


Trends in Health Service Utilization After Enrollment in an Interdisciplinary Primary Care Clinic for Veterans with Addiction, Social Determinants of Health, or Other Vulnerabilities



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BACKGROUND: Models of interdisciplinary primary care (IPC) may improve upon traditional primary care approaches in addressing addiction and social determinants of health.

OBJECTIVE: To compare the trends in health care utilization in the year before and after enrollment in an IPC clinic model, and explore the variations in temporal patterns for patients with histories of high emergency department (ED) use, homelessness, and/or substance use disorders (SUDs).

DESIGN AND PARTICIPANTS: Interrupted time series study of utilization among IPC patients.

MAIN MEASURES: Quarterly ED, inpatient, primary care, and behavioral health visits were abstracted from administrative data before and after IPC enrollment. Negative binomial segmented regressions estimated changes in health care utilization over time. We used interactions to test for statistical differences in temporal patterns for IPC subgroups.

RESULTS: Among IPC patients ($n=994$), enrollment was associated with overall reductions in ED, inpatient, and behavioral health visits ($p's<0.001$) and increases in primary care ($p's<0.001$). Temporal patterns of ED visits, hospitalizations, and behavioral health differed across IPC subgroups (interaction $p's<0.001$). For those with histories of high ED use ($n=265$), ED, inpatient, and behavioral health visits decreased after enrollment (level change incidence rate ratios [IRRs]=0.57–0.69) and continued to decline over time (post-enrollment IRRs=0.80–0.88). Among other patients with homeless experiences ($n=123$), there were initial declines in hospitalizations (IRR=0.33) and overall declines in behavioral health visits

(level change and post-enrollment IRRs=0.46–0.94). Other patients with SUDs had initial declines in hospitalizations (IRR=0.46), and post-enrollment declines in rates of specialty SUD visits (IRR=0.92). For all patients, primary care visits initially increased (level change IIRs=2.47–1.34) then gradually declined (post-enrollment IRRs=0.92–0.92).

CONCLUSIONS: An IPC model of care reduces acute care and behavioral health service use, particularly for patients with historically high ED use. IPC models may improve patient and system outcomes of vulnerable patient populations with social, clinical, and addiction morbidities.

KEY WORDS: primary care; opioid use disorder; homelessness; Veterans.

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INTRODUCTION

Patients who are vulnerable to poor health outcomes due to substance use disorders (SUDs), social determinants of health (SDOH; e.g., homelessness), and high levels of medical complexity often have fragmented health care experiences. They sometimes encounter access barriers and other negative care experiences in traditional primary care settings,^{1–3} which may result in excess emergency department (ED) utilization, hospitalizations, and health system costs.^{4–7}

Integrated primary care (IPC) models that address addiction and SDOH could promote primary care engagement and mitigate problematic patterns of acute care utilization.^{8–10} IPC models utilize interdisciplinary teams to provide longitudinal, patient-centered care; reduce care fragmentation; and avert preventable hospitalizations via enhanced primary care access

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and disease management.⁹ Such approaches have increased primary care utilization (especially preventive services) and reduced ED visits and hospitalizations for patients with chronic health conditions, serious mental illness, and experience of homelessness.^{9–14} However, the impact of IPC approaches on utilization patterns when SUD prevention and treatment are central components of care is less established.

A small body of literature shows that IPC increases SUD treatment initiation and retention.^{15–19} However, IPC's effectiveness in reducing acute care use may depend on the specific composition and integration into clinical care. In one study, Wakeman et al. found that inclusion of addiction pharmacotherapy, counseling, and recovery coaching in primary care was associated with lower 9-month hospitalizations and ED visits relative to a matched control group in other primary care practices.¹⁶ In another study, Saitz et al. found no such effect 12 months after interdisciplinary chronic care management was offered in parallel to standard primary care services.¹⁵ Additional research into different IPC configurations could help to identify important features of service design that mitigate problematic patterns of acute care use.

We sought to evaluate changes in health care utilization among patients enrolled in an IPC clinic where SDOH and SUD prevention, assessment, and treatment are central components of service design. Comparing utilization trends before and after the intervention using an interrupted time series approach may help to elucidate initial intervention effects as well as sustained changes in utilization over time.^{20,21} Thus, we sought to (1) determine changes in ED, inpatient, primary care, and behavioral health service use following IPC enrollment throughout a 12-month period, and (2) explore variations in the effects of IPC on utilization for patients with histories of high ED use, homelessness, and SUDs. Understanding how IPC models impact trajectories of health care utilization may provide evidence to support continued investment in integrated care approaches for SUDs.^{14,22}

METHODS

Setting

The Vulnerable Veteran Innovative Patient-Aligned Care Team (VIP) Initiative at the Veterans Affairs (VA) Salt Lake City Health Care System is a 5-year clinical and research collaboration that uses IPC to improve health care access for Veterans with SUDs, homelessness, high patterns of ED use, and those with other unmet medical and social needs. The VIP Initiative has been previously described.²³ Briefly, VIP is a unique staffing model led by dedicated (i.e., not shared with other teams) primary care providers with certification in addiction medicine ($n=3$), an x-waivered internist ($n=1$), and nurse care manager ($n=1$). VIP also includes 2 mental health pharmacists²⁴ specializing in SUD treatment, a mental health nurse, and a social worker. During the study period, five

prescriber-led teams had a nurse care manager and mental health pharmacist co-located and integrated within every aspect of care, where appropriate. VIP differs from VA's standard team-based primary care approach²⁵ in other notable ways: (1) prioritized enrollment for patients with medical, mental health, and social morbidities; (2) greater staffing-to-patient ratios; and (3) nurse provision of chronic pain management and medication treatment for opioid use disorder. Patients are enrolled following referral from other VA clinicians and service lines.

Study Design

We conducted an interrupted time series analysis of health care utilization among a cohort of Veterans enrolled in IPC between March 1, 2018, and September 30, 2019. All study procedures were approved by the VA Salt Lake City Institutional Review Board.

Data Sources and Procedures

We abstracted information on IPC enrollment, health care utilization, and demographic and clinical characteristics from electronic medical records stored in the VA corporate data warehouse. Enrollment was determined from administrative records of primary care team assignment and primary care visits to IPC clinicians. For each patient, we defined the start of the IPC intervention as the date of the first outpatient visit with an IPC prescribing provider. For the small percentage of Veterans assigned but without any recorded encounter with a prescribing provider ($n=66$, 7%), we defined the start of the intervention as the date of assignment to the IPC team. We include these patients in analyses to estimate the effect of IPC on the target population, even if patients did not engage in the intervention.

Measures

Health Care Utilization. The interrupted time series analysis included eight quarters of health care utilization by visit type across the 2-year study period. In each quarter, we counted emergency department (ED) visits, hospitalizations, primary care visits to prescribing providers, primary care visits to all IPC clinicians (i.e., prescribing and non-prescribing team members), and mental health clinic and SUD clinic visits. For each type of utilization, we also calculated total visits per year.

Time. The main independent variable, time, was coded sequentially from 0 to 7 and captured each quarter from 1 year prior to 1 year after enrollment. For the post-enrollment regression segment, we created a time variable for the quarters following IPC enrollment (coded 0–3).

Pre/post. We coded quarters as occurring prior to or following enrollment (0 or 1).

Subgroups. We examined baseline characteristics of referred patients, including histories of ED utilization, homelessness, and SUDs in the pre-enrollment year. We coded patients as having high levels of ED use if they had three or more ED visits. Homelessness was determined from international classification of disease (ICD) codes related to unstable housing and VA homeless service records.²⁶ We coded patients as having a history of SUD if they had one or more outpatient visits or inpatient stays with an ICD code for an SUD in the pre-enrollment year.¹ Patients who met multiple subgroup criteria were categorized into the following groups: (1) high ED use (regardless of homeless or SUD histories), (2) history of homelessness but not high ED use, or (3) history of SUD only. Patients who did not meet any subgroup criteria were categorized as being eligible for “other” reasons, including opioid risk mitigation, chronic pain, and complex comorbidity.

Demographic and Clinical Variables. Demographic variables included Veterans’ age, sex, race/ethnicity, marital status, urban-versus-rural residence, and service connection status at the time of data abstraction (October 2020). Other baseline clinical characteristics, determined in the pre-enrollment year, included outpatient opioid prescriptions (proxy for pain treatment), count of medical conditions from the Elixhauser Comorbidity Index (categorized as 0–1, 2–3, 4 or more)²⁷, and mental health diagnoses determined from the Agency for Healthcare Research and Quality’s Clinical Classification System.²⁸ Specifically, we examined pre-enrollment depression, post-traumatic stress disorder (PTSD), anxiety disorders, serious mental illness (encompassing bipolar disorder and schizophrenia spectrum disorders), and other mental health conditions (i.e., personality, adjustment, and somatic disorders). To account for other possible historical effects on service utilization, we created a dummy variable to identify patients whose 12-month outcome utilization overlapped with the coronavirus disease (COVID-19) pandemic. Because the VA saw service reductions beginning in March 2020,²⁹ patients with enrollment start dates from March to September 2019 could have experienced a care disruption in March–September 2020.

Statistical Analyses

All analyses were conducted using Stata version 17. First, we used chi-square tests to examine differences in distributions of sociodemographic and clinical variables for the patient subgroups. Second, we used descriptive statistics (proportions, means, medians) and graphing techniques to examine distributions of outcome variables over time and for visual inspection of the data to identify potential trends. Third, we used generalized estimating equations with a log link and negative

binomial family to assess changes in number of visits in the year post-enrollment compared to pre-enrollment. Models were run separately for each visit type.

Last, we used segmented negative binomial regressions³⁰ to assess changes in post-enrollment versus pre-enrollment trends in utilization by quarter. For analyses of primary care visits, we omitted data from the first quarter post-enrollment (quarter 4) because the first visit defined cohort entry. We modeled utilization as a function of time (0–7), pre/post-enrollment status, and post-enrollment time (0–3). In this design, the level and trend of the pre-enrollment segment serve as the control for the post-enrollment segment. To account for potential historical effects, we controlled for the COVID time indicator.

We provide estimates of four parameters from the models:^{20,21} (a) the slope of utilization prior to enrollment; (b) the immediate effect of IPC (i.e., change in the level of visits in the quarter immediately following enrollment compared to the quarter immediately prior); (c) the slope of utilization in the post-enrollment quarters—to determine if the immediate IPC effect is sustained or dissipates over time; and (d) the change in the slope of utilization post-enrollment compared to the slope pre-enrollment. To explore potential differences in program effects, we tested for statistical interactions of subgroups by time and used model stratification.

RESULTS

The sample included 994 patients enrolled from March 2018 to September 2019 (Table 1). Most patients were male, age 45 or older, non-Hispanic white, non-married, and resided in an urban area. Two-thirds had a service-connected disability, while one-half experienced two or more chronic medical conditions and two-fifths were recently prescribed opioids. Enrolled patients experienced marked mental health and SUD comorbidities, with two-thirds of patients having a history of mental health diagnoses and nearly one-half a history of SUD diagnoses.

Nearly one-third of patients ($n=265$) had histories of high ED use prior to enrollment. In those without high ED use, $n=123$ had documented experiences of homelessness and, from the remaining cohort, $n=169$ had a prior SUD diagnosis. Patients in the high ED group, compared to the others, were most likely to have two or more medical conditions and receive prescription medications for pain. Those in the homeless-experienced group were most likely to have a mental health diagnosis. Patients who did not meet core enrollment criteria (ED use, homeless, SUD history; $n=437$) were more likely, when compared to the specified subgroups, to be female, at retirement age, and married.

Changes in Utilization Over Time

In the year following enrollment, IPC patients experienced fewer ED, inpatient, and behavioral health visits compared

Table 1 Characteristics of Patients Enrolled in an Integrated Primary Care (IPC) Clinic for Veterans with Addiction, Social Determinants of Health, or Other Vulnerabilities

	Subgroup*					p value
	Total	High ED use	Homeless experienced	Substance use disorder	Other	
	n=994	n=265	n=123	n=169	n=437	
Female sex	85 (8.6)	16 (6.0)	9 (7.3)	8 (4.7)	52 (11.9)	0.008
Age						<0.001
25–44	248 (25.0)	66 (24.9)	42 (34.2)	56 (33.1)	84 (19.2)	
45–64	360 (36.2)	113 (42.6)	57 (46.3)	66 (39.1)	124 (28.4)	
65+	386 (38.8)	86 (32.5)	24 (19.5)	47 (27.8)	229 (52.4)	
Race/Ethnicity						0.06
Non-Hispanic White	832 (84.6)	222 (84.4)	96 (78.7)	145 (86.3)	369 (85.8)	
Non-Hispanic Black	46 (4.7)	17 (6.5)	12 (9.8)	5 (3.0)	12 (2.8)	
Hispanic/Latino	68 (6.9)	18 (6.8)	8 (6.6)	12 (7.1)	30 (7.0)	
Other	37 (3.8)	6 (2.3)	6 (4.9)	6 (3.6)	19 (4.4)	
Marital status						<0.001
Married	395 (39.9)	65 (24.5)	22 (17.8)	60 (35.5)	248 (57.1)	
Previously married	443 (44.7)	157 (59.3)	73 (61.8)	79 (46.8)	131 (30.2)	
Single, never married	153 (15.4)	43 (16.2)	25 (20.3)	30 (17.8)	55 (12.7)	
Rural residence	140 (14.1)	32 (12.1)	13 (10.6)	21 (12.5)	74 (16.9)	0.15
Experienced homelessness	266 (26.8)	143 (54.0)	–	–	–	–
Priority (service connection)						<0.001
50–100% service connected	489 (49.2)	118 (44.5)	44 (35.8)	108 (63.9)	219 (50.1)	
<50% service connected	150 (15.1)	39 (14.7)	28 (22.8)	18 (10.7)	65 (14.9)	
No service connection	355 (35.7)	108 (40.8)	51 (41.5)	43 (25.4)	153 (35.0)	
Number of medical conditions						<0.001
0–1	502 (50.5)	78 (29.4)	73 (59.4)	108 (63.9)	243 (55.6)	
2–3	287 (28.9)	83 (31.3)	37 (30.1)	46 (27.2)	121 (27.7)	
4+	205 (20.6)	104 (39.3)	13 (10.6)	15 (8.9)	73 (16.7)	
Pain medication	417 (42.0)	175 (66.0)	47 (38.2)	68 (40.2)	127 (29.1)	<0.001
Mental health conditions†						<0.001
Depression	460 (46.3)	194 (73.2)	81 (66.9)	84 (49.7)	101 (23.1)	<0.001
Post-traumatic stress disorder	385 (38.7)	129 (48.7)	57 (46.3)	92 (54.4)	107 (24.5)	<0.001
Anxiety	291 (29.3)	125 (47.2)	50 (40.7)	43 (25.4)	73 (16.7)	<0.001
Serious mental illness	104 (10.5)	46 (17.4)	20 (16.3)	22 (13.0)	16 (3.7)	<0.001
Other	144 (14.5)	68 (25.7)	32 (26.0)	18 (10.7)	26 (6.0)	<0.001
Any of the above	660 (66.4)	229 (86.4)	119 (96.8)	136 (80.5)	176 (40.3)	<0.001
Substance use disorder‡						
Alcohol use disorder	254 (25.6)	103 (38.9)	53 (43.1)	98 (58.0)	–	–
Opioid use disorder	201 (20.2)	93 (35.1)	40 (32.5)	68 (40.2)	–	–
Stimulant use disorder	203 (20.4)	111 (41.9)	50 (40.7)	42 (24.9)	–	–
Cannabis use disorder	105 (10.6)	52 (19.6)	31 (25.2)	22 (13.0)	–	–
Other drug use disorder	103 (10.4)	65 (24.5)	16 (13.0)	22 (13.0)	–	–
Any of the above	447 (45.0)	188 (70.9)	90 (74.8)	–	–	–
Flag if enrolled after March 1, 2019	341 (34.3)	81 (30.6)	41 (33.3)	55 (32.5)	164 (37.5)	0.27

ED emergency department visits

*High ED use includes Veterans with 3+ visits to the emergency department in the 12 months prior to joining the IPC clinic; Homeless includes Veterans with a recent history of homelessness or use of VA housing services; Substance use disorder (SUD) includes Veterans with a diagnosis of SUD in the 12 months prior to enrollment; other includes Veterans at risk for opioid mitigation, medical complexity, and other Veterans referred to the IPC. Patients who met multiple subgroup criteria were categorized into the following groups: (1) high ED use (regardless of homeless or SUD histories); (2) history of homelessness but not high ED use; or (3) history of SUD only

†Column percentages do not add to 100% because the conditions are not mutually exclusive. Serious mental illness includes bipolar disorder, schizophrenia spectrum disorders, and other psychosis. Other mental health conditions include personality disorders, adjustment disorders, and somatic disorders. Other substance use disorders include diagnoses of abuse or dependence related to sedatives, hallucinogens, inhalants, or polysubstances
p value obtained from the chi-square test

Table 2 Health Service Utilization in the Year Before and After Enrollment in an Integrated Primary Care (IPC) Clinic for Veterans with Addiction, Social Determinants of Health, or Other Vulnerabilities

Type of utilization	Before enrollment			After enrollment			p value‡
	%*	Mean (SD)	Median (IQR)	%	Mean (SD)	Median (IQR)	
Emergency department	58.0	2.1 (3.6)	1 (0–3)	53.2	1.8 (3.2)	1 (0–2)	<.001
Hospitalization	32.5	0.8 (1.9)	0 (0–1)	28.6	0.7 (1.7)	0 (0–1)	<.001
Primary care prescriber	74.0	2.1 (2.2)	1 (0–3)	97.2	4.2 (3.6)	3 (2–5)	<.001
All primary care	87.8	6.8 (7.2)	5 (2–9)	98.7	11.3 (10.0)	8 (5–15)	<.001
Mental health clinic	62.7	11.4 (20.9)	3 (0–13)	58.2	10.0 (19.4)	2 (0–11)	<.001
Specialty SUD clinic	33.9	6.1 (14.4)	0 (0–4)	31.0	5.3 (13.4)	0 (0–2)	<.001

IQR interquartile range, SD standard deviation, SUD substance use disorder

*Percent with any visit

‡p value obtained from generalized estimating equation with log link and negative binomial family, controlling for COVID-19 historical effects

to the year prior to enrollment (all p 's<0.001; Table 2). Primary care visits increased following IPC enrollment (p 's<0.001).

Trends in Utilization Before and After Enrollment in IPC

Trends in utilization post-enrollment were statistically different from the pre-enrollment utilization trends, with specific patterns by type of visit (Table 3).

ED Visits and Hospitalizations. Before enrollment, the rates of ED visits and hospitalizations were increasing each quarter (incident rate ratios [IRRs]=1.18 and 1.28, respectively). At the time of enrollment, there was an immediate reduction in ED visits and hospitalizations (level change from quarter 3 to 4: IRRs=0.70/0.58). After enrollment, the rate of ED visits and hospitalizations continued to decline through quarter 7 (IRRs=0.89/0.85).

Table 3 Negative Binomial Estimates for the IPC Intervention Outcomes in Segmented Regression Analysis

Type of visit	IRR	SE	p value
Emergency department			
Pre-enrollment slope*	1.18	0.02	<0.001
Level change†	0.70	0.04	<0.001
Post-enrollment slope‡	0.89	0.02	<0.001
Trend change (%)§	-25%		<0.001
Hospitalizations			
Pre-enrollment slope	1.28	0.04	<0.001
Level change	0.58	0.05	<0.001
Post-enrollment slope	0.85	0.03	<0.001
Trend change (%)	-33%		<0.001
Primary care prescriber			
Pre-enrollment slope	0.93	0.02	0.005
Level change	2.60	0.23	<0.001
Post-enrollment slope	0.84	0.03	<0.001
Trend change (%)	10%		0.002
Primary care team			
Pre-enrollment slope	1.08	0.02	<0.001
Level change	1.74	0.08	<0.001
Post-enrollment slope	0.87	0.01	<0.001
Trend change (%)	-20%		<0.001
Mental health clinic			
Pre-enrollment slope	1.17	0.02	<0.001
Level change	0.69	0.03	<0.001
Post-enrollment slope	0.91	0.01	<0.001
Trend change (%)	-22%		<0.001
Specialty SUD clinic			
Pre-enrollment slope	1.17	0.02	<0.001
Level change	0.74	0.03	<0.001
Post-enrollment slope	0.84	0.01	<0.001
Trend change (%)	-28%		<0.001

IPC, integrated primary care

Estimates from segmented negative binomial regressions, controlling for COVID-19 historical effects. IRR incidence rate ratio

*The pre-enrollment slope represents trends in the rate of utilization in the four quarters prior to enrollment

†The level change, representing the immediate effect of the IPC, is the change in the rate of utilization in the first quarter after enrollment, compared to the quarter immediately prior to enrollment

‡The post-enrollment slope represents trends in the rate of utilization in the four quarters after enrollment

§The trend change is the percent change in the post-enrollment slope, compared to the pre-enrollment slope

Primary Care Visits. There was an immediate increase in the rate of visits to primary care prescribers and all primary care clinicians at the time of enrollment (level change from quarter 3 to 5: IRRs = 2.60/1.74), followed by a decline in primary care use (post-enrollment slope: IRRs=0.84/0.87).

Behavioral Health Visits. Before enrollment, rates of mental health and SUD clinic visits were increasing each quarter (IRRs=1.17/1.17). At the time of enrollment, there were immediate reductions (level change from quarter 3 to 4: IRRs=0.69/0.74) and continued declines (IRRs=0.91/0.84) in mental health and SUD clinic visits post-enrollment.

Trends in Utilization Before and After IPC Enrollment for Patients with Histories of High ED Use, Homelessness, and SUDs

Temporal patterns of ED visits, hospitalizations, and behavioral health visits differed for patients with histories of high ED use and other social and clinical vulnerabilities (interaction of time by cohort, p 's<0.001; Table 4).

ED Visits and Hospitalizations. Patients with histories of high ED use had the highest level of acute care use prior to enrollment, with upward pre-enrollment trends for both ED visits and hospitalizations (IRRs=1.16/1.12; Fig. 1). These patients experienced immediate reductions (level change from quarter 3 to 4: IRRs=0.57, 0.57) and continued declines in ED visits and hospitalizations post-enrollment (IRRs=0.85/0.80). Other patients with histories of homelessness or SUDs also had increasing rates of ED visits and hospitalizations prior to enrollment (IRRs=1.20–1.68). However, for these patients, rates of ED visits stabilized following IPC enrollment (no significant level change or post-enrollment slope), while rates of hospitalization immediately fell (level change IRRs=0.33/0.46) then stabilized (post-enrollment slope, p 's>0.05).

Primary Care Visits. There was no evidence of subgroup variation in temporal patterns of primary care visits (interaction p 's > 0.05). All subgroups experienced increases in primary care visits following enrollment, which attenuated over time (subgroup results not tabled).

Behavioral Health Visits. Patients with histories of high ED use or homelessness had increasing rates of mental health and SUD clinic visits prior to enrollment (IRRs=1.17–1.35). Patients in these groups experienced immediate reductions (level change from quarter 3 to 4: IRRs=0.46–0.69) and continued declines (post-enrollment IRRs=0.78–0.94). Other patients with histories of SUDs had increasing behavioral health visits pre-enrollment (mental health and

Table 4 Negative Binomial Estimates for the IPC Intervention Outcomes in Segmented Regression Analysis by Patient Subgroups

Type of visit	Subgroup											
	High ED use			Homeless experience			SUD			Other		
	IRR	SE	<i>p</i> value	IRR	SE	<i>p</i> value	IRR	SE	<i>p</i> value	IRR	SE	<i>p</i> value
Outcome												
ED visit												
Pre-enrollment slope*	1.16	0.04	<0.001	1.49	0.14	<0.001	1.28	0.12	0.008	1.19	0.09	0.01
Level change†	0.57	0.05	<0.001	0.69	0.18	0.16	0.97	0.25	0.92	1.18	0.23	0.41
Post-enrollment slope‡	0.85	0.03	<0.001	1.03	0.04	0.55	0.98	0.06	0.72	0.92	0.04	0.1
Trend change (%)§	-27%		0.001	-31%		<0.001	-24%		0.02	-22%		0.004
Inpatient												
Pre-enrollment trend	1.22	0.05	<0.001	1.54	0.18	<0.001	1.68	0.23	<0.001	1.2	0.17	0.22
Level change	0.57	0.06	<0.001	0.33	0.11	<0.001	0.46	0.16	0.03	1.58	0.62	0.25
Post-enrollment trend	0.8	0.04	<0.001	1.17	0.11	0.08	0.88	0.08	0.19	0.87	0.09	0.18
Trend change (%)	-35%		<0.001	-34%		0.04	-47%		<0.001	-27%		0.09
Mental health clinic												
Pre-enrollment trend	1.17	0.03	<0.001	1.35	0.06	<0.001	1.12	0.04	0.003	1.07	0.02	0.004
Level change	0.6	0.04	<0.001	0.46	0.06	<0.001	0.91	0.09	0.37	1.24	0.09	0.002
Post-enrollment trend	0.88	0.02	<0.001	0.94	0.03	<0.001	0.96	0.03	0.17	0.88	0.02	<0.001
Trend change (%)	-34%			-30%		0.1	-15%		<0.001	-18%		<0.001
Specialty SUD clinic												
Pre-enrollment trend	1.18	0.03	<0.001	1.31	0.06	<0.001	1.1	0.04	0.02	–		
Level change	0.69	0.05	<0.001	0.66	0.09	<0.001	0.94	0.1	0.54	–		
Post-enrollment trend	0.81	0.02	<0.001	0.78	0.03	<0.001	0.92	0.03	0.007	–		
Trend change (%)	-31%		<0.001	-40%		<0.001	-16%		0.001	–		

ED, emergency department; IPC, integrated primary care; IRR, incidence rate ratio

*The pre-enrollment slope represents trends in the rate of utilization in the four quarters prior to enrollment

†The level change, representing the immediate effect of IPC enrollment, is the change in the rate of utilization in the first quarter after enrollment, compared to the quarter immediately prior to enrollment

‡The post-enrollment slope represents trends in the rate of utilization in the quarters after enrollment

§The trend change is the percent change in the post-intervention slope, compared to the pre-intervention slope

–Model estimate not obtained due to sparse utilization pre- and post-enrollment

SUD clinic IRRs=1.12/1.10), no immediate change (level change p 's>0.05), but declining specialty SUD visits over time (post-enrollment slope IRR=0.92).

DISCUSSION

Integrated service delivery models that address addiction and SDOH hold promise for improving patient- and systems-level outcomes. In an IPC clinic for patients with histories of SUDs, homelessness, and unmet medical and social needs, we found improved primary care engagement and reductions in acute care and specialty mental health and SUD services following clinic enrollment. The largest changes were observed for patients with historically high levels of ED use. And yet, for other patients with histories of homelessness or SUDs, increasing trends in ED visits and hospitalizations prior to IPC were attenuated upon IPC enrollment. These findings demonstrate that increasing primary care capacity to address addiction and SDOH may benefit health systems striving to reduce acute care overuse.

A unique contribution of this study is the examination of trends in utilization post-intervention. In the case of ED visits and hospitalizations, utilization among the high ED use group not only fell immediately after IPC enrollment but also continued to decline over a 12-month period. Importantly, the reductions in acute care services observed in quarters 6 and 7 surpassed all baseline levels (quarters 0–3), suggesting meaningful change in the trajectory of acute care services among those with histories of high use. One hypothesized reason for this pattern is that some patients may require fewer ED services or hospitalizations over time when receiving more

preventive services and better chronic care management in primary care.³¹ For example, IPC patients taking prescribed or illicit opioids are educated about and offered naloxone overdose kits, which have shown effectiveness in mitigating overdose risk.³² Likewise, contextual risks (e.g., environment) for patients engaging in high-risk behaviors or demonstrating symptoms of early progressive chronic diseases can be addressed within an integrated care team to avert adverse events.

Unlike the continuous decline in ED visits following enrollment in IPC, the initial increase in primary care visits diminished in later time periods for all groups. Early rises in primary care use likely relate to an uptick in preventive services, medication monitoring, and/or chronic disease management. But because patients sometimes enter primary care in a period of crisis, later reductions in primary care use may reflect crisis resolution or improved management of chronic health conditions. It is important to note that, despite a diminished effect, primary care visits following IPC remained higher than baseline levels. Given this IPC's clinical focus on SUD prevention and treatment, some sustained primary care use could be attributable to retention in primary care-based SUD treatment. An important avenue for future research is to determine whether, for those with SUDs, IPC approaches like the VIP Initiative's clinical model offer superior quality of care compared to traditional delivery models.

While primary care visits increased overall, we found that much of the increase in primary care utilization was for visits to non-prescribing providers. In this IPC, nurse care managers,

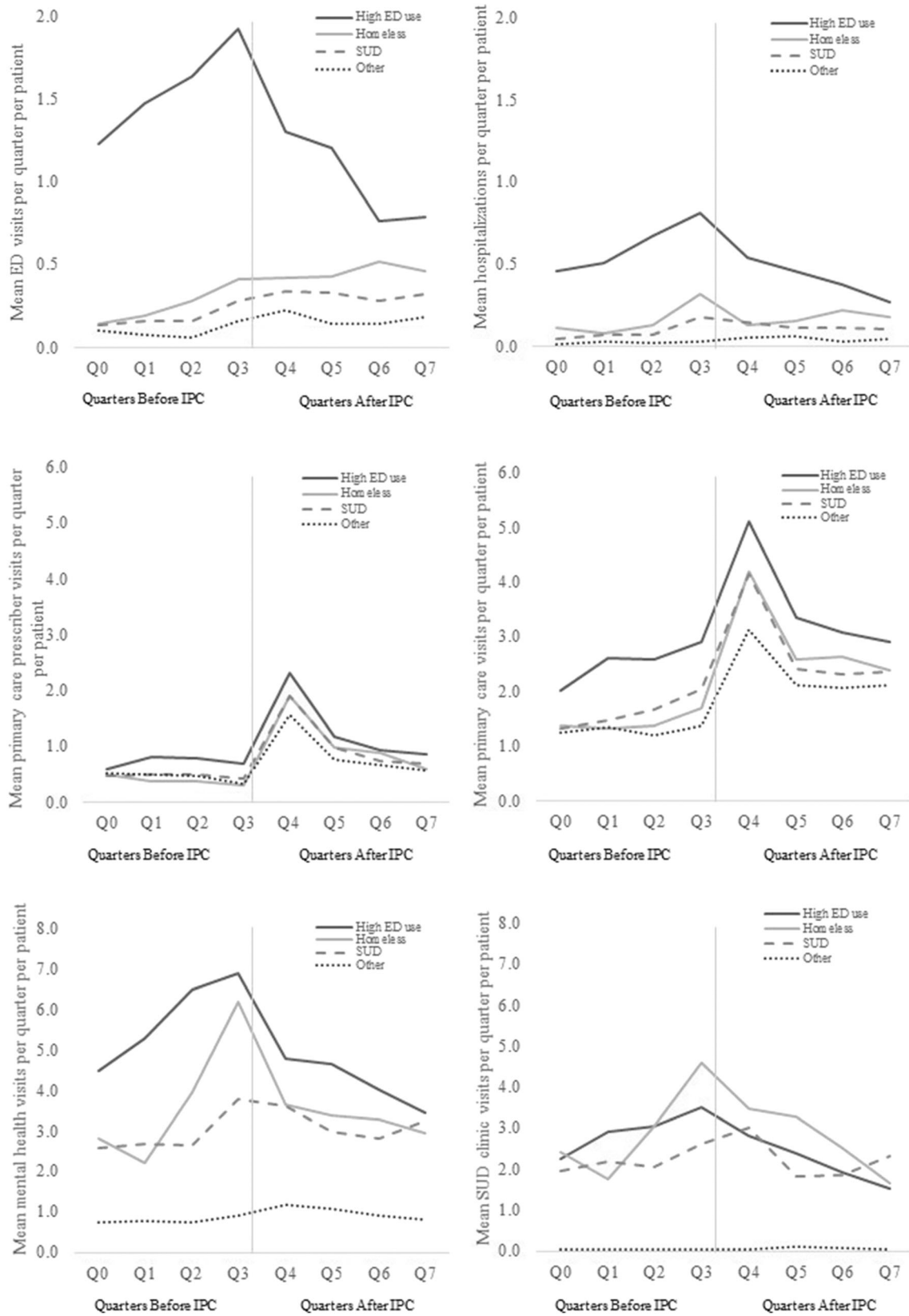


Figure 1 Patterns of health care utilization for patients with histories of high ED use, homeless experiences, and substance use disorder (SUD) diagnoses, before and after enrolling in an integrated primary care (IPC) clinic for Veterans with addiction, social determinants of health, or other vulnerabilities

social workers, and mental health pharmacy specialists play vital roles in addressing medical and social vulnerabilities, including SUDs, homelessness, and other contextual complexities.³³ These roles include SUD pharmacotherapy, opioid education, and naloxone distribution (harm reduction), and providing linkages to housing and specialty behavioral health services. For most subgroups, we observed reductions in visits to specialty mental health and SUD clinics post-intervention suggesting a shifting of services to the IPC setting. An important area for additional study is to determine whether such changes are cost-neutral or even cost-saving over time.

This study has limitations. First, the observational study design limits causal interpretations. Second, patients were hierarchically grouped to facilitate model stratification. Substantial clinical overlap exists between high ED use, homelessness, and addiction. Third, the group of patients who did not meet core subgroup criteria was clinically heterogeneous, challenging the interpretation of effects for this population. Fourth, the study is limited by its lack of non-intervention comparison groups. It is possible the changes in utilization observed in our study represent mean reversions rather than strong intervention effects. While this is possible, our pre/post comparisons and trend analyses offer compelling evidence of some sustained changes that would not be observed with simple mean reversions. Finally, this study did not measure changes in other specialty services that might illustrate referral processes (e.g., pain clinic, whole health) and changes in chronic disease management. Additional research that includes matched controls, longer follow-up periods, and specialty care utilization would offer more robust estimates of the long-term effects of IPC approaches.

While there is a growing interest in providing SUD prevention and treatment services in primary care settings, optimal approaches have yet to be determined.¹⁹ In this IPC model, staffing and resources to provide SUD prevention, treatment, and recovery services and to facilitate access to behavioral health, social services, and other supports appear effective for reducing problematic patterns of ED use and hospitalizations. Continued evaluation will be essential to determine the sustainability and scalability of this promising model of care going forward.

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Data Availability All data from the VIP study are stored behind secured, password-protected VA servers behind a firewall used by the Department of Veterans Affairs (VA). Data containing confidential identifiers is stored in a secure research environment known as the VA Informatics and Computing Infrastructure (VINCI). Sensitive patient data does not leave the VA environment; only aggregate summary statistics and results of our analyses are permitted to be removed from behind the VA firewall in compliance with the VA information security program policies, procedures, and practices. Access to a deidentified dataset can be made available pending ethical approval and in accordance with VA guidelines. Those wishing to access the study data may contact the corresponding author to discuss the VA data access approval process.

Declarations:

Conflict of Interest: All authors were employed or contracted by the Department of Veterans Affairs and the Vulnerable Veteran Innovative Patient-Aligned Care Team (VIP) Initiative during the preparation of this manuscript. AJG receives an honorarium for an online chapter on alcohol management in the perioperative period from the UpToDate online reference; and is on the board of directors (not-for profit; not remunerated) for the American Society of Addiction Medicine (ASAM), the Association for Multidisciplinary Education and Research in Substance use and Addiction (AMERSA), and the International Society of Addiction Journal Editor (ISAJE), all non-for-profit organizations.

REFERENCES

1. Jones AL, Kertesz SG, Hausmann LRM, et al. Primary care experiences of veterans with opioid use disorder in the Veterans Health Administration. *J Subst Abuse Treat.* 2020;113:107996.
2. Hoggatt KJ, Frayne SM, Saechao FS, Yano EM, Washington DL. Substance use disorder-related disparities in patient experiences of primary care. *Health Equity.* 2019;3(1):193-197.
3. Jones AL, Hausmann LRM, Haas GL, et al. A national evaluation of homeless and nonhomeless veterans' experiences with primary care. *Psychol Serv.* 2017;14(2):174-183.
4. Kendall CE, Boucher LM, Mark AE, et al. A cohort study examining emergency department visits and hospital admissions among people who use drugs in Ottawa, Canada. *Harm Reduct J.* 2017;14(1):16.
5. Doran KM, Rahai N, McCormack RP, et al. Substance use and homelessness among emergency department patients. *Drug Alcohol Depend.* 2018;188:328-333.
6. Gundlapalli AV, Jones AL, Redd A, et al. Characteristics of the highest users of emergency services in Veterans Affairs Hospitals: homeless and non-homeless. *Stud Health Technol Inform.* 2017;238:24-27.
7. Painter JM, Malte CA, Rubinsky AD, et al. High inpatient utilization among Veterans Health Administration patients with substance-use disorders and co-occurring mental health conditions. *Am J Drug Alcohol Abuse.* 2018;44(3):386-394.
8. Cornell PY, Halladay CW, Ader J, et al. Embedding social workers in Veterans Health Administration primary care teams reduces emergency department visits. *Health Aff.* 2020;39(4):603-612.
9. Stephenson MD, Lisy K, Stern CJ, Feyer AM, Fisher L, Aromataris EC. The impact of integrated care for people with chronic conditions on hospital and emergency department utilization: a rapid review. *Int J Evid Based Healthc.* 2019;17(1):14-26.
10. O'Toole TP, Johnson EE, Borgia M, et al. Population-tailored care for homeless veterans and acute care use, cost, and satisfaction: a prospective quasi-experimental trial. *Preven Chronic Dis.* 2018;15:E23.
11. Jones AL, Thomas R, Hedayati DO, Saba SK, Conley J, Gordon AJ. Patient predictors and utilization of health services within a medical home for homeless persons. *Subst Abuse.* 2018;39(3):354-360.
12. Domino ME, Kilany M, Wells R, Morrissey JP. Through the looking glass: Estimating effects of medical homes for people with severe mental illness. *Health Serv Res.* 2017;52(5):1858-1880.
13. Grove LR, Gertner AK, Swietek KE, et al. Effect of enhanced primary care for people with serious mental illness on service use and screening. *J Gen Intern Med.* 2021;36(4):970-977.
14. Yoon J, Chang E, Rubenstein LV, et al. Impact of primary care intensive management on high-risk veterans' costs and utilization: a randomized quality improvement trial. *Ann Intern Med.* 2018;168(12):846-854.

15. Saitz R, Cheng DM, Winter M, et al. Chronic care management for dependence on alcohol and other drugs: the ahead randomized trial. *JAMA*. 2013;310(11):1156-1167.
16. Wakeman SE, Rigotti NA, Chang Y, et al. Effect of integrating substance use disorder treatment into primary care on inpatient and emergency department utilization. *J Gen Intern Med*. 2019;34(6):871-877.
17. Watkins KE, Ober AJ, Lamp K, et al. Collaborative care for opioid and alcohol use disorders in primary care: the summit randomized clinical trial. *JAMA Intern Med*. 2017;177(10):1480-1488.
18. Brackett CD, Duncan M, Wagner JF, Fineberg L, Kraft S. Multidisciplinary treatment of opioid use disorder in primary care using the collaborative care model. *Subst Abus*. 2021:1-5.
19. Lagisetty P, Klasa K, Bush C, Heisler M, Chopra V, Bohnert A. Primary care models for treating opioid use disorders: what actually works? A systematic review. *PLoS One*. 2017;12(10):e0186315.
20. Lavoie MC, Langenberg P, Villaveces A, et al. Effect of Maryland's 2011 alcohol sales tax increase on alcohol-positive driving. *Am J Prev Med*. 2017;53(1):17-24.
21. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther*. 2002;27(4):299-309.
22. Clemans-Cope L, Wishner JB, Allen EH, Lallemand N, Epstein M, Spillman BC. Experiences of three states implementing the Medicaid health home model to address opioid use disorder-case studies in Maryland, Rhode Island, and Vermont. *J Subst Abuse Treat*. 2017;83:27-35.
23. Codell N, Kelley AT, Jones AL, et al. Aims, development, and early results of an interdisciplinary primary care initiative to address patient vulnerabilities. *Am J Drug Alcohol Abuse*. 2021;47(2):160-169.
24. McFarland MS, Groppi J, Jorgenson T, et al. Role of the US Veterans Health Administration clinical pharmacy specialist provider: shaping the future of comprehensive medication management. *Can J Hosp Pharm*. 2020;73(2):152-158.
25. Rosland AM, Nelson K, Sun H, et al. The patient-centered medical home in the Veterans Health Administration. *Am J Manag Care*. 2013;19(7):e263-272.
26. Peterson R, Gundlapalli AV, Metraux S, et al. Identifying homelessness among veterans using VA administrative data: opportunities to expand detection criteria. *PLoS One*. 2015;10(7):e0132664.
27. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005;43(11):1130-1139.
28. Clinical classification software refined (CCSR). In: Healthcare Cost and Utilization Project (HCUP). Rockville, MD: Agency for Healthcare Research and Quality; 2021: www.hcup-us.ahrq.gov/toolssoftware/ccsr/ccs_refined.jsp. Accessed 10/20/2021.
29. Heyworth L, Kirsh S, Zulman D, Ferguson JM, Kizer KW. Expanding access through virtual care: the VA's early experience with COVID-19. *NEJM Catalyst Innovations in Care Delivery*. 2020;1(4). <https://doi.org/10.1056/CAT.20.0327>
30. Byers AL, Allore H, Gill TM, Peduzzi PN. Application of negative binomial modeling for discrete outcomes: a case study in aging research. *J Clin Epidemiol*. 2003;56(6):559-564.
31. Hollander MAG, Cole ES, Donohue JM, Roberts ET. Changes in Medicaid utilization and spending associated with homeless adults' entry into permanent supportive housing. *J Gen Intern Med*. 2021;36(8):2353-2360.
32. Walley AY, Xuan Z, Hackman HH, et al. Opioid overdose rates and implementation of overdose education and nasal naloxone distribution in Massachusetts: interrupted time series analysis. *BMJ*. 2013;346:f174.
33. Radmall A, Calder S, Codell N, et al. Roles and perceptions of nurses during implementation of medication treatment for opioid use disorder national initiative. *J Addict Nurs* (in press).

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