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Clinician Care Team Composition and Health Care Utilization

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Abstract

Objective: To test the hypothesis that a greater proportion of physician time on primary care teams are associated with decreased emergency department (ED) visits, hospital admissions, and readmissions, and to determine clinician and care team characteristics associated with greater utilization.

Patients and Methods: We retrospectively analyzed administrative data collected from January 1 to December 31, 2017, of 420 family medicine clinicians (253 physicians, 167 nurse practitioners/physician assistants [NP/PAs]) with patient panels in an integrated health system in 59 Midwestern communities serving rural and urban areas in Minnesota, Wisconsin, and Iowa. These clinicians cared for 419,581 patients through 110 care teams, with varying numbers of physicians and NP/PAs. Primary outcome measures were rates of ED visits, hospitalizations, and readmissions.

Results: The proportion of physician full-time equivalents on the team was unrelated to rates of ED visits (rate ratio [RR] = 0.826; 95% confidence interval [CI], 0.624 to 1.063), hospitalizations (RR = 0.894; 95% CI, 0.746 to 1.072), or readmissions (RR = −0.026; 95% CI, 0.364 to 0.312). In separate multivariable models adjusted for clinician and practice-level characteristics, the rate of ED visits was positively associated with mean panel hierarchical condition category (HCC) score, urban vs rural setting, NP/PA vs physician, and lower years in practice. The rate of inpatient admissions was associated with HCC score, and 30-day hospital readmissions were positively associated with HCC score, lower years in practice, and male clinicians.

Conclusion: Care team physician and NP/PA composition was not independently related to utilization. More complex panels had higher rates of ED visits, hospitalization, and readmissions. Statistically significant differences between physician and NP/PA panels were only evident for ED visits.

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The potential impact of primary care team composition, personnel and ratios, on health care utilization and cost is not fully understood. Health care costs in the United States have risen at a pace consistently higher than inflation over the last decade and now account for 17.9% of the gross domestic product.[1] The United States spends far more on health care than other high-income countries, with spending levels that rose continuously over the past 3 decades.[1] Utilization and pricing of health care services are the primary drivers of cost in health care.[2] In particular, decreasing emergency department (ED) visits, hospital utilization, and readmissions have been identified as opportunities to drive down the cost of care.[3] A robust and integrated primary care system has been shown to decrease utilization and cost.[4,5] The impact on utilization and cost based on the type of clinician (physician, nurse practitioner [NP], physician assistant [PA]) has been studied,[6-8] with variable results with regard to quality outcomes and utilization. What is less clear is the impact of the clinician composition of the primary care team on utilization of health care services.

With the current and projected shortage of primary care physicians, NPs and PAs are assuming an increased role in health care;[7,9,10] NPs and PAs have demonstrated similar quality of care as physicians,[11] although their impact on health care utilization is less certain.[8,12,13] The difference in education and training of physicians, NPs, and PAs provide each group with unique skills to enhance the functioning and effectiveness of the care team.

Regardless of clinician type, the overall efficiency of the care team is improved when the team is designed for all to be working to the full extent of their licensure and training.[14,15] Further, burnout is decreased with increased team efficiency[16] and with an increased proportion of physician relative to NP and PA staffing on the care team.[17]

Our primary objective was to test the hypothesis that a higher proportion of physician full-time equivalent (FTE) on care teams would be associated with decreased ED visits, hospital utilization, and readmissions of empaneled patients. Secondary objectives were to determine if these utilization measures differed between physician and NP/PA panels and to identify individual clinician and care team characteristics associated with greater utilization. By using individual clinician, panel, and care-team characteristics such as complexity and rural status, we aim to see if there are patient level statistics that could identify differences in outcomes between care provided by physicians and NPs/PAs. This, in turn, could be modifiable to drive down utilization and cost.

PATIENTS AND METHODS

Setting

We studied 420 family medicine physicians, NPs, and PAs employed by a single integrated health system in 59 different midwestern communities serving rural and urban areas in southern Minnesota, western Wisconsin, and northern Iowa, as previously described.[17,18] Specifically, 253 physicians (60%) and 167 NPs/PAs (40%) provided care to 419,581 empaneled patients through 110 family medicine care teams. Care teams consisted of a varying number of physicians (MD or DO) and NPs/PAs, based on practice needs, hiring

ability, or building design. The purpose of the care team is to provide the highest level of care in the most efficient and effective manner for the patients empaneled to the team. This is done by striving to have each member of the care team working to the highest of his or her licensure. Other care team members included nurses and clinical/medical assistants, and some teams had pharmacists, social workers, and integrated behavioral health staff. Ten rural care teams had no physicians and were staffed only by 1 or 2 NP/PAs. The physicians, NPs, and PAs on the care teams are all assigned a panel of patients. Patient complexity is considered in assigning patients to panels, with more complex-case patients counting for more than 1, based on number of comorbidities. Although there is effort in assigning the most complex cases to physicians, complex cases were assigned to all 3 clinician types. Given that NPs and PAs would be assigned complex cases, and acknowledging that this may require consultation with physicians, which would take additional time, panel size targets were set at 2200 and 1350 for NPs and PAs. Four family medicine-care teams had internists or pediatricians in addition to family medicine clinicians.

When patients were hospitalized, the attending clinician varied based on community geography and size. In smaller communities, the patient's primary physician often provided hospital care. In larger communities, and for patients empaneled to NPs and PAs, hospitalists may provide the care.

Data Collection

To gather information on clinician, panel, and care-team characteristics, we retrospectively analyzed administrative data for each physician, NP, and PA patient panel between January 1, 2017, and December 31, 2017. We included all physicians, NPs, and PAs who predominantly provided care within a family medicine care team and had a defined panel of community patients. We excluded clinicians whose practice was limited to urgent care, skilled nursing facilities, hospital medicine, or residency training programs. Supplemental clinicians with no assigned care team, and clinicians who provided acute care encompassing multiple care teams, were excluded.

We collected data on physician, NP, and PA certification; practice region; gender; years in practice; mean FTE; proportion of time in clinical practice; panel size; and mean panel complexity as defined by the Centers for Medicare and Medicaid Services Hierarchical Condition Category (HCC) model normalized to 1.0. Care-team characteristics included the total number of physicians, NPs, and PAs on the care team; total physican, NP, PA FTE (physician + NP + PA FTE); and the proportion of physician FTE (physician FTE/total FTE). Rural-urban commuting area (RUCA) codes, combining census tract population density, and population commuting patterns to nearby urban areas were used to categorize practice sites as rural or urban at the ZIP-code level.[19,20]

We collected data for the total number of ED visits and inpatient hospital admissions within our health system for each clinician panel for the entire 2017 calendar year. The 30-day readmission rate represented the proportion of index admissions over the 12 months when patients had unplanned readmissions to the hospital within 30 days of discharge.

We assessed whether patient satisfaction was associated with ED visits, hospitalizations, and readmissions. Patient satisfaction with their primary care clinician was reported as percent top box. This score was calculated from the clinician-specific section of the patient-satisfaction survey used by our institution.[21] Patients are asked to respond to 10 provider-specific questions regarding care and communication. The scale is 1 to 5, with 5 being very good. The percent top box is a percentage of "very good = 5" (top box) scores on the 10 questions for each patient survey completed. For each clinician, the mean percent top box scores were calculated for all surveys completed during the year. The Mayo Clinic Institutional Review Board approved the study.

Statistical Analysis

Data analyses were performed in SAS 9.4 and JMP Pro 14.1.0 (SAS Institute, Cary, North Carolina). Descriptive statistics consisted of frequencies for categorical variables and means with standard deviations for continuous variables. Categorical variables were compared with use of the χ^2 test or Fisher's exact test as appropriate. The 2-tailed Student's t-test or analysis of variance was used to compare mean values of continuous variables between groups as appropriate.

Multivariable Poisson analyses (log-linear models) of outcomes with count data (hospital admissions and ED visits) were performed with the GENMOD procedure (SAS Institute). We adjusted for differing panel sizes by including an offset variable, which was the natural logarithm of the number of patients in the clinician's panel. Effect sizes were calculated as e to the power of the parameter estimates and represent incidence rate ratios. An overdispersion parameter, estimated by the Pearson χ^2 divided by the degrees of freedom, was included in the Poisson models, as the values for this parameter were generally greater than 1.

Multivariable generalized linear mixed models of the proportional outcome of hospital readmissions were constructed with the GLIMMIX procedure (SAS Institute). The GLIMMIX procedure fits statistical models to data with correlations or nonconstant variability and does not require that the outcome be normally distributed. The proportion of physician effort on the care team was included as a fixed effect in the linear mixed model, and a β distribution of hospital readmissions was modeled. We added clinician practice location as a random effect to account for correlation caused by clustering effects.

Individual physician, NP, and PA level and care-team level characteristics in the multivariable models were selected based on factors considered to be potential contributors to hospital and ED utilization. In all analyses, P values less than 0.05 were considered significant.

RESULTS

The characteristics of the physicians, NPs, and PAs are detailed in Table 1. Care teams were composed of a median of 4 clinicians, with a maximum care team size of 10. Compared with physcians, NPs and PAs had a greater proportion of women, fewer years in practice, and smaller panel sizes, with lower HCC scores.

In the adjusted care-team panel model, the proportion of physician FTE on care teams was not significantly associated with ED visits

TABLE 1. Comparison of Individual Physician and NP/PA Characteristics and Unadjusted Utilization Outcomes (N=420)

Characteristic	NP/PA (N=167)	Physician (N=253)	P
Female (%)	147 (88.0)	110 (43.5)	<.001
Region A	36 (21.6)	42 (16.6)	.10
Region B	37 (22.2)	64 (25.3)	
Region C	47 (28.1)	53 (21.0)	
Region D	29 (17.4)	48 (19.0)	
Region E	18 (10.8)	46 (18.2)	
Patient satisfaction (% top box)	.83 ± .10	.84 ± .07	.15
Panel complexity score: HCC	.41 ± .16	.47 ± .13	<.001
Proportion of time in clinical practice	.47 ± .19	.50 ± .19	.10
Years in practice	6.9 ± 7.2	19.1 ± 10.6	<.001
Number of clinicians on care team	5.0 ± 2.3	4.8 ± 2.1	.72
Rural practice site	111 (66.5)	152 (60.1)	.19
Panel size	646 ± 403	1260 ± 628	<.001
Admissions per 1000 panel patients	72.1 ± 47.9	77.6 ± 38.5	.20
Proportion of hospital readmissions	0.107 ± 0.092	0.123 ± 0.062	.04
ED visits per 1000 panel patients	317 ± 219	280 ± 165	.05

Mean values are shown with ± standard deviation. Counts are shown with percentages in parentheses.
Burnout survey responses were available for 94 NP/PAs and 123 physicians: 0 = never, 1 = a few times a year or less, 2 = once a month or less, 3 = a few times a month, 4 = once a week, 5 = a few times a week, 6 = every day.
ED, emergency department; FTE, full-time equivalent; HCC, hierarchical condition category; NP/PA, nurse practitioner/physician assistant.

rates (rate ratio [RR] = 0.826; 95% CI, 0.624 to 1.063; Table 2). The rate of ED visits was significantly greater with higher panel HCC score (r = 0.40; P<.001; Figure [A]), with an adjusted 27.2% greate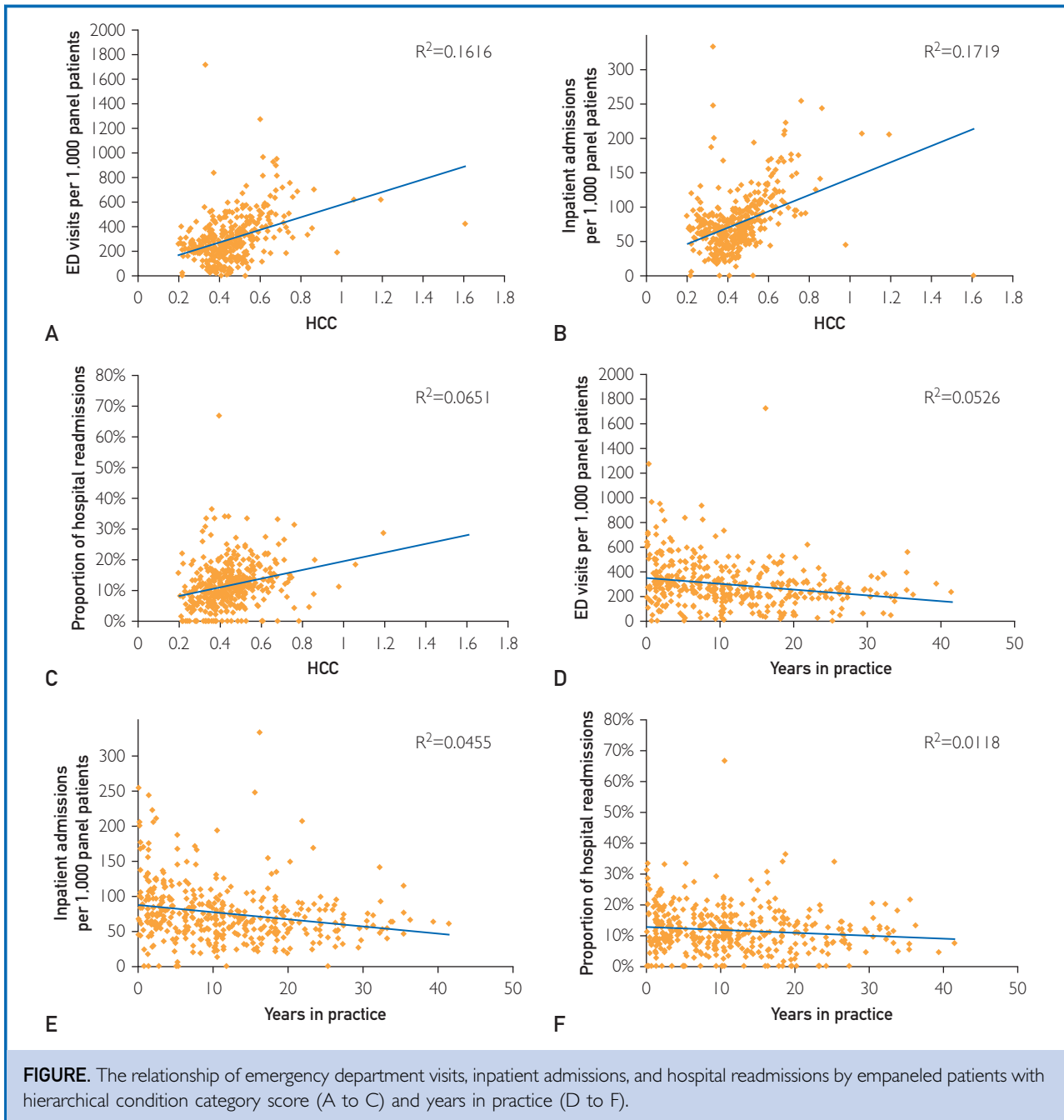r rate of ED visits per 0.1 increase in panel HCC score. The number of years the clinician had in practice was negatively associated with ED visits (r = −0.23; P<.001; Figure [B]), with an adjusted 9.7% lower rate of ED visits per 10-year increase in years in Mayo Clinic practice. Care in a rural area was associated with an

TABLE 2. Poisson Multivariable Regression Analysis of ED Visit Rate (N=385)

Variable	Rate ratio	95% CI		P
Physician FTE % on care team	0.826	0.642	1.063	.14
Physician (NP/PA reference)	0.851	0.742	0.976	.02
Female sex	0.963	0.868	1.068	.48
Region A	Reference			
Region B	0.985	0.822	1.179	.87
Region C	0.723	0.589	0.887	.0018
Region D	0.949	0.775	1.163	.62
Region E	0.923	0.753	1.133	.45
Years in practice	0.990	0.984	0.995	<.001
Patient satisfaction: % top box	0.561	0.284	1.129	.10
Panel complexity score: HCC	11.1	7.23	16.8	<.001
Rural site (urban reference)	0.874	0.765	0.999	.05

The offset variable was the natural logarithm of the number of patients on the clinician panel. Rate ratios were calculated as e to the power of the parameter estimates.
CI, confidence interval; FTE, full-time equivalent; HCC, hierarchical condition category; NP/PA, nurse practitioner/physician assistant.

FIGURE. The relationship of emergency department visits, inpatient admissions, and hospital readmissions by empaneled patients with hierarchical condition category score (A to C) and years in practice (D to F).

adjusted 12.6% lower rate of ED visits than care in an urban area (P=.05), and physician panels were associated with an adjusted 14.9% lower rate of ED visits than NP/PA panels (P=.02).

In the adjusted inpatient admissions model, the proportion of physician FTE on care teams was not significantly associated with inpatient admission rates (RR = 0.894; 95% CI, 0.746 to 1.072; Table 3). The rate of hospital admissions was significantly associated with HCC score (Figure [C]). The number of years in practice (Figure [D]) was associated with a lower inpatient admission rate. The clinician type was not associated with inpatient admission rates.

TABLE 3. Poisson Multivariable Regression Analysis of Inpatient Admission Rate (N=385)

Variable	Rate Ratio	95% CI		P
Physician FTE % on care team	0.894	0.746	1.072	.23
Physician (NP/PA reference)	0.976	0.882	1.081	.65
Female sex	0.963	0.894	1.038	.32
Region A	Reference			
Region B	0.664	0.583	0.755	<.001
Region C	0.617	0.536	0.709	<.001
Region D	0.671	0.580	0.775	<.001
Region E	0.718	0.621	0.831	<.001
Years in practice	0.991	0.987	0.995	<.001
Patient satisfaction: % top box	0.848	0.511	1.417	.53
Panel complexity score: HCC	12.8	9.40	17.4	<.001
Rural site (urban reference)	0.911	0.826	1.006	0.07

The offset variable was the natural logarithm of the number of patients on the clinician panel. Rate ratios were calculated as e to the power of the parameter estimates.
CI, confidence interval; FTE, full-time equivalent; HCC, hierarchical condition category; NP/PA, nurse practitioner/physician assistant.

In the adjusted hospital readmission model, the proportion of physician FTE on care teams was not significantly associated with hospital readmission rates (RR = −0.026, −0.364 to 0.312; Table 4). The rate of readmissions was increased with a higher HCC score (Figure [E]). The number of years in practice (Figure [F]) and female clinician panels were associated with lower readmission rates. The clinician type was not associated with readmission rates.

We performed a sensitivity analysis (data not shown) to account for sites where patients had access to ED or hospital facilities that were not part of our health system and data for patients' ED visits and hospitalizations may have been incomplete. In the adjusted models, access to only our health system hospitals was associated with a greater rate of recorded ED (RR = 2.34) and hospital (RR = 1.54) utilization. Including this health system facility variable in the adjusted ED visit model did not change the significant associations of HCC score, years in practice, and clinician type with ED visits. However, urban location was no longer significantly associated with rates of ED visits. Including the health system

TABLE 4. Generalized Linear Mixed Multivariable Regression Model of the Proportion of Hospital Readmissions (N=340)

Variable	Estimate	95% CI		P
Physician FTE % on care team	−0.026	−0.3643	0.3120	.88
Physician (NP/PA reference)	−0.123	−0.2797	0.03396	.12
Female sex	−0.283	−0.4146	−0.1508	<.001
Region A	Reference			
Region B	−0.122	−0.3577	0.1148	.31
Region C	−0.037	−0.2946	0.2197	.77
Region D	0.109	−0.1498	0.3671	.41
Region E	0.252	−0.00884	0.5122	.06
Years in practice	−0.0080	−0.01493	−0.00097	.03
Patient satisfaction: % top box	−0.532	−1.3987	0.3351	.23
Panel complexity score: HCC	0.865	0.3824	1.3471	<.001
Rural site (urban reference)	0.013	−0.1625	0.1879	.89

CI, confidence interval; FTE, full-time equivalent; HCC, hierarchical condition category; NP/PA, nurse practitioner/physician assistant.

facility variable in the adjusted hospital admission model did not change the significant associations of HCC score and years in practice with hospital admissions.

DISCUSSION

We found no relationship between a greater proportion of physician FTE on care teams and ED visits, hospital utilization, or readmission rates. Previous studies[1,7,10,11,22] found both no difference in clinical outcomes between provider types, and less utilization in the NP/PA patient panels. We anticipated that a higher percentage of physician time on the care team would lead to decreased utilization, as physicians have the highest level of training on the care teams in recognition and management of acute complex illnesses and that they would contribute their expertise to the entire team.[23-25]

As expected, more patients with complex cases had increased rates of ED visits, hospital admissions, and readmissions. The HCC scoring is only as accurate as the amount of effort put into appropriate documentation and maintenance of problem lists, but we found that it was the best predictor of utilization. It is feasible that variation in care-team structure may also contribute to the accuracy of HCC coding. In our practice, physicians, NPs, and PAs are responsible for entering and updating the problem list and entering the visit diagnosis code appropriately, from which the HCC code is assigned.

Years in practice were significantly associated with decreased utilization. This may be because of an increased comfort level with the uncertainty of diagnosis that comes with more time in practice or because of familiarity with their patients. Another possibility is that providers who have practiced longer have a more refined clinical acumen to determine who may not require an ED visit or hospitalization.[26]

Several factors may have contributed to the variability among regions in utilization (admissions, readmissions, and ED visits). Our utilization data do not capture the total cost of care for our patients. Some patients received care from other health care providers who are not part of our health system, and we were unable to capture utilization at these other health care sites. Although a general care-team concept

has been structurally implemented in these practices,[18] specific care-team composition and team-implementation strategy are not consistent. The geographic distribution of our clinics and hospitals is a barrier in maintaining uniform priorities, metrics, models of care, and training. In addition, the primary care practices were in the process of integration, with different timelines of implementation of a model of care that emphasized cost reduction in addition to improving quality. Care-team composition is determined by administrative and financial needs of the practice, but the needs of the patients are determined by the complexity of their cases. Further investigation is needed to determine whether aligning patient needs with care-team structure can reduce overall health care utilization and cost.

Possible factors contributing to higher ED utilization in urban areas could include a lack of timely access in the outpatent clinics and closer proximity to emergency departments. The lower patient satisfaction score and increased ED visits (Table 2) may indicate a lack of confidence that they would receive adequate care in the outpatient clinic or dissatisfaction with access to their clinicians.

Emergency department visits by patients empaneled to NPs and PAs have been studied previously; this group had a lower rate of ED utilization;[7] NPs and PAs perform myriad roles on care teams, making it difficult to set a single standard. The ideal composition of the care team and ratios of physician to NP/PA to improve quality and decrease utilization is uncertain and likely to be variable, based on the skills of the practitioners and the needs of the population that is being served. However, having a greater proportion of physician FTE on the care time did not affect ED utilization. This implies that the physicians may not have assumed a consultative role to support the NP/PAs on the care teams. Decreased hospital readmissions in patients empaneled to female clinicians compared with male clinicians has been shown previously.[27] Previous studies have shown that female physicians were more likely to practice evidence-based medicine[28] and provide more patient-centered care.[29] A possible explanation for improved readmissions rate and not ED visits or admissions may include the predictability of managing a discharged patient vs an acutely

ill patient who needs to be evaluated in a more unpredictable pattern.

Strengths of our study included encompassing a large network of physicians, NPs, and PAs in family medicine care teams over a broad geographic area of the midwestern United States. We were able to adjust for important factors such as panel size, panel complexity, total FTE, and clinician qualification, which can influence team workload.

Study Limitations

Our study was limited to family medicine care team practices, which may reduce the generalizability of our results to internal medicine and pediatric primary care teams. We were unable to capture data for hospitalizations or ED visits that ocurred outside our facilities. However, most sites had hospitals within our network that provided the majority of care for paneled patients in the practice. We also did not control for who provided the care in the hospital: that is, patient's primary clinician or hospitalist.

Combining NPs and PAs into a single category may be a limitation, as some studies have found differences between these roles.[30] Roles of NPs and PAs may differ in other settings, identified as the primary provider for the patient vs part of a team with the physician as the primary or whether or not they perform acute care only, chronic disease care only, or a combination of acute and chronic care. The decision in our practice to set different panel sizes for physicians and NPs/PAs was made to acknowledge the difference in training between these 2 groups and to allow acute capacity for the care team. The physicians, NPs, and PAs had their own panels of patients in the care team, but the team covered each others' patients, based on capacity in the individual calendars. We did not control for continuity or organization of care, which has been shown to have an effect on many aspects of care including management of chronic disease, ED visits, and hospital readmissions.[31-34] There was variability of time on the floor among the teams, with urban practices having more time away from patient care for academic pursuits. This variability may affect utilization and needs further study. We did not control for ancillary support services in care-team composition, such as pharmacy and social work, which could have affected ED and hospital utilization. This additional support was greater in larger urban practices in which the patient numbers supported these services. The NPs and PAs are often viewed as interchangeable; it is important to recognize the differences in training and previous experience requirements.[30,35,36]

Hospital care and transition of patients from the hospital was not assessed in this study. When patients required hospitalization, the providing service varied. In the smaller communities, this care was likely to be provided by the patient's primary physician, whereas, in the larger communities, this could be done by a hospitalist-staffed service. The impact on utilization of who provides inpatient care and how transitions of care are managed are important subjects for futher study.

CONCLUSION

We found no association of health care utilization with the ratio of physicians to NPs/PAs on the care team. Emergency department visits, hospital admissions, and 30-day readmissions were associated with higher HCC scores, and a greater number of years in practice was associated with reduced utilization.

Further studies are needed to identify the optimal ratio of physicians and NPs/PAs on care teams, to distinguish their roles, and to enhance team performance, with a goal of moving toward care that provides higher value.

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