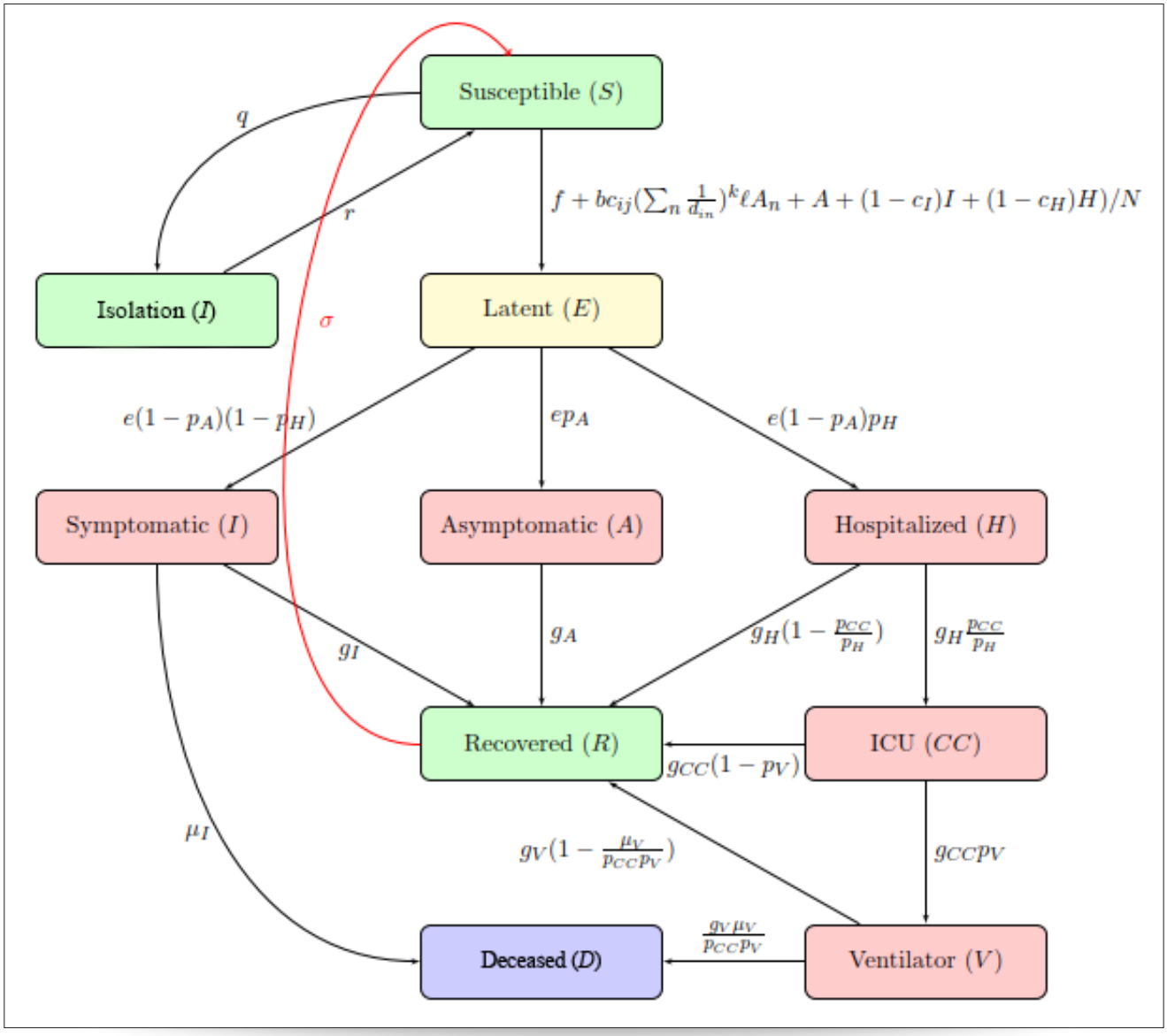
A MODEL TO ASSIST IN IDENTIFYING EFFECTIVE MITIGATION STRATEGIES TO REDUCE THE IMPACT OF COVID-19 ON IDAHOANS

PURPOSE

To help Idaho Gov. Brad Little's Coronavirus Working Group make data-driven policy decisions, the Idaho Department of Health and Welfare (DHW) and five universities were asked to develop a model to assist in identifying effective mitigation strategies to reduce the impact of COVID-19 on Idahoans. The strategies would help by minimizing the number of infections, hospitalizations, and deaths in our state. The model could also be used to get a rough estimate of resource needs such as ICU beds, ventilators, and personal protective equipment (PPE).

IDAHO COVID-19 RESPONSE CONSORTIUM

DHW collaborated with the University of Idaho, Boise State University, Lewis-Clark State College, Idaho State University, and Washington State University. Dr. Holly Wichman, director of the Institute for Modeling Collaboration and Innovation at the University of Idaho, coordinated model development by modelers, mathematicians, biostatisticians, and other experts with support from DHW's Division of Public Health. The consortium presented several mathematical models and visualizations to DHW for consideration.



MODEL

A model developed by Dr. Benjamin Ridenhour, assistant professor at the University of Idaho's College of Science, Department of Mathematics, was ultimately determined to be the most useful for the purposes of the Governor's Coronavirus Working Group. The model allows the user to enter different values for each parameter, based on the best information available at the time. It is based on a standard model in which people move between four specific categories related to the virus including being susceptible, exposed, infected, or recovered. Dr. Ridenhour's model provides additional precision by considering different presentations within those categories, such as being asymptomatic or symptomatically infected. The model is also dynamic, rather than a static model. It accounts for time-dependent changes, considers the degree of connectivity between cities, and the contact rate between people based on certain factors, such as age.

The model can simulate the timing and number of infections over time, depending on the type and level of mitigation measures used, timing of those mitigation measures, and it can be updated with the most current data available. The simulations can assist with planning for hospitalizations, ICU admissions, and ventilators needed. The simulations can be run at the state level, with the ability to observe the impact on smaller geographic areas, including the county level and Idaho cities with a population of 2,700 residents or more.

PARAMETERS AND ASSUMPTIONS

The model inputs are based on the latest research available and published in journals such as the ***Emerging Infectious Diseases*** and ***Morbidity and Mortality Weekly Report***, both from the Centers for Disease Control and Prevention (CDC) as well as publications such as the ***Journal of the American Medical Association*** and ***New England Journal of Medicine***. Early COVID-19 models were based on the outbreak progression in China. As COVID-19 has spread, information from Western Europe and the United States has become available and the model has been updated based on recent information.

Parameters in the model are:

1. Age – weighted (contact matrix, city level demographics, travel, health outcomes, etc.),
2. Virus – specific (R0, incubation period, infectious period, etc.)
3. Disease – specific (percentage subclinical infections, percentage admitted to hospital and ICU, percentage requiring ventilators, etc.)
4. Geography-specific (travel between cities, out-of-state introductions, etc.)
5. Depended on mitigation strategies (Actions: stay-home orders, school closures, etc. and Behaviors: self-isolation).
6. Depended on inputs (known confirmed cases, number of resources available, etc.)

The most important parameters for this model and the ones that have the most impact on the output are: virus transmission rate, infectious period, and contact rate. Changes to these factors has a major impact on the overall number of infections as well as the shape of the epidemic curve. Policy measures and behavior changes that limit contact between people result in lower disease transmission. Social distancing, targeted efforts at long-term care facilities, and stay-home orders reduce contact rates, resulting in lower virus transmission.

The model allows users to set intervention beginning and end dates and to make adjustments to the model inputs. Since this work started, assumptions have been updated several times based on new information and the latest research available.

SCENARIOS

The Governor's Coronavirus Working Group has reviewed the effect of multiple assumptions and scenarios, such as no mitigation and more mitigation in different areas of the state.

OUTCOMES

The model was developed to simulate the effect of policy decisions and not necessarily to estimate the number of hospitalizations, ICU admissions, or deaths. Therefore, the Governor's Coronavirus Working Group does not intend to publish disease projections. We can conclude that continued mitigation efforts aimed at reducing contact rates are effective strategies to slow the spread of COVID-19, delay the peak of the outbreak in Idaho by weeks, and flatten the curve. This provides multiple benefits, including giving healthcare facilities and response agencies more time to implement surge capacity plans and procure resources.

The model indicates that stricter policies aimed to protect vulnerable populations such as older adults may limit the number of deaths due to COVID-19. However, more information about the type and effectiveness of specific tactics is needed.

We can also conclude that opening certain parts of the state that might have only a few cases would not be an effective strategy. Unless you can protect these areas of the state from having the virus introduced into the area, the model shows a resurgence of infections until the majority of the population has been infected.

COMPARISON TO THE IHME MODEL

The consortium has compared this model to others, including the model from the Institute for Health Metrics and Evaluation (IHME) at the University of Washington which is widely cited and provides Idaho-specific estimates [http://www.healthdata.org/covid].

Some of the main differences between these two models include:

1. **Different underlying model structure**
   The model used by the Governor's Coronavirus Working Group is a dynamic model that accounts for changes over time in social distancing practices and is dependent on specific characteristics of the virus that causes COVID-19, disease progression, geography, demographics, and level of mitigation. The number of infections, hospitalizations, deaths, and other measures are calculated based on the number of people who move from being susceptible to the virus through either recovering or dying from the infection over time.
   In contrast, the IHME models the observed COVID-19 population death rate curves. The researchers chose this approach because the identification of infected people varies geographically based on availability of testing. The modelers used age-specific death rates for COVID-19 from China, Italy, Korea, and the United States and information from Wuhan, China, to measure the impact social distancing had on the death rate over time.

2. **Differences in coverage area:**
   The Idaho model provides city, public health district, and statewide analysis, while only statewide projections are available from the IHME model.

3. **Differences in timeframe:**
   The Idaho model spans one year and the IHME model is limited to a four-month period.

4. **Differences in public health intervention strategies:**
   The Idaho model simulates the effect of different public health intervention strategies at different levels, while the IHME model assumes that strict mitigation measures (including adherence to mitigation measures) will remain in place for the duration of the four-month period the model is considering.

STRENGTH AND LIMITATIONS

Strengths:

- The model can simulate scenarios based on different mitigations strategies and has the flexibility to adjust parameters.
- The model can simulate effects at the state, public health district, and city-level.
- The model can assist in estimating resource planning based on timeframes for peak number of infections.

Limitations:

- Many assumptions in this model are based on studies from China and Western Europe. More research is needed to understand how the COVID-19 outbreak is impacting smaller cities and rural areas, including Idaho.
- An influential parameter is contact rates and reduction in contacts. We don't have a lot of data to measure contact rates as a standalone measure.
- More testing is needed to know the real size of the outbreak in Idaho.

CONCLUSION

There are many things about COVID-19 that we do not know yet. The model used by the Governor's Coronavirus Working Group is providing outcomes based on assumptions and parameters from the most recent literature and research available. Much of these assumptions are based on research from China, Western Europe, or other parts of the United States. More data and information are needed to really understand this disease and how it might impact Idaho.

After reviewing different scenarios, the model shows that mitigation efforts targeting a reduction in contact rates, such as social distancing and targeted efforts at older adults, are effective strategies to slow the spread of the virus that causes COVID-19. When mitigation measures are stopped, we expect a second wave of infections will occur unless testing and contact tracing capacity increases so that infections can be identified, and contacts isolated.

IDAHO DEPARTMENT OF HEALTH & WELFARE