

Fact and Stats of Pandemics

Momin Quddus

Senior Member, IEEE

5/8/2021

This work was done as a private venture and not in the author's capacity as an employee of the Jet Propulsion Laboratory, California Institute of Technology.

Introduction

Good afternoon

- I hope you are all keeping safe
- We are living thru one of the most challenging events, the modern industrial society has faced.
- This summer we are taking a break from technical talks and presenting a lecture on pandemics.
- My name is Momin Quddus. I am a member of IEEE. I have been in the Aerospace, Wireless and Avionics industry for over 30 years.
- I am an engineer like most of you. Three things I know about engineers, which are,
 1. We like numbers
 2. We like to know the facts and
 3. We like to make up our own minds.
- I created this presentation to give you the information and analytics, so that you can make up your own minds,

Theme

- This talk is mostly informational
- If you have any interesting Stats to share, then please send the link to :

BV_MTTs@YAHOO.COM

- Recording of this presentation is here:

<https://ieeemeetings.webex.com/webappng/sites/ieeemeetings/recording/play/a7c4ebba40484991b452feed21a53ccf>

- I will put this presentation on the IEEE BV Section website :

<https://www.ieee-bv.org/facts-stats-of-pandemics/>

The first part of the lecture covers the history of Pandemics. And in the second parts I will present the facts and analytics of COVID-19 aka coronavirus



Definition –Pandemic and Epidemic

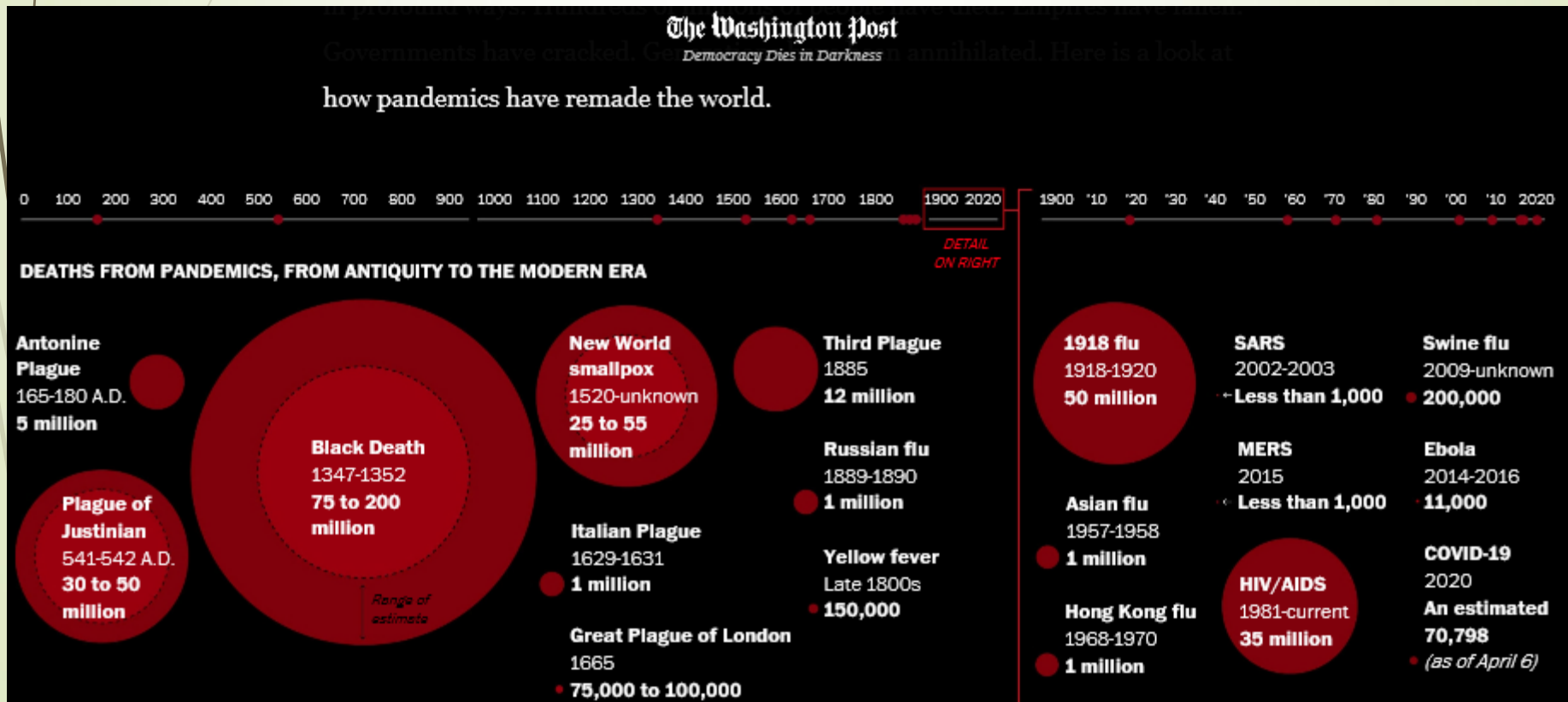
- **Pandemic** - an outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population.

Example: Spanish Flu, COVID-19 etc.

- **Epidemic** - an outbreak of disease that spreads quickly and affects many individuals at the same time.

Example : Ebola, Nipah etc.

History –Pandemic and Epidemic



Antonine Plague

- Year - 165-180 AD
- Cause : Measles and Smallpox
- Type : Viral Infection
- Casualty : 5 Million
- Historian trace the fall of the Roman Empire to this plague.
- Location : Rome





Plague of Justinian

- Year - 541-542 AD
- Cause : Bubonic Plague
- Type : Bacterium Yersinia
- Casualty : 30-50 Million
- Region: Byzantine Empire
- Spread by Rats and fleas

Black Death

- Year – 1347-1352 AD
- Cause : Bubonic Plague
- Type : Bacterium Yersinia Pestis
- Casualty : 75-200 Million
- Region : Europe
- Spread by rats and fleas
- Some historians attribute the start of the renaissance period to this event. They believe that this pandemic severely disrupted the society and from the ashes rose the new ideas of renaissance.



New World Pandemics

- Year - 1520-Mid 1900
- Cause : Smallpox, Measles
- Type : Variola Virus
- Casualty : 25-55 Million
- Region: North & South America
- Brought to the new world thru migration from Europe.
- 80-95% of the Native American Population was decimated by these diseases.


Cholera Pandemics

- Year - 1817-1923
- Cause : V. Cholera Bacteria
- Casualty : 1 Million
- Region: Worldwide
- Spread due to poor sanitation.
- Symptoms: Choleric
Dysentery

The 1918 Flu (Spanish Flu)

- Year - 1918-1920
- Cause : H1N1 Virus
- Origin : Avian / Mammalian (Likely from Bats)
- Type: Viral Infection
- Casualty : 50 Million, 500 Million infected
- Region: Worldwide
- Spread after WWI. President Woodrow Wilson got it.
- People ages 20-40 were most susceptible.
- Half the US soldiers deployed in WW I died of the flu.



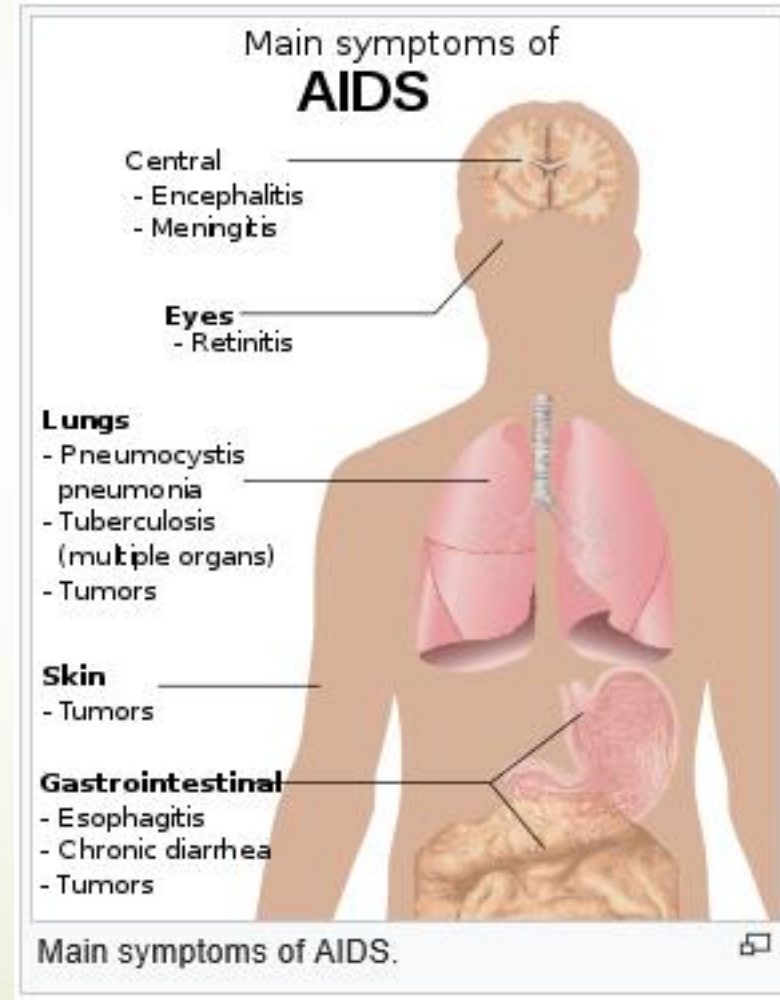


Questions : Why was the mortality rate so much higher (50%) for soldiers than that of regular populations (10%)?

Speaker Response : Population between the age of 20 and 40 were most susceptible to this flu. Majority of the soldier were in that age group. That may be part of the reason their mortality rate was higher

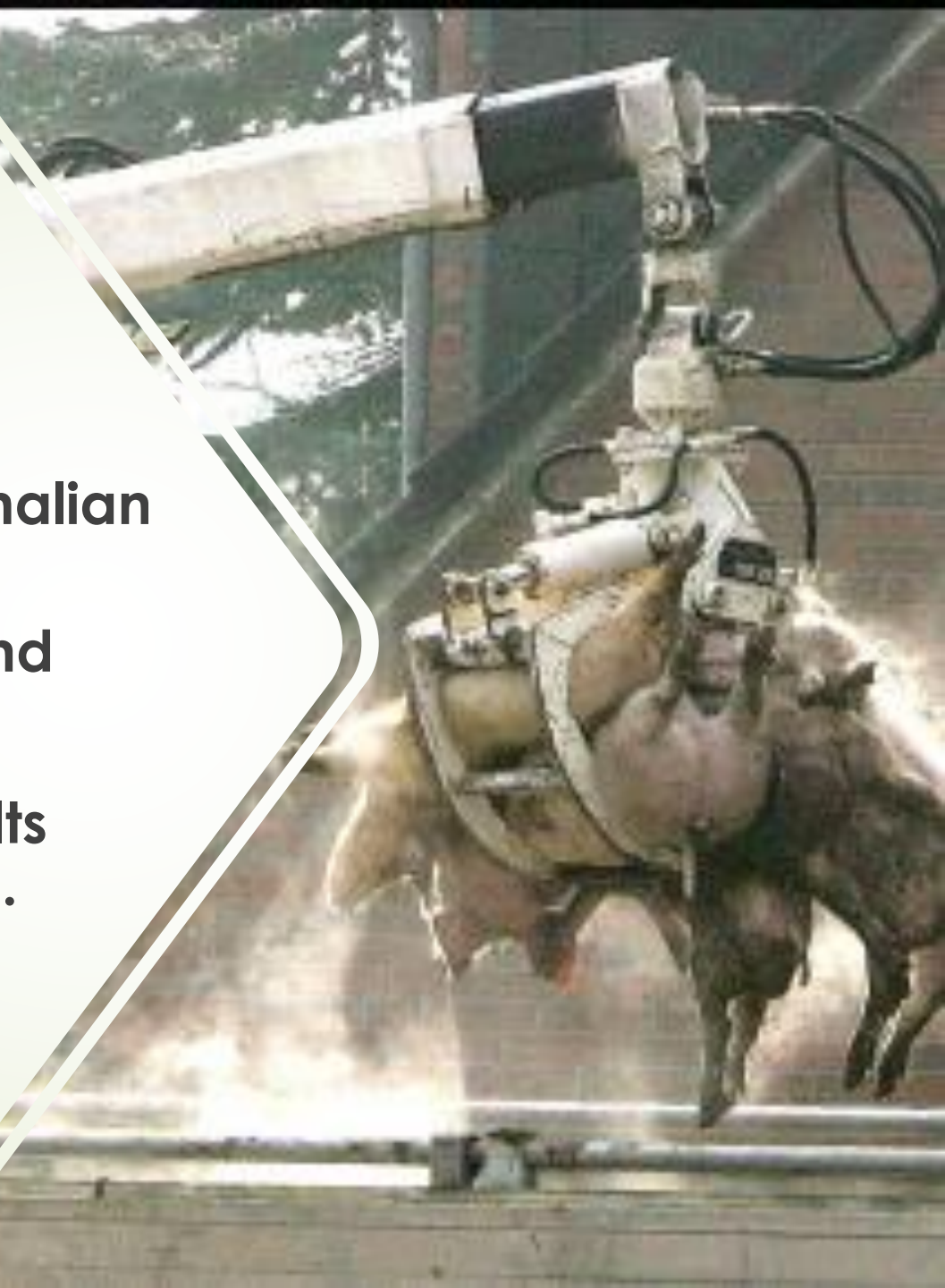
HIV/AIDS –Acquired Immune Deficiency Syndrome

- Year – 1980 - Present
- Cause : HIV- Human Immunodeficiency Virus
- Origin : Primates (Chimpanzee, Green Monkey)
- Casualty : 35 Million
- Region: Worldwide
- Spreads thru bloodily fluids (Blood, etc).



The Swine Flu

- Year - 2009
- Cause : H1N1 Virus
- Origin : Avian / Mammalian
(Came thru Pigs)
- Casualty : 200 Thousand
- Region: Worldwide
- Children & young adults
were most susceptible.
- People over 60 had
immunity

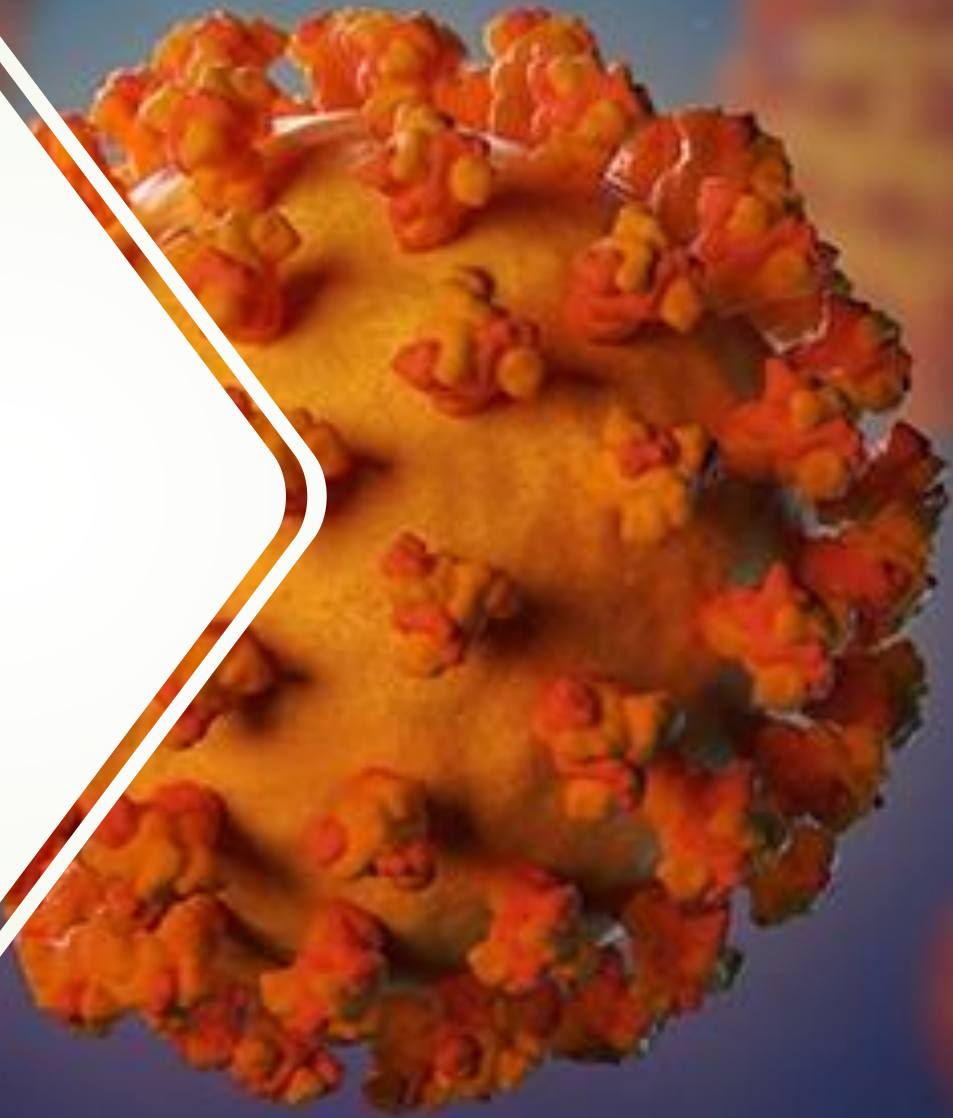




Part II- COVID-19

COVID-19 (Corona Virus)

- Year - 2019-Present
- Corona Virus Infectious Disease of 2019
- Cause : SARS-CoV-2 Virus
- Region: Worldwide
- COVID-19 first appeared in human population in the City of Wuhan in Hubei province.



Origin of SAR CoV-2

- Originated in a Wet market in City of Wuhan in Hubei province.
- SAR-CoV-2 Virus DNA is 88% similar to BAT-SL-CoVZC45 and BAT-SL-CoVZXC21
- SAR-CoV-2 Virus genome sequence has 99% match with virus found in Pangolin



Question: Wet markets have existed for thousands of years. Why did Coronavirus appear now?

Speaker Response: There are three possible reasons for this i.e

- 1. Chinese people have become wealthier so they can afford more exotic animals.**
- 2. Due to the advance in supply chain more exotic animals are flown from different parts of the world into one place. Whereas naturally they would not have come in contact with each other due to geographic separation of their natural habitats.**
- 3. Centuries ago when a virus appeared in human population, it would not spread much and die out with the patients. Now in a global economy infected people can spread a new virus across the world within days.**

Transmission to Humans

➔ **BATs** ➔ **Pangolin** ➔ **Humans**





Question: I heard that the virus came from the bats to snakes and then to humans?

Speaker Response: Well there is no conclusive evidence that the virus may have come thru snake.

It may be possible however it is unlikely since snake is a cold-blooded reptile.

The virus that come into the humanity come thru carnivorous mammals most of the time. Since the anatomy of the carnivorous mammals are closest to humans.

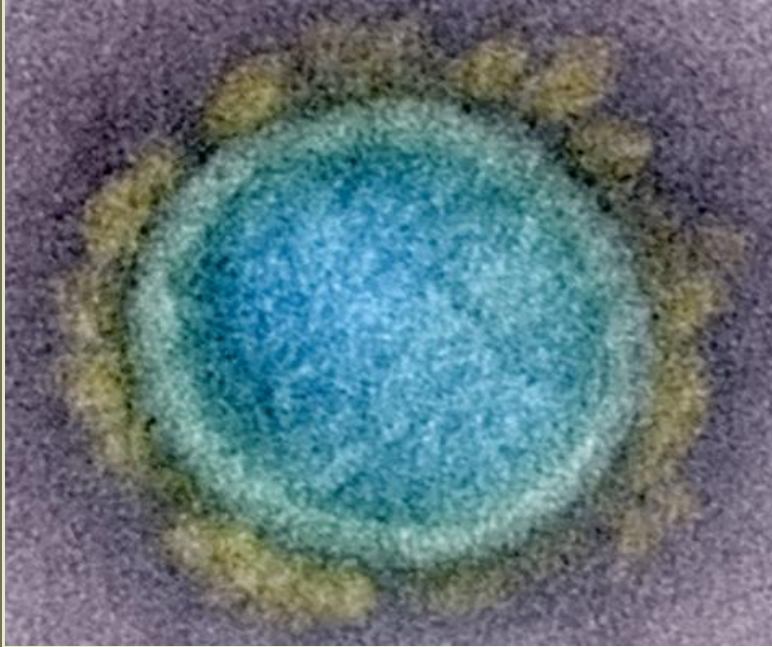
Other Viruses from BATs

- SARS – Severe Acute Respiratory Syndrome
- EBOLA
- Rabies
- SARS-CoV
- Nipah
- Bats carry ~1700 other viruses

Why BATs

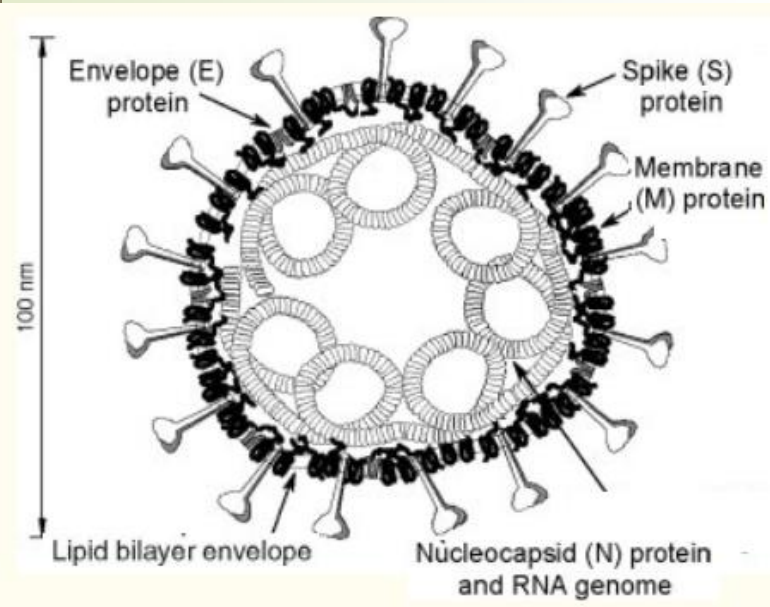
- Bats are few remaining flying mammals since the dinosaur era.
- Flying is an extraneous activity which weakens its immune system. So over millions of years Bats internal system has learned to live with the viruses
- Diet- Bats feed on animal blood and mosquitos. So they collect viruses thru their diet.
- Bats are virus reservoirs
- 1/3 of all mammals are Bats

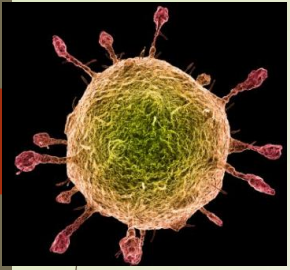




SARS-CoV-2 or Corona Virus

- Severe **A**cute **R**espiratory **S**yndrome-**C**orona **V**irus-2
- Anatomy: Made of a strand of RNA wrapped in Membrane(M) protein, Envelop Protein(E) and Lipid Bilayer envelop.
- Envelop has tentacles made of Spike Proteins.
- Spike proteins have the capability to attach themselves to upper respiratory membrane cells (Mucus) and lower respiratory membrane cells in the lungs .
- Tentacles make it look like a crown thus the name '**CORONAVIRUS**'

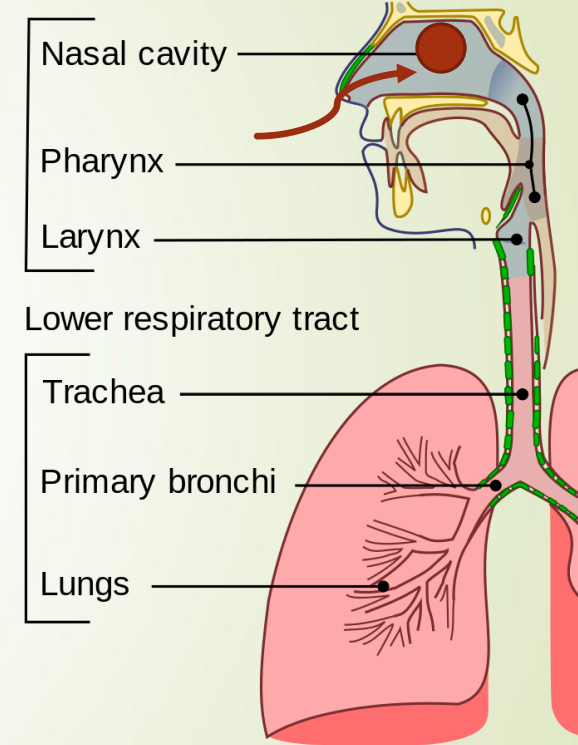


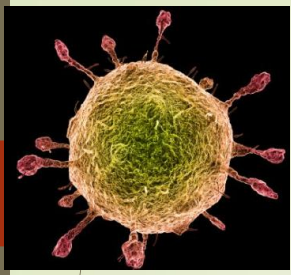


SAR-CoV-2: How does it affect Humans

- SARS-CoV-2 virus can infect upper and lower respiratory system.
- It passes from an infected person to a new host thru nasal or cough droplets.
- It enters the hosts nasal cavity and attaches to the mucus membrane.
- The virus incubates and multiplies in the nasal cavity for 2-14 days.
- During this period the host experiences cough, sore throat and sniffles.

Upper respiratory tract





SAR-CoV-2: How does it affect Humans

- During this period the host is highly contagious and can infect others.
- After the incubation period SAR-CoV-2 virus drops (or is inhaled) into the lungs (lower respiratory system) .
- It makes it way to the air sacs or alveoli.
- It attaches to the membrane in the air sacs and inflames the alveola.
- During this time patient may suffer from difficulty of breathing , fever, pneumonia, secondary infection, etc.

Upper respiratory tract

Nasal cavity

Pharynx

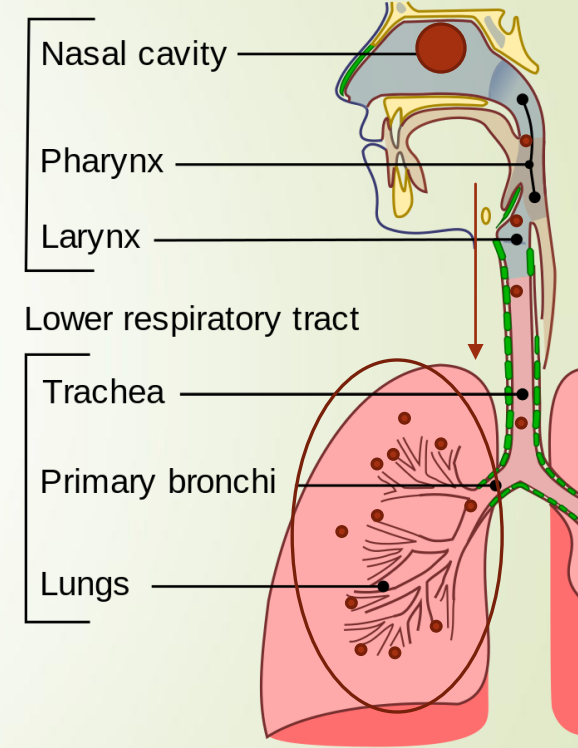
Larynx

Lower respiratory tract

Trachea

Primary bronchi

Lungs





Question: I heard that the virus artificially created in a lab (Wuhan Lab, China). Is there any truth to it?

Speaker Response: There is no conclusive evidence that SARCoV-2 was created in a lab. I did see a story in news media that the viral lab in question was in the practice of acquiring animals from the wet market and returning them to the market for sale when they were done with them. There is an article in the web written by a Chinese scientist who worked there, where he/she states that this practice was dangerous and should stop.

Also this virus is too perfect a pathogen to be natural. Few characteristics of this virus makes you think that it was artificially created i.e

1. This virus does not mutate as often as natural viruses do. Natural viruses mutate thousands of times, and eventually the benign ones survive, and dangerous ones die off with their host.
2. This virus can infect upper and lower respiratory system whereas most flu viruses either infect upper respiratory or the lower respiratory system.
3. SARCoV-2 has a long (2-14) incubation period in the host. So the dangerous strands can spread before they kill their host and perish with them.
4. This virus can survive and spread in warm weather whereas most flu viruses can only survive colder temperatures.

How does COVID-19 compare with Common Cold (Flu)

- Mostly Common cold viruses infect the upper respiratory System
- SAR-Cov-2 virus can infect upper and lower respiratory system
- Both Flu and SAR-CoV-2 virus spread thru nasal and cough discharge
- Mortality rate for Flu is $<0.1\%$ and mortality rate for COVID-19 is 3-4%
- Since the beginning of this flu season ~26000 people have died from Flu in US.
- Since January 2020 >140000 people have died from COVID-19 in US.

Mortality Rate of COVID-19 by age (if Infected by SAR-CoV-2)


- >85 years : 10-27%
 - 65-84 years : 3-11%
 - 55-64 years : 1-3%
 - 20-54 years - <1%
 - <19 years - <0.1%
-
- ~88% of people who are infected show little to no symptoms
 - ~50% of the SAR-CoV-2 virus (Strands/Mutations) may be benign.

COVID-19 casualty distribution by age in US

- >85 years - ~33%
 - 75-84 years - ~27%
 - 65-74 years - ~20%
 - 55-64 years - ~12%
 - 45-54 years - ~5%
 - 35-44 years - ~2%
 - 25-34 years - ~0.7%
 - <24 years - <0.3 %
-
- >~80% of the total casualties are >65 years of age
 - >~92% of the total casualties are >55 years of age

US Population distribution by age

- >65 years - ~16%
 - 55-64 years - ~13%
 - 35-54 years - ~26%
 - <35 years - ~45 %
-
- ~80% of the total casualties are from 16% of population (>65 years of age)
 - ~20% of the total casualties are from 84% of population (<65 years of age)
 - 88% of the total casualties had underlying conditions (Heart disease, Asthma, Diabetes, Obesity, cancer etc.)



Question: Is here any stat that shows the percentage of the US population who have one or more underlying health conditions (Heart disease, Asthma, Diabetes, Obesity, cancer etc.) (distinct count)? If not, could you guess?

Speaker Response: Statistics for distribution of these diseases are available for past years. Here are stats for 2018,

Among US population,

10.5% of the people have Diabetes

9 % have heart disease

5.5%. Have been diagnosed with cancer.

Number of deaths by leading causes in US per year

- Heart disease: 647,457
- Cancer: 599,108
- COVID-19 : >300,000 (in 2020)
- Accidents (unintentional injuries): 169,936
- Chronic lower respiratory diseases: 160,201
- Stroke (cerebrovascular diseases): 146,383
- Alzheimer's disease: 121,404
- Diabetes: 83,564
- Influenza and Pneumonia: 55,672
- Nephritis, nephrotic synd. and nephrosis: 50,633
- Intentional self-harm (suicide): 47,173
- Total: 2,813,503

Testing for SAR-CoV-2

United States Laboratory Testing

TOTAL TESTS
REPORTED

253,605,932

National totals as of: Jan 06 2021

TOTAL POSITIVE TESTS

22,568,883

TOTAL % POSITIVE

8.9%

CDC | Updated: Jan 8 2021 6:19PM



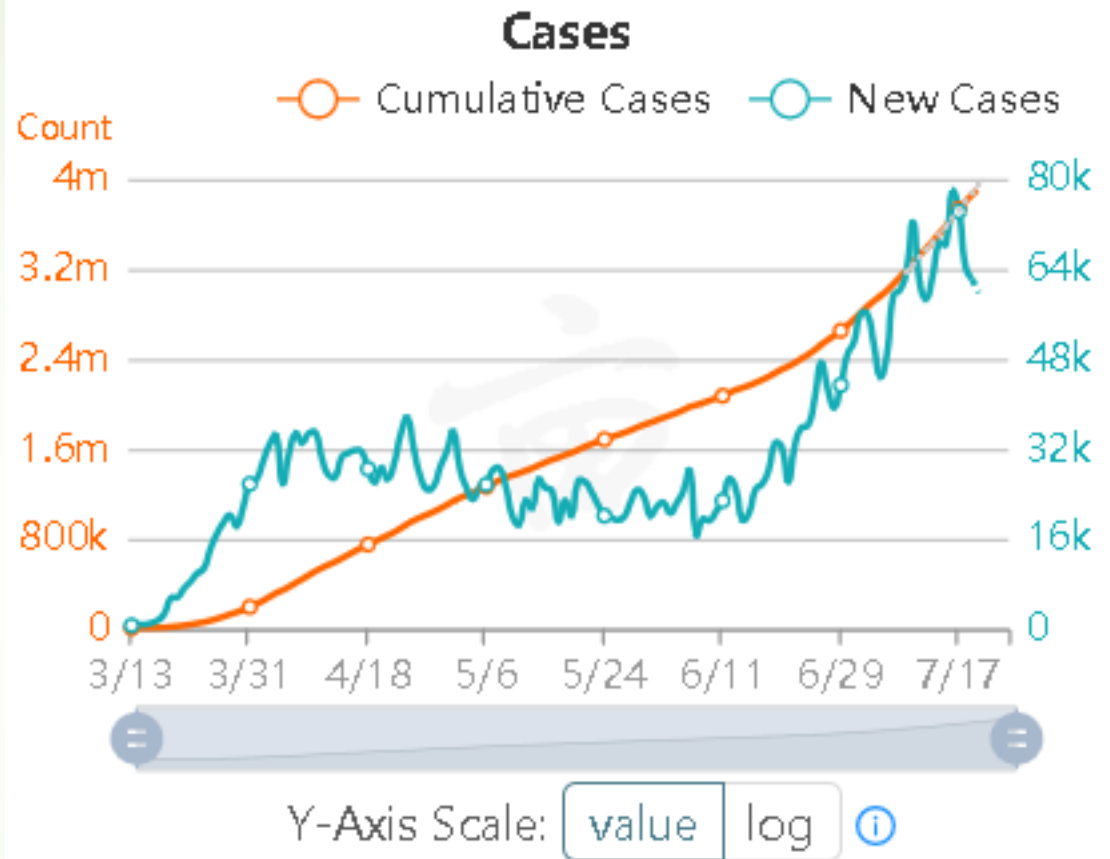
Question: How are the active cases book kept?

Speaker Response :

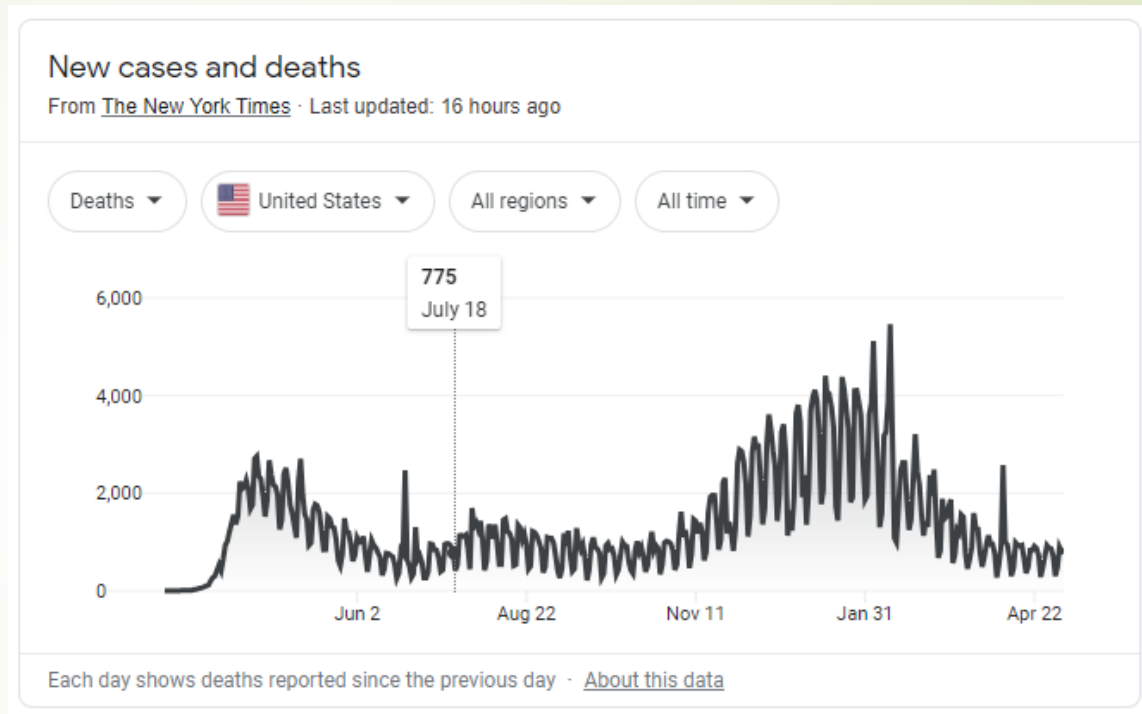
Active cases= Previous Days active Cases + New cases – deaths – recovered.


Using this formula on 7/24/20 Active cases should be 4166127. However reported on the website is 4201109.

Cumulative and new cases of COVID-19



Casualties of COVID-19

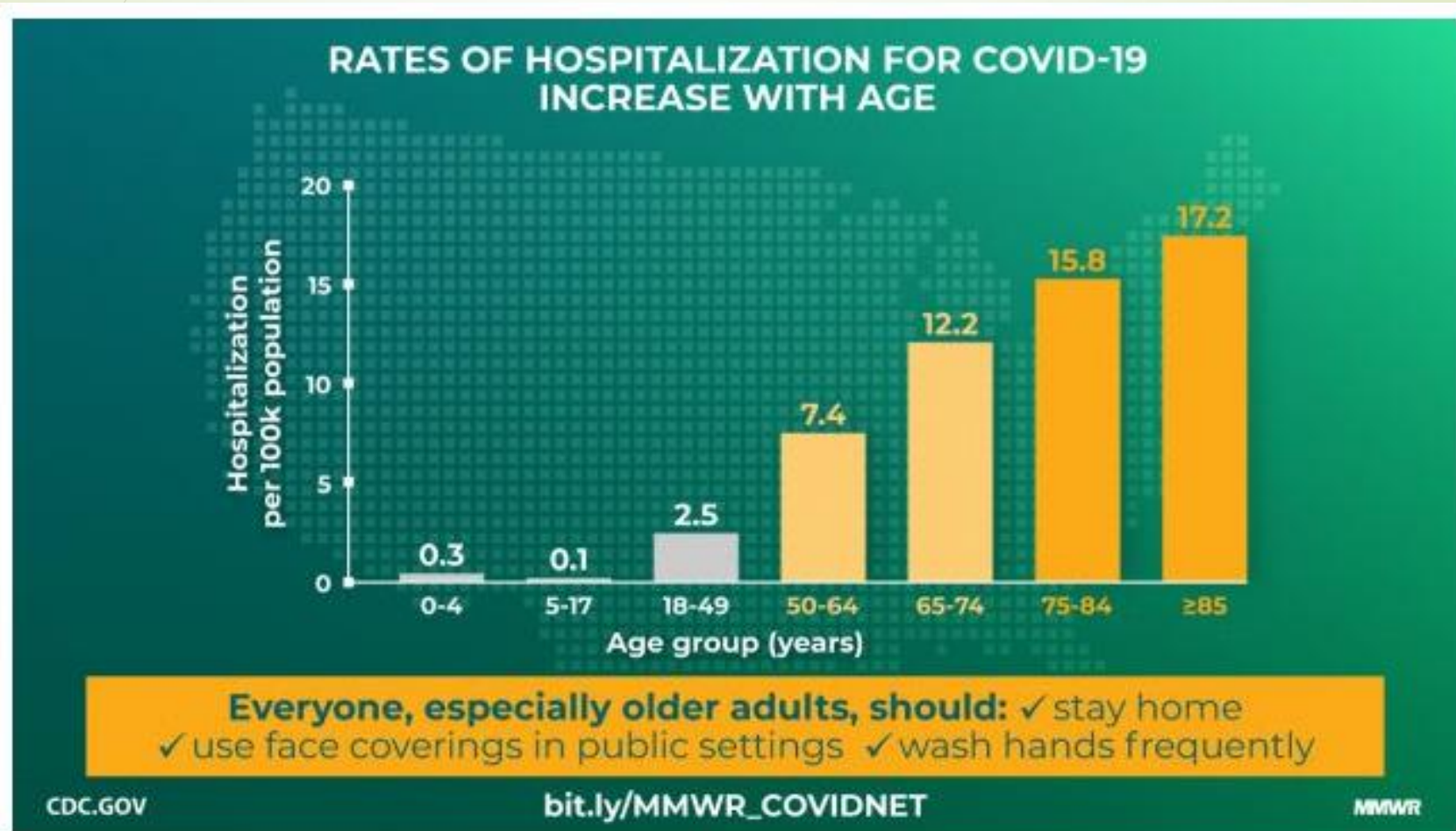




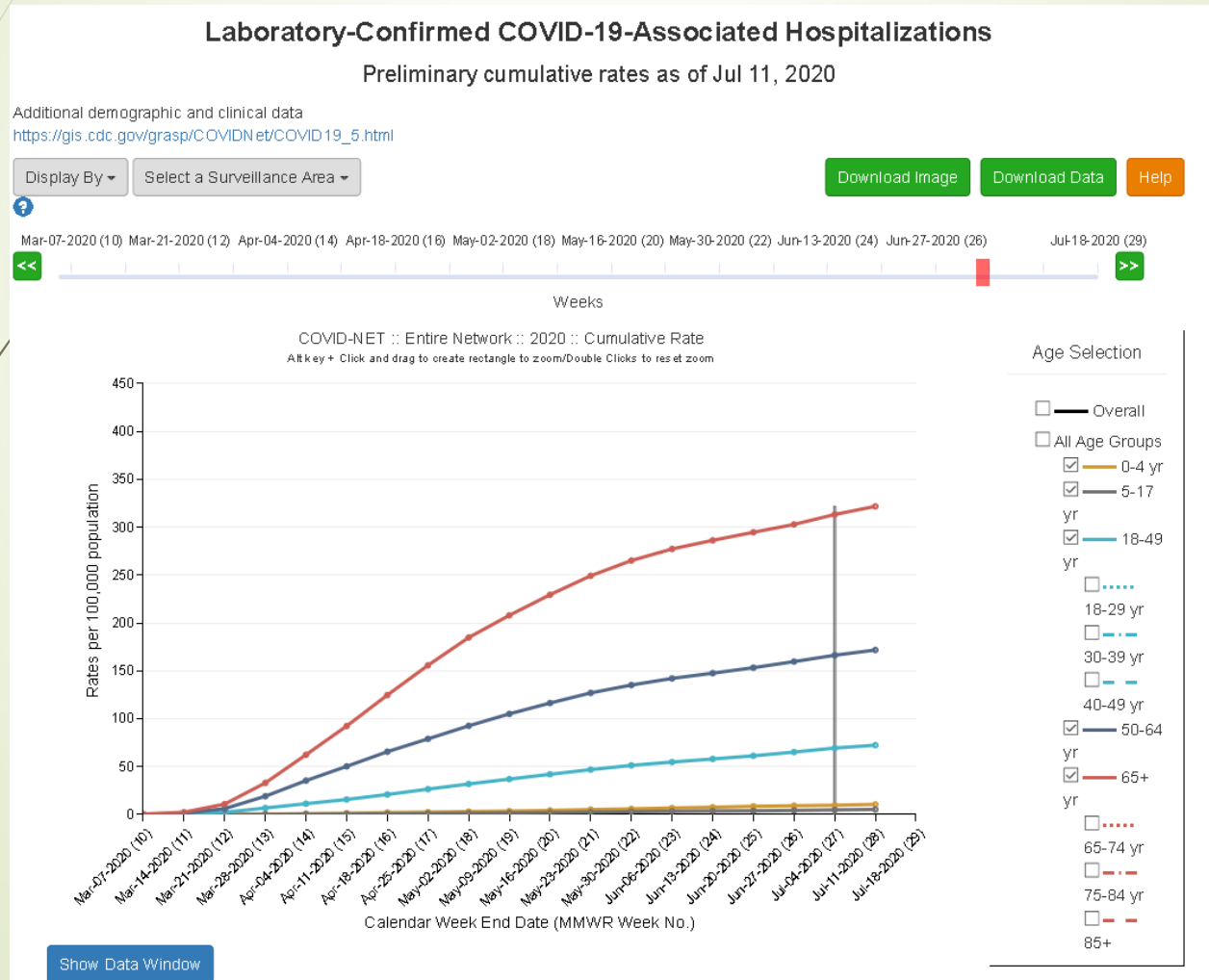
Question : Why have the mortality rate gone down from March/April peak and stabilized, even though the infection numbers have steadily gone up.

Speaker Response : Most likely reason is early during the pandemic most vulnerable population (>65 years old, Senior Homes, hospices etc) were infected. Thus the casualty rates were higher. As time has passed people have been informed about dangers and precautions. Most of the newer infections are among younger people who are mostly immune to the disease.

Hospitalization rate by age due to COVID-19



Hospitalization rate by age over time due to COVID-19





Question : Why has the infection rate not gone down due to warmer temperatures.

Speaker Response : When a flu virus is out of a host it is in a dormant state. It needs a cool temperature ($<90^{\circ}$ F) in a mucus membrane of a new host to survive and multiply. In cold weather a human host breaths in cold air, which brings the temperature of his/her mucus membrane below 90° F. This allows a flu virus to survive and multiply in the mucus membrane. In warm weather the host inhales warmer air. So his/her mucus membrane is at temperature $>90^{\circ}$ F. The virus cannot survive and thrive at these elevated temperature, thus it dies out and infection stops.

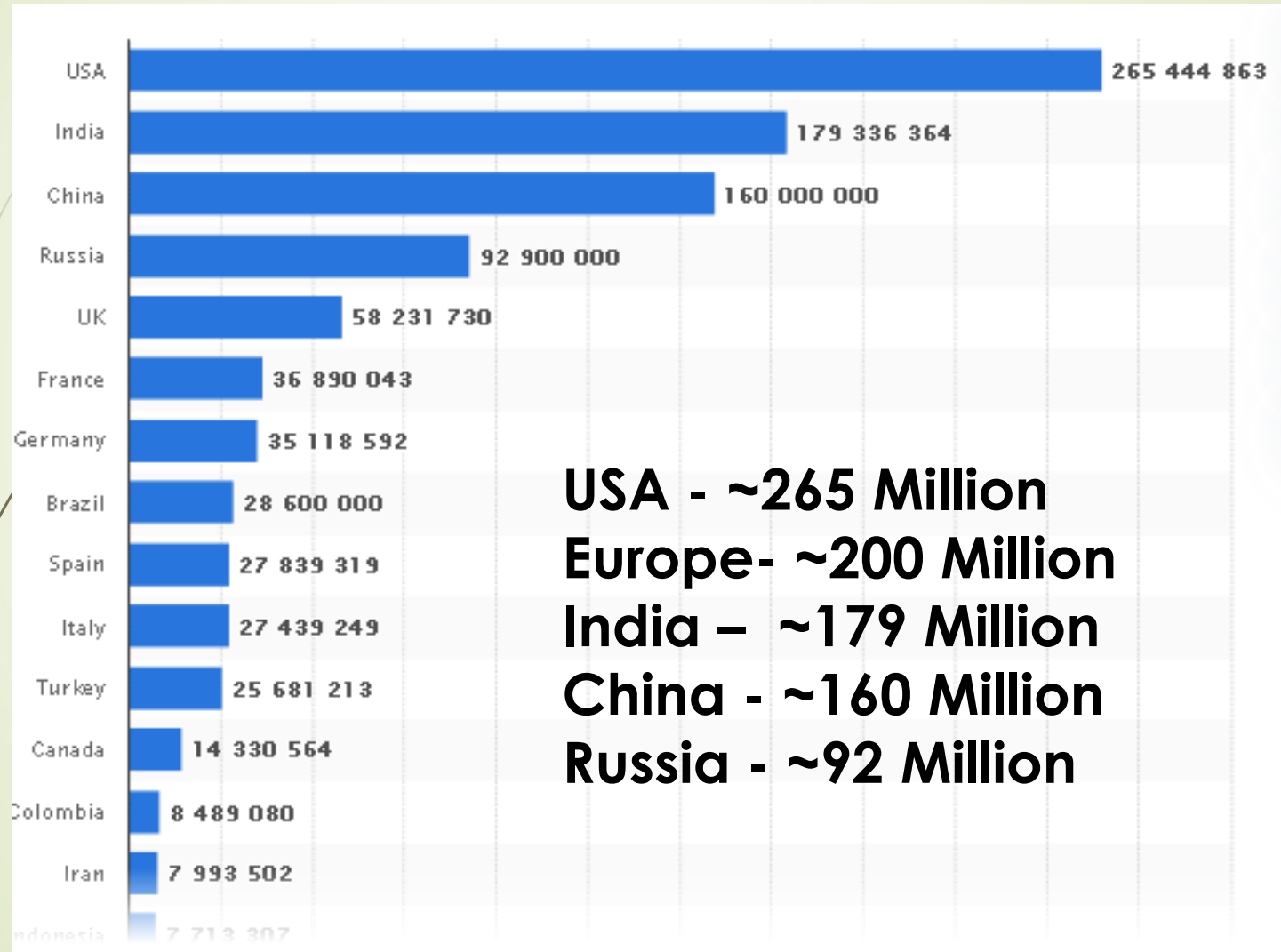
What makes coronavirus so dangerous is that it seems to be surviving and propagating in warmer temperatures.

Probability of Hospitalization due to COVID-19 by age (If Infected)

- <35 years : 1%
- 35-74 years : 8%
- >75 years : 19%

- 0-17 years : Hospitalization is less than regular influenza
- 18-64 years: Hospitalization is higher than regular influenza
- >64 years: Hospitalization is higher than regular cold .

How is USA doing in terms of COVID-19 Testing



USA - ~265 Million
Europe- ~200 Million
India - ~179 Million
China - ~160 Million
Russia - ~92 Million

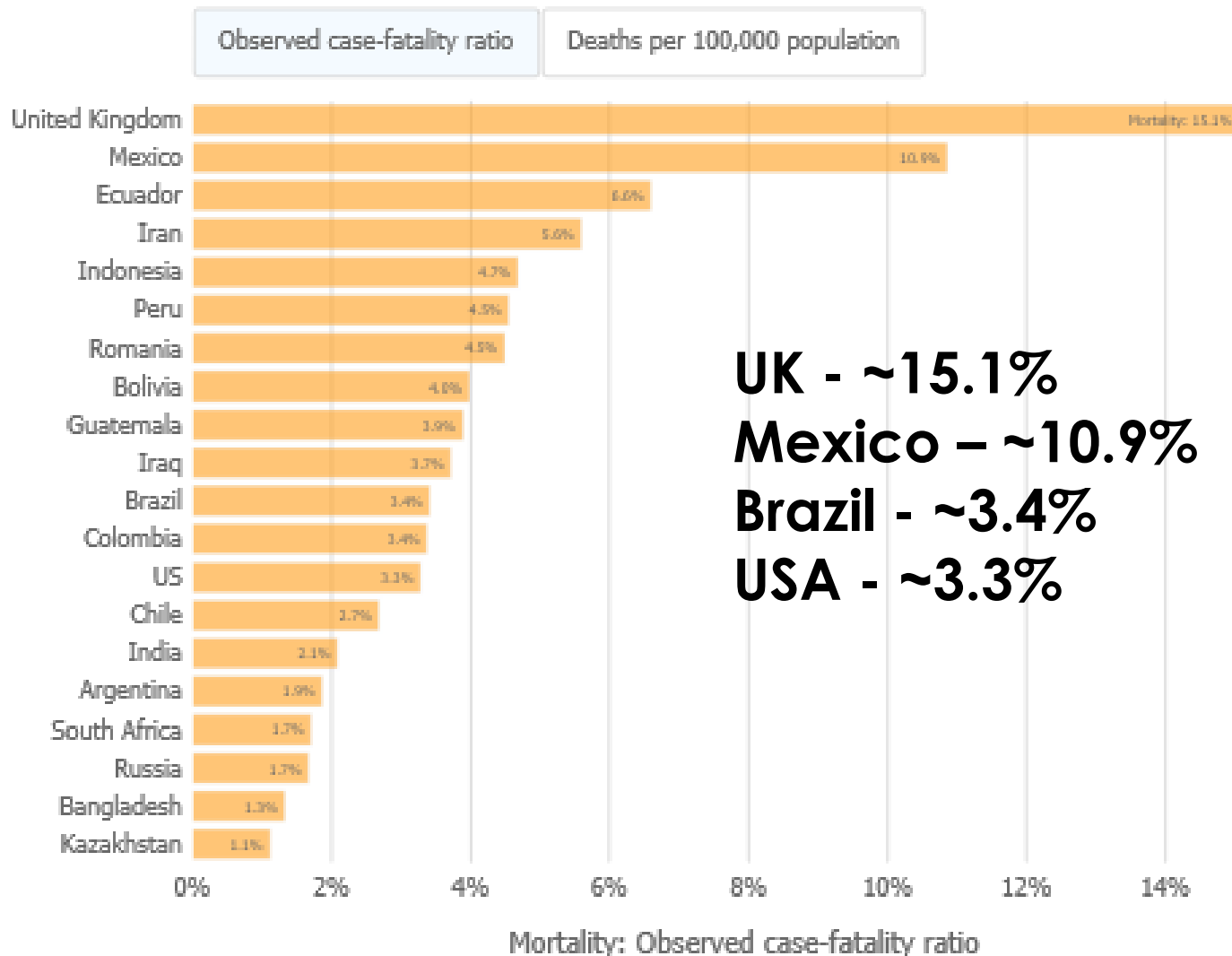
How is US doing in terms of COVID-19 Casualty

Country	Cases	Deaths	Region
United States	22,456,902	378,149	North America
India	10,432,526	150,835	Asia
Brazil	8,015,920	201,542	South America
Russia	3,355,794	60,911	Europe
United Kingdom	2,957,472	79,833	Europe
France	2,747,135	67,431	Europe
Turkey	2,307,581	22,450	Asia
Italy	2,237,890	77,911	Europe
Spain	2,050,360	51,874	Europe
Germany	1,895,139	40,401	Europe
Colombia	1,755,568	45,431	South America
Argentina	1,703,352	44,273	South America
Mexico	1,507,931	132,069	North America

Europe - ~500k
USA - ~378 K
Brazil - ~201k
India - ~150k
Mexico - ~132k

How is US doing in terms of COVID-19

Death rate/100k





Question : Why is mortality rate due to COVID-19, lower in third world countries compared to developed western countries?

Speaker Response : There are two possible reasons the mortality rate due to COVID -19 is lower in third world countries, i.e,

1. Western countries have an advanced healthcare system with access to modern medication. The health care system has successfully managed diseases like heart disease, diabetes, cancer, asthma and other co-morbid conditions. Thus the segment of population with these conditions have been living normal lives. COVID-19 has been deadly to this segment of population. Whereas people with these diseases in third world countries succumb to those diseases.

Speaker Response : (Continued).

2. To understand the second reason we have to look at the history of Polio. Polio was around since the 1800. Polio spreads thru particles of fecal matter. In those days sanitary system was not developed. People were exposed to polio virus during their childhood and developed immunity. Thus polio did not spread in those days due to herd immunity. In the early 1900 modern sanitation systems were developed. Disinfectants and cleaning products were invented. People were not exposed to virus anymore. So over a couple of generation the herd immunity dissipated. So towards the end of WW II, when the soldier brought polio into the country it was devastating to the population.

In third world countries the sanitation and water quality is not very good. Thus people are exposed to many viruses including variants of SARS virus over their lifetime. So the population has developed herd immunity.

IMMUNITY

Scientists may now have an answer to one of the most crucial lingering questions about COVID-19: whether people develop long-term immunity. Early research suggested that coronavirus antibodies — blood proteins that protect the body from subsequent infections — could fade within months. But in their concern about those findings' implications, many people failed to consider our immune system's multilayered defense against invading pathogens.

Specifically, they discounted the role of white blood cells, which have impressive powers of recollection that can help your body mount another attack against the coronavirus should it ever return. Memory T cells are an especially key type, since they identify and destroy infected cells and inform B cells about how to craft new virus-targeting antibodies.

A study published Friday in the journal *Cell* suggests that everyone who gets COVID-19 — even people with mild or asymptomatic cases — develops T cells that can hunt down the coronavirus if they get exposed again later. "Memory T cells will likely prove critical for long-term immune protection against COVID-19," the study authors wrote, adding that they "may prevent recurrent episodes of severe COVID-19."

That's because memory T cells can stick around for years, while antibody levels drop following an infection.



Virus Vs Bacteria

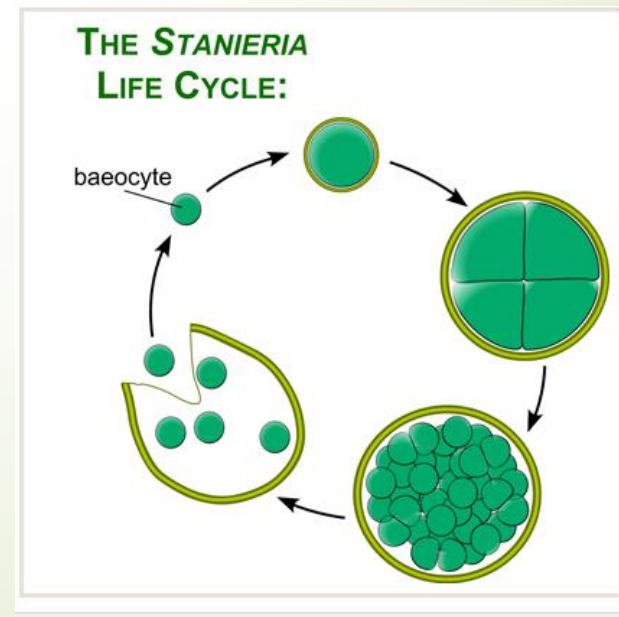
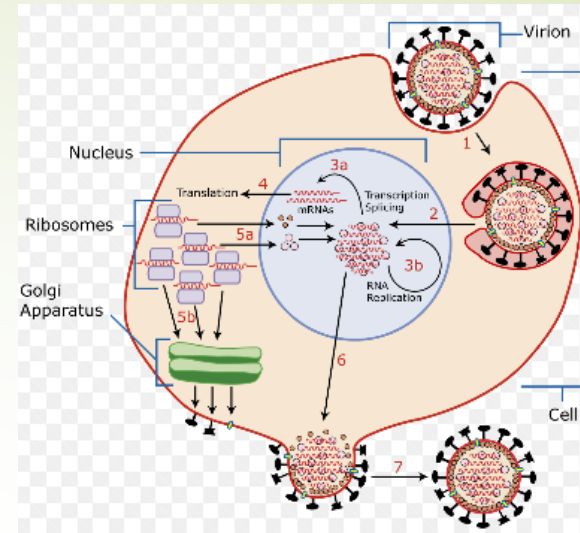
Virus is not living organism, Bacteria is living organism

Virus cannot reproduce , Bacteria can reproduce itself.

Virus is 0.02-0.25 micron, Bacteria is 0.4 micron in size.

Virus cannot live on its own. It must live inside a host. Bacteria can survive on its own.

Reproduction Virus Vs Bacteria



References

- <https://www.washingtonpost.com/graphics/2020/local/retropolis/coronavirus-deadliest-pandemics/>
- <https://www.webmd.com/lung/what-does-covid-do-to-your-lungs#1>
- <https://www.google.com/amp/s/www.livescience.com/amp/new-coronavirus-compare-with-flu.html>
- <https://coronavirus.1point3acres.com/en>
- <https://data.cdc.gov/NCHS/Provisional-COVID-19-Death-Counts-by-Sex-Age-and-S/9bhg-hcku>
- <https://www.kff.org/other/state-indicator/distribution-by-age/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D>
- <https://www.cdc.gov/nchs/fastats/deaths.htm>
- <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/testing-in-us.html>

References

- <https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e3.htm>
- <https://medicalxpress.com/news/2020-03-odds-hospitalization-death-covid-steadily.html>
- <https://arxiv.org/pdf/2007.11988.pdf>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7112330/#sec0011title>
- <https://www.statista.com/statistics/1028731/covid19-tests-select-countries-worldwide/>
- <https://www.worldometers.info/coronavirus/countries-where-coronavirus-has-spread/>
- <https://coronavirus.jhu.edu/data/mortality>
- <https://www.yahoo.com/news/now-best-evidence-yet-everyone-195200113.html>

Thanks for listening
I hope this information
was usefull



The End

Please be safe and
take care of yourselves.

Goodbye!