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The Role of Schedule Volatility in Home Health Nursing Turnover

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Abstract

Despite considerable research on nursing turnover, few studies have considered turnover among nurses working in home health care. Using novel administrative data from one of the largest home health care organizations in the U.S., this study examined turnover among home health nurses, focusing on the role of schedule volatility. We estimated separation rates among full-time and part-time registered nurses and licensed practical nurses and used daily visit logs to estimate schedule volatility, which was defined as the coefficient of variation of the number of daily visits in the prior four weeks. Between 2016 and 2019, the average annual separation rate of home health nurses was over 30%, with most separations occurring voluntarily. Schedule volatility and turnover were positively associated for full-time nurses, but not for part-time nurses. These results suggest that reducing schedule volatility for full-time nurses could mitigate nursing turnover in home health care.

Keywords

Home health; nursing; scheduling; staffing; turnover

Introduction

High levels of turnover in professions that rely heavily on skill acquisition is a major source of inefficiency (David & Brachet, 2011). Turnover among nurses is a particular concern due to their central role in the provision of direct care to patients (Institute of Medicine, 2011;

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Waldman et al., 2010) and the fact that they are the largest health care profession, with nearly three million registered nurses (RNs) and 700,000 licensed practical nurses (LPNs, who are called licensed vocational nurses in California and Texas) employed nationwide (U.S. Bureau of Labor Statistics, 2019; Smiley et al., 2018).

Inadequate nursing care has been associated with longer lengths of stay and higher rates of adverse outcomes, including infections, hospital readmissions, and mortality (Kane et al., 2007; Castle, Engberg, & Men, 2007; Cimiotti et al., 2012; Hayes et al., 2012; Thomas et al., 2013; Griffiths et al., 2016). In addition to harms to patients that can arise when nursing turnover leads to staffing shortfalls, the economic costs of nursing turnover are substantial. One study found that a quarter of total turnover costs in a hospital was due to nursing turnover, and a second study estimated that the inflation-adjusted cost of turnover was over $100,000 per nurse (Waldman et al., 2010; Jones, 2008).

In 2015, over 4.5 million patients in the U.S. received home health care from over 12,000 home health care agencies, 170,000 RNs, and nearly 85,000 LPNs (MedPAC, 2018; Daedal Research, 2020, Bureau of Labor Statistics, 2020). Despite the large role of home health care—as well as the predicted growth in demand for home health care attributable to COVID-19's disproportionate impact on long-term care facilities (Grabowski & Joynt Maddox, 2020)—most studies of nursing turnover have focused on hospitals and nursing homes. A national survey of hospitals estimated that 16% of RNs changed jobs in 2019, more than double the rate of physician turnover (NSI Nursing Solutions, 2020). Turnover in nursing homes was even higher, with a recent study reporting average annual turnover rates for total nursing staff of over 125% (Castle, Engberg, & Men, 2007; Donoghue, 2010; Gandhi, Yu, & Grabowski, 2021). One exception to the focus on nursing turnover in hospitals and nursing homes is Luo, Lin, and Castle (2012), who estimated rates of RN and LPN turnover of over 10% per quarter in the home health and hospice industry.

In this study, we use detailed administrative data from a large multi-state home health care organization from January 2016 through March 2019 to quantify the relationship between schedule volatility and nursing turnover. We begin by estimating separation rates among full-time and part-time RNs and LPNs working in home health care, separately accounting for voluntary and involuntary separation. We then used daily visit logs to estimate schedule volatility, which captures the day-to-day variability of schedules and was measured as the coefficient of variation of the number of daily visits in the prior four weeks. Finally, we examined the relationship between nurse turnover and schedule volatility using multivariate regression analyses.

Conceptual Framework

We draw on the conceptual framework of nursing turnover described by Gilmartin (2013), who summarized the multitude of factors that contribute to turnover decisions among nurses. Many of these factors relate to organizational characteristics, cultures, and climates, such as low compensation or limited autonomy (Kravits et al., 2010; Maslach, Schaufeli, & Leiter, 2001; Monsalve-Reyes et al., 2018; Willard-Grace, et al., 2019; Hayes et al., 2012). In home health care, lower nursing turnover has been associated with smaller agency size, non-profit

ownership, chain ownership, having more nursing staff per patient, high-quality feedback to nurses, income stability, and better fringe benefits (Luo, Lin, & Castle, 2012; Ellenbecker et al., 2007; Ellenbecker et al., 2008; Tourangeau et al., 2014; Van Waeyenberg, Decramer, & Anseel, 2015).

Our study focuses on one component of the work environment—schedule volatility—which has been shown to adversely affect workers in non-health care settings, particularly with regard to work-family conflict and stress that results from unstable and unpredictable schedules (Golden, 2015; Lusher, Yasenov, & Luong, 2019). Within home health care, nurses practice with a high degree of independence; while this affords nurses more autonomy in the field, complex or irregular scheduling practices may contribute to attitudes about their job and create more stressful environments (Demir, Ulusoy, & Ulusoy, 2003; Lusher, Yasenov, & Luong, 2019).

Myriad studies have explored nursing scheduling practices, including the impact of scheduling practices on exhaustion, burnout, and patient satisfaction (Castle & Engberg, 2006; Stimpfel, Sloane, & Aiken, 2012; Vahey et al., 2004). Fewer studies have focused on schedule volatility. In cases where volatility is the manifestation of greater flexibility, such as rotating shifts versus fixed shifts, volatility is associated with lower rates of burnout among inpatient nurses (Shamali et al., 2015) and less nursing turnover among home health nurses (Luo, Lin, & Castle, 2012; Tourangeau et al., 2014).

Higher turnover rates among nurses can influence both individual outcomes (e.g., strain) and organizational outcomes (e.g., performance, subsequent turnover) (Gilmartin, 2013; Holtom et al., 2008). Thus, a deeper understanding of schedule volatility and whether it contributes to nursing turnover could unveil new ways to improve work environments for home health nurses, thereby increasing the quality of care delivered in home health care.

New Contributions

This study uses novel data from one of the largest home health care organizations in the U.S., providing the first estimate of the average annual separation rate of home health nurses based on administrative data. To date, literature on nursing turnover has largely focused on hospital and nursing home settings, with most estimates derived from self-reported survey data. Using granular employee-level and visit-level data to track the number of visits conducted by each nurse per day, we also develop a measure of schedule volatility that has not previously been used in the nursing turnover literature.

Methods

Data

We obtained detailed proprietary data from one of the five largest home health care organizations operating in the U.S., covering the period of January 2016 through March 2019. During this period, the organization operated in more than 30 states, managed over 200 home health agencies, which are also referred to as branches, and cared for hundreds of thousands of patients. Each branch services a specific geographic region (usually a city)

and maintains its own roster of full-time and part-time nurses. Scheduling is managed by each branch individually, while hiring and terminations are jointly decided by both branch management and the organization's corporate office.

The organization provided us with two types of data. First, we obtained human resources records which include, for all active employees in the organization between January 2016 and March 2019, the employee hiring date, termination date (if terminated), branch, position, promotions, transfers, age, and sex. Second, we obtained visit logs for all home health visits performed between January 2016 and March 2019, which identify the employee performing the visit, the visit start time, the visit length time, and the time spent traveling to the visit location.

We combined human resources records and visit logs to construct a panel dataset at the provider-day level. This dataset had unbalanced panels, with each nurse's panel ranging from the date of the first home health visit to either the nurse's separation date or March 31, 2019, whichever was earlier.

Sample Definition

To construct our data sample, we began by identifying RNs and LPNs (N = 7,398) among all field workers (N = 15,180). We then implemented several restrictions. First, because provider work logs were available beginning on January 1, 2016, we restricted our sample to nurses who were hired on or after that date (N = 4,877). Second, we kept each nurse's first employment spell with the company and excluded any subsequent employment spells, as the latter may look fundamentally different than the former (N = 4,817). Third, we restricted the sample to nurses who conducted at least one field visit over the course of their employment (N = 4,812). In effect, this excluded any administrative staff without clinical duties. We also excluded nurses working at branches that provided only hospice care (N = 3,872). Finally, we restricted our sample to nurses who did not shift across branches, disciplines (RN versus LPN), or contractual statuses (full-time versus part-time), so that we could assign each nurse to a single branch, discipline, and contractual status (N = 3,716).

Key Measures

To assess turnover, we used two measures of separation: voluntary separation and involuntary separation. The type of separation was directly identifiable from the data, which captured whether the nurse initiated the separation (voluntary separation) or not (involuntary separation). While we present summary statistics and trends for both types of separation, we focused our analyses on voluntary separation, as it comprises the predominant type of turnover and is the less desirable type of turnover in terms of efficiently maintaining a productive workforce.

We measured schedule volatility as the coefficient of variation (CV) of the number of visits per day over the past 28 days, where the CV is defined as the standard deviation divided by the mean. We used the CV to operationalize schedule volatility rather than the standard deviation because the CV is a normalized and unitless measure that accounts for differences across nurses in their baseline levels of visit volume. This measure has been used previously

to study schedule volatility in other contexts, including machine processing (De, Ghosh, and Wells, 1996) and outpatient appointment scheduling (Anderson et al., 2015).

We calculated the CV for each provider-day by dividing the standard deviation of the number of visits per day over the past 28 days for each nurse by the mean number of visits per day over the same period. We excluded days with zero visits from the calculations of means and standard deviations of visits per day over the past 28 days, which prevents regular days-off (usually Saturday and Sunday), vacations, and sick days, from affecting our schedule volatility measure. Our results were qualitatively robust to different measures of schedule volatility, such as the CV of the number of visits per week over the past 28 days, the number of hours worked per day over the past 28 days, and the number of visits per day over shorter versus longer time windows.

Analytic Approach

To estimate the relationship between schedule volatility and voluntary separation, we imposed two additional restrictions to the main sample to reduce bias in our estimations. First, we restricted the sample to nurses with at least 90 days of tenure with the organization. Newly hired nurses make fewer daily visits, gradually increasing their workload over the first two months of employment. This structured week-over-week increase mechanically translates into higher schedule volatility in the first three months of employment, when nurses are likelier to quit for numerous reasons, which may result in spurious correlation between schedule volatility and separations. In addition, we restricted the sample to nurses who worked in each of the past four weeks, since a nurse may stop field work for a number of weeks prior to officially terminating their position, which also would mechanically translate to higher schedule volatility.

To analyze the role of schedule volatility on voluntary separation, we estimated the following linear probability model:

$$Separation_{it} = \beta_0 + \beta_1 ScheduleVolatility_{it} + \beta_2 Tenure_{it} + \beta_3 Tenure_{it}^2 + monthXyear_t + \gamma_i + \epsilon_{it} \quad \#(1)$$

Here, $Separation_{it}$ equals 1 on the provider-day that the nurse voluntarily separates (i.e., quits), and equals 0 otherwise. The main independent variable of interest is $ScheduleVolatility_{it}$, which is defined above. We controlled for the length of the provider's tenure ($Tenure_{it}$) and its squared term $\left(Tenure_{it}^2\right)$, given a non-linear relationship between tenure and voluntary separation. For nurses with a short tenure (less than a year), an additional month of tenure has a large impact on their probability of turnover. As tenure increases, the differentiation between one month more (or less) of tenure becomes less significant.

We also employed a set of fixed effects to control for potential confounders. We included a month-year fixed effect, which accounts for seasonality in separation that might be correlated with schedule volatility (e.g., if both volatility and turnover are high around the holidays), and for any temporal shock that might affect both turnover and volatility across the entire organization (e.g., a new corporate policy relating to scheduling). We further

included a provider fixed effect, γ_i, which should absorb any time-invariant characteristic of the provider, including previous work experience, previous training, age, gender, and race. As each provider is associated with a single branch, the provider fixed effects also capture branch fixed effects, which account for time-invariant branch characteristics like geographic location, average patient acuity, average size of the branch, and state laws relating to home health care, among others. Finally, ϵ_{it} denotes the error term, which we clustered at the provider level.

We refrain from interpreting our results as causal (though our fixed effects allow us to rule out numerous potential confounders as sources of variation) as we are unable to control for time-varying provider-level unobservable variables that may be correlated with both schedule volatility and voluntary separation. For example, a provider's deteriorating health may affect their schedules through increased absenteeism, and may also lead to a voluntary separation.

We used a linear probability model as opposed to a non-linear model (e.g., probit or logit) because non-linear models perform poorly in the presence of multiple high-dimensional fixed effects (Fernández-Val, 2009), and since non-linear models offer little improvement over linear probability model when estimating marginal effects (Angrist & Pischke, 2008). As a complementary approach, we also estimated the following model that takes a linear-log functional form:

$$Separation_{it} = \beta_0 + \beta_1 \ln ScheduleVolatility_{it} + \beta_2 Tenure_{it} + \beta_3 Tenure_{it}^2 + monthXyear_t + \gamma_i + \epsilon_{it} \quad \#(2)$$

The linear-log model allowed us to describe the marginal effects of schedule volatility on the likelihood of voluntary separation in terms of percent change rather than in units of CV.

Results

Summary Statistics

We present summary statistics in Table 1. Our main sample comprised nearly 1.1 million provider-days across 1,573 full-time RNs, 813 full-time LPNs, 835 part-time RNs, and 495 part-time LPNs. On average, full-time RNs conducted 4.09 (SD=1.76) home health visits per day over the course of 4.77 (SD=2.10) hours, of which 3.34 (SD=1.46) hours were spent conducting visits and 1.51 (SD=0.91) hours were spent traveling between visits. Over the course of a week, full-time RNs conducted 17.91 (SD=7.66) home health visits, on average. In comparison, full-time LPNs conducted 5.52 (SD=2.08) visits per day over 6.16 (SD=2.19) hours, of which 4.22 (SD=1.59) hours were spent in visits and 1.96 (SD=0.96) hours were spent traveling between visits. Over the course of a week, full-time LPNs conducted 24.98 (SD=9.17) visits, on average. Part-time RNs and LPNs had fewer visits per day, hours per day, and visits per week than their full-time counterparts.

Turnover Among Nurses in Home Health

Overall, a much greater share of annual turnover was employee-driven (i.e., voluntary separation) as opposed to employer-driven (i.e., involuntary separation). On average, 27.14%

(SD=4.04 percentage points (pp)) of full-time RNs voluntarily separated from the company each year, whereas 4.25% (SD=0.80 pp) separated involuntarily (Table 1). For full-time LPNs, these figures were 20.15% (SD=2.69 pp) and 5.02% (SD=0.59 pp), respectively. Part-time RNs and LPNs each had slightly higher rates of voluntary separation and slightly lower rates of involuntary separation compared to their respective full-time counterparts.

In Figure 1, we provide a longitudinal view by showing the cumulative share of nurses separating from the company over the first 360 days of tenure with the company. We present the cumulative shares by provider type, in addition to differentiating between voluntary and involuntary separation. The cumulative probability of separating at the end of 360 days in Figure 1 was higher than the average annual separation rate reported in Table 1 because the former excluded nurses with tenures longer than one year whereas the latter included them. We found that, over the first 360 days of employment, a nurse's probability of separating was monotonically increasing with tenure, with a higher likelihood of separating over the first 180 days compared to the next 180 days; this pattern is more pronounced for voluntary separations than for involuntary separations.

Schedule Volatility Among Nurses in Home Health

Schedule volatility varied across the four provider types (Table 1). We found that part-time nurses had higher levels of schedule volatility, on average, compared to their full-time counterparts; the magnitude of the CV was approximately twice that of the full-time nurses. Specifically, the CV of 2.13 for part-time nurses indicates that the standard deviation of the number of visits that these nurses conducted over the last 28 days is 2.13 times higher than the average number of visits they conducted over the same time period. In comparison, full-time RNs had a CV of 1.00, which indicates that, for these nurses, the average number of visits and the standard deviation of the number of visits that they conducted over the last 28 days are equal. Within the same contractual status, RNs had slightly higher levels of schedule volatility, on average, compared to LPNs.

Given the granularity of our data, we were able to gain a deeper understanding of schedule volatility by reconstructing what a nurse's schedule looked like each day. In Panel 1 of Figure 2, we present an example of a work week of a full-time RN conducting home health visits. In this example, the nurse worked 5 days, which reflects the typical work-week arrangement for full-time RNs. On a given day of that week, the nurse had as few as 3 visits in a day and as many as 7 visits in a day. On 3 out of the 5 days worked, the first visit started before 9am; on one day (day 3), the first visit started around 10am. The last visit ended as early as 1:30pm on one day (day 5) to as late as 5:00pm on another (day 4). This example work week is representative of a typical week for many full-time RNs at the home health organization.

In Panel 2 of Figure 2, we take a broader perspective and examine a "year in the life" of three full-time RNs who belonged to the same branch. Here, we excluded weekend days with 0 visits, paid days off, and leaves of absence. Each of the three nurses (nurse A, B, and C) conducted a similar number of visits per day when averaged over the entire year (3.96 visits for nurse A, 3.92 visits for nurse B, and 3.47 visits for nurse C). However, they experienced different levels of schedule volatility, with nurses A and B experiencing lower

levels (CV=0.20 and 0.18, respectively), and nurse C experiencing a higher level (CV=0.31). The figures demonstrate that nurse A had a relatively stable number of visits per day for much of the year, with the exception of four weeks with lower-than-average numbers of visits, and two short spells of inactivity in early July and late September. A similar pattern emerges for nurse B, who had long periods of a relatively stable number of visits, punctuated by shorter periods of inactivity. By comparison, nurse C had a more volatile schedule, with weeks of high activity and low activity following one another throughout the year. Despite the volatile schedule of nurse C, the branch maintained a relatively stable number of visits per day over the course of the year; this can be seen in the bottom panel, which pools visits across nurses A, B, and C. The schedule volatility of full-time RNs at the branch level (CV=0.16) was lower than that of any of the individual nurses', which is consistent with the principles of pooling. Similar variations in schedules are observed among LPNs.

The Effect of Schedule Volatility on Nursing Turnover in Home Health

Table 2 presents our estimation results, with the sample stratified by provider type. Within each provider type, we present the results from estimating the linear model (first panel; equation (1)) and the linear-log model (second panel; equation (2)). The first column within each provider type shows the least restrictive model, including only month-year fixed effects; each subsequent model becomes more restrictive, first adding branch fixed effects and then adding provider fixed effects. Within each provider type, across both functional forms and all three degrees of restrictiveness, our results were highly consistent. For brevity, we focus our interpretation of specific coefficient estimates using the linear-log model with the most restrictive specification (third column within each provider type), which provides the most conservative estimates. In this specification, the model controls for any nurse-specific characteristics that might be correlated with both schedule volatility and a propensity to separate from the organization, as well as any organizational "shocks" to visit activity that might increase schedule volatility across all branches while also inducing nurses to quit.

Our estimation results show that for full-time RNs and LPNs, a higher level of schedule volatility was associated with a higher likelihood of voluntary separation. Specifically, the most restrictive models show that a 10% increase in schedule volatility over the past 28 days was associated with an increase of a full-time RN's probability of quitting on a given day by 0.0137 percentage points and a full-time LPN's probability of quitting that day by 0.0181 percentage points. For part-time RNs, schedule volatility was associated with a slightly higher likelihood of voluntary separation, with a 10% increase in schedule volatility over the past 28 days being associated with an increase of a part-time RN's probability of quitting on a given day by 0.0091 percentage points. Note, for this provider type, our results were only statistically significant in the most restrictive model and not when provider fixed effects were excluded. For part-time LPNs, schedule volatility was not significantly associated with a change in the likelihood of voluntary separation across both functional forms and all three degrees of restrictiveness.

To help interpret these results, we plotted the predicted hazard ratio of voluntarily separation for different values of schedule volatility, for both full-time RNs and full-time LPNs (Figure

3). We focus on the full-time nurses because these are the provider types for which we find consistent results that are both statistically and economically significant. The hazard ratio was defined as the predicted probability of voluntary separation as a function of schedule volatility, over the average probability of voluntary separation observed in the sample. We constructed the predicted probability of voluntary separation using our estimates from the linear-log model with provider- and month-year fixed effects, holding provider tenure fixed at the sample average.

As seen in Figure 3, full-time RNs in the 25th percentile of the schedule volatility distribution were 20% less likely to quit on a given day than the average nurse, while those in the 75th percentile were 16% more likely to quit. Nurses with extreme values of schedule volatility were more greatly affected, with RNs in the 5th percentile of the distribution being 40% less likely to quit than average, and RNs in the 95th percentile being 51% more likely to quit. For full-time LPNs, we found that nurses in the 25th percentile of the distribution were 42% less likely to quit than the average full-time LPN; those in the 75th percentile were 34% more likely to quit.

Using the marginal effects, we conducted a counterfactual analysis in which we estimated the effect of changing a nurse's schedule volatility from the 75th percentile of the distribution (quartile 3) to the 25th percentile of the distribution (quartile 1) for the duration of 1 year. For a full-time RN conducting an average of 4 visits per day, this would correspond to a reduction in the standard deviation of visits per day by 0.86 visits. We used the following approach to estimate the change in this nurse's probability of quitting (i.e., separate voluntarily):

$$\Pr(Quit\ in\ a\ given\ day|Q) = \Pr(Quit\ in\ a\ given\ day) \cdot f(hazard\ ratio|Q)$$

$$\Pr(Quit\ in\ a\ given\ year|Q) = 1 - (1 - \Pr(Quit\ in\ a\ given\ day|Q))^{365}$$

$$\Pr(Quit\ in\ a\ given\ year|Q3) - \Pr(Quit\ in\ a\ given\ year|Q1)$$

$$= 1 - (1 - 0.001 \cdot 0.80)^{365} - \left(1 - (1 - 0.001 \cdot 1.16)^{365}\right) = -9.2pp$$

In other words, we estimated that this reduction in schedule volatility from moving from the 75th percentile of the distribution to the 25th percentile of the distribution was associated with a 9.2 percentage point decrease in an average's full-time RN's probability of quitting. This accounts for approximately 20% of a full-time RN's propensity to quit within the first year of employment.

Discussion

This study used detailed administrative data from a multi-state home health care organization to examine the relationship between nursing turnover and schedule volatility. We found that over 30% of full-time RNs and roughly 25% of full-time LPNs left their position in a given year. Turnover rates were higher for part-time nurses than full-time nurses.

Nursing turnover in home health care may compromise patient care in a variety of ways, including reduced average experience of staff, increased inconsistency when implementing care plans, disruptions in the detection of complications, and less supervision and training (Thomas et al., 2013). If a nurse's turnover increases the workload of retained nurses, it could also result in shorter visits, which has been shown to increase hospital readmissions (Song, Andreyeva, & David, 2020). The relatively high separation rate in home health care compared to hospital settings may help explain mixed findings in the literature regarding the impact of home health care on total spending and hospital readmissions (Thomas et al., 2013; Polsky et al., 2014; Tian, 2016; Werner et al., 2019).

In our data, the vast majority of turnover was voluntary, which affords employers an opportunity to increase retention through changes in nurses' working environment (Mazurenko, Gupte, & Shan, 2015; Van der Heijden, Mahoney, & Xu, 2019). In this study, we focused on the role of scheduling—specifically schedule volatility, as measured as the coefficient of variation of the number of visits per day—and found that schedule volatility was positivity associated with turnover among full-time nurses, but was generally unrelated to turnover among part-time nurses. The differences between full-time and part-time nurses may stem from the fact that, while full-time nurses expect stable schedules throughout the work week, part-time nurses may desire and request a more flexible schedule. Hence, schedule volatility for full-time nurses appears more likely to be employer-driven while schedule volatility for part-time nurses is more likely to reflect employee preferences. These results suggest that, for full-time nurses, greater predictability and evenness in scheduling could be a valuable lever to mitigate nursing turnover, especially in the first 180 days of employment when the risk of voluntary separation is particularly high. This result is supported by a previous survey of home health nurses, who reported that flexibility and greater control over scheduling increased job retention (Ellenbecker, 2004).

Efforts to reduce schedule volatility can be costly, so trade-offs must be considered. For example, if home health care organizations and branches were to reduce schedule volatility by increasing handoffs, by relying more heavily on part-time nurses to help streamline schedules, or by paying less attention to matching patients and providers based on skill and personal characteristics, there may be discontinuities in care as well as a reduction in care quality (David & Kim, 2018).

While our data are unique in their level of detail, this study faced important limitations. First, the study sample included nurses from a single home health care organization. The organization had a large footprint across the U.S., but our findings may not generalize to other home health care organizations or to nurses in other health care settings. Second,

while branch-level fixed effects were included in most specifications, access to detailed branch-level characteristics was limited. Third, although nurses could be linked to individual patients, schedule volatility did not capture case complexity. Finally, we were only able to establish an association between schedule volatility and turnover, and it could be that turnover was contributing to schedule volatility (Castle & Engberg, 2006). This reverse causation is akin to a "loss cycle," where current turnover contributes to future turnover by increasing the workload and stress for remaining nurses (Halbesleben, 2010). To break out of these loss cycles, additional resource investment is needed, which may be difficult because Medicare's reimbursement of home health care is linked to the number of visits within an episode (MedPAC, 2018).

Despite these limitations, our study contributes to the robust nursing turnover literature, which has typically focused on hospital and nursing home settings, often relying on self-reported survey data. Nurses working in home health care have varied and dynamic schedules, which motivated a novel measure of schedule volatility that has not previously been used in the nursing turnover literature.

Another benefit of studying home health care is its expanding role in health care delivery —between 2001 and 2017, Medicare spending on home health care more than doubled (MedPAC, 2018). An aging population, technological advances, and patient preferences could increase demand for home health care in the future (MedPAC, 2018; Harris-Kojetin et al., 2019). For example, home-based acute care models, such as the Hospital at Home system, have been shown to be effective at cost containment, alleviating stress experienced by family members, and improving patient-level outcomes relative to traditional hospital care (Cryer et al., 2012; Frick et al., 2009; Howard et al., 2019; Leff et al., 2008). There are projections that home health will be more common due to COVID-19 outbreaks in nursing homes and other long-term care facilities (Grabowski & Joynt Maddox, 2020).

While demand for home health nurses appears robust, the same cannot be said for supply. Many nurses are nearing retirement and nursing shortages are projected in some regions of the country (Buerhaus et al, 2017; Auerbach, Buerhaus, & Staiger, 2017; American Association of Colleges of Nursing, 2020). Too few nurses coupled with a lack of experience could increase nursing turnover further, with some nurses opting to leave the profession altogether (Toh, Ang, & Devi, 2012; Mazurenko, Gupte, & Shan, 2015). Our results suggest that streamlined scheduling, a challenging operations practice in a tight reimbursement environment, may improve the retention of some nurses. These findings, along with prior research linking scheduling practices to nurses' intention to leave, also suggest that reducing schedule volatility can improve patient-level outcomes.

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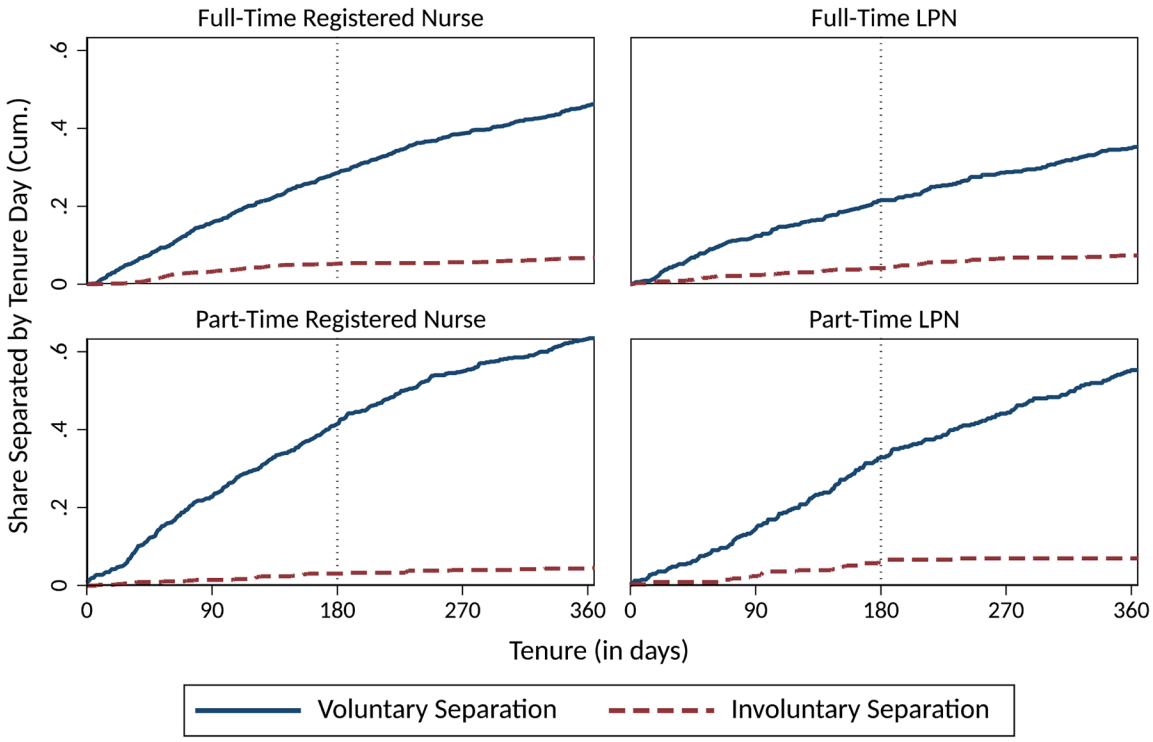
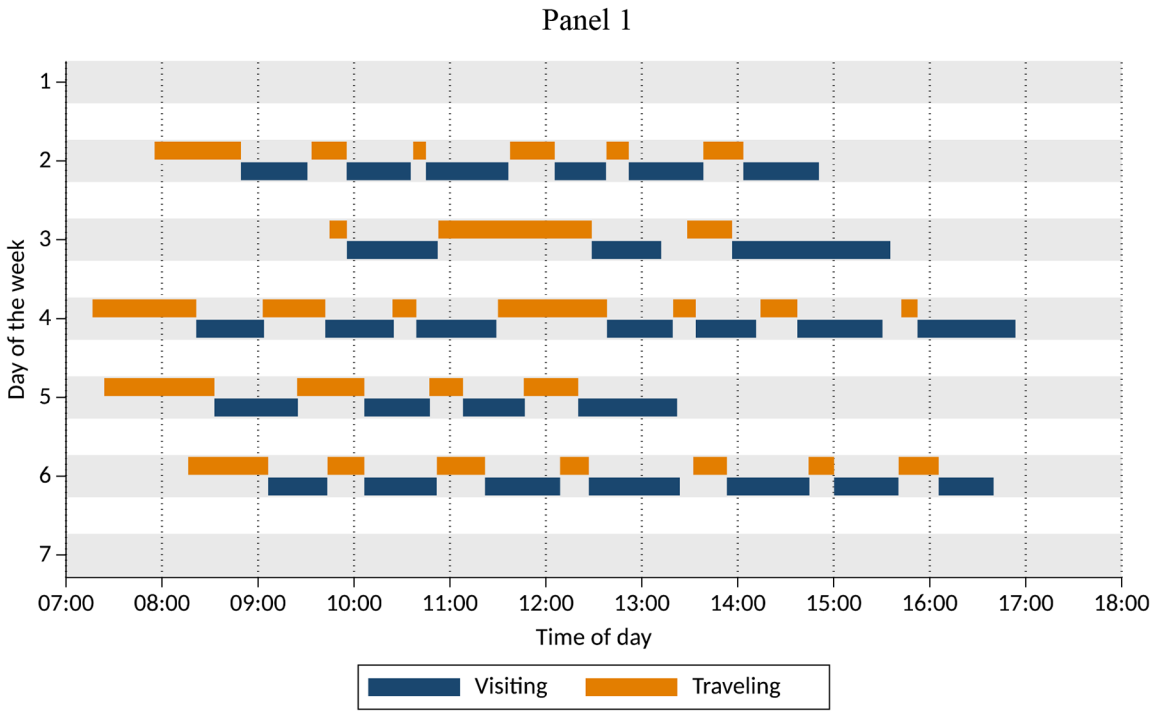


Figure 1:

Turnover in First 360 Days of Employment

Notes: Share of nurses separating, either voluntarily or involuntary, from the home health care organization over the course of the first year of work, by type of nurse (registered nurse or licensed practical nurse) and work arrangement (full-time or part-time).



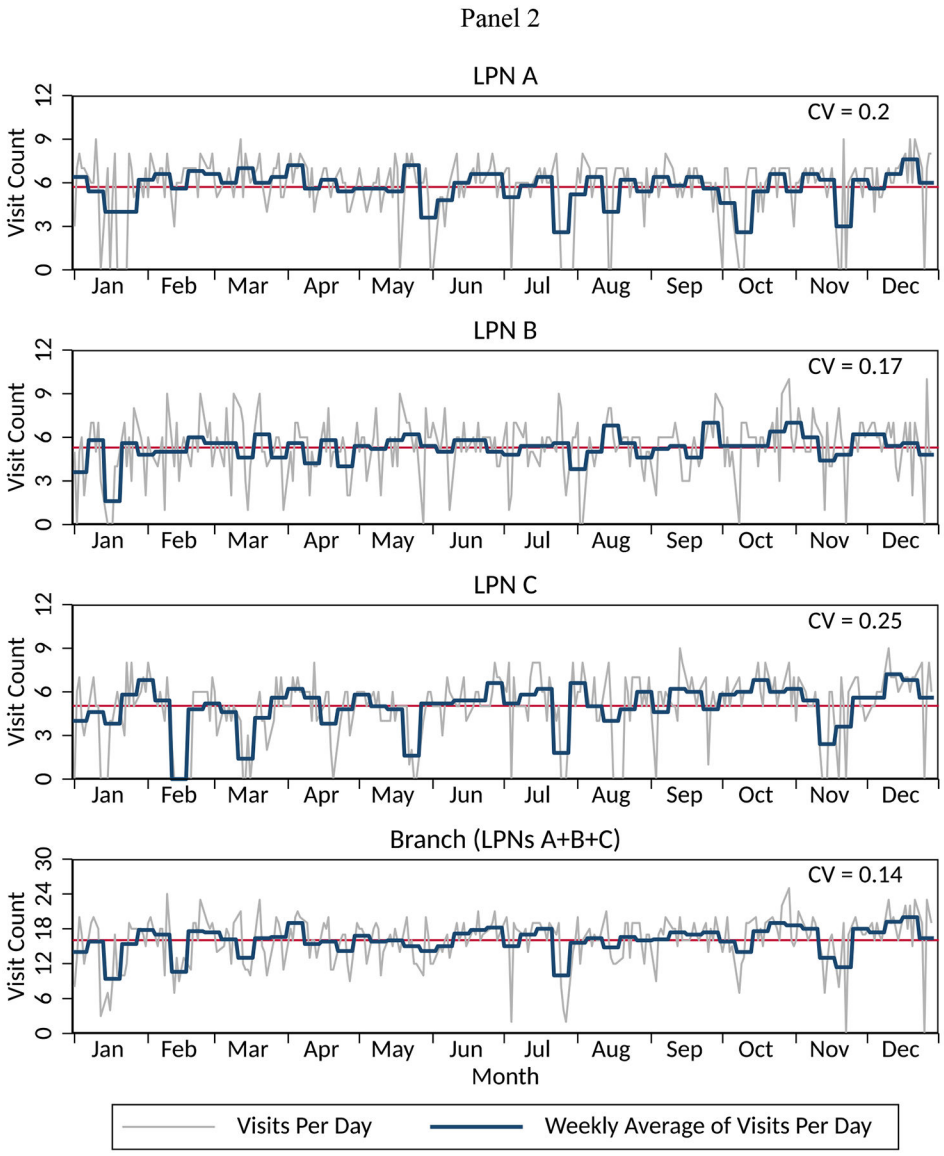


Figure 2:

Snapshot of One Week and One Year for a Full-time Registered Nurse

Notes: Time spent in home visits and traveling to patient homes over the course of one week for one full-time registered nurse, as recorded by company logs.

Notes: Coefficient of variation (CV) measures the standard deviation of the weekly average number of visits per day over the course of the year divided by its mean. The figure shows the count of visits per day (grey) and its weekly average (blue) over the course of a year for three full-time registered nurses (RNs) working at the same branch. The horizontal line (red) shows the mean of visits per day over the entire year. Weekend days with 0 visits, paid days off, and leaves of absence are excluded.

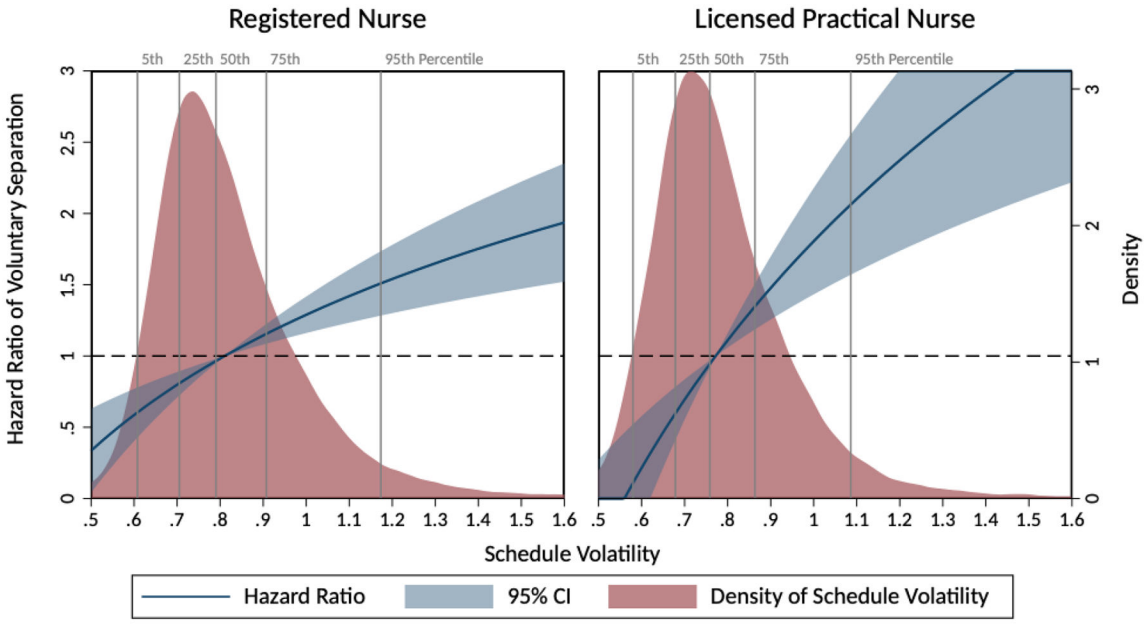


Figure 3:

Marginal Effect of Schedule Volatility on Voluntary Separations

Notes: The figures plots (a) the estimated hazard ratio of voluntary separation as a function of schedule volatility over the distribution of schedule volatility for both registered nurses (left panel) and licensed practical nurses (right panel); and (b) the schedule volatility distribution for both nurse types. Schedule volatility is measured as the coefficient of variation of the number of visits per day over the past 28 days.

Table 1:

Summary Statistics

		Full Time		Part Time	
		RN	**LPN**	**RN**	**LPN**
Work Characteristics					
Visits Per Day	Schedule Volatility	1.00	0.90	2.13	1.97
		(0.70)	(0.54)	(1.27)	(1.23)
	Visit Count	4.09	5.52	2.99	4.16
		(1.76)	(2.08)	(1.79)	(2.44)
Hours Per Day	Total Time	4.77	6.16	3.26	3.81
		(2.10)	(2.19)	(1.98)	(2.28)
	In-Visit Time	3.34	4.22	2.39	2.76
		(1.46)	(1.59)	(1.39)	(1.57)
	Travel Time	1.51	1.96	0.91	1.07
		(0.91)	(0.96)	(0.83)	(0.95)
Visits Per Week	Visit Count	17.91	24.98	6.28	9.85
		(7.66)	(9.17)	(6.34)	(9.63)
Provider Characteristics					
Average Annual Turnover	Voluntary	27.14	20.15	32.33	28.18
	Separation (%)	(4.04)	(2.69)	(4.18)	(7.66)
	Involuntary	4.25	5.02	2.88	3.77
	Separation (%)	(0.80)	(0.59)	(0.84)	(0.83)
Age at Hire Date (Years)		42.52	41.36	44.58	40.69
		(10.96)	(10.36)	(12.46)	(10.56)
Female (%)		89.51	90.28	80.72	82.22
Number of providers	Count	1,573	813	835	495
	Share (%)	42.33	21.88	22.47	13.32
Number of visits	Count	1,214,525	1,024,549	173,980	178,470
	Share (%)	46.87	39.53	6.71	6.89
Number of provider-days	Count	488,064	293,115	199,497	128,951
	Share (%)	43.98	26.42	17.98	11.62

Notes: RN = Registered nurse. LPN = Licensed practical nurse. Standard deviation in parentheses. Voluntary separation is defined as the average of the company-wide annual voluntary separation rates in years 2016 to 2019.

Table 2:

Effect of Schedule Volatility on Voluntary Separation

	Full Time RN			Full Time LPN			Part Time RN			Part Time LPN		
(a) Linear Model												
Schedule Volatility	0.00163**	0.00155**	0.00125**	0.00255**	0.00272**	0.00205**	0.000273	0.000424	0.000640*	0.000268	0.000478	0.00110
	(.000314)	(.000330)	(.000327)	(.000500)	(.000536)	(.000533)	(.000203)	(.000277)	(.000312)	(.000295)	(.000428)	(.000619)
Adj. R-squared	.00027	.00082	.03205	.00048	.00213	.01999	.00007	.00078	.01369	−.00014	.00084	.07226
(b) Linear-Log Model												
Ln(Schedule Volatility)	0.00183**	0.00179**	0.00137**	0.00229**	0.00250**	0.00181**	0.000374	0.000555	0.000905*	0.000246	0.000436	0.00103
	(.000298)	(.000321)	(.000314)	(.000402)	(.000435)	(.000430)	(.000249)	(.000344)	(.000400)	(.000281)	(.000408)	(.000566)
Adj. R-squared	.00031	.00086	.03206	.00049	.00214	.01998	.00007	.00077	.01370	−.00015	.00081	.07219
Fixed Effects:												
{Month, Year}	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Branch		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Provider			Yes			Yes			Yes			Yes
Observations	296,797	296,797	296,797	199,487	199,487	199,487	66,060	66,060	66,060	44,847	44,847	44,847
Providers	1,172	1,172	1,172	619	619	619	425	425	425	284	284	284
Sample Avg. Pr(Vol. Separation)	0.101	0.101	0.101	0.0587	0.0587	0.0587	0.0500	0.0500	0.0500	0.0535	0.0535	0.0535

Notes: RN = Registered nurse. LPN = Licensed practical nurse. Schedule volatility is defined as the coefficient of variation of the number of visits per day over the past 28 days. Each column reports the coefficient estimate of schedule volatility for both the (a) linear-linear model and the (b) linear-log model. The fixed effects listed in the column are included in the both linear-linear and linear-log models. The number of observations and providers is common across both linear-linear and linear-log models within a single column.

** p <0.01,

* p<0.05.