WEBVTT

00:00:00.060 --> 00:00:03.500 - Hi everyone, welcome to the sixth seminar

00:00:03.500 --> 00:00:06.330 of our seminar series on COVID-19

00:00:06.330 --> 00:00:08.220 organized by the Department of Biostatistics

00:00:08.220 --> 00:00:10.490 at Yale University.

00:00:10.490 --> 00:00:14.230 I'm very pleased to have here today Nicholas Christakis.

00:00:14.230 --> 00:00:17.890 He's a senior professor of social and medical science

00:00:19.320 --> 00:00:21.130 at Yale university.

00:00:21.130 --> 00:00:24.520 He's very well know for his research on social networks

00:00:25.740 --> 00:00:30.740 and his recent work focuses on how essentially human biology

00:00:31.470 --> 00:00:36.370 and health affect and are affected

00:00:36.370 --> 00:00:39.200 by social interaction, social networks.

00:00:39.200 --> 00:00:41.580 So today, he's gonna talk a little bit

00:00:41.580 --> 00:00:45.130 about the epidemiology of COVID-19.

00:00:45.130 --> 00:00:47.970 He's gonna give us an overview and updates

00:00:47.970 --> 00:00:51.830 and then he's gonna talk about his recent paper

00:00:51.830 --> 00:00:53.630 just published in Nature

00:00:53.630 --> 00:00:58.630 on how to use mobility data and population overflow

00:00:58.820 --> 00:01:03.200 from Wuhan to predict the spread of the COVID-19

00:01:03.200 --> 00:01:04.820 in all the areas of China.

00:01:04.820 --> 00:01:08.260 And then finally he's gonna talk about the new shining app

00:01:08.260 --> 00:01:13.260 called Hunala which is gonna use network science

00:01:14.370 --> 00:01:18.200 to essentially develop network sensors

00:01:18.200 --> 00:01:20.393 to four epidemic forecasting.

00:01:23.265 --> 00:01:26.400 So Nicholas is gonna take question anytime.

00:01:26.400 --> 00:01:29.800 So you're welcome to write questions in the chat box.

00:01:29.800 --> 00:01:34.180 And I will try to monitor it and read them to him.

00:01:34.180 --> 00:01:39.120 Or you can just unmute yourself and ask questions any time.

00:01:39.120 --> 00:01:40.500 - Well raise your hands,

00:01:40.500 --> 00:01:43.270 I can monitor the participant list

00:01:43.270 --> 00:01:45.560 for raised hands electronically raised.

00:01:45.560 --> 00:01:47.427 That's easy for me.

00:01:47.427 --> 00:01:48.440 - All right.

00:01:48.440 --> 00:01:51.577 So Nicholas, thank you for participating

00:01:52.443 --> 00:01:54.810 and why don't you take it from here.

00:01:54.810 --> 00:01:55.643 - Thank you Laura.

00:01:55.643 --> 00:01:56.940 Thank you so much.

00:01:56.940 --> 00:01:58.850 I see many names that I recognize

00:01:58.850 --> 00:02:00.693 on this big panel in front of me.

00:02:01.660 --> 00:02:03.350 I'm gonna talk without slides

00:02:03.350 --> 00:02:05.020 because I find it very stressful

00:02:05.020 --> 00:02:08.370 and weird to use slides on Zoom.

00:02:08.370 --> 00:02:10.060 I find Zoom like probably many of you

00:02:10.060 --> 00:02:11.830 do pretty weird already.

00:02:11.830 --> 00:02:15.260 It's so disembodied and taxing in some ways.

00:02:15.260 --> 00:02:16.600 So I'm just gonna tell you a little bit

00:02:16.600 --> 00:02:19.210 about the epidemiology of Coronavirus

00:02:19.210 --> 00:02:22.450 as it has come to be known by many people around the world

00:02:22.450 --> 00:02:26.450 in the last few months since the epidemic started.

00:02:26.450 --> 00:02:29.910 And some of these things may be very simple or known to you,

00:02:29.910 --> 00:02:31.670 others will not be perhaps known to you,

00:02:31.670 --> 00:02:34.130 I hope I will tell you some things you don't know.

00:02:34.130 --> 00:02:36.010 And I'm happy to take questions at any time.

00:02:36.010 --> 00:02:37.100 And then towards the end,

00:02:37.100 --> 00:02:39.550 I'm gonna tell you a little bit about some of the projects

00:02:39.550 --> 00:02:41.760 in my lab that have raised a number,

00:02:41.760 --> 00:02:44.980 are raising a number of difficult statistical questions

00:02:44.980 --> 00:02:46.270 that we are absolutely eager

00:02:46.270 --> 00:02:49.000 to collaborate with people about.

00:02:49.000 --> 00:02:51.710 And Laura has been interacting with us now

00:02:51.710 --> 00:02:53.090 for quite a number of years

00:02:53.090 --> 00:02:54.800 as I've certain others of you

00:02:54.800 --> 00:02:57.450 that I can see on this list.

00:02:57.450 --> 00:03:00.730 So we are experiencing something very unusual

00:03:00.730 --> 00:03:03.700 in our species that happens from time to time,

00:03:03.700 --> 00:03:06.680 which is the introduction of a new pathogen.

00:03:06.680 --> 00:03:08.830 We happen to be alive at a moment

00:03:08.830 --> 00:03:12.420 when a new germ is entering our species

00:03:12.420 --> 00:03:15.810 and having what is known as an ecological release.

00:03:15.810 --> 00:03:18.080 It's just like when the rats were first introduced

00:03:18.080 --> 00:03:22.010 to New Zealand, and they found you know, Terra Incognita,

00:03:22.010 --> 00:03:24.510 and could just take over and do whatever they wanted.

00:03:24.510 --> 00:03:28.050 This virus spent decades evolving in barks,

00:03:28.050 --> 00:03:30.200 probably spent some time in pangolins

00:03:30.200 --> 00:03:31.890 that's still being worked out.

00:03:31.890 --> 00:03:33.770 And then in an unseen way,

00:03:33.770 --> 00:03:37.320 almost surely in October or November in Wuhan China,

00:03:37.320 --> 00:03:41.450 leapt into human beings and gradually spread among them

00:03:41.450 --> 00:03:43.980 and then spread around the world.

00:03:43.980 --> 00:03:47.170 This pathogen SARS-CoV-2

00:03:47.170 --> 00:03:49.980 bears a strong similarity to other pathogens

00:03:49.980 --> 00:03:52.250 that have been long circulating in bats.

00:03:52.250 --> 00:03:56.880 And it's the seventh such Coronavirus species

00:03:56.880 --> 00:03:58.060 that afflicts us.

00:03:58.060 --> 00:04:01.250 There are four species of Coronavirus

00:04:01.250 --> 00:04:03.270 that just cause the common cold,

00:04:03.270 --> 00:04:06.190 they cause about 20 or 30% of the common cold

00:04:06.190 --> 00:04:07.400 that people get.

00:04:07.400 --> 00:04:09.210 The other viruses that cause the common cold

00:04:09.210 --> 00:04:11.170 are other species of viruses.

00:04:11.170 --> 00:04:14.820 And two of these Corona viruses also came from bats.

00:04:14.820 --> 00:04:18.390 In addition, there are two prior Coronavirus,

00:04:18.390 --> 00:04:22.090 a serious Corona viruses that have afflicted us,

00:04:22.090 --> 00:04:26.280 what is the so called SARS-1 that was pandemic in 2003.

00:04:27.300 --> 00:04:30.090 It was a kind of limited pandemic, which I think,

00:04:30.090 --> 00:04:33.100 on the one hand, gave certain Asian countries

00:04:33.100 --> 00:04:37.030 a taste of what could happen so they prepared well.

00:04:37.030 --> 00:04:38.580 But on the other hand,

00:04:38.580 --> 00:04:40.210 because the pandemic petered out,

00:04:40.210 --> 00:04:42.090 it kind of lulled the rest of the world

00:04:42.090 --> 00:04:44.210 into a false sense of security.

00:04:44.210 --> 00:04:48.580 And then the seventh, before the current SARS-CoV-2,

00:04:48.580 --> 00:04:50.040 the seventh Corona virus

00:04:50.040 --> 00:04:52.810 is something called Middle Eastern Respiratory Syndrome,

00:04:52.810 --> 00:04:56.620 or MERS, which is a virus that has a R naught

00:04:56.620 --> 00:04:58.110 which we'll talk about in a moment

00:04:58.110 --> 00:05:00.010 of less than one we think.

00:05:00.010 --> 00:05:04.850 Each infection yields about .9 new infections.

00:05:04.850 --> 00:05:07.240 So that epidemic self extinguishes,

00:05:07.240 --> 00:05:08.200 which is one reason

00:05:08.200 --> 00:05:13.200 that MERS has not become as serious as SARS-2 has become.

00:05:13.830 --> 00:05:17.310 Anyway this SARS-CoV-2 leapt into humans

00:05:17.310 --> 00:05:21.740 sometime in November, started causing cases in December.

00:05:21.740 --> 00:05:23.300 And by the middle of January,

00:05:23.300 --> 00:05:27.560 the Chinese knew that it was extremely serious.

00:05:27.560 --> 00:05:30.840 I was contacted by some colleagues in China and Hong Kong

00:05:30.840 --> 00:05:33.420 on January 23 or 24th,

00:05:33.420 --> 00:05:35.870 about the possibility of collaborating to do some work.

00:05:35.870 --> 00:05:37.950 We had been working for a long time,

00:05:37.950 --> 00:05:41.760 using phone data from China to look at the impact of things

00:05:41.760 --> 00:05:46.250 like earthquakes on shaping people's social interactions,

00:05:46.250 --> 00:05:48.970 or the building of high speed rail lines.

00:05:48.970 --> 00:05:50.860 So we had a well established collaboration

00:05:50.860 --> 00:05:53.620 and well established procedures for handling data.

00:05:53.620 --> 00:05:54.870 And they contacted me

00:05:54.870 --> 00:05:57.660 and we decided to study the impact

00:05:57.660 --> 00:05:59.710 or something to do with phone data

00:05:59.710 --> 00:06:01.393 and the pandemic.

00:06:02.250 --> 00:06:06.870 And so we began working in earnest on the 24th of January,

00:06:06.870 --> 00:06:07.910 and all the one 58,

00:06:07.910 --> 00:06:10.000 it reminded me of when I was a graduate student,

00:06:10.000 --> 00:06:12.570 because we worked non stop for three weeks,

00:06:12.570 --> 00:06:13.860 it was very exciting.

00:06:13.860 --> 00:06:15.500 And of course, because they were on the other side

00:06:15.500 --> 00:06:16.650 of the world, you know,

00:06:16.650 --> 00:06:18.670 I would work during the day and then hand it to them,

00:06:18.670 --> 00:06:19.503 and then they wake up

00:06:19.503 --> 00:06:22.100 and they work during their day while I slept.

00:06:22.100 --> 00:06:23.620 And then it would come back to me.

00:06:23.620 --> 00:06:26.180 When we submitted the paper on February the 18th,

00:06:26.180 --> 00:06:29.441 and it was ultimately published two months later

00:06:29.441 --> 00:06:30.620 in the middle of April.

00:06:30.620 --> 00:06:32.450 That's the paper that Laura mentioned.

00:06:32.450 --> 00:06:35.470 And in this paper, what we did is is we had phone data

00:06:35.470 --> 00:06:38.710 on 11 and a half million transits through Wuhan.

00:06:38.710 --> 00:06:42.470 We could track people as they transited through Wuhan

00:06:42.470 --> 00:06:45.830 and spread out around the country.

00:06:45.830 --> 00:06:48.680 And we had the misfortune as a species,

00:06:48.680 --> 00:06:52.560 that this epidemic left to us at a moment in time

00:06:52.560 --> 00:06:55.993 and in a place where the one of the largest I think,

00:06:57.330 --> 00:06:59.040 annual human migration takes place.

00:06:59.040 --> 00:07:04.040 During that annual Harvest Moon Festival in China,

00:07:04.374 --> 00:07:06.459 the new year festival.

00:07:06.459 --> 00:07:11.230 So there are 3 billion translocations of people

00:07:11.230 --> 00:07:14.650 that take place in China in the run up to this holiday,

00:07:14.650 --> 00:07:17.453 which was on January 24th or 25th this year.

00:07:18.519 --> 00:07:21.670 So the virus steps into us at a time

00:07:21.670 --> 00:07:23.400 when people are spreading out,

00:07:23.400 --> 00:07:26.090 and millions of Chinese moved throughout the country,

00:07:26.090 --> 00:07:28.090 including transiting through Wuhan.

00:07:28.090 --> 00:07:31.020 And unbeknownst to them, they carry the virus with them.

00:07:31.020 --> 00:07:32.260 And what we were able to do

00:07:32.260 --> 00:07:35.480 is using simply the movement of people,

00:07:35.480 --> 00:07:37.960 track with phone data, the aggregate number of people

00:07:37.960 --> 00:07:42.190 that left Wuhan between January 1st and January 24th,

00:07:42.190 --> 00:07:46.120 and spread out to the other 296 prefectures of China.

00:07:46.120 --> 00:07:48.540 By tracking the number of people who left

00:07:48.540 --> 00:07:50.130 and carry the germ with them,

00:07:50.130 --> 00:07:52.100 we were able to build a model that allowed us

00:07:52.100 --> 00:07:54.680 to predict the timing, intensity

00:07:54.680 --> 00:07:59.680 and location of the epidemic up through late February.

00:08:00.100 --> 00:08:01.530 And this model we believe,

00:08:01.530 --> 00:08:03.300 and I'll return to a little bit later,

00:08:03.300 --> 00:08:05.710 this model we believe could be useful

00:08:05.710 --> 00:08:07.700 in other sorts of situations

00:08:07.700 --> 00:08:11.270 in which there is a risk source or risk sources

00:08:11.270 --> 00:08:15.770 that one is trying to assess in terms of its impact

00:08:15.770 --> 00:08:17.950 on this spreading of an epidemic,

00:08:17.950 --> 00:08:19.650 especially if there's data available.

00:08:19.650 --> 00:08:21.413 And I'll come back to that later.

00:08:23.530 --> 00:08:25.860 So of course, these people in China in Wuhan,

00:08:25.860 --> 00:08:28.060 then of course spread out throughout the world.

00:08:28.060 --> 00:08:31.220 The Chinese were criticized for closing

00:08:31.220 --> 00:08:36.210 their internal borders by January the 25th,

00:08:36.210 --> 00:08:39.200 the Chinese had imposed stay at home orders

00:08:39.200 --> 00:08:41.410 on prefectures in China,

00:08:41.410 --> 00:08:44.823 that encompassed past 930 million people.

00:08:45.890 --> 00:08:49.590 So beginning on January 25, nearly a billion people

00:08:49.590 --> 00:08:52.150 were under some form of home isolation.

00:08:52.150 --> 00:08:54.300 And this really got my attention,

00:08:54.300 --> 00:08:56.040 because the Chinese had judged

00:08:56.040 --> 00:08:58.343 that in order to combat this pathogen,

00:08:58.343 --> 00:09:00.230 that the enemy that they were facing

00:09:00.230 --> 00:09:03.950 and the virus required them to basically detonate

00:09:03.950 --> 00:09:05.840 a social nuclear weapon.

00:09:05.840 --> 00:09:08.830 This was how strong they rightly in my view

00:09:08.830 --> 00:09:12.480 felt that the epidemic was.

00:09:12.480 --> 00:09:14.500 So they close down their own country,

00:09:14.500 --> 00:09:17.080 but they lagged a little in closing down travel

00:09:17.080 --> 00:09:18.540 and leaving Wuhan.

00:09:18.540 --> 00:09:20.160 Some people have have said

00:09:20.160 --> 00:09:22.050 that there was some conspiracy to do that.

00:09:22.050 --> 00:09:23.540 I see no evidence of that.

00:09:23.540 --> 00:09:26.140 I just think they were scrambling to cope with a pandemic,

00:09:26.140 --> 00:09:27.930 they closed internal travel

00:09:27.930 --> 00:09:31.650 but didn't close external travel till a week or so later.

00:09:31.650 --> 00:09:34.040 And without of course the germ you know,

00:09:34.040 --> 00:09:35.200 spread around the world.

00:09:35.200 --> 00:09:37.810 Although it would have spread no matter what.

00:09:37.810 --> 00:09:40.250 It's in the nature of these pathogens

00:09:40.250 --> 00:09:41.700 once they take root.

00:09:41.700 --> 00:09:43.260 There's really no stopping them

00:09:44.560 --> 00:09:46.663 as I alluded to earlier.

00:09:49.050 --> 00:09:52.120 So the Chinese quarantined Wuhan

00:09:52.120 --> 00:09:54.150 and then Hubei province surrounded home

00:09:54.150 --> 00:09:57.723 to 58 million people on January the 24th.

00:09:58.870 --> 00:10:01.860 Now, the first paper about this pathogen,

00:10:01.860 --> 00:10:03.610 regarding the first 41 cases

00:10:03.610 --> 00:10:06.290 appeared in The Lancet on the same date

00:10:06.290 --> 00:10:08.827 around January the 24th.

00:10:08.827 --> 00:10:11.600 And that very first paper noted the extreme likelihood

00:10:11.600 --> 00:10:15.440 of interpersonal spread and the severity of the infection.

00:10:15.440 --> 00:10:18.030 So the nature of what we were confronting

00:10:18.030 --> 00:10:23.030 was well understood by scientists early in January.

00:10:23.060 --> 00:10:26.640 I don't think we can claim that we had no idea

00:10:26.640 --> 00:10:28.410 there was interpersonal spread,

00:10:28.410 --> 00:10:29.730 or that it was serious.

00:10:29.730 --> 00:10:33.610 And the virus we now know from genetic studies

00:10:33.610 --> 00:10:36.980 arrived in Seattle already by the middle of January.

00:10:36.980 --> 00:10:39.027 And this is one of the reasons that border closures

00:10:39.027 --> 00:10:42.030 are so ineffective as other scientists

00:10:42.030 --> 00:10:46.050 including Neil Ferguson's group, and Mark Lipschitz's group

00:10:46.050 --> 00:10:47.550 have also looked at

00:10:47.550 --> 00:10:50.780 is that by the time you're aware of what's happening,

00:10:50.780 --> 00:10:53.560 and you try to close the borders, it's too late.

00:10:53.560 --> 00:10:57.360 The pathogen has spread, you know, surreptitiously

00:10:57.360 --> 00:10:58.820 and cross the borders.

00:10:58.820 --> 00:11:00.530 And in fact, it had arrived in Seattle

00:11:00.530 --> 00:11:02.170 by the middle of January,

00:11:02.170 --> 00:11:07.170 and via Italy, in New York City by the middle of February.

00:11:07.210 --> 00:11:10.030 And by then, after that point,

00:11:10.030 --> 00:11:13.480 most of the cases throughout the rest of the United States

00:11:13.480 --> 00:11:16.810 actually were seated from internal cases.

00:11:16.810 --> 00:11:19.660 And eventually, community transmission took over

00:11:19.660 --> 00:11:23.210 at importation, whether from abroad or from other states

00:11:23.210 --> 00:11:26.350 became a progressively tinier fraction of the size

00:11:26.350 --> 00:11:28.580 of operates at any particular location.

00:11:28.580 --> 00:11:32.710 This is, again, typical of what happens with epidemics.

00:11:32.710 --> 00:11:35.880 You know, some cases move in, epidemic starts,

00:11:35.880 --> 00:11:37.100 and then it just takes off

00:11:37.100 --> 00:11:38.520 and it's not doesn't matter

00:11:38.520 --> 00:11:41.793 how many more people come in to a location.

00:11:44.086 --> 00:11:46.010 And of course, it's spread into other countries

00:11:46.010 --> 00:11:48.150 around the world as well.

00:11:48.150 --> 00:11:49.280 Now right from the beginning,

00:11:49.280 --> 00:11:50.920 there was a lot of effort

00:11:50.920 --> 00:11:54.270 to estimate key epidemiological parameters

00:11:54.270 --> 00:11:55.230 about this pathogen.

00:11:55.230 --> 00:11:58.340 And I suspect everyone in this group knows about this,

00:11:58.340 --> 00:12:00.450 but I'll just review quickly what's known,

00:12:00.450 --> 00:12:02.460 and then highlight one other interesting parameter

00:12:02.460 --> 00:12:05.370 that not as many people pay attention on

00:12:05.370 --> 00:12:08.120 but I know this group will be interested in.

00:12:08.120 --> 00:12:11.490 So the so called R naught, the R0

00:12:11.490 --> 00:12:13.110 is the number of new cases

00:12:13.110 --> 00:12:16.110 in a fully susceptible non-immune

00:12:16.110 --> 00:12:19.540 normally interacting, typical population.

00:12:19.540 --> 00:12:21.660 That's an attempt to measure something intrinsic

00:12:21.660 --> 00:12:26.150 about the virus in a kind of typical human population

00:12:26.150 --> 00:12:27.350 where no one is immune,

00:12:27.350 --> 00:12:29.870 the virus is brand new to us,

00:12:29.870 --> 00:12:31.290 people are interacting normally,

00:12:31.290 --> 00:12:34.400 we haven't yet taken any protective action.

00:12:34.400 --> 00:12:36.557 So this is known as the R naught.

00:12:36.557 --> 00:12:39.460 And for this germ, for SARS-CoV-2,

00:12:39.460 --> 00:12:42.020 it's probably around two and a half,

00:12:42.020 --> 00:12:44.680 and it could be as high as three.

00:12:44.680 --> 00:12:47.230 This is high, actually.

00:12:47.230 --> 00:12:51.010 The seasonal flu has an R naught of about 1.3 to 1.6.

00:12:52.900 --> 00:12:56.460 Chickenpox has an R naught of 3.5 to 6.

00:12:56.460 --> 00:12:58.813 Ebola has an R naught of 1.5 to 1.9.

00:13:00.815 --> 00:13:04.260 And of course the champion pathogen is measles,

00:13:04.260 --> 00:13:06.490 which has an R naught of 18,

00:13:06.490 --> 00:13:09.390 which is why vaccination rates for measles

00:13:09.390 --> 00:13:10.950 have to be so high,

00:13:10.950 --> 00:13:12.670 because the pathogen is so infectious,

00:13:12.670 --> 00:13:15.637 there's a relationship between the amount of the pathogen

00:13:15.637 --> 00:13:19.480 and the required vaccination rate to stop it,

00:13:19.480 --> 00:13:22.560 before you could get herd immunity for example.

00:13:22.560 --> 00:13:24.280 Now, the so called Re, R sub e

00:13:26.170 --> 00:13:28.490 is the effective reproductive rate.

00:13:28.490 --> 00:13:32.120 This is the number of new cases as the epidemic proceeds,

00:13:32.120 --> 00:13:35.890 and as immunity rises, or as people take action.

00:13:35.890 --> 00:13:38.370 And this number can fall and change.

00:13:38.370 --> 00:13:41.590 So for example, if we all of a sudden became hermits,

00:13:41.590 --> 00:13:43.770 nobody interacted with anyone else,

00:13:43.770 --> 00:13:46.110 the Re would fall below one.

00:13:46.110 --> 00:13:48.140 This is actually what happened to China.

00:13:48.140 --> 00:13:49.667 They were able to track the Re

00:13:49.667 --> 00:13:51.640 and find that whereas it started

00:13:51.640 --> 00:13:54.050 at around 3 in Wuhan in January.

00:13:54.050 --> 00:13:55.640 After their national lockdowns,

00:13:55.640 --> 00:13:57.960 it fell to about 0.3,

00:13:57.960 --> 00:14:02.260 each new case only created a third of a new case.

00:14:02.260 --> 00:14:05.700 So that's, you know, when the epidemic extinguishes.

00:14:05.700 --> 00:14:09.630 So this Re is very sensitive to the natural rise

00:14:09.630 --> 00:14:11.650 of immune people in the population,

00:14:11.650 --> 00:14:13.460 and also the human behaviors

00:14:13.460 --> 00:14:18.450 or ultimately for lucky vaccination that we might implement.

00:14:18.450 --> 00:14:20.470 But there's another very important parameter

00:14:20.470 --> 00:14:21.930 that I think will interest this group

00:14:21.930 --> 00:14:24.820 and that many that perhaps not all of you have heard about,

00:14:24.820 --> 00:14:27.120 which is the variance in the R naught,

00:14:27.120 --> 00:14:28.420 or the variance in the Re.

00:14:29.570 --> 00:14:31.330 And there was a landmark paper

00:14:31.330 --> 00:14:32.960 that was published by Lloyd Smith

00:14:32.960 --> 00:14:35.890 and his colleagues in Nature in 2005,

00:14:35.890 --> 00:14:38.570 that quantify this using a dispersion parameter

00:14:38.570 --> 00:14:40.320 they called Kappa,

00:14:40.320 --> 00:14:44.260 which seeks to quantify the interindividual variation

00:14:44.260 --> 00:14:48.470 in the R, in the reproductive rate of the pathogen.

00:14:48.470 --> 00:14:52.080 So imagine a situation where,

00:14:52.080 --> 00:14:55.360 for everyone, every single person in the population,

00:14:55.360 --> 00:14:59.440 the R is two, each person infects two other people,

00:14:59.440 --> 00:15:01.760 and another situation in which it is zero

00:15:01.760 --> 00:15:04.940 for many people, but let's say 50 for one person,

00:15:04.940 --> 00:15:08.370 imagine the population, a small population.

00:15:08.370 --> 00:15:12.003 The average R in these two situations could be the same.

00:15:13.460 --> 00:15:16.730 But the ability of the epidemic to establish itself

00:15:16.730 --> 00:15:18.710 actually could be quite different,

00:15:18.710 --> 00:15:21.630 and would be much easier in the former case.

00:15:21.630 --> 00:15:26.480 In the latter case, you have more super spreading events.

00:15:26.480 --> 00:15:27.750 There's a variance in the R

00:15:27.750 --> 00:15:30.200 so you've got that right tail distribution,

00:15:30.200 --> 00:15:32.557 some situations where one person might infect 50

00:15:32.557 --> 00:15:36.030 or 100 people, but also most of the cases

00:15:36.030 --> 00:15:39.030 are dead ends, most people infect no one.

00:15:39.030 --> 00:15:41.280 So in a population of such people infected

00:15:41.280 --> 00:15:42.430 with such a germ,

00:15:42.430 --> 00:15:45.070 if one person leaves and goes somewhere else,

00:15:45.070 --> 00:15:47.710 most of the time they won't be able to establish an epidemic

00:15:47.710 --> 00:15:49.500 in the new location.

00:15:49.500 --> 00:15:52.110 So the random movement of people from one population

00:15:52.110 --> 00:15:54.760 to another, from a risks source to another place

00:15:54.760 --> 00:15:57.840 won't be able to establish an epidemic.

00:15:57.840 --> 00:16:01.530 So this dispersion parameter is actually quite important

00:16:01.530 --> 00:16:04.837 for what might happen in these types of a situation.

00:16:04.837 --> 00:16:09.700 And it turns out that the dispersion parameter for SARS-2,

00:16:09.700 --> 00:16:11.330 what we're currently facing

00:16:11.330 --> 00:16:14.130 is smaller, the variance is smaller

00:16:14.130 --> 00:16:16.960 than the variance was for SARS-1.

00:16:16.960 --> 00:16:18.540 And this actually is one of the things

00:16:18.540 --> 00:16:21.010 that's making SARS-2 worse for us.

00:16:21.010 --> 00:16:24.130 Even though there are super spreading events now,

00:16:24.130 --> 00:16:27.730 they are fewer than they were for the previous pathogen.

00:16:27.730 --> 00:16:31.050 And more often now, a move of a person

00:16:31.050 --> 00:16:34.110 from one place to another starts the epidemic

00:16:34.110 --> 00:16:36.373 and can result in it taking off.

00:16:37.720 --> 00:16:40.410 Now, superspreading depends not only on the pathogen,

00:16:40.410 --> 00:16:42.360 but also of course on the host,

00:16:42.360 --> 00:16:45.880 attributes of the host that are immunity to the pathogen,

00:16:45.880 --> 00:16:47.700 how irritable like some people,

00:16:47.700 --> 00:16:50.160 let's say my cough more than other people,

00:16:50.160 --> 00:16:51.710 so that might make me more likely

00:16:51.710 --> 00:16:54.570 to be a super spreader than you.

00:16:54.570 --> 00:16:56.820 Super-spreading events also have to do with the environment.

00:16:56.820 --> 00:17:00.840 This is why a pact conferences of people

00:17:00.840 --> 00:17:03.720 are more likely to cause super spreading events,

00:17:03.720 --> 00:17:07.383 then open air concerts and so forth.

00:17:08.470 --> 00:17:11.130 So people try quickly to get a sense

00:17:11.130 --> 00:17:13.280 of the reproductive rate of this pathogen

00:17:13.280 --> 00:17:14.630 and they were successful.

00:17:14.630 --> 00:17:17.220 There have been like dozens of studies now quantifying this

00:17:17.220 --> 00:17:18.590 and the summary statistic

00:17:18.590 --> 00:17:20.840 is around two and a half that I told you.

00:17:20.840 --> 00:17:22.890 And also the dispersion parameter

00:17:22.890 --> 00:17:24.113 they tried to quantify.

00:17:24.970 --> 00:17:28.140 Distinctly, people tried to quantify the case fatality rate

00:17:28.140 --> 00:17:31.200 or the infection fatality rate of this parameter.

00:17:31.200 --> 00:17:34.030 And there's still ongoing of this pathogen

00:17:34.030 --> 00:17:36.992 and there's still ongoing debate about the CFR

00:17:36.992 --> 00:17:37.825 and the IFR.

00:17:38.920 --> 00:17:43.630 The CFR is the fraction of people who die conditional

00:17:43.630 --> 00:17:46.170 on their coming to medical attention,

00:17:46.170 --> 00:17:48.740 or a little bit better definition,

00:17:48.740 --> 00:17:51.680 conditional on their developing symptoms,

00:17:51.680 --> 00:17:53.950 something which is called the S-CFR,

00:17:53.950 --> 00:17:56.550 the symptomatic case fatality ratio.

00:17:56.550 --> 00:18:01.460 And we think this number is about between 0.5 and 1% still.

00:18:01.460 --> 00:18:03.393 It could be as low as 0.3%.

00:18:04.630 --> 00:18:06.403 But I doubt that it's any lower.

00:18:07.460 --> 00:18:09.330 And notice that the case fatality rate

00:18:09.330 --> 00:18:12.310 is very sensitive to people's behavior.

00:18:12.310 --> 00:18:14.330 You know, do people seek medical care?

00:18:14.330 --> 00:18:16.280 You know, if they have mild symptoms from the disease,

00:18:16.280 --> 00:18:17.780 they might never tell anybody.

00:18:18.640 --> 00:18:21.290 Or it's sensitive to the ability of the healthcare system

00:18:21.290 --> 00:18:22.660 to save their lives.

00:18:22.660 --> 00:18:25.560 So this is not something that's sort of written in stone,

00:18:25.560 --> 00:18:27.100 but it's something that attempts

00:18:27.100 --> 00:18:29.960 to quantify how lethal a pathogen is it

00:18:29.960 --> 00:18:31.313 that we have on our hands.

00:18:32.330 --> 00:18:36.860 The case fatality rate for the seasonal flu is about 0.1%.

00:18:36.860 --> 00:18:39.060 So on average, about one out of 1000 people

00:18:39.060 --> 00:18:41.390 who get seasonal flu will die,

00:18:41.390 --> 00:18:44.680 and SARS-2, the current pathogen we're facing

00:18:44.680 --> 00:18:47.150 is less deadly than SARS-1.

00:18:47.150 --> 00:18:51.260 The case fatality rate for SARS-1 was about 10%.

00:18:51.260 --> 00:18:52.860 Yeah, was about 10%.

00:18:52.860 --> 00:18:55.990 So it's about about 10 times as deadly

00:18:55.990 --> 00:18:57.860 as the current pathogen.

00:18:57.860 --> 00:19:00.160 And similarly the case fatality rate

00:19:00.160 --> 00:19:03.190 for the 1918 flu pandemic,

00:19:03.190 --> 00:19:06.223 which was very bad, was about 4 to 5%.

00:19:07.310 --> 00:19:09.350 Now, one of the things that's interesting about this,

00:19:09.350 --> 00:19:10.420 as many of you may know

00:19:10.420 --> 00:19:15.170 is that actually a less fatal disease is more difficult

00:19:15.170 --> 00:19:19.620 to treat, to stop,

00:19:19.620 --> 00:19:22.240 because when the disease kills us rapidly

00:19:22.240 --> 00:19:24.650 like Ebola, the victim dies

00:19:24.650 --> 00:19:28.290 before they can transmit the disease.

00:19:28.290 --> 00:19:29.623 But if the disease's less deadly,

00:19:29.623 --> 00:19:31.760 and the person is walking around

00:19:31.760 --> 00:19:33.010 for a longer period of time,

00:19:33.010 --> 00:19:36.163 while sick, they can infect more people.

00:19:37.130 --> 00:19:39.490 So this this difference between SARS-2,

00:19:39.490 --> 00:19:42.740 what we're facing and SARS-2 in 2003,

00:19:42.740 --> 00:19:45.480 I should have mentioned that the SARS-1 petered out

00:19:45.480 --> 00:19:48.477 there were only eight and a half thousand cases worldwide.

00:19:48.477 --> 00:19:51.130 You know, it was a trivial pandemic

00:19:51.130 --> 00:19:52.863 compared to what we're facing now.

00:19:53.900 --> 00:19:56.560 So and I forgot how many deaths but it was in,

00:19:56.560 --> 00:20:00.030 you know, I think 500 or six 700 deaths

00:20:00.030 --> 00:20:02.023 from the SARS-1 pandemic.

00:20:03.130 --> 00:20:05.760 So the lower the fatality of this pandemic,

00:20:05.760 --> 00:20:08.680 ironically makes it more dangerous,

00:20:08.680 --> 00:20:11.180 lower the fatality on a per case basis,

00:20:11.180 --> 00:20:12.450 because it can spread farther

00:20:12.450 --> 00:20:14.967 and ultimately cause many deaths.

00:20:14.967 --> 00:20:17.930 And in general, it's an evolutionary biology principle

00:20:17.930 --> 00:20:20.860 that the pathogens don't want to kill us.

00:20:20.860 --> 00:20:24.040 That is to say, pathogens do better

00:20:24.040 --> 00:20:27.020 when they're not as deadly because they can spread.

00:20:27.020 --> 00:20:30.120 And also variants of the pathogen

00:20:30.120 --> 00:20:33.070 that don't kill us or don't kill us fast,

00:20:33.070 --> 00:20:36.473 typically outstrip variants that do kill us fast.

00:20:38.056 --> 00:20:40.350 So that's one of the reasons in general

00:20:40.350 --> 00:20:43.060 we tend to see the evolution of pathogens

00:20:43.060 --> 00:20:46.010 to be less severe as time goes by.

00:20:46.010 --> 00:20:48.913 And I'll come back to this point as well in just a moment.

00:20:52.001 --> 00:20:54.580 And then the infection fatality rate

00:20:54.580 --> 00:20:57.200 as distinct from the case fatality rate,

00:20:57.200 --> 00:21:01.500 is the fraction of people who get infected and die.

00:21:01.500 --> 00:21:04.020 Not the ones that come to medical attention.

00:21:04.020 --> 00:21:08.010 So we think that about 50% or develop symptoms,

00:21:08.010 --> 00:21:10.200 we think that about 50% of people

00:21:10.200 --> 00:21:12.830 who get SARS-2 are asymptomatic.

00:21:12.830 --> 00:21:15.200 And so this means that in this case,

00:21:15.200 --> 00:21:17.600 because of that 50% number,

00:21:17.600 --> 00:21:22.240 it means that the IFR is about half the CFR in this case.

00:21:22.240 --> 00:21:26.460 So, half the people that get infected,

00:21:26.460 --> 00:21:28.220 don't get any symptoms at all.

00:21:28.220 --> 00:21:30.330 And so this makes the IFR lower

00:21:30.330 --> 00:21:32.743 by a factor of two than the CFR.

00:21:33.870 --> 00:21:35.510 Now you can take these two parameters,

00:21:35.510 --> 00:21:38.960 the reproductive rate and the case fatality rate,

00:21:38.960 --> 00:21:40.900 and you can put them on a little graph

00:21:40.900 --> 00:21:43.850 and then you can plot all of the pandemics

00:21:43.850 --> 00:21:46.680 that have occurred, let's say in the last hundred years,

00:21:46.680 --> 00:21:50.920 this is a typical exercise that epidemiologists engage in.

00:21:50.920 --> 00:21:54.840 And if you do that, you find very distressingly

00:21:54.840 --> 00:21:56.850 that the SARS-2 pandemic

00:21:56.850 --> 00:22:01.820 falls between the 1957 influenza A pandemic,

00:22:01.820 --> 00:22:04.470 which was the second deadliest pandemic

00:22:04.470 --> 00:22:06.760 we've had in the last hundred years.

00:22:06.760 --> 00:22:10.100 And the 1918 pandemic, which is the deadliest.

00:22:10.100 --> 00:22:13.500 So, this is a serious pathogen SARS-CoV-2.

00:22:13.500 --> 00:22:17.300 It's right there in between the upper right corner is 1918,

00:22:17.300 --> 00:22:18.680 it's not as bad as that,

00:22:18.680 --> 00:22:20.757 but it's worse than 1957

00:22:22.130 --> 00:22:25.063 when you look at these two numerical parameters.

00:22:26.430 --> 00:22:29.630 And in fact, it was clear to many people in certainly

00:22:29.630 --> 00:22:32.270 by February, that without action,

00:22:32.270 --> 00:22:34.170 many people would die.

00:22:34.170 --> 00:22:36.950 I think hundreds of thousands of Americans would have died,

00:22:36.950 --> 00:22:38.410 had we done nothing.

00:22:38.410 --> 00:22:39.800 And unfortunately, I still think

00:22:39.800 --> 00:22:41.560 that hundreds of thousands will die.

00:22:41.560 --> 00:22:43.850 We've already had 100,000 deaths,

00:22:43.850 --> 00:22:47.010 I think we're gonna very likely have at least another couple

00:22:47.010 --> 00:22:48.510 of hundred thousand deaths

00:22:48.510 --> 00:22:52.290 before the epidemic ultimately winds down

00:22:52.290 --> 00:22:54.540 in two or three years.

00:22:54.540 --> 00:22:55.990 And this partly relates to the fact

00:22:55.990 --> 00:22:57.570 that we're gonna have more waves,

00:22:57.570 --> 00:22:59.320 which is a point I'll come back to.

00:23:00.470 --> 00:23:04.250 The disease itself has very wide range of presentations,

00:23:04.250 --> 00:23:07.240 from asymptomatic to mild to critical

00:23:07.240 --> 00:23:09.110 and can affect many organ systems,

00:23:09.110 --> 00:23:11.480 not just the upper airway or the lungs,

00:23:11.480 --> 00:23:14.160 but also the heart and the kidneys

00:23:15.875 --> 00:23:18.290 and the intestinal system and so forth.

00:23:18.290 --> 00:23:21.060 And the symptomatology is very protein as well.

00:23:21.060 --> 00:23:22.477 People manifest a great variety of symptoms.

00:23:22.477 --> 00:23:24.990 There are three clusters of symptoms,

00:23:24.990 --> 00:23:28.080 most are respiratory cough, shortness of breath, fever.

00:23:28.080 --> 00:23:31.930 Some are the musculoskeletal system, fatigue,

00:23:31.930 --> 00:23:34.060 muscle pains, joint pains.

00:23:34.060 --> 00:23:36.830 And some are intera, diarrhea, vomiting,

00:23:36.830 --> 00:23:39.453 nausea, and again, maybe a fever.

00:23:41.740 --> 00:23:44.820 The case fatality rate for this respiratory,

00:23:44.820 --> 00:23:46.890 for respiratory diseases in general

00:23:46.890 --> 00:23:49.500 typically varies with age.

00:23:49.500 --> 00:23:54.060 And most most of the respiratory pandemics

00:23:54.060 --> 00:23:57.060 of the last century have had a U-shaped function.

00:23:57.060 --> 00:23:59.580 So the very young and the very old

00:23:59.580 --> 00:24:01.373 are at the greatest risk of death.

00:24:02.510 --> 00:24:07.020 Famously, in 1918, there was a W-shaped function.

00:24:07.020 --> 00:24:08.300 There's some interesting theories

00:24:08.300 --> 00:24:09.610 if we have time and you're interested,

00:24:09.610 --> 00:24:11.540 I can tell you what some other scientists

00:24:11.540 --> 00:24:14.840 have speculated as to why it was a W, the very young,

00:24:14.840 --> 00:24:17.403 very old were killed and middle aged,

00:24:18.330 --> 00:24:22.563 sort of working age young adults, 20s and 30s were killed.

00:24:23.710 --> 00:24:25.430 And then finally, there's an L-shaped

00:24:25.430 --> 00:24:27.580 or backward L-shaped curve.

00:24:27.580 --> 00:24:30.530 So polio has a regular L-shape curve.

00:24:30.530 --> 00:24:32.960 So polio pandemics, they kill the young

00:24:32.960 --> 00:24:34.870 and they sort of spare the old.

00:24:34.870 --> 00:24:38.190 But Coronavirus has a backward L-shaped,

00:24:38.190 --> 00:24:40.850 it spares the young and kills the old

00:24:40.850 --> 00:24:42.640 and this is unusual,

00:24:42.640 --> 00:24:44.833 very unusual actually for a pathogen,

00:24:46.420 --> 00:24:48.240 and the fatality rate rises

00:24:48.240 --> 00:24:52.000 from about one out of 3000 people younger than 20.

00:24:52.000 --> 00:24:54.860 The case fatality rate so conditional on getting sick,

00:24:54.860 --> 00:24:57.030 one out of 3000 people will die

00:24:57.030 --> 00:24:58.780 to about one out of 100 for people

00:24:58.780 --> 00:25:01.030 in their late 50s, early 60s

00:25:01.030 --> 00:25:05.010 to about one out of five for people who are older than 80.

00:25:05.010 --> 00:25:08.593 So pretty sharp L-shaped curve.

00:25:09.820 --> 00:25:12.193 And I found it very poignant,

00:25:13.340 --> 00:25:14.830 almost biblical actually

00:25:14.830 --> 00:25:18.510 and sweet that this epidemic spared the young

00:25:18.510 --> 00:25:20.040 because, you know, the young,

00:25:20.040 --> 00:25:23.390 the leading killer of young children is infectious disease,

00:25:23.390 --> 00:25:25.480 something like 60% of kids

00:25:25.480 --> 00:25:28.773 under five worldwide die of infections.

00:25:30.040 --> 00:25:32.660 And the fact that this virus spared them

00:25:32.660 --> 00:25:34.423 was very pleasing to me.

00:25:35.410 --> 00:25:38.530 And moving actually, and as a parent,

00:25:38.530 --> 00:25:40.760 I didn't have to worry about my college age kids

00:25:40.760 --> 00:25:42.900 or we have a new child but Eric

00:25:42.900 --> 00:25:44.150 and I do that's 10 years old,

00:25:44.150 --> 00:25:47.253 and so we didn't have to worry about him, which was helpful.

00:25:48.520 --> 00:25:50.520 Now, another important part of the epidemiology

00:25:50.520 --> 00:25:51.830 of this condition is something known

00:25:51.830 --> 00:25:53.720 as the incubation period.

00:25:53.720 --> 00:25:58.720 Incubation period is the time between being infected

00:25:58.900 --> 00:26:00.850 and developing symptoms.

00:26:00.850 --> 00:26:03.910 And that is between two and 24 days,

00:26:03.910 --> 00:26:06.730 I'm sorry, two and 14 days,

00:26:06.730 --> 00:26:09.720 the incubation period varies between two and 14 days,

00:26:09.720 --> 00:26:13.040 more precise estimates of this have shown recently

00:26:13.040 --> 00:26:18.040 and people are studying this a lot, that 97.5% of people,

00:26:19.120 --> 00:26:21.130 if they're going to get symptoms,

00:26:21.130 --> 00:26:24.693 after being infected, get them by 11 and a half days.

00:26:25.600 --> 00:26:27.810 So, people are still studying the details of this,

00:26:27.810 --> 00:26:29.860 but the gist is that early on,

00:26:29.860 --> 00:26:33.460 it was established that 95% of cases got symptoms

00:26:33.460 --> 00:26:35.640 within the first 14 days of infection.

00:26:35.640 --> 00:26:39.000 And this is the origin of the 14 day quarantine

00:26:39.000 --> 00:26:41.740 that we have all been practicing.

00:26:41.740 --> 00:26:45.510 There's a different quantity known as the latency period.

00:26:45.510 --> 00:26:48.150 This is the time from infection to infectiousness,

00:26:48.150 --> 00:26:49.670 how long between when you're infected

00:26:49.670 --> 00:26:54.270 and can infect others and very sadly for us

00:26:54.270 --> 00:26:59.270 in this pathogen, unlike SARS-1 in 2003,

00:26:59.560 --> 00:27:01.860 this latency period can be a couple of days

00:27:01.860 --> 00:27:05.140 shorter than the incubation period.

00:27:05.140 --> 00:27:08.290 That means that people can spread the infection

00:27:08.290 --> 00:27:10.420 when they're asymptomatic.

00:27:10.420 --> 00:27:12.380 And many estimates from China and Italy

00:27:12.380 --> 00:27:15.520 and England suggest that the majority of cases,

00:27:15.520 --> 00:27:18.883 the bare majority maybe or sometimes the great majority,

00:27:20.170 --> 00:27:23.105 arise from this type of transmission.

00:27:23.105 --> 00:27:26.340 So most people become infected from other people

00:27:26.340 --> 00:27:28.880 who don't have symptoms let's say.

00:27:28.880 --> 00:27:30.330 The difference between these two

00:27:30.330 --> 00:27:32.810 is known as the mismatch period.

00:27:32.810 --> 00:27:34.110 Actually, in veterinary medicine,

00:27:34.110 --> 00:27:35.280 there's some veterinary scientists

00:27:35.280 --> 00:27:37.150 that call it the Omega period,

00:27:37.150 --> 00:27:39.240 which I think is kind of interesting

00:27:39.240 --> 00:27:41.490 when you think about the implications for us.

00:27:43.910 --> 00:27:47.060 In some cases, the latency period

00:27:47.060 --> 00:27:49.510 is shorter than the incubation period,

00:27:49.510 --> 00:27:51.563 for example, like in HIV.

00:27:52.731 --> 00:27:55.630 So people with HIV can be infectious for years

00:27:55.630 --> 00:27:57.590 before they have symptoms,

00:27:57.590 --> 00:28:00.510 that makes the disease difficult to control,

00:28:00.510 --> 00:28:03.190 or the latency period can be equal to

00:28:03.190 --> 00:28:07.520 or longer than the incubation period, like smallpox.

00:28:07.520 --> 00:28:09.620 You have to get smallpox vesicles

00:28:09.620 --> 00:28:12.120 on your body before you can infect other people.

00:28:12.120 --> 00:28:14.620 So we can see who's infected.

00:28:14.620 --> 00:28:17.527 And that makes quarantine so much easier

00:28:17.527 --> 00:28:19.123 and so much effective.

00:28:20.780 --> 00:28:23.820 So the fact that there is a negative mismatch period,

00:28:23.820 --> 00:28:25.530 that is to say that the latency is shorter

00:28:25.530 --> 00:28:27.490 than the intubation on average.

00:28:27.490 --> 00:28:29.510 And this condition is one of the things

00:28:29.510 --> 00:28:32.973 that makes it so nasty and difficult to treat.

00:28:33.960 --> 00:28:35.610 In terms of transmission modes,

00:28:35.610 --> 00:28:37.360 there's a lot of ongoing research on this,

00:28:37.360 --> 00:28:39.800 it's clear that the primary mode

00:28:39.800 --> 00:28:43.650 is through respiratory droplets, people coughing,

00:28:43.650 --> 00:28:46.530 or speaking loudly or singing.

00:28:46.530 --> 00:28:48.210 There have been a number of super spreading operates

00:28:48.210 --> 00:28:50.683 associated with singing or yelling.

00:28:52.480 --> 00:28:53.560 But there's also evidence

00:28:53.560 --> 00:28:55.070 that there's airborne transmission

00:28:55.070 --> 00:28:57.360 which is small little parts of droplets

00:28:57.360 --> 00:28:58.890 come out of your mouth and fall down,

00:28:58.890 --> 00:29:01.400 which is why wearing a mask is effective.

00:29:01.400 --> 00:29:03.670 Airborne droplets can stay suspended

00:29:03.670 --> 00:29:05.540 in the air and spread farther.

00:29:05.540 --> 00:29:07.400 There is airborne transmission.

00:29:07.400 --> 00:29:09.560 But it's not so bad.

00:29:09.560 --> 00:29:11.850 We don't think in this condition.

00:29:11.850 --> 00:29:13.290 Although well, I won't go into it.

00:29:13.290 --> 00:29:14.640 There's some examples.

00:29:14.640 --> 00:29:16.510 There's also spread by fomites,

00:29:16.510 --> 00:29:18.940 that's surfaces that we touch.

00:29:18.940 --> 00:29:21.430 Although this is increasingly not seen

00:29:21.430 --> 00:29:23.800 as a major vehicle for transmission,

00:29:23.800 --> 00:29:25.480 there's also fecal transmission

00:29:25.480 --> 00:29:28.270 although again, this is not a major explanation

00:29:28.270 --> 00:29:30.120 for what's happening in the epidemic.

00:29:31.010 --> 00:29:35.520 Now, how do humans respond to epidemics?

00:29:35.520 --> 00:29:39.450 Well, the broad division is pharmaceutical interventions,

00:29:39.450 --> 00:29:42.270 and so called non-pharmaceutical interventions.

00:29:42.270 --> 00:29:44.200 We don't have any pharmaceutical interventions

00:29:44.200 --> 00:29:45.360 really for this pathogen.

00:29:45.360 --> 00:29:46.630 We have no vaccines for it,

00:29:46.630 --> 00:29:47.810 although we're working on it.

00:29:47.810 --> 00:29:50.570 We have no drugs, although Remdesivir

00:29:50.570 --> 00:29:53.480 has recently been felt to have some benefit

00:29:53.480 --> 00:29:55.760 it's modest benefit and we don't have drugs,

00:29:55.760 --> 00:29:57.410 and in general viruses are very difficult

00:29:57.410 --> 00:29:59.870 to treat, antiviral medications generally

00:29:59.870 --> 00:30:02.760 are weak in their effectiveness.

00:30:02.760 --> 00:30:07.760 So, just like plague is an ancient threat to human beings,

00:30:09.440 --> 00:30:11.900 we have to respond to a familiar enemy

00:30:11.900 --> 00:30:14.520 with a familiar response,

00:30:14.520 --> 00:30:16.610 which is physical distancing.

00:30:16.610 --> 00:30:18.710 People have been physical distancing

00:30:18.710 --> 00:30:21.240 in times of plague for centuries.

00:30:21.240 --> 00:30:24.440 And unfortunately, that's what we have to do.

00:30:24.440 --> 00:30:28.720 We have to engage in a non-pharmaceutical interventions.

00:30:28.720 --> 00:30:29.770 There are two broad kinds

00:30:29.770 --> 00:30:31.870 of non-pharmaceutical interventions,

00:30:31.870 --> 00:30:35.820 individual interventions, things like hand washing,

00:30:35.820 --> 00:30:39.590 or mask wearing, or self-isolation

00:30:39.590 --> 00:30:41.050 and collective interventions

00:30:41.050 --> 00:30:43.680 that required the action of groups of people

00:30:43.680 --> 00:30:47.930 or the state, border closures, collective hygiene,

00:30:47.930 --> 00:30:50.240 you know, cleaning the subways for example,

00:30:50.240 --> 00:30:53.820 testing and tracing, bans on gatherings,

00:30:53.820 --> 00:30:58.820 school closures, and ultimately stay at home orders.

00:30:58.940 --> 00:31:00.590 And these two classes,

00:31:00.590 --> 00:31:02.390 these non-pharmaceutical interventions

00:31:02.390 --> 00:31:06.020 can be divided into individual and collective,

00:31:06.020 --> 00:31:08.560 but they can be divided in a different way

00:31:08.560 --> 00:31:11.730 in what are known as transmission reduction

00:31:11.730 --> 00:31:13.580 and contact reduction.

00:31:13.580 --> 00:31:15.300 So transmission reduction are things

00:31:15.300 --> 00:31:17.120 that try to reduce the likelihood

00:31:17.120 --> 00:31:18.920 that conditional on my interacting

00:31:18.920 --> 00:31:20.360 with you, I give you the germ.

00:31:20.360 --> 00:31:22.300 So wearing a mask or washing my hands

00:31:22.300 --> 00:31:24.250 or sanitation measures

00:31:24.250 --> 00:31:27.530 might be transmission reduction measures.

00:31:27.530 --> 00:31:31.320 But contact reduction or condom use

00:31:31.320 --> 00:31:35.150 in the case of HIV is a transmission reduction intervention.

00:31:35.150 --> 00:31:36.750 And contact reduction

00:31:36.750 --> 00:31:40.100 is when you try to reduce the amount of social mixing.

00:31:40.100 --> 00:31:44.330 So gathering bands, self isolation, school closures,

00:31:44.330 --> 00:31:47.470 or in the case of HIV reduction and partner number,

00:31:47.470 --> 00:31:51.210 those are examples of contact reduction interventions.

00:31:51.210 --> 00:31:53.690 And the point of these interventions

00:31:53.690 --> 00:31:57.023 however we taxonomise them, is to flatten the curve.

00:31:57.880 --> 00:31:59.040 We've all heard about that now,

00:31:59.040 --> 00:32:01.420 but why are we trying to flatten the curve?

00:32:01.420 --> 00:32:02.930 We're trying to spread out,

00:32:02.930 --> 00:32:04.270 we're trying to this wave

00:32:04.270 --> 00:32:05.980 is about to hit us with a new pathogen

00:32:05.980 --> 00:32:07.420 for which we have no immunity.

00:32:07.420 --> 00:32:09.290 And the force, the compressive force

00:32:09.290 --> 00:32:11.410 of the wave is gonna hit us,

00:32:11.410 --> 00:32:13.900 what we're trying to do is deaden the wave, slow it down,

00:32:13.900 --> 00:32:16.180 like build breakwaters offshore,

00:32:16.180 --> 00:32:19.860 so maybe even if the same amount of water comes ashore,

00:32:19.860 --> 00:32:22.073 it will come ashore with lower intensity.

00:32:23.270 --> 00:32:24.370 So that's what we're trying to do.

00:32:24.370 --> 00:32:26.710 We're trying to flatten the curve.

00:32:26.710 --> 00:32:28.550 And what we mean by that

00:32:28.550 --> 00:32:31.360 is that we are going to allow the healthcare system

00:32:31.360 --> 00:32:33.570 and the supply chains time to work.

00:32:33.570 --> 00:32:35.070 By flattening the curve,

00:32:35.070 --> 00:32:36.810 maybe we can save more lives

00:32:36.810 --> 00:32:39.270 by not overwhelming our healthcare system.

00:32:39.270 --> 00:32:40.163 That's one bit.

00:32:41.050 --> 00:32:43.230 The second reason we flatten the curve

00:32:43.230 --> 00:32:45.030 is that it postpones some cases

00:32:45.030 --> 00:32:47.023 and deaths into the future,

00:32:47.880 --> 00:32:50.160 at which time we might have a vaccine,

00:32:50.160 --> 00:32:52.060 that might prevent some of the deaths

00:32:52.060 --> 00:32:53.460 or we might have better knowledge

00:32:53.460 --> 00:32:55.020 of how to treat the condition.

00:32:55.020 --> 00:32:57.400 Again, reducing the total number of deaths.

00:32:57.400 --> 00:32:59.830 So flattening the curve could reduce deaths

00:32:59.830 --> 00:33:04.260 in this way as well merely by the postponement function.

00:33:04.260 --> 00:33:05.820 And finally flattening the curve

00:33:05.820 --> 00:33:09.750 may be beneficial because it postpones some of the cases

00:33:09.750 --> 00:33:12.830 to occur at a time when the pathogen might,

00:33:12.830 --> 00:33:16.800 if we're lucky, have mutated to be less deadly.

00:33:16.800 --> 00:33:18.590 Remember, we mentioned this earlier.

00:33:18.590 --> 00:33:20.750 So if the pathogen has become less deadly,

00:33:20.750 --> 00:33:22.540 people will become infected in the future,

00:33:22.540 --> 00:33:26.330 we'll get a milder variant of the disease.

00:33:26.330 --> 00:33:29.570 But to be clear, what flattening the curve does not do

00:33:31.546 --> 00:33:33.790 is eradicate the pathogen.

00:33:33.790 --> 00:33:36.400 What we are doing is stopping transmission,

00:33:36.400 --> 00:33:38.790 not killing the germ.

00:33:38.790 --> 00:33:42.300 The pathogen is still there, and it's going to come back.

00:33:42.300 --> 00:33:44.300 It's coming back in Asia,

00:33:44.300 --> 00:33:46.630 it's gonna come back in the United States,

00:33:46.630 --> 00:33:49.380 there is no escaping from this.

00:33:49.380 --> 00:33:51.900 The pathogen is now a feature of our environment

00:33:51.900 --> 00:33:53.653 with which we must cope.

00:33:55.000 --> 00:33:57.010 Now, one of the features of this pandemic

00:33:57.010 --> 00:33:58.600 I won't spend much time on it

00:33:58.600 --> 00:34:01.270 is the affliction of healthcare workers,

00:34:01.270 --> 00:34:04.300 why health care workers were at special risk.

00:34:04.300 --> 00:34:06.620 This increased risk of healthcare workers

00:34:06.620 --> 00:34:09.040 has been noted since time immemorial.

00:34:09.040 --> 00:34:10.990 Thucydides in the plague of Athens

00:34:10.990 --> 00:34:13.940 in 430 BC, talks about how doctors

00:34:13.940 --> 00:34:15.800 are dying in greater numbers

00:34:15.800 --> 00:34:17.060 and knew the reason.

00:34:17.060 --> 00:34:18.670 It's because they're having contact

00:34:18.670 --> 00:34:20.080 with sick patients.

00:34:20.080 --> 00:34:22.330 The same thing is happening in our society

00:34:22.330 --> 00:34:25.320 and happened in China and happened in Italy.

00:34:25.320 --> 00:34:27.160 And part of the reason they're at special risk

00:34:27.160 --> 00:34:28.670 is that health care workers

00:34:28.670 --> 00:34:30.960 in the course of caring for path people,

00:34:30.960 --> 00:34:32.390 especially when they have not had

00:34:32.390 --> 00:34:35.460 adequate personal protective equipment,

00:34:35.460 --> 00:34:39.600 the lack of which has enraged me, in our society.

00:34:39.600 --> 00:34:42.530 The reason is they get high viral inoculum.

00:34:42.530 --> 00:34:44.080 So they're up close working with the patient,

00:34:44.080 --> 00:34:46.320 the patient coughs in their face.

00:34:46.320 --> 00:34:49.860 So they, you might get the germ from touching something

00:34:49.860 --> 00:34:53.600 in the subway, or interacting with a colleague at work

00:34:53.600 --> 00:34:56.620 who speaks loudly and some number of particles

00:34:56.620 --> 00:34:57.680 leave that person's mouth

00:34:57.680 --> 00:35:01.380 and enter your body, by the time those viruses

00:35:01.380 --> 00:35:04.070 are able to multiply, your body might be able

00:35:04.070 --> 00:35:07.020 to mount an immune system, immune response

00:35:07.020 --> 00:35:08.870 and clamp down on the infection

00:35:08.870 --> 00:35:11.560 so you don't get a serious infection.

00:35:11.560 --> 00:35:14.910 But a healthcare worker getting a high viral load,

00:35:14.910 --> 00:35:19.910 a large inoculum actually can't do that, is overwhelmed,

00:35:20.020 --> 00:35:21.670 their body is overwhelmed.

00:35:21.670 --> 00:35:23.410 And there's a very moving website

00:35:23.410 --> 00:35:26.470 that's tracking the needs of healthcare workers

00:35:26.470 --> 00:35:29.310 around the world who have died during this pandemic

00:35:29.310 --> 00:35:31.103 and it's growing every day.

00:35:32.750 --> 00:35:34.040 Other places of outbreaks

00:35:34.040 --> 00:35:37.523 have been nursing homes, prisons, ships.

00:35:38.730 --> 00:35:40.270 You've all heard about the cruise ships

00:35:40.270 --> 00:35:42.870 and of course the aircraft carrier

00:35:42.870 --> 00:35:44.640 and meatpacking plants,

00:35:44.640 --> 00:35:46.620 which is a very interesting if you want,

00:35:46.620 --> 00:35:49.430 we can talk a little bit about the packing plants.

00:35:49.430 --> 00:35:52.210 The burden of this illness falls harder on men.

00:35:52.210 --> 00:35:55.050 Men are more likely to die to get it and to die.

00:35:55.050 --> 00:35:57.140 But equally likely to get it

00:35:57.140 --> 00:35:59.870 but they're more likely to die than women.

00:35:59.870 --> 00:36:02.250 And as is typical of infectious diseases,

00:36:02.250 --> 00:36:04.060 it's socially stratified,

00:36:04.060 --> 00:36:07.250 the poor and the marginalized and the sick

00:36:07.250 --> 00:36:11.563 are more prone to die of this condition.

00:36:13.180 --> 00:36:16.030 Now, let's turn briefly to this issue of waves

00:36:16.030 --> 00:36:17.193 of the pandemic.

00:36:19.750 --> 00:36:20.720 Because I think

00:36:22.470 --> 00:36:23.853 it's a serious problem.

00:36:24.960 --> 00:36:27.980 Every respiratory pandemic, in the last century

00:36:27.980 --> 00:36:29.767 has had multiple waves.

00:36:29.767 --> 00:36:32.720 And these typically recur in the fall.

00:36:32.720 --> 00:36:33.940 Not always, I think,

00:36:33.940 --> 00:36:37.150 because of all the protests that we've seen and the rush

00:36:37.150 --> 00:36:42.150 to even before the protest, the rush to leave the lockdowns,

00:36:42.220 --> 00:36:44.400 I think we're gonna see an earlier wave

00:36:44.400 --> 00:36:45.503 in the United States.

00:36:46.620 --> 00:36:50.490 And these waves typically come every year

00:36:50.490 --> 00:36:51.580 for two or three years

00:36:51.580 --> 00:36:55.203 until eventually the epidemic becomes endemic in us.

00:36:56.050 --> 00:37:01.010 We saw waves in 2009 with a very mild H1N1 pandemic,

00:37:01.010 --> 00:37:03.210 there was a pandemic in 2009,

00:37:03.210 --> 00:37:04.900 but that pathogen was not very deadly.

00:37:04.900 --> 00:37:06.360 So nobody noticed.

00:37:06.360 --> 00:37:08.420 It was actually less deadly than the flu.

00:37:08.420 --> 00:37:09.830 So it circulated the whole world

00:37:09.830 --> 00:37:12.720 there were waves, we can see the waves of H1N1,

00:37:12.720 --> 00:37:15.850 but we didn't care because it didn't kill very many people.

00:37:15.850 --> 00:37:19.090 The 1918 pandemic,

00:37:19.090 --> 00:37:22.490 the second wave famously came out of phase

00:37:22.490 --> 00:37:23.323 with the first wave.

00:37:23.323 --> 00:37:24.540 There's some interesting theories

00:37:24.540 --> 00:37:27.140 as to why and was much four times

00:37:27.140 --> 00:37:29.120 as deadly as the first wave.

00:37:29.120 --> 00:37:32.417 We have no way of knowing how deadly the Coronavirus

00:37:32.417 --> 00:37:34.123 the second wave will be.

00:37:35.250 --> 00:37:37.750 But I don't believe it'll be less deadly

00:37:37.750 --> 00:37:41.500 than the first wave for various reasons.

00:37:41.500 --> 00:37:42.730 Now the reason for the occurrence

00:37:42.730 --> 00:37:45.300 of these waves, it's complicated.

00:37:45.300 --> 00:37:47.770 It has to do with human behavior in part,

00:37:47.770 --> 00:37:50.030 which is the fact that people return to school

00:37:50.030 --> 00:37:52.600 and move indoors with the coming of the fall

00:37:52.600 --> 00:37:53.880 and it gets colder.

00:37:53.880 --> 00:37:56.820 It has perhaps to do with environmental factors

00:37:56.820 --> 00:37:57.960 to the extent that heat

00:37:57.960 --> 00:37:59.820 and humidity affect the spread

00:37:59.820 --> 00:38:03.490 or modify our body's resistance to the pathogen.

00:38:03.490 --> 00:38:05.840 And of course, the epidemic right now has gone

00:38:05.840 --> 00:38:08.520 to the southern hemisphere and is raging there.

00:38:08.520 --> 00:38:11.210 And Brazil is having for a number of reasons,

00:38:11.210 --> 00:38:12.710 including that it didn't make any efforts

00:38:12.710 --> 00:38:14.090 to do anything about it.

00:38:14.090 --> 00:38:16.940 You know, many, many hundreds of thousands of people

00:38:16.940 --> 00:38:19.113 are going to die in Brazil.

00:38:19.990 --> 00:38:21.543 Incidentally, I should mention.

00:38:23.350 --> 00:38:25.450 I'll just take a small digression

00:38:25.450 --> 00:38:28.830 that there's a lot of geographic variation

00:38:28.830 --> 00:38:30.260 with these respiratory pandemics.

00:38:30.260 --> 00:38:32.010 And we don't fully know the reason.

00:38:32.010 --> 00:38:34.900 For example, in the 1957 pandemic,

00:38:34.900 --> 00:38:36.790 there was a 30-fold variation

00:38:36.790 --> 00:38:38.440 in the final attack rate,

00:38:38.440 --> 00:38:40.520 the number of people that got the disease.

00:38:40.520 --> 00:38:45.520 So Chile was really hard hit and Egypt was spared in 1957.

00:38:45.940 --> 00:38:47.540 We're gonna say that see the same thing

00:38:47.540 --> 00:38:49.770 with this pandemic, some parts of the country

00:38:49.770 --> 00:38:51.290 will be very hard hit,

00:38:51.290 --> 00:38:53.710 other parts of the country will not,

00:38:53.710 --> 00:38:57.070 some countries in the world will be hard hit, some will not.

00:38:57.070 --> 00:39:00.260 Sometimes this will have to do with the temperature

00:39:00.260 --> 00:39:02.420 in the region, sometimes it'll have to do with what

00:39:02.420 --> 00:39:04.280 the nations did in response.

00:39:04.280 --> 00:39:06.940 But mostly, most of the variants will be chance,

00:39:06.940 --> 00:39:10.080 as far as we can tell from previous analyses

00:39:10.080 --> 00:39:12.980 of geographic variation in the pandemic.

00:39:12.980 --> 00:39:17.130 Anyway, Brazil is being hard hit at the moment.

00:39:17.130 --> 00:39:19.220 But the point I wanna make about this

00:39:19.220 --> 00:39:23.230 is that these waves illustrate the fundamental point.

00:39:23.230 --> 00:39:27.230 But this epidemic is going to become endemic among us.

00:39:27.230 --> 00:39:29.383 Either we will develop herd immunity,

00:39:30.810 --> 00:39:33.130 probably at around 50%, ultimately,

00:39:33.130 --> 00:39:34.720 of people will be required.

00:39:34.720 --> 00:39:37.490 And we can talk about, there's a subtle detail here.

00:39:37.490 --> 00:39:40.580 So, if you can compute the fraction of people

00:39:40.580 --> 00:39:41.720 that need to be infected

00:39:41.720 --> 00:39:44.720 before you get herd immunity naturally infected

00:39:44.720 --> 00:39:47.610 and naturally immune before you get herd immunity,

00:39:47.610 --> 00:39:48.580 with a little formula

00:39:48.580 --> 00:39:51.290 that relies on the R naught of the pathogen,

00:39:51.290 --> 00:39:53.630 as we mentioned earlier, in the case of measles,

00:39:53.630 --> 00:39:56.330 this epidemic has an R,

00:39:56.330 --> 00:39:57.970 let's say around two and a half,

00:39:57.970 --> 00:40:00.900 it means that about 60% of people need to be immune

00:40:00.900 --> 00:40:04.543 before the epidemic goes away.

00:40:06.209 --> 00:40:10.550 But actually, you can sometimes reach herd immunity

00:40:10.550 --> 00:40:12.200 at lower percentages,

00:40:12.200 --> 00:40:15.170 because of the fact that human populations

00:40:15.170 --> 00:40:16.750 are not well mixed,

00:40:16.750 --> 00:40:19.170 they have a structured, a network structure.

00:40:19.170 --> 00:40:24.150 So typically popular people are more likely to get infected

00:40:24.150 --> 00:40:26.280 and therefore more likely to get immune.

00:40:26.280 --> 00:40:27.880 And once they become immune,

00:40:27.880 --> 00:40:30.300 they're no longer pathways for the movement,

00:40:30.300 --> 00:40:33.340 they're no longer vectors for the movement of the pathogen.

00:40:33.340 --> 00:40:35.630 So in fact, if you immunize,

00:40:35.630 --> 00:40:38.090 let's say, 30% of the most popular people

00:40:38.090 --> 00:40:40.790 in a population, you could reach herd immunity

00:40:40.790 --> 00:40:42.620 at lower percentages.

00:40:42.620 --> 00:40:43.910 So, in practice,

00:40:43.910 --> 00:40:46.360 what we typically find is that herd immunity

00:40:46.360 --> 00:40:48.740 is reached at a lower percentage.

00:40:48.740 --> 00:40:51.920 This is, you know, the pre-pharmaceutical era

00:40:51.920 --> 00:40:55.040 at a lower percentage than you would predict

00:40:55.040 --> 00:40:56.630 based on the amount of the R naught of the pathogen,

00:40:56.630 --> 00:40:59.190 for example in 1957,

00:40:59.190 --> 00:41:02.430 the epidemic maxed out at around 40%,

00:41:02.430 --> 00:41:03.487 was the final attack rate,

00:41:03.487 --> 00:41:07.160 you know from retrospective serology studies

00:41:07.160 --> 00:41:09.393 that were done after the epidemic.

00:41:12.189 --> 00:41:14.150 So, in our case with this pandemic,

00:41:14.150 --> 00:41:17.920 either we will get herd immunity, or we will get a vaccine.

00:41:17.920 --> 00:41:22.920 And I've now concluded that for whatever it's worth,

00:41:23.010 --> 00:41:25.550 that it doesn't really matter which of those two we get

00:41:25.550 --> 00:41:28.760 to first because there'll be approximately at the same time,

00:41:28.760 --> 00:41:30.920 the likelihood that we will be able to invent

00:41:30.920 --> 00:41:35.920 a good vaccine, fast enough, manufactured

00:41:35.990 --> 00:41:40.020 and distributed fast enough to outstrip

00:41:40.020 --> 00:41:42.880 the inevitable herd immunity seems low to me.

00:41:42.880 --> 00:41:45.300 I do think we will get a vaccine eventually,

00:41:45.300 --> 00:41:47.320 but I'm no longer putting my hopes

00:41:47.320 --> 00:41:50.440 in that as an exit strategy for this pandemic.

00:41:50.440 --> 00:41:51.273 Maybe we'll get lucky.

00:41:51.273 --> 00:41:53.770 I hope I'm disproven,

00:41:53.770 --> 00:41:56.690 not disprove it, but I hope that doesn't prove

00:41:56.690 --> 00:41:57.533 to be the case.

00:41:59.470 --> 00:42:01.350 So the attack rate if you multiply

00:42:01.350 --> 00:42:02.620 all these quantities together

00:42:02.620 --> 00:42:03.980 that I've been telling you,

00:42:03.980 --> 00:42:05.260 in the end for this pandemic,

00:42:05.260 --> 00:42:08.930 in my view will be 40 to 50%.

00:42:08.930 --> 00:42:11.583 Maybe more probably higher if we overshoot,

00:42:12.780 --> 00:42:14.860 which is another thing, you know,

00:42:14.860 --> 00:42:16.530 the epidemic rages onward

00:42:16.530 --> 00:42:19.333 before we have a time to actually catch up with it.

00:42:20.645 --> 00:42:23.830 And this partly relates to the issue of who are,

00:42:23.830 --> 00:42:26.230 you know, like I already said, the popular people

00:42:26.230 --> 00:42:28.493 and the acquisition of immunity.

00:42:29.910 --> 00:42:32.610 Now, where do we stand with this pandemic so far?

00:42:32.610 --> 00:42:34.350 If you look at Cyril prevalence studies

00:42:34.350 --> 00:42:36.070 to date in Sweden,

00:42:36.070 --> 00:42:39.340 which has adopted a pretty mild approach

00:42:39.340 --> 00:42:40.430 to coping with it.

00:42:40.430 --> 00:42:44.300 Nationwide there are about 4% of people have had the disease

00:42:44.300 --> 00:42:46.700 and are now immune, I think in Stockholm

00:42:46.700 --> 00:42:48.580 with seven or eight or 9%

00:42:48.580 --> 00:42:51.620 in the most densely populated part of Sweden.

00:42:51.620 --> 00:42:53.690 In New York City, it's about 21%

00:42:53.690 --> 00:42:56.300 we know from a good study,

00:42:56.300 --> 00:42:58.880 and in various era prevalence studies,

00:42:58.880 --> 00:43:00.480 no one has really done a perfect study

00:43:00.480 --> 00:43:02.200 at anywhere in the United States.

00:43:02.200 --> 00:43:04.610 We've been thinking in my lab of doing such a study

00:43:04.610 --> 00:43:06.170 in the Greater New Haven area,

00:43:06.170 --> 00:43:07.900 picking a random sample of New Haveners,

00:43:07.900 --> 00:43:10.930 and then following them prospectively.

00:43:10.930 --> 00:43:13.700 Most people have done others sub-optimal.

00:43:13.700 --> 00:43:14.630 And I don't criticize them,

00:43:14.630 --> 00:43:19.410 it's difficult to get a random sample of people.

00:43:19.410 --> 00:43:23.150 But if I had to guess, in our cities,

00:43:23.150 --> 00:43:26.910 probably we are at no more than 2, 3, 4, 5%

00:43:26.910 --> 00:43:28.180 around the country.

00:43:28.180 --> 00:43:30.310 So if we're gonna get to an attack rate of 40,

00:43:30.310 --> 00:43:34.223 or 50%, we have a long way to go unfortunately.

00:43:35.640 --> 00:43:36.850 I think it's important to note

00:43:36.850 --> 00:43:39.510 that the United States response to the pandemic

00:43:39.510 --> 00:43:43.000 has been awful, has been completely incompetent frankly.

00:43:43.000 --> 00:43:45.770 And the failures in my judgment have occurred

00:43:45.770 --> 00:43:49.000 at multiple levels of government, but certainly,

00:43:49.000 --> 00:43:50.980 at the White House,

00:43:50.980 --> 00:43:52.000 has, you know,

00:43:52.000 --> 00:43:54.710 there's been an appalling lack of coordination.

00:43:54.710 --> 00:43:57.570 I think the expertise at the CDC was there,

00:43:57.570 --> 00:43:59.970 but there were men with deep expertise

00:43:59.970 --> 00:44:03.210 at the CDC and deep expertise at the National Institute

00:44:03.210 --> 00:44:06.113 of Allergic and Infectious Diseases,

00:44:08.070 --> 00:44:10.010 but it hasn't been deployed properly.

00:44:10.010 --> 00:44:11.100 But I also think it's fair to say

00:44:11.100 --> 00:44:12.590 that many of the state governments

00:44:12.590 --> 00:44:13.930 were caught flat footed.

00:44:13.930 --> 00:44:16.130 And let's also acknowledge that many European countries

00:44:16.130 --> 00:44:17.940 that didn't have the incompetence

00:44:17.940 --> 00:44:20.030 at the level of the White House

00:44:20.030 --> 00:44:21.720 also seem to have been caught flat footed.

00:44:21.720 --> 00:44:23.570 I don't understand why.

00:44:23.570 --> 00:44:26.730 The you know, it's not a mystery.

00:44:26.730 --> 00:44:29.140 I can reach over and grab a book on my shelf

00:44:29.140 --> 00:44:32.840 that's called National Strategy for Influenza Pandemic.

00:44:32.840 --> 00:44:35.540 Many, many experts knew what was happening

00:44:35.540 --> 00:44:37.270 in January and February.

00:44:37.270 --> 00:44:41.340 And the Chinese bought us time, you know,

00:44:41.340 --> 00:44:43.070 by locking down their nation.

00:44:43.070 --> 00:44:44.910 We had two months to look at what was happening

00:44:44.910 --> 00:44:46.883 in China and become concerned.

00:44:48.320 --> 00:44:51.120 Let me tell you briefly and then I'll shut up.

00:44:51.120 --> 00:44:53.190 What are some of the projects that are happening

00:44:53.190 --> 00:44:54.490 in my lab right now

00:44:56.600 --> 00:44:58.657 which we'd be welcome.

00:44:58.657 --> 00:45:00.060 Welcome collaborators.

00:45:00.060 --> 00:45:02.860 And Laura's cooperating with us on some of these things.

00:45:03.740 --> 00:45:07.780 We have ongoing work on using big data techniques.

00:45:07.780 --> 00:45:10.423 Laura mentioned this paper on human movements.

00:45:11.670 --> 00:45:13.500 Many scientists are working on this right now

00:45:13.500 --> 00:45:14.790 and there are labs around the world

00:45:14.790 --> 00:45:16.120 that are famous for this.

00:45:16.120 --> 00:45:18.760 We're trying to contribute to that in a certain way,

00:45:18.760 --> 00:45:23.760 a tracking human movements or symptom reporting,

00:45:24.120 --> 00:45:26.270 that will using various Big Data techniques,

00:45:26.270 --> 00:45:29.260 including Twitter data that would allow us to forecast

00:45:29.260 --> 00:45:31.230 the course of the epidemic, to get ahead of it,

00:45:31.230 --> 00:45:32.800 to know where it's gonna strike

00:45:32.800 --> 00:45:34.160 based on knowing what's happening.

00:45:34.160 --> 00:45:36.000 Another similar project like that,

00:45:36.000 --> 00:45:37.760 being spearheaded by another graduate student

00:45:37.760 --> 00:45:41.430 in my lab, Eric Feltham is looking at gatherings.

00:45:41.430 --> 00:45:43.660 For example, we were very interested in the gatherings

00:45:43.660 --> 00:45:45.360 to vote the primary elections.

00:45:45.360 --> 00:45:47.610 Did they, you know, people got together to vote

00:45:47.610 --> 00:45:50.150 at polling places, did that cause a spike?

00:45:50.150 --> 00:45:53.930 This is of course highly relevant to our national security,

00:45:53.930 --> 00:45:56.290 we need to somehow have a good vote, a fair

00:45:56.290 --> 00:45:59.480 and honest vote in November and for that,

00:45:59.480 --> 00:46:02.420 in my judgment, We need to have widespread absentee

00:46:02.420 --> 00:46:04.680 balloting to allow for this.

00:46:04.680 --> 00:46:07.160 Otherwise, if people stay away from the polls,

00:46:07.160 --> 00:46:09.291 because they're afraid of the pandemic,

00:46:09.291 --> 00:46:12.470 or if they go to the polls and then become infected,

00:46:12.470 --> 00:46:13.560 either one of those outcomes

00:46:13.560 --> 00:46:16.410 is a threat to our society in my view.

00:46:16.410 --> 00:46:18.700 But similarly, I believe that the recent protests

00:46:18.700 --> 00:46:23.040 that we've seen after the appalling murder

00:46:23.040 --> 00:46:24.433 that we saw in Minnesota,

00:46:26.700 --> 00:46:29.060 and the rioting that we've seen,

00:46:29.060 --> 00:46:31.660 are gonna contribute to a spike in cases

00:46:31.660 --> 00:46:34.490 and I mentioned this earlier.

00:46:34.490 --> 00:46:36.630 Finally, we had just released last week

00:46:36.630 --> 00:46:37.986 an app from my lab.

00:46:37.986 --> 00:46:41.413 That's called Hunala, hunala.yale.edu.

00:46:47.160 --> 00:46:49.840 This app relies on some old ideas of ours,

00:46:49.840 --> 00:46:51.880 involving network science

00:46:51.880 --> 00:46:53.750 that I previously discussed with Raphael

00:46:53.750 --> 00:46:56.283 and others on this call,

00:46:57.250 --> 00:46:58.710 which is that if you think about

00:46:58.710 --> 00:47:02.600 a contagion that begins stochastically in a graph,

00:47:02.600 --> 00:47:03.650 you should have the intuition,

00:47:03.650 --> 00:47:04.553 it's obvious that the contagion

00:47:04.553 --> 00:47:07.550 as it winds its way a social contagion,

00:47:07.550 --> 00:47:09.910 winds its way a biological contagion,

00:47:09.910 --> 00:47:11.410 that winds its way through the graph

00:47:11.410 --> 00:47:13.230 is gonna reach central people

00:47:13.230 --> 00:47:16.590 sooner than it reaches random people in the population.

00:47:16.590 --> 00:47:19.470 So if we could identify central people,

00:47:19.470 --> 00:47:21.680 and monitor them, they would function

00:47:21.680 --> 00:47:24.080 as a kind of canary in a coal mine

00:47:24.080 --> 00:47:28.090 forecasting the state of the epidemic at some future time.

00:47:28.090 --> 00:47:31.040 We published several papers about this 10 years ago,

00:47:31.040 --> 00:47:34.060 that showed that we could do it with each one and one,

00:47:34.060 --> 00:47:36.070 that we could track central people,

00:47:36.070 --> 00:47:37.633 and that we can monitor them.

00:47:39.028 --> 00:47:41.650 And then we would therefore be able to use them

00:47:41.650 --> 00:47:44.170 to predict the future state of the epidemic

00:47:44.170 --> 00:47:47.463 between two and six weeks in advance.

00:47:48.700 --> 00:47:51.710 So this is one of the things that our app

00:47:51.710 --> 00:47:53.410 is attempting to exploit.

00:47:53.410 --> 00:47:57.020 we're attempting to get people to report their symptoms

00:47:57.020 --> 00:47:59.620 and then we are attempting to monitor that

00:47:59.620 --> 00:48:04.620 or redraw the graph anonymously or privately.

00:48:04.640 --> 00:48:06.290 We don't inform anyone

00:48:06.290 --> 00:48:09.790 for example, if you get sick, we do not inform your friends

00:48:09.790 --> 00:48:11.520 that you are sick.

00:48:11.520 --> 00:48:13.470 But we exploit people's reports

00:48:13.470 --> 00:48:17.010 to create a kind of ways for Coronavirus.

00:48:17.010 --> 00:48:19.430 So everyone contributes a little information

00:48:19.430 --> 00:48:21.800 saying whether or not they have symptoms.

00:48:21.800 --> 00:48:25.720 And we can then by manipulating that information

00:48:25.720 --> 00:48:27.970 using some machine learning algorithms

00:48:27.970 --> 00:48:30.250 in partnership with a mean car buses group

00:48:30.250 --> 00:48:32.853 in the electrical engineering department here.

00:48:34.090 --> 00:48:38.120 We can predict what your risk of getting the epidemic

00:48:38.120 --> 00:48:38.953 is in the future.

00:48:38.953 --> 00:48:41.190 So if your friends friends friends

00:48:41.190 --> 00:48:45.020 had respiratory disease three weeks ago,

00:48:45.020 --> 00:48:46.840 that should modify your risk.

00:48:46.840 --> 00:48:49.970 Or if your friends had a fever a week ago,

00:48:49.970 --> 00:48:51.840 that should modify your risk.

00:48:51.840 --> 00:48:54.620 And so our app is attempting to collect these data

00:48:54.620 --> 00:48:57.120 and forecasts the future course of the epidemic.

00:48:57.120 --> 00:48:59.780 We expect to have, if we're lucky

00:48:59.780 --> 00:49:01.853 and if the app is widely adopted,

00:49:03.710 --> 00:49:04.543 we will have a ton

00:49:04.543 --> 00:49:07.540 of very difficult complicated data to analyze.

00:49:07.540 --> 00:49:08.900 And just because I haven't been as clear

00:49:08.900 --> 00:49:10.983 about this as I hope because I'm rushing,

00:49:12.370 --> 00:49:14.210 the app is like waves for Coronavirus.

00:49:14.210 --> 00:49:16.930 It warns you just like waves does

00:49:16.930 --> 00:49:19.440 that there's a traffic jam two miles ahead,

00:49:19.440 --> 00:49:22.930 the app can warn you that there is pathogen

00:49:22.930 --> 00:49:25.090 in your social network neighborhood.

00:49:25.090 --> 00:49:27.750 And just like in ways you might, you know, take an exit

00:49:27.750 --> 00:49:30.450 and avoid the traffic jam, with ways you might say,

00:49:30.450 --> 00:49:32.060 you know, I'm gonna stay at home now,

00:49:32.060 --> 00:49:33.800 because my risk is high.

00:49:33.800 --> 00:49:37.720 And we give people daily assessments of their risk

00:49:37.720 --> 00:49:39.690 based on where they live.

00:49:39.690 --> 00:49:42.790 And here we include lots of public source data

00:49:42.790 --> 00:49:45.840 and the reports of our users.

00:49:45.840 --> 00:49:49.130 And we give them a risk of like based on where you live,

00:49:49.130 --> 00:49:51.163 is the risk low, medium, high.

00:49:52.280 --> 00:49:55.810 Like for example, like a fire like a forest fire prediction,

00:49:55.810 --> 00:49:57.820 you know, based on the humidity today,

00:49:57.820 --> 00:50:00.460 what's the risk of a forest fire?

00:50:00.460 --> 00:50:03.030 And, we also give you a personal risk

00:50:03.030 --> 00:50:04.780 based on where you are in the network.

00:50:04.780 --> 00:50:07.970 So traffic is bad in New York City in general,

00:50:07.970 --> 00:50:10.380 but it's really bad on your block right now,

00:50:10.380 --> 00:50:11.730 waves might tell you.

00:50:11.730 --> 00:50:13.773 So our app also does that.

00:50:14.730 --> 00:50:16.620 People have reported seeing a fire,

00:50:16.620 --> 00:50:18.660 it's not just that it's dry and hot,

00:50:18.660 --> 00:50:21.850 actually other users in your area have seen a fire.

00:50:21.850 --> 00:50:25.870 So your risk now is much higher.

00:50:25.870 --> 00:50:27.160 So I'm gonna say one last thing,

00:50:27.160 --> 00:50:31.650 which is that the issue is when will this epidemic end?

00:50:31.650 --> 00:50:33.390 And I already alluded to the fact that

00:50:33.390 --> 00:50:36.380 it's gonna end when it becomes endemic among us,

00:50:36.380 --> 00:50:38.820 but it's also gonna end,

00:50:38.820 --> 00:50:42.680 or epidemics have a biological end and a social end.

00:50:42.680 --> 00:50:44.500 And basically, the epidemic is gonna end

00:50:44.500 --> 00:50:46.370 when we declare that it's over.

00:50:46.370 --> 00:50:48.970 But we have come to accept it.

00:50:48.970 --> 00:50:51.220 And so I think we're still in the early phases

00:50:51.220 --> 00:50:53.850 of the Kübler-Ross model of grief.

00:50:53.850 --> 00:50:56.210 You know, we have anger

00:50:57.868 --> 00:51:00.790 and we have sadness, you know, depression.

00:51:00.790 --> 00:51:03.210 And we have bargaining, you know,

00:51:03.210 --> 00:51:05.430 but soon we're gonna have acceptance,

00:51:05.430 --> 00:51:10.115 which is the only way out from this pandemic.

00:51:10.115 --> 00:51:10.948 Thank you.

00:51:12.100 --> 00:51:15.060 - Thank you Nicholas for this great talk.

00:51:15.060 --> 00:51:16.777 We have time for questions.

00:51:21.540 --> 00:51:23.610 - [Jose] Hello, I'm Jose.

00:51:23.610 --> 00:51:25.120 So I was curious about the app

00:51:26.676 --> 00:51:28.863 that you develop in collecting data.

00:51:29.800 --> 00:51:34.800 Are you interested in like, what network properties

00:51:35.500 --> 00:51:39.160 are you like hoping to gauge, are you looking into,

00:51:39.160 --> 00:51:43.840 like sensitivity, you know, like a core.

00:51:44.860 --> 00:51:49.860 And do you have a particular hypotheses about like,

00:51:50.000 --> 00:51:51.580 because like when you're in a network,

00:51:51.580 --> 00:51:54.240 you receive information,

00:51:54.240 --> 00:51:56.260 the more connected you are just like,

00:51:57.230 --> 00:52:01.160 forgot the term but I think you tend to get more information

00:52:01.160 --> 00:52:02.453 based on your connection,

00:52:03.420 --> 00:52:08.420 are you expecting that people in certain types of networks

00:52:08.440 --> 00:52:09.970 would be reporting

00:52:11.420 --> 00:52:13.440 like symptoms like earlier?

00:52:13.440 --> 00:52:15.550 Or I was just wondering like,

00:52:15.550 --> 00:52:19.020 what are you hoping to capture using those parameters?

00:52:19.020 --> 00:52:20.510 - So we've studied that if you want,

00:52:20.510 --> 00:52:24.390 you can look at our 2010 paper on the H1N1.

00:52:24.390 --> 00:52:27.720 Networks with low transitivity are at higher risk.

00:52:27.720 --> 00:52:29.860 So individuals that have low transitivity

00:52:29.860 --> 00:52:31.300 in their neighborhood are at higher risk

00:52:31.300 --> 00:52:32.580 for getting the flu.

00:52:32.580 --> 00:52:34.570 Unsurprisingly, people with higher degree

00:52:34.570 --> 00:52:35.910 are at higher risk,

00:52:35.910 --> 00:52:39.840 and people that have high centrality are at higher risk.

00:52:39.840 --> 00:52:41.030 So we've shown that before.

00:52:41.030 --> 00:52:44.380 And eventually we hope if we reach the appropriate scale,

00:52:44.380 --> 00:52:46.910 that these parameters will also be relevant.

00:52:46.910 --> 00:52:49.790 But it's not just the structure of the network

00:52:49.790 --> 00:52:50.660 as I alluded to earlier.

00:52:50.660 --> 00:52:52.960 It's what's happening in the network and when.

00:52:52.960 --> 00:52:55.410 So I don't know exactly yet.

00:52:55.410 --> 00:52:58.640 We don't have the data yet to know what is the real signal.

00:52:58.640 --> 00:53:02.960 is it COVID three weeks ago in your third degree alters,

00:53:02.960 --> 00:53:07.960 is it COVID 10 days ago or 12 days ago in your alters?

00:53:07.990 --> 00:53:10.240 You know, we don't know all these details yet.

00:53:10.240 --> 00:53:12.710 If we get enough data, we will know the answer.

00:53:12.710 --> 00:53:15.730 But we do know from principles that we published before

00:53:15.730 --> 00:53:17.790 and that are mathematically predicted

00:53:17.790 --> 00:53:18.783 what should matter.

00:53:19.940 --> 00:53:24.200 Excuse me, I've been dying to do a K cornice forecasting.

00:53:24.200 --> 00:53:25.980 And I've been talking to Dan Spielman,

00:53:25.980 --> 00:53:28.420 I actually had to (mumbles) about this for years.

00:53:28.420 --> 00:53:29.900 We have another project in Honduras

00:53:29.900 --> 00:53:31.430 that Laura's involved with

00:53:31.430 --> 00:53:33.520 where we're gonna look at K cornice,

00:53:33.520 --> 00:53:35.440 I don't know whether we'll be able to do with this app.

00:53:35.440 --> 00:53:37.513 It depends on how much use we get.

00:53:39.100 --> 00:53:40.050 - [Jose] Thank you.

00:53:44.219 --> 00:53:46.378 - Other questions?

00:53:46.378 --> 00:53:48.500 - Yeah, I have a question.

00:53:48.500 --> 00:53:50.860 Hi, my name's Sam Burma, graduate in genetics.

00:53:50.860 --> 00:53:52.320 I'm interested in understanding a little bit more

00:53:52.320 --> 00:53:54.810 about the dispersion you're talking about

00:53:54.810 --> 00:53:57.110 with the equivalent reproductive,

00:53:57.110 --> 00:53:59.260 the effective reproductive rate of the virus,

00:53:59.260 --> 00:54:01.520 and I think I made it just missed a little bit there.

00:54:01.520 --> 00:54:04.210 But can you just go back and explain a little bit more

00:54:04.210 --> 00:54:06.780 about how this relates to the fact that

00:54:06.780 --> 00:54:10.810 there's a lower dispersion rate actually is worse?

00:54:10.810 --> 00:54:11.710 - Yeah.

00:54:11.710 --> 00:54:14.920 It's a wonderful, beautiful paper by Lloyd Smith

00:54:14.920 --> 00:54:18.520 at all in Nature 2005 which is it's just,

00:54:18.520 --> 00:54:20.820 it's like one of those papers, you read it,

00:54:20.820 --> 00:54:22.517 and you get the point that you read and you get

00:54:22.517 --> 00:54:23.900 "There's more subtlety here," and then you read it again,

00:54:23.900 --> 00:54:25.640 "There's more subtlety here."

00:54:25.640 --> 00:54:26.803 It's a wonderful paper.

00:54:28.010 --> 00:54:29.510 The gist is, if you think about it,

00:54:29.510 --> 00:54:32.010 and also just incidentally, as an intellectual point,

00:54:32.010 --> 00:54:33.870 there's something happening in the sciences.

00:54:33.870 --> 00:54:35.740 This is an old issue in the sciences

00:54:35.740 --> 00:54:37.470 between lumpers and splitters.

00:54:37.470 --> 00:54:40.830 No Darwin talks about this, lumpers and splitters.

00:54:40.830 --> 00:54:42.450 There are scientists who are concerned about

00:54:42.450 --> 00:54:43.830 getting the sense of a thing

00:54:43.830 --> 00:54:45.727 and like the average and they're scientists

00:54:45.727 --> 00:54:47.540 who are interested in variants

00:54:47.540 --> 00:54:49.600 like what's, you know, what are exceptions?

00:54:49.600 --> 00:54:50.940 How do things spread out?

00:54:50.940 --> 00:54:53.660 And so much of statistics and social sciences

00:54:53.660 --> 00:54:56.270 in the last 50 years has been focused

00:54:56.270 --> 00:54:59.060 on measures of central tendency, why?

00:54:59.060 --> 00:55:01.810 Because we invented regression models and statistical tools

00:55:01.810 --> 00:55:04.240 that were easier for us to say that,

00:55:04.240 --> 00:55:06.430 whereas variance is also so important.

00:55:06.430 --> 00:55:08.347 And so there's a lot across the social scientists

00:55:08.347 --> 00:55:10.070 and people that are becoming much more interested

00:55:10.070 --> 00:55:12.150 in variants and in variation.

00:55:12.150 --> 00:55:13.780 And so this is another example of that,

00:55:13.780 --> 00:55:15.750 where for a long time, people were, you know,

00:55:15.750 --> 00:55:17.210 trying to estimate the R naught.

00:55:17.210 --> 00:55:19.420 And Lloyd Smith comes along at all,

00:55:19.420 --> 00:55:22.520 and says, "Wait a minute, the variance is also important."

00:55:22.520 --> 00:55:23.970 Why does it matter?

00:55:23.970 --> 00:55:26.210 So if everyone in the population

00:55:26.210 --> 00:55:28.570 has an R naught of two,

00:55:28.570 --> 00:55:31.440 then every single time one person goes from one place

00:55:31.440 --> 00:55:34.423 to another, then we'll restart the epidemic.

00:55:35.650 --> 00:55:38.120 But if there's variation and some people

00:55:38.120 --> 00:55:40.400 or most people have an R naught of zero,

00:55:40.400 --> 00:55:42.100 they cannot give it to anyone.

00:55:42.100 --> 00:55:45.770 And one out of 100 people can give it to a lot of people,

00:55:45.770 --> 00:55:48.180 the epidemic is more likely to extinguish

00:55:48.180 --> 00:55:50.630 'cause 99 out of 100 times when one person

00:55:50.630 --> 00:55:52.640 in the latter example goes somewhere,

00:55:52.640 --> 00:55:54.020 the epidemic stops.

00:55:54.020 --> 00:55:56.230 Only if that's superspreader,

00:55:56.230 --> 00:55:58.580 the person with a capacity to be a superspreader

00:55:58.580 --> 00:56:00.400 goes does it get started.

00:56:00.400 --> 00:56:02.600 And if it's something intrinsic to the germ,

00:56:02.600 --> 00:56:04.170 then in the next cycle,

00:56:04.170 --> 00:56:08.270 most of the transmissions will also be zero.

00:56:08.270 --> 00:56:10.780 And so this dispersion, which they in that paper,

00:56:10.780 --> 00:56:13.440 they quantified across pathogens

00:56:13.440 --> 00:56:16.540 seems to fit with the ability of the pathogen

00:56:16.540 --> 00:56:18.023 to get instantiated.

00:56:22.030 --> 00:56:23.030 - Thank you so much.

00:56:24.546 --> 00:56:26.480 And I also shared that paper in the chat for him.

00:56:26.480 --> 00:56:28.420 - Yeah, and also, just so you know,

00:56:28.420 --> 00:56:31.170 it's estimated that with with SARS-2

00:56:31.170 --> 00:56:32.770 what we're currently facing,

00:56:32.770 --> 00:56:37.770 is you need four importations to get one transmission,

00:56:38.080 --> 00:56:39.800 one community transmission.

00:56:39.800 --> 00:56:42.850 So in fact, in Seattle patient zero,

00:56:42.850 --> 00:56:45.040 did not infect anybody else.

00:56:45.040 --> 00:56:47.620 The first case that arrived in the middle of January,

00:56:47.620 --> 00:56:49.760 when they did contact tracing elaborately,

00:56:49.760 --> 00:56:51.380 and now genetic studies,

00:56:51.380 --> 00:56:52.460 he didn't infect anyone else.

00:56:52.460 --> 00:56:53.650 It was a dead end.

00:56:53.650 --> 00:56:55.395 You needed subsequent importations

00:56:55.395 --> 00:56:58.620 before the epidemic took root in Seattle.

00:56:58.620 --> 00:56:59.870 Same in China by the way.

00:57:03.630 --> 00:57:04.563 Other questions?

00:57:06.710 --> 00:57:09.140 It's very weird Zoom, 'cause I can't see you.

00:57:09.140 --> 00:57:10.520 I don't know if I'm boring you,

00:57:10.520 --> 00:57:13.760 I have no way of judging how I'm coming across.

00:57:13.760 --> 00:57:16.700 You know, I could be coming across as very aggressive,

00:57:16.700 --> 00:57:18.350 which of course not my intention.

00:57:21.592 --> 00:57:22.630 - I mean, if no one else has questions.

00:57:22.630 --> 00:57:24.510 I was also wondering what are the factors

00:57:24.510 --> 00:57:27.030 that influence our ability to detect the difference

00:57:27.030 --> 00:57:29.120 between the latency and the infectivity period

00:57:29.120 --> 00:57:32.720 'cause I remember at the early days in the US,

00:57:32.720 --> 00:57:34.300 CDC was still saying they didn't think

00:57:34.300 --> 00:57:38.900 that asymptomatic spread was a major factor for COVID-19.

00:57:38.900 --> 00:57:40.300 But now it seems like...

00:57:42.360 --> 00:57:44.050 - I haven't dug deep in what the CDC

00:57:44.050 --> 00:57:46.740 was saying but they knew

00:57:46.740 --> 00:57:48.150 there was a symptomatic transmission

00:57:48.150 --> 00:57:49.793 certainly by the end of January.

00:57:51.117 --> 00:57:53.590 There's some CDC announcements

00:57:53.590 --> 00:57:55.620 that I haven't traced it all the way back

00:57:55.620 --> 00:57:57.060 but for sure, by the end of January,

00:57:57.060 --> 00:57:58.510 they were already saying this

00:57:58.510 --> 00:58:00.000 and I think earlier in January too.

00:58:00.000 --> 00:58:02.373 There was some confusion in December still,

00:58:03.380 --> 00:58:06.023 but certainly by January, people knew.

00:58:11.050 --> 00:58:12.880 The genetics of human susceptibility

00:58:12.880 --> 00:58:14.750 are very interesting, by the way.

00:58:14.750 --> 00:58:17.570 I think we're gonna find that a small part

00:58:17.570 --> 00:58:20.220 of the geographic variation will relate

00:58:20.220 --> 00:58:23.390 to the genetics of the pathogen.

00:58:23.390 --> 00:58:27.300 Right now, there's no evidence that yet that some strains

00:58:27.300 --> 00:58:28.710 of the pathogen are more deadly

00:58:28.710 --> 00:58:30.470 or more infectious than other streams,

00:58:30.470 --> 00:58:33.320 a lot of interest in this topic right now.

00:58:33.320 --> 00:58:35.260 We probably will find some of that.

00:58:35.260 --> 00:58:38.140 And there's also some small evidence

00:58:38.140 --> 00:58:40.840 that human genes, that some people may be more of you

00:58:40.840 --> 00:58:43.320 than others, because of, you know,

00:58:43.320 --> 00:58:46.800 their various variants still to be described.

00:58:46.800 --> 00:58:48.340 So I think that's gonna be

00:58:48.340 --> 00:58:49.790 and I think that'll be a small part

00:58:49.790 --> 00:58:52.590 of explaining that geographic variation, not a big part.

00:58:53.490 --> 00:58:56.343 - Nicholas, Luke here in the chat box has a question.

00:58:57.340 --> 00:59:00.870 He's interested in your thoughts about transmission settings

00:59:00.870 --> 00:59:03.110 like nursing homes, meatpacking.

00:59:03.110 --> 00:59:05.693 Is it network structures susceptibility

00:59:05.693 --> 00:59:08.450 excetera driving transmission?

00:59:08.450 --> 00:59:09.820 - Well, I think the meatpacking,

00:59:09.820 --> 00:59:12.730 the story for the meat packers was aerosolization

00:59:12.730 --> 00:59:15.170 of the pathogen in a cold environment

00:59:15.170 --> 00:59:18.250 and high density and I have a long Twitter thread

00:59:18.250 --> 00:59:22.100 on this if anyone is interested on why meatpacking

00:59:22.100 --> 00:59:23.570 and it's a worldwide phenomenon,

00:59:23.570 --> 00:59:26.310 it's not just a phenomenon in the United States.

00:59:26.310 --> 00:59:30.835 So I think the explanation by the Secretary of Health,

00:59:30.835 --> 00:59:33.270 the Secretary of Health in our country,

00:59:33.270 --> 00:59:35.390 that it had to do with the living arrangements

00:59:35.390 --> 00:59:38.320 of the immigrants working in these factories,

00:59:38.320 --> 00:59:39.720 is not correct.

00:59:39.720 --> 00:59:40.750 There are other factories

00:59:40.750 --> 00:59:43.920 with other industries with similar immigrant populations

00:59:43.920 --> 00:59:45.320 and similar living conditions

00:59:45.320 --> 00:59:46.490 and they didn't have the operates.

00:59:46.490 --> 00:59:49.870 I think it's to do with the temperature in the environment

00:59:49.870 --> 00:59:50.703 where these people work.

00:59:50.703 --> 00:59:54.090 It's refrigerated, the very tight packing of the workers

00:59:54.090 --> 00:59:57.880 and up aerosolization using saws and other equipment

00:59:57.880 --> 00:59:59.010 that create aerosols

00:59:59.010 --> 01:00:01.170 that are in the turbulent wind conditions

01:00:01.170 --> 01:00:02.143 in these factories.

01:00:03.680 --> 01:00:04.910 The nursing homes is different,

01:00:04.910 --> 01:00:08.110 I think it's a very customary health care situation

01:00:08.110 --> 01:00:10.480 where you have very vulnerable elderly people

01:00:10.480 --> 01:00:12.240 and health care workers that are up close

01:00:12.240 --> 01:00:13.620 and intimate working with people.

01:00:13.620 --> 01:00:15.900 So once the epidemic takes root, you know,

01:00:15.900 --> 01:00:17.610 you get a very rapid spread.

01:00:17.610 --> 01:00:20.100 I think nursing homes are more like prisons, actually,

01:00:20.100 --> 01:00:22.760 in terms of their epidemiology,

01:00:22.760 --> 01:00:24.010 meatpacking is different.

01:00:26.530 --> 01:00:28.040 You know, ships,

01:00:28.040 --> 01:00:29.650 ships are close quarters as well.

01:00:29.650 --> 01:00:31.660 So you have young people in ships,

01:00:31.660 --> 01:00:34.570 you know, in the US's Theodore Roosevelt,

01:00:34.570 --> 01:00:36.120 you know, you have young healthy sailors,

01:00:36.120 --> 01:00:37.600 although one died already,

01:00:37.600 --> 01:00:41.250 we should acknowledge from the disease,

01:00:41.250 --> 01:00:42.410 but they're very tight.

01:00:42.410 --> 01:00:43.480 People are living in bunks,

01:00:43.480 --> 01:00:46.130 you know, one on top of each other in that situation.

01:00:49.540 --> 01:00:51.520 - Nicholas I have a question.

01:00:51.520 --> 01:00:53.170 So we're used to think that

01:00:53.170 --> 01:00:56.310 these social distancing measure, these lockdowns,

01:00:56.310 --> 01:00:57.320 what they're really doing

01:00:57.320 --> 01:01:00.420 is reducing the number of susceptible people

01:01:00.420 --> 01:01:01.310 in the population

01:01:01.310 --> 01:01:03.790 so that essentially we plug in this number,

01:01:03.790 --> 01:01:05.900 this lower number in our serial models

01:01:05.900 --> 01:01:07.620 and predict the spread.

01:01:07.620 --> 01:01:11.780 But, I think what in addition to reducing the density

01:01:11.780 --> 01:01:13.980 of the network, what they're also doing

01:01:13.980 --> 01:01:15.630 is reshaping the network

01:01:15.630 --> 01:01:17.670 because essentially the structure of the network

01:01:17.670 --> 01:01:20.300 because people don't go to school anymore.

01:01:20.300 --> 01:01:22.480 People don't gather in bars.

01:01:22.480 --> 01:01:24.027 So what do you think of this?

01:01:24.027 --> 01:01:26.190 Do you think we should make this information

01:01:26.190 --> 01:01:29.690 will be useful to include in our model is right?

01:01:29.690 --> 01:01:31.440 - Yes I do think that.

01:01:31.440 --> 01:01:33.020 And just if there's a little detail there,

01:01:33.020 --> 01:01:35.560 which was seen in China and the United States

01:01:35.560 --> 01:01:38.790 is, ironically household transmission,

01:01:38.790 --> 01:01:40.230 cases of household transmission

01:01:40.230 --> 01:01:42.010 typically are more severe than cases

01:01:42.010 --> 01:01:44.040 of community acquired transmission

01:01:44.040 --> 01:01:45.870 because of the viral inoculum idea.

01:01:45.870 --> 01:01:48.520 If I get the pathogen from my wife,

01:01:48.520 --> 01:01:52.510 I'm gonna get a sicker than if I get the same pathogen

01:01:52.510 --> 01:01:54.700 from riding in the subway,

01:01:54.700 --> 01:01:55.650 because I'm writing something

01:01:55.650 --> 01:01:57.680 I might get a low viral inoculum

01:01:57.680 --> 01:01:58.720 whereas if I get it from my wife,

01:01:58.720 --> 01:01:59.900 I'm gonna get a serious case.

01:01:59.900 --> 01:02:01.800 You know, I kiss my wife, for example.

01:02:03.690 --> 01:02:06.920 So intra-household transmission is often more severe

01:02:06.920 --> 01:02:11.340 and more efficacious than out-of-household transmission.

01:02:11.340 --> 01:02:13.700 So the dynamics will change in quite complicated ways,

01:02:13.700 --> 01:02:15.900 just like like you're alluding to,

01:02:15.900 --> 01:02:18.730 and I'm sure other groups are looking at this.

01:02:18.730 --> 01:02:20.730 It's not something we're actively doing.

01:02:21.809 --> 01:02:23.100 But again, if you are interested Laura,

01:02:23.100 --> 01:02:24.330 I'm always eager to work with you,

01:02:24.330 --> 01:02:25.530 I love working with you.

01:02:27.450 --> 01:02:29.150 - All right after this (laughing).

01:02:30.020 --> 01:02:32.540 Now, do you do you wanna take one more question?

01:02:32.540 --> 01:02:33.860 - I'm happy to take one more

01:02:33.860 --> 01:02:37.840 but pick one I wanna go so, let's do one more then stop.

01:02:37.840 --> 01:02:39.190 Anyone else have something?

01:02:41.600 --> 01:02:42.510 I'm looking around here

01:02:42.510 --> 01:02:45.353 and all the things I need to monitor.

01:02:50.040 --> 01:02:52.670 Alright, thank you all very much.

01:02:52.670 --> 01:02:54.230 - Thank you.

01:02:54.230 --> 01:02:57.950 Yeah, Luke says thank you for a very interesting point

01:02:57.950 --> 01:03:00.350 as we think about contact tracing.

01:03:00.350 --> 01:03:01.570 Okay.

01:03:01.570 --> 01:03:03.720 - And someone else asked about school reopening.

01:03:03.720 --> 01:03:06.890 That's a long topic to keep people at the last minute.

01:03:06.890 --> 01:03:09.500 My wife had a nice piece in The Atlantic about this,

01:03:09.500 --> 01:03:10.940 if you're interested,

01:03:10.940 --> 01:03:12.770 I think schools are gonna reopen,

01:03:12.770 --> 01:03:15.150 I think they need to reopen.

01:03:15.150 --> 01:03:17.200 They're going to reopen only 'cause we have no choice

01:03:17.200 --> 01:03:19.100 but it would be better from pandemic point of view

01:03:19.100 --> 01:03:20.590 if they did not.

01:03:20.590 --> 01:03:22.720 I think that if they're gonna reopen,

01:03:22.720 --> 01:03:24.820 a lot of procedures are gonna have to be put in place

01:03:24.820 --> 01:03:27.300 at Yale, at nursery schools, at elementary schools.

01:03:27.300 --> 01:03:30.220 It'll be different from place to place.

01:03:30.220 --> 01:03:35.090 And I think that there will be a second wave.

01:03:35.090 --> 01:03:37.090 So I think the schools will close again,

01:03:37.090 --> 01:03:40.123 just what I suspect is gonna happen in October, November.

01:03:42.688 --> 01:03:44.196 Thank you all very much.

01:03:44.196 --> 01:03:45.029 - Thank you Nicholas.

01:03:45.029 --> 01:03:46.540 Thank you all for joining.

01:03:46.540 --> 01:03:47.373 Bye bye.