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Humboldt-Universität zu Berlin
Department of Communications,
Marketing and Events
Communications and Media Office

Unter den Linden 6
10099 Berlin
Tel.: +49 30 2093-2946
Fax: +49 30 2093-2107
www.hu-berlin.de

Press Spokesperson
Hans-Christoph Keller
Tel.: +49 30 2093-2946
hans-christoph.keller@hu-berlin.de

Expert database
www.hu-berlin.de/expertendatenbank

Vaccination strategy can be optimised with computer model

HU research team simulates COVID-19 outbreaks with virtual agents

A new model for simulating COVID-19 outbreaks helps to develop the right strategy for herd immunity for every municipality and city – even in the event of vaccine shortages.

For, even after two years of the pandemic, countries, municipalities and cities are still experiencing severe COVID-19 outbreaks. The fact that the incidence can increase even in areas with a high vaccination rate shows that vaccination rate alone is not a guarantee of assured herd immunity. The composition of the population, the vaccination strategy, previous waves of infection and the use of non-pharmaceutical interventions also have a strong impact on when sufficient immunity for community protection is attained within a population group.

In order to better understand the influence of these diverse factors and be able to deploy measures in a more targeted manner during future outbreaks, the Theoretical Biophysics working group at the Humboldt-Universität zu Berlin, headed by Prof. Dr Edda Klipp, has developed a novel computer model for simulating COVID-19 outbreaks. The model and initial findings from simulations have now been published in the journal *Advanced Science*.

Dr Björn Goldenbogen, a postdoc in the working group and the lead author of the study, explains: "Since our model is based on so-called agents – virtual persons who simulate the complex behaviour of real people very well – random encounters that are particularly relevant at the beginning of an outbreak are also taken into account. This is what makes it so realistic and useful."

Various vaccination strategies are simulated

In simulated outbreaks, the team altered factors such as the age of the virtual agents, their behaviour or their vaccination status, and, in doing so, noted that there is no *one* vaccination rate that leads to herd immunity. The population groups and the various courses taken by the pandemic in each municipality and each city are too different. The new model now improves the ability to calculate the required vaccination rate for a very specific community.

The researchers have also used the model to simulate and compare different vaccination strategies. When the availability of vaccines is limited – as is still the case in many countries

around the world – different prioritisations when it comes to the order of groups to whom vaccines are administered have different effects on the course of the pandemic.

For example, vaccinating the elderly first will reduce the number of deaths, but the number of infections will increase. On the other hand, if you first vaccinate those people who have a particularly high level of contact with others, those who are younger and mobile, this can also prevent a wave of infections.

Another important finding from the simulations is that, even when there is a limited supply of vaccines, combining different strategies could achieve herd immunity within a community.

The model developed by the team, GERDA (the GEospatially Referenced Demographic Agent-based model), is being made available as an open simulation platform that can be used by researchers, but also authorities, to analyse COVID-19 outbreaks and to test various strategies for combating outbreaks.

Original publication

Goldenbogen, B., Adler, S. O., Bodeit, O., Wodke, J. A., Escalera-Fanjul, X., Korman, A., Krantz, M., Bonn, L., Morán-Torres, R., Haffner, J. E., Karnetzki, M., Maintz, I., Mallis, L., Prawitz, H., Segelitz, P. S., Seeger, M., Linding, R., & Klipp, E. (2022). Control of COVID-19 outbreaks under Stochastic Community Dynamics, Bimodality, or limited vaccination. *Advanced Science*, 2200088. https://doi.org/10.1002/advs.202200088

Contact

Prof. Dr Dr h.c. Edda Klipp
Humboldt-Universität zu Berlin
Department of Biology, Theoretical Biophysics
10099 Berlin

Email: edda.klipp@rz.hu-berlin.de
Tel.: +49 30 2093-9040