Covid-19

Cause:

SARS-CoV-2 virus (related to SARS)

Single stranded RNA

"Coronavirus" inludes a number of different viruses including the commoon cold, SARS, MERS, Covid-19

Origin:

Animals? - until recently, the most likely candidate was a bat, but recently racoon dogs (coondogs) have been implicated.

Early reports also implicated pangolins, which are one of the most trafficked animals on the planet.

Many of these animals are bought and sold for food in many parts of the world, including China.

Recently a report came out that caused confusion in the scientific community. It implicated the lab in Wuhan as being responsible.

Most scientists didn't believe this, and then the evidence came out implicating racoon dogs.

What we do know is that its' been mostly human - human transmission since early January 2020.

Timeline:

Well..... things have changed. Here is what I reported back in early March of 2020:

87,137 cases globally

79,968 cases in China

2,873 deaths

7,169 cases outside China

104 deaths

Here is what I reported for the fall class (as of November 3rd, 2020):

(See https://www.worldometers.info/coronavirus/ for good up to date information)

47,524,292 cases globally

1,214,151 deaths globally

In the U.S.:

9,574,004 cases in the U.S.

237,068 deaths

Spring of 2021 (as of March 28th)

Globally:

129,134,180 cases

2,821,083 deaths

Nationally (U.S.):

31,109,108 cases

564,399 deaths

Spring of 2022 (as of March 30th)

Globally:

486,282,025 cases

6,159,278 deaths

Nationally (U.S.):

81,686,628 cases

1,005,056 deaths (depends on which web site you go to; the CDC is at 979,177 as of four days ago).

Spring of 2023 (as of April 7th)

Globally:

684,649,198 cases

6,836,548 deaths

Nationally (U.S.):

106,359,724 cases

1,156,850 deaths

Spring of 2024 (as of March 20th)

Globally:

704,269,898 cases

7,006,314 deaths

Nationally (U.S.):

111,684,069 cases

1,217,751 deaths

Despite being one of the most advanced countries on Earth, the U.S. has been one of the hardest hit. We have the highest number of cases and the highest deaths:

Brazil second in line for deaths, India third.

Brazil's former president was downplaying the virus and even pretending that it doesn't exist (or is nothing more than a mild flu). He also went around without a mask.

Worldwide there was a surge in April 2020, another one in June/July 2020, a third wave over the winter months 2020/2021, another surge in spring of 2021, another in the fall of 2021, and a massive surge over the winter months (2021/2022).

Since then there have been several smaller surges (Summer 2022, winter 2022/2023).

New Zealand has done an exceptionally good job in controlling Covid-19.

New Zealand has been able to almost return to normal with freely open bars, restaurants, etc.

New Zealand is roughly 90% vaccinated, and although cases surged in February/March, the death rate has remained very low.

(New Zealand was under a complete quarantine until recently - this allowed them to get everyone vaccinated - and to stay relatively open).

We (the U.S.) couldn't seem to get our act together:

One of the issues is that each state was doing it's own thing. Some states are very vigilant, others not so much.

“Quarantines” didn't work very well as there is a free movement of people (you're supposed to quarantine in some areas, but not many people do - and how is it enforced?).

Some people also refused to wear masks (***why??***). More on masks later.

This has also lead to an increasing number of violent incidents on planes (the FDA is handing out massive fines as a result).

Large gatherings (often mask less) can also a source of recurring infections.

Three years ago GMU canceled spring break precisely because GMU was trying to avoid students getting together in large groups over spring break.

Also three years ago Florida had to impose a curfew after students descended on areas like Miami Beach and started partying in large numbers without masks (some students also rioted a bit).

Despite a governor who thinks Covid is not an issue.

Right now it looks like the worst is over, and the health emergency has been lifted.

We're hopeful as many people (not enough) are vaccinated, and a good portion of the rest have recovered. and hopefully wouldn't get as sick.

But to summarize, the virus was first seen in Wuhan, China, probably in late December (2019), although it might have been a bit earlier.

We all remember the news about the lockdown in China and the attempt to isolate and control the spread.

Unfortunately it spread from there to Europe, the U.S., and eventually most of the rest of the world.

The WHO declared Covid-19 a pandemic on March 11th, 2020.

Incidentally, some definitions:

pandemic - an epidemic that has spread over a large area (e.g., country, continent, or world)

epidemic - rapid spread of a disease in one area at roughly the same time.

endemic - disease that is prevalent in a particular area. For example, plague is endemic to rodents in the American Southwest.

Spread:

Most commonly through small droplets from nose or mouth (coughing, sneezing, talking, etc.)

Some spread is probably also due to fomites can also transmit Covid-19, but this doesn't seem as important as once thought.

Early studies showed virus can survive on stainless steel and plastics for 3 days, on cardboard for 1 day.

More recent study shows virus can survive for longer on things like cell phone screens.

Despite these studies, this doesn't seem to be a major contributor to the spread of the virus.

Direct air transmission does appear to be a factor - this is why areas with better ventilation are lower risk

(i.e., don't eat inside if Covid is surging).

Other transmission routes may be possible (e.g., the virus has been found in feces).

This is one reason why some authorities in the U.S. were worried - they saw an uptick in viral particles in sewage systems.

Basic reproduction number:

This is known as R_0, and indicates how many people each (infected) person can infect.

For example, if $R_0 = 1$, then each infected person infects one other person (the disease is considered “stable”.

$R_0 < 1$ means the disease will die out

$R_0 > 1$ means the disease is spreading

This assumes:

No one is vaccinated.
No one has had the disease before (no immunity).
No way to control the spread.

Some diseases:

Hepatitis	2	Mumps	10
Ebola	2	Measles	18
HIV	4	Covid-19	
SARS	4	orignal strain	2 - 3
		delta	≈ 7
		omicron	≈ 10
		omicron subvariants	> 10

Symptoms:

Mostly based on pre-omicron variants (omicron is similar, but the symptoms are usually less severe):

Incubation period seems to be from 1-14 days, with an estimated median of 4-5 days

Most common symptoms include:

fever
cough (dry)
shortness of breath (difficulty breathing)
loss of taste or smell

Other symptoms include fatigue, headache, muscle/body aches, sore throat, runny nose, nausea, vomiting, diarrhea.

Illness severity for original strain (based on a study mostly from China) shows:

81% mild to moderate symptoms
14% severe symptoms (lung involvement)
(median time to severe symptoms: 5 - 8 days from onset of symptoms).
5% critical (respiratory failure, shock, multiorgan failure)
(median time to critical symptoms: 8 - 12 days from onset of symptoms).

Mortality rate for patients admitted to the ICU ranges from 39 - 72%.

Case fatality also varies by age (we're all familiar with this). For the U.S. at the beginning of the pandemic we had:

10 - 27% for people over 85 3 - 11% for people 65 - 84
1 - 3% for people 55 - 64 < 1% for people less than 55.

But remember - even less than 1% still means that some young people die (many have!!).

Fortunately this has improved considerably:

For people 65 and over it has dropped to 0.53% (as of spring 2023).

Median time to death (if death occurs) from initial symptoms is around 14 days.

Overall mortality rate varies widely based on country. In the U.S. right now it stands at about 1.1% (as of March 10th, 2023).

The mortality rate has also been declining due to better treatment, particularly in developed countries.

Other complications:

Blood clotting occurs in some that can lead to thrombosis.

Immune overreaction.

Long term problems - some people still show shortness of breath many months after they have "recovered" (long Covid).

Other issues such as "Covid toes" (skin infections around the toes) or rashes have also been reported.

Some infants get "multisystem inflammatory syndrome", which appears to be due to an immune system overreaction.

Recovery takes anywhere from 2 to 6 weeks depending on how sick one gets and on other factors such as age and health.

(This is ignoring the long term problems mentioned above).

Prognosis:

Based on mid-December estimates:

About 43% of cases are asymptomatic (you don't even know you have it).

Asymptomatic individuals are thought to be 75% as infectious as people with symptoms.

50% of transmission occurs before you get sick (if you do get sick).

Among fatalities, many had pre-existing conditions:

hypertension	diabetes
cardiovascular disease	obesity

Blood type O also seems to make someone less susceptible with less severe symptoms.

Remember, this is just a trend - people with blood type O can still get very sick and/or die.

Diagnosis:

In addition to symptoms and evaluating risk, testing is available.

Numerous different tests are available, the best are based on PCR (amplification of genetic information), but sometimes takes a few days for results.

Many home quick tests are available - these take about 15 minutes and test for antigens.

They're not as good as the PCR tests, but do a decent screening job.

(Test is fairly accurate if positive; not quite so good if negative).

Prevention:

Who know the term “social distancing” before March 2020??

Anyway, some of the most effective ways to prevent Covid-19 include:

Wearing masks. This has been shown to be very effective (contrary to early indications). Masks prevent droplets and such from spreading when you're talking, sneezing, etc.

With cheaper masks, this mostly protect other people from you.

With better masks (N-95, KF-94, KN-95) this also gives you some protection.

If everyone is wearing a mask, the number of droplets, etc. in the air is minimized.

This is the single best thing you can do to help prevent Covid-19.

Think of it this way - if you sneeze, you cover your mouth with your hand (or better, your elbow). That's just being polite. Wearing a mask does the same thing

- it prevents all of your droplets and such from spreading.

Note that this also works well with other air-borne diseases like the flu or common cold.

Other things include:

Hand washing. Soap breaks down the membrane of the virus and inactivates it.

Hand-sanitizer also works well.

Not touching your face - if the virus is on your hands, touching your face often provides an easy way for the virus to "get inside" you.

Avoiding large gatherings. Large gatherings can provide an easy way for the virus to spread from one person to many other people (masks do help, but it's best to avoid large crowds).

Unfortunately this is a big problem, particularly with groups of young people. Young people rarely get ill, so they see no need to follow Covid-19 guidelines.

Spring break in Florida two years ago (2021) was responsible for several outbreaks.

As we've pointed out, many younger people will be asymptomatic; they can easily act as superspreaders, passing the virus on to other people in different age groups.

Social distancing - staying at least 6 feet away from other people - **particularly if they're not wearing a mask!**

Droplets and such don't seem to spread much past 6 feet, but see above about direct air transmission.

If the outbreak is widespread and increasing, other things help:

Shutting down non-essential stores and restaurants (or limiting occupancy, depending on the severity of the outbreak).

Encouraging people to stay indoors as much as possible. Some countries have made this mandatory, although it's rare nowadays.

Enforcing quarantines (works best for international travel - it can be hard to enforce for domestic travel in countries like the U.S.).

A few other things to consider:

Ventilation in most restaurants isn't that good; if there's a serious outbreak it's better to stay outside.

(Doesn't work well in winter).

Planes? The airline industry was hurting and in the fall of 2020 issued a study saying flying is safe. Other scientists were not convinced.

The mask mandate on planes was dropped.

Treatment:

Several treatment options do exist, but overall, one of the best treatments is still to treat the symptoms.

For less serious cases, the usual treatments:

- Rest, cold/flu drugs, staying home, etc.

For more serious cases (generally those that require hospitalization):

Ventilators:

In early days, ventilators were widely used. This helps a patient to breathe. However, more recent treatment tries to avoid ventilators and help patients breathe on their own by, for example, turning them on to their stomachs (not using ventilators right away has increased survival!).

For some patients, ventilators still remain critical.

Remdesivir:

The results are dubious at best.

Latest results seem to indicate it really doesn't do much for Covid-19, despite having been approved in the U.S. for the treatment of Covid-19.

Dexamethasone:

Some of the symptoms of Covid-19 can be due to the immune system overreacting. This can cause a “cytokine storm” in which the immune system also attacks healthy body cells.

Dexamethasone can slow down this cytokine storm. It's a powerful steroid and suppresses the immune system.

But - it should only be given if needed. Given too early, for example, it can suppress the immune system right when it's actually needed.

(As an aside, a lot of the deaths from the Spanish flu were due to cytokine storms, which is why it targeted the people with the best immune systems - although in the case of Covid-19, a healthy immune system doesn't appear to be a “risk factor”).

Antibody cocktails:

These do turn out to be an effective treatment for Covid-19 (although not so much with omicron). They work best if given early.

Sick people are injected with an antibody cocktail containing antibodies for Covid-19.

This has shown promising success including a shortened period of symptoms and reduced viral load.

The odd thing about antibody cocktail treatments is that although they are available, many doctors seem to be reluctant to use them.

Often, if you are sick with Covid-19 you have to ask for the treatment.

They are quite effective with strains prior to omicron.

Recently a new antibody treatment for omicron was given emergency use authorization by the FDA. It's not clear how effective it is.

Hydrochloroquine:

Useless. After numerous studies, this drug has been found not to do anything for Covid-19, and the side effects can be serious enough so that this is not recommended.

(It is used for malaria, although it's no longer the first choice of treatment even for malaria).

Other drugs:

Several other drugs have recently been identified and show some promise, but no serious trials have been done:

amodiaquine (another anti-malarial drug)

zuclophentixol (anti-psychotic)

nebivolol (for high blood pressure)

A little over a year ago, both Pfizer and Merck have developed antivirals in pill form that seem to be effective.

Pfizer's (Paxlovid) seems rather more effective, but both need to be taken early.

Bogus and ineffective treatments:

Unfortunately there are lots of bogus treatments out there. If you're interested, just do a Google search.

(I hope everyone realizes that drinking or injecting disinfectant is just stupid and can kill you!)

Vaccine:

Several vaccines have been approved in the U.S. We have all heard about Pfizer, Moderna, and Johnson & Johnson.

Estimates were that if about 60 - 80% (no one quite agrees) of the U.S. public gets vaccinated, it is estimated that we would get “herd immunity”. In other words, the incidence would drop to the point where very few people would get the disease (with most people “immune”, the risk of transmission drops considerably).

We are currently at about 69% fully vaccinated, and 81% with one dose.

About 40% have gotten some kind of booster (highly recommended for older or at risk people).

In order to be approved, the vaccines needed to complete phase III trials. Two (Pfizer and Moderna) were approved late in 2020, a third (Johnson & Johnson) was approved early in 2021.

Trial phases in the U.S.:

Phase I - small groups of people.

Phase II - larger, and also given to people who have characteristics (age, sex, etc.) similar to target population.

Phase III - very large group - vaccine is tested for effectiveness and safety.

Phase IV - sometimes used - this is basically a follow up after the vaccine is approved.

Although the distribution of vaccines was a little slow getting started, vaccines are now available everywhere. The problem is convincing holdouts to get vaccinated.

None of the vaccines is 100% effective in preventing Covid-19, but two of them (Pfizer and Moderna) are over 90% effective, and one (J & J) is over 74% effective (against the original strain).

One reason for the lower effectiveness of the J & J vaccine may be that it was tested in areas with variants.

The big advantage of the J & J vaccine is that it only requires one injection, and that it does not need ultra cold storage.

Regardless, all of them will almost certainly keep you out of the hospital!!

(There is a very, very low rate of hospitalization and/or death from Covid even with a vaccine).

Remember that the flu shot isn't 100% effective, but even if you do get sick, usually you don't get nearly as sick as without the vaccine.

We're not sure yet how long the vaccines are effective, but it appears to be at least six months.

Boosters were authorized for most people after six months, and just recently a fourth shot (2^{nd} booster) was authorized as well.

A quick description of the vaccines (how they work):

Pfizer and Moderna are both mRNA vaccines.

Essentially, a piece of mRNA contains the code for the “spike” in the coronavirus.

The spike is what allows the virus to enter your cells - but it's also what your immune system can recognize as an antigen (if you don't remember antigens, take a quick look at

the immune system notes).

The mRNA is wrapped in a special coating that protects the mRNA and also allows it to enter cells.

Once inside cells, your cells read the mRNA (we're simulating a virus here!) and makes the spike proteins.

The spike proteins are released into your body, and your immune system starts to recognize these “antigens”, giving you immunity.

(Recent (last few days) evidence shows Pfizer vaccine also works against young kids (12 and older).)

Johnson and Johnson

This vaccine uses DNA, but this time the DNA is wrapped in a harmless virus “envelope”. The envelope comes from something like a cold virus (without it's genetic information).

The DNA for making the antigen is inserted into the “virus”, which is then injected.

From there this modified “virus” behaves like a regular virus, but only makes antigens (and doesn't make you sick).

Not approved: Astra-Zeneca

Although approved in many countries, there are multiple problems in getting this one approved in the U.S.

One issue is that there appears to be some confusion as to what data they actually provided to the FDA. As a result, several things (including efficacy) were revised. This seems a bit disturbing.

Another issue is that in very rare cases there is a link to blood clots. It appears to be linked to people with a very rare genetic condition, but it's not clear yet.

However, it does appear the the vaccine is saving lives, which is the most important thing.

It is also one of the cheapest vaccines and doesn't require extreme storage.

It is a DNA vaccine similar to J & J, but requires 2 doses.

There was also much confusion early on about using half a dose for the first shot - this doesn't seem to hold up.

Variants:

One very disturbing trend is that lately the number of variants has been increasing.

What is a variant?

Most viruses evolve (mutate)!!

This isn't news - we've known this for the flu for a long time.

(It is true that some viruses evolve quickly, others not at all).

We have all heard about Covid-19 variants:

Some of the most important variants (as of March 2022):

Alpha (sometimes the UK variant):

One of the first variants of concern, this made Covid much more infectious.

The mutations of this variant made it easier for the virus to infect people. There is some conflicting information that it might have been more deadly.

It spread rapidly and became the dominant strain in most countries.

Fortunately the vaccines seem to be effective against this strain.

Delta:

This strain is even easier to transmit than alpha.

Originated in India, and spread worldwide from there.

Was the dominant strain in the U.S. late last summer.

The vaccines are still effective, but the effectiveness drops.

Mortality does seem a bit higher than with the original variant.

Omicron:

Even more transmissible than delta.

Apparently can multiply about 70 times as fast as delta in the bronchi.

The good news here is that its quite a bit less severe that previous forms.

But because so many more people became infected, overall hospitalizations increased dramatically.

There are endless subvariants of omicron.

Vaccinations are not quite as effective at preventing omicron, but they do reduce the probability of serious illness dramatically.

The bivalent booster seems to help with omicron.

Get vaccinated!

As is obvious, we may need boosters for a few years until we get a firm grip on Covid-19.

Economic & social impacts:

Shutdown of economy - job losses, etc.

We have had the most serious job losses in generations. At one point unemployment surged to over 15%.

This is the highest unemployment rate in over 70 years.

Many people lost their jobs, and lower income people are still having a hard time.

(You all know that restaurants, shops, etc. had to close - some have closed permanently).

Fortunately the economy has largely recovered and the jobless rate is very low.

This doesn't account for folks who have quit and are looking for better jobs.

The hospitality industry is still suffering from being understaffed.

Social isolation - increase in psychological problems.

Humans are (mostly) social - being in isolation and away from friends and family has caused many psychological problems.

This is ongoing. The demand for psychologists has surged!

During lockdowns we were not able to hold weddings (or funerals!)

Related to this is people dying in isolation. No one could visit them.

There has been a strong resentment against lock downs etc. due to all the economic problems.

People were desperate to get back to normal.

Health care professionals are suffering from burn out:

Rates of suicide have increased.

Essentially many of them are suffering from PTSD.

Somehow this all got political! Covid-19 (any disease!!) should NOT be political. It's not an “opinion” that the virus kills people or that it will magically disappear.

Science should be providing the guidance.

Bad/misleading information is also widely disseminated.

Antivaxers??? Antimaskers???

We won't say more about this, although this is definitely was very large part of the problem in the U.S. until January 20th, 2021.

More recent developments:

Covid is no longer a health emergency - as mentioned.

The CDC and others now no longer even recommend a 5 day isolation period. Now it's "stay home until you feel better and no longer have a fever" - then just be careful for the next few days.

They still recommend masks, distancing and testing if you are positive.

They do recommend vaccines, particularly for people aged 65 +.

Hopefully any new variants will no longer cause major health issues.

But remember, Covid is still killing people (roughly 100 people a day in the U.S.)