I would now like to introduce our next Speaker, Doctor Nicholas Christakis. Christakis is a sociologist and physician who conducts research in the areas of social networks and biosocial science. His current research is mainly focused on two topics. First, the social mathematical, and 2nd the social and biological implications of how these networks form.
operates to influence thoughts, feelings, and behaviors. Doctor Crystal Kiss.

Thank you for being here. Thank you all. Of course I can’t see any of you and there are 268 of you. I see.

It’s a very odd experience using zoom to do this and I lately have not been using slides in order to communicate in a way I think is more effective. So I’m going to try to cultivate some visual images in what I’m
going to talk to you about. I’m going to start with just a couple of brief remarks or to set the stage about the coronavirus pandemic. I suspect everyone on this audience will know these numbers already. Then I’m going to talk a little bit about the issue of waves of pandemics. And then I’m going to tell you a little bit about some of the work in my lab, including an app that we just released called who nala HUNALA that we think can be quite helpful and it’s quite different than all the other apps that are available at the moment.
So as you all know, the are not for a pathogen is felt to be something intrinsic to the pathogen or as it relates to the host as well. Uh, this is the number of new cases that can arise from a prior case. In, uhm, fully susceptible population. That is to say, no individual is immune to a pathogen and the end host hasn’t responded yet. We haven’t taken any actions were not pulling apart and living in like Hermits for example were
interacting normally and it is

estimated and there was a recent meta analysis just released by the land set a couple of days ago or a couple of weeks ago that they are not for this condition is. Probably around 3, maybe 2.4 somewhere in the range probably, and that’s quite high. Actually that is a high are not. The seasonal flu has and are not of 1.3 Ebola of about 1.5 to one point 9. And of course a chicken pox and of course measles is the
champion which has one of the highest arnotts estimated of around 18 new cases for each new case.

This so called are not of course is different than what is called the RE. The affective reproductive rate, which is the number of new cases that arise in a kind of more steady state of the epidemic. For every old case. So some people are immune. People are beginning to take responsive action, for example, were beginning to engage in physical distancing.
and this would be known as the affective reproductive rate and the ariav courses can fall as an epidemic proceeds because of what we do or how we've been affected by the pathogen. I just a different parameter, something known as the case fatality rate. That's the fraction of people who died conditional on coming to medical attention course. Whether you come to medical attention or not depends on what kind of health care system you have, kind of health care system you have, what patients do when they get symptoms, and so on. And sometimes people estimate
something instead known as the symptomatic case fatality rate. The SCF are, which is what fraction people die, conditional on developing a symptoms. We think this is still much more debated than they are not. We think this numbers between 0.5 and 1% or perhaps as low as zero point 3%. Now the case fatality rate for the seasonal flu is about zero point, ignoring other features, just on average. About one out of 1000 people who get the seasonal flu will die. We think that this disease is between
5 and 10 times as bad as that and the epidemic we’re having right now is about a 10th as deadly as the SARS one epidemic from 2003. The case fatality rate for SARS of one was about 10%. That was a much deadlier condition and the 1918 influenza A pandemic had a case fatality rate. We think about four to 5%. So these two parameters there are not or the RE something about the transmissibility of the disease, and the fatality of the disease could be put on two axes, and you could plot every respiratory
NOTE Confidence: 0.89728874
00:04:31.110 --> 00:04:33.132 pandemic for the last 100 years
NOTE Confidence: 0.89728874
00:04:33.132 --> 00:04:34.256 on these two axes,
NOTE Confidence: 0.89728874
00:04:34.260 --> 00:04:36.557 and then you could see well, how?
NOTE Confidence: 0.89728874
00:04:36.557 --> 00:04:38.192 How does this pandemic compared
NOTE Confidence: 0.89728874
00:04:38.192 --> 00:04:39.173 to previous ones,
NOTE Confidence: 0.89728874
00:04:39.180 --> 00:04:41.148 and when you do this exercise,
NOTE Confidence: 0.89728874
00:04:41.150 --> 00:04:44.270 it’s actually kind of alarming.
NOTE Confidence: 0.89728874
00:04:44.270 --> 00:04:46.292 Of the worst pandemic we’ve had
NOTE Confidence: 0.89728874
00:04:46.292 --> 00:04:48.436 in terms of how transmissible it
NOTE Confidence: 0.89728874
00:04:48.436 --> 00:04:51.308 was and how deadly it was is 1918
NOTE Confidence: 0.89728874
00:04:51.382 --> 00:04:53.247 in the upper right corner.
NOTE Confidence: 0.89728874
00:04:53.250 --> 00:04:56.114 The second worst we had was in 1957,
NOTE Confidence: 0.89728874
00:04:56.120 --> 00:04:57.910 which had sort of Intermediate
NOTE Confidence: 0.89728874
00:04:57.910 --> 00:04:58.626 Intermediate Lethality,
NOTE Confidence: 0.89728874
00:04:58.630 --> 00:04:59.746 an intermediate transmissibility,
and this disease is probably slightly more transmissible and slightly more deadly than the 1957 pandemic, so it’s getting up there. It’s above the 1957 pandemic and not as bad as the 1918 pandemic. However, the point is, it’s bad. This is bad and I think what we have to accept is that this moment in historical time. That we all happen to live in is a moment when a new species of pathogen has entered our species. There’s a new germ out there that is going to have its way with us. It’s going to spread in our species.
and affect us and it is bad and without action many people would have died even with the actions we have taken about. 100,000 people have already died. Now as a nation and as different districts, we have taken different sorts of actions that people have been sort of locked down in various ways. We’ve closed our schools, we’ve pathetically done some contact tracing and some testing we have had work from home orders or stay at home orders in most states in the union, and the point of this,
of course, was to flatten. The curve was to reduce the intensity at any given moment of the number of cases that we have. But every single respiratory pandemic. The last century has come in waves. All we have done by flattening the curve is we've not eradicated the pathogen. We just stopped the transmission. The germ is still out there. It will come back to China. It will come back to us. It's going to come back. All of the rest any pandemics, even the mild ones of the last 100 years have come back and typically.
they come back in the fall.
And this has to do with a variety of things.
They typically come back every fall for two or three years before they kind of damp down.
And this has to do partly with human behavior.
You know, when the fall comes, the students return to school, adults return to work.
We move indoors. 

So are are dense interactions the proximity which we interact which enhances transmissibility. 

There may be some environmental factors which affect the pathogen heat or humidity, or our responsiveness to the pathogen. 

So we might do better in the sunny weather. 

Our bodies might be more able to resist the pathogen is not sunny weather. 

And so on. 

And ultimately, 

one of the factors of parameters that we could think about is it. 

bikiniologists In addition to.
Well, there are a number of parameters, but in addition to the transmissibility, the case fatality ratio is something known as the attack rate, which is the fraction of people who actually get the disease in the end. For this pathogen it’ll probably be above 50%, maybe a bit higher if we overshoot in ways we can discuss. If there’s time now in the 1957 pandemic, nationally, about 25% of people got the disease were infected.
but in some hard hit areas it was as high as 40%.

I got the disease now.

Our best estimates of how many people have gotten it already in the United States is low. So for example, if you look at Sweden, they just released a quite good study. Sweden has had less severe sort of social or physical distancing than we’ve had about 4% of Swedes using a national Sero prevalence study just released this week have been infected. And they have been mixing more than we’ve been mixing.
As you know, in New York it was about 21% of New Yorkers in a rather good sort of representative sample of New Yorkers have become infected, and other studies around the United States of high quality that have been done show relatively low fractions of people have yet been exposed to the epidemic, so we have quite a way to go still. Unfortunately, we’re going to have more deaths with this condition.
What can we do to predict the course of this? Oh, and I should say that I think I've been flip flopping on my opinion as to the likelihood of successful development of a vaccine. So some days I'm optimistic some days I'm pessimistic. I'm not an expert on vaccines, but what I suspect is that no matter how fast we go on the vaccine, it's likely that plus or minus six months the vaccine will be widely available around the same time we otherwise would have gotten herd immunity anyway, so I don't think the vaccine is going to change the story.
Very much unfortunate.

How can we predict the course of this epidemic?

Can we develop some tools that help us confront how we might emerge from the lockdowns that we’re currently engaged in and might anticipate the course of the epidemic in the fall when it comes back my love.

Has been doing quite a few projects in this regard.

We have a in the midst of developing New Haven wide sero prevalence study that will follow people longitudinally.

Our work if we launch it,
00:10:10.630 --> 00:10:12.110 will have some different features
NOTE Confidence: 0.90805906
00:10:12.110 --> 00:10:14.242 than some of the other studies that
NOTE Confidence: 0.90805906
00:10:14.242 --> 00:10:16.024 have been done around the world.
NOTE Confidence: 0.90805906
00:10:16.030 --> 00:10:18.130 Some features that we think offer some
NOTE Confidence: 0.90805906
00:10:18.130 --> 00:10:19.030 interesting research opportunities,
NOTE Confidence: 0.90805906
00:10:19.030 --> 00:10:21.730 but I’m not going to talk about that today.
NOTE Confidence: 0.90805906
00:10:21.730 --> 00:10:22.030 Instead,
NOTE Confidence: 0.90805906
00:10:22.030 --> 00:10:24.430 I want to talk about two other things.
NOTE Confidence: 0.90805906
00:10:24.430 --> 00:10:26.306 One is a work that exploits the
NOTE Confidence: 0.90805906
00:10:26.306 --> 00:10:27.730 use of human movement.
NOTE Confidence: 0.90805906
00:10:27.730 --> 00:10:30.338 We had a paper just published in nature.
NOTE Confidence: 0.90805906
00:10:30.340 --> 00:10:32.601 About two weeks ago that took advantage
NOTE Confidence: 0.90805906
00:10:32.601 --> 00:10:35.353 of a big data that track the flow
NOTE Confidence: 0.90805906
00:10:35.353 --> 00:10:37.508 of people through Wuhan in China
NOTE Confidence: 0.90805906
00:10:37.508 --> 00:10:39.728 throughout the whole of China are
NOTE Confidence: 0.90805906
00:10:39.728 --> 00:10:41.779 up through sort of late February,
so we had data on 11.5 million transits using phone data. So people paying the tower when they were in Wuhan, and then they relocated to another part of China and such data can be used to track the flow of human beings, even if you don’t know who’s infected or who is not. The movement of people, which, depending on data availability, could be tracked in basically in real time. Can be used. We showed using a certain model to predict the intensity,
location and timing of the pandemic. So there are tools you can use that rely on other sorts of information. For example human movement, and it doesn’t have to be fun data. It could be tolling data on highways as cars, a shift from place to place. Sort of other kinds of Geo. Location data, air travel data, and so forth. So human movement can be used. Another kind of thing that can be done is using searches and probably many of you are remember the so called Google flu trends that was proposed. You know 10 or 15 years ago.
Now the idea there was the following idea. Right now what the CDC does or other monitoring agencies do and what? What doctor Weinberger’s talk just talked about as well is you wait in a central location for data to accumulate and be reported to you. For example, testing data for people doing influenza testing or people showing up in an emergency room or death counts for example. And what that means is that you know some period of time distant from now two to three weeks from now. You might know where the epidemic is today.
Well, that’s frustrating because you’re always behind the epidemic. You can never get out ahead of it. Google flu trends was an idea. That’s it. Well, maybe we can use something about people’s behavior today like there searching behavior for flu symptoms. For example. Maybe that can tell us where the epidemic is today and their first paper by Larry brilliant group showed that could be affected. Then there was a whole literature that emerged that sort of debunk that and said,
well, no, there it won’t be effective and so on. But that’s an illustration of a set of tools like the movement of data that I just described you from. The other project we had done. It’s an illustration of a set of tools that allow you to a survey or note where is the epidemic today based on what I’m seeing today? But we have another idea that I’m about to tell you about that allows you to tell where the epidemic will be in the future. So it’s not just rapid notification, it’s advanced warning of the epidemic.
00:13:21.870 --> 00:13:23.574 How does this work?
NOTE Confidence: 0.8712325
00:13:23.574 --> 00:13:25.668 Well, imagine you’re the network of people.
NOTE Confidence: 0.8712325
00:13:25.670 --> 00:13:27.525 There may be many of you can
NOTE Confidence: 0.8712325
00:13:27.525 --> 00:13:29.019 cultivate in your mind’s eye,
NOTE Confidence: 0.8712325
00:13:29.020 --> 00:13:31.244 a kind of image of such a network.
NOTE Confidence: 0.8712325
00:13:31.250 --> 00:13:33.210 Since I’m doing this talk without slides,
NOTE Confidence: 0.8712325
00:13:33.210 --> 00:13:35.712 I have to kind of try to do that.
NOTE Confidence: 0.8712325
00:13:35.720 --> 00:13:37.370 Their little dots that are people
NOTE Confidence: 0.8712325
00:13:37.370 --> 00:13:39.070 in lines that connect the people.
NOTE Confidence: 0.8712325
00:13:39.070 --> 00:13:41.509 Many of you have seen these images and you
NOTE Confidence: 0.8712325
00:13:41.509 --> 00:13:44.088 have this sense that there’s a middle of it,
NOTE Confidence: 0.8712325
00:13:44.090 --> 00:13:45.480 which is a very densely
NOTE Confidence: 0.8712325
00:13:45.480 --> 00:13:46.592 interconnected group of people.
NOTE Confidence: 0.8712325
00:13:46.600 --> 00:13:47.990 And then it feathers out
NOTE Confidence: 0.8712325
00:13:47.990 --> 00:13:49.102 to the social periphery,
NOTE Confidence: 0.8712325
00:13:49.110 --> 00:13:50.500 where there are people who,
let’s say, only have very few friends and whose friends have very few friends. So in the middle of the network you have people that are very popular and whose friends are very popular and as you get to the edge of the network, you don’t have those qualities. That sense of centrality in the network can be quantified in a variety of mathematical ways. In fact, the mathematics of that lies at the core of how Google you know the billions of dollars that were made by the founding of Google using
the so called page rank algorithm. So you can figure out what is the central website. Or you can figure out who’s this central person in a network. Now imagine is such a network that a pathogen begins strikes someone at random in the population and then begins moving across the ties through the social graph. You should have the intuition that it should reach central people in the network sooner in the course of the epidemic, popular people should be more likely to get infected. And popular people should get
infected sooner in the course of the epidemic than unpopular people. That means if we can identify this, incidentally, is the same reason that popular people get better stock tips or more information sooner. ’cause if information flows through the network, there are more central in the network they can acquire this knowledge just like they acquired germs sooner in the course of the epidemic. Actually, there’s a side light on some work.
we’ve done in the lab on the evolutionary biology of friendship, where we argue that the spread of germs is the price we pay for the spread of information. That’s a whole other topic anyway, so central people can be like Canaries in a coal mine. If we can find them and monitor them, they will tell us those people should get the epidemic should strike them earlier in the course. Then it strikes a random person, so identifying such people and monitoring them gives us a tool to forecast the future course of the epidemic.
My lab about 10 years ago for the H1N1 Pandemic showed that this was possible. It could be done, and now we've developed new tools in combination with a mean car. Posse’s group in the at Yale Electrical Engineering using certain machine learning tricks, which I'll describe in just a moment. That allow us to deploy these ideas in the form of an app that is sort of like ways for coronavirus, where everyone anonymously and privately contributes a little information. This information is aggregated.
and then fed back to the users,

just like when you use when you drive

on the highway and you use ways,

you report that there’s a traffic

accident or that there’s a traffic jam,

and then this informs people that

are behind you on the highway and

gives them something of value.

You get something of value and

you share with others.

It’s like a crowdsourced way.

Of tracking traffic,

but we have like ways for coronavirus.

So for example,

when we saw all the politicians

and celebrities that were getting
that were in the news with getting sick from coronavirus early on, it was not just that they were rich and famous, so they were able to get tests and people cared what happened to them. They actually were getting sick more so Boris Johnson was out there shaking hands with all these other people. He was also spreading the germs exactly, which was irresponsible or Tom Hanks and his wife are all of these people. There are more connected so they get stricken. Earlier they were Canaries in a coal
00:17:00.444 --> 00:17:03.165 mine so our new app which were just
NOTE Confidence: 0.91899866
00:17:03.165 --> 00:17:05.268 released this past week on Monday
NOTE Confidence: 0.91899866
00:17:05.268 --> 00:17:07.739 were doing a soft launch this week.
NOTE Confidence: 0.91899866
00:17:07.740 --> 00:17:09.966 If you would like to use it
NOTE Confidence: 0.91899866
00:17:09.966 --> 00:17:12.508 you can go to who nala HUNAL,
NOTE Confidence: 0.91899866
00:17:12.510 --> 00:17:13.750 a.yale.edu and download it.
NOTE Confidence: 0.91899866
00:17:13.750 --> 00:17:15.610 We are asking that you not
NOTE Confidence: 0.91899866
00:17:15.674 --> 00:17:16.940 broadly advertised it.
NOTE Confidence: 0.91899866
00:17:16.940 --> 00:17:19.118 You can invite your friends but
NOTE Confidence: 0.91899866
00:17:19.118 --> 00:17:21.040 please don’t broadly advertise it yet.
NOTE Confidence: 0.91899866
00:17:21.040 --> 00:17:22.540 We’re still debugging it.
NOTE Confidence: 0.91899866
00:17:22.540 --> 00:17:25.718 If you find any bugs please email me or.
NOTE Confidence: 0.91899866
00:17:25.720 --> 00:17:27.645 Let us know and then we will.
NOTE Confidence: 0.91899866
00:17:27.650 --> 00:17:29.946 We’re working on it and then next
NOTE Confidence: 0.91899866
00:17:29.946 --> 00:17:32.339 week we’re going to do a kind of a
NOTE Confidence: 0.91899866
00:17:32.339 --> 00:17:34.611 big goof and try to get a lot of
00:17:34.611 --> 00:17:36.758 attention and try to get if we can.
00:17:36.758 --> 00:17:38.138 Hundreds of thousands of users.
00:17:38.140 --> 00:17:40.065 The more people that use the app,
00:17:40.070 --> 00:17:42.128 the better it can monitor what’s happening
00:17:42.128 --> 00:17:44.206 in terms of the flu in your area.
00:17:44.210 --> 00:17:45.870 it only takes a on the first time you use it.
00:17:45.870 --> 00:17:48.900 You tell us some basic information
00:17:48.900 --> 00:17:51.318 about yourself and then.
00:17:51.318 --> 00:17:52.930 Every day you are pinned.
00:17:52.930 --> 00:17:54.360 If you, uh, if nothing is happening,
00:17:54.360 --> 00:17:56.355 you’ve had no symptoms.
00:17:56.360 --> 00:17:58.934 You haven’t seen the doctor.
00:17:58.940 --> 00:18:00.572 You say no, no,
00:18:00.572 --> 00:18:01.388 you’re done.
If something is happening, you have some symptoms, or you’ve seen the doctor or you been out and about in some way. You might take a minute to answer and then you immediately get feedback in the form of your risk. Your told how much respiratory diseases where you live based on a machine learning algorithm that takes advantage of lots of information not only from the CDC and other sources, but from our users. And then you’re also told your individual risk based on where you are in the social network.
For example, if your friends, friends have the flu three weeks ago. This means your risk is different than some of his friends, friends, friends did not have the flu three weeks ago, or if your friends friends are very popular. Your risk is different than if my friends friends are not very popular.

Another work is then combined and processed and fed back to you and you can monitor your risk everyday. Like I said,
it's anonymous and private and it is like ways for respiratory disease.

Now and we are also building from this a dashboard. So imagine that the state police in a state wanted to know which parts of the highway are dangerous. In principle they could take a years worth of reports or months worth of reports by citizens traveling saying where are there traffic accidents and they could say, Oh my goodness, this part of the highway is very dangerous. Maybe we should put a redesign.
That part of the highlight.

So this is this.

Our app will work the same way.

We’re building a dashboard that could be used,

for instance by people running a hospital system that want to monitor what’s happening in their area,

or that could be used to to detect where is are the hot spots,

and to see it’s coming.

We’re seeing a spike in people who are central in the network and not a spike in average.

People that difference between those things?
The difference between the at risk people and the less at risk people when there's divergence in those curves, that's a harbinger. But the epidemic is going to spike that the 2nd wave has begun, for example, or that the lockdowns are beginning to foster a spread of the pathogen, and so of course the individuals who get this information can act accordingly on their own benefit, but collective decision makers can also now have some vision into what's happening in the system. And I'll just stop.
I have two more minutes.

I'll shut up what I want to say is.

That to my eye,

there is no escape from this pathogen.

It will become endemic among us.

There are to our knowledge 7

coronavirus species that that afflict

us for that cause the common cold.

I think that those pathogens that

cause the common cold right now,

are probably distant echoes of previous introduction of

coronavirus pandemics into our species.

In the distant past.

I think what happens is these pathogens
tend to mutate to become milder. Remember from the point of view of the pathogen, it doesn’t want to kill us. It’s better if it doesn’t kill us. So if we die too fast we don’t spread it. So as time goes by, in general, pathogens mutate to become milder, but unfortunately and then there are two other coronaviruses, the SARS 1 from 2003 and Murs, the Middle Eastern respiratory syndrome, which has a very low are not, which is one of the reasons this has not become pandemic and
then the one we’re in right now, which unfortunately is awful for us and. It will spread and it will kill many of us I think is the sad truth until such time is. Either we invent an effective vaccine or we get herd immunity so it will become endemic and we have to use the best tools that we have to cope with its existence among us. Thank you very much doctor Chris Nagus.