The Importance of Long-term Care Populations in Models of COVID-19

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In February 2020, the US outbreak of novel coronavirus disease 2019 (COVID-19) began with a cluster of cases at a long-term care (LTC) facility in Washington State. Since then, 34 of the 40 states with available data report that at least 40% of COVID-19-related deaths in those states have occurred in LTC facilities,[1] which provide ideal conditions for rapid spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Although the populations in these facilities bear a significant burden of the pandemic, mathematical models that contribute to US national or state policy do not account for residents of LTC facilities separately from surrounding populations in their calculations.[2] This Viewpoint explores why it is important to separate projections for residents of LTC facilities and the general population.

Current major COVID models, including mechanistic ones like that from Imperial College London and hybrid forecasting ones like that from the Institute for Health Metrics and Evaluation, assume similar dynamics of SARS-CoV-2 transmission.[3,4] Models like these calculate the number of susceptible, exposed, infectious, and recovered individuals (the standard SEIR

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framework) in an entire population, estimating the chance that individuals of different ages come into contact with one another and accounting for age-based risks of becoming infected or having worse outcomes.

Although this model structure can incorporate protective strategies like school closure and physical distancing, its currently used forms do not capture the dynamics of specific at-risk subpopulations and thus may not capture the complexities of how COVID-19 is spreading in LTC settings. During the Ebola outbreak in West Africa in 2014, modelers and policy makers recognized that existing models needed modification after transmission from deceased individuals was discovered[5]; that point has now been reached with COVID-19.

The spread of COVID-19 is substantially different in LTC facilities than in the general population. Residents of LTC facilities usually are older adults who have multiple illnesses, functional impairment, dementia, and high mortality if they contract COVID-19.[6] Many aspects of community-wide protective measures can-

not be implemented in LTC settings. For example, physical distancing measures to reduce community spread of SARS-CoV-2 are not possible in LTC for most residents, because of their frailty and close living quarters. Quarantine and isolation of exposed or symptomatic residents are also challenging. Modeling the spread and mortality of COVID-19 within nursing homes requires different assumptions than modeling outside of these facilities.

Furthermore, staff members who provide intimate personal care for multiple LTC residents often do not have access to adequate personal protective equipment (PPE). Staff members thus can contribute to transmission of SARS-CoV-2 within a facility, and some staff members work across several different facilities. Staff may not have sufficient paid time off, incentivizing working while symptomatic. These factors, combined with underlying comorbidities and age of the residents, help to explain why residents in these facilities account for a substantial percentage of severe cases and mortality compared with community-dwelling older persons. Reflecting these dynamics in models will require reevaluating their assumptions for 2 important reasons.

First, current models may not be providing policy makers with accurate analysis of the outbreak and its anticipated course in LTC facilities vs the community, possibly leading to inadequate resources devoted to nursing homes or delays in developing aggressive, creative strategies to protect this vulnerable population. Using a non-SEIR approach, New Jersey conducted an accurate analysis of its LTC facilities in March 2020,[7] leading to curtailment of visitation and shipment of nearly 11 million PPE kits to those facilities.

Second, estimating the true effect of community-based public health measures, which are essential to planning the end to community restrictions, may not be possible if community cases and LTC cases are modeled together. Different, non-SEIR-type models may be needed to capture the dynamics of infection within confined living and working situations like LTC. The state of New Jersey found that adaptive growth models fit at the LTC facility level, which can capture saltatory bursts in addition to smooth growth in cases, predicted the increases in COVID-19 cases at LTC facilities better than SEIR-based models.[8]

Just as the outbreaks occurring in these 2 settings are distinct, the responses to them need to differ. For LTC facilities, intensive measures are needed, including priority provision of PPE, sick leave policies that allow contagious staff to stay home, and transporting residents

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with actual or suspected infection to special units.[9] Some facilities are taking extraordinary measures, such as providing temporary housing for employees near the worksite until the outbreak has been controlled, thus allowing staff to provide care without interacting with their families or with the general public.

For community-based populations in some regions, the outbreak may be slowing enough to allow safe reopening of businesses sooner than currently projected, assuming that sufficient monitoring capability is in place. As states move toward reopening, they typically include numbers of deaths in counties as a criterion. However, a single nursing home outbreak with multiple deaths in a small rural county, for example, can mask very low community death rates.

Both modelers and public health policy makers should recognize that COVID-19 is not a unitary epidemic; in the US and other countries, it likely consists of multiple, contemporaneous, and intertwined suboutbreaks prominently including those in LTC settings. Distinguishing the rates and pattern of disease occurring in the general population from those in LTC facilities is both feasible and critical to control of infection in these high-risk settings. Creating separate models that reflect how COVID-19 has affected these different populations could provide more accurate evidence to guide mitigation efforts in the community and in LTC facilities, and could be helpful to better understand and reduce the morbidity and mortality this infection has caused among the most frail and vulnerable individuals.

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