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# Individual Nurse Productivity in Preparing Patients for Discharge Is Associated With Patient Likelihood of 30-Day Return to Hospital

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**Objective:** Applied to value-based health care, the economic term “individual productivity” refers to the quality of an outcome attributable through a care process to an individual clinician. This study aimed to (1) estimate and describe the discharge preparation productivities of individual acute care nurses and (2) examine the association between the discharge preparation productivity of the discharging nurse and the patient’s likelihood of a 30-day return to hospital [readmission and emergency department (ED) visits].

**Research Design:** Secondary analysis of patient-nurse data from a cluster-randomized multisite study of patient discharge readiness and readmission. Patients reported discharge readiness scores; postdischarge outcomes and other variables were extracted from electronic health records. Using the structure-process-outcomes model, we viewed patient readiness for hospital discharge as a proximal outcome of the discharge preparation process and used it to measure nurse productivity in discharge preparation. We viewed hospital return as a distal outcome sensitive to discharge preparation care. Multilevel regression analyses used a split-sample approach and adjusted for patient characteristics.

**Subjects:** A total 522 nurses and 29,986 adult (18+y) patients discharged to home from 31 geographically diverse medical-surgical units between June 15, 2015 and November 30, 2016.

**Measures:** Patient discharge readiness was measured using the 8-item short form of Readiness for Hospital Discharge Scale (RHDS). A 30-day hospital return was a categorical variable for an inpatient readmission or an ED visit, versus no hospital return.

**Results:** Variability in individual nurse productivity explained 9.07% of variance in patient discharge readiness scores. Nurse productivity was negatively associated with the likelihood of a readmission (−0.48 absolute percentage points,  $P < 0.001$ ) and an ED visit (−0.29 absolute percentage points,  $P = 0.042$ ).

**Conclusions:** Variability in individual clinician productivity can have implications for acute care quality patient outcomes.

**Key Words:** individual productivity, nurses, readmissions

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Acute care nursing is a team-based practice whose value contribution has traditionally been inferred from the association of the quantity or quality of the nurse staffing with hospital-level or unit-level patient outcomes. As such, nurses are often measured in the aggregate as an input into the production of health care, by the number of nursing full-time equivalents, nurse hours per patient day, or by quality attributes including the proportion of baccalaureate-prepared nurses, skill mix, or years of average experience. A large body of evidence demonstrates associations of quantity and quality of the nursing input with patient outcomes, measured at the hospital-level and unit-level (eg, mortality rates, readmission rates, pressure ulcer rates).<sup>1–6</sup>

Aggregating the measurement and contribution of nurses, however, masks the underlying reality that no 2 nurses are alike, just as no 2 patients are alike and vary in their needs for nursing care. Each nurse uses a unique combination of education, experience, skills, communication proficiency, leadership, and other unmeasured attributes when providing care. Differences in these attributes are important and are likely associated with patient care outcomes, but our understanding of nurse-specific differences in patient outcomes is limited.

In economics, “individual productivity” encompasses the quantity and quality of an output or outcome attributable to an individual worker, and it is one of the key indicators of

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organizational efficiency and effectiveness.<sup>7-9</sup> Applied to value-based health care delivery, where the core product is quality patient outcomes, individual clinician productivity would be measured by the quality outcomes produced rather than the quantity of care provided. Health care resources are typically costly and, given the growth of health care expenditures, increasing attention is being devoted to using resources efficiently and effectively, to produce high-quality outcomes. Because nurses are high wage earners, comprise the largest portion of labor employed by health care organizations, and provide round-the-clock hands-on patient care, it is critical that an organization's nursing workforce is configured in ways that maximize productivity (quality outcomes) of this valuable human resource.

To a large extent, individual worker's productivity is determined by organizational culture, structure, and process factors like a positive work environment, workload and access to resources, and use of evidence-based practice.<sup>7-11</sup> However, there is also an individual-specific component that can make some individuals in an organization thrive where their colleagues might struggle. This individual-specific component is a combination of productivity-enhancing characteristics (eg, education, clinical experience, knowledge, clinical judgment)<sup>10,12</sup> and it can be isolated by examining variability in individual productivity among individuals within an organization.<sup>9</sup>

A handful of recent studies demonstrated an association of an individual patient's outcome with the individual nurses assigned to provide the patient's care.<sup>13-17</sup> Nurses who were prepared with baccalaureate degree and those with higher expertise levels tended to produce better patient outcomes.<sup>15-17</sup> In addition, patients assigned to these more highly productive nurses experienced greater clinical improvement, had shorter lengths of stay, incurred lower hospitalization costs, and were less likely to be readmitted.<sup>15</sup>

The amount of variability of clinician-level productivity within an organization can be considered a quality indicator that is independent of either a hospital-level or unit-level quality metrics.<sup>12,18</sup> Even in well-performing organizations, variability in individual clinician productivity means that some patients will inevitably be assigned to clinicians who produce better patient outcomes, and others will be assigned to clinicians who produce poorer outcomes, increasing the patients risk of an adverse outcome. Moreover, the detriment associated with variable clinician productivity could be further amplified in poorly performing units. In this era of value-based health care, the time has come to focus greater attention to understanding and improving individual clinician productivity.

## SPECIFIC AIMS AND HYPOTHESES

We used a large multihospital data set from a cluster-randomized clinical trial of a discharge readiness intervention<sup>19</sup> to study the association of nurse productivity with patient outcomes. The study had 2 specific aims:

- (1) To estimate and describe the discharge preparation productivities of individual nurses. Hypothesis 1: There will be significant differences among nurses in their individual productivity levels, as measured by risk-adjusted scores on

the Readiness for Hospital Discharge Scale (RHDS) of their assigned patients.

- (2) To examine the association between the discharge preparation productivity of the discharging nurse and the patient's likelihood of a postdischarge return to hospital [readmission and emergency department (ED) visits]. Hypothesis 2: In a separate sample, patients assigned for discharge preparation care to higher-productivity nurses (identified aim 1 analysis) will have a lower likelihood of a postdischarge return to hospital than patients assigned to lower-productivity nurses.

## METHODS

### Conceptual Framework

Our conceptual framework is guided by the Donabedian structure-process-outcome model<sup>20</sup> and the Irvine nursing role effectiveness model.<sup>21</sup> Adopting the structure-process-outcome model,<sup>20</sup> we examined patient outcomes (readiness for discharge, readmissions, and ED visits) in relation to the process of discharge preparation. Discharge teaching is a key component of discharge preparation as it covers aspects of postdischarge recovery, from disease-specific self-care, to medication management, contacting the health care team for emerging problems, and other strategies to avoid serious complications during the postdischarge period that may require a repeat admission.<sup>22</sup> Discharge teaching is a primary function of acute care nurses throughout hospitalization, but it occurs most intensively in the period immediately before discharge by the discharging nurse.<sup>22</sup> We viewed readiness for hospital discharge as a proximal outcome of the discharge preparation process and used it to measure nurse productivity in discharge preparation. We viewed readmissions and ED visits as distal outcomes sensitive to discharge preparation care.<sup>22</sup> The sequential path of influence is supported by evidence: patients who receive higher quality discharge teaching are more ready for discharge at the end of hospitalization, experience fewer coping difficulties during the postdischarge period, and are less likely to return to the hospital.<sup>23,24</sup> The nursing effectiveness model<sup>21</sup> allowed us to link a patient's level of discharge readiness on the day of discharge to each of the patient's direct care nurses through the nurses' independent roles (own effort in preparing a patient for discharge) and dependent and interdependent roles (as part of the patient's clinical care team) (Supplementary Fig. A, Supplemental Digital Content 1, <http://links.lww.com/MLR/B827>).

### Research Design

We conducted a secondary analysis of data collected for the READI (Readiness Evaluation And Discharge Interventions) study.<sup>19</sup> The parent study was a multihospital cluster-randomized clinical trial to test the impact of unit-based implementation of a discharge readiness assessment intervention on readmission and ED use. The sample included adult (18+) patients discharged to home from general medical, surgical, or combined medical-surgical units. Thirty-one US hospitals and 2 Saudi Arabian hospitals, all with Magnet designation, participated in the study between October 2014 and March 2017. Although Saudi Arabian health care system is largely nationalized, the 2 Magnet-designated Saudi hospitals in the READI study were not affiliated

with the Saudi Ministry of Health and had a decentralized independent general organization similar to US hospitals.<sup>25</sup> Each study hospital contributed 2 units that were randomly assigned to intervention and usual care control conditions. The READI intervention had 3 phases: in phase 1 nurses were required to conduct a formalized assessment of patient discharge readiness before discharge, in phases 2 and 3 nurses were required to also obtain patients' self-reported readiness assessments before conducting own assessment. Throughout the intervention, nurses were instructed to use their best judgment with the assessment information to guide actions in completing their patients' preparation for discharge.

For this study, we used data from READI intervention units where patient self-assessment of discharge readiness was implemented as a component in phases 2 and 3 of the READI study. At each study site, each phase consisted of 4 months of data collection during the period between June 2015 and March 2016. Deidentified nurse code numbers linked to the patients' readiness for discharge assessments were collected from 32 intervention units. One US hospital did not provide nurse codes and was excluded. The nurse code numbers were provided by each patient's discharging nurse only; therefore we do not have information about other nurses who provided care for the patient before the day of discharge.

## Sample

Ninety-five percent of all eligible nurses participated in training for the READI study, and 86% provided their assigned deidentified code for at least 1 patient. The READI phase 2 and 3 data include 1,775 nurses and 35,629 patient discharges. We excluded 385 nurses who discharged fewer than 10 patients during phase 2, and we excluded 247 float nurses and 3 Licensed Practical Nurses; we also excluded 4,382 patients discharged by these nurses.

Analyses for aim 1 (estimating individual nurse productivities) used an estimation sample and a validation sample. The estimation sample included 522 registered nurses linked to 18,903 patients discharged during phase 2, and the validation sample included 471 of the 522 nurses (10% loss to follow-up) linked to 13,244 patients discharged during phase 3. Analyses for aim 2 (testing the association of the individual nurse productivity variable with return hospital visits) used the nurses' productivity estimates from the estimation sample linked to the outcomes and characteristics of phase 3 patients in the validation sample. Aim 2 excluded 2161 short (<48 h) hospitalizations owing to an expected small effect size on the basis of their low readmission rate of 6.8%.

The sample had >99% power at <5% significance for detecting small (0.02  $f^2$ ) effect sizes for the 522 individual nurse effect sizes in aim 1 and 80% power for detecting a 1 percentage point change in ED visits and readmissions for a 1 unit change in individual nurse productivity aim 2.<sup>26</sup>

## Outcomes and Measures

The primary patient outcomes were patient discharge readiness (aim 1) and postdischarge return to hospital (aim 2) (Table 1, Supplementary Table 1, Supplemental Digital Content 2, <http://links.lww.com/MLR/B828>). We measured *patient discharge readiness* using the RHDS. RHDS is a patient

self-assessment of readiness for hospital discharge typically completed within 4 hours before discharge. The 8-item RHDS uses a 0–10 scale with higher scores indicating greater readiness. The RHDS has undergone rigorous testing, providing evidence for acceptable reliability in adult medical-surgical patients, construct validity, and predictive validity for postdischarge utilization.<sup>23,24,27,28</sup> We measured the second outcome, *postdischarge return to hospital*, as a categorical variable taking 3 values: "Readmission" if a patient had at least 1 readmission with inpatient status during 30 days postdischarge; "ED," if a patient had at least 1 ED visit during 30 days postdischarge without being readmitted with the "inpatient" status; and "None" if a patient did not have a record of ever returning to the hospital during 30 days postdischarge. We combined patients who were readmitted for observation (short stay <23 h, outpatient-in-bed) but not with the inpatient status within 30 days postdischarge in the "ED" category. The postdischarge utilization data were provided by the study hospitals and did not include readmissions and ED visits outside of the study hospital. We assigned each patient to only 1 postdischarge return to hospital.

The main predictors were individual nurse fixed effects (aim 1) and individual nurse discharge preparation productivity (aim 2). A nurse fixed effect is a 0/1 index variable with the value of 1 uniquely identifying a nurse. Individual nurse discharge preparation productivity was defined as the risk-adjusted average patient RHDS score among patients discharged by each nurse. Higher adjusted average readiness for discharge among a nurse's patients indicated higher individual discharge preparation productivity of the nurse.

## Statistical Analysis

We used multilevel (patient, nurse, hospital unit) regression modeling. All analyses were adjusted for patient characteristics (listed in Table 1) and unit fixed effects. We adjusted for clustering at the unit level (aim 1) and at the nurse and unit level (aim 2) and implemented a finite population adjustment at the nurse level in both aims. We tested the coefficients using a 2-tailed significance test at the 0.05 level. We conducted all analyses in Stata 15.1.

### Aim 1

To estimate and describe individual nurse discharge preparation productivities, we used the estimation sample to estimate a linear regression model of the patients' RHDS scores as the dependent variable on the nurse fixed effects as predictors, adjusting for unit fixed effects and patient characteristics. The regression coefficient estimates of the nurse fixed effects measured nurse-specific deviations in their assigned patients' adjusted RHDS scores relative to the average patient on the nursing unit.

We jointly tested the nurse fixed effect coefficients using Cohen  $f$ -squared<sup>26</sup> and examined the proportion of variance in RHDS attributable to the nurse effects independent of the unit effects and patient characteristics. We then calculated each nurse's productivity as the nurse's individual fixed effect coefficient plus the predicted average RHDS on the nurse's unit and examined the properties of the sampling distribution of the individual productivity variable (mean, median, SD, skewness, kurtosis, interdecile range, and Kolmogorov-Smirnov test of normality).

**TABLE 1.** Descriptive Statistics, by Study Aim

Variables	n (%)	
	Aim 1 18,903 Patients in Phase 2 (522 Nurses)	Aim 2 11,083 Patients in Phase 3 (471 Nurses)
<b>Outcomes</b>		
PTRHDS		
Mean (SD)	8.39 (1.47)	8.55 (1.37)
30-day postdischarge outcomes		
None	NA (NA)	8568 (77.3)
ED/OBS	NA (NA)	1037 (9.4)
Readmission	NA (NA)	1478 (13.3)
<b>Predictors</b>		
Individual nurse effects*		
522 nurse effects	10–50 (0.1–0.48)	NA (NA)
Individual nurse productivity		
Mean (SD)	NA (NA)	8.4 (0.68)
Low (4.41–8.21)	NA (NA)	3999 (36.1)
Medium (8.32–8.59)	NA (NA)	3511 (31.7)
High (8.59–9.93)	NA (NA)	3573 (32.2)
<b>Controls</b>		
Patient sex		
Male	9241 (48.9)	5474 (49.4)
Female	9662 (51.1)	5609 (50.6)
Patient age		
Mean (SD)	59.2 (17.6)	59.7 (17.5)
Patient race		
American Indian or Alaska Native	206 (1.1)	103 (0.9)
Asian	596 (3.2)	340 (3.1)
Black or African American	2445 (12.9)	1450 (13.1)
Native Hawaiian or other Pacific Island	63 (0.3)	23 (0.2)
White	12,603 (66.7)	7022 (63.4)
Unknown	2990 (15.8)	2145 (19.4)
Patient ethnicity		
Non-Hispanic	15,594 (82.5)	8620 (77.8)
Hispanic	3272 (17.3)	2006 (18.1)
Unknown	37 (0.2)	457 (4.1)
Patient marital status		
Not married	8292 (43.9)	4528 (40.9)
Married	8830 (46.7)	5286 (47.7)
Unknown	1781 (9.4)	1269 (11.5)
Patient insurance <sup>†</sup>		
Private	5715 (30.2)	3039 (27.4)
Medicare	7283 (38.5)	4383 (39.6)
Medicaid	2623 (13.9)	1377 (12.4)
Uninsured	432 (2.3)	256 (2.3)
Other	2850 (15.1)	2028 (18.3)
Length of hospital stay		
Mean (SD)	4.56 (4.9)	6.14 (6.07)
Patient had an ICU stay		
No	15,659 (82.8)	58,262 (82.9)
Yes	3244 (17.2)	12,001 (17.1)
Patient MDC		
Nervous system	1056 (5.6)	574 (5.2)
Eye	17 (0.1)	17 (0.2)
ENT	251 (1.3)	125 (1.1)
Respiratory	2249 (11.9)	1515 (13.7)

(Continued)

**TABLE 1.** Descriptive Statistics, by Study Aim (continued)

Variables	n (%)	
	Aim 1 18,903 Patients in Phase 2 (522 Nurses)	Aim 2 11,083 Patients in Phase 3 (471 Nurses)
Circulatory	2977 (15.8)	1840 (16.6)
Digestive	2784 (14.7)	1607 (14.5)
Hepatobiliary & pancreatic	1072 (5.7)	593 (5.4)
Musculoskeletal	1208 (6.4)	517 (4.7)
Skin & subcutaneous	567 (3)	342 (3.1)
Endocrine & metabolic	1087 (5.8)	418 (3.8)
Kidney & urinary	1135 (6)	680 (6.1)
Female reproductive	92 (0.5)	47 (0.4)
Female reproductive	275 (1.5)	119 (1.1)
Pregnancy	92 (0.5)	44 (0.4)
Blood & immunological	343 (1.8)	205 (1.9)
Meloproliferative DD	68 (0.4)	41 (0.4)
Infectious & parasitic DD	1306 (6.9)	985 (8.9)
Mental	28 (0.2)	21 (0.2)
Alcohol & drug	251 (1.3)	150 (1.4)
Injury, poison, & toxin	271 (1.4)	142 (1.3)
Multiple trauma	37 (0.2)	30 (0.3)
HIV	43 (0.2)	18 (0.2)
Transplants	44 (0.2)	34 (0.3)
Unrelated	87 (0.5)	81 (0.7)
Other	757 (0.5)	47 (0.4)
Missing	1412 (7.5)	891 (8)
Patient type of service		
Medical	69 (68.8)	7658 (69.1)
Surgical	5225 (27.6)	3006 (27.1)
Unknown	673 (3.6)	419 (3.8)
DX coding system		
ICD10	14,128 (74.7)	10,259 (92.6)
ICD9	4506 (23.8)	716 (6.5)
Missing	269 (1.4)	108 (1)
Patient had a hospitalization prior 30 d		
No	13,850 (73.3)	8165 (73.7)
Yes	2308 (12.2)	1529 (13.8)
Unknown	2745 (14.5)	1389 (12.5)
Patient's Elixhauser Comorbidity Index		
Mean (SD)	7.17 (8.75)	7.72 (8.5)

\*"NA" means that the variable was not used in the analyses for the aim.

\*N, % patients discharged by each nurse are shown in the Supplementary Table DS.1 (Supplemental Digital Content 2, <http://links.lww.com/MLR/B828>).

<sup>†</sup>Reported for US hospitals only, coded as "Other" for Saudi hospitals.

DD indicates diagnoses and diseases; ED, emergency department; ICU, intensive care unit; MDC, major diagnostic category; OBS, observation stay; PTRHDS, patient readiness for hospital discharge score.

For cross-validation analysis, we obtained a second set of productivity estimates for the nurses, this time using the validation sample linked to the same nurses, and we examine concordance between the estimation and the validation set of

independently obtained productivities using a scatterplot and a simple correlation coefficient. If productivity effects are nurse specific and not spurious, they should be robust when estimated using different patient samples.

## Aim 2

To test the association between individual nurse productivity and patient likelihood of a return hospital visit, we estimated a multinomial logistic model of a patient's log-odds of readmission or ED visits on the patient's assigned discharging nurse's individual productivity as the predictor. We regressed return to hospital (readmission, ED visit) from phase 3 patients on their discharging nurse's productivity estimate (from aim 1 using phase 2 readiness data). We modeled each relationship with both a continuous productivity variable and a categorical High/Medium/Low variable for the tertiles of the continuous productivity variable to examine a dose-response relationship. If the discharging nurse's productivity affects a patient's readiness for discharge and postdischarge outcomes (readmission and ED visits), we expect a statistically significant coefficient of the productivity variables for the outcome variable, and a greater effect on postdischarge return to hospital in patients discharged by high-productivity nurses than in patients discharged by medium-productivity nurses.

We conducted 3 sensitivity analyses. First, we tested the observable patient characteristics as predictors of the assigned nurse's individual productivity to ascertain if non-random assignment of patients to nurses can bias the results. In the second sensitivity analysis, we restricted the sample to 3527 patients who were assigned to the same nurse on the day of and the day before discharge. Lastly, we examined the robustness of the results to excluding the 2 Saudi hospitals.

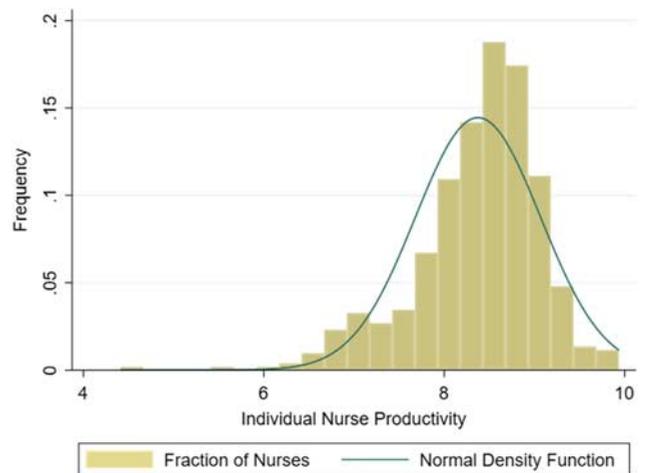
## RESULTS

### Descriptive Statistics

The patient sample was representative of adult medical-surgical patients (59 y old, 51% female individuals). The average patient's RHDS was close to 8.5, consistent with prior work in similar patient populations.<sup>19,22,23,27,28</sup> Approximately 13% of patients were readmitted during the 30 days postdischarge (Table 1).

### Aim 1

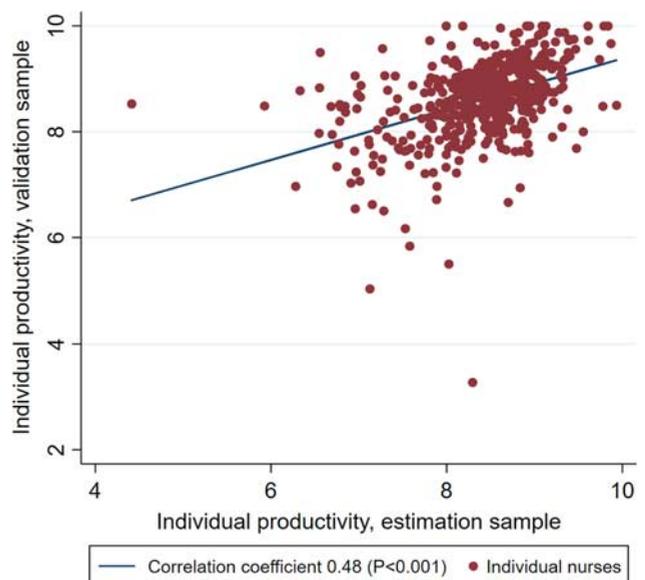
Nurse fixed effects on patient RHDS had a Cohen  $f$ -squared of 4.62 ( $P < 0.001$ ) and independently explained 9.07% of variance in patient-level RHDS scores in the adjusted model (patient characteristics explained 5.44% of the variance, and unit fixed effects explained 3.53%) (Figs. 1, 2). Productivities had a mean of 8.38 (SD = 0.69), a median of 8.51, and an interdecile range of 1.673 points (from 7.424 to 9.097). The frequency distribution of productivities was moderately skewed (skewness = -1.1), had a sharp peak (kurtosis = 5.51), and was significantly different from the Normal distribution (K-S distance = 0.0841,  $P = 0.001$ ) (Fig. 1). The correlation between the productivities between the estimation and validation samples was 0.48 (SE = 0.05,  $P < 0.001$ ) (Fig. 2).



**FIGURE 1.** Frequency distribution of individual nurse productivities (Estimation sample). Productivity is the adjusted average discharge readiness of patients discharged by a nurse. Source: Authors' analyses of the READI data.

### Aim 2

Using the continuous productivity variable, 1 SD (0.69 points) was associated with a 0.48 ( $P < 0.001$ ) absolute percentage points (app) reduction in the likelihood of a readmission and a 0.29 app ( $P = 0.04$ ) reduction in the likelihood of an ED visit (Table 2). Using the categorical productivity variable, relative to patients discharged by "Low" productivity nurses, patients discharged by "Medium" productivity nurses had a 2.44 ( $P < 0.001$ ) app reduction in ED visits without a readmission and a nonsignificant change in readmissions; patients discharged by "High" productivity nurses had a 0.86 ( $P < 0.001$ ) app reduction in



**FIGURE 2.** Cross-validation of individual productivity estimates (Estimation and validation samples). Productivity is the adjusted average discharge readiness of patients discharged by a nurse. Source: Authors' analyses of the READI data.

**TABLE 2.** Association of a Patient’s Likelihood of Postdischarge Outcomes With Individual Nurse Productivity in Discharge Preparation (11,083 Patients, 741 Nurses)

	30-Day Return to Hospital	
	ED Visit	Readmission
Model with a continuous nurse productivity variable		
Absolute likelihood change	-0.29*	-0.48**
SE	0.14	0.10
95% CI	-0.57, -0.01	-0.68, -0.28
Model with a categorical nurse productivity variable		
Low productivity [omitted category]	NA	NA
Medium productivity		
Absolute likelihood change	-2.45**	0.60
SE	0.40	0.38
95% CI	-3.24, -1.66	-0.13, 1.34
High productivity		
Absolute likelihood change	-0.47	-0.86**
SE	0.35	0.28
95% CI	-1.15, 0.21	-1.40, -0.32

Shown are the estimated absolute percentage point changes in a patient’s likelihood of a 30-day return to hospital for an emergency department (ED) visit and readmission associated with an increase in the individual discharge preparation productivity of the discharging nurse. The estimates were obtained from a patient-level multinomial logistic regression model of the return to hospital outcome on individual nurse productivity adjusted for patient characteristics, unit fixed effects, and data clustering at the unit and nurse level. In the top panel, individual nurse productivity is modeled as a continuous range variable scaled to represent a 1 SD (0.69 points on the Readiness for Hospital Discharge scores) change. In the bottom panel, individual nurse productivity is modeled as a categorical variable for the tertile of the individual nurse productivity distribution.

CI indicates confidence interval; ED, emergency department; NA, not applicable.

\**P* < 0.05.

\*\**P* < 0.01.

readmissions and nonsignificant change in ED visits without a readmission.

In sensitivity analyses (Supplementary Tables DS. 2–4, Supplemental Digital Content 2, <http://links.lww.com/MLR/B828>), older age and having a previous hospitalization within 30 days before admission were the only 2 patient characteristics significantly associated with higher productivity of the assigned nurse. The association of productivity with outcomes was twice as high in the subsample of patients assigned to the same nurse on the last 2 hospitalization days. Results were robust to excluding Saudi hospitals.

## DISCUSSION

The study demonstrated a robust pattern of outcome variability among nurses: individual nurse effects explained almost 10% of patient-level variability in readiness for hospital discharge, independent of unit-level effects and patient characteristics. Patients of higher productivity nurses were less likely to return to the hospital for either a readmission or an ED visit. Relative to patients of nurses in the low productivity group, patients discharged by medium productivity nurses had a lower likelihood of an ED visit without a readmission (but a similar likelihood of readmission) while patients of nurses in the high-productivity group were less likely to be readmitted, supporting a pattern of reduced postdischarge hospital utilization with higher individual nurse productivity. The 0.86 app risk differential in adjusted readmission likelihoods between patients discharged by low productivity nurses (12.6), versus high productivity nurses

(13.4) represented a 7% relative readmission risk increase attributable solely to variability in individual nurse productivity in discharge preparation. It is, therefore, the responsibility of each health care system to not only strive for high organizational performance, but to also monitor and address clinician-level variability.

Under the Affordable Care Act, outcome-based performance measures, like individual productivity, are emerging as the gold standard of provider performance measurement.<sup>29–32</sup> Outcome-based measures have several advantages over process-based measures—they are more specific (presence of a process may not imply good quality), more difficult to manipulate (process compliance is easier to demonstrate than a true improvement in quality), and encourage novel care processes to improve quality of care.<sup>33</sup> In the nursing profession, performance is typically evaluated as a process-based measure devoid of a link to patient outcomes and most commonly by manual audits (chart reviews or direct observation).<sup>32</sup> The value of an individual nurse as a care provider is largely based on nurse manager case-by-case evaluation, portfolio review, or inferred from a nurse’s internal and external certifications.<sup>32,34–36</sup> Evidence of variability in individual nurse productivity in discharge preparation can allow for future development of quantitative productivity metrics that would be outcome-based, data-driven, and free of subjectivity bias.<sup>18,32,37</sup>

We must be cautious in measuring and interpreting individual clinician productivity. As a measure of quality outcomes, productivity is not intended to measure individual attributes and characteristics like skill, aptitude, or motivation. Low productivity must not, therefore, be approached by organizations punitively as a “bad apple” problem—rather, a positive organization will view clinician-level variability as a source of strength and an opportunity to learn from one another in an atmosphere of open communication, trust, and mutual respect. For promoting high organizational efficiency and quality outcomes within an organization, learning about individual clinician practices that do not work could be just as informative as learning about practices that do work. Second, we must recognize that many health care professions contribute to a patient’s outcome. Through a nurse’s direct, dependent, and interdependent roles, individual nurses’ productivities are integral to the overall productivity of the care team. Isolating the contributions of nurses from other types of clinicians is methodologically complex; it is even more challenging to further isolate the contributions of individual nurses. Yet it is an important scientific endeavor, given the cost of health care and nurses’ unique opportunity to influence patient outcomes.

The study had several limitations. First, nurses were not randomly assigned to patient care, limiting causal inference. Although we controlled for an extensive set of patient characteristics, data on patient’s socioeconomic background (income, education, health literacy) were not available, thus possibly leading to residual selection bias in nurse productivity estimates. However, sensitivity analyses were consistent with priority assignment of higher-productivity nurses to higher-acuity patients, which was also the case in earlier work in this area,<sup>13,15,16,38</sup> suggesting that the selection bias likely underestimated effect sizes. Second, we do not have information on all nurses and other providers who may have

contributed to a patient's discharge readiness. Sensitivity analyses produced stronger results when nurse productivity over 2 last hospitalization days was observed, suggesting that an attenuation bias from not observing the entire productivity dose is also likely to result in understated effect estimates. Lastly, although the study used a multisite geographically diverse nondisease/condition-specific patient sample, generalizability is limited due to selection of Magnet hospitals.

Uncovering the contributions of individual clinician productivity to overall quality of patient care is a necessary next step in advancing the science of value-based care delivery. As value-based payment and care delivery systems evolve, it will become increasingly important for hospitals, policy makers, and educators to shift their views of nurses away from a replaceable input whose cost are to be minimized toward a view that recognizes nurses as individual providers contributing to value by producing desired quality outcomes while constraining costs. Some nurses will be more productive relative to others in producing quality and value.

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