Using Discrete Event Simulation model to simulate COVID19 epidemics in Switzerland.

New Results

We appreciated all the comments we received after the publication of our simulation. Switzerland started to open on April 27. The last phase is supposed to be on the 6th of June.

In the mean time we have worked to improve our model and it's time to see some more results.

Let's first remember how the model works. Every day the simulation checks how many patients are in the incubation phase and how many are with symptoms at home. These two categories of patients will contaminate new cases. Patients with symptoms at home includes patients in Home Care. The model considers a certain number of elderlies who died in Home Care.

The value of R0 we apply differs for the two categories. People with symptoms, almost since the very beginning and after the first announcements from the ministry of health have been asked to stay at home. This is why the "symptom's R0" decreases very rapidly to a value we fixed at 0.05. This means that with 10'000 people with symptoms at the peak of the epidemic, contaminate 500 people in 5 days. The "incubation R0" instead, is used in the simulation as the main factor of contagion.

Length of stay in each stage of the model (incubation, symptoms, hospital ward and ICU) is beta distributed with minimum, average and maximum number of days. We used data available from official information.

We also make a difference between the number of cases generated by the model and the number of declared cases. Most of the people during the incubation period are not tested.

The number of declared cases of the model are calculated as follow:

Simulation declared cases **=** Total cases generated by the model **-** Total cases incubating,

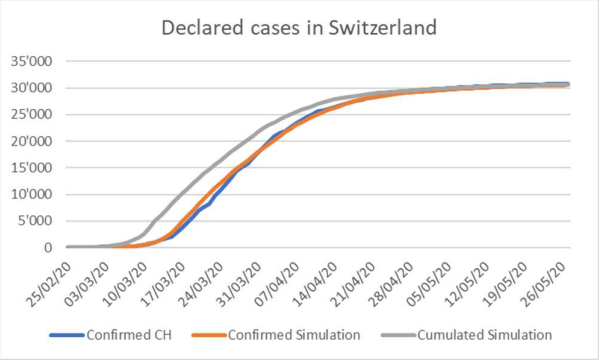
Date	Decision
20/02/2020	Starting phase
28/02/2020	Meetings >1000
13/03/2020	Meetings > 100, Restaurant <50, Schools
16/03/2020	Close All shops and restaurants
20/03/2020	Lockdown
28/04/2020	Open Phase 1
11/05/2020	Open Phase 2
20/05/2020	Open Phase 3
06/06/2020	Open Phase 4 to be announced

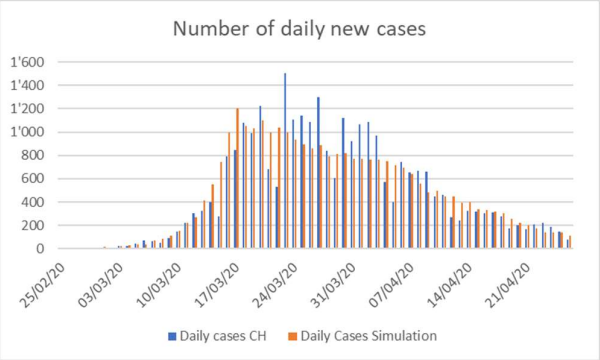
The simulation we present today runs from February 20, to May 27. On 20 February, six starting cases are introduced into the incubation queue. The model starts with a R0 = 2.5 for 8 days. This is what we call the starting phase and there seems to be agreement from epidemiologists on this starting value of 2.5. Then we adjusted the R0 after each government decision in order to fit the observed number of declared cases.

The detail of these government measures can be seen on the website of the Swiss administration.

The graph below shows the evolution of confirmed cases in Switzerland, according to the official statistics and the number of confirmed cases simulated with our model. The grey line represents the number of cases generated by the model. The gap between the red line and the grey line represent the cases infected but not declared.

Accuracy of the simulation



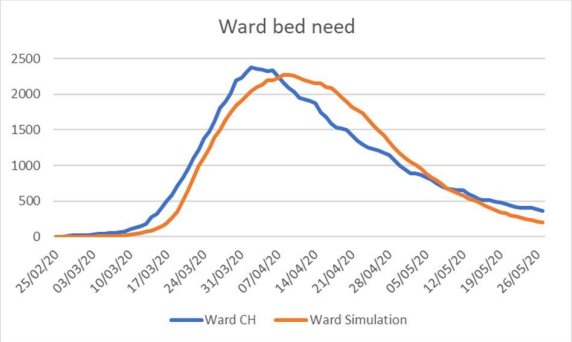


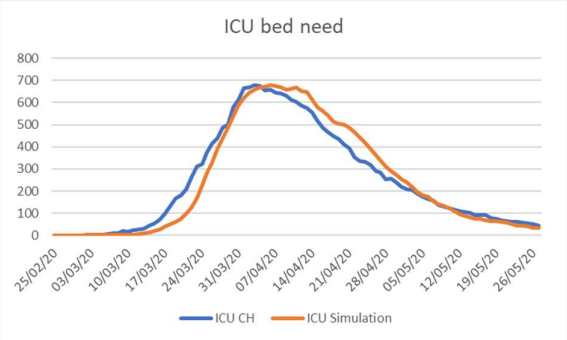
To measure the accuracy of our results, we also used SIMUL8 Trial. The table below presents the simulated values with variation in a range of ± 5%, and observed values.

	Values at 27/05/2020			
	Simulation values			Swiss official
	-95%	**Result**	*95%*	**Values**
Confirmed	*30'436*	**30'780**	*31'124*	**30'743**
Death	*1'865*	**1'940**	*2'014*	**1'918**
Max Ward Bed Used	*2'277*	**2'324**	*2'371*	**2'377**
Max ICU Beds Used	*670*	**704**	*737*	**680**

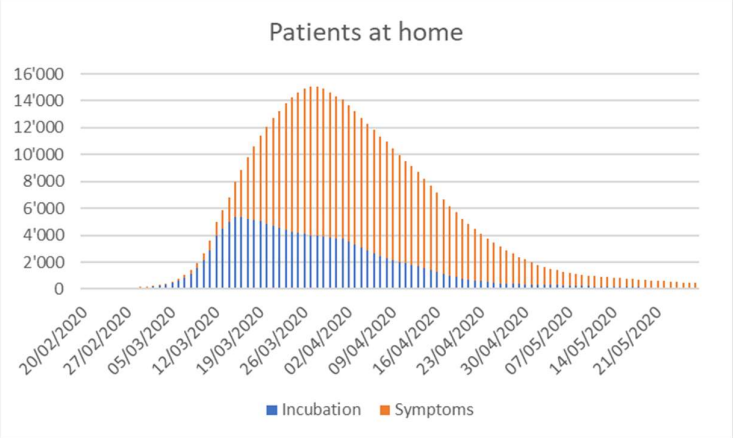
The hospital bed capacity needs during the simulation is also very close to the observed data.

Hospital needs simulation / observed data





How many people are in incubation phase or at home with symptoms today?



The model estimates every day how many people have contracted the disease and are in the incubation phase or at home, with symptoms, recovering or with a worsening condition before hospitalization. According to our model, at the peak of the epidemic more than 14'000 infected people were at home.

On May, 27 the model shows that more than 400 people were at home, incubating or with the symptoms.

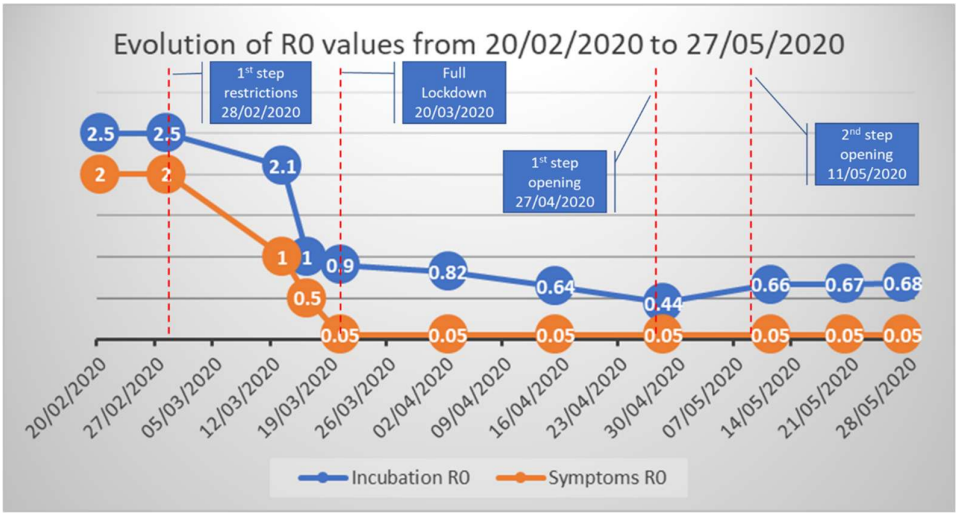
	Simulation values at 27/05/2020		
	-95%	**Result**	*95%*
Incubating	*83*	**93**	*103*
With Symptoms	*324*	**344**	*364*
Total	*407*	**437**	*467*

This numbers are related to the 30'000 cases declared in Switzerland. Our model is designed to fit this data, but serology testing conducted recently in several countries shows that these values could be much higher. We discuss this in the limits of our model.

Our estimation of R0 values

At the end of April 2020, when the government starts to open again, we estimate the value of R0 was around 0.44. Presently it is up around 0.68.

As we know, with values over 1.1, the epidemic grows again very fast.



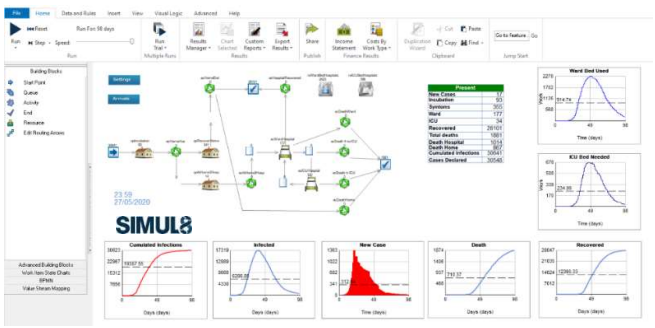
Some limits of the model

Several studies are showing that most countries have more cases than the number declared. A recent study in Geneva mentioned that 5.5% of the Geneva population have been in contact with the virus. This would be approximately 5 times more than the number declared. Does this mean that we could have around 150'000 people in Switzerland instead of the declared 30'000, that have been in contact with the virus? The good news would be that the population is slightly more immune (if it is confirmed that it's not possible to catch the disease twice). Our model takes into consideration the immunity level of the population, calculating the ratio Susceptible / Total population. It would also mean that hospitalization rate and death rate are lower. The bad news would be that today, we have more people in the population spreading the virus.

The model doesn't work by clusters. It starts on February 20, 2020 with 6 cases introduced into the system. In Switzerland the first patient declared was in Lugano area, but we know other clusters appeared in the same time in the rest of Switzerland.

Another point is the impact of cross borders workers. Our model works with a constant population, but more than 300'000 workers cross the border every day. During the lockdown the borders were mostly closed (except for health care professional). The model is designed as if these workers are included in the swiss population. It is probably not such a big bias to the model, since France, Germany, Italy and Austria are also following the same barrier gestures and social distance measures.

What's next?



In the coming weeks, we will try to follow the evolution of R0 values and improve our Discrete Event Simulation model as we receive some more detailed data. We would also like to try to do the same for a single region, Ticino, where the outbreak started in Switzerland. But we developed this simulation during the lockdown, not sure we have as much time as in the last three months to continue!