Proposal to Investigate Changes in SNF Staffing Level Effects on Patient Outcomes

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# Introduction

The quality of care in skilled nursing facilities (SNFs) is of great concern to many in the United States who have elderly relatives or other loved ones with disabilities or chronic conditions who must stay at them, away from home, for short rehabilitation (up to 100 days with conditions) or for long periods of time. SNF patients are often vulnerable and a great amount of trust is placed in SNFs to treat them well by attending to their daily needs and giving them the specific medical care they require. This care can include round-the-clock outpatient medical care and rehabilitation to help patients recover from illness, injury, or surgery, which is often known as post-acute care. SNFs also offer physical and occupational therapy and daily living assistance such as helping patients bathe, eat, and dress, providing medication reminders and administering medication, and generally monitoring patients’ health. SNFs can employ certified nursing assistants (CNAs) to help with more of these simple daily tasks, but SNFs are set apart as facilities by employing registered nurses (RNs), licensed practical nurses (LPNs), and even physical and occupational therapists to provide more expert and specialized care.

News media and word of mouth from friends and family report stories of neglect, fraud, and abuse coming from SNFs all over the United States. When it comes time to choose a facility to send a patient to, family or other caregivers feel pressured to choose a place with a good reputation. However, depending on conditions attached to the patient’s healthcare plan, whether that be Medicare, Medicare Advantage, or Medicaid for example, patients may not have the freedom to choose any facility they desire. Facilities also need to have capacity for a new patient. This can make selection difficult, especially if the available facilities include those with reported citations.

SNFs need to apply to be eligible to take Medicare patients and receive government funding by going through a certification process. An SNF can be privately owned and for-profit, or nonprofit. Facilities must keep up a required standard of care, including thorough documentation, safety, quality patient care, having licensed professionals on staff, and more. Facilities can gain access to even more government funding if they choose by broadening the scope of their patients, such as providing Medicaid accommodations for example. However, a breach in any of the standards an SNF’s license is predicated upon may result in a citation, which will be publicly available data. These breaches coincide with what the literature reports as “deficiencies.” Citations and deficiencies in standards over an extended period of time may result in an investigation, which can lead to an SNF losing its Medicare license and the associated funding. These breaches and citations will lower an SNF’s Five Star Rating, which is supplied by the Centers for Medicare & Medicaid Services (CMS) using measures associated with the standards and gives patients and their caregivers a publicly available rating from 1-5 stars for each Medicare licensed facility.

However, licensed facilities with low star ratings still remain with funding intact, and highly rated facilities may still carry citations or provide poor care anyway, especially if they are new, for example. Different facts about SNFs underlie the “true” quality and potential patient risks associated with a facility. This study seeks to identify how a key SNF quality, staffing levels, have been associated with patient outcomes, or health outcomes, of such facilities over time.

# Background and Literature Review

Research on the topic of SNF quality has been done extensively, but is disseminated across many viewpoints on how to measure quality. These include studies on the CMS Five Star Rating itself, staffing levels, the differences between nonprofit and for-profit facilities, the number of patients in facilities experiencing delirium, patient outcomes after they are discharged from facilities, levels of patient nutrition, and more. Many of these measures are intertwined. For example, staffing levels may influence the Five Star Rating, but the effect may be more complicated based on whether or not the facilities in question are nonprofit or for-profit.

To briefly touch on the better-known work done here, it’s been found that low/insufficient staffing levels are a major contributor to the appearance of citations in an SNF’s record and to poorer health outcomes for patients. For-profit facilities are more highly associated with lower quality care and higher citations. Five-star facilities are more highly associated with better patient outcomes compared to one-star facilities, though only those furthest extremes in the Five Star Rating system showed significantly different results.

Notably, research on the quality of SNFs in recent years can be divided into three parts: research prior to COVID, during COVID and the lockdown period, and post-COVID. In the prior-COVID period, there was general interest in the quality of SNFs and is viewed by this report as the default or “baseline” of research as well as facility quality itself to compare against. However, during COVID, a wealth of interest emerged in patient care in the wake of reports of illness and infections sweeping through places such as retirement homes, and of course, SNFs. This raised concerning questions about whether facilities’ staff were adequately trained to prevent infections and to prevent those infections from spreading. Of key interest, however, was the question: are SNFs adequately staffed to handle the rise of COVID and other infections in the first place?

The question of adequate staffing is a balance of several datapoints: the number of nurses compared to how many beds there are at a facility, and therefore, how many minutes of care a patient gets per day, and conversely, how many minutes one nurse can give a patient per shift. Medicare licensed facilities are expected to provide a baseline amount of time of care to each patient – about an hour of care from an RN per day and a couple hours of care from a CNA per day. Facilities are also required to have certain specialists on staff to provide nutritional care, therapeutic care, and there should be a licensed nurse leading each shift. Yet despite these standards, patients report going several hours without seeing a CNA, often enduring unclean conditions or having no choice but to spend extended periods in bed as a result. In the same vein, individual nurses report having only being able to spend a few minutes on a patient per day. This even further raises concerns about whether patients, who were already especially vulnerable to COVID due to the reasons they were in an SNF in the first place, as well as being mostly elderly, were given enough time and observation to care for them during this period. (This was also a period of shifting employment levels and climbing wages in the United States, which may have made it difficult for SNFs to find staff and keep them.)

In the wake of this spike in interest and research, and in the wake of disquieting findings of low staffing levels and increased rates of infection at lower-rated facilities, our attention now turns to what these staffing levels and overall SNF quality look like in the current “post-COVID” period. Reports have found that the number of residents in SNFs has decreased by 10% since the pandemic due to the number of deaths at facilities during that period, and many patients have opted for in-home care instead. And yet, the amount of time given to each patient in a facility has declined 8% from 2015 to 2024. In addition, the average amount of deficiencies found in facilities – leading to citations and the conditions that could cause a Medicare licensed facility to lose its license – have increased, and the share of facilities with deficiencies has increased from 17% to 28% in the same period nationwide.

These are troubling statistics, combined with the fact that the U.S.’s aging population means that the Medicare system will likely be seeing more patients in need of nursing care in the near future. Findings continue to point to staffing and staffing levels as a key indicator of the quality of patient healthcare outcomes. Therefore, we propose a quantitative study that bridges the concepts of facility staffing, facility quality, and patient health outcomes by measuring the effect of facility staffing levels on patient outcomes in the prior and COVID period, and compare it to the current post-COVID period.

# Methodology

This study poses the question: "How have changes in nursing facility staffing levels between 2018 and 2024 affected the quality of care and patient outcomes, comparing prior-COVID and COVID years to post-COVID?” We hypothesize that lower staffing levels have a greater negative impact on patient outcomes in the current post-COVID period compared to the prior period.

This study will employ a quantitative research design to analyze data on SNF staffing levels and patient outcomes per facility per reporting year in the U.S. Secondary data will be obtained primarily from the CMS government website. There are a few datasets of interest:

* [MDS Quality Measures](https://data.cms.gov/provider-data/dataset/djen-97ju)
  + “Quality measures that are based on the resident assessments that make up the nursing home Minimum Data Set (MDS). Each row contains a specific quality measure for a specific nursing home and includes the 4-quarter score average and scores for each individual quarter.”
* [Medicare Claims Quality Measures](https://data.cms.gov/provider-data/dataset/ijh5-nb2v)
  + “Quality measures that are based on Medicare claims data. Each row contains a specific quality measure for a specific nursing home and includes the risk-adjusted score.”
* [Health Deficiencies](https://data.cms.gov/provider-data/dataset/r5ix-sfxw)
  + “A list of nursing home health citations in the last three years, including the nursing home that received the citation, the associated inspection date, citation tag number and description, scope and severity, the current status of the citation and the correction date. Data are presented as one citation per row.”
* [Provider Information](https://data.cms.gov/provider-data/dataset/4pq5-n9py)
  + “General information on currently active nursing homes, including number of certified beds, quality measure scores, staffing and other information used in the Five-Star Rating System. Data are presented as one row per nursing home.”

The CMS offers all of these datasets by report year snapshots from 2018-2024 year end. Each dataset can be combined or “joined” by the CMS Certification Number (CCN), which is a unique identifier for a facility.

In order to measure the strength of the effect of staffing levels on patient outcomes, we will fit a regression model in order to quantify and analyze the effect of the independent variable (staffing levels) on the dependent variable (patient outcomes).

The dependent variable, patient outcomes, can be defined in a number of ways based on the data found in the provided datasets. Candidate target variables for analysis include:

* Percentage of short-stay residents who made improvements in function
* Percentage of long-stay residents whose ability to move independently worsened
* Percentage of long-stay residents who have depressive symptoms

And other measures of quality from the MDS Quality Measures dataset. While these measures seem similar, if opposing, and there are several to choose from, each quality measure tells a slightly different story about patient outcomes. The first variable listed seems to provide the most general statement of the quality of patient outcomes for short-term stays, which is a telling measure based on the urgency and riskiness that may accompany post-acute care, while the other measures are appropriate candidates for comparison during the analysis process.

Because of the nature of facilities such as SNFs, it may be necessary for the sake of clarity of results to use the type of stay – short-term or long-term – as a way to compare results between two different models. The Medicare Claims dataset also provides different measures of patient outcomes separated out by short-term and long-term stays, such as:

* Percentage of short-stay residents who were rehospitalized after a nursing home admission
* Number of hospitalizations per 1000 long-stay resident days

The data provides a few different and closely related measures of the independent variable, staffing levels, provided by the Provider Information dataset. Of primary interest is:

* Adjusted Total Nurse Staffing Hours per Resident per Day

This seems to be the measure closest to what is often quoted in reports and literature as how much time a resident gets for care based on available staffing hours. Other staffing level datapoints available for analytical purposes include:

* Adjusted RN Staffing Hours per Resident per Day
* Adjusted Nurse Aide Staffing Hours per Resident per Day

Along with the complexity that short-term stay target measures vs. long-term stay target measures pose on the analysis, and in addition to the use of prior period snapshot dates to use as a control in order to compare to current post-COVID period snapshot dates, the data provides a number of variables that could be useful for controls, or as “grouping” variables. These include:

* + Nonprofit vs. for-profit facilities
  + Facilities with health citations versus facilities without
  + Medicare, Medicaid, and Medicare & Medicaid facilities
  + Five Star Rating (1 star vs. 5 star)

We do not expect that every datapoint here will prove to be useful for the modeling or analysis process, but they are datapoints that have been associated with facility quality and patient outcomes in prior literature, while some, especially the Medicare vs. Medicaid and Five Star Rating datapoints, are inconclusive in the directionality of their relationship to facility quality, and so it may be particularly useful to block out these facility groups for control purposes.

# Data Collection

* Selecting prior and post timeframe data snapshots in order to calculate the Lower\_Staffing variable
* Aggregating and joining multiple datasets by the provider ID
* Aggregating by count and by sum
* Excluding facilities with no Lower\_Staffing result, testing models on excluding facilities with little to no staffing changes within the timeframe

# Results

* Most clearly associated variables include ones where staffing levels factor into these other variables:
  + Poor staffing rating, high ratio of residents to beds, lower five star quality rating
* Removing staffing-related variables reveals health-related metrics closely related to facilities with staffing levels that lowered over time
  + Longterm stay patients who developed depressive symptoms
* Modeling results become clearer and more stratified when removing facilities from the dataset that had little to no staffing changes over time, leaving only facilities that had a notable increase or a notable decrease in staffing levels
* For-profit LLCs associated with lowered staffing levels

# Discussion

* Lowered staffing levels associated with depressive symptoms in longterm stay patients, LLC for-profit orgs, poor staffing ratings, facilities that received their Medicare/Medicaid licenses fairly recently, Medicare-only facilities
* Correlated variables aren’t always indicative of one variable driving the other, but are indicative of various markers associated with a facility being more common in facilities that reduced staff over time
* Tree model feature importance can reveal the magnitude of a variable’s effect, but it requires something like Shapley values to get an idea of the direction of the effect
* Dummy encoding and one hot encoding expands the feature set, but also allows us to pluck detailed observations from results when working with more granular datapoints (such as each possible MDS quality measure description)
* Removing facilities where the staffing level didn’t change as much removes a lot of data, but does show that the tree model has the ability to discern less noisy data, giving us confidence in the important features that are common between the more stratified model and the more noisy model
* This exploration doesn’t need to make predictions or inform us why a facility may have lowered its staffing levels, but it does show us more frequent observations and occurrences within facilities that lowered staffing levels
* Non-reporting facilities create more noise

# Conclusion

* The amount of data collected on nursing facilities is overwhelming, so it is difficult to know what is most important to look for when considering facility quality
* Staffing level is a datapoint closely associated with patient care, and we see that facilities that reduced staff over time tend to be