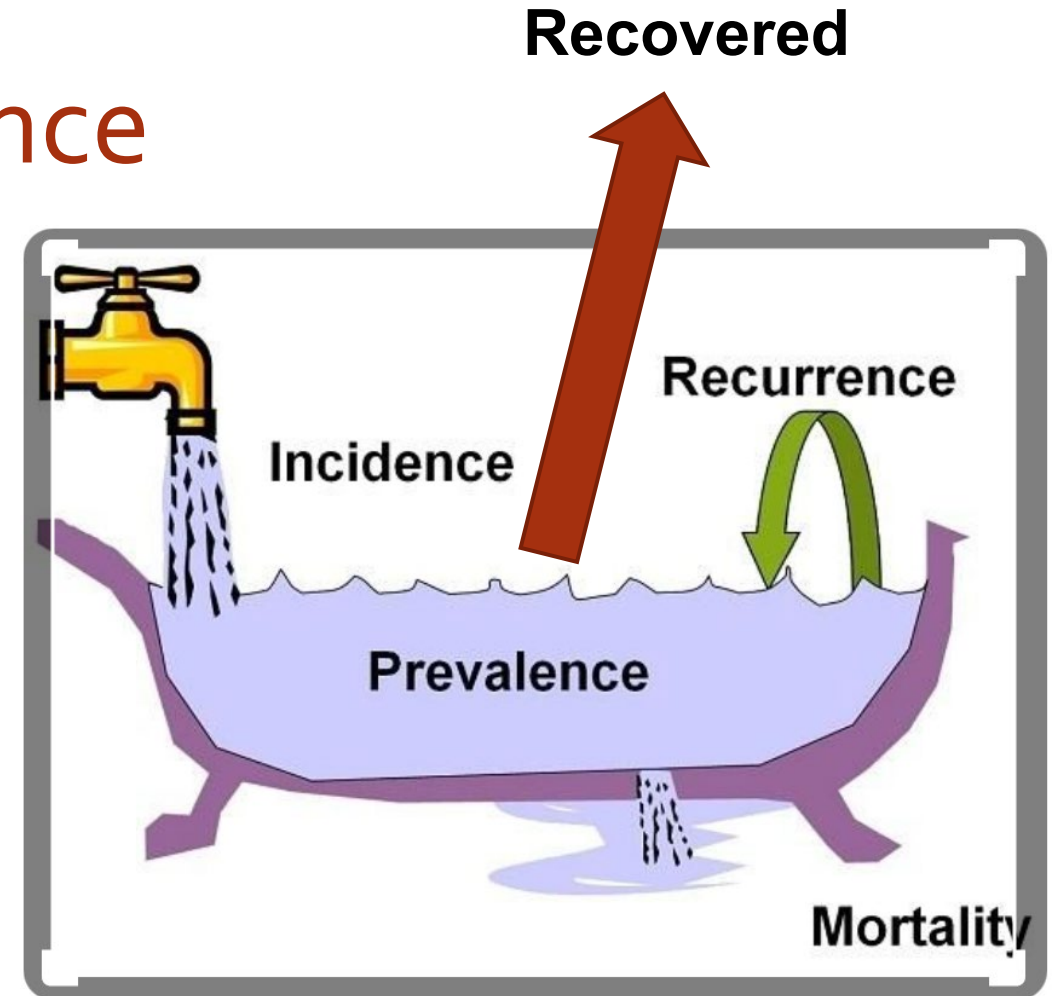
Wait, what is the story with measles?  
Don't we have a safe and effective vaccine for that?

- <https://www.youtube.com/watch?v=Z5MjKrqbLGO>



# Incidence versus prevalence

- Incidence is how many new infections are being diagnosed over a specified time period.
- Prevalence is how many people are living with a disease at one point in time, within a specified population (geographic area).
- Used to determine impact on public health and healthcare system and where to focus control efforts
  - if incidence is high and death rate is low
  - if prevalence is high and death rate is low

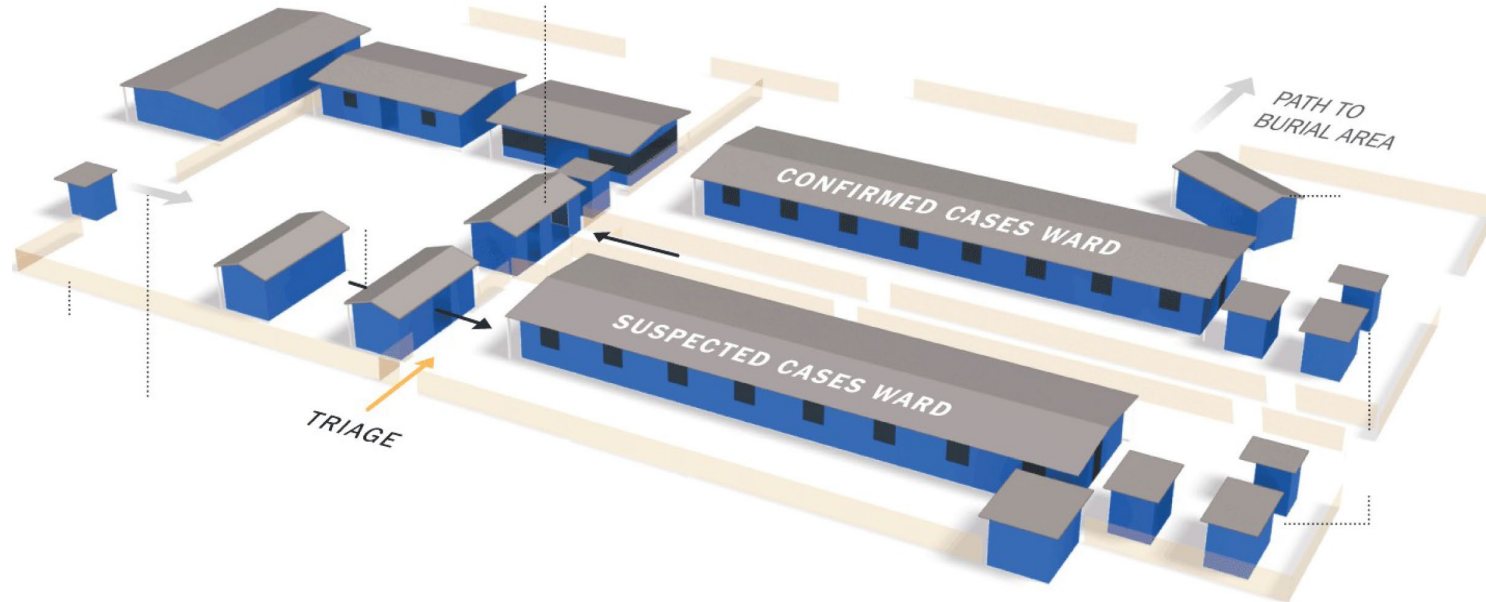


# Ebola: lessons learned from 2014-2015 epidemic in west Africa to stop the spread

- Transmission: Viral shedding when patient was symptomatic later in disease
- Diagnostics: Many common illnesses had the same symptoms as Ebola, including influenza (flu), malaria, or typhoid fever. Rapid PCR diagnostic tests to confirm diagnosis and quarantine patient.
- Contact tracing: Person-to-person transmission via blood or body fluids (urine, saliva, sweat, feces, vomit, breast milk and semen). Viral contamination on dry surfaces could last for several hours and for days after death. Engaged epidemiologists and teams of workers to find each contact and test them.
- Mortality rate unacceptable: 90% before non-pharmaceutical interventions, 50% after interventions in-place, and now ring-vaccination for contacts and healthcare workers

# Ebola Treatment Centers (ETU) - innovations

## Bong ETU

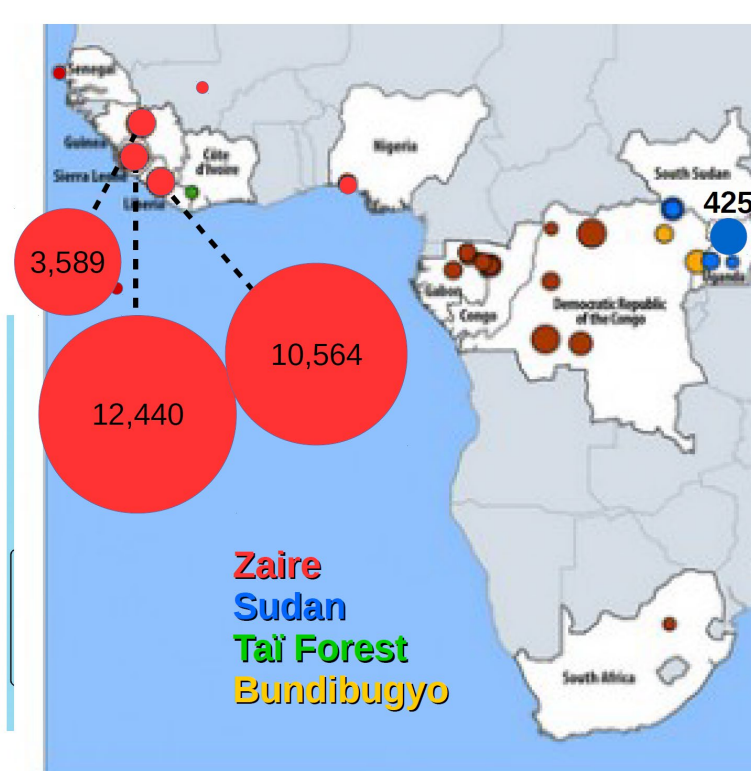


**20 doctors and nurses working with hundreds of Liberians  
at International Medical Corps (IMC) Treatment Center in Bong**

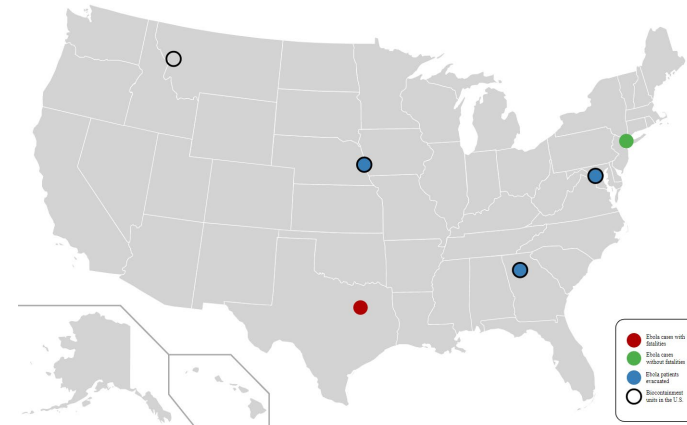
# Scope of the Ebola epidemic

- Index patient became ill on Dec 29, 2014
- Last patient was admitted to an Ebola treatment unit (ETU) on Feb 18, 2015
- The chain of transmission was stopped because of early detection of new cases; identification, monitoring, and support of contacts in acceptable settings; effective triage within the health care system; and rapid isolation of symptomatic contacts.
- People also changed their behavior (elbow bump instead of handshake) and changed burial practices.
- Hospital staff learned to don and doff PPE (personal protective equipment)

# Impact in 2014 Ebola epidemic



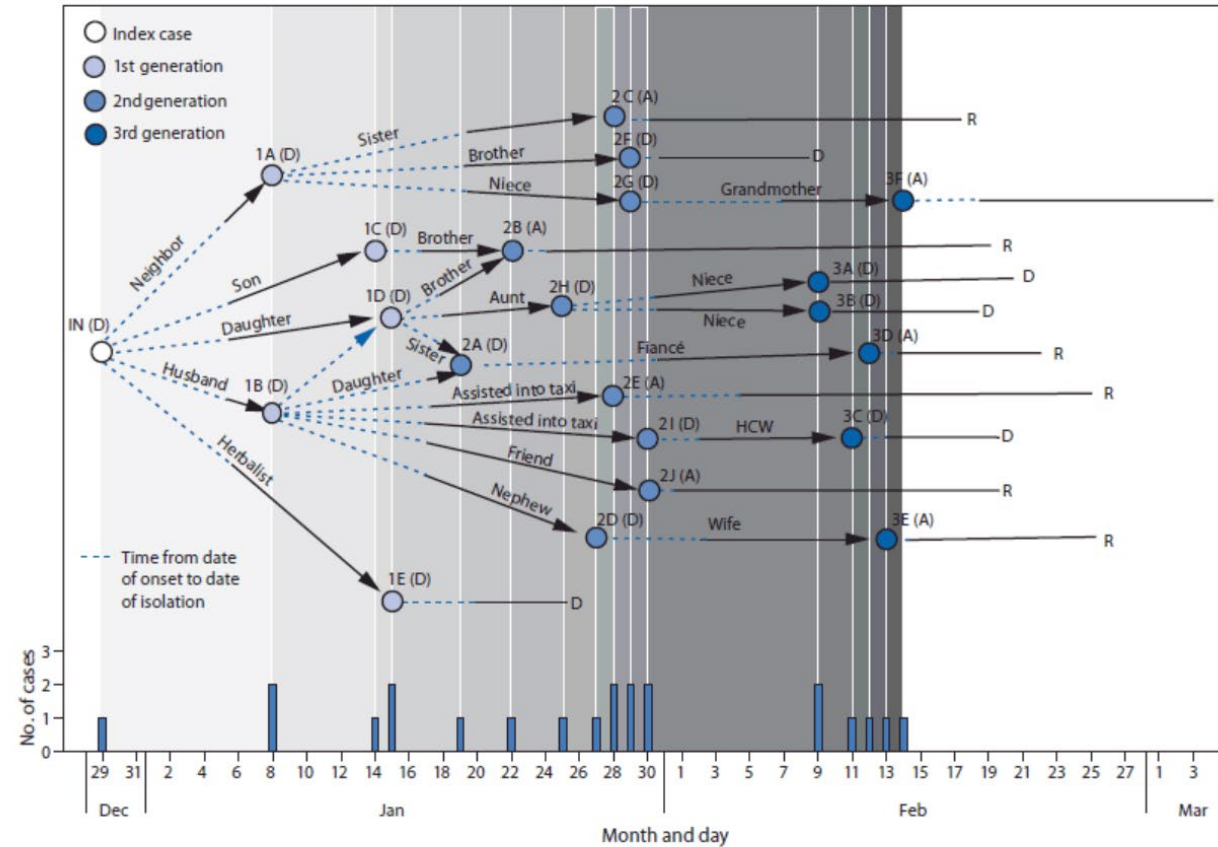
26,536 cases: 10,980 deaths



11 cases treated in USA: 2 deaths

# Controlling the Last Known Cluster of Ebola Virus Disease — Liberia, January–February 2015

FIGURE 1. Transmission diagram for the last known cluster of Ebola virus disease cases (N = 22) — Liberia, December 29, 2014–March 5, 2015\*



Abbreviations: D = dead; A = alive; R = recovered.

[https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6418a5.htm?s\\_cid=mm6418a5\\_w](https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6418a5.htm?s_cid=mm6418a5_w)

**Q7. Where is Ebola epidemic now?**

**Q8. Which human infectious disease(s) have been eradicated?**



**Q7. Where is Ebola epidemic now? ( Single Choice)**

Answer 1: Liberia

Answer 2: The Democratic Republic of Congo

Answer 3: Uganda

Answer 4: no where

**Q8. Which human infectious disease(s) have been eradicated? ( Single Choice)**

Answer 1: Small pox

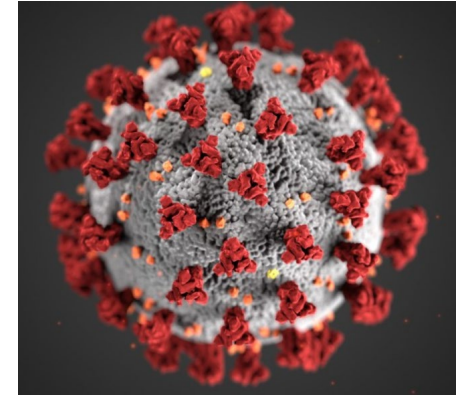
Answer 2: Poliomyelitis

Answer 3: none



Questions before I move on to last  
disease example?

# WHO declared COVID19 a Pandemic on March 11, 2020



- SARS-CoV-2 is related to corona viruses that causes SARS and MERS
- COVID19 is the disease – symptoms are high fever, dry cough, aches, fatigue, may have vomiting, nausea, diarrhea (starting sound familiar?) – loss of smell and ability to taste seem to be specific although not in everyone
- Diagnostic test is NP swab to collect virus for RT-PCR detection
- Serology diagnostics to test for IgA, IgM and IgG antibodies to viral proteins being qualified and validated in the USA
- “Non-pharmaceutical interventions” (social distancing - 6 feet/2 meters apart and small groups - home isolation, closing non-essential work places for a period of time)
- Currently no treatment, supportive care for acute respiratory distress (ARD) syndrome

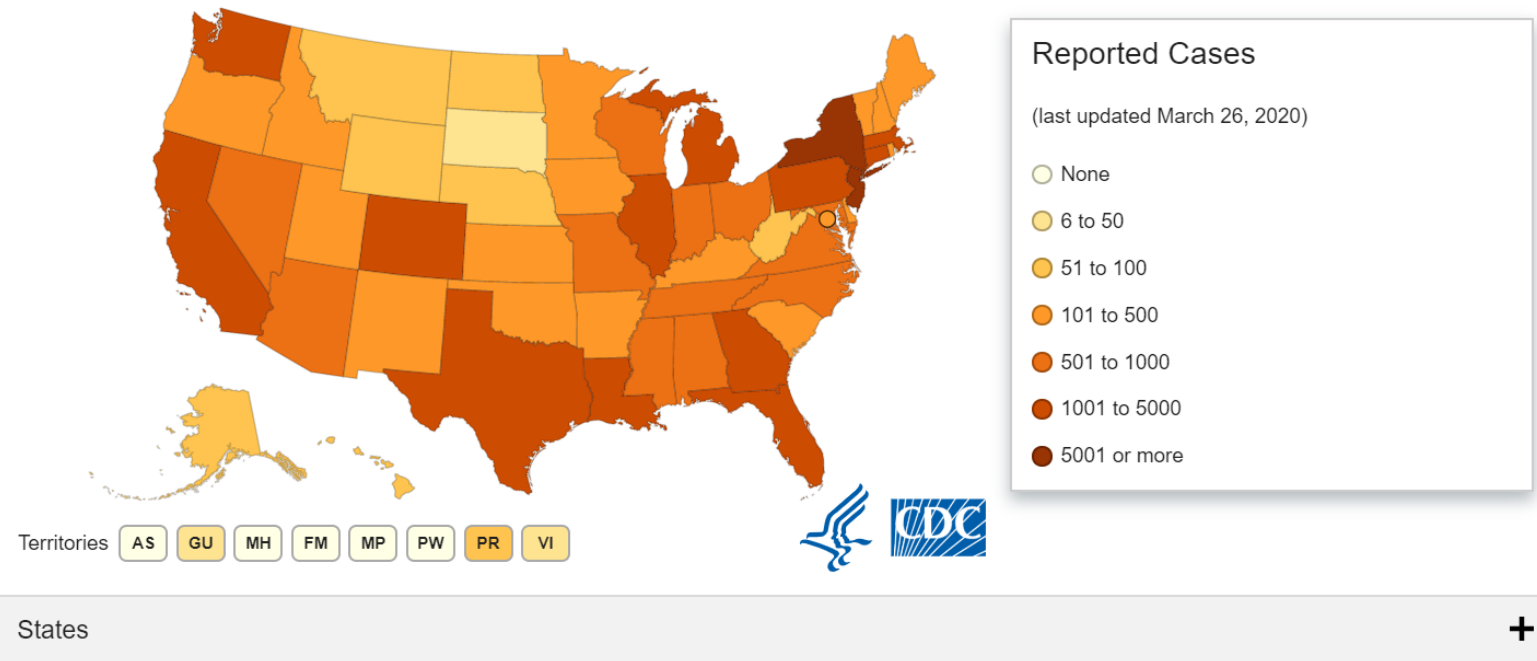
IFR = infection fatality ratio

**Table 1: Current estimates of the severity of cases. The IFR estimates from Verity et al.<sup>12</sup> have been adjusted to account for a non-uniform attack rate giving an overall IFR of 0.9% (95% credible interval 0.4%-1.4%). Hospitalisation estimates from Verity et al.<sup>12</sup> were also adjusted in this way and scaled to match expected rates in the oldest age-group (80+ years) in a GB/US context. These estimates will be updated as more data accrue.**

Age-group (years)	% symptomatic cases requiring hospitalisation	% hospitalised cases requiring critical care	Infection Fatality Ratio
0 to 9	0.1%	5.0%	0.002%
10 to 19	0.3%	5.0%	0.006%
20 to 29	1.2%	5.0%	0.03%
30 to 39	3.2%	5.0%	0.08%
40 to 49	4.9%	6.3%	0.15%
50 to 59	10.2%	12.2%	0.60%
60 to 69	16.6%	27.4%	2.2%
70 to 79	24.3%	43.2%	5.1%
80+	27.3%	70.9%	9.3%

# COVID19

## States Reporting Cases of COVID-19 to CDC\*

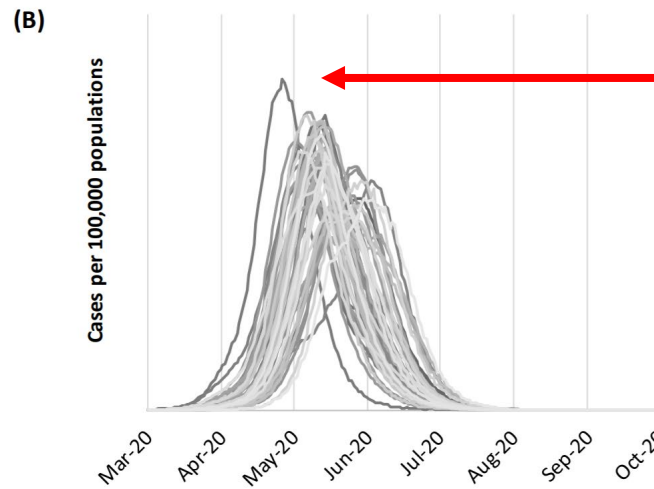
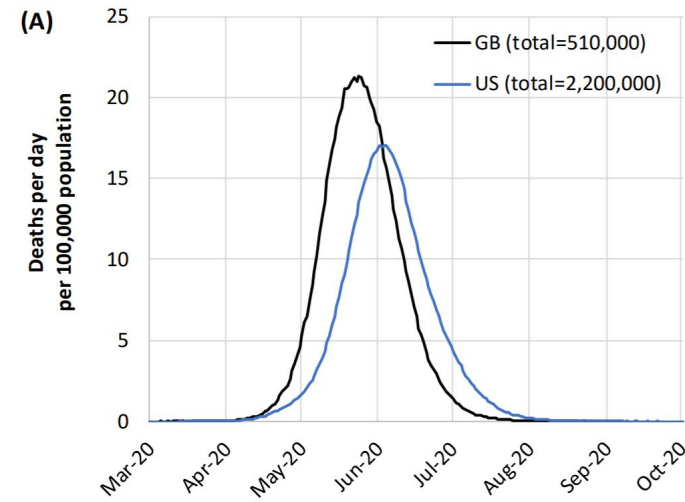


\* Data include both confirmed and presumptive positive cases of COVID-19 reported to CDC or tested at CDC since January 21, 2020, with the exception of testing results for persons repatriated to the United States from Wuhan, China and Japan. State and local public health departments are now testing and publicly reporting their cases. In the event of a discrepancy between CDC cases and cases reported by state and local public health officials, data reported by states should be considered the most up to date.

\*Self-reported by health department characterizing the level of community transmission in their jurisdiction as: "Yes, widespread" (defined as: widespread community transmission across several geographical areas); "Yes, defined area(s)" (defined as: distinct clusters of cases in a, or a few, defined geographical area(s)); "Undetermined" (defined as: 1 or more cases but not classified as "Yes" to community transmission); or "N/A" (defined as: no cases).

# Contrasting Ebola and COVID19: lessons

- For COVID19, the virus is shedding when people are NOT symptomatic !
- For COVID19, virus transmission by droplets makes it easier to transmit from person-to-person ( $R_0 \sim 3.0$ )
- For COVID19, older people have more severe disease and mortality but we don't know if young people can transmit the virus to others
- Our system is ill equipped for a respiratory pandemic – with no vaccine and no specific treatment



New York State: prediction modeled not based on confirmed cases but on how many people travel and where

Figure 1: Unmitigated epidemic scenarios for GB and the US. (A) Projected deaths per day per 100,000 population in GB and US. (B) Case epidemic trajectories across the US by state.

# Mitigation strategies “to flatten the curve”

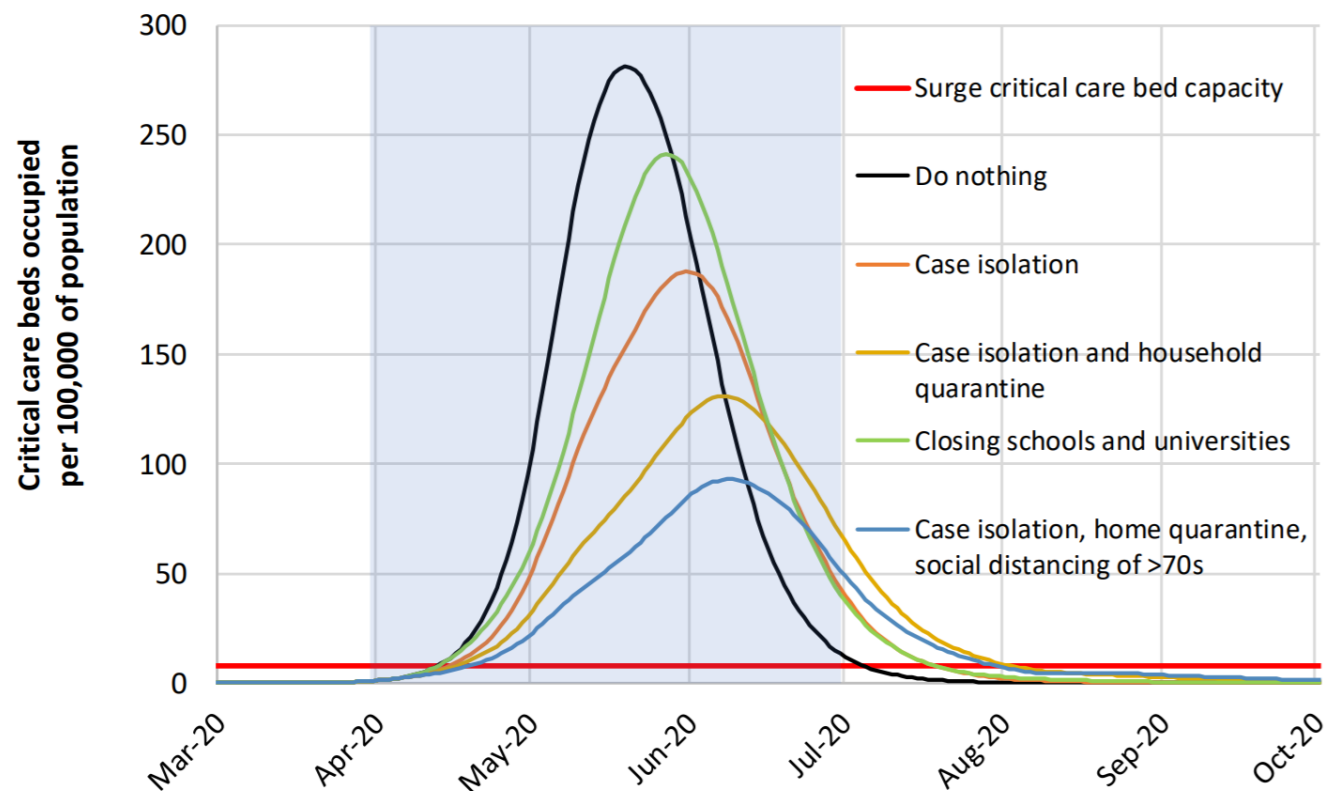


Figure 2: Mitigation strategy scenarios for GB showing critical care (ICU) bed requirements. The black line shows the unmitigated epidemic. The green line shows a mitigation strategy incorporating closure of schools and universities; orange line shows case isolation; yellow line shows case isolation and household quarantine; and the blue line shows case isolation, home quarantine and social distancing of those aged over 70. The blue shading shows the 3-month period in which these interventions are assumed to remain in place.

Suppression models – what may happen when we try to go back to 'normal'?

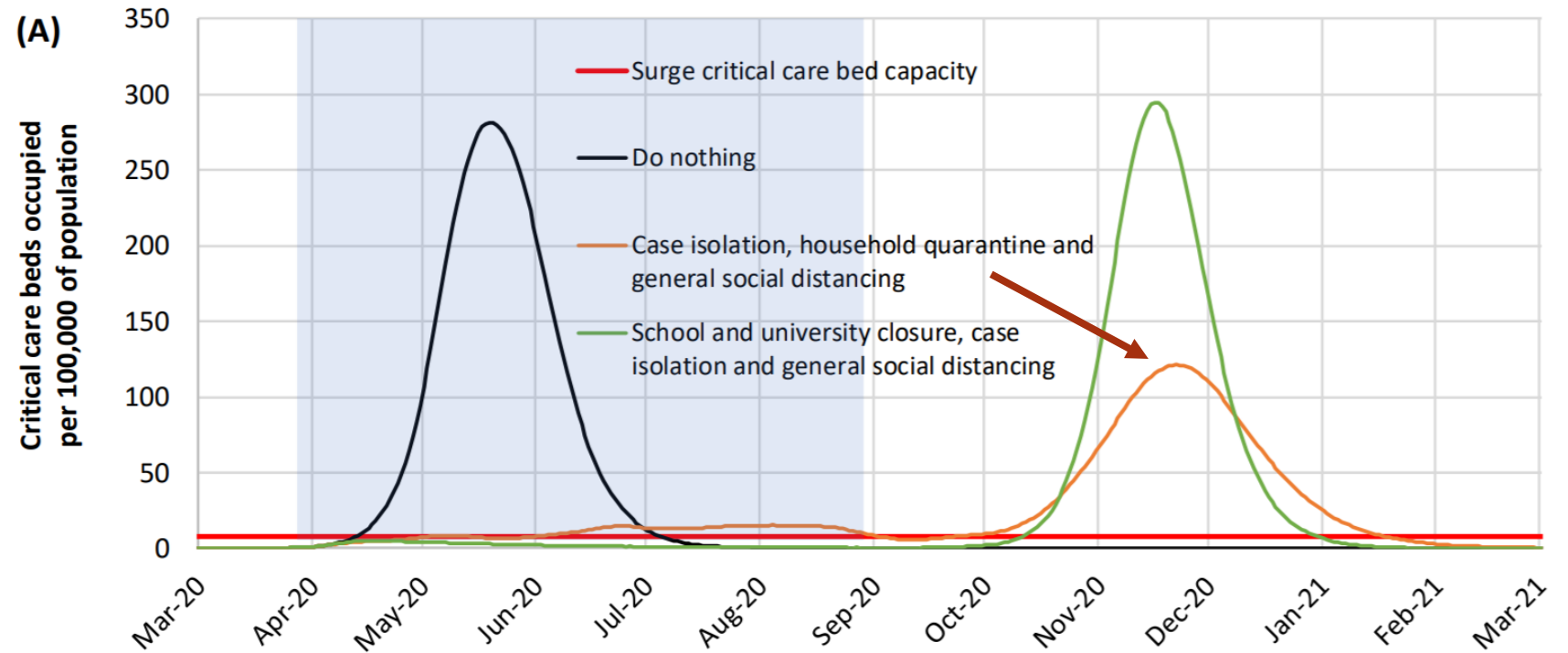


Figure 3: Suppression strategy scenarios for GB showing ICU bed requirements. The black line shows the unmitigated epidemic. Green shows a suppression strategy incorporating closure of schools and universities, case isolation and population-wide social distancing beginning in late March 2020. The orange line shows a containment strategy incorporating case isolation, household quarantine and population-wide social distancing. The red line is the estimated surge ICU bed capacity in GB. The blue shading shows the 5-month period in which these interventions are assumed to remain in place. (B) shows the same data as in panel (A) but zoomed in on the lower levels of the graph. An equivalent figure for the US is shown in the Appendix.



# Ambulatory Testing Centers @ UMass



# Drive through testing – park, ID, NP, and go



- **Q9. What are the best ways to eliminate COVID-19? (Select all that apply)**

- Answer 1: Case isolation

- Answer 2: Social distancing (small groups and 2 meter distances)

- Answer 3: Closing schools and universities

- Answer 4: Household quarantine

- Answer 5: Contact tracing

**What tools do we not have (or are not using) that would help end this pandemic?**

Raise your zoom-hand or type in the zoom-chat answer or questions

# Modeling prediction worldwide without mitigation or suppression interventions

“We estimate that in the absence of interventions, COVID-19 would have resulted in 7.0 billion infections and 40 million deaths globally this year.

Mitigation strategies focusing on shielding the elderly (60% reduction in social contacts) and slowing but not interrupting transmission (40% reduction in social contacts for wider population) *could reduce this burden by half*, saving 20 million lives, but we predict that even in this scenario, health systems in all countries will be quickly overwhelmed.

This effect is likely to be most severe in lower income settings where capacity is lowest: our mitigated scenarios lead to peak demand for critical care beds in a typical low-income setting outstripping supply by a factor of 25, in contrast to a typical high-income setting where this factor is 7. As a result, we anticipate that the true burden in low-income settings pursuing mitigation strategies could be substantially higher than reflected in our estimates. “

## Last question

**Q10. What is the best source of factual information about infectious disease control and prevention?**

A: The Centers for Disease Control and Prevention, based in Atlanta, GA USA

B: The World Health Organization (WHO) based in Geneva, Switzerland

C: Your local health officials because they know what is going on locally

D: Twitter or Facebook

E: It's best to triangulate important information,  
so I would check with 1, 2 and 3 above.

Raise your zoom-hand or type in the zoom-chat your questions

# Disclaimer

- Any opinions expressed by Dr. Moormann were her own.
- COVI19 is a continually evolving pandemic so please visit the CDC, WHO and UMMS/UMMHC websites for updated information.
- Some images were downloaded off the web and may not have been properly cited – for this I apologize.
- Figures within this presentation may be under copy right. They have been referenced and are intended for educational purposes only.
- Dr. Moormann has no conflicts of interest to declare