Title

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Journal

Infection Control and Hospital Epidemiology, 45(6)

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Publication Date

2024-06-01

DOI

10.1017/ice.2024.9

HHS Public Access
Author manuscript
Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2024 June 01.

Published in final edited form as:
Infect Control Hosp Epidemiol. 2024 June ; 45(6): 754–761. doi:10.1017/ice.2024.9.

Cost-Effectiveness of SARS-CoV-2 Testing and Isolation Strategies in Nursing Homes

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Abstract

Objective: Nursing home (NH) residents may be particularly vulnerable to COVID-19. Therefore, a question is when and how often NHs should test staff for COVID-19 and how this may change as COVID-19 evolves.

Design: We developed an agent-based model representing a typical NH, COVID-19 spread, and its health and economic outcomes to determine the clinical and economic value of various screening and isolation strategies and how it may change under various circumstances.

Results: Under Winter 2023–2024 Omicron variant conditions, symptom-based antigen testing averted 4.5 COVID-19 cases compared to no testing, saving $191 in direct medical costs. Testing implementation costs far outweighed these savings, resulting in a net cost of $990, $1,545, and $57,155 from the Centers for Medicare & Medicaid Services, third-party payer, and societal perspectives, respectively. Testing did not return sufficient positive health effects to make it cost-effective ($50,000/quality-adjusted life-year threshold), exceeding this threshold in ≥59% of simulation trials. Testing remained not cost-effective when routinely testing staff and varying face mask compliance, vaccine efficacy, and booster coverage. However, all antigen testing strategies

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Potential conflicts of interest: All authors report no conflict of interest.

became cost-effective (≤$31,906/quality-adjusted life-year) or cost saving (≤$18,372,) when the severe outcome risk was ≥3 times higher than current Omicron variants.

Conclusions: COVID-19 testing costs outweigh benefits under Winter 2023–2024 conditions; however, testing becomes cost-effective with increasingly severe clinical outcomes. Cost-effectiveness can change as the epidemic evolves since it depends on clinical severity and other intervention use, highlighting the need for NH administrators and policymakers to monitor and evaluate viral virulence and other interventions over time.

Keywords

SARS-CoV-2; COVID-19; Nursing Homes; Testing; Economic; Cost-Effectiveness

Introduction

Throughout much of the COVID-19 pandemic, many nursing homes (NHs) have relied on testing staff and residents for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) to help prevent virus spread and reduce infection risk.[1] It is particularly important in NHs since residents are at greater risk for infection and more severe COVID-19 outcomes, given their age, comorbidities, and congregate living setting.[2] Since residents have limited interactions outside the NH, staff and visitors are the main ways SARS-CoV-2 is introduced. Often, staff are under-resourced, work multiple jobs, have low levels of education, insufficient paid sick time, and are accustomed to working while ill[3–5] making it difficult to speak up when experiencing COVID-19 symptoms. Thus, routine testing strategies coupled with assurances of paid sick leave may provide solutions for containing SARS-CoV-2 spread.

To date, implementation of NH staff testing strategies has varied,[1, 6, 7] partly because the value of such strategies has not been quantified. For example, in August 2020, the Centers for Medicare & Medicaid Services (CMS) required at least once weekly routine testing of staff. This was revised in September 2022 given the widespread adoption of vaccines.[8] Implementing testing requires time, effort, and money, which are not trivial since NHs have constrained resources. Thus, determining testing's value can help guide its implementation. Understanding how frequently NH staff should be tested, which test should be used [e.g., antigen, polymerase chain reaction (PCR)], and how testing's value can vary based on several factors, such as SARS-CoV-2 activity in the community, can help determine effective testing strategies. Therefore, to inform NH care, we developed an agent-based model (ABM) representing a typical NH and SARS-CoV-2 spread to determine the clinical and economic value of various COVID-19 screening and isolation strategies under various circumstances.

Methods

Agent-Based Model Overview

We developed an ABM in Python representing a typical NH with 100 residents, its staff, their interactions with each other, SARS-CoV-2 spread, potential health and economic outcomes[9–15], and testing. The NH consists of 50 occupied double rooms, each in a housing pod, representing a physical location of 10 rooms. We represented three types of NH staff: resident-facing staff providing routine care (e.g., certified nursing assistants, licensed vocational/registered nurses, environmental services workers), resident-facing staff providing specialty care (e.g., physical, occupational, and speech therapists, wound care nurses), and non-resident-facing staff (e.g., medical records, office/administrative support). Routine care staff have an assigned housing pod since they are generally assigned to the same NH area/section and its residents for continuity of care. The model advances in discrete, one-day time steps for a typical winter season (December-February) when respiratory viruses tend to spread. Appendix Table 1 shows model input parameters, values, and sources.

Agent Movement and Mixing

Figure 1a shows how residents and staff mix and move throughout the NH. Each day, agents within the NH interact with each other (Appendix Table 2). A resident's degree of interaction varies based on his/her location (e.g., roommates), social groups/connections, and assigned staff (e.g., routine care, specialty care). A resident's social groups/connections involves either mixing or not mixing with other residents (e.g., resident is non-mobile, limited interaction). Routine staff interact with residents in their assigned housing pods, while specialty care staff interact with post-acute care residents (those with a length-of-stay <100 days) weekly. Interactions between staff members vary based on staff type. Agents mix each day, until leaving the NH (length-of-stay elapses, hospitalized, or dies from COVID) or their job not due to COVID-19 (94% annual turnover rate based on CMS data of 492 million nurse shifts[16]). Each day, new individuals enter the NH such that the number of new admissions equals the number of resident deaths and bed turnovers and new staff equals the number of staff deaths and turnovers.

SARS-CoV-2 Transmission

Figure 1b–c shows the 7 mutually exclusive SARS-CoV-2 states that each agent can be in on any given day and how agents move through them. Hospitalized residents temporarily leave the NH and cannot transmit to others in the facility. Staff convalesce at home.

Each day, agents interact with each other, and an infectious person can potentially transmit SARS-CoV-2 to a susceptible person. If a susceptible person comes into effective contact (i.e., interact and SARS-CoV-2 is transmitted) with an infectious person, he/she becomes exposed, infected, but not yet contagious. The following example equation governs if a susceptible resident becomes infected:

$$1-\Big((1-DailyContactProbabilityResidentsToRoutineStaff*TransmissionProbability)^{NumberInfectedRoutineStaff}*(1-DailyContactProbabilityResidentsToSpecialtyStaff*TransmissionProbability)^{NumberInfectedSpecialtyStaff}*(1-DailyContactProbabilityToSocialResidents*TransmissionProbability)^{NumberInfectedSocialResidents}*(1-DailyContactProbabilityResidentToRoommate*TransmissionProbability)^{NumberInfectedRoommates}\Big)$$

As the transmission probability between any two individuals is unknown, we calibrated this parameter to achieve a reproduction number (R_0; average number of secondary cases generated by a single infectious case in a fully susceptible population) of 9, corresponding to the omicron variant[17]. To do this, we simulated SARS-CoV-2 spread assuming homogeneous mixing (average daily contact probability: 3.7%) and determined that a 15% transmission probability per contact with an infectious agent resulted in an R_0 of 9.

Each infected individual becomes infectious up to 2 days prior to symptom onset, regardless of symptom development, and has a probability of being asymptomatic (non-overt symptoms) or symptomatic (overt symptoms). After agents recover they are unable to become reinfected for the remainder of the simulation (immunity is assumed to last for ≥90 days[18]).

Agent COVID-19 Health Outcomes

Each symptomatic individual starts with a mild infection and has a probability of progressing to severe disease requiring hospitalization (a distribution draw determines when he/she becomes hospitalized). On hospital admission, each agent draws a length-of-stay from a distribution and remains hospitalized for that duration. A hospitalized agent has probabilities of intensive care unit admission and COVID-19-associated mortality. If the resident survives and their length-of-stay is ≤10 days (bed held for ≤10 days), he/she returns to the NH.

Ongoing Prevention and Control Measures: Vaccination and Face Mask Use

As previously described[10–13], vaccination decreases an individual's risk of getting infected during the simulation (by 1-vaccine efficacy against infection). Once infected, a vaccinated individual has a lower probability (1–vaccine efficacy against severe disease) of severe outcomes requiring hospitalization. Given robust vaccination campaigns in NHs, individuals who were vaccinated could either have received the primary series plus a booster or have also received the bivalent booster (within the last 6 months).

Each day, staff members wear surgical masks, which decreases the probability of transmission by 1 minus the effectiveness of face masks [face mask efficacy multiplied by compliance with their use multiplied by percent of time masked (accounting for unmasked mealtimes)].

COVID-19 Testing

NH staff are tested at set intervals as well as on demand when reporting possible COVID-19 symptoms (i.e., symptom-based testing). The antigen or PCR test has an associated sensitivity, specificity, turnaround time, and cost. When undergoing testing at set intervals, staff awaiting results still work, maintaining surgical face mask use. However, staff undergoing symptom-based testing wear N95 respirators while awaiting test results and only continue working if testing negative. Staff testing positive stay home for at least 6 days or until they recover/test negative, following Centers for Disease Control and Prevention (CDC) guidance.[19] During this time, they are not replaced by other staff.

Residents undergo symptom-based testing when presenting with symptoms (e.g., due to COVID-19, other respiratory pathogens). Residents with symptoms have a probability of informing or demonstrating to staff they have symptoms. Residents undergoing symptom-based testing are quarantined while awaiting test results. Residents testing positive are isolated for 10 days. The roommates of residents testing positive are quarantined for 10 days due to potential exposure. Resident isolation/quarantine requires N95 respirator use by staff. Additionally, per national guidance, all agents testing positive are not eligible for repeat PCR testing within 90 days, as individuals may remain positive on molecular tests but not be infectious,[8]; further, a false positive PCR result is uncommon.

Costs and Economic Outcomes

Each person accrues relevant direct medical costs, productivity losses, and health effects as he/she travels through the model. These then contribute to the calculation of cost-effectiveness from the CMS (a type of third-party payer), total third-party payer, and societal perspectives (described in the Appendix).

For each scenario, we calculated the incremental cost-effectiveness ratio (ICER) as:

$$ICER = (Cost_{Testing} - Cost_{NoTesting}) / (Health\ Effects_{Testing} - Health\ Effects_{No\ Testing})$$

where health effects are measured in quality-adjusted life-years (QALYs) lost due to COVID-19. Each COVID-19 infection loses QALYs based on their age-dependent healthy QALY value and severity-specific utility weights for their infection duration. Death results in the loss of the net present value of QALYs for the remainder of an individual's lifetime.[20] We considered testing to be cost-effective if the ICER was ≤$50,000/QALY. All costs are reported in 2023 values.

Experimental Scenarios

Experiments consisted of 100 trials and comparing testing versus no testing in the NH, assuming the omicron variant and Winter 2023–2024 vaccination and face mask use conditions. Scenarios consisted of varying test and SARS-CoV-2 parameters including the test type (antigen, PCR) with its associated performance characteristics (sensitivity/specificity, cost, turnaround time), testing frequency (2 times a week to 1 time a week to every other week in addition to testing, when residents and staff reported/had discoverable symptoms), and the risk of COVID-19 in the community (10%–50% over 3 months). We also varied the probability of having more severe outcomes (e.g., hospitalization, death) to account for new variants. Sensitivity analyses varied face mask compliance (50%–90%), bivalent booster coverage among residents (30%–70%) and staff (10%–50%), and vaccine efficacy against infection (primary series and booster: 10%–60%; bivalent booster: 25%–75%). Additional scenarios assumed staff did not routinely use face masks and only used them when interacting with quarantined/isolated residents.

Results

Winter 2023–2024 Omicron Variant Situation

Our first set of scenarios represented the Winter 2023–2024 situation and current testing strategy of symptom-based antigen testing when staff and residents reported or had discoverable symptoms. Appendix Table 1 shows the parameter values for these scenarios which reflect highly vaccinated staff and resident populations and high compliance with face masks. We set the risk of COVID-19 in the community at 30% over the 3-month winter season (0.4% per day) with 10% of the population with prior immunity.

In this context, we first compared symptom-based antigen testing to no testing, assuming that detecting infectious persons accelerates isolation at home (staff) or in their room (residents) and therefore reduces spread. Symptom-based testing averted only a median of 1 (range: −23, 28) COVID-19 cases among staff and 3.5 (range: −20, 34) cases among residents compared to no testing when only 50% of those experiencing symptoms were reported/discovered and subsequently tested, leaving half to continue spreading to others.

The low number of averted cases from symptom-based testing generated minimal averted hospitalizations and deaths given the mild severity of the Omicron variant: 0 (range: −5, 7) averted hospitalizations, 0 (range: −2, 2) averted deaths, and 0.004 (range: −38.39, 36.65) averted lost QALYs. Overall, over the 3-month winter season, the averted clinical outcomes saved $191 (range: −$99,923, $204,903) in direct medical costs due to illness for all residents and staff.

However, testing costs money, and the costs of implementing testing far outweighed the cost of clinical outcomes averted. When removing testing costs from costs averted, symptom-based testing generated a net cost of $990 (range: −$66,281, $81,579) from the CMS perspective, $1,545 (range: −$102,277, $199,558) from the third-party payer perspective, $54,765 (range: $23,768, $90,787) in productivity losses, and $57,155 (range: −$175,790, $173,348) from the societal perspective with mild severity variants circulating.

These significant costs did not return enough positive health effects to make testing cost-effective as measured by the ICER (ratio of the difference in costs over the difference in effectiveness) when using the $50,000/QALY cost-effectiveness threshold. The ICER exceeded this threshold in 64%, 59%, and 85% of simulation trials from the CMS, third-party payer, and societal perspectives, respectively, deeming symptom-based antigen testing not cost-effective because net costs were much higher and net health effects were small.

Testing remained not cost-effective when staff were tested on a weekly basis in addition to symptom-based testing. Table 1 shows how testing remained not cost-effective when varying the frequency of routine testing down to once every other week and up to twice a week. Additionally, testing with the more costly, but highly sensitive PCR test was not cost-effective (ICERs ≥$1,167,511/QALY).

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How the Value of Testing Changes with the Risk of COVID-19 in the Community

Given the changing contagiousness of SARS-CoV-2 variants across winter seasons, the next set of scenarios explored how the value of testing may change with SARS-CoV-2 contagiousness in the community. We ranged the risk of staff acquiring COVID-19 in the community from 10%–50% over 3 months (0.12%–0.76% per day), but given the mild severity of the Omicron variant, testing and isolation was not cost-effective even with higher staff case counts (Table 1). The number of cases averted decreases with increases in the community risk as there are more cases brought into the NH, resulting in more chances for infection before testing occurs.

How the Value of Testing Changes with Face Mask Use

We varied face mask use compliance from 50%–90% and found that while the number of cases increased with decreased compliance, all testing strategies remained not cost-effective (median ICERs ≥$83,291/QALY). For example, when compliance decreased to 70%, symptom-based antigen testing averted 1.0 (range: −39, 47) cases among staff and residents but was not cost-effective from all perspectives with ICERs above the $50,000/QALY threshold in ≥59% of simulation trials. Further, even when staff to do not routinely use face masks, all testing strategies remained not cost-effective with ICERs above the $50,000/QALY threshold in ≥55% of trials (e.g., median ICER $121,104/QALY from CMS perspective).

How the Value of Testing Changes with Vaccination Efficacy and Coverage

Varying vaccination efficacy against infection (10%–60% for staff, 25%–75% for residents) and vaccination coverage with the bivalent booster (10%–50% for staff and 30%–70% for residents) also did not substantially change the value of testing. The various testing strategies remained not cost-effective. For example, decreased vaccine efficacy caused cases to rise, but weekly antigen testing averted only 6 (range: −17, 23) cases among staff and 11 (range: −19, 58) among residents because cases were not identified/isolated quickly enough to substantially reduce spread. More frequent testing was not cost-effective with ICERs well above the $50,000/QALY threshold in ≥71% of simulation trials (median ICERs ≥$1,117,206/QALY from all perspectives). Similarly, reducing coverage of the bivalent booster increased cases and decreased the number of cases averted (e.g., weekly testing averted 7 cases among staff and 14 cases among residents with 10% coverage among staff and 30% among residents). Across a range of vaccine efficacy and coverage estimates, testing remained not cost-effective as individuals still had protection from the primary series and initial booster vaccines against severe illness.

How the Value of Testing Changes with the Severity of Clinical Outcomes

The severity of clinical outcomes did affect the cost-effectiveness of different testing strategies, such that all strategies became cost-effective when the risk of hospitalization and death was at least 3 times higher than seen with 2022–2023 Omicron variants (Table 2). This corresponds to hospitalization and death rates observed earlier in the pandemic with other SARS-CoV-2 variants.

Discussion

Our study demonstrates that under Winter 2023–2024 Omicron variant SARS-CoV-2 conditions, COVID-19 testing and isolation for ≥6 days is not cost-effective for all testing strategies explored. This remains true when varying COVID-19 contagiousness in the community, face mask compliance, bivalent booster vaccination coverage, or vaccine efficacy against infection. This is because the costs of testing and isolation far outweigh the cost of clinical outcomes averted. Even when not including isolation costs (productivity losses), testing is not cost-effective. However, when increasing the severity of clinical outcomes, as seen earlier in the pandemic or if a new or worse variant emerges, testing and isolation becomes cost-effective.

Our results emphasize that the cost-effectiveness of interventions implemented during a pandemic are highly dependent on clinical outcome severity and other interventions in place. This is important because as pandemics evolve, greater knowledge about effective prevention measures emerges and enables effective vaccines and personal protective equipment. Thus, reductions in viral virulence, either due to adaptive mutations or human prevention efforts, should be monitored and evaluated over time to ensure guidance for testing remains beneficial. Monitoring and adjusting becomes increasingly important with multilayered interventions.

Such monitoring and reevaluation becomes important in at least three settings: 1) as severe cases decline with immunity development (through infection or vaccination) and better application of preventative activities; 2) as variants evolve to become more or less deadly; and 3) when pandemic recovery results in a de-intensified phase where vaccinations update and preventative activities wane.[21–23] Our findings suggest it is necessary to monitor variant severity and resulting clinical outcomes to quickly adapt testing protocols (e.g., as severity decreases, testing and isolation strategies become less valuable and may be reduced or stopped). Under such conditions, it is important to determine if robust vaccination uptake and face mask use is necessary to maintain with decreased severity or if normalization of activities is recommended due to negative trade-offs on socialization and mental health. Adaptiveness may need to become the norm as the pandemic evolves.

Limitations

All models are simplifications of reality and therefore cannot account for every possibility.[24] We assumed a fixed staffing ratio and that staff assignments did not change when staff were sent home. In reality, this may result in understaffing, staff interacting with more residents, or the NH bringing in additional staff from outside the NH, potentially increasing transmission. This may increase the value of symptom-based testing if more individuals report symptoms; however, it may be difficult for routine testing to identify cases quickly enough to isolate before transmission occurs. While we quarantine roommates of residents testing positive, we did not represent contact tracing among other residents and staff when an individual tests positive, which would increase the number of individuals isolated and the cost of testing.

Under Winter 2023–2024 Omicron variant conditions, COVID-19 testing and ≥6-day isolation is not cost-effective. Testing becomes cost-effective when increasing severity of clinical outcomes. The value of testing depends on outcome severity and other interventions in place, highlighting the need for NH administrators and policymakers to regularly monitor and evaluate viral virulence and the value of interventions so guidance for testing remains beneficial, especially with multilayered interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Financial Support:

This work was supported by the Agency for Healthcare Research and Quality (AHRQ) via grant 1R01HS028165-01, the National Institute of General Medical Sciences as part of the Models of Infectious Disease Agent Study network under grants R01GM127512 and 3R01GM127512-01A1S1, and by the National Science Foundation proposal number 2054858, the National Center for Advancing Translational Sciences of the National Institutes of Health via award number U54TR004279, and by the City University of New York (CUNY) in support of the Pandemic Response Institute (PRI). Statements in the manuscript do not necessarily represent the official views of, or imply endorsement by, the National Institute of Health, AHRQ, the US Department of Health and Human Services, CUNY, or the PRI.

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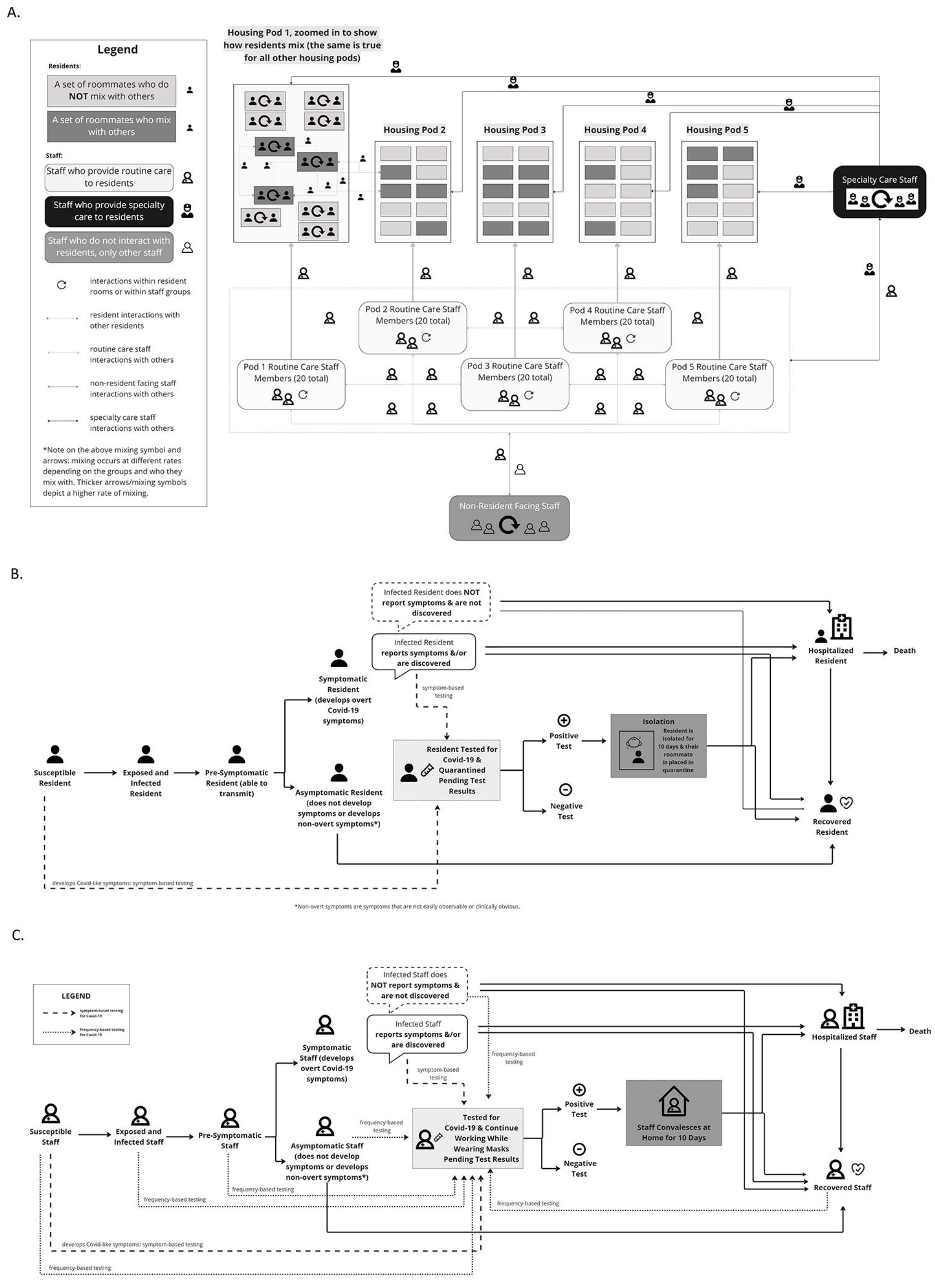

Figure 1.

Model overview: A) NH structure and agent mixing and movement; B) NH resident SARS-CoV-2 infection pathway and testing and isolation interventions; and C) NH staff SARS-CoV-2 infection pathway and testing and isolation interventions

Table 1.

Epidemiologic, clinical, and economic outcomes averted [median (range)] by various NH staff COVID-19 antigen testing and isolation strategies for different risks of NH staff acquiring COVID-19 in the community

	COVID-19 Cases Averted Among Residents	COVID-19 Cases Averted Among Staff	Hospitalizations Averted	Deaths Averted	QALYs Gained	Net Costs from the CMS Perspective	Net Costs from Third- Party Payer Perspective	Net Productivity losses (Residents & Staff)	Net Costs Societal Perspective
NH staff have a 30% risk of acquiring COVID-19 in the community over the 3-month winter season									
Symptom-based testing	3.5 (−20 to 34)	1 (−23 to 28)	0 (−5 to 7)	0 (−2 to 2)	0.004 (−38.39 to 36.65)	989.9 (−81,579 to 66,281)	1,545 (−199,558 to 102,277)	54,766 (23,768 to 90,788)	57,156 (−175,790 to 173,348)
Testing weekly	13 (−22 to 61)	7 (−19 to 34)	0 (−5 to 5)	0 (−2 to 1)	0.013 (−28.6 to 29.8)	22,906 (−59,663 to 105,154)	24,880 (−117,344 to 149,958)	121,135 (74,332 to 158,960)	145,096 (−6,440 to 254,081)
Testing every 3 days	29 (−4 to 80)	19 (−10 to 68)	0 (−4 to 5)	0 (−2 to 1)	0.037 (−37.41 to 29.85)	51,786 (−57,191 To 150,746)	50,337 (−69,604 to 205,559)	103,327 (−61,345 to 156,100)	147,771 (33,479 to 340,323)
Testing every other week	8 (−32 to 39)	8 (−19 to 38)	0 (−4 to 5)	0 (−1 to 1)	0.013 (−29.89 to 29.83)	11,965 (−88,231 to 113,505)	9,954 (−145,948 to 118,844)	91,399 (55,584 to 135,169)	103,001 (−56,613 to 235,020)
NH staff have a 10% risk of acquiring COVID-19 in the community over the 3-month winter season									
Symptom-based testing	3 (−44 to 37)	2 (−51 to 35)	0 (−5 to 5)	0 (−2 to 1)	0.003 (−60.12 to 11.32)	1,177 (−97,398 to 94,513)	4,234 (−139,465 to 113,037)	55,019 (5,740 to 109,397)	60,133 (−109,060 to 169,303)
Testing weekly	16 (−40 to 66)	11 (−39 to 72)	0 (−6 to 5)	0 (−1 to 1)	0.015 (−26.24 to 11.32)	22789.3 (94657.2 to −72746.9)	21,773 (−91,386 to 137,657)	108,840 (−5,282 to 172,028)	133,080 (−48,940 to 286,065)
Testing every 3 days	32 (−37 to 85)	27.5 (−43 to 93)	1 (−3 to 6)	0 (−2 to 1)	0.053 (−28.95 to 11.39)	47803.2 (110876.9 to −47458.9)	40,803 (−88,641 to 122,663)	87,379 (42,350 to 175,576)	116,639 (−72,812 to 245,398)
Testing every other week	11 (−41 to 38)	6 (−42 to 37)	0 (−5 to 5)	0 (−1 to 1)	0.009 (−29.37 to 11.31)	12,054 (−86,441 to 140,724)	18,326 (−128,120 to 222,068)	88,390 (46,754 to 125,875)	103,169 (−45,000 to 326,557)
NH staff have a 50% risk of acquiring COVID-19 in the community over the 3-month winter season									
Symptom-based testing	0.5 (−35 to 37)	2.5 (−18 to 31)	0 (−5 to 4)	0 (−1 to 2)	0.004(−26.25 to 26.25)	1,102 (−91,180 to 94,682)	7,034 (−98,824 to 141,107)	55,595 (26,467 to 86,911)	62,624 (−63,033 to 215,596)
Testing weekly	11 (−8 to 39)	6 (−12 to 30)	0 (−6 to 6)	0 (−1 to 2)	0.018 (−26.3 to 29.9)	22,896 (−137,605 to 105,944)	18,243 (−124,840 to 173,416)	123,116 (76,489 to 157,081)	135,264 (8,029 to 300,508)
Testing every 3 days	24 (2 to 58)	12.5 (−16 to 35)	0 (−3 to 8)	0 (−1 to 2)	0.037 (−28.8 to 29.8)	48,529 (−108,954 to 159,584)	42,407 (−110,995 to 176,555)	112,884 (68,908 to 161,479)	159571 (−21,272 to 308,503)

	COVID-19 Cases Averted Among Residents	COVID-19 Cases Averted Among Staff	Hospitalizations Averted	Deaths Averted	QALYs Gained	Net Costs from the CMS Perspective	Net Costs from Third- Party Payer Perspective	Net Productivity losses (Residents & Staff)	Net Costs Societal Perspective
Testing every other week	5 (−23 to 41)	4.5 (−26 to 29)	0 (−5 to 5)	0 (−1 to 2)	0.013 (−29.7 to 29.8)	9,852 (−98,331 to 123,336)	4,264 (−93,802 to 160,517)	93,866 (51,148 to 127,453)	97,542 (−10,959 to 270,932)

Note: Negative net costs are cost savings.

Table 2.

Epidemiologic, clinical, and economic outcomes averted [median (range)] by various NH staff COVID-19 antigen testing and isolation strategies when varying the risk of severe clinical outcomes

	COVID-19 Cases Averted Among Residents	COVID-19 Cases Averted Among Staff	Hospitalizations Averted	Deaths Averted	QALYs Gained	Net Costs from the CMS Perspective	Net Costs from Third-Party Payer Perspective	Net Productivity losses (Residents & Staff)	Net Costs Societal Perspective
Severity of clinical outcomes are 3x higher than the 2023–2024 omicron variant									
Symptom-based testing	4.5 (−23 to 37)	−1 (−29 to 31)	0.5 (−9 to 11)	0 (−4 to 5)	0.02 (−66.04 to 82.57)	−6,243 (−232,064 to 176,125)	−3,209 (−406,423 to 232,679)	51,908 (20,547 to 89,518)	48,112 (−369,443 to 297,081)
Testing weekly	18 (−16 to 50)	11.5 (−24 to 45)	1 (−7 to 6)	0 (−4 to 4)	0.08 (−56.59 to 59.86)	8,142 (−185,327 to 157,660)	**2,412 (−158,432 to 309,538)**	110,284 (56,881 to 148,265)	113,431 (−83,971 to 434,549)
Testing every 3 days	28.5 (−12 to 77)	13 (−10 to 40)	1 (−6 to 12)	1 (−3 to 6)	5.02 (−46.7 to 86.95)	**30,820 (−204,151 to 208,866)**	**20,564 (−329,318 to 240,271)**	105,155 (35,533 to 165,036)	**130,950 (−293,786 to 340,598)**
Testing every other week	8 (−25 to 39)	4.5 (−17 to 26)	0 (−6 to 6)	0 (−3 to 4)	3.58 (−58.57 to 48.05)	**7,310 (−196,644 to 120,874)**	**5,852 (−156,686 to 188,849)**	91,682 (51,983 to 129,645 to)	**96,162 (−75,451 to 289,808)**
Severity of clinical outcomes are 4.5x higher than the 2023–2024 omicron variant									
Symptom-based testing	3 (−33 to 32)	3 (−22 to 29)	1 (−7 to 10)	0 (−3 to 5)	2.7 (−53 to 99)	−14,780 (−209,844 to 185,962)	−18,372 (−253,685 to 200,018)	53,305 (12,317 to 95,901)	**32,885 (−221,821 to 259,683)**
Testing weekly	14.5 (−11 to 48)	7.5 (−15 to 33)	1 (−8 to 12)	0 (−3 to 5)	3.6 (−49.9 to 70.1)	**10,246 (−218,180 to 179,937)**	**5,089 (−199,076 to 224,055)**	113,405 (66,185 to 158,964)	**114,627 (−118,251 to 361,033)**
Testing every 3 days	34 (−11 to 70)	17 (−14 to 43)	1.5 (−6 to 10)	1 (−3 to 6)	8.1 (−70.1 to 87.8)	**23,949 (−184,451 to 181,286)**	**13,052 (−190,954 to 248,148)**	98,296 (36,750 to 180,642)	**120,638 (−124,099 to 344,324)**
Testing every other week	9.5 (−21 to 41)	4 (−19 to 28)	1 (−6 to 9)	0 (−4 to 6)	0.6 (−63.8 to 71.9)	−1,638 (−224,014 to 198,190)	−1,921 (−206,503 to 205,407)	86,914 (35,387 to 144,476)	84,218 (−149,504 to 330,442)

Note: Negative net costs are cost savings. Bold values indicate where testing was cost-effective compared to no testing when using a $50,000/QALY cost-effectiveness threshold. Scenarios assume NH staff have a 50% risk of acquiring COVID-19 in the community.