Stemming the Tide of COVID-19 Infections in Massachusetts Nursing Homes

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BACKGROUND/OBJECTIVES: In April 2020, Massachusetts nursing homes (NHs) became a hotspot for COVID-19 infections and associated deaths. In response, Governor Charles Baker allocated $130 million in additional funding for 2 months contingent on compliance with a new set of care criteria including mandatory testing of all residents and staff, and a 28-point infection control checklist. We aimed to describe the Massachusetts effort and associated outcomes.

DESIGN: Longitudinal cohort study.

SETTING: A total of 360 Massachusetts NHs.

PARTICIPANTS: The Massachusetts Senior Care Association and Hebrew SeniorLife rapidly organized a Central Command team, targeted 123 “special focus” facilities with infection control deficiencies for on-site and virtual consultations, and offered all 360 facilities weekly webinars and answers to questions regarding infection control procedures. The facilities were also informed of resources for the acquisition of personal protective equipment (PPE), backup staff, and SARS-CoV-2 testing.

MEASUREMENTS: We used two data sources: (1) four state audits of all NHs, and (2) weekly NH reports to the Massachusetts Center for Health Information and Analysis. Primary independent process measures were the checklist scores and adherence to each of its six core competencies. Primary outcomes were the average weekly rates of new infections, hospitalizations, and deaths in residents and staff. We used a hurdle mixed effects model adjusted for county COVID-19 prevalence to estimate relationships between infection control process measures and rates of new infections or deaths.

RESULTS: Both resident and staff infection rates started higher in special focus facilities, then rapidly declined to the same low level in both groups. Adherence to infection control processes, especially proper wearing of PPE and cohorting, was significantly associated with declines in weekly infection and mortality rates.

CONCLUSION: This statewide effort could serve as a national model for other states to prevent the devastating effects of pandemics such as COVID-19 in frail NH residents. J Am Geriatr Soc 68:2447-2453, 2020.

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for other states to prevent the devastating effects of pandemics like COVID-19 in frail NH residents who are at the greatest risk of morbidity and mortality from this disease.\textsuperscript{1,2}

\section*{METHODS}

Within 2 days of the governor’s announcement, MSCA and HSL rapidly organized a Central Command Committee and five teams responsible for these activities: infection control consultation and training, PPE procurement, staffing, testing, and data management. Eighty NHs with previous infection control deficiencies, and 43 additional facilities that failed an initial audit were targeted for on-site and virtual consultations, and all facilities were offered weekly webinars and answers to questions regarding infection control procedures. The facilities were also informed by MSCA of available resources for the acquisition of PPE and backup staff, and the Massachusetts National Guard was mobilized to provide universal testing.

\subsection*{Intervention}

The intervention consisted of these components:

\begin{enumerate}
\item \textbf{Checklist}: A 28-item Infection Control Competency Checklist was created by the Massachusetts Executive Office of Health and Human Services (EOHHS), the Massachusetts Department of Public Health (DPH), MassHealth (Medicaid), and HSL in an effort to align guidance from the DPH, Centers for Disease Control and Prevention (CDC),\textsuperscript{3} and Centers for Medicare & Medicaid Services (CMS).\textsuperscript{4} Checklist items were developed and vetted by experts in infection control, public health, geriatrics, and NH care. The items included best practices in infection control, the use of PPE, staffing plans, clinical care, and communication with staff, residents, and families. The 28 items included six core (must-pass) competencies related to the cohorting of COVID-19 cases, closing of congregate spaces, training and demonstrated proficiency in the donning and doffing of PPE, proper wearing of PPE, the presence of appropriate infection control policies, and the ability to recognize and respond to the signs and symptoms of COVID-19 infection. A copy of the checklist is available at https://www.mass.gov/doc/nursing-facility-infection-control-competency-checklist/download.

\item \textbf{Payment incentive}: The governor’s plan provided for a 50\% increase in payments to NHs for 2 months contingent on passing unannounced state inspection audits by achieving a score of 24 or higher on the checklist while meeting all six core competencies, testing 90\% of residents and staff for SARS-CoV-2 RNA nasopharyngeal positivity by a given date, uploading key data each week, and providing residents with technology for virtual visits with family and friends. The state provided testing support to meet the 90\% threshold for the NHs. All facilities underwent baseline and monthly audits, and those that scored below 24 on the checklist or were deficient in any of the core competencies were reinspected within 2 weeks. The additional payments were required to be used to pay for additional staff or staff hours, procure PPE and sanitation supplies, reconfigure living spaces to enable cohorting, and other costs incurred by the pandemic.

\item \textbf{On-site and virtual infection control consultation}: As noted earlier, 123 facilities were identified at the outset as deficient in infection control practices. These facilities were targeted for on-site visits by infection control consultants trained and deployed by Pathway Health from Lake Elmo, Minnesota. The consultants traveled to Massachusetts, conducted in-person inspections of the facilities while wearing proper PPE, and developed an action plan. They then followed up with weekly on-site or video visits to help the facilities implement their plans and improve their performance on subsequent state audits. Those targeted for continued on-site support included facilities with the lowest scores on the checklist, a high number of resident and staff infections, and infection control deficiencies across multiple domains. The Pathway consultants also trained a local team of six infection control specialists who made follow-up visits to facilities that still needed on-site support to improve their infection control processes and procedures. These specialists communicated with the Pathway Health consultants by video during and after their in-person visits. Weekly facility reports were generated by Pathway Health and shared with the facilities and the MSCA/HSL Infection Control Command team to promote continued progress toward full adherence with the checklist. A total of 362 visits were conducted within 6 weeks by a team of nine Pathway consultants and six local specialists. Specific elements of the consultants’ intervention included the following:

\begin{itemize}
\item Reviewed audit findings for areas of nonadherence.
\item Observed staff practices and procedures.
\item Discussed strategies for proper cohorting and resident placement.
\item Addressed guidance for PPE use and optimization.
\item Reviewed and guided facility procedures for cleaning and disinfection.
\item Identified resource needs and accessibility.
\item Provided just-in-time training of staff and NH trainers.
\item Participated in quality improvement discussions.
\item Provided updates on state and federal guidance.
\item Identified priorities and goals for the next scheduled visit.
\end{itemize}

\item \textbf{Weekly webinars}: The Pathway Health consultants and members of the MSCA/HSL Infection Control Command team conducted six weekly webinars for all Massachusetts facilities that focused on the checklist competencies and areas of poor performance on the audits. These topics included cohorting practices, proper PPE use, the role of the PPE coach, how to engage leadership and hold staff accountable, and how to sustain infection control processes through Quality Assessment and Performance Improvement mechanisms.

\item \textbf{Continuous question and answer (Q&A) communication}: After each webinar and during the Pathway Health consultations, lists of questions were sent to representatives of MassHealth and the DPH who provided answers and included them in a running Q&A document disseminated by MSCA. Members of the MSCA/HSL Infection Control Command team met with Pathway Health consultants and MassHealth/DPH representatives three times per week to
maintain close communication between staff on the frontlines and regulators in state government.

6. **PPE, staffing, and testing resources**: In addition to the infection control interventions just described, other Central Command teams provided resources for PPE procurement, the recruitment of temporary staff (resident care assistants, certified nursing assistants, and in emergency situations, the National Guard), and SARS-CoV-2 testing.

**Figure 1.** Weekly rates of (A) COVID-19 infection, (B) hospitalizations, and (C) mortality for Massachusetts nursing home residents during the 9-week intervention period. Rates for special focus facilities are plotted with triangles (N = 123); rates for other facilities (N = 237) are plotted with squares.

**Figure 2.** Weekly rates of (A) COVID-19 infection and (B) nursing care hours per patient day (HPPD) for Massachusetts nursing home staff during the 9-week intervention period. Rates for special focus facilities are plotted with triangles (N = 123); rates for other facilities (N = 237) are plotted with squares. [Color figure can be viewed at wileyonlinelibrary.com]

**Data Sources**

We used two data sources: (1) the baseline and monthly EOHHS audits of all NHs, plus the biweekly audits of those that failed to meet the checklist threshold score of 24 and/or were not adherent to the six core competencies, and (2) weekly nursing facility reports to the Massachusetts Center for Health Information and Analysis (CHIA), the state agency responsible for health care statistics during the COVID-19 crisis. The EOHHS audits were used to track

| Audit no. | 1  | 2  | 3  | 4  |
|-----------|----|----|----|----|
| Special focus, N = 123 (%) | | | | |
| Passed    | 36.6 | 77.9 | 94.6 | 87.4 |
| Failed    | 63.4 | 22.1 | 5.4  | 12.6 |
| Other facilities, N = 237 (%) | | | | |
| Passed    | 77.2 | 79.6 | 90.0 | 90.2 |
| Failed    | 22.8 | 20.4 | 10.0 | 9.8 |
compliance with infection control guidelines. CHIA data were used to determine each facility’s average daily census, confirmed COVID-19 infections (cumulative and weekly numbers) for residents and staff; numbers of residents tested, confirmed positive, confirmed negative, and awaiting results each week; cumulative mortality and weekly deaths; weekly facility admissions and hospitalizations; and nursing hours per patient day (HPPD). Average weekly rates of new infections, hospitalizations, and deaths were calculated by computing the differences in cumulative cases between consecutive weeks and dividing by the average daily census. None of the data included any identifying information about individual residents.

### Data Analysis

Data were reviewed for completeness and consistency; missing and erroneous values were replaced with imputed values calculated as the mean of the values from the previous and following reporting periods or last observation carried forward where appropriate. The cleaned data set was used to construct weekly new case and death variables along with change scores for each of the predictor and outcome variables. The first 2 weeks of mortality data were excluded due to inaccuracies in NH reporting.

For the purpose of our analyses, we dichotomized NHs into two groups: (1) special focus facilities: the 123 facilities that either (a) failed the first audit or (b) were previously

### Table 2. Descriptions of the Six Core Infection Control Competencies

| Question | Category | Competency | Special focus facilities | Other facilities |
|----------|----------|------------|--------------------------|-----------------|
| 17 PPE   |          | If there are COVID-19 cases identified in the facility, HCP is wearing recommended PPE for care of all residents, in line with the most recent DPH PPE guidance. | 39.84% 13.93% 5.38% 7.21% | 12.66% 17.59% 5.33% .00% |
| 12 PPE   |          | Staff have been trained on selecting, donning, and doffing appropriate PPE and demonstrate competency during resident care. | 25.20% 7.38% 1.08% 5.41% | 5.91% 8.33% 3.33% 6.56% |
| 03 IC    |          | Residents who are confirmed by testing to be infected with COVID-19 or who are recovering from COVID-19 have been separated from residents who are not infected and have unknown status (ie, in dedicated wings/units or in separate rooms). | 17.89% 3.28% 1.08% .00% | 4.64% 1.85% 2.00% 1.64% |
| 06 IC    |          | All congregate spaces have been closed and all group events involving close proximity ceased. | 15.45% .82% 1.08% .90% | 2.11% .93% .67% 1.64% |
| 25 Clinical care | All HCP have been trained to recognize the signs and symptoms of COVID-19 (ie, fever, cough, sore throat, or shortness of breath). | 11.38% 2.46% .00% .00% | .42% .00% .00% .00% |
| 24 Clinical care | The facility has infection control policies that outline the recommended transmission-based precautions that should be used when caring for residents with respiratory infection. These policies should accommodate for DPH and CDC guidance on PPE conservation methods. | 6.50% .00% .00% .90% | .00% .00% .00% .00% |

Abbreviations: CDC, Centers for Disease Control and Prevention; DPH, Department of Public Health; HCP, healthcare personnel; IC, infection control; PPE, personal protective equipment.

*Identified by question number in the left column and percentage missed at each of four audits for special focus and other facilities. Note that adherence to questions 17 and 3 were associated with reductions in infection rates and mortality (see Table 3).
identified as having infection control deficiencies, and (2) other facilities: the remaining 237 facilities that passed the first audit. Among the 123 special focus facilities, one refused the Pathway Health intervention, but we took an “intention-to-treat” approach and included all 123 in the analyses. Given that our outcome data were highly skewed with excess zeros, we fit a hurdle mixed effects model for semi-continuous data to estimate the relationships between changes in infection control process measures and associated changes in rates of new infections or deaths. Specifically, these models specify a logistic regression for the dichotomous indicator that the outcome is zero or not, and a standard linear mixed model for the non-zero responses. Variations in the neighboring county prevalence of COVID-19 infections and baseline total audit score were considered as covariates in all models. Hurdle models were done using the R package GLMMadaptive.7

Human Studies
Due to the anonymous nature of the data, this project was ruled not to be a human study by the Advarra institutional review board.

RESULTS
Over the first 6 weeks of the 9-week intervention period, the cumulative COVID-19 infection rate increased from 46% to 53% of all Massachusetts NH residents and the mortality rate increased from 24% to 26% of all residents with COVID-19 infections. Both of these rates leveled off with COVID-19 infections. The special focus facilities started with higher infection rates but rapidly declined to the same level as the other facilities within a week of starting the intervention. Mortality declined in parallel in both groups, reaching fewer than 2 deaths per 1,000 residents per week by the end of the intervention, which is half of the average rate reported for Cleveland, Detroit, and New York NHs in 2019.8

Table 3 shows the relationships between adherence to infection control processes and infection rate and mortality outcomes, adjusting for county COVID-19 prevalence. The logistic mixed model portion of the hurdle model indicated that for each 1-point increase in checklist audit score, the weekly infection rate decreased by 8% (P = .0007) and weekly mortality rate decreased by 3% (P = .179). The logistic portion of the model indicated that a higher audit

| Weekly infection rate | Weekly mortality rate |
|-----------------------|-----------------------|
| **Continuous audit score** | **Mixed model** | **β Coefficient** | **95% CI** | **P value** | **β Coefficient** | **95% CI** | **P value** |
| Audit score | -.08 | (-.12 to -.03) | .0007 | -.03 | (-.09 to .02) | .179 |
| Community prevalence | .06 | (.05 to .08) | <.0001 | .04 | (.02 to .05) | <.0001 |
| **Logistic model** | Odds ratio | 95% CI | P value | Odds ratio | 95% CI | P value |
| Audit score | 1.13 | (1.04 to 1.23) | .0040 | 1.16 | (1.06 to 1.27) | .0009 |
| Community prevalence | .82 | (.80 to .85) | <.0001 | .83 | (.80 to .86) | <.0001 |

**Statistically significant core competencies**

| **Mixed model** | **β Coefficient** | **95% CI** | **P value** | **Logistic model** | **Odds ratio** | **95% CI** | **P value** |
| Cohorting (Q3) | -.50 | (-.84 to -.16) | .0040 | -.38 | (-.75 to .00) | .0527 |
| PPE use (Q17) | -.23 | (-.45 to -.01) | .0379 | -.02 | (-.21 to .17) | .8296 |
| Community prevalence | .07 | (.05 to .08) | <.0001 | .05 | (.03 to .06) | <.0001 |
| **Logistic model** | Odds ratio | 95% CI | P value | Odds ratio | 95% CI | P value |
| Cohorting (Q3) | 3.00 | (1.34 to 6.71) | .0076 | 1.98 | (.58 to 6.75) | .2775 |
| PPE use (Q17) | 2.16 | (1.42 to 3.30) | .0003 | 3.20 | (1.87 to 5.48) | <.0001 |
| Community prevalence | .83 | (.80 to .85) | <.0001 |

Abbreviations: CI, confidence interval; PPE, personal protective equipment; Q, question.

A negative β coefficient indicates a decrease in weekly infection rate or weekly mortality rate with a 1-unit increase in the independent variable.

Odds ratio indicates increased odds of have zero infections or zero mortality with 1-unit increase in independent variable.
score was associated with 13% increased odds of a zero infection rate ($P = .004$) and 16% increased odds of zero mortality ($P = .0009$). Of the six core competencies, compliance with Question (Q) 3 (cohorting) and Q17 (PPE) (see Table 2 for full descriptions) were associated with large reductions in the weekly infection rate ($Q3: -50\%; P = .004$; Q17: $-23\%; P = .0379$) and increased odds of a zero infection rate ($Q3: \text{odds ratio [OR]} = 3.0; P = .0076$; Q17: $\text{OR} = 2.16; P = .0003$). Additionally, compliance with Q3 was associated with a 38% reduction in mortality rate ($P = .5277$) and 98% increased odds of zero mortality ($P = .2775$). Compliance with Q17 was associated with a 2% reduction in mortality rate ($P = .8296$) and 3.2% increased odds of zero mortality ($P < .0001$). Adjustments for baseline checklist scores did not change the results. In all models, increased county prevalence was associated with increased weekly infection and mortality rates (all $P < .0001$).

**DISCUSSION**

The COVID-19 pandemic has ravaged NHs across the United States, largely because the frail older residents residing in these facilities are at high risk of serious complications, and NHs are poorly equipped with appropriate infection control expertise, training, procedures, and supplies. Efforts to improve infection control through regulatory oversight with surveys and fines tend to be reactive and punitive, rather than enabling and supportive. The Massachusetts effort to improve infection control was unique in offering expert guidance, on-site and video consultation, resources for the acquisition of PPE, backup staff, SARS-CoV-2 testing, and additional payments to enable facilities to contain and prevent the spread of COVID-19 infection.

The Massachusetts effort was associated with several positive outcomes, but without a randomized controlled study it is difficult to conclude that these were attributable solely to the intervention. Infection and mortality rates declined statewide over the intervention period, and it is now well recognized that the community prevalence of COVID-19 is one of the strongest risk factors for infections within nursing facilities. Nevertheless, our analysis did show significant correlations between adherence to best infection control practices and reductions in infection and mortality rates, even when county prevalence was taken into account. One concern is the possibility of backsliding during the last week of the intervention when the number of infections among residents and staff and audit failure rates began to increase. This suggests that constant vigilance, reinforcement, and funding of infection control procedures in NHs and the surrounding community may be necessary to prevent another surge. We do not know whether improvements in infection control processes can be sustained without payment incentives.

Many of the infection control processes included in the Massachusetts checklist are being implemented nationally in Singapore nursing homes but not in the United States. Previous authors have called for public policies that promote pandemic preparedness in nursing homes and fundamental changes in the way we pay for long-term care.

There are also challenges to implementing several infection control procedures, such as cohorting residents with cognitive impairment who wander and encouraging them to wear masks. Social isolation also poses significant risks of deconditioning, cognitive decline, delirium, loneliness, depression, anxiety, dehydration, and weight loss. Therefore, the risks of COVID-19 transmission need to be balanced against the risks of quarantine.

This project provided several important lessons that may help inform future statewide efforts to improve infection control in NHs. These lessons not only apply to COVID-19, but also to the many transmissible infections that plague nursing homes including influenza, norovirus, *Clostridioides difficile*, antibiotic-resistant bacteria, and others. Most importantly, facilities require clear and consistent PPE guidance from state and federal authorities that is well aligned and adaptable when shortages are present. This guidance should include when and where to use different types of PPE, recommended signage, appropriate donning and doffing practices, optimization procedures to prevent shortages, tools to calculate burn rate, and recommendations regarding where to find vendors for high-quality supplies. Massachusetts also introduced the PPE coach as a vital member of the infection control team. Other state infection prevention and control efforts should also be aligned with CMS and CDC guidance, and the same nomenclature should be used by all regulatory agencies (eg, infection preventionist vs designated infection control lead). The infection preventionist is another critical position that should be required and funded for all NHs.

The innovative Commonwealth of Massachusetts program that included an Infection Control Competency Checklist, routine audits, and both financial and technical support for PPE acquisition and staffing was unprecedented in this country. It helped long-term care providers increase their knowledge of and access to best infection control practices and reduce the risk of COVID-19 spread for both residents and staff. We hope to see this intervention replicated in other states, appropriately funded, and sustained in all NHs, so that future pandemics can be prevented or mitigated.

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