Proceedings of the Operational Research Society Simulation Workshop 2023 (SW23)
C. Currie and L. Rhodes-Leader, eds.
https://doi.org/10.36819/SW23.021

HEALTH SYSTEMS SIMULATION MODELLING TO SUPPORT DECISION-MAKING IN COVID-19 PREVENTION AND CONTROL IN CARE HOMES

Dr. Le Khanh Ngan Nguyen

Department of Management Science
University of Strathclyde
Nguyen-le-khanh-ngan@strath.ac.uk

Prof. Susan Howick

Department of Management Science
University of Strathclyde
Susan.howick@strath.ac.uk

Dr. Itamar Megiddo

Department of Management Science
University of Strathclyde
Itamar.megiddo@strath.ac.uk

1 BACKGROUND

The COVID-19 pandemic has highlighted care homes' vulnerability to infectious disease outbreaks and the lack of context-specific best practice infection prevention and control (IPC) guidance for this setting. Care homes, where the majority of residents are elderly and have complex medical and care needs, have suffered devastating outcomes. Suspension of visiting due to COVID-19 outbreaks has also caused substantial unintended harms to the health and wellbeing of residents.

Since April 2020, we have collaborated with decision-makers from Health and Social Care Lanarkshire (HSCL) in Scotland, the Scottish Government, and the UK Government Department of Health and Social Care to provide evidence to support them in mitigating the impact of COVID-19 in care homes. We developed novel systems simulation models, which included agent-based models (ABM) and hybrid System Dynamics (SD) – ABM models, to help address the gaps in IPC knowledge and practice in this setting.

2 APPROACH

The initial objective of the ABM was to simulate the transmission dynamics of COVID-19 via contacts between individuals in a care home setting to evaluate the effectiveness of a range of intervention strategies relating to testing of staff and residents, using PPE, visiting policy, and cohorting (Nguyen et al. 2020 and Nguyen et al. 2021). When the vaccine rollout was launched in winter 2020, we adapted the model to explore the impact of different vaccination strategies and the impact of lifting routine testing of staff when vaccine coverages among staff and residents reach a certain threshold.

The objective of the integrated hybrid SD-ABM model was to understand the impact that temporary bank/agency staff, who work across multiple care homes, have on the spread of COVID-19 in care homes and to evaluate the effectiveness of a range of intervention strategies (Nguyen, Megiddo, and Howick, 2022).

We collected data from various sources. We interviewed care home stakeholders, including managers, staff in different roles, and had regular discussions with representatives from the Health and Social Care Partnerships, Public Health in Lanarkshire, and Scottish Government. We utilised these interviews and discussion to scope the problem, build the models, and design the intervention strategies. We also conducted literature reviews to obtain the values for parameters characterising the transmission of COVID-19 and the disease progression. Other parameters are based on national data (Scotland and UK) and regional data for North Lanarkshire where available. We gained confidence in the modules and the overall hybrid model using several approaches adapted from both SD and ABM practice.

3 IMPACT

At the time of our ABM study, no other published models considered elements specific to care homes, and interventions proposed by wider population models (e.g., closure and social distancing in schools) were not suitable for this setting—care homes act as a residence and staff interaction with residents is often unavoidable. We worked with partners in care homes and public health to model behaviour in these settings. To the best of our knowledge, our hybrid model is the first study that evaluated the effects of different interventions targeting bank/agency staff working across multiple care homes. Our work provided our partners with evidence that was more timely and easier to justify than guidance that was being provided, at the time, from central government.

Our models have improved understanding of what interventions work well in the environment of care homes, which has contributed to their implementation. Our early models, which we later published (Nguyen et al. 2020 and Nguyen et al. 2021), contributed to decisions on several interventions, including who to test in care homes and at what interval, creation of smaller cohorts of residents and staff, and development of visitation policy. HSCL stated that the decision to test staff weekly "potentially averted an estimated 9,250 COVID-19 cases among the 37,000 care homes residents in Scotland over a period of 3 months". The decision not to test residents but staff "has saved approximately £8.4 million in Scotland". Our work contributed to understanding the circumstances under which care homes could permit visiting, and the Scottish Government changing its visitation policy based on this evidence helped promote the mental health and well-being of residents and their families (SDG3). The modelling provided evidence underpinning decisions about effective interventions in care homes which, as stated by HSCL, "safeguarded the physical and mental health of residents, preventing unnecessary distress and reducing morbidity and mortality". The findings from our hybrid SD-ABM model have policy implications for care homes, which are heavily reliant on bank/agency staff due to staff shortages. The work is informing current policy and IPC guidance in these settings. Our work has received media attention which helps engage public audience and relevant stakeholders in meaningful conversations about the problem raised in the research.

REFERENCES

Nguyen, L. K. N., Howick, S., McLafferty, D., Anderson, G. H., Pravinkumar, J., Van Der Meer, R., & Megiddo, I. (2020). Evaluating intervention strategies in controlling COVID-19 spread in care homes: an agent-based model. *Infection Control and Hospital Epidemiology*. https://doi.org/10.1017/ice.2020.1369

Nguyen, L. K. N., Howick, S., McLafferty, D., Anderson, G. H., Pravinkumar, S. J., Van Der Meer, R., & Megiddo, I. (2021). Impact of visitation and cohorting policies to shield residents from covid-19 spread in care homes: an agent-based model. *American Journal of Infection Control*, *49*(9), 1105-1112. https://doi.org/10.1016/j.ajic.2021.07.001

Nguyen L.K.N., Megiddo I., Howick S. (2022) Hybrid simulation modelling of networks of heterogeneous care homes and the inter-facility spread of Covid-19 by sharing staff. *PLoS Computational Biology* 18(1): e1009780. https://doi.org/10.1371/journal.pcbi.1009780