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Economic Evaluation

Provider Differences in Costs, Utilization, and Quality of Primary Care for Traumatic Brain Injury in the Military

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ABSTRACT

Objectives: Differences in costs, utilization, and quality of care provided by primary care physicians (PCPs) versus nurse practitioners (NPs) and physician assistants (PAs) for mild traumatic brain injury (mTBI) were examined to determine savings and address PCPs shortage.

Methods: The Military Data Repository, which includes claims records for beneficiaries in the Military Health System, was used. Active-duty service members, retirees, and military dependents diagnosed with mTBI from 2011 to 2021 were included. Total cost, relative value units, and quality indicators of primary visits were dependent variables. The sample was stratified into patient-risk categories (high, low) and evaluation and management services (new and established patients).

Results: Per military patient, PAs and NPs provided care at a lower cost than PCPs, with savings of $53.2 to $99.9 and $72.0 to $275.5, respectively. Per dependent patient, PAs provided care at a lower cost than PCPs, with savings of $64.3 to $91.1; NPs provided care at a lower cost than PCPs, with savings of $71.4 and $81.6. For quality for military patients, PAs ordered fewer brain and spine imaging (4.2%) and conducted fewer depression assessments (6%) than PCPs for patients with "new/high" risk. NPs conducted a higher proportion of neuropsychological testing (1.6%) for patients with "existing/high" risk compared with PCPs. For dependents, PAs conducted more health risk assessments and physical exams (2.5%) for patients with "existing/low" risk compared with PCPs. A total of 7.5% of patients with "new/low" risk treated by NPs compared to PCPs experienced fewer readmissions.

Conclusions: NPs and PAs provide services for mTBI at lower costs than PCPs, with mixed results for quality.

Keywords: costs, military, provider, quality, traumatic brain injury.

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Highlights

- Differences in cost, utilization, and quality of care provided by primary care physicians (PCPs), nurse practitioners (NPs), and physician assistants (PAs) for mild traumatic brain injury (mTBI) were examined.
- NPs and PAs care for mTBI at lower costs than PCPs; mixed results were found for quality of care provided by PAs and NPs compared to PCPs.
- There may be savings when substituting physician assistants and nurse practitioners for primary care physicians to address the shortage of primary care physicians.

Introduction

The COVID-19 pandemic has exacerbated the existing shortage and maldistribution of primary care physicians (PCPs) in the United States.[1-6] Over 117 000 physicians left the workforce during the first 15 months of the pandemic, mainly because of burnout.[7] Before the pandemic, this problem was amplified by the increased demand for healthcare services associated with the enactment of the Affordable Care Act and the aging population.[8-10] Concerned over the adverse effects of the PCP shortage on patients' health outcomes, policymakers and researchers have renewed calls to consider the expansion of the scope of practice (SOP) of nurse practitioners (NPs) and physician assistants (PAs) as a viable solution.[11] There is empirical support for these concerns because shortage and geographic maldistribution of PCPs in the United States are associated with a lack of access to timely preventive services, resulting in adverse health outcomes, such as lower patient-rated health quality, higher hospitalization rates, and increased morbidity and mortality.[8,11-17] Expanding the SOP for NPs and PAs may help alleviate the PCP shortage and access problems, including in rural and underserved areas.[18,19]

Interest on whether NPs and PAs may represent a cost-effective solution to PCP shortage and maldistribution have increased. NPs and PAs may be able to independently provide between 70% to 80% of primary care services comparable to PCPs[20] and play an important role in deciding whether patients seen in ambulatory care settings should be hospitalized.[21] As a result, 32 states have broadened the SOP for NPs over the past decades, which ranges from allowing NPs to prescribe controlled substances without physician supervision to fully practicing without physician supervision.[22] PAs perform healthcare services delegated to them by physicians, as well as a range of activities similar to PCPs.[23] Despite the benefits on both the demand and supply sides, the expansion of SOP laws for NPs and PAs remains slow.[22,24]

Utilization and Costs

Several studies have used state-level variation in the implementation of SOP laws, findings are mixed and

inconsistent. Some studies found an association between the implementation of SOP laws and increased utilization and costs of healthcare services.[25,26] Likewise, other studies have found evidence that NPs and PAs overuse medical resources by ordering more diagnostic imaging than physicians, referring patients for specialty care inappropriately and overprescribing opioids and antibiotics[27-34] for specific conditions, such as diabetes, in settings such as inpatient hospitals[30,35] and healthcare systems, such as emergency services in the Veterans Administration (VA).[36,37] Controlling for the expansion of Medicaid in the Affordable Care Act, states that granted NPs more autonomy and authority experienced a smaller increase in emergency department services use than those restricting the SOP of NPs.[38] On the other hand, another study using individual-level data found that individuals consumed less acute care under relaxed SOP laws because of increased access to care.[25] Similarly, Kleiner et al[39] found that the price of some common health services declined after the implementation of SOP laws for NPs. Although individual-level studies are informative, they are often limited by issues of differential case complexity seen by different providers (case mix). To address this issue, Razavi et al[40] stratified Medicare beneficiaries' data into different risk categories. The authors found that NPs were more likely to use fewer and less expensive services and have lower labor costs than PCPs.[40] For low risk Medicare beneficiaries using primary care services, the average cost of providing an episode of care to a patient by a PCP was 34% higher compared with the average cost of providing the same care by an NP.[40] Similar results were found using Medicare beneficiary data for diabetic patients.[41]

Quality of Care

Using the quasi-experimental nature of state variation in SOP laws, studies have also found evidence of increased quality[25] and improved mental health outcomes[42] in states that expanded SOP laws compared with those that did not. For instance, a recent systematic review of 39 separate studies of PAs found that "PAs delivered the same or better care outcomes as physicians with the same or less cost of care."[43] This finding is consistent with studies that used patient-level data and found that patients receiving care from NPs compared to PCPs have better outcomes, including a lower likelihood of being hospitalized or readmitted to inpatient care.[30,44-48] Similarly, it has been found that NPs and PAs manage the care of patients diagnosed with diabetes at the same level with that of PCPs during the first five years after diagnosis in the VA healthcare system.[49] For instance, Lutfiyya and colleagues, to address issues of selection or case mix, constructed a medical productivity index that stratified patients by different categories of health risk to investigate variations in health outcomes between NPs and PCPs for Medicare beneficiaries diagnosed with diabetes.[41] Patients receiving care from NPs overall and stratified by medical productivity index status had significantly improved outcomes and quality of care compared with those receiving care from PCPs. Studies have also found that NPs provide higher quality of care to patients receiving care in primary care settings compared with PCPs.[50,51] However, Kurtzman and Barnow (2017) found no significant differences among PCPs and PAs in 3 quality measures.[50] Some studies have found an association between SOP restriction and poor quality of care,[36,51,52] whereas another study[53] found no evidence that relaxing SOP laws leads to the provision of more low-value services. For instance, Buerhaus et al[54] and Perloff et al[55] used Medicare data and 16 different quality measures grouped into 4 domains of primary care and found that restrictive SOP laws do not improve the quality of care delivered by NPs.

The conceptual underpinning of limiting SOP regulation is rooted in the "human capital" theory, which postulates that there may be significant variation in the level of productivity and quality of healthcare services provided by NPs and PAs compared with PCPs because of differences in level of education, experience, information-gathering, decision making, and case complexity.[37,56-60] Although the labor costs to provide care by NPs and PAs is lower compared with PCPs, care provided by NPs and PAs might not be cost-effective if they recommend more healthcare services that do not provide additional benefits to patients and/or provide care at a lower quality compared with PCPs.[27,37,57,59,61] Arguably, given PCPs higher level of training or human capital, they are more apt to reduce the level of uncertainty associated with the diagnosis and treatment of medical care, thereby offering a higher quality of care.[62] However, proponents of expanding SOP laws claim that limitations in SOP increase the costs of healthcare services provided by physicians; research supports the quality of care provided by NPs and PAs.[19,31,33,39,63-65]

Military Health System

Military treatment facilities (MTFs) have been using NPs and PAs in its network of clinics, hospitals, and outpatient clinics for many years in a quasi-random manner in which NPs and PAs practice independently without supervision[66,67] by physicians. This provides us with a unique opportunity to use data from the Military Health System (MHS) as a natural experiment to investigate differences in costs, utilization, and quality of primary care services provided to patients diagnosed with mild traumatic brain injury (mTBI) by type of provider. That is, in the MHS the assignment of patients to physicians, NPs and PAs is quasi-random and hence exogenous to patients' choice and mainly dependent on providers' availability at a particular clinic or hospital outpatient setting. Indeed, the MHS, which provides care to about 9.6 million beneficiaries, has been known to expand the roles of NPs and PAs to provide primary care in MTFs.[66] However, there is limited understanding of the differences in the costs and quality of primary care provided by different types of providers. For instance, Dietrich et al[68] used 2015 Military Data Repository (MDR) data to investigate variations among the different categories of providers (PCPs, PAs, and NPs) in the provision of care to patients diagnosed with acute low back pain and the results were mixed. The authors found greater odds of prescribing nonsteroidal anti-inflammatory prescriptions and ordering radiography for both PAs and NPs compared with PCPs.[68] In contrast, they found lower odds of ordering advanced imaging, such as computed tomography and magnetic resonance, by NPs and PAs compared with PCPs.

This study advances the literature in this area by testing whether there are provider differences in costs, utilization, and quality of primary care services provided to patients diagnosed with mTBI in MTFs. We focus on TBI because this condition has been considered the "signature" injury of Operation Enduring Freedom/Operation Iraqi Freedom wars because about half a million Service Members who participated in these wars have been diagnosed with TBI between 2000 and 2021.[69] Studies have found TBI incidence rates of up to 23% in active-duty service members (ADSMs) who participated in these wars; the incidence can be up to 91% higher for ADSMs who served in combat theaters.[70-72] It is important to note that mTBI comprises about 82% of all TBIs.[69] Despite the high number of mTBI diagnoses in the MHS and the important role that different healthcare providers play in providing primary care, there is a lack of research assessing provider differences in costs and quality of care. This analysis assesses this situation because

findings may have important implications for delivery of care and to address healthcare workforce shortage and maldistribution. This study also accounts for issues of sample selection and case mix among types of providers.

Methods

Data, Sample, and Design

We used data from the MDR, which contains administrative claims data on beneficiaries receiving care in the MHS. MDR is a rich data set that contains diagnostic and procedure codes related to inpatient and outpatient services received in MTFs (direct care) and civilian healthcare settings (private care). We are focusing on care provided in MTFs because MTFs and civilian healthcare settings assign providers differently. MDR data provide us with a unique opportunity because NPs and PAs are critical components of the provider's mix for primary care services. A supply-side analysis was conducted where providers (NPs, PAs, and PCPs) are the unit of analysis. We used direct care data from the MDR Comprehensive Ambulatory/Provider Encounter Record database. We analyzed primary care visits, defined as encounters with at least 1 Current Procedural Terminology (CPT) code other than lab or imaging, involving a PCP, PA, or NP. We excluded providers who saw fewer than 50 patients for a wellness or telephone evaluation and management visit in the calendar year. Patients were assigned to providers based on the plurality rule. In the plurality rule, patients are assigned to the provider that they have had the most visits with or have been provided care by the most.[73] In the majority rule, the patient is assigned to the provider if the provider provides more than 50% of the care.[73] The plurality rule has been found to be more efficient in correctly attributing patients to providers than the majority rule.[73–75] From the supply side, we included active duty providers (81%), civilian providers (14%), contractors (3%), and other personnel (about 2%), such as ex-employees and volunteers. From the demand side, military patients included ADSMs and military retirees (MRs); nonmilitary (civilian) patients included dependents of ADSMs and dependents and survivors of MRs diagnosed with mTBI. Patients, aged 18 to 64 years, received a diagnosis of mTBI and were treated by providers from 2011 to 2021.

Study Measures

Total cost, the first outcome, included the full cost of a primary healthcare visit (clinical, professional and laboratory costs) based on the allocation of the Department of Defense (DoD) Medical Expense and Performance Reporting System dollars by relative value units (RVUs) and adjusted by the Ambulatory Payment Classification weight. These adjusted RVUs are multiplied by the Centers for Medicare and Medicaid Services conversion factor to determine the total cost in MTFs.[76,77] Costs included all primary care visits for the patient with a provider. The medical care price index from the Bureau of Labor and Statistics was used to adjust costs to a baseline of 2021.[78] We also used RVU as an outcome to measure efficiency among the different providers. The second set of outcomes included 5 quality indicator measures based on the DoD/VA clinical practice guidelines for the management of concussion and mTBI.[79] These included the following services: (1) brain/spine imaging, (2) depression treatment, (3) health risks/physical exams, (4) neuropsychological testing, and (5) inpatient hospitalization within 6 months of the index visit. The quality indicators were selected based on the literature to show both health benefits and those that could result in harms. For example, quality indicators, such as brain/spine imaging, could result in harms if overused. CPT codes were used to measure these quality indicators (see Appendix Table 1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016). The key independent variables of interest compared the outcomes noted above for 3 different categories of providers: (1) PCPs (general medical officer, family practice physician, internist, general practice physician, pediatrician, and geriatrician), (2) NPs (primary care nurse practitioner; qualified, primary care nurse practitioner; entry, pediatric nurse practitioner), and (3) PAs. We used PCPs as the reference group. mTBI was measured using the *DoD Standard Surveillance Case Definition for TBI Adapted for AFHSB Use* (https://www.health.mil/Reference-Center/Publications/2015/12/01/Traumatic-Brain-Injury). It provides a list of International Classification of Diseases, Tenth Revision codes, and DoD codes for TBI. We also controlled for a set of covariates that are based on an MHS-relevant conceptual framework used by Richard et al[80] (see Appendix Table 2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016). Although the results have broad societal implications from a DoD perspective, such as medical readiness, our focus was on a healthcare system perspective that can allocate resources to programs and interventions to reduce attrition.

Measures of Stratification of Levels of Risk

We further stratified the sample into 4 different patient-risk categories to control for any residual sample selection and confounding by indication. These risk stratification measures are based on "Evaluation and Management" services received in offices or hospital outpatient settings, determined by the amount of time or level of difficulty of medical decision making using CPT codes 99201 to 99215. The level of decision making depends on the "complexity of the medical problem that is being addressed, the amount of time it takes, and the risk of medical complications and/or morbidity or mortality associated with the problem."[81,82] These risk-level categories include (1) new patients, low risk/low level of decision making; (2) new patients, high risk/high level of decision making; (3) existing patients, low risk/low level of decision making; and (4) existing patients, high risk/high level of decision making. The use of CPT codes is not a risk adjustment method per say, but by stratifying patients as high or low risk based on the CPT codes, because physicians use this as a decision making tool during the encounter, we are able to determine the patients that require complex treatment. We combined the 4 risk categories into 3 for civilians diagnosed with mTBI because of limited sample sizes: (1) existing and new/high, (2) existing/low, and (3) new/low.

Statistical Analyses

This is a provider level analysis, but patients were nested into providers to capture providers case mix and adjust for patients' clinical risks. For both cost and RVU, we used a generalized linear model (GLM) with gamma distribution and log link to address the skewness in costs data because studies in the civilian population have shown that these models are better suited to provide unbiased predicted values of medical care costs.[83,84] We conducted several GLM family tests by using a modified Park test as recommended by Manning and Mullahy (2001) and found a gamma distribution as the most suitable family.[85] Furthermore, we focused on the "effectiveness" dimension of quality[86] and used GLMs with log link to compute the proportion of the quality-of-care indicators assigned to each provider. Marginal effects were computed for all outcomes.

Additional details are in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016.

Table 1. Costs and quality measures of primary care services by patient population diagnosed with mTBI, risk category, and provider type, MDR, 2011 to 2021.

Risk category	Military population					
	Existing/high			New/high		
	PCP (Ref)	PA	NP	PCP (Ref)	PA	NP
N	1493	1580	545	88	83	54
Number of patients	6165	7978	4778	1405	1280	2919
Total primary care costs ($2021)	660.1 [637.39, 682.91]	510.3‡ [497.20, 523.32]	547.2‡ [523.76, 570.74]	1017.2 [886.82, 1147.48]	888.5 [691.12, 1085.96]	898.3 [746.76, 1049.74]
Total provider-affected practice expense RVUs	2.05 [2.00, 2.10]	1.94‡ [1.90, 1.97]	1.97 [1.91, 2.04]	3.03 [2.74, 3.32]	3.09 [2.69, 3.49]	3.05 [2.70, 3.39]
Patient-brain/spine imaging	0.023 [0.02, 0.03]	0.024 [0.02, 0.03]	0.025 [0.02, 0.03]	0.034 [0.00, 0.07]	0.0026 [−0.00, 0.01]	0.007 [0.00, 0.01]
Patient-depression treatment	0.075 [0.06, 0.08]	0.062* [0.05, 0.07]	0.061 [0.05, 0.07]	0.13 [0.07, 0.19]	0.074 [0.04, 0.11]	0.13 [0.08, 0.19]
Patient-health risk assessment/physical exam	0.037 [0.03, 0.05]	0.041 [0.03, 0.05]	0.043 [0.03, 0.06]	0.085 [0.03, 0.14]	0.051 [0.01, 0.09]	0.024 [−0.00, 0.05]
Patient-neuro-psychological testing	0.019 [0.01, 0.02]	0.024 [0.02, 0.03]	0.036† [0.02, 0.05]	0.098 [0.04, 0.15]	0.11 [0.05, 0.17]	0.14 [0.06, 0.21]
Patient-inpatient hospitalization (within 6 months)	0.055 [0.05, 0.06]	0.057 [0.05, 0.07]	0.076* [0.06, 0.09]	0.1 [0.05, 0.15]	0.028* [0.00, 0.05]	0.093 [0.04, 0.15]

Risk category	Existing/low			New/low		
	PCP (Ref)	PA	NP	PCP (Ref)	PA	NP
N	1507	1535	487	646	812	250
Number of patients	5482	7335	2076	1581	2095	1474
Total primary care costs ($2021)	434.1 [417.56, 450.67]	343.6‡ [331.73, 355.56]	400.8 [363.28, 438.30]	535.4 [503.15, 567.70]	401.1‡ [380.52, 421.59]	438.1‡ [406.56, 469.62]
Total provider-affected practice expense RVUs	1.42 [1.37, 1.46]	1.34† [1.31, 1.37]	1.42 [1.35, 1.49]	1.69 [1.61, 1.77]	1.57* [1.52, 1.63]	1.67 [1.56, 1.78]
Patient-brain/spine imaging	0.021 [0.02, 0.03]	0.022 [0.02, 0.03]	0.027 [0.02, 0.04]	0.01 [0.00, 0.02]	0.02 [0.01, 0.03]	0.032† [0.01, 0.05]
Patient-depression treatment	0.044 [0.04, 0.05]	0.04 [0.03, 0.05]	0.043 [0.03, 0.06]	0.059 [0.04, 0.08]	0.058 [0.04, 0.07]	0.067 [0.04, 0.09]
Patient-health risk assessment/physical exam	0.036 [0.03, 0.04]	0.042 [0.03, 0.05]	0.061† [0.04, 0.08]	0.037 [0.02, 0.05]	0.035 [0.02, 0.05]	0.037 [0.02, 0.06]
Patient-neuro-psychological testing	0.014 [0.01, 0.02]	0.02 [0.01, 0.03]	0.024* [0.01, 0.03]	0.033 [0.02, 0.05]	0.024 [0.01, 0.03]	0.033 [0.01, 0.05]
Patient-inpatient hospitalization (within 6 months)	0.048 [0.04, 0.06]	0.051 [0.04, 0.06]	0.047 [0.03, 0.06]	0.046 [0.03, 0.06]	0.044 [0.03, 0.06]	0.029 [0.01, 0.04]

Risk category	Civilian population		
	Existing and new/high		
	PCP (Ref)	PA	NP
N	785	444	373
Number of patients	1690	990	933

continued on next page

Table 1. Continued

Risk category	Civilian population		
	Existing and new/high		
	PCP (Ref)	PA	NP
Total primary care costs ($2021)	637.4 [610.42, 664.40]	548‡ [524.81, 571.13]	545‡ [513.08, 576.90]
Total provider-affected practice expense RVUs	1.83 [1.78, 1.88]	1.77 [1.71, 1.82]	1.83 [1.75, 1.92]
Patient-brain/spine imaging	0.037 [0.03, 0.05]	0.04 [0.03, 0.06]	0.024 [0.01, 0.04]
Patient-depression treatment	0.089 [0.07, 0.11]	0.074 [0.05, 0.09]	0.065 [0.05, 0.08]
Patient-health risk assessment/physical exam	0.024 [0.01, 0.03]	0.035 [0.02, 0.05]	0.044* [0.03, 0.06]
Patient-neuro-psychological testing	0.023 [0.01, 0.03]	0.03 [0.02, 0.04]	0.029 [0.01, 0.05]
Patient-inpatient hospitalization (within 6 months)	0.059 [0.05, 0.07]	0.05 [0.03, 0.07]	0.057 [0.04, 0.08]

Risk category	Existing/low			New/low		
	PCP (Ref)	PA	NP	PCP (Ref)	PA	NP
N	641	306	287	198	118	121
Number of patients	1161	562	598	229	136	142
Total primary care costs ($2021)	442.7 [417.58, 467.76]	371.3‡ [348.15, 394.46]	390.3* [363.06, 417.60]	572.6 [502.08, 643.20]	449.7* [405.94, 493.40]	472 [403.20, 540.83]
Total provider-affected practice expense RVUs	1.36 [1.28, 1.44]	1.21* [1.15, 1.27]	1.29 [1.22, 1.36]	1.69 [1.54, 1.84]	1.47* [1.37, 1.58]	1.7 [1.52, 1.87]
Patient-brain/spine imaging	0.025 [0.01, 0.03]	0.036 [0.02, 0.05]	0.026 [0.01, 0.04]	0.033 [0.01, 0.06]	0.051 [0.01, 0.09]	0.025 [−0.00, 0.05]
Patient-depression treatment	0.063 [0.05, 0.08]	0.057 [0.03, 0.08]	0.041 [0.02, 0.06]	0.083 [0.05, 0.12]	0.11 [0.06, 0.16]	0.079 [0.03, 0.13]
Patient-health risk assessment/physical exam	0.026 [0.02, 0.04]	0.044 [0.02, 0.06]	0.045 [0.02, 0.07]	0.068 [0.03, 0.10]	0.059 [0.02, 0.10]	0.074 [0.03, 0.12]
Patient-neuro-psychological testing	0.012 [0.01, 0.02]	0.014 [0.00, 0.03]	0.016 [0.00, 0.03]	0.03 [0.01, 0.05]	0.047 [0.01, 0.08]	0.033 [0.00, 0.07]
Patient-inpatient hospitalization (within 6 months)	0.051 [0.04, 0.07]	0.048 [0.03, 0.07]	0.042 [0.02, 0.06]	0.068 [0.03, 0.10]	0.03 [0.00, 0.06]	0.0041† [−0.00, 0.01]

mTBI indicates mild traumatic brain injury; MDR, Military Data Repository; PCP, Primary Care Physician; PA, Physician Assistant; NP, Nurse Practitioner; RVUs, relative value units.
*$P < .05$.
†$P < .01$.
‡$P < .001$.

Table 2. Incremental effect estimates of costs and quality measures from GLMs for primary care services by patient population diagnosed with mTBI, risk category, and provider type, MDR, 2011 to 2021.

Risk category	Military population			
	Existing/high		New/high	
	PA	NP	PA	NP
Total primary care costs ($2021)	−99.9‡ [−123.16, −76.65]	−119.2‡ [−147.82, −90.57]	−95.4 [−240.94, 50.19]	−275.5‡ [−423.83, −127.17]
Total provider-affected practice expense RVUs	−0.13‡ [−0.19, −0.06]	−0.15‡ [−0.22, −0.07]	−0.17 [−0.49, 0.15]	−0.53† [−0.88, −0.18]
Patient-brain/spine imaging	0.0031 [−0.00, 0.01]	0.0023 [−0.01, 0.01]	−0.042† [−0.07, −0.02]	−0.021 [−0.04, 0.00]
Patient-depression treatment	−0.011 [−0.03, 0.00]	−0.015 [−0.03, 0.00]	−0.059* [−0.12, −0.00]	−0.026 [−0.11, 0.06]
Patient-health risk assessment/physical exam	0.0021 [−0.01, 0.01]	0.0055 [−0.01, 0.02]	−0.029 [−0.10, 0.04]	−0.057 [−0.13, 0.02]
Patient-neuro-psychological testing	0.0049 [−0.00, 0.01]	0.016* [0.00, 0.03]	0.012 [−0.08, 0.10]	0.0045 [−0.09, 0.10]
Patient-inpatient hospitalization (within 6 months)	0.0042 [−0.01, 0.02]	0.016 [−0.00, 0.04]	−0.034 [−0.09, 0.03]	0.021 [−0.05, 0.09]

Risk category	Existing/low		New/low	
	PA	NP	PA	NP
Total primary care costs ($2021)	-53.2‡ [−71.30, −35.19]	-26.0 [−53.67, 1.65]	-73.2‡ [−105.71, −40.61]	-72.0‡ [−113.39, −30.66]
Total provider-affected practice expense RVUs	−0.058* [−0.11, −0.01]	−0.015 [−0.09, 0.06]	−0.093* [−0.19, −0.00]	−0.04 [−0.17, 0.09]
Patient-brain/spine imaging	0.0001 [−0.01, 0.01]	0.0079 [−0.01, 0.02]	0.0087 [−0.00, 0.02]	0.018 [−0.00, 0.04]
Patient-depression treatment	−0.0055 [−0.02, 0.01]	−0.0014 [−0.02, 0.02]	−0.0076 [−0.04, 0.02]	0.00062 [−0.04, 0.04]
Patient-health risk assessment/physical exam	0.00039 [−0.01, 0.01]	0.011 [−0.01, 0.03]	−0.0052 [−0.03, 0.01]	0.0021 [−0.02, 0.03]
Patient-neuro-psychological testing	0.0051 [−0.00, 0.01]	0.0085 [−0.00, 0.02]	−0.0076 [−0.03, 0.01]	−0.011 [−0.03, 0.01]
Patient-inpatient hospitalization (within 6 months)	−0.0011 [−0.01, 0.01]	0.00083 [−0.02, 0.02]	0.0081 [−0.02, 0.03]	−0.018 [−0.04, 0.01]

Risk category	Civilian population	
	Existing & new/high	
	PA	NP
Total primary care costs ($2021)	-80.4‡ [−111.97, −48.81]	-71.4‡ [−105.46, −37.28]
Total provider-affected practice expense RVUs	−0.049 [−0.12, 0.02]	−0.033 [−0.12, 0.05]
Patient-brain/spine imaging	0.00097 [−0.02, 0.02]	−0.008 [−0.03, 0.01]

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Table 2. Continued

Risk category	Civilian population	
	Existing & new/high	
	PA	NP
Patient-depression treatment	−0.013 [−0.04, 0.01]	−0.022 [−0.05, 0.01]
Patient-health risk assessment/ physical exam	0.012 [−0.01, 0.03]	0.018 [−0.01, 0.04]
Patient-neuro-psychological testing	0.0065 [−0.01, 0.02]	0.0035 [−0.02, 0.02]
Patient-inpatient hospitalization (within 6 months)	−0.0026 [−0.03, 0.02]	−0.0054 [−0.03, 0.02]

Risk category	Existing/low		New/low	
	PA	NP	PA	NP
Total primary care costs ($2021)	-64.3‡ [−93.88, −34.69]	-32.5 [−67.35, 2.38]	-91.1† [−147.81, −34.43]	-81.6* -144.13, −19.16]
Total provider-affected practice expense RVUs	−0.13‡ [−0.21, −0.06]	−0.068 [−0.16, 0.02]	−0.15* [−0.30, −0.00]	−0.04 [−0.22, 0.14]
Patient-brain/spine imaging	0.01 [−0.01, 0.03]	0.0055 [−0.01, 0.02]	0.029 [−0.01, 0.07]	0.0079 [−0.03, 0.04]
Patient-depression treatment	−0.0062 [−0.03, 0.02]	−0.023 [−0.05, 0.00]	0.027 [−0.04, 0.09]	−0.018 [−0.08, 0.04]
Patient-health risk assessment/physical exam	0.025* [0.00, 0.05]	0.02 [−0.01, 0.05]	0.01 [−0.05, 0.07]	0.027 [−0.04, 0.09]
Patient-neuro-psychological testing	0.0033 [−0.01, 0.02]	0.0049 [−0.01, 0.02]	0.03 [−0.02, 0.08]	0.019 [−0.03, 0.07]
Patient-inpatient hospitalization (within 6 months)	−0.0042 [−0.03, 0.02]	−0.01 [−0.04, 0.02]	−0.022 [−0.06, 0.02]	−0.075† [−0.12, −0.03]

Note. All models controlled for provider characteristics such as specialty (primary care physician, NP, and PA), age, age squared, sex, racial/ethnic categories, marital status, military rank, branch of service, personnel category (active duty, civilian, and contractor) as well as similar patient characteristics in addition to deployment status (Operation Enduring Freedom [OEF] only, Operation Iraqi Freedom [OIF] only, OEF and OIF, and other deployment), insurance status, Military Health System of care (direct, private, or both), hospitalization, outpatient rehabilitative services and surgical care, different geographic regions, 4 Neurobehavioral Symptom Inventory domains (vestibular, somatosensory, cognitive, and affective), post-traumatic stress disorder, chronic pain, a pre-morbid Elixhauser Comorbidity IIndex for the past 12 months, and year fixed effects to account for secular trends.
GLMs indicates generalized linear models; mTBI, mild traumatic brain injury; MDR, Military Data Repository; PA, Physician Assistant; NP, Nurse Practitioner; RVUs, relative value units.
*$P < .05$.
†$P < .01$.
‡$P < .001$.

Results

Descriptive

Descriptive results are in Table 1 and Appendix Table 2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016.

Multivariate

Military

The following results are for the costs of care provided. PAs provided care to patients diagnosed with mTBI at lower cost than PCPs, savings of $99.9 ($P < .001$) for those in the "existing/high," $53.2 ($P < .001$) in the "existing/low," and $73.2 ($P < .001$) in the "new/low" risk categories (Table 2). Similarly, NPs provided care to patients at lower cost than PCPs, savings of $119.2 ($P < .001$) for those in the "existing/high," $275.5 ($P < .001$) in the "new/high," and $72.0 ($P < .001$) in the "new/low" risk categories. These savings may be partially explained by both PAs and NPs spending less time or fewer RVUs treating these patients than PCPs. For example, the above-mentioned $275.5 in savings by NPs is associated with a reduction in RVUs of 0.53 ($P < .01$).

The following results are for quality of care. For care provided by PAs compared with PCPs, we found mixed results. PAs ordered

about 4.2% ($P < .01$) fewer brain and spine imaging than PCPs when treating patients with "new/high" risk. PAs conducted a lower proportion of depression assessments, about 6% ($P < .05$), for patients with "new/high" risk than PCPs. For care provided by NPs compared with PCPs, NPs conducted a higher proportion of neuropsychological testing, 1.6% ($P < .05$), for patients with "existing/high" risk than PCPs.

Additional tables for GLM coefficients are Appendix Tables 3-6 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016. Appendix Table 7 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2025.06.016 provides a summary of predicted means and incremental effects of costs from GLMs.

Civilian (dependents of ADSMs and MRs)

The following results are for the costs of care provided. PAs provided care at lower cost than PCPs, ranging in savings from \$80.4 ($P < .001$) for patients with combined "existing and new/high" risk, \$64.3 ($P < .001$) for patients with "existing/low" risk, and \$91.1 ($P < .01$) for patients with "new/low" risk. Likewise, NPs provided care at lower cost than PCPs, savings of \$71.4 ($P < .001$) for patients with "existing and new/high" risk and \$81.6 ($P < .05$) for patients with "new/low" risk.

The following results are for the quality of care provided. PAs conducted a higher proportion of health risk assessments and physical exams of about 2.5% ($P < .05$) for patients with "existing/low" risk compared with PCPs. For NPs, about 7.5% ($P < .01$) of patients with "new/low" risk treated by NPs experienced fewer inpatient hospital readmissions compared with treatment by PCPs.

Discussion

Both PAs and NPs provided care to patients diagnosed with mTBI in MTFs at lower costs than PCPs for military and civilian populations. Savings as high as \$275.5 per patient may be achieved when NPs provide care to patients in the "new/high" risk category compared with PCPs. These savings could be substantial given that about half a million Service members have been diagnosed with TBI since 2001, and about 82% of these are mTBI.[69] Similarly, for civilians, both PAs and NPs provided care at lower costs than PCPs.

Our findings for military and civilian populations are consistent with the study by Razavi et al[40] that used a similar risk stratification approach to address issues of sample selection and providers case mix. The authors found differences in the average costs of providing primary care services to Medicare beneficiaries of 34% between PCPs and NPs in the "low-risk" stratum compared with a 21% difference between PCPs and NPs in the "high-risk" stratum.[40] We found similar differences in the costs of primary care services for military and civilian patients diagnosed with mTBI; albeit higher savings for military patients. For instance, for military populations we found that the MHS saves about \$72.0 per patient (or 15%) when NPs provide care to patients with "new/low" risk compared with PCPs. We also found higher savings when NPs treated patients compared with PCPs, ranging from \$119.2 per patient (or 19%) for patients with "existing/high" risk to \$275.5 (or 29%) for patients with "new/high" risk. Savings could be substantial when NPs treat new patients diagnosed with mTBI with high risk, savings could be up to 29% compared with a physician treating the same patient with no adverse effect on the quality of primary care provided to patients diagnosed with mTBI. For the civilian population, total cost savings were as high as \$81.6 (or 15%) for NPs and \$91.1 (or 17%) for PAs for care provided to patients with "new/low" risk.

On the other hand, we have seen mixed results in terms of quality of care provided by PAs and NPs compared with PCPs. The VA and DoD provide recommendations for the diagnosis and assessment of patients with TBI[79] that can be used to determine the quality of care provided. For example, neuroimaging is not recommended for diagnosis and treatment of mTBI. Indeed, we found that PAs ordered fewer brain and spine imaging tests than PCPs when treating "new/high" risk military patients. Furthermore, assessing for depression is recommended for patients with mTBI. However, PAs conducted fewer depression screenings than PCPs for "new/high" risk military patients. Our findings are similar to those of Kurtzman and Barnow (2017) who used data from the National Ambulatory Medical Care Survey on 1139 providers (PCPs, PAs, and NPs) matched with 23 704 patients to assess differences in quality among providers using 3 quality measures of smoking cessation, depression treatment, and statins for hyperlipidemia.[50] Similarly, our analysis included quality measures such as depression treatment, imaging services, and physical examination.[50] Although Kurtzman and Barnow used a return to visit measure,[50] we used an all-cause rehospitalization within 6 months as a measure of quality.

Our study has several important limitations and strengths. Although we carefully tried to account for confounding by indication, case mix, and providers fixed effects, we recognize that there could be omitted variables that may explain some behaviors of some providers, such as provider's beliefs that may not be captured by the data.[87] Furthermore, intraclass correlations were not evaluated. A future study could seek to understand how much of the variation (savings) in outcomes is associated with providers and MTFs. Given the presence of complex symptoms in the study population stratification, another limitation is that metrics to assess the resource needs to reduce headaches, balance disturbance, behavioral health, and sleep disruptions is beyond the scope of this analysis. Future studies should address the effectiveness of holistic recovery resources to get a more precise calculation of provider type optimization. An additional limitation is that the quality indicators used in this study were not validated in administrative claims data. However, there are 2 complementary approaches that can be used to reinforce the level of confidence in the validity of the measures. The first is that the DoD/VA clinical practice guidelines[79] rely on best practice clinical guidelines and well-designed empirical studies, including those that have used claims data.[40,41] The second is that, to inform our study design, we utilized some of the studies that have used similar quality metrics from medical claims data in their analysis. For strengths, we used the "Evaluation and Management" CPT codes to stratify patients into 4 different risk categories. We think that this approach allows us to minimize any potential confounding by indication bias because it relies on risk categorization made by the clinician.[88,89] Additionally, we controlled for patients' premorbid conditions using the Elixhauser Comorbidity Index and the different domains of the Neurobehavioral Symptom Inventory, such as vestibular, somatosensory, cognitive, and affective. Furthermore, we controlled for conditions such as migraine, posttraumatic stress disorder, and chronic pain in our analysis as recommended by the DoD Traumatic Brain Injury Center of Excellence. Our approach ensured that we accounted for sample selection from the demand side and case mix from the supply side, in addition to the quasi-random nature of assigning patients to providers in MTFs. Furthermore, taking advantage of the fact that the MHS is an integrated health system and the MDR is a rich data set, we were able to control for individual and facility level characteristics compared with other studies on this topic.

Conclusions

Our findings contribute to the body of empirical evidence that supports the increased utilization of NPs and PAs and the need to review the barriers imposed by SOP laws, at least in primary care settings. The military practice of authorizing NPs and PAs to fully practice without physician supervision substantially improves access to care and efficiency in health systems, and the identification of mixed quality of care issues can target the areas of NPs' and PAs' practice that could benefit from enhanced education and/or physician supervision. Future research should expand on this study and explore provider differences in resource utilization and health outcomes, such as headache syndromes, sleep disturbances, and behavioral health, so as to understand the full impact of NPs and PAs in mTBI patient care. Furthermore, future research can leverage this framework of analysis to investigate other expensive healthcare conditions.

Author Disclosures

Author disclosure forms can be accessed below in the Supplemental Material section.

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