

Covid-19 Pandemic

Richard L. Garwin
IBM Fellow Emeritus
IBM Thomas J. Watson Research Center
Yorktown Heights, NY 10598

www.fas.org/RLG/
[search with, e.g., \[site:fas.org/RLG/ pandemic\]](http://www.fas.org/RLG/)

RLG2@us.ibm.com

Cosmos Club National Security Group (Zoom) Meeting

September 1, 2020, 6:00 p.m.

Abstract

The talk begins with the concept of epidemic disease, e.g., influenza epidemics, and then discusses some of the differences with the current pandemic of Covid-19. On September 1, the disease has infected at least 6 million people in the United States and has killed almost 200,000. Had measures not eventually been taken in the form of social distancing and mask wearing-- still only advised on a federal scale-- deaths in the United States would likely have amounted by now to 1 million, on track to about 2 million by the time *herd immunity* was reached. Without an effective vaccine or treatment of the disease, that number will still die to achieve herd immunity, although draconian measures with severe impact on the economy and other aspects of life can keep hospitals and funeral homes operable.

The talk then introduces results new since late May, that a couple percent of those infected have viral titers that contain 95% of the total viral load, so that it is only these individuals with million-fold greater viral load than the median infected person who need to be isolated, while the rest can work while infected with normal masking and social distancing, if they are without symptoms, though still infected. Some 30% or more of those who recover from Covid-19 never have symptoms.

And on August 26, Abbott Labs obtained FDA emergency use authorization-- EUA-- for a "\$5, 15 minute" test that does not require an instrument to read it and that identifies a person with the highest titer probably in a couple of minutes, although requiring 15 minutes to show that a person does not have antigens present at the sensitivity of the test. Understanding the mechanism of creation of the super-titers of viral load is not essential to the utility of the strategy enabled by their existence, but might be important in the longer run in eliminating such super titers. There seems to be only one published study, from Charité – Universitätsmedizin Berlin, with data on the range of viral load from 3.6 to 11.7 "log10 viral load"-- that is from 5,000 to 500 billion virions per cc of fluid from a nasal swab, and that is a matter of concern. [One hour after I distributed this Absact as D9.doc, I received from Scott Kemp a paper¹ with his comment, "*This comparison between two PCR methods shows a range of 3×10^{10} , see figure 1, also attached.*" This is the only modification from D9.doc as presented.]

Without major action by the CDC, other countries can benefit from these perceptions and advances, and it may also happen that states and cities, universities and large corporations may proceed. FDA approval of workplace and home employment of this and analogous tests is essential and might be facilitated by adoption of such an approach abroad.

¹ <https://jcm.asm.org/content/58/6/e00599-20> Posted online 10 April 2020, "Clinical Evaluation of the cobas SARS-CoV-2 Test and a Diagnostic Platform Switch during 48 Hours in the Midst of the COVID-19 Pandemic"

Partial Bibliography for Garwin on This COVID-19 Pandemic

1. 052106V4f *Conquering* Pandemic Flu by Practical Measures.doc Conquering Pandemic Flu by Practical Measures. <https://fas.org/rlg/060521-flu.pdf>
2. <http://gabgoh.github.io/COVID/index.html> (Gabriel Koh) with Epidemic Calculator
3. <https://fas.org/rlg/conquering.pdf> Mt. **Sinai** School of Medicine, New York, NY February 16, “Conquering **Pandemic** Flu by Non-Pharmaceutical Means, and Other Thoughts on Health Care”
4. March 11-12 Partial C-SPAN transcript of House Committee Hearing with Dr. Robert R. Redfield, CDC Director and others.
5. How Much Worse the Coronavirus Could Get, in Charts, by [Nicholas Kristof](#) and [Stuart A. Thompson](#), March 13, 2020 [with epidemic simulator]
6. <https://www.erinbromage.com/post/the-risks-know-them-avoid-them> [05/06/20 Excellent, readable]
7. *COVID Immune Responses Explained*, Eric J. Topol, MD; Abraham Verghese, MD; Akiko Iwasaki, PhD August 21, 2020
provide controlled site for URL access.
8. <https://www.newyorker.com/tech/annals-of-technology/jonathan-rothbergs-race-to-invent-the-ultimate-rapid-at-home-covid-19-test>
9. *You're Positive, But Are You Contagious?* by [Apoorva Mandavilli](#), 08/29/2020, at <https://nyti.ms/31DJixp>.

Thank you for the opportunity to discuss the current Covid pandemic. This is the third version of this talk I have prepared, and I feel that I have been working on it for 15 years. Here is a brief section of a presentation I gave in Erice, Sicily, in 2006. This is not new, and certainly not original with me. It is hard-won knowledge in fighting pandemics and was put to good use in the Ebola outbreak and in other quite different diseases.

Primary PPM²:

1. Wash the hands after contact with potential contagion—e.g., when returning home, to the workplace, or frequently in space shared with others who may be symptomatic. If hand washing is inconvenient, use a 60+% alcohol-content hand sanitizing gel.
2. When in the presence of others, use a surgical mask or an N95 filter mask to protect against droplets or aerosols respectively. If masks are not available, improvise a mask such as a scarf over the eyes and mouth.
3. Don't shake hands; bump elbows in greeting.
4. Keep hands away from your face—especially eyes, nose, and mouth.
5. Don't infect others; use a tissue or piece of paper towel for sneezes and coughs and have a bag for used tissues.
6. Eliminate or reduce unnecessary trips, even local ones.
7. If you need to care for a person who might be sick with flu, use additional precautions such as diluted household bleach for bed clothes and for cleaning surfaces.
8. Practice these procedures at least one day every two weeks.
9. Clean and circulate air where people are in proximity, e.g., in transport, offices, assembly work

² From *Conquering Pandemic Flu by Practical Measures* <https://fas.org/rlg/060521-flu.pdf> (05/21/2006)

What is the problem, and why does this work?

Most epidemics arise from diseases communicated from one individual to another (*community transmission*) by means that are implicit in the prescription for quenching the pandemic. The germ (which includes bacteria, viruses, parasites, and other forms of "life") has evolved to make a living, so to speak, by infecting humans. One speaks of these episodes in terms of the population (number of people) susceptible– S , infected– I , and removed (recovered or dead)– R and assumed no longer infectible, at least in the short term. Such models have existed for almost a century, and are available in many examples, e.g. in a NYT article of 04/13/20³. I will exercise such a model, Zoom willing⁴.

In the early days of this epidemic, one person with the disease infects *more* than one other person, so the disease grows with a *reproduction factor* $R_0 > 1.0$ per *generation* of the epidemic. It grows *exponentially*, so that if in a certain time interval T_2 , the number of those infected doubles, then in the next interval it will double again, and again, and again. It is the nature of the exponential that not only does the number I of those currently infected expand in this fashion, but also those that *have been infected* and that join the population in the R category. You can play with this yourself. If the current case load expands by a factor 10 in T_{10} days, it will expand a further ten-fold (*one log*) in the next T_{10} days.

About February 1, 2020, when I became well aware of the Covid-19 epidemic that began in Wuhan, Hubei Province, China, in December, 2019 or earlier, I tried, as did others, of course, to warn that according to the data made available by China at that time, the United States could expect to lose two million people— mostly old people. What were those data?

³ *How Much Worse the Coronavirus Could Get, in Charts*, by [Nicholas Kristof](#) and [Stuart A. Thompson](#), March 13, 2020 [with epidemic simulator]

⁴ Epidemic Calculator, <http://gabgoh.github.io/COVID/index.html>

The table shows data from China about the age distribution of victims of the novel coronavirus-- Covid-19,

COVID-19 Fatality Rate by AGE:

AGE	DEATH RATE confirmed cases	DEATH RATE all cases
80+ years old	21.9%	14.8%
70-79 years old		8.0%
60-69 years old		3.6%
50-59 years old		1.3%
40-49 years old		0.4%
30-39 years old		0.2%
20-29 years old		0.2%
10-19 years old		0.2%
0-9 years old		no fatalities

***Death Rate** = (number of deaths / number of cases) = **probability of dying if infected by the virus (%)**. The percentages do not have to add up to 100%, as they **do NOT represent share of deaths by age group**.

The *case-fatality ratio-- CFR--* was a few percent, overall. This compares with the ~35,000 people in the United States who die of seasonal influenza each year, of many tens of millions of people infected– or a *CFR* in the case of seasonal flu of about 0.1%.

Clearly this was a serious disease. After initially denying the existence of an epidemic in Wuhan, and even punishing physicians who attempted to alert their colleagues, China came relatively clean, inviting representatives of the World Health Organization– WHO– to the scene of the epidemic, providing a joint WHO-China report on the visit of 16-24 February 2020⁵ The Wuhan Institute of Virology (WIV) early-on sequenced the genome of the SARS-CoV-2 virus responsible for Covid-19, and published it freely on 1/10/20, which allowed scientists in China and anywhere else in the world to begin efforts to create a vaccine and pharmaceuticals for treatment of the disease; there are none yet accepted as a result of this effort.

It is essential to understand that with an *Ro* of 3.0 and an inter-generation time (*serial interval—i*) of 5 days, the doubling time of the case load is 3.1 days, and with an *Ro* of 6.0, as seems to have been the case in the crowded quarter of Wuhan, the doubling time is half that, or 1.5 days. So a short response time is of the essence; for *Ro* = 3, a week's delay increases the number of cases by a factor 4.7

⁵ <https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf>
09/01/2020

The world was left with non-pharmaceutical intervention-- *NPI*-- or non-pharmaceutical measures-- *NPM*. These were exactly what I, as an observer, had been advocating for many years, especially after the SARS outbreak in 2002-2004. SARS-- *sudden acute respiratory syndrome* – began in Guangdong province, China. SARS is much more lethal than SARS-CoV-2— with a *CFR* of 11% but was vanquished with a total number of cases worldwide⁶ <9,000, and deaths <900; no case of SARS has been reported since 2004. The world was lucky with SARS that an infectee can communicate the virus only after showing symptoms, namely an elevated body temperature. China led the way (after initially denying the existence of the disease) by deploying remote body temperature monitoring equipment at travel centers, diverting and quarantining those with elevated body temperature. [RLG demo].

That this was a fortunate accident, became apparent with Covid-19, for which it is clear that people who do not yet show symptoms, and people who have and recover from the disease in a couple of weeks without any symptoms, effectively transmit the disease during the first days of the infection and for about two weeks.

What is the mechanism of transmission? This is a crucial point, emphasized in my talks a decade ago, for instance one of 02/16/2016 at Mount Sinai Hospital Medical Center in NYC⁷,

Economists are largely undeterred by lack of facts, which only make their job more difficult. But I mean this as approbation for the presentation and papers of Wein, in this case. First, Larry Wein judges (without much experimental confirmation) that influenza is communicated in large part by aerosol transmission and not by droplets or by fomites. His prescription, therefore, is that individuals wear N95 masks, capable of trapping 95% of aerosols of diameter 0.3 micron or larger. There are, of course, many problems with such a prescription. The masks are uncomfortable and warm or even stifling. They are often not fitted very well, and there are, by far, insufficient masks and money to pay for them if they are used by the public as they are in the hospital surroundings, with a new mask for every encounter. So I long ago set out with my friend Stirling Colgate to encourage simple experimental determination of the possibility of multiple reuse of N95 masks. I referred to this in my presentation to an Institute of Medicine panel and, of course, made it a point to bring up at our 2006 workshop.

In February 2020, the United States with no intervention and essentially no guidance from CDC— the Centers for Disease Control and Prevention— was on track for two million deaths. The CDC later advised voluntary lock-down and optional mask wearing, after explicitly recommending that the population should not wear masks or face covering. I will discuss this further with a verified C-SPAN transcript of a long House hearing of 03/11-12/20 with CDC Director, Dr. Robert R. Redfield.

Epidemics are typically self-limited by the development of "herd immunity" where the number of susceptible people is reduced sufficiently by transfer from the *S* to the *I* and then to the *R* category so that, with a given *R₀*, the virus doesn't find enough susceptibles to spread, so it gradually and totally dies out.

⁶ https://en.wikipedia.org/wiki/Severe_acute_respiratory_syndrome [Good article]

⁷ <https://fas.org/rlg/conquering.pdf>

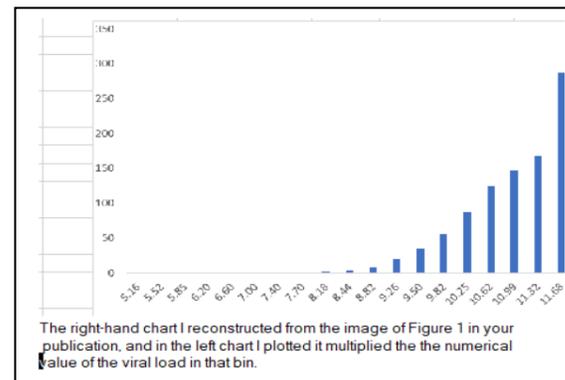
I should also have commented that in the early days of this epidemic in the United States-- in New York in particular-- the doubling time for the infected population was 2-3 days. Had total isolation been introduced, the virus would have been gone in about two weeks, although 2% or even 15% of those infected (depending on age) would have died over the next month. Furthermore, the epidemiological modeling community has not over the decades properly identified and observed R_0 as characteristic not of the virus itself, but also strongly affected by the social conditions.

I do emphasize that whether herd immunity is developed by inaction or by continued limitation of social contacts to limit the steady case load to numbers that do not overwhelm hospital facilities, we will still suffer the two million deaths in the United States in achieving herd immunity, unless an effective vaccine or treatment is developed. To say that this is "unacceptable" is not helpful. But new developments, even in the last few days, show the way out.

Now I quote from the work of Scott Kemp, physicist at MIT, who was a principal in writing the JASON report⁸ of July 10 on reopening university research laboratories in a Covid-19 era. In a Zoom presentation 08/17/20, Kemp has included the next five slides. The first two build on a finding⁹ from May, 2020, that a few percent of those infected (of 3712 in the cohort) harbor 95% of the viral load, and, if identified quickly after they are infected, could be quarantined, while the rest of those infected could go about its business with $R_0 < 1.0$, and so the epidemic would die out in that society, as did SARS in 2004. Kemp's theory, sketched on these slides, accounts for the fact that a tiny fraction of people infected have a million times the viral load usual to those who have Covid-19. And his final slide shows the potential solution to this problem. [→ Kemp slides]

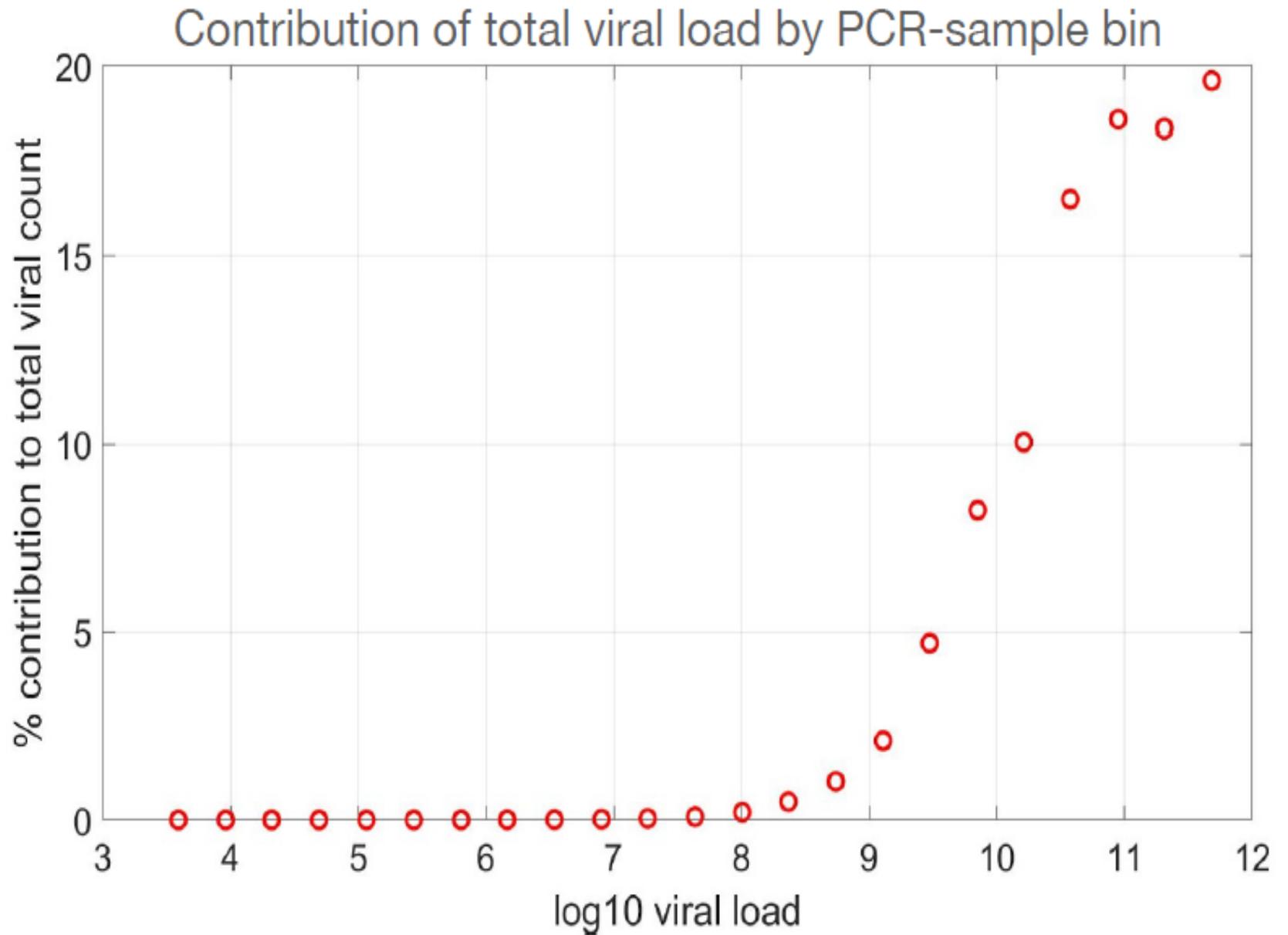
Kemp's Slide 11 reproduces the banal-appearing data of that "Viral load" publication. On 06/03/20 I had written the authors with an early version of Kemp's Slide 12. So the analysis goes from

"Distribution of viral titers found in PCR samples" to
"Contribution of total viral load by PCR-sample bin," via
"Temporal Patter of Average Infection" to "Distribution of Viral Titers." The top curve is the prediction for the highest 2% of the viral titers of Kemp's Slides 11 and 12, via a theory of viral reproduction and suppression in the human body. The Red curve, peaking at 1 is the single curve of the previous slide on a log scale of Viral Titer, making clear the exponential nature of the growth and decay of the virus in this simple theory.



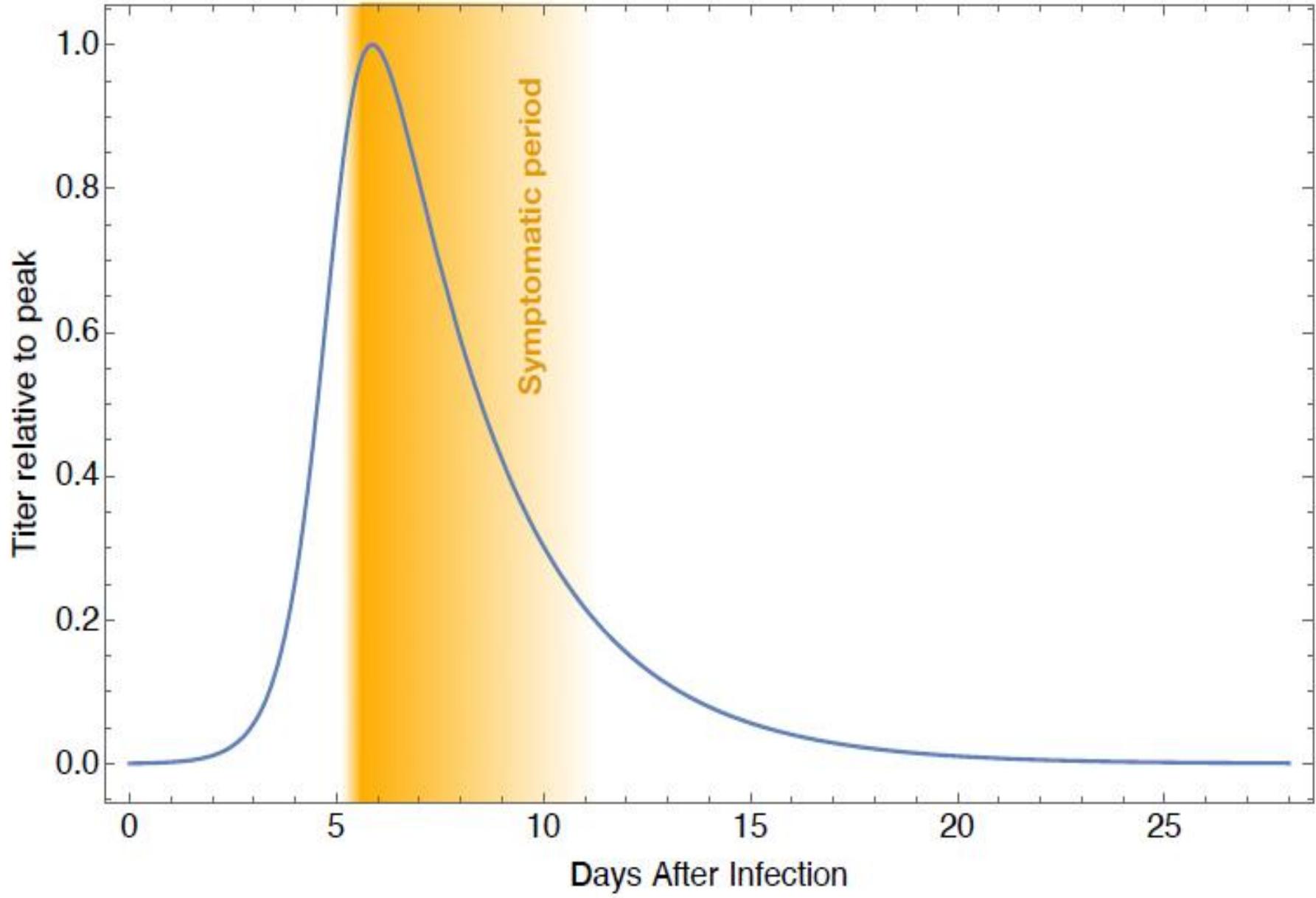
⁸ <https://fas.org/irp/agency/dod/jason/covid-19.pdf>

⁹ https://zoonosen.charite.de/fileadmin/user_upload/microsites/m_cc05/virologie-ccm/dateien_upload/Weitere_Dateien/analysis-of-SARS-CoV-2-viral-load-by-patient-age.pdf

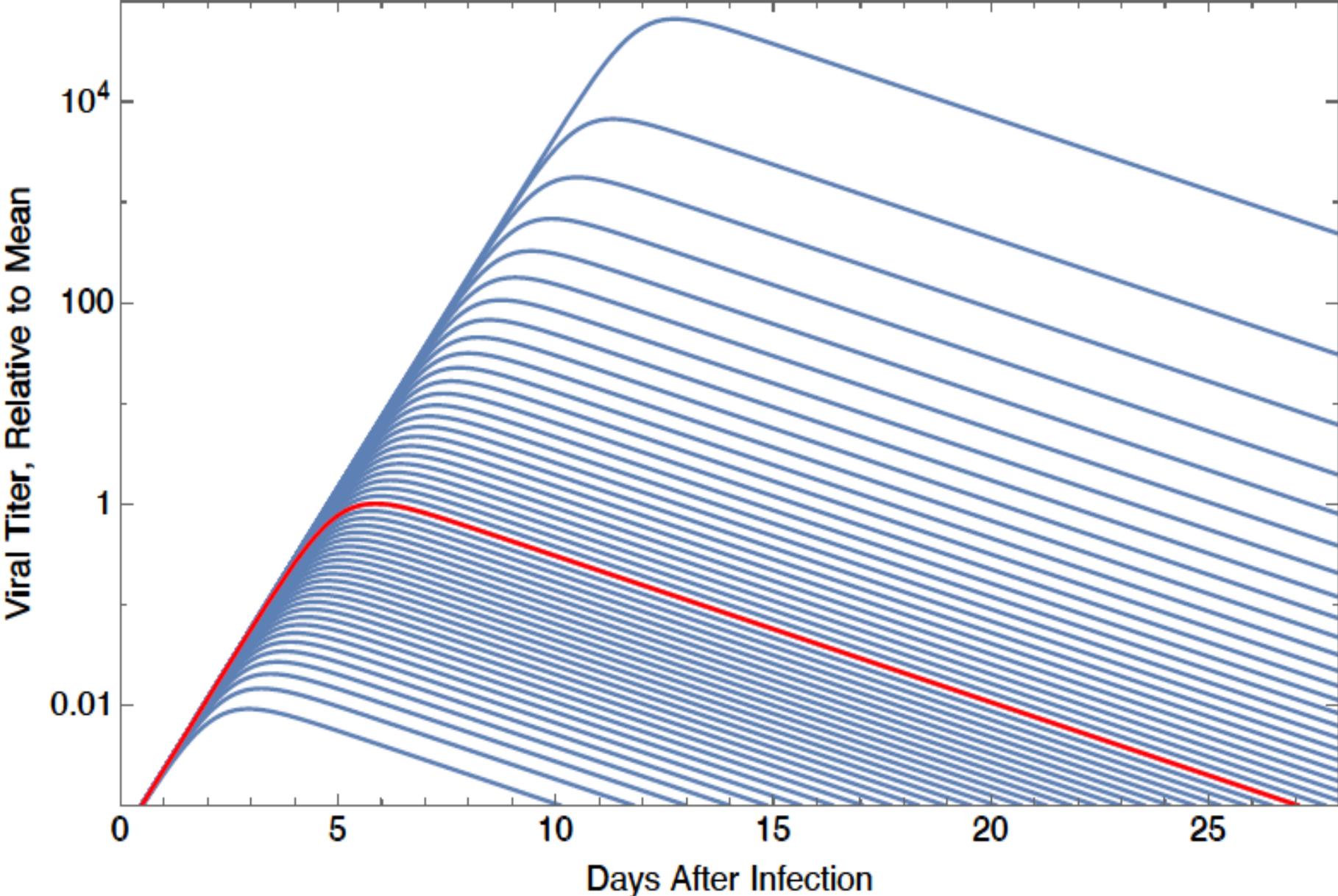


Source: JASON, JSR-20-NS1. <https://fas.org/irp/agency/dod/jason/covid-19.pdf>. - Original data from Terry C. Jones et al., "An Analysis of SARS-CoV-2 Viral Load by Patient Age" (Charité - Universitätsmedizin Berlin, n.d.)

Temporal Pattern of Average Infection

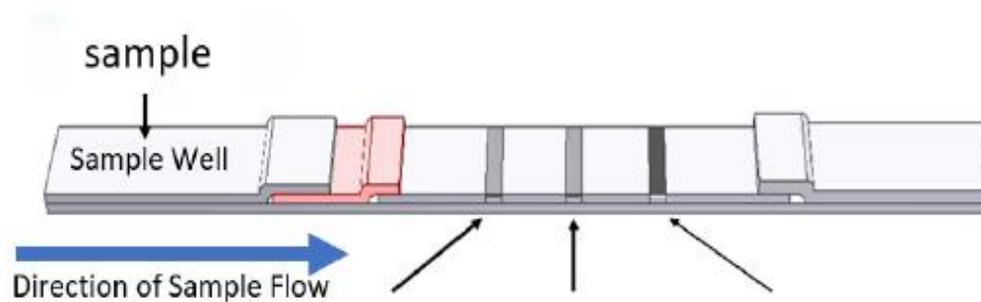


Distribution of Viral Titers



Test Requirements

- Comfortable
- Accessible at home or place of business
- Extremely inexpensive
- No laboratory required
- Rapid (ideally instant) results



16

Abbott Laboratory announced 08/26/20¹⁰ its “\$5, 15-minute” BinaxNOW™ COVID-19 Ag Card test not for the virus, but for antigens—Ag-- in the virus, which shows almost 100% detection sensitivity for those infected. A key point is that the "super-titerers" can probably be identified in about one minute, and that the test will probably work as well with saliva input as it does with a nasal swab.

What does this mean?

Germany is reopening its schools with a low ambient Covid incidence, limiting the contact of students to those in a single classroom, without mixing with others during the day. They use an active program of monitoring and contact tracing, and quarantining only those in a classroom, rather than the whole school.

In using the Abbott Ag test to find those with super titers, one has to choose testing frequency and strategy in a particular context. For instance, in a school or a building with many suites occupied by a single corporation, until the virus is eliminated locally the need is to test sufficiently frequently, with consequent isolation of those testing positive, to reduce the R_0 below 1.0. Here [RLG demonstrate] I remind you what reducing R_0 from 2.2 to 0.5 does to an epidemic. As I could have said at the beginning, although perfect protection of oneself against the ambient virus is not possible, absolute protection of oneself by societal response is indeed feasible, as demonstrated by the return of unencumbered social contact in Wuhan in recent weeks, and in the elimination of SARS worldwide. That bears repeating. But as I said in 2006, to remind people that the danger is not far off, but that it can be absolutely conquered by NPI even before an effective vaccine or treatment is available, we need to

8. Practice these procedures at least one day every two weeks.

Roughly speaking, if a Covid-19 case spreads the virus by aerosol route for three days of asymptomatic (including pre-symptomatic) breathing and speaking, testing each person each day is likely to catch infected individuals within no more than one day of infection, and isolating them (denying them entry) would thus reduce R_0 by the target factor of three.

But in the longer term-- when for the most part there is no virus present and no infected people in the pod, one can adopt a policy of adaptive sampling, since the next generation of those infected will likely require several days in order to have achieved the titer required for significant transmission in the community. If this seems tentative, you're right. To say that we lack full understanding of the implications that a tiny fraction of those infected are responsible for essentially all of the aerosol transmission overstates greatly the state of our knowledge.

¹⁰ https://Abbott.mediaroom.com/press-releases_09/01/2020_

To illustrate specifically the human problems of progress in understanding this novel virus, I quote an expert comment¹¹ on the February 2020 paper regarding the time and mode of Covid-19 transmission.

“This virus is transmitted by people sneezing or coughing on you. Masks are for those people who are coughing and sneezing—for them to wear to reduce their coughing or sneezing their virus upon you—not for you to wear when you’re not the one coughing or sneezing. This behavior of everyone wearing masks doesn’t stop the spread; in fact it may increase the potential for warm moist areas for the virus to survive and it promotes unnecessary fear. “

This represents the faction evidently dominant in the WHO that lacked understanding or acceptance of aerosol transmission, which is the only mode that can account for many examples of community spreading, including the early one choir practice in Washington State 03/10/20¹²; according to the CDC, 87% of the choir members contracted Covid-19 and two died.

To summarize, if super titerers account for almost all the community transmission, then it is only they who need be found and isolated. This reduces the impact on society by perhaps a factor 40 compared with universal lockdown, even while there are a lot of people infected. Just as we were gifted by the fact that SARS is communicated only by those with high body temperature, so there is a fortunate aspect of SARS-CoV-2 in that those with high titers may be detectable much more quickly even with the Abbott test than those infected with normal titers. Perhaps the million-fold super titerer can be detected in real time before entry; but even admitting a person who will test positive after 15 minutes and has already been seated at her workstation, contributes little to R_0 if sent home promptly, compared with having the super-titerer work all day.

That is, even if all were admitted to their workplace, having been sampled on entry, isolating these super titerer after 30 minutes still reduces substantially the communication that can have taken place, although the titer is sometimes so high that even a few minutes of aerosol production may provide a high probability of transmission. This does not have to be all worked out in advance of this talk, but it clearly merits discussion and intensive research.

Without major action by the CDC, other countries can benefit from these perceptions and advances, and it may also happen that states and cities, universities and large corporations may proceed. FDA approval of workplace and home employment of this and analogous tests is essential and might be facilitated by adoption of such an approach abroad.

¹¹ Richard M Fleming, PhD, MD, JD; Matthew R Fleming, BS, NRP; Tapan K Chaudhuri, MDFHHI-OI-Camelot; FHHI-OI-Camelot; Eastern Virginia Medical School 10 March 2020

¹² <https://www.cnn.com/2020/05/13/us/coronavirus-washington-choir-outbreak-trnd/index.html>

Two, partial transcripts of: House Oversight and Reform Committee Hearing on Coronavirus Response, March 11, 2020

Derived from C-Span coverage: <https://www.c-span.org/video/?470224-1/dr-fauci-warns-congress-coronavirus-outbreak-worse>

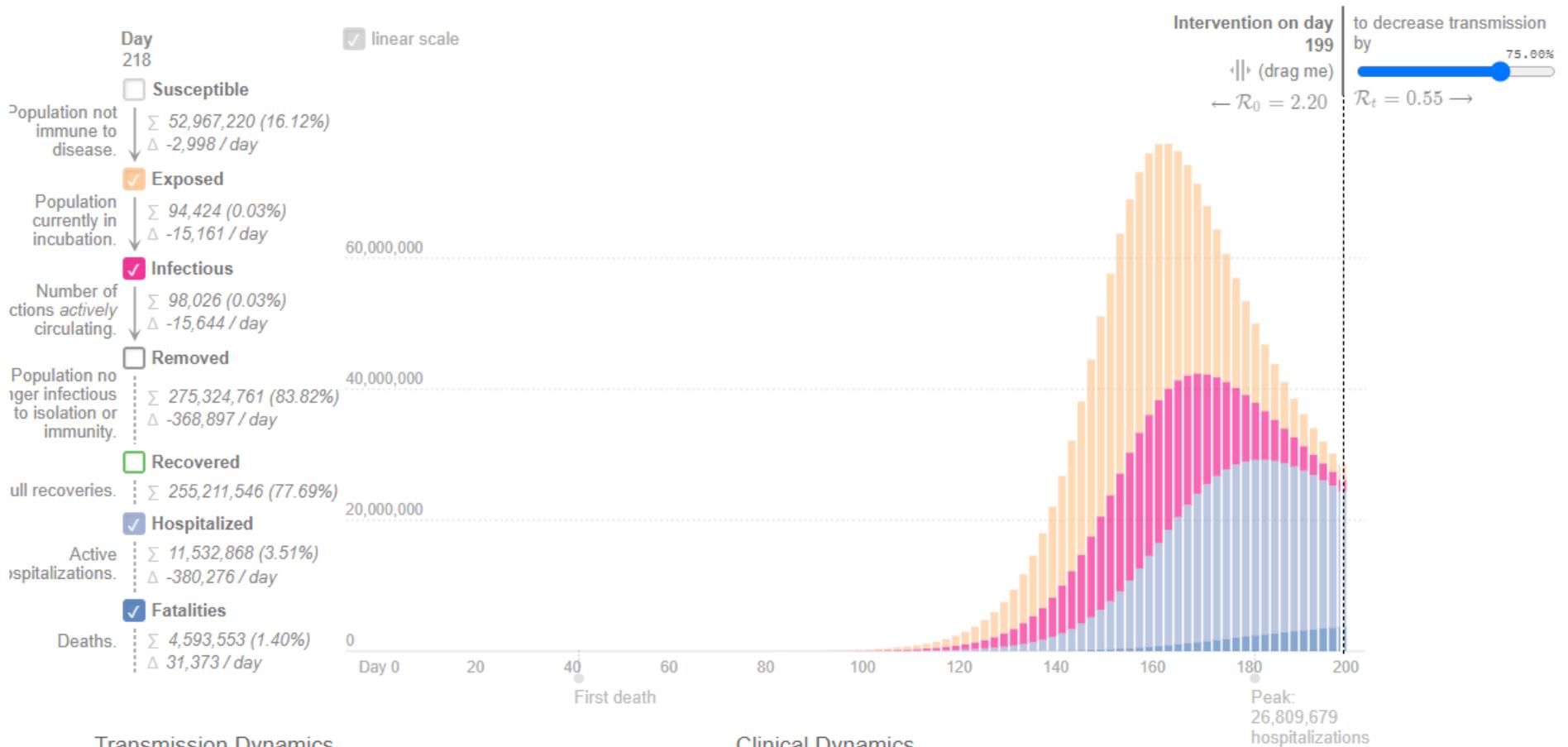
01:00:07 **MR. COOPER**

ARE THERE ANY PLANS TO HAVE DRIVE-THRU TESTING IN AMERICA SO WE DO NOT PANIC EMERGENCY ROOMS WHEN PEOPLE COME IN AND COUGH?

01:00:15 **DR. REDFIELD**

NOT AT THIS TIME. I THINK WE'RE TRYING TO MAINTAIN THE RELATIONSHIP BETWEEN INDIVIDUALS AND THEIR HEALTH CARE PROVIDERS.

Epidemic Calculator



Transmission Dynamics

Population Inputs

Size of population.



Number of initial infections.



Basic Reproduction

Number R_0

Measure of contagiousness: the number of secondary infections each infected individual produces.



Transmission Times

Length of incubation period, T_{inc} .



Duration patient is infectious, T_{inf} .



Clinical Dynamics

Mortality Statistics

Case fatality rate.



Time from end of incubation to death.



Recovery Times

Length of hospital stay



Recovery time for mild cases



Care statistics

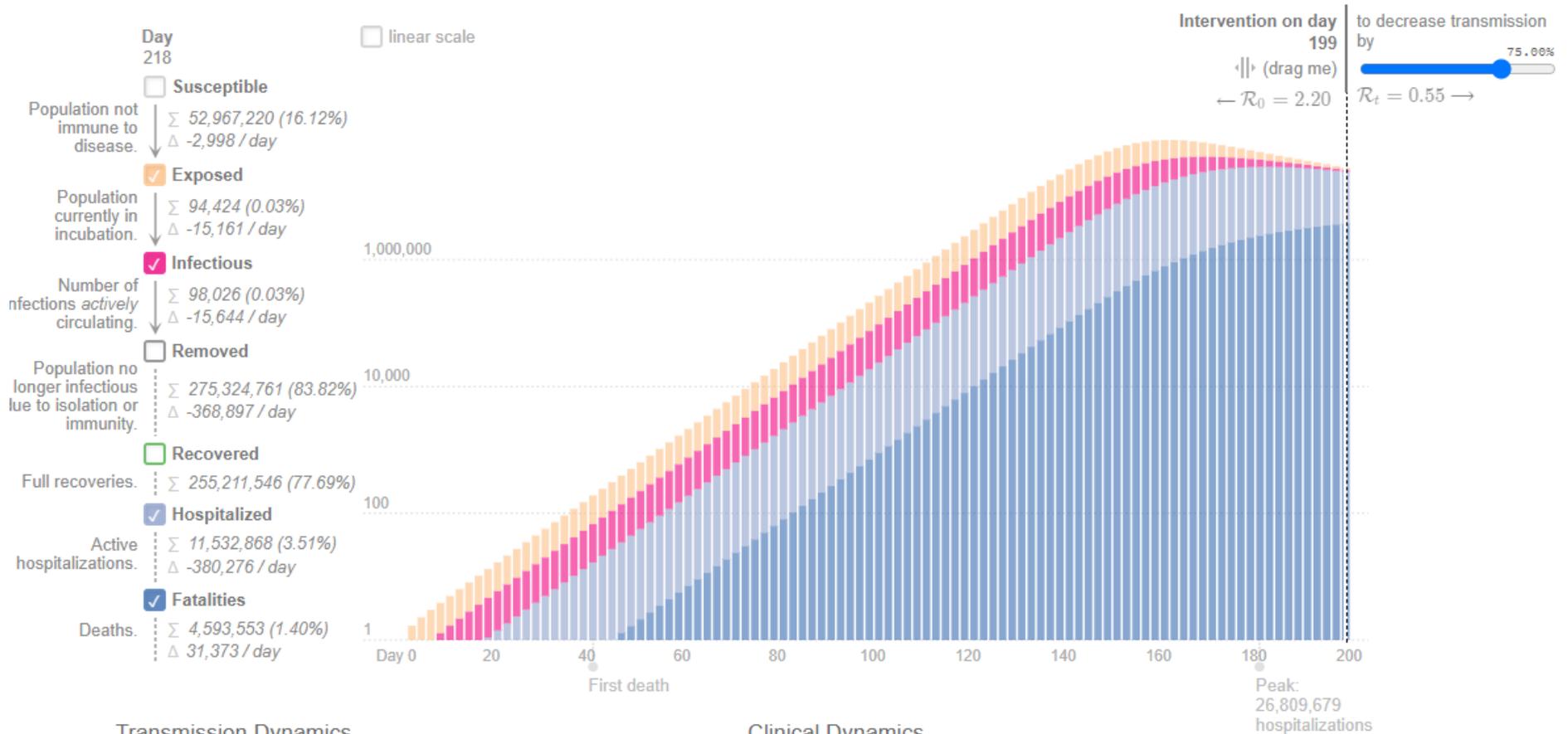
Hospitalization rate.



Time to hospitalization.



Epidemic Calculator



Transmission Dynamics

Population Inputs

Size of population.



Number of initial infections.



Basic Reproduction Number \mathcal{R}_0

Measure of contagiousness: the number of secondary infections each infected individual produces.



Transmission Times

Length of incubation period, T_{inc} .



Duration patient is infectious, T_{inf} .



Clinical Dynamics

Mortality Statistics

Case fatality rate.



Time from end of incubation to death.



Recovery Times

Length of hospital stay



Recovery time for mild cases



Care statistics

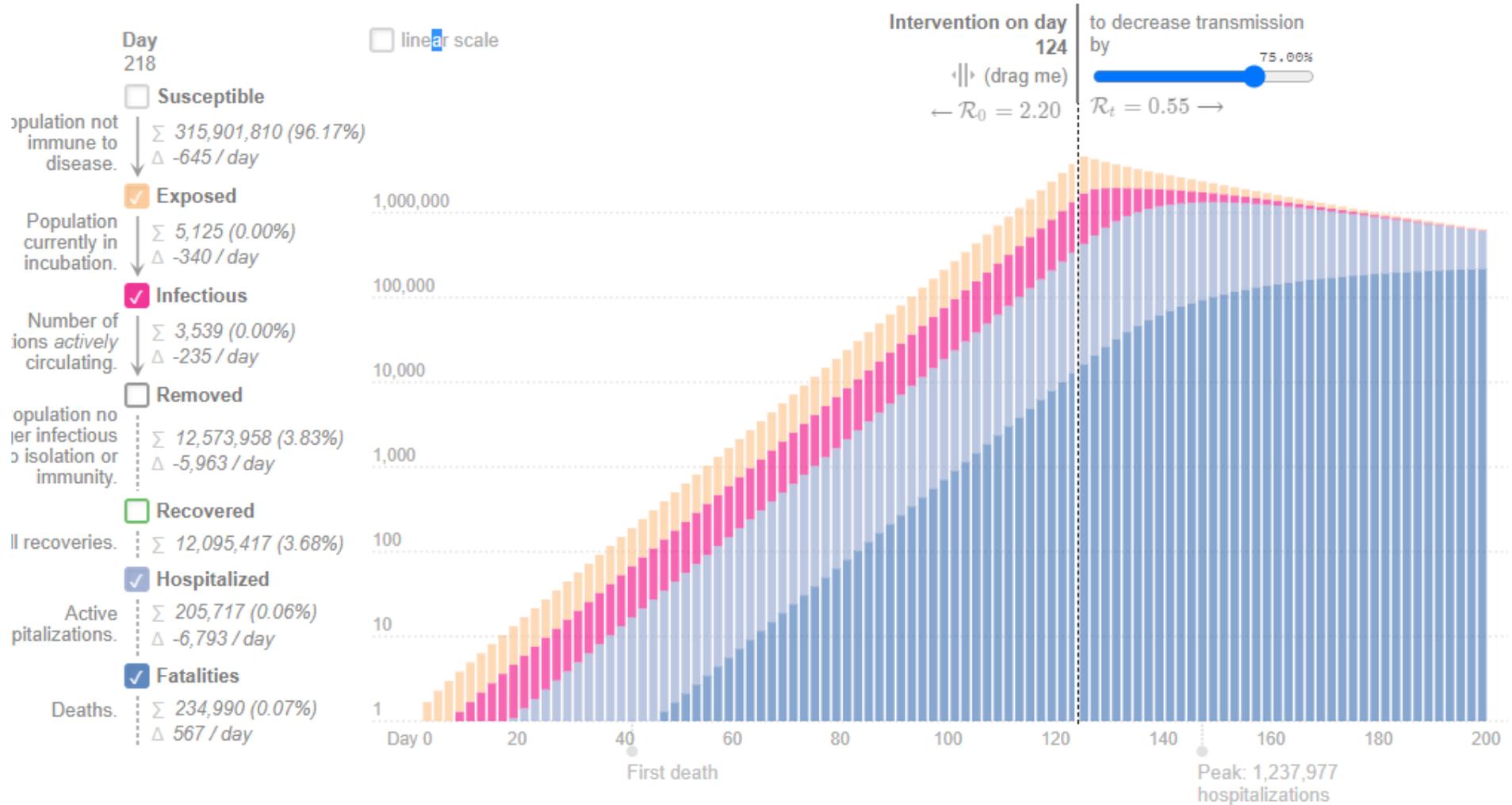
Hospitalization rate.



Time to hospitalization.



Epidemic Calculator



Transmission Dynamics

Population Inputs

Size of population.



Number of initial infections.



Basic Reproduction Number \mathcal{R}_0

Measure of contagiousness: the number of secondary infections each infected individual produces.



Transmission Times

Length of incubation period, T_{inc} .



Duration patient is infectious, T_{inf} .



Clinical Dynamics

Mortality Statistics

Case fatality rate.



Time from end of incubation to death.



Recovery Times

Length of hospital stay



Recovery time for mild cases



Care statistics

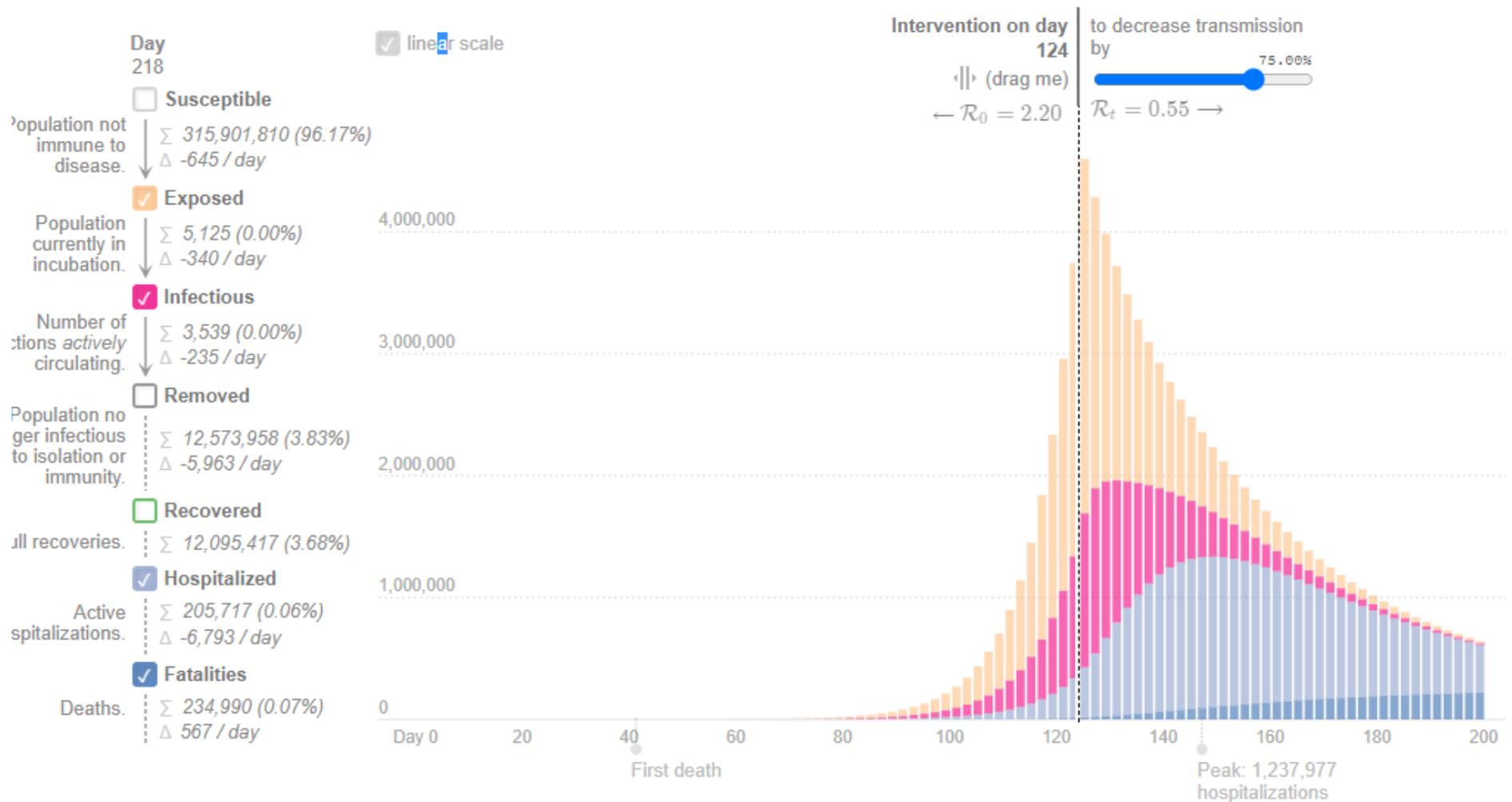
Hospitalization rate.



Time to hospitalization.



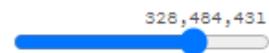
Epidemic Calculator



Transmission Dynamics

Population Inputs

Size of population.



Number of initial infections.



Basic Reproduction

Number \mathcal{R}_0

Measure of contagiousness: the number of secondary infections each infected individual produces.



Transmission Times

Length of incubation period, T_{inc} .



Duration patient is infectious, T_{inf} .



Clinical Dynamics

Mortality Statistics

Case fatality rate.



Time from end of incubation to death.



Recovery Times

Length of hospital stay



Recovery time for mild cases



Care statistics

Hospitalization rate.



Time to hospitalization.

