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Impact of using a centralized matching process on nursing home staffing

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Abstract

Objective: To examine the effectiveness of adopting a novel centralized matching process for reducing staff shortages in Massachusetts nursing homes during the COVID-19 pandemic.

Methods: This study involved several datasets and 216 Massachusetts nursing homes that used a novel online portal to enter demand for nursing staff from May 2020 to April 2021.

Results: There were significant associations between the staff-to-resident ratio and demand entries lagged by three and four weeks, and no significant associations between the staff-to-resident ratio and demand entries lagged by one and two weeks. In contrast, we found significant associations between the staff-to-resident ratio and the number of generated staff matches lagged by one, two, and three weeks, with larger impacts overall.

Conclusion: This study shows how adopting a centralized matching process may expedite and increase improvement in the staff-to-resident ratio in nursing homes, compared with the setup in which nursing homes need to seek nurses on their own.

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Introduction

Staffing shortages have plagued US nursing homes for decades.\textsuperscript{1,2} Barriers such as lower wages compared to alternative options, staff workload, and stressful duties make hiring and keeping workers complicated for nursing homes.\textsuperscript{3-5} This problem has worsened with the COVID-19 pandemic onset.\textsuperscript{6} According to a survey, 94\% of nursing homes faced staffing shortages during the COVID-19 pandemic,\textsuperscript{7} caused by nurses testing positive for COVID-19,\textsuperscript{8} staff quitting,\textsuperscript{7} lack of childcare for staff,\textsuperscript{1} and overall pandemic burnout and fatigue.\textsuperscript{1}

In addition to nationwide efforts to reduce these shortages,\textsuperscript{9} many state governments have implemented various local policies for the same goal. For instance, Michigan offered bonus payments to recently hired staff, created a rapid response team, and paid for staffing services; Utah invested in recruitment efforts and volunteer programs; Washington created a new tool for requesting volunteer staff, California subsidized travel costs for volunteer staff commuting across the state, Georgia allowed nursing homes to hire temporary (not certified) nursing assistants; Delaware provided nursing aid training for unemployed workers; Indiana created a list of available staff for nursing homes facing shortages; Wisconsin gave free training programs to volunteers.\textsuperscript{10} Such a wide variety of potential solutions deployed by different states reflects not only differences in policies across states, but also our lack of understanding of how effective these solutions are.\textsuperscript{10}

This paper aims to comprehensively evaluate the effectiveness of reducing staff shortages in nursing homes for one of such solutions, implemented by the Commonwealth of Massachusetts during COVID-19. The core idea was to design and run a centralized process for matching demand for and supply of nursing staff, based on prior successful implementations of similar processes in various other labor markets.\textsuperscript{11–14} The solution, supervised by Commonwealth’s Executive Office of Elder Affairs and executed in collaboration with local researchers (experts from the Executive Office of Health and Human Services, Northeastern University, and University of Massachusetts Chan Medical School), involved creating an online portal to enable the dynamic and real-time collection of nursing staff demand and supply data, and using this data to optimize matching staff to nursing homes in need algorithmically.\textsuperscript{15}

Nursing homes looking to hire nursing staff and nurses looking for work could register and interact with the portal. Nursing homes could use the portal to report their current needs for each nursing staff position in real time; nurses could note their current availability to start working. Throughout the paper, staff positions refer to three nursing positions which are certified nursing assistant (CNA), licensed practical nurse (LPN), and registered nurse (RN).
After the Commonwealth’s Executive Office of Elder Affairs set policies and criteria of matching that considered the temporal and spatial aspects of staff and nursing homes (e.g., the closeness of staff to nursing homes, staff available date and demand urgency), the centralized matching process generated matches that were then shared with the matched nursing homes. Nursing homes then could contact, interview, and hire the suggested matches to reduce their nursing staff shortage. Fig. 1 shows the roles of each stakeholder in the centralized matching process.15

The study hypothesis was that implementing the centralized matching process is strongly associated with increases in staff-to-resident ratios of nursing homes after controlling for the weekly numbers of resident deaths due to COVID-19, weekly numbers of COVID-19 positive cases among staff, and weekly numbers of resident admissions. We further hypothesized that these increases occurred faster, when compared with the setup in which nursing homes would need to seek nurses on their own.

To test these hypotheses, we examined the centralized matching process effectiveness by combining the proprietary portal data with publicly available longitudinal datasets.

**Methods**

**Design**

We designed this descriptive study to investigate the performance of the centralized matching process.

**Sample and procedure**

Our dataset combines weekly data (for 45 weeks, from the week ending on May 31, 2020, until the week ending on April 4, 2021) for nursing homes in Massachusetts from the following four sources:

1. We used the Center of Medicare and Medicaid Services (CMS) COVID-19 nursing home database16 for the number of cases and deaths among residents, shortage of different resources such as PPE and staff, COVID-19 testing, and weekly resident admissions.
2. We used the CMS Payroll Based Journal (PBJ) nurse staffing database17 for the daily hours of nurse staffing and the number of residents in nursing homes. We have transformed these daily values to weekly ones for each nursing home by averaging nurse (RN, LPN, and CNA) staffing hours and the number of residents over the seven days comprising the corresponding week.
3. We used the portal database for weekly demand entries of nursing homes for different nurse positions and the weekly numbers of matched nurse staff to nursing homes. This novel data source, a central and crucial element of this study, was made available to us in real time during the study period (the data was used to optimize matching staff to nursing homes in need algorithmically, on a weekly basis). This real-time data availability allowed the central matching process to operate without any data lag.
4. We used LTCFocus (2019)18 (available from Brown University) database for some of the general characteristics of nursing homes and residents in Table 1.

After removing 83 (0.9%) nursing-home-week records with missing values in either the CMS COVID-19 nursing home or CMS PBJ nurse staffing databases for 216 nursing homes in Massachusetts that participated in the centralized matching process (i.e., got matched to a worker at least once during the study time window), our resulting dataset had 9,637 nursing-home-week records.

Except for the portal data, all other datasets used in our study are publicly available. We received an exemption from the IRB at Northeastern University for collecting the portal data. We kept all personal information associated with nursing homes confidential.
Table 1
General characteristics of participating nursing homes in Massachusetts.

| Participating nursing homes | Mean | Min | Max    | SD   | Median |
|-----------------------------|------|-----|--------|------|--------|
| Proportion of all admissions during the calendar year 2019 that were from an acute care hospital (n = 208, unit: percentage) | 86.92 | 41.46 | 98.45 | 9.67 | 89.49 |
| Acuity Index (a measure of the care needed by a nursing home’s residents. (n = 213, range is from 0 to 28. 0 indicates completely independent and 28 completely dependent) | 12.19 | 8.566 | 18.835 | 1.01 | 12.2 |
| Average resident age (n = 213, unit: years) | 81.37 | 25.74 | 91.29 | 7.21 | 82.97 |
| Availability of an Alzheimer’s disease Special Care Unit (SCU) (n = 213) Yes = 46 | No = 167 |
| Median Length of Stay (n = 209, unit: days) | 30.45 | 14 | 120 | 23.31 | 22 |
| Proportion of residents present on the 1st Thursday in April, 2019 who had a body mass index (BMI) of 35 or higher. (n = 188, unit: percentage) | 25.75 | 0 | 60 | 6.96 | 25 |
| Proportion of residents present on the 1st Thursday in April, 2019 who have congestive heart failure. (n = 168, unit: percentage) | 23.33 | 0 | 46.67 | 7.38 | 22.99 |
| Proportion of residents admitted during the calendar year (2019) with Alzheimer’s disease or related dementia. (n = 208, unit: percentage) | 27.79 | 0 | 98.18 | 13.86 | 24.95 |
| Proportion of residents admitted during the calendar year who were low care, according to the broad definition (n = 68, unit: percentage) | 3.48 | 0 | 42.42 | 7.19 | 0 |
| Proportion of residents whose primary support is Medicaid (n = 213, unit: percentage) | 63.44 | 0 | 100 | 18.59 | 64.94 |
| Proportion of residents whose primary support is Medicare (n = 213, unit: percentage) | 11.08 | 0 | 75 | 9.06 | 9.89 |
| Proportion of long-stay residents with ADL decline (n = 203, unit: percentage) | 14.46 | 0 | 45.45 | 6.66 | 14.29 |
| Proportion of high-risk long-stay residents with a pressure ulcer (n = 203, unit: percentage) | 5.61 | 0 | 17.14 | 3.51 | 5.48 |
| Overall Rating (n=214, ranges from 1 to 5 where 5 is highest) Yes = 150 | No = 63 |
| Long-Stay QM Rating (n=214, ranges from 1 to 5 where 5 is highest) | 3.27 | 1 | 5 | 1.37 | 4 |
| Short-Stay QM Rating (n=200, ranges from 1 to 5 where 5 is highest) | 3.53 | 1 | 5 | 1.29 | 4 |
| Number of certiﬁed beds (n = 214) | 119 | 28 | 333 | 45.46 | 120 |

NOTES: Among the nursing homes in Massachusetts that got matched to a worker at least once during the study time window (N=216); for each metric, we also list the number of nursing homes with available data for that metric.

Outcome variable

We operationalized our outcome variable as a weekly staff-to-resident ratio (S/R ratio) for each nursing home; such ratio is frequently used for measuring staffing levels in nursing homes. We calculated it by dividing inferred weekly nurse staffing hours by the inferred number of residents in the same week for each nursing home, using the CMS PBJ daily nurse staffing database.

Other nursing home characteristics

We controlled for other nursing home characteristics that could affect the S/R ratio, including the weekly numbers of resident deaths due to COVID-19, weekly numbers of COVID-19 positive cases among staff, and weekly numbers of resident admissions (number of residents admitted or readmitted after being previously hospitalized and treated for COVID-19).

Data analysis

The performance of the centralized matching process is quantified by how much it impacts the number of nursing staff hired through that process. The most direct way to examine that would have been to collect accurate feedback from the nursing homes on how many additional nursing staff they hired as a result of receiving staff matches through this process. However, while the operational team has tried implementing several different approaches focused on collecting such feedback (such as calling the nursing homes after not receiving feedback and providing easier interfaces for nursing homes to provide accurate feedback on matches), none of these approaches were successful.

Because we cannot observe that metric of the centralized matching process performance directly, we estimate it by comparing the results of two regression models: one that accounts for the weekly demands and another that approximates the setup in which nursing homes would need to seek nurses on their own. Specifically, we examined the relative effectiveness of the centralized matching process by comparing impacts of the weekly matches that the process provided for nursing homes with impacts of the weekly demand entries of nursing homes alone (approximating the setup in which nursing homes would need to seek nurses on their own), using two nursing-home-week fixedeffects regression models. In both models, we used lagged (by 1–4 weeks) values of the number of demand entries (Model 1) and the number of matches (Model 2) to estimate and compare their impacts on the S/R ratio of nursing homes.

Results

Out of 373 nursing homes that submitted data to the CMS, 216 (58%) participated in the centralized matching process. These nursing homes vary on quality, as measured by CMS overall ratings, and capacity, as measured by the number of beds (Min = 26, Max = 333, another that approximates the setup in which nursing homes would need to seek nurses on their own.
Mean = 119, Median = 120, SD = 45.46. Table 1 presents descriptive statistics for general characteristics of the participating nursing homes (available in the CMS20 and LTCFocus16 datasets), and Table 2 presents descriptive statistics for characteristics of the participating nursing homes that change weekly, at the nursing-home-week level.

During the study time window, the participating nursing homes have entered a demand for 38,522 nursing staff positions and received 10,581 matches.

Performance of the centralized matching process

Table 3 presents the results of our two nursing-home-week fixed effects regression models. We find a significant impact of the number of needed staff (demand entries) on the S/R ratio after three and four weeks. We used nursing-home-week fixed effects regression models. Coefficients show changes in daily staff to resident ratio by 1 unit change of each variable. *p<.01, **p<.05, ***p<.001.

NOTES: Model 1 estimates the association between weekly staff to resident ratio and weekly number of staff that nursing homes in Massachusetts needed. Model 2 estimates the association between weekly staff to resident ratio and weekly number of staff that the central matching process provided for nursing homes in Massachusetts. Time lags are in weeks. We used nursing-home-week fixed effects regression models. Coefficients show changes in daily staff to resident ratio by 1 unit change of each variable. *p<.01, **p<.05, ***p<.001.

### Table 3

| Variable                                      | Lag | Coeff.                  | P value |
|-----------------------------------------------|-----|-------------------------|---------|
| Number of needed staff                        | 1   | -0.0003 (-0.0016, 0.0010) | 0.574   |
|                                               | 2   | 0.0006 (-0.0007, 0.0018)  | 0.148   |
|                                               | 3   | 0.0012** (-0.0001, 0.0024) | 0.004   |
|                                               | 4   | 0.0014*** (0.0002, 0.0025) | 0.02    |
| Residents weekly COVID-19 deaths              | -   | 0.1019*** (0.0886, 0.118) | 0.001   |
| Staff weekly COVID-19 cases                   | -   | 0.0058 (0.0005, 0.0121)  | 0.239   |
| Residents weekly admissions COVID-19          | -   | -0.1016*** (-0.1015, -0.0055) | 0.014   |

### Discussion

The number of nursing matches driven by centralized matching process was strongly and significantly associated with the S/R ratio of nursing homes when controlling for different measures of nursing homes. For instance, for a nursing home with 100 residents, each suggested match in a given week is associated with an increase of 0.21 staffing hours per day in the next week, 0.21 in two weeks, and 0.26 three weeks later. Overall, we found that the centralized matching process increased the improvement of the S/R ratio of nursing homes and helped them address the staff shortage issue faster.

Our results suggest that developing and using a centralized platform for matching a severely limited number of available workers to nursing homes during public emergencies, such as the COVID-19 pandemic, can help nursing homes improve their S/R ratio. Furthermore, implementing a centralized matching process enables policymakers to observe real-time supply and demand levels at the nursing home level and promptly make necessary policy adjustments (such as modifying local hiring incentives).

However, these benefits of having a centralized matching process in place could materialize only if the process is developed through a close collaboration of nursing homes, policymakers and the centralized matching process development team. Therefore, it is essential to design such a process prior to public health emergencies and assign teams to launch the process and communicate with staff and nursing homes. Moreover, since it is critical to access accurate real-time data for a robust centralized matching process performance, local policymakers may want to provide a secure, accessible, and incentive-compatible mechanism for nursing homes to share their demands for staff and hiring decisions. Finally, while in our study the nurses have not received any incentives connected with their online portal enrollment and participating in the centralized matching process, we hope future research will examine how various incentive schemes may interact with the process effectiveness.

### Study limitations

Given that the CMS PBJ daily nurse staffing and the CMS COVID-19 nursing home databases have data on nursing homes only, we have restricted our analysis accordingly (while more LTCFs such as assisted living centers and rest homes in Massachusetts have also used the centralized matching process). Also, since the CMS COVID-19 nursing home database has weekly data only starting from the week ending on May 31, 2020, we have adjusted the starting date for our statistical analyses accordingly.

### Conclusion and implications

This study shows how adopting a centralized matching process may expedite and increase improvement in the staff-to-resident ratio in nursing homes, compared with the setup in which nursing homes need to seek nurses on their own. Public policymakers may consider developing a similar process prior to public health emergencies and assigning teams to launch, run and monitor the process during the emergencies.

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