

Veterans with Post-Traumatic Stress Disorder in the
Patient Centered Medical Home:
Assessing utilization patterns
and identifying key medical home elements

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Abstract

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The Veterans Health Administration (VHA) started implementing a patient-centered medical home (PCMH) model—named Patient Aligned Care Teams (PACT)—across the nation in 2010. The PACT initiative focused on seven foundational principles: 1) creating patient-driven services, 2) offering team-based care, 3) increasing care efficiency, 4) providing comprehensive care including access to specialists, 5) developing longitudinal patient relationships, 6) improving communication, and 7) developing coordinate care. Key features of

the PACT model hold promise to improve primary care and reduce avoidable utilization of resource-intensive services for vulnerable and high-need patient subpopulations. At the VHA, one such group is Veterans with Post-Traumatic Stress Disorder (PTSD), a condition with high prevalence among Veterans that is associated with combat trauma. To date, we are unaware of existing research that provides a comprehensive assessment of the effect of PTSD on utilization patterns across a range of utilization outcomes, utilizes a control group, or explores individual associations between PACT elements and utilization outcomes.

This dissertation research seeks to address these knowledge gaps by addressing the following research questions: 1) What is the association between whether a Veteran with PTSD received care in the pre- or post-PACT period, and the quarterly utilization rates for key health services? 2) What is the effect of receiving care in a high-PACT implementation clinic on utilization patterns, compared to receiving care in a low-PACT implementation clinic? 3) What is the association between PACT elements and clinic-level utilization rates for hospitalizations and ED encounters for all eight PACT elements developed in the PI²: 1) Access, 2) Continuity, 3) Care Coordination, 4) Comprehensiveness, 5) Self-Management Support, 6) Patient-Centered Care and Communication, 7) Shared Decision Making, and 8) Delegation, Staffing and Team Functioning.

Results from Chapter 2 indicate that Veterans receiving care in the post-PACT period experienced significantly lower utilization rates of hospitalizations and specialty care, and higher primary care rates. Results from Chapter 3 research indicate that Veterans that received care in VHA clinics with high levels of PACT implementation experienced decreased utilization rates for hospitalizations, specialty mental health, urgent care and emergency department (ED) utilization, compared to a low-level of PACT implementation. We did not find an increase in

primary care rates in Chapter 3, and effect sizes for changes in utilization and mental health visits were modest. In Chapter 4, we found that high levels of Access, Comprehensive Care and Self-Management Support were associated with significantly lower ED utilization rates. We did not find any significant associations between PACT elements and hospitalization rates.

This dissertation research provides ample evidence that PACT is driving changes in utilization patterns and reducing downstream utilization of resource-intensive health services. There is also some evidence that PACT is intensifying primary care, or potentially improving primary care, which is causing the subsequent decline in hospitalizations, and specialty, urgent and emergent care. Finally, this research sheds light on three PACT elements that were associated with decreases in ED utilization-- Access, Comprehensive Care and Self-Management Support—offering evidence to health systems and policymakers about high-impact interventions within the PCMH model.

This dissertation is dedicated to my Dad. I know you would be proud of me.

“He who has a why to live for, can bear almost any how.” ~ Nietzsche

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Chapter 1: Introduction

1.1 Background

A high-quality primary care system is the cornerstone of an effective health care system.^{1,2} High-quality primary care—characterized as having both a usual source of primary care and receiving key features of primary care such as longitudinal, coordinated, comprehensive and evidence-based care—is associated with lower mortality rates, improved health status, and reduced rates of hospital and emergency department (ED) utilization.^{3,4,5} The lack of a strong primary care system is a principal reason why the United States has the second highest health care costs per capita in the world, yet still performs poorly relative to other developed nations on key outcomes such as life expectancy, infant mortality, and mortality amenable to medical care.⁶ Health systems in other developed countries invest more in primary care and have similar or better health outcomes at an average of half the per capita costs of the United States.⁷ In short, our country is less healthy and less wealthy because of our underperforming primary care system.

Although reform efforts at the local, state and federal levels continue to drive improvements in access, affordability and quality of health services,⁸ the health care system remains specialized, fragmented and resource intensive,⁹ and adults across the country face barriers to accessing primary care.¹⁰ The provision of primary care (as opposed to specialty care) is associated with more equitable health outcomes,⁴ as well as greater efficiency in the provision of health services.⁶ Reform efforts, spearheaded by the Affordable Care Act (ACA) and bolstered by subsequent legislation, promulgation of federal and state rules, and private sector efforts, have rightly focused on improving primary care and integrating physical and behavioral

health care.¹¹ One critical aim of health reform efforts has been the promotion of the Patient Centered Medical Home (PCMH) model to bolster primary care. The ACA, for example, contains several provisions that seek to drive the implementation of the PCMH model in health systems across the country.¹²

In 2010, the Veterans Health Administration (VHA) implemented a PCMH model—known as Patient Aligned Care Teams (PACT)—to increase access to care, intensify preventive health services, and drive better care coordination between primary, specialty and behavioral health care,¹³ among multiple aims. The PACT model was implemented at about 1,000 VHA hospital-based and community clinics across the country.¹⁴ The PACT initiative focused on seven foundational principles to guide design and implementation: 1) creating patient-driven services, 2) offering team-based care, 3) increasing care efficiency, 4) providing comprehensive care including access to specialists, 5) developing longitudinal patient relationships, 6) improving communication, and 7) developing coordinate care.¹⁵ PACT builds on VHA reforms enacted in the 1990s when the VHA began its evolution from a system of loosely organized hospitals into a regionally integrated health system providing inpatient and outpatient care.¹⁶ Key changes pursued through PACT include multidisciplinary care teams responsible for caring for empaneled patients;¹⁴ enhanced patient access accomplished by advanced access scheduling,¹⁷ shared medical appointments, virtual and telephonic patient touches, and secure messaging;¹⁶ increased nurse care management; and, augmented health self-promotion efforts activated by health promotion specialists,¹⁸ among others. The VHA PACT initiative has been described in greater detail in several other studies.^{14,16,19}

The PCMH model, and the PACT model specifically, holds promise to intensify primary care, improve health outcomes, reduce unnecessary utilization of health services,²⁰ and reduce

racial disparities in health outcomes.²¹ A 2016 literature review of PCMH programs found that 23 of 25 studies included in the review found reductions in utilization, with many of them observing decreases in ED utilization and hospitalizations.^{22,23} Literature reviews have also found that more mature PCMH programs achieved greater success in decreasing utilization of resource-intensive services like ED, specialty and inpatient care.²⁰ Some studies have also found that the PCMH model led to improvements in patient satisfaction and clinical process measures, though the evidence is less consistent for these outcomes.^{20,24,25} At the VHA, research examining utilization patterns for the entire VHA patient population found that PACT was associated with an increase in primary care visits and small decreases in hospitalizations and outpatient mental health specialty visits.¹⁹

The PACT model is uniquely promising for the VHA population because of the prevalence of mental health conditions among Veterans, and specifically the high rate of Post-Traumatic Stress Disorder (PTSD). The prevalence of PTSD among Veterans is higher than among the general public²⁶ and is associated with combat trauma.²⁷ Among Operation Iraqi Freedom (OIF) and Enduring Freedom (OEF) combat Veterans, the prevalence of PTSD is an estimated 14%; for Veterans of the Gulf War, the prevalence is an estimated 12%, and for Vietnam Veterans, the prevalence is an estimated 15%.²⁸ All of these rates are significantly higher than the general population.²⁸ Veterans with mental illness also suffer from high levels of physical comorbidity, with highly prevalent rates of pain, hypertension and diabetes.²⁹ In the broader public, mental illness is two to three times more common in patients with chronic medical illnesses such as diabetes, arthritis, chronic pain, neurological pain, and heart disease.^{30,31} And left untreated, mental illness leads to functional impairment, noncompliance with treatment plans and adverse health behaviors.^{32,33,34}

Features of the PACT model that could potentially impact Veterans with PTSD differentially include same-day specialist access, coordinated and longitudinal team-based care with specialists including mental health specialists, and proactive outreach to high-need patients through telephonic and virtual medical appointments.¹⁴ The availability of more timely, accessible and clinically appropriate care through PACT also presents an opportunity to improve the provision of care for PTSD through various therapeutic modalities, including cognitive-based and pharmacotherapy treatments. The team-based care model utilizes clinical pharmacists to manage patients through proactive patient outreach,¹⁶ creating the potential for better medication management and adherence. And the availability of an enhanced online Personal Health Record (PHR)—an element of PACT—can improve the effectiveness of pharmacotherapy as Veterans are better able to manage and track their medications.³⁵ Likewise, enhanced care coordination with physical and mental health specialists and empaneled patient relationships allow for more intensive patient follow-up and communication, enabling clinical teams to address the complex and often traumatogenic interplay of comorbid physical and behavioral conditions. All of these features are capable of improving primary care, and subsequently improving health outcomes decreasing the high rates of mortality among Veterans with PTSD.³⁶ Conversely, failure to provide high-quality primary care can lead to exacerbations of mental illness and subsequent declines in physical health, which can in turn further worsen a Veteran's mental health status.³⁷ PTSD symptoms are believed to hinder a patient's coping mechanisms and diminish a patient's ability to address the sequella of various illnesses and social factors that may arise;³⁸ PTSD is associated with greater instability in the home, higher levels of relationship distress,⁸ and higher rates of negative inter-personal relationships with children⁹ and partners,¹⁰ presenting deleterious social factors that can adversely impact health.³⁹

While the evidence base about the effectiveness of PACT continues to grow, researchers have repeatedly called for additional research to explore how PCMH impacts important patient subpopulations, such as patients with chronic disease, behavioral health issues, and vulnerable and socioeconomically diverse patient populations.²² Researchers have also called for future research to measure the impact of PCMH in more mature medical home models to fully capture the PCMH effect,²² and to conduct implementation studies to assess how the nature and scope of implementation modified the effect of the PCMH.²³ There is also a broad recognition that future research needs to better measure the extent of PCMH implementation at individual providers, to better understand how varying levels of implementation affect outcomes—much of the existing research has relied on using a binary indicator of PCMH implementation, which fails to capture how varying levels of implementation impact outcomes. The renewed call to expand and grow the evidence base about the medical home is accompanied by heightened incentives and momentum to implement the PCMH, and an expanding base of advocates for the model.⁴⁰

1.2 Research Aims

This dissertation seeks to pursue the aforementioned research opportunities by employing increasingly rigorous estimation methods and study designs to assess the effect of PACT on utilization patterns for Veterans with PTSD. This patient population is a uniquely vulnerable patient population—on average, Veterans are older, sicker and have lower incomes than the general population⁴¹—and has been identified as a priority research population by the VHA and the Department of Defense (DOD).⁴² This research project also seeks to explore and identify which PACT elements may be individually associated with estimated reductions in certain utilization outcomes, to inform future PCMH efforts that target Veterans with PTSD and enable

clinical leaders and policymakers to identify and implement high-impact interventions within the PCMH model.

The PACT initiative was officially implemented simultaneously across the VHA, yet there has been significant variation in the nature and breadth of implementation at VHA clinics.^{18,43} Similar to much of the early research conducted about the PCMH, previous research about PACT at the VHA often assumed a uniform, binary implementation of the intervention, failing to capture important differences in the implementation at different provider sites and systems. This heterogeneous implementation provided an opportunity to measure varying levels of PACT implementation—and varying levels of implementation of different elements of the PACT model—and catalyzed efforts by VHA researchers to develop an instrument to measure the nature and breadth of PACT implementation. Researchers subsequently developed the PACT Implementation Progress Index (PI²) to measure the nature of PACT implementation across eight PCMH domains (herein referred to as elements).⁴³

For this dissertation, we initially used observational data from VHA clinical and administrative databases to create a pre-post study design to estimate the association between PACT and the utilization of key health services.⁴⁴ We then worked with a larger research team at the VHA (including authors Randall and Maynard) to develop the PI², the validated instrument to measure the nature and extent of PACT implementation at individual clinics. This enabled the creation of a control group to strengthen the study design and enable causal inference from estimates of utilization outcomes.⁴³ We then employed an interrupted time series design to measure the effect of PACT on utilization patterns, using a larger time period, more years of post-implementation data, and controlling for an earlier 2007 Primary Care Mental Health Integration (PCMHI) that co-located mental health and primary care services in a subset of VHA

clinics.²⁹ Finally, we aggregated the results of the interrupted time series study to the clinic level to identify quarterly clinic-level utilization rates, and then assessed the relationship between a clinic's score on the eight different PACT elements defined in the PI² and the estimated change in utilization attributable to the PACT implementation.

Specific Aims

Aim 1: Measuring the association between whether care was received in the pre- or post-PACT period and the utilization of key health services.

Aim 1 investigates the association between whether the patient received care in the pre- or post-PACT period and the quarterly utilization rates for key health services—specifically, hospitalizations and primary, specialty, mental health, ED and urgent care. We utilized a pre-post design and fit both negative binomial regression and extended estimating equation models to estimate average marginal effects and incidence rate ratios.

Aim 2: Measuring the effect of receiving care in a high-PACT implementation clinic on the utilization rate of key health outcomes, compared to receiving care in a low-PACT implementation clinic.

Aim 2 investigates the effect of receiving care in a high-PACT implementation clinic on the same utilization outcomes tested in Aim 1, compared to receiving care in a low-PACT implementation clinic. We employed an interrupted time series study design and fit a multilevel mixed-effects negative binomial regression model, and then estimated average marginal effects and incidence rate ratios. High- and low-PACT implementation cohorts were developed using the top and bottom quartiles from the distribution of the PI² to measure the extent and nature of

PACT implementation at VHA clinics across eight domains.

Aim 3: Measuring the association between PACT elements and utilization among Veterans with PTSD at the VHA.

Aim 3 investigates the association between PACT elements and clinic-level utilization rates for hospitalizations and ED encounters for all eight PACT elements developed in the PI²: 1) Access, 2) Continuity, 3) Care Coordination, 4) Comprehensiveness, 5) Self-Management Support, 6) Patient-Centered Care and Communication, 7) Shared Decision Making, and 8) Delegation, Staffing and Team Functioning. We used the interrupted time series study design from Aim 2, and tested the effect of being in the top quartile of a particular PACT element compared to being the bottom quartile. We fit a random effects negative binomial regression and then estimated average marginal effects and incidence rate ratios at the clinic level.

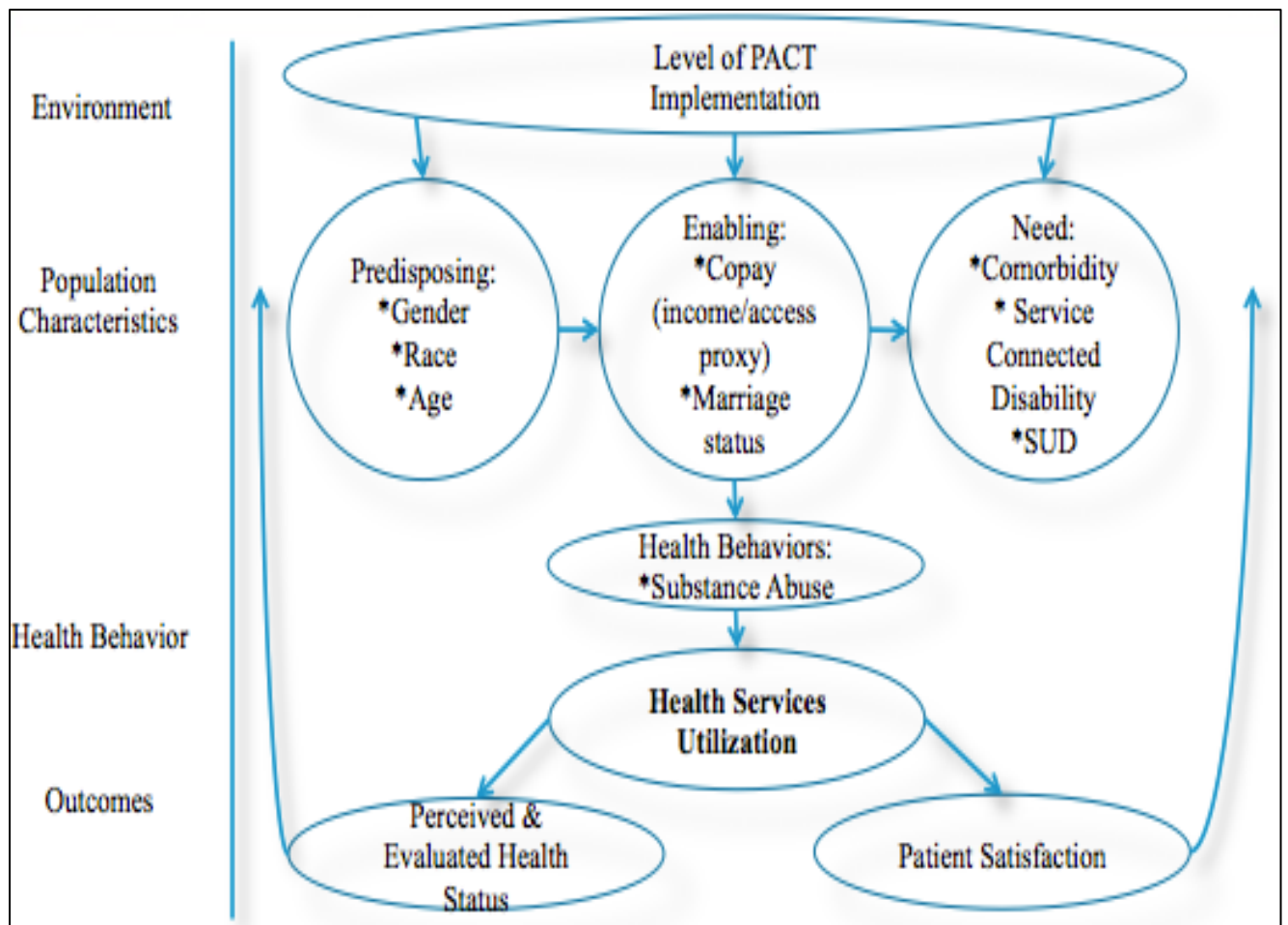
1.3 Overarching Conceptual Framework

An overarching conceptual framework is presented in Figure 1.1. The conceptual model depicts the relationship between the level of PACT implementation, patient characteristics, health behaviors and utilization outcomes. This proposal's conceptual model hypothesizes a priori that the relationship between PACT and health services utilization may be modified by a Veterans having PTSD, a central motivation for this research proposal. The conceptual framework developed to hypothesize pathways through which PACT may affect the utilization and costs of key health services for Veterans with PTSD draws on the behavioral model of health service utilization originally developed by Donabedian, positing a conceptualization of structure, process and outcomes elements to examine health services and evaluate quality of care.^{45,46} The conceptual model also draws on the models developed by Andersen and Newman, and Andersen's revised model, that conceptualize environmental and population characteristics as

determinants of utilization and include a feedback loop from outcomes to predisposing, enabling and need determinants.^{47,48} Anderson's model hypothesizes relationships between population characteristic factors that impact health behavior and health services utilization.⁴⁸ Predisposing factors hypothesized to confound the PACT-health services utilization association include gender, race and age; enabling factors include socioeconomic and marriage status; and need factors include comorbidity (as measured by the Elixhauser comorbidity score), service-connected disability and presence of Substance Use Disorder (SUD).

The model also reflects the relationship between the receipt of health services and predisposing, enabling and need variables that impact a patient's ability to access health services. A key feature of this model is the recognition that both the effectiveness of the PACT model, as well as the patient's individual characteristics and health behaviors, are believed to impact the patient's ultimate utilization of services. The receipt of health services—specifically, the receipt of high-quality primary care—has a downstream impact on perceived and evaluated health status, and patient satisfaction. These health outcomes then feed back into the patient's health status, specifically impacting enabling and need variables. Variables represented by the intermediate “Health Services Utilization” outcome level include hospitalizations, and primary care, specialty care, mental health, ED and urgent care service utilization.

Figure 1.1: Overarching Conceptual Framework



1.4 References

1. Ginsburg J, Doherty R, Ralston F, Senkeeto N. Achieving a High-Performance Health Care System with Universal Access: What the United States Can Learn from Other Countries. *Ann Intern Med.* 2008;148:55–75.
2. Landon BE, Gill JM, Antonelli RC, Rich EC. Prospects for rebuilding primary care using the patient-centered medical home. *Health Aff.* 2010;29(5):827–834.
3. Caminal J, Starfield B, Sánchez E, Casanova C, Morales M. The role of primary care in preventing ambulatory care sensitive conditions. *Eur J Public Health.* 2004;14(3):246–51.
4. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *Milbank Q.* 2005;83(3):457–502.
5. Nielsen M, Gibson A, Buelt L, Grundy P, Grumbach K. The Patient-Centered Medical Home’s Impact on Cost and Quality Quality: Annual Review of Evidence 2013-2014.; 2015.
6. Davis K, Stremikis K, Squires D, Schoen C. Mirror, mirror on the wall: How the performance of the U.S. health care system compares internationally. *Commonwealth Fund.* 2014;(June):1–32.
7. Landon BE, Gill JM, Antonelli RC, Rich EC. Prospects for rebuilding primary care using the Patient-Centered Medical Home. *Health Aff.* 2010;29(5).
8. Obama BJ. United States Health Care Reform. *JAMA J Am Med Assoc.* 2016;316(5):525–532.
9. Bodenheimer T, Pham HH. Primary care: Current problems and proposed solutions. *Health Aff.* 2010;29(5):799–805.
10. Bodenheimer MD T, Grumbach MD K, Berenson MD R. A Lifeline for Primary Care. *N Engl J Med.* 2009;26(26):2693–2696.
11. Cassidy A. Patient-Centered Medical Homes. A new way to deliver primary care may be more affordable and improve quality. But how widely adopted will the model be?; 2010.
12. Davis K, Abrams M, Stremikis K. How the Affordable Care Act Will Strengthen the Nation’s Primary Care Foundation. *J Gen Intern Med.* 2011;26(10):1201–1203.
13. Klein B, Leffler KB, Journal T, Aug N. The Role of Market Forces in Assuring Contractual Performance. *J Polit Econ.* 2006;89(4):615–641.
14. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation’s Largest Integrated Delivery System. 2011;16(September).
15. Kearney LK, Post EP, Zeiss A, Goldstein MG, Dundon M. The role of mental and behavioral health in the application of the patient-centered medical home in the Department of Veterans Affairs. *Transl Behav Med.* 2011;1(4):624–8.
16. Rosland A-M, Nelson K, Sun H, et al. The Patient-Centered Medical Home in the Veterans Health Administration. *Am J Manag Care.* 2013;19(7):e263-72.
17. Murray M, Berwick DM. Advanced Access. *JAMA.* 2003;289(8):1035–1040.
18. Helfrich CD, Dolan ED, Fihn SD, et al. Association of medical home team-based care functions and perceived improvements in patient-centered care at VHA primary care clinics. *Healthcare.* 2014;2(4):238–244.
19. Hebert PL, Liu C-F, Wong ES, et al. Patient-Centered Medical Home Initiative Produced Modest Economic Results For Veterans Health Administration, 2010-12. *Health Aff.* 2014;33(6):980–987.

20. Nielsen M, Gibson A, Patel K, Nichols L. The Patient-Centered Medical Home's Impact on Cost and Quality: Annual Review of Evidence, 2014-2015.; 2016.
21. Hernandez SE. A First Look at the Patient-Centered Medical Home for Minority Veterans : Implementation and Utilization. 2015.
22. Nielsen M, Olayiwola JN, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost & Quality: Annual Update of the Evidence, 2012-2013.; 2014.
23. Peikes D, Zutshi A, Genevro J, Smith K, Parchman M, Meyers D. Early Evidence on the Patient-Centered Medical Home.; 2012.
24. Hoff T, Weller W, DePuccio M. The patient-centered medical home: a review of recent research. *Med Care Res Rev.* 2012;69(6):619–44.
25. Jackson G, Powers B, Chatterjee R, Bettger JP. The Patient-Centered Medical Home: A Systematic Review. *Ann Intern Med.* 2013;158(3):169–178.
26. Thielke S, Vannoy S, Unutzer J. Integrating Mental Health and Primary. *Prim Care Clin Off Pract.* 2007;34(3):571–592.
27. Richardson L, Frueh BC, Acierno R. Prevalence Estimates of Combat-Related PTSD: A Critical Review. *Aust N Z J Psychiatry.* 2010;44:4–19.
28. Gradus J. Epidemiology of PTSD; 2016.
29. Trivedi RB, Post EP, Sun H, et al. Prevalence, comorbidity, and prognosis of mental health among US veterans. *Am J Public Health.* 2015;105(12):2564–2569.
30. Katon W, Unutzer J, Fan M-Y, Williams J. Cost-Effectiveness and Net Benefit of Enhanced Treatment of Depression for Older Adults With Diabetes and Depression. *Diabetes Care.* 2006;29(2):265–270.
31. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. *Biol Psychiatry.* 2003;54(3):216–226.
32. Scott KM, Bruffaerts R, Tsang A, et al. Depression-anxiety relationships with chronic physical conditions: Results from the World Mental Health surveys. *J Affect Disord.* 2007;103(1–3):113–120.
33. Kinnunen T, Haukkala A, Korhonen T, Quiles ZN, Spiro A, Garvey AJ. Depression and smoking across 25 years of the Normative Aging Study. *Int J Psychiatry Med.* 2006;36(4):413–26.
34. Cronin-Stubbs D, Leon CFM De, Beckett LA, Field TS, Glynn RJ, Evans DA. Six-Year Effect of Depressive Symptoms on the Course of Physical Disability in Community-Living Older Adults. *Arch Intern Med.* 2000;160:3074–3080.
35. Burton L, Anderson G, Kues I. Using electronic health records to help coordinat care. *Hum Resour Abstr.* 2005;4:2005.
36. Simon, GE, VonKoff M BW. Health care costs of primary care patients with recognized depression. *Arch Gen Psychiatry.* 1995;52(10):850–856.
37. M.B. H, Hamner MB. Exacerbation of posttraumatic stress disorder symptoms with medical illness. *Gen Hosp Psychiatry.* 1994;16(2):135–137.
38. Alonzo A. The experience of chronic illness and posttraumatic stress disorder: the consequences of cumulative adversity. *J Cardiovasc Nurs.* 1999;13(3):33–45.
39. Pincus T, Esther R, DeWalt D a, Callahan LF. Social conditions and self-management are more powerful determinants of health than access to care. *Ann Intern Med.* 1998;129(5):406–11.
40. Backer LA. The Medical Home: An Idea Whose Time Has Come ... Again. *Fam Pract Manag.* 2007;14(8):38–41.

41. Kessler CS, Bhandarkar S, Casey P, Tenner A. Predicting patient patterns in veterans administration emergency departments. *West J Emerg Med.* 2011;12(2):204–7.
42. VA, DOD to Fund \$100 Million PTSD and TBI Study. American Forces Press Service. 2012.
43. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med.* 2014;174(8):1350–8.
44. Randall I, Maynard C, Chan G, Devine B, Johnson C. Assessing the effect of the VHA PCMH on utilization among Veterans with PTSD.; 2016.
45. Donabedian A. Evaluating the quality of medical care. 1966. *Milbank Q.* 2005;83(4):691–729.
46. Donabedian A. Basic Approaches to Assessment: Structure, Process, and Outcome. *Explorations in quality assessment and monitoring: The definition of quality and approaches to its assessment.* Heal Adm Press. 1980;1.
47. Andersen RM. Revisiting the Behavioral Model and Access to Medical Care: Does It Matter? *J Health Soc Behav.* 1995;36(March):1–10.
48. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc.* 1973;51(1):95–124.

Chapter 2: VHA Patient-Centered Medical Home associated with lower utilization of inpatient and specialty care among Veterans with Post-Traumatic Stress Disorder

2.1 Abstract

Background: The Veterans Health Administration (VHA) implemented a patient-centered medical home (PCMH) model, termed Patient-Aligned Care Teams (PACT), in 2010. We assessed the association between PACT and the utilization of health services among US Veterans with Post-Traumatic Stress Disorder (PTSD).

Study Design: We analyzed VHA clinical and administrative data to conduct a pre-post implementation study. Data were obtained for the pre-PACT period of April 1, 2009 – March 31, 2010 and post-PACT period of June 1, 2011 – May 31, 2012. Outcomes included hospitalizations, primary, specialty and mental health visits, and emergency department and urgent care utilization rates.

Methods: We utilized both negative binomial regression and extended estimating equation models for the full sample. We also stratified negative binomial models to create < 65 and ≥ 65 models to account for Medicare eligibility. The final analysis contained 696,379 unique Veterans in both pre- and post-PACT periods; 336,123 (48%) had PTSD diagnosis codes in both periods, creating an imbalanced longitudinal sample. We estimated the linear incremental effect of PACT on utilization outcomes.

Results: In the full sample population, PACT was associated with a decrease in hospitalizations (Incremental Effect: -0.02, 95% Confidence Interval: -0.03, -0.01), a decrease in specialty care visits (IE: -0.45, 95% CI: -0.07, -0.23), and an increase in primary care visits (IE: 0.96, 95% CI: 0.67, 1.25). We observed largely similar directional results in the stratified < 65 model. In the \geq 65 model, we found an increase in primary care visits and a decrease in ED visits, but an increase in specialty care visits.

Conclusion: In the period following the PACT implementation, we observed a higher rate of primary care visits, suggesting improved access to care. For Veterans under 65, PACT was associated with less hospitalizations and specialty care visits, while for Veterans 65 or older, PACT was associated with more specialty care visits. Future research should investigate the effect of PACT using longitudinal data and measure the level of PACT implementation to enable causal inference.

2.2 Background

The Patient-Centered Medical Home (PCMH) model has been identified as a promising innovation to bolster primary care and improve quality.^{1,2} The VHA implemented a version of PCMH, referred to as the Patient Aligned Care Team (PACT) model, in 2010. Various features of PACT—including improved longitudinal care coordination and chronic disease management, timely access to clinician networks including specialists, and intensified preventive health interventions, among others^{3,4}—offer potential advantages to improve primary care and reduce inpatient and specialty care, especially for patients with chronic conditions.⁵ Key PACT components include redesigning care processes and increasing staffing ratios; improving access to primary and specialty care and expanding the use of shared and virtual appointments; and, implementing health information technology to better coordinate care, manage chronic illness and provide evidence-based medicine.⁶ The PACT initiative has been described in greater detail in several VHA studies.^{6,7,8,9} More detail about PACT elements are outlined in Figure 2.1.

Researchers have emphasized the need to study the PCMH model's impact on high-risk and vulnerable patient subgroups.^{1,10} One vulnerable subgroup is Veterans with PTSD, a condition with high prevalence among Veterans that is often related to combat trauma.¹¹ Patients with PTSD have high levels of psychiatric and physical comorbidity¹² and high rates of health services utilization.¹³ PTSD is also highly prevalent among Veterans: longitudinal studies found that deployment increased PTSD incidence in active-duty, Reservists and National Guard members.¹⁴ US combat Veterans demonstrate a two- to four-fold increase in PTSD prevalence compared to civilians,¹⁵ equating to a 7-14% prevalence. Veterans also face distinctive barriers to receive mental health care¹⁶ and underutilize mental health services relative to stated intentions.¹⁷

The PCMH model has been found to be effective in treating mental illness in randomized controlled trials.¹⁸ Because primary care is a main avenue for the diagnosis and treatment of mental illness¹⁹—and primary care physicians are critical in linking patients with appropriate mental health care²⁰—intensified primary care may enable better treatment of mental illness. Integrating primary care and mental health treatment strategies has been shown to reduce costs relative to usual care.^{21,22} Moreover, integrating mental health specialists and primary care practices may reduce patient visits and lower costs.⁶ Patients with mental illness use more health services and have higher expenses than those without, even after controlling for higher comorbidity levels associated with mental illness.^{23,24} If mental illness is treated more effectively, there is an opportunity to reduce costs and improve care for physical health.²⁵

The PMCH model has been promoted and implemented in various environments, including private and government health systems, medical centers, commercial payers, and State Medicaid programs.⁵ While research points to a trend of favorable findings about PCMH's effect on utilization and cost, we lack conclusive evidence that the PCMH model improves access or reduces cost, particularly for vulnerable patient populations with chronic conditions.^{1,5,10} We hypothesized that PACT may be beneficial in reducing hospitalizations, emergency department (ED) and specialty care visits, and enhancing access to primary care. Hospitalizations and ED visits are sometimes representative of sub-optimal care and often signify breakdowns that could have been prevented with better primary care.²⁶ We also hypothesized that Medicare eligibility may moderate the association between PACT and utilization because some Veterans may receive care at non-VA facilities that is paid for by the Medicare program, instead of seeking care at a VA facility.²⁷ This study assessed the association between PACT and health service utilization

among Veterans with PTSD, explored how Medicare eligibility might confound the association, and highlighted areas for future research.

2.3 Methods

We conducted a pre-post implementation study to explore the associations between PACT implementation and utilization outcomes using clinical and administrative data from the VHA's Corporate Data Warehouse (CDW). Inpatient and outpatient encounter data were obtained from VHA Inpatient and Outpatient Treatment Files. The study population was an imbalanced longitudinal (e.g., a repeated cross-sectional) sample. Veterans with PTSD were identified by ICD-9 diagnosis code 309.81. Veterans with at least one inpatient or 2 outpatient encounters that included the PTSD ICD-9 code within one year of the respective cohort period were defined as having PTSD. Data were obtained for the pre-PACT period of April 1, 2009 – March 31, 2010 and post-PACT period of June 1, 2011 – May 31, 2012. The pre-PACT time period corresponds to the year directly before PACT implementation occurred on April 1, 2010. Veterans were only eligible for the study if they were in the Primary Care Management Module, an indicator of receiving empaneled primary care from an assigned provider team. This meant that Veterans included in the sample had the opportunity to experience potential effects of the PACT initiative in the primary care setting.

Main Measures

The independent variable of interest was a binary indicator of whether a Veteran received care in the pre-PACT (value of 0) or post-PACT period (value of 1). Our primary outcomes were counts of VHA health services. These outcomes included: 1) hospitalizations, 2) primary care

visits, 3) specialty care visits, 4) mental health visits, 5) ED visits and 6) urgent care visits. The samples for the ED and urgent care models were limited to a sub-sample of clinics due to coding inconsistencies at many VHA clinics. With respect to covariates, we adjusted for age, gender, race, VHA co-pay status (an indicator of access and financial resources), percent service connected disability, diagnosis of Substance Use Disorder, and Elixhauser comorbidity index. Patient race data were obtained from the VHA data sources as well as Medicare data provided to VHA. ICD-9 codes were obtained for all encounters and were used to identify patients with PTSD as well as adjust for comorbid conditions using the Elixhauser method.²⁸

Statistical methods

We specified both negative binomial regression and extended estimating equation models for all utilization outcomes. The negative binomial model allows for flexibility in the mean-variance equality assumption,²⁹ while extended estimating equation models allow for flexible mean and variance structures.³⁰ Extended estimating equations uses the data to estimate the link function and mean-variance relationship, offering improved model fit if the log-linear link incorrectly specifies the link function.³⁰ We tested the extended estimating equation models for all outcomes to validate the estimates of the negative binomial regression. Both models were assessed for goodness of fit using the Pearson Correlation, Pregibon's Link and Hosmer-Lemshow tests. We specified clustering at the clinic level and estimated robust standard errors, producing estimates that are both cluster and heteroskedastic-robust.³¹ Post-estimate Wald tests were utilized to test the significance of coefficients. Results were considered significant at $\alpha=0.05$.

For both models, we calculated incidence rate ratios to estimate the percent change in utilization. We then applied the method of recycled predictions to estimate the incremental change in utilization on the additive scale.³² Estimates represent the average incremental linear effect of receiving care in the post-PACT period on the number of utilization encounters for a specific outcome. In the negative binomial models, results were stratified by age (< 65 and \geq 65) to assess potential confounding effects of Medicare eligibility.⁸

2.4 Results

We screened administrative records for 5,116,918 Veterans in the pre-PACT period and 5,631,664 Veterans in the post-PACT period for PTSD. We identified 461,980 Veterans with PTSD in the pre-PACT period and 575,579 Veterans in the post-PACT period, resulting in an estimated pre-PACT prevalence of 9.03% and a post-PACT prevalence of 10.22%. The analysis included 696,379 unique Veterans from both pre- and post-PACT periods; 336,123 (48%) had PTSD in both periods, creating an imbalanced longitudinal sample. The final sample included Veterans with PTSD in both periods and those with PTSD in only one period, to avoid introducing confounding due to age and health status. Characteristics of individuals in the pre- and post-PACT periods are shown in Table 1.

In the negative binomial models, the adjusted incremental effect on hospitalizations was -0.02 (95% confidence interval (CI): -0.03, -0.01). This equates to an estimated 8.6% reduction in hospitalizations in the post-PACT period. The incremental effect on specialty care visits was -0.45 (95% CI: -0.067, -0.23), an estimated 7.54% decrease in the post-PACT period. The incremental effect on primary care visits was 0.96 (95% CI: 0.67, 1.25), an estimated 10.79% increase in the post-PACT period. We did not find significant PACT effects on mental health,

ED, or urgent care visits (Table 2). In the extended estimating equation models, we found directional associations between PACT and hospitalizations and primary and specialty care visits that were of similar magnitudes to those estimated in negative binomial models (Table 3).

Finally, we stratified negative binomial models to examine associations between PACT and utilization outcomes for Veterans < 65 , and Veterans ≥ 65 . In the < 65 model, we found identical directional findings to the full-sample models, with significantly lower hospitalizations and specialty care visit rates and higher primary care visit rates in the post-PACT period. In the ≥ 65 model, however, we observed significant increases in both primary and specialty care visits, no significant decrease in hospitalizations, and significant decreases in urgent care visits in the post-PACT period (Table 4, 5).

2.5 Discussion

Intensified primary care resulting in better access to primary and specialty clinicians, enhanced management of chronic illness, and longitudinal relationships with dedicated care teams are only some of the PACT components that can bolster primary care and reduce downstream utilization of resource-intensive specialty and inpatient care. This research sought to determine if hypothesized effects on utilization could be observed among a particularly vulnerable patient population, Veterans with PTSD. Results indicate that the PACT model holds promise to enhance primary care and reduce hospitalizations and high-cost specialty care for Veterans with PTSD. Among the general Veteran population with PTSD, both statistical models found significant decreases in hospitalizations and specialty care visits as well as significant increases in primary care. These results are largely consistent with an earlier VHA study assessing utilization for the broader Veteran population, which also found increased rates of

primary care visits and decreases rates of hospitalizations.⁸ It is unclear which elements of the PACT model may have led to these types of changes, so further investigation may be helpful to assess what factors led to an increase in primary care visits while reducing specialist visits. These results also held in the < 65 stratified model; the only discordant results occurred in the ≥ 65 stratified model, where we saw no association with hospitalizations.

The implementation of PACT, however, did not appear to lower utilization rates, as hypothesized, in mental health or urgent care. While urgent care and ED visit rates appeared to decrease slightly, they did not reach a level of significance for the study. Potentially, PTSD patients may still have had emergent issues that could not be handled by their PACT provider and team. It was also unclear why mental health visit rates did not change. It could be that patients are getting many needs addressed in primary care, but also rely on specialty mental health services for certain services, like therapeutic counseling not provided in primary care, or to receive pharmaceutical agents typically prescribed by psychiatrists.

Finally, this study indicates that among Veterans with PTSD, problems related to primary care access at the VA do not appear to be driven by the PACT implementation. While many Veterans have experienced long wait times for primary care visits within the VA system, Veterans with PTSD have experienced an overall increase in primary care visits. Given the recent attention paid to long waiting times for initial primary care appointments, this research provides evidence that PACT has not had a detrimental impact on access for this vulnerable Veteran population.

Limitations

There are several key limitations to this study. The pre-post study design limits the ability

to infer causality because of potential for residual endogeneity from unmeasured or unobserved confounders driven by differences between pre- and post-PACT cohorts. Additionally, findings about the effect of PACT on PTSD patients' health services utilization may not be generalizable to other patient populations because the Veteran population is older, primarily male, and with high rates of comorbidity and mental illness.³³ One of the shortfalls of the existing body of PMHC literature is that many evaluations have taken place in practices that are part of larger delivery systems and lacked generalizability to the wider public.¹⁰ This study does not serve to remedy that deficit. Another limitation is that we identified PTSD patients by administrative ICD-9 codes rather than the PTSD Checklist (PCL), which is a more reliable method for PTSD screening.³⁴ The use of ICD-9 codes carries the risk of miscoding or missing proper diagnoses at several stages of the care continuum.³⁵ However, PCL data were not available for many Veterans at the VHA. Finally, we did not measure the extent of PACT implementation at individual clinics, and thereby assumed a uniform level of implementation that is unlikely.

Conclusion

Features of the PACT model hold promise to improve health care for Veterans with PTSD. Despite these limitations, our results indicate there is an association between PACT and health care utilization for Veterans with PTSD. The increased rate of primary care visits after PACT implementation holds promise to improve the quality of primary care over time and further reduce mental and physical illness exacerbations that can lead to specialty care, hospitalizations, and ED and urgent care visits. Considered in their totality, these results add to the mostly positive trend of findings about the PCMH model, although we encourage readers to interpret these results with caution. We recommend that future research utilize panel data over a

longer time period and identify a control group to establish causal inferences. Furthermore, we believe that results indicate a need for further research to explore why older Veterans may not be benefiting equally from PACT's intensified primary care model.

Figure 2.1 Descriptions of PACT Elements

PACT Element	Description
<p>Enhancing Access</p>	<ul style="list-style-type: none"> * Offer same day appointments and same-day access to specialists * Increase shared medical appointments * Increase non-appointment care through wider access to and use of electronic messaging and telephone appointments/consultations * Actively identify and mitigate barriers to care for vulnerable patient populations
<p>Improving Care Management & Coordination</p>	<ul style="list-style-type: none"> * Identify and proactively manage care for high-risk and chronically ill patients * Rationalize care to allow physicians and nurse practitioners to focus on higher need patients, while delegating non-critical tasks to other team members * Measure performance on key process and outcome indicators as well as patient experience for defined patient populations
<p>Redesigning Clinical Practices</p>	<ul style="list-style-type: none"> * Develop multidisciplinary care teams that consist of physicians, nurse practitioners or registered nurses, clinical assistants such as LPNs, and a medical clerk * Increase staffing levels of core PACT teamlet and ancillary providers to meet PACT staffing ratio guidelines * Care teams (PACT teamlets) are responsible for providing longitudinal care for an assigned patient population * Redesign scheduling practices to promote easier patient access

Table 2.1 Patient characteristics in pre-PACT and post-PACT Period

Characteristic	Pre-PACT Mean (N=461,980)	Post-PACT Mean (N=575,579)
Age (years)	54.7	54.9
Male (%)	92.4	91.7
Black race (%)	16.4	16.7
Other race (%)	18.0	18.5
Elixhauser Comorbidity Index	0.83	0.81
No copay (%)	93.4	94.1
Service connected disability (%)	53.2	57.8
Substance use disorder (%)	13.5	13.8

Table 2.2 Multivariable Results: Negative Binomial Regression Models

Utilization Outcome	IE (95% CI)	Delta Method Standard Error	Percent change from pre-PACT to post-PACT
Hospitalizations	-0.02* (-0.03, -0.01)	0.01	-8.61%*
Primary care visits	0.96* (0.67, 1.25)	0.15	10.79%*
Specialty care visits	-0.45* (-0.07, -0.20)	0.11	-7.54%*
Mental health visits	-0.40 (-1.12, 0.31)	0.37	-1.59%
Emergency department visits	-0.01 (-0.16, 0.14)	0.08	-0.59%
Urgent care visits	-0.16 (-0.35, 0.03)	0.10	-15.54%

IE: Incremental Effect; CI: Confidence Interval

* Denotes statistically significant difference in means based on t-test, results were considered significant at $\alpha=0.05$.

Table 2.3 Multivariable Results: Extended Estimating Equation Models

Utilization Outcome	IE (Min, Max)	Standard Deviation	Percent change from pre-PACT to post-PACT
Hospitalizations	-0.02* (-0.05, -0.01)	0.005	-6.18%*
Primary care visits	1.23* (0.85, 2.14)	0.185	13.60%*
Specialty care visits	-0.38* (-0.92, -0.26)	0.079	-6.19%*
Mental health visits	-0.36 (-0.63, 0.26)	0.080	-1.48%
Emergency department visits	n/a ^a		
Urgent Care Visits	n/a ^a		

* Statistically significant difference in means, results were considered significant at $\alpha = 0.05$.

^a EEE model did not converge for ED and urgent care subsample populations.

IE, incremental effect; CI, confidence interval.

Table 2.4 Multivariable Results: Negative Binomial Regression Results: < 65

Utilization Outcome	IE (95% CI)	Standard Deviation	Percent change from pre-PACT to post-PACT
Hospitalizations	-0.021* (-0.031, -0.011)	0.005	-9.41%*
Primary care visits	0.938* (0.774, 1.103)	0.084	11.23%*
Specialty care visits	-0.140 * (-0.189,-0.091)	0.025	-2.56%*
Mental health visits	-0.586 (-1.345, 0.172)	0.387	-2.20%
Emergency department visits	0.085 * (0.040, 0.130)	0.023	4.59%*
Urgent Care Visits	-0.146 (-0.194,-0.098)	0.024	-13.9%

*Statistically significant difference in means, results were considered significant at $\alpha = 0.05$.
IE, incremental effect; CI, confidence interval.

Table 2.5 Multivariable Results: Negative Binomial Regression Results: ≥ 65

Utilization Outcome	IE (95% CI)	Standard Deviation	Percent change from pre-PACT to post-PACT
Hospitalizations	-0.002 (-0.051, 0.510)	0.026	-0.001%
Primary care visits	1.239* (1.012, 1.466)	0.116	11.86%*
Specialty care visits	0.243* (0.116, 0.369)	0.065	-3.49%*
Mental health visits	-0.659(-2.942, 1.624)	0.116	-3.34%
Emergency department visits	-0.012 (-0.092, 0.067)	0.041	-0.76%
Urgent Care Visits	-0.170* (-0.255, -0.086)	0.043	-18.47%*

*Statistically significant difference in means, results were considered significant at $\alpha = 0.05$.
IE, incremental effect; CI, confidence interval.

2.6 References

1. Jackson G, Powers B, Chatterjee R, Bettger JP. The Patient-Centered Medical Home: A Systematic Review. *Ann Intern Med.* 2013;158(3):169–178.
2. Stange KC, Nutting P a, Miller WL, et al. Defining and measuring the patient-centered medical home. *J Gen Intern Med.* 2010;25(6):601–12.
3. Reid RJ, Coleman K, Johnson E a, et al. The group health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health Aff (Millwood).* 2010;29(5):835–43.
4. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA.* 2002;288(15):1909–14.
5. Nielsen M, Olayiwola JN, Grundy P, Grumbach K. The Patient-Centered Medical Home’s Impact on Cost & Quality: Annual Update of the Evidence, 2012-2013.; 2014.
6. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation’s Largest Integrated Delivery System. 2011;16(September).
7. Rosland A-M, Nelson K, Sun H, et al. The Patient-Centered Medical Home in the Veterans Health Administration. *Am J Manag Care.* 2013;19(7):e263-72.
8. Hebert PL, Liu C-F, Wong ES, et al. Patient-Centered Medical Home Initiative Produced Modest Economic Results For Veterans Health Administration, 2010-12. *Health Aff.* 2014;33(6):980–987.
9. Nelson K, Helfrich C, Sun H, et al. Validation of a Method to Assess Implementation of the Patient Centered Medical Home (PCMH) in the Veterans Health Administration (VHA).; 2014.
10. Peikes D, Zutshi A, Genevro J, Smith K, Parchman M, Meyers D. Early Evidence on the Patient-Centered Medical Home.; 2012.
11. Richardson L, Frueh BC, Acierno R. Prevalence Estimates of Combat-Related PTSD: A Critical Review. *Aust N Z J Psychiatry.* 2010;44:4–19.
12. Magruder KM, Frueh BC, Knapp RG, et al. Prevalence of posttraumatic stress disorder in Veterans Affairs primary care clinics. *Gen Hosp Psychiatry.* 2005;27(3):169–79.
13. Outcalt SD, Yu Z, Hoen HM, Pennington TM, Krebs EE. Health Care Utilization Among Veterans with Pain and Posttraumatic Stress Symptoms. *Pain Med.* 2013.
14. Litz B. PTSD in Service Members and New Veterans of the Iraq and Afghanistan Wars: A Bibliography and Critique. *PTSD Res Q.* 2009;20(1):1–8.
15. Thielke S, Vannoy S, Unutzer J. Integrating Mental Health and Primary. *Prim Care Clin Off Pract.* 2007;34(3):571–592.
16. Brooks E, Novins DK, Thomas D, et al. Personal characteristics affecting veterans’ use of services for posttraumatic stress disorder. *Psychiatr Serv.* 2012;63(9):862–7.
17. Jakupcak M, Hoerster KD, Blais RK, Malte CA, Hunt S, Seal K. Readiness for Change Predicts VA Mental Healthcare Utilization Among Iraq and Afghanistan War Veterans. *J Trauma Stress.* 2013;26(February):165–168.
18. Reid RJ, Fishman P a, Yu O, et al. Patient-centered medical home demonstration: a prospective, quasi-experimental, before and after evaluation. *Am J Manag Care.* 2009;15(9):e71-87.
19. Wang PS, Demler O, Olfson M, Pincus H a, Wells KB, Kessler RC. Changing profiles of service sectors used for mental health care in the United States. *Am J Psychiatry.* 2006;163(7):1187–98.
20. Croghan T, Brown J. Integrating Mental Health Treatment Into the Patient Centered

- Medical Home. *AHRQ Publ.* 2010;10:1–23.
21. Bower P, Gilbody S. Managing Common Mental Health Disorders In Primary Care : Conceptual Models And Evidence Base. *Br Med J.* 2005;330(7495):839–842.
 22. Pyne JM, Rost KM, Zhang M, Williams DK, Smith J, Fortney J. Cost-effectiveness of a primary care depression intervention. *J Gen Intern Med.* 2003;18(6):432–41.
 23. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. *Biol Psychiatry.* 2003;54(3):216–226.
 24. Katon W, Ciechanowski P. Impact of major depression on chronic medical illness. *J Psychosom Res.* 2002;53(4):859–63.
 25. Katon W, Unutzer J, Fan M-Y, Williams J. Cost-Effectiveness and Net Benefit of Enhanced Treatment of Depression for Older Adults With Diabetes and Depression. *Diabetes Care.* 2006;29(2):265–270.
 26. Caminal J, Starfield B, Sánchez E, Casanova C, Morales M. The role of primary care in preventing ambulatory care sensitive conditions. *Eur J Public Health.* 2004;14(3):246–51.
 27. Zhu CW, Penrod JD, Ross JS, Dellenbaugh C, Sano M. Use of Medicare and Department of Veterans Affairs health care by veterans with dementia: a longitudinal analysis. *J Am Geriatr Soc.* 2009;57(10):1908–14.
 28. Sharabiani MT a, Aylin P, Bottle A. Systematic review of comorbidity indices for administrative data. *Med Care.* 2012;50(12):1109–18.
 29. Cameron AC, Trivedi PK. Regression-Based Tests For Overdispersion In the Poisson Model. *J Econom.* 1990;46:347–364.
 30. Basu A, Rathouz PJ. Estimating marginal and incremental effects on health outcomes using flexible link and variance function models. *Biostatistics.* 2005;6(1):93–109.
 31. Cameron AC, Trivedi PK. *Microeconomics Using Stata: Revised Edition.* Revised Ed. Stata Press; 2010.
 32. Kleinman LC, Norton EC. What’s the Risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res.* 2009;44(1):288–302.
 33. Kessler CS, Bhandarkar S, Casey P, Tenner A. Predicting patient patterns in veterans administration emergency departments. *West J Emerg Med.* 2011;12(2):204–7.
 34. *Using the PTSD Checklist (PCL).*; 2012.
 35. O’Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. *Health Serv Res.* 2005;40 (5 Pt 2):1620–39.

Chapter 3: Measuring the effect of the Patient-Centered Medical Home on utilization patterns among Veterans with Post-Traumatic Stress Disorder

3.1 Abstract

Background: The Veterans Health Administration (VHA) implemented a patient-centered medical home (PCMH) model in 2010. We examined its effect on the utilization of health services among US Veterans with Post-Traumatic Stress Disorder (PTSD).

Study Design: We analyzed VHA clinical and administrative data to conduct an interrupted time series study. Encounter-level data were obtained for the period of April 1, 2005 through March 31, 2014. We identified 642,660 Veterans with PTSD that were assigned to either a high- or low-PCMH implementation group based on a validated VHA PCMH measurement instrument.

Methods: We measured the effect of high-PCMH implementation on the count of hospitalizations, and primary, specialty care, specialty mental health, emergency department and urgent care encounters, compared to low-PCMH implementation. We fit a multilevel mixed-effects negative binomial regression model and estimated average marginal effects and incidence rate ratios.

Results: Compared to patients in low-PCMH implementation clinics, patients that received care in high-PCMH implementation clinics experienced a decrease in hospitalizations (incremental effect [IE]: -0.036, 95% confidence interval [CI], -0.0371, -0.0342), a decrease in specialty

mental health encounters (IE: -0.009, CI: -0.009, -0.008), a decrease in urgent care encounters (IE: -0.210, CI: -0.212, -0.207) and a decrease in ED encounters (-0.056, CI: -0.057, -0.054).

Conclusions: High PCMH implementation positively affected utilization patterns by reducing downstream utilization of resource-intensive inpatient and specialty care services. Future research should investigate whether the reduction in utilization of health services has resulted in higher levels of virtual and non-face-to-face access, or if PACT has reduced necessary access to care.

3.2 Background

The Veterans Health Administration (VHA) provides care to nearly six million Veterans annually at more than 1,000 clinics located across the country.¹ On April 1, 2010, the VHA implemented a Patient-Centered Medical Home (PCMH)-based Patient Aligned Care Teams (PACT) model across the VHA system. Key goals of the PACT initiative include enhancing patient access, improving care coordination and redesigning clinical teams.² To achieve these goals, VHA clinics have developed multidisciplinary care teams, increased staffing ratios, expanded virtual access for patients and implemented new health information technology tools, among other steps, to drive care coordination and expand access.³ The PACT initiative has been described in greater detail elsewhere.^{3,4,5,6}

Literature reviews have found that elements of the PCMH such as enhanced chronic disease management, longitudinal relationships with empaneled patients, and multidisciplinary care teams have been successful in improving access to primary physical and behavioral health care,^{7,8,9} and reducing downstream utilization of specialty visits¹⁰ and the emergency department.¹¹ However, we lack conclusive evidence that the PCMH model improves care for vulnerable patient populations with chronic conditions.^{8,7,12} One such vulnerable subgroup is Veterans with PTSD, a condition that is often related to combat trauma¹³ and that is highly prevalent among Veterans.¹⁴ This research focuses on how PACT has affected the utilization patterns of Veterans with PTSD at the VHA. The study population was selected because Veterans suffer from PTSD and utilize health services at significantly higher rates than the general public. Combat Veterans demonstrate a two- to four-fold increase in PTSD prevalence compared to civilians,¹⁴ and longitudinal studies found that deployment increased PTSD incidence among service members.¹⁵ Patients with PTSD suffer disproportionately from

psychiatric and physical comorbidity,¹⁶ utilize health services at elevated rates,¹⁷ and face distinctive barriers to receiving mental health care.^{18,19} Furthermore, patients that suffer from mental illness, and PTSD specifically, face unique barriers in adhering to treatment plans and complying with medication regimens.^{20,21}

The PCMH model has shown the potential to reduce resource-intensive health care utilization for high-needs patients.^{8,22} Because the PCMH model intensifies primary care, there is heightened ability for physicians to effectively diagnose and treat patients with mental illness²³ and link patients with mental health care specialists.²⁴ We hypothesized that PACT would increase the rate of primary care encounters and subsequently reduce the rate of hospitalizations, specialty outpatient, urgent care and emergency department encounters. In the United States, mental illness cases are the fastest growing component of emergency department utilization, and patients presenting to the ED with mental illness often have complex psychiatric, medical and social histories.²⁵ Patients with mental health disorders have higher rates of unexplained medical complaints, utilize more specialty care, and have nearly two-fold higher medical costs.¹⁴ Downstream encounters such as inpatient admissions and emergency department visits are often indicative of sub-optimal care and may reflect encounters that could have been prevented with better primary care.²⁶ When mental illnesses such as PTSD are left untreated, it can lead to exacerbations of mental and physical ailments. And the development of physical illness can subsequently worsen the severity of PTSD symptoms,²⁷ creating a harmful feedback loop. If mental health is treated more effectively, there is an opportunity to improve health outcomes and reduce the high mortality rate among Veterans with mental illness,²⁸ and achieve savings from decreased utilization of downstream utilization.^{29,30}

Previous PCMH studies have often been constrained by methodological limitations, including inconsistent definitions of what constitutes a PCMH, an inability to define the level of PCMH implementation and small sample sizes that limit generalizability.³¹ Moreover, PCMH research has often been hampered by an inability to decouple the PCMH model from other practice transformation initiatives, and the confounding influence of Electronic Health Records (EHR).^{10,12} Many PCMH studies have also conducted studies using pre-post study designs, used short time periods of data, or measured several interventions simultaneously.^{8,12} Short time periods in particular are problematic, because research indicates that the longer a PCMH model has been implemented, any true effects become more discernible.⁷ As a result, it is difficult to infer causality from many studies about the PCMH model. Finally, there are still a limited number of studies that have focused on the relationship between PACT and utilization patterns among vulnerable patient populations with mental health conditions, such as Veterans with PTSD.^{7,32}

The ability to assess causation in this study is aided by a number of factors, including an enhanced ability to measure the extent of PACT implementation at VHA clinics, longer time periods to better assess causal relationships, and larger anticipated effect sizes due to higher rates of utilization among Veterans with PTSD. Heterogeneous levels of PACT implementation at VHA clinics—and the subsequent development of a validated instrument to measure PACT implementation at individual VHA clinics—present a unique opportunity to detect potential causal effects of PACT. Lastly, this study was able to control for the potential confounding effects of an earlier Primary Care Mental Health Integration (PC-MHI) that was implemented at a subset of VA clinics starting in 2007.^{33,34}

3.3 Methods

Data and Subjects

Data were collected from VHA administrative databases for the period between April 1, 2005 and March 31, 2014. We collected data on Veterans assigned to 1,006 VHA clinics, and combined clinical, administrative and demographic data. We screened records from 11,546,562 unique Veterans to assess whether they were diagnosed with PTSD. ICD-9 codes were used to identify patients with PTSD as well as for risk adjustment using the Elixhauser method.³⁵

Veterans with at least one inpatient or two outpatient encounters that included the PTSD ICD-9 code (309.81) within one year of a respective quarter were identified as having PTSD in that quarter. Out of all Veterans screened, 1,455,295 were identified as having PTSD in at least one quarter of the research period. Out of these 1,455,295 Veterans, we identified 642,660 Veterans that received care at a clinic that was designated as either a low- or high-PACT implementation clinic. A low-PACT implementation clinic is one with a composite score in the bottom quartile of the PACT Implementation Progress Index (PI²) score distribution, while a high-PACT implementation clinic is one with a composite score in the top quartile. The PI² was developed by researchers to measure the extent of PACT implementation at individual VHA clinics across eight domains that reflect meaningful adoption of the PCMH model.^{36 39}

Veterans were only included in the sample population if they were part of the Primary Care Management Module (PCMM), an indicator of receiving empaneled primary care from an assigned provider team. Only Veterans in PCMM were included because these Veterans would have had at least one primary care visit and would be able to receive the potential benefits of the PACT initiative in the primary care setting. At the clinic level, we utilized administrative data to assign a binary marker for whether a clinic had implemented the Primary Care Mental Health

Integration (PCMHI) initiative. The final sample population was an imbalanced longitudinal (e.g., a repeated cross-sectional) sample. The average Veteran included in the final sample was in the data set for an average of 30 quarters, or 7.5 years, indicating that the majority of Veterans were tracked over a significant period of time and were in the data set in both the pre- and post-PACT periods.

Main Measures

The independent variable of interest was a binary indicator of whether a Veteran was assigned to a VA clinic in the high- or low-PACT implementation cohort, based on whether the clinic's PI² score was in the highest or lowest quartile of the PI² score distribution, respectively. The primary outcomes in this study were the quarterly counts of specific health services. These outcomes included: 1) hospitalizations, 2) primary care encounters, 3) specialty care encounters (excluding mental health), 4) specialty mental health encounters, 5) Emergency Department (ED) encounters, and 6) urgent care encounters. Multivariable regression models adjusted for age, sex, race, VHA co-pay status (an indicator of financial resources and access to care), marriage status, percent service connected disability, and Elixhauser comorbidity score.³⁷

Because we hypothesized that the PCMHI model would likely confound the relationship between PACT and utilization patterns, we included the PCMHI marker as a binary covariate in the multivariable model.

Estimating the effect of PACT on utilization

We conducted an interrupted time series study to explore the effect of PACT on utilization patterns. An interrupted time series design that includes a control group has been

described as a strong quasi-experimental study design, in part because of the ability to control for secular trends (e.g., macroeconomic factors) that would otherwise confound estimated effects.³⁸ We modeled trends in the utilization of specified health outcomes using a multilevel mixed-effects negative binomial regression. Multilevel models have been applied to various health services research studies involving multi-level clustered data and specifically count data.⁴⁰ Multilevel mixed effects models have also been used to model other health services outcomes when the data structure includes multiple clusters of correlated observations.⁴¹ Mixed effects models have been shown to reduce bias from intra-cluster correlation relative to models that ignore clustering at one or more levels.⁴² The imbalanced longitudinal sample data used for this analysis contains correlated observations at both the individual patient level as well as at the clinic level. To account for intra-cluster correlation, the mixed-effects model treats these clusters as random effects and estimates a random intercept and slope for each cluster. In the mixed effects model, the fixed effects are analogous to standard regression coefficients and are estimated directly.

To determine the functional form, we first fit a multi-level mixed effects Poisson model. We then tested for over-dispersion to assess if the mean-variance equality assumption held, as violation of the mean-variance equality assumption may produce unstable estimates.⁴³ Over-dispersion tests were significant, indicating that the mean-variance assumption was violated and the Poisson models were inappropriate.⁴⁴ Consequently, we tested the multilevel mixed effect negative binomial model and assessed goodness of fit using the Pearson Correlation, Pregibon's Link and Hosmer-Lemshow tests. The negative binomial model applies two parameterizations of the over-dispersion. This first is the mean parameterization, where the over-dispersion is a

function of the mean, $1 + \alpha E(Y | x)$, $\alpha > 0$; the second is the constant parameterization, where the over-dispersion is a constant function, $1 + \delta$, $\delta \geq 0$.

We specified clustering at the clinic and patient level and estimated robust standard errors, creating estimates that are cluster- and heteroskedastic-robust.⁴⁵ Post-estimate Wald tests were utilized to test the significance of coefficients. Results were considered significant at $\alpha=0.05$. For interpretation of fixed effects, we calculated incidence rate ratios to estimate the percent change in utilization. We then utilized the recycled predictions method to estimate the incremental effect on utilization on the linear scale.⁴⁶ To obtain this estimated incremental effect, we interpreted the model parameter that interacts: 1) a binary indicator of whether the patient received care a high-PACT implementation clinic, 2) a binary indicator of whether the care was received before or after PACT implementation, and 3) a quarter term centered at PACT implementation. We also estimated the incidence rate ratio, which transforms the log count of services into a percentage change in the count of services for all utilization outcomes. See Figure 3.1 for more detail on the parameterization of the interrupted time series model.

3.4 Results

We screened administrative records from 11,546,562 unique Veterans and identified 1,405,185 Veterans with at least one PTSD diagnosis in the study time frame. Based on the aforementioned criteria for identifying a Veteran with PTSD, the prevalence of PTSD among screened Veterans was 8.7% in the pre-PACT period and 12.2% in the post-PACT period. This is slightly lower than other estimates of PTSD prevalence among Veterans,¹⁴ but may be explained by this study's stringent inclusion criteria. Out of those Veterans with PTSD, 642,660 were assigned to either the case or control groups based on their VA clinic affiliation and were thus

included in the final sample population. Characteristics of individuals with PTSD in the pre- and post-PACT periods are shown in Table 3.1. Before conducting multivariable modeling, we examined unadjusted utilization rates in both the pre-PACT and post-PACT periods. Results in Table 3.2 reflect the mean utilization count for each outcome per quarter across all quarters before for the PACT implementation, and across all quarters after PACT implementation, respectively. Unadjusted post-PACT utilization rates were uniformly higher in the post-PACT period than the pre-PACT period. As anticipated, the most frequent encounters were specialty care, specialty mental health and primary care encounters in both the pre- and post-PACT encounters.

We estimated the average marginal effect of receiving care in a high-PACT implementation clinic, as well as the corresponding incidence rate ratio, for each outcome. The marginal effects can be interpreted as the adjusted average marginal effect of a Veteran receiving care at a clinic identified as a high-PACT implementation clinic, compared to receiving care at a low-PACT implementation clinic, on the count of encounters for a particular utilization outcome. As shown in Table 3.3, the adjusted marginal effect on hospitalizations was an estimated -0.036 (95% confidence interval (CI): -0.037, -0.034). This equates to an estimated 3.3% reduction in hospitalizations per quarter for each Veteran. The adjusted marginal effect on mental health encounters was an estimated -0.009 (95% confidence interval (CI): -0.009, -0.008). This equates to an estimated 0.9% reduction in specialty mental health encounters per quarter for each Veteran. The adjusted marginal effect on ED encounters was an estimated -0.056 (95% confidence interval (CI): -0.057, -0.055). This equates to an estimated 5.5% reduction in ED encounters per quarter for each Veteran. The adjusted marginal effect on urgent care encounters was an estimated -0.210 (95% confidence interval (CI): -0.057, -0.055). This equates to an

estimated 19.0% reduction in urgent care encounters per quarter for each Veteran. We did not find significant PACT effects on primary or specialty care encounters.

3.5 Discussion

Along with improving patient outcomes and patient experience, PACT seeks to reduce per capita cost, in line with Triple Aim goals.⁴⁷ For the PACT model to be successful and to capture savings that offset significant implementation costs,⁶ Veterans must receive improved preventive care to ultimately reduce the use of costly, resource-intensive downstream inpatient, emergency and specialist services. The results from this study indicate that the VA has achieved modest levels of success in reducing the utilization rate of inpatient, specialty mental health, ED and urgent care services. Assuming that access to necessary care has not been jeopardized, this is a promising finding, albeit with slight effects on utilization that are detectable in part because of the very large sample population available.

We hypothesized that primary care encounters would increase after the PACT implementation. For patients to realize the benefits of enhanced primary care, we would anticipate that they would have more frequent, regular contact with their primary care clinician teams. This hypothesized effect was not observed. If PACT is simply driving reduced access to care across the range of health services, it is difficult to conclude that PACT has succeeded in its broader aims. However, it is also possible that primary care encounters have been replaced through virtual or telephonic communication between patients and physicians. Future research should investigate the impact of the PCMH model on the rate of virtual, telephonic and other alternative care modules that may be replacing traditional primary care encounters.

The results of this study are largely positive and indicate that PCMH has led to decreased

utilization of costly inpatient, ED and specialty services for Veterans with PTSD, the types of services that effective primary care and integrated physical and mental health may help avoid. However, PACT may be reducing access to some types of services, with potentially adverse consequences for patient care. Future research should also seek to explore how PACT is affecting key population health measures.

Limitations

Our findings are not necessarily generalizable to broader patient populations because the Veteran population is older, heavily male, and has high rates of mental illness and comorbidity.⁴⁸ This research also took place at a large delivery system, and may not apply to PCMH models in smaller provider settings. An additional limitation is that Veterans were identified as having PTSD by ICD-9 codes,⁴⁹ creating the possibility that some Veterans with PTSD were excluded from the final sample because of coding issues.⁵⁰ Finally, while the estimates of PACT's effects are likely conservative because we are estimating the effect of a Veteran receiving care in a high-PACT clinic compared to a low-PACT implementation clinic, and not comparing the presence and absence of the PCMH model, potentially attenuating the effect size and increasing the possibility of Type II error.

Figure 3.1 Parameterization of Interrupted Time Series Model

For the Interrupted Time Series study design that adjusts for PCMHI, a general specification of the model is as follows:

$$g[E(Y|X)] = \beta_0 + \beta_1 * High_PACT_Implementation + \beta_2 * PACT(0,1) + \beta_3 * QTR + \beta_4 * PCMHI(0,1) + \beta_5 * PACT_QTR + \beta_6 * HPI_PACT + \beta_7 * HPI_QTR + \beta_8 * HPI_PACT_QTR + \beta_9 * PCMHI_QTR + \beta_{10} * PCMHI_PACT + \beta_{11} * PCMHI_HPI + \beta_{12} * PCMHI_HPI_PACT + \beta_{13} * PCMHI_QTR_HPI + \beta_{14} * PCMHI_PACT_QTR + \beta_{15} * X_i + \epsilon_{ij}$$

where: g is a link function estimated using a Flexible Mean Model; HPI=High Pact Implementation (Veteran received care from a clinic in the top quartile of the PI^2 distribution); QTR represents quarter of data centered at PACT implementation on April 1, 2010; PCMHI indicates that the patient had an encounter within the PCMHI module; and, PACT=1 in the post-PACT period.

Table 3.1 Patient characteristics in High- and Low-PACT Implementation Clinics

Characteristic	High-PACT Implementation Clinics: Mean	Low-PACT Implementation Clinics: Mean
Age (years)	54.7	54.9
Male (%)	92.4	91.7
Black race (%)	16.4	16.7
Other race (%)	18.0	18.5
Elixhauser Comorbidity Index	0.83	0.81
No copay (%)	93.4	94.1
Service connected disability (%)	53.2	57.8

Table 3.2 Unadjusted utilization rates per quarter, Pre-PACT and Post-PACT periods

Outcome	Pre-PACT Mean (SD)	Post-PACT Mean (SD)
Hospitalizations	0.03 (0.20)	0.03 (0.21)
Primary care encounters	1.18 (1.61)	1.24 (1.77)
Specialty care encounters	2.51 (2.83)	3.58 (3.15)
Mental health encounters	2.02 (7.01)	2.29 (7.26)
ED encounters	0.020 (0.17)	0.02 (0.20)
Urgent care encounters	0.10 (0.51)	0.14 (0.59)

Table 3.3 Multivariable Results: Average Marginal Effects and Incidence Rate Ratios

Utilization Outcome	ME (95% CI)	Incidence Rate Ratio	Delta Method Standard Error
Hospitalizations	-0.036 ** (-0.037, -0.034)	0.967**	0.001
Primary care encounters	- 0.006 * (-0.011, 0.01)	0.999*	0.009
Specialty care encounters	- 0.001 (-0.003, 0.001)	0.998	0.010
Mental health encounters	-0.009 ** (-0.009, -0.008)	0.992**	0.001
ED encounters	-0.056 ** (-0.057, -0.055)	0.945**	0.001
Urgent care encounters	-0.210 ** (-0.022, -0.020)	0.811**	0.001

ME: Margin Effect; CI: Confidence Interval

* Denotes statistically significant difference in means, results were considered significant at $\alpha=0.05$.

3.6 References

1. Panangala SV. Health Care for Veterans: Answers to Frequently Asked Questions.; 2015.
2. Randall I, Mohr DC, Maynard C. VHA Patient-Centered Medical Home Associated With Lower Rate of Hospitalizations and Specialty Care Among Veterans With Posttraumatic Stress Disorder Abstract : J Healthc Qual. 2014;0(0):1-8.
3. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation's Largest Integrated Delivery System. 2011;16(September).
4. Rosland A-M, Nelson K, Sun H, et al. The Patient-Centered Medical Home in the Veterans Health Administration. Am J Manag Care. 2013;19(7):e263-72.
5. Nelson K, Helfrich C, Sun H, et al. Validation of a Method to Assess Implementation of the Patient Centered Medical Home (PCMH) in the Veterans Health Administration (VHA).; 2014.
6. Hebert PL, Liu C, Wong S, et al. The Economic Effects and Return on Investment of the Veterans Health Administration's Patient Centered Home Initiative, 2010 through 2012.; 2013.
7. Nielsen M, Olayiwola JN, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost & Quality: Annual Update of the Evidence, 2012-2013.; 2014.
8. Jackson G, Powers B, Chatterjee R, Bettger JP. The Patient-Centered Medical Home: A Systematic Review. Ann Intern Med. 2013;158(3):169-178.
9. Stange KC, Nutting P a, Miller WL, et al. Defining and measuring the patient-centered medical home. J Gen Intern Med. 2010;25(6):601-612.
10. Kaushal R, Edwards A, Kern L. Association between the patient-centered medical home and healthcare utilization. Am J Manag Care. 2015;21(5):378-386.
11. Hoff T, Weller W, DePuccio M. The patient-centered medical home: a review of recent research. Med Care Res Rev. 2012;69(6):619-644.
12. Peikes D, Zutshi A, Genevro J, Smith K, Parchman M, Meyers D. Early Evidence on the Patient-Centered Medical Home.; 2012.
13. Richardson L, Frueh BC, Acierno R. Prevalence Estimates of Combat-Related PTSD: A Critical Review. Aust N Z J Psychiatry. 2010;44:4-19.
14. Thielke S, Vannoy S, Unutzer J. Integrating Mental Health and Primary. Prim Care Clin Off Pract. 2007;34(3):571-592.
15. Litz B. PTSD in Service Members and New Veterans of the Iraq and Afghanistan Wars: A Bibliography and Critique. PTSD Res Q. 2009;20(1):1-8.
16. Magruder KM, Frueh BC, Knapp RG, et al. Prevalence of posttraumatic stress disorder in Veterans Affairs primary care clinics. Gen Hosp Psychiatry. 2005;27(3):169-179.
17. Outcalt SD, Yu Z, Hoen HM, Pennington TM, Krebs EE. Health Care Utilization Among Veterans with Pain and Posttraumatic Stress Symptoms. Pain Med. February 2013.
18. Brooks E, Novins DK, Thomas D, et al. Personal characteristics affecting veterans' use of services for posttraumatic stress disorder. Psychiatr Serv. 2012;63(9):862-867.
19. Bower P, Gilbody S. Managing Common Mental Health Disorders In Primary Care : Conceptual Models And Evidence Base. Br Med J. 2005;330(7495):839-842.
20. Kronish IM, Edmondson D, Goldfinger JZ, Fei K, Horowitz CR. Posttraumatic stress disorder and adherence to medications in survivors of strokes and transient ischemic attacks. Stroke. 2012;43(8):2192-2197.
21. Dimatteo MR, Lepper HS, Croghan TW. Depression Is a Risk Factor for Noncompliance With Medical Treatment. Arch Intern Med. 2000;160:2101-2107.

22. Reid RJ, Fishman P a, Yu O, et al. Patient-centered medical home demonstration: a prospective, quasi-experimental, before and after evaluation. *Am J Manag Care*. 2009;15(9):e71-87.
23. Wang PS, Demler O, Olfson M, Pincus H a, Wells KB, Kessler RC. Changing profiles of service sectors used for mental health care in the United States. *Am J Psychiatry*. 2006;163(7):1187-1198.
24. Croghan T, Brown J. Integrating Mental Health Treatment Into the Patient Centered Medical Home. *AHRQ Publ*. 2010;10:1-23.
25. Boudreaux ED, Clark S, Camargo CA. Mood disorder screening among adult emergency department patients: a multicenter study of prevalence, associations and interest in treatment. *Gen Hosp Psychiatry*. 2008;30(1):4-13.
26. Caminal J, Starfield B, Sánchez E, Casanova C, Morales M. The role of primary care in preventing ambulatory care sensitive conditions. *Eur J Public Health*. 2004;14(3):246-251.
27. Hamner M. Exacerbation of posttraumatic stress disorder symptoms with medical illness. *Gen Hosp Psychiatry*. 1994;16(2):135-137.
28. Simon, GE, VonKoff M BW. Health care costs of primary care patients with recognized depression. *Arch Gen Psychiatry*. 1995;52(10):850-856.
29. Katon W, Unutzer J, Fan M-Y, Williams J. Cost-Effectiveness and Net Benefit of Enhanced Treatment of Depression for Older Adults With Diabetes and Depression. *Diabetes Care*. 2006;29(2):265-270.
30. Unützer J, Harbin H, Schoenbaum M, Druss BG. The Collaborative Care Model: An Approach for Integrating Physical and Mental Health Care in Medicaid Health Homes. *Heal Home Inf Resour Cent*. 2013;(May):1-13.
31. Rich E, Lipon D, Libersky J, Parchman M. Coordinating-Care-for-Adults-With-Complex-Care-Needs-White-Paper.; 2012.
32. Peikes D, Chen A, Schore J, Brown R. Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries: 15 randomized trials. *JAMA*. 2009;301(6):603-618.
33. Post E. VA PCMH Integration Update.
34. Brawer P a, Brugh AMT, Martielli RP, et al. Enhancing entrance into PTSD treatment for post-deployment veterans through collaborative/integrative care. *Transl Behav Med*. 2011;1(4):609-614.
35. Sharabiani MT a, Aylin P, Bottle A. Systematic review of comorbidity indices for administrative data. *Med Care*. 2012;50(12):1109-1118.
36. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med*. 2014;174(8):1350-1358.
37. Li B, Evans D, Faris P, Dean S, Quan H. Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases. *BMC Health Serv Res*. 2008;8:12.
38. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. *Acad Pediatr*. 2013;13(6 SUPPL.):S38-S44.
39. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med*.

- 2014;174(8):1350-1358.
40. Rabe-Hesketh, Skrondal. *Multilevel and Longitudinal Modeling Using Stata.*; 2012.
 41. Hedeker D. A mixed-effects multinomial logistic regression model. 2003;1446:1433-1446.
 42. Tenhave TR, Kunselman AR, Tran L. A comparison of mixed effects logistic regression models for binary response. *Stat Med.* 1999;18:947-960.
 43. Cameron AC, Trivedi PK. Regression-Based Tests For Overdispersion In the Poisson Model. *J Econom.* 1990;46:347-364.
 44. Gardner W, Mulvey EP, Shaw EC. Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychol Bull.* 1995;118(3):392-404.
 45. Cameron AC, Trivedi PK. *Microeconomics Using Stata: Revised Edition.* Revised Ed. Stata Press; 2010.
 46. Kleinman LC, Norton EC. What's the Risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res.* 2009;44(1):288-302.
 47. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood).* 2008;27(3):759-769.
 48. Kessler CS, Bhandarkar S, Casey P, Tenner A. Predicting patient patterns in veterans administration emergency departments. *West J Emerg Med.* 2011;12(2):204-207.
 49. *Using the PTSD Checklist (PCL).*; 2012.
 50. O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. *Health Serv Res.* 2005;40(5 Pt 2):1620-1639.

Chapter 4: Investigating the association between Patient Centered Medical Home elements and utilization among Veterans with Post-Traumatic Stress Disorder

4.1 Abstract

Background: The Veterans Health Administration (VHA) implemented a patient-centered medical home (PCMH) model—termed Patient Aligned Care Teams (PACT)—in 2010. We examined how elements of the PACT model team were associated with hospitalizations and emergency department (ED) utilization rates among Veterans with Post-Traumatic Stress Disorder (PTSD).

Study Design: We analyzed VHA clinical and administrative data to conduct an interrupted time series study. Encounter-level data were obtained for the period of April 1, 2005 through March 31, 2014. We aggregated data to the clinic level for 1,006 total clinics to measure the association between a clinic’s performance on specific PACT elements and the rate of hospitalizations and ED encounters.

Methods: We measured the association between a clinic achieving high implementation on a specific PCMH element and clinic-level hospitalizations and ED utilization rates, compared to low implementation of that element. We fit a random effects negative binomial regression model and estimated average marginal effects and incidence rate ratios.

Results: Patients that received care in clinics with high levels of Access (Incidence Rate Ratio (IRR): - 4.35%, 95% CI: 0.917, 0.994), Comprehensiveness (IRR: -4.79%, 95% CI: 0.914,

0.992) and Self-Management Support (IRR: -3.78%, 95% CI: 0.927, 0.999) had lower rates of ED utilization than clinics with low implementation levels of these PACT elements. There were no significant associations between a higher implementation level of any PACT elements and hospitalization rates.

Conclusions: High implementation of Access, Comprehensiveness and Self-Management Support PACT elements were associated with lower rates of ED encounters among Veterans with PTSD. Future research should utilize more rigorous study designs to test the impact of implementing various PCMH elements to test the effectiveness of PCMH elements in the context of implementing PCMH in resource-constrained environments.

4.2 Background

The Veterans Health Administration (VHA) implemented a Patient-Centered Medical Home model, called Patient-Aligned Care Teams (PACT), in 2010.¹ The PACT implementation featured a variety of initiatives, including hiring new primary care providers (PCPs) and mid-level clinicians such as Physician Assistants (PAs) and Nurse Practitioners (NPs) to lower patient: clinician ratios; creating multidisciplinary care teams responsible for cultivating longitudinal patient relationships; and, increasing patient access to care through same-day appointment, co-located physical and behavioral health care, and increased virtual and telephonic access.^{2,3} However, there was a high degree of heterogeneity in the implementation of PACT,² with individual VHA clinics investing resources in disparate practice redesign areas and achieving varying levels of PACT implementation in core PCMH domains.⁴ The VHA PACT initiative has been described in detail elsewhere.^{3,4,5,6}

Heterogeneity in the implementation of the PCMH model is not unique to the VHA. Several literature reviews have noted that significant variation exists in the scope and nature of the PCMH model;⁵ PCMH practices display variation in their implementation, measurement and performance.⁶ Moreover, PCMH practices with high levels of PCMH implementation show significant variation and perform well on different PCMH characteristics.⁷ The recent inclusion of PCMH certification to determine payments under the new Medicare Access and CHIP Reauthorization Act (MACRA) incentive program provides an opportunity to unify around a definition of the PCMH, but at this juncture no such uniform definition exists.⁸ This has led to the renewed call for additional research to identify which components of the medical home have the greatest impact⁵ to best invest resources on high-impact interventions.

A growing body of evidence about the PCMH indicates that the model is successful in

reducing avoidable downstream utilization and costs.^{5,16} The PCMH model also seeks to transition from face-to-face care to a broader spectrum of service modalities that includes co-located physical and behavioral health services, and secure electronic, telephonic, virtual or shared appointments.¹⁷ High-quality primary care achieved by PCMH early adopters has achieved reduced admission and readmission rates¹⁸ as well as reduced ED encounter rates.¹⁹ Subsequent research has found that the PCMH model has been associated with higher rates of secure messaging and telephonic encounters.²⁰ This points to an evolving, integrated primary care system that is providing intensive, patient-centered, high-touch primary care that prevents downstream illness.

There have been myriad calls for improved measurement of the nature and extent of the PCMH model across the spectrum of delivery systems.^{9,10} One consistent limitation of early PCMH research was the underlying assumptions of the binary nature and/or heterogeneity of PCMH implementation.¹¹ This research attempts to address that knowledge gap not only by utilizing a validated instrument that measures PACT implementation at the VHA, but by investigating the specific associations between elements of the PACT model—as measured by the PCMH measurement instrument—and estimated changes in utilization rates of two key utilization outcomes: hospitalizations and emergency department (ED) encounters. We limited this study to those outcomes because previous research has reliably demonstrated an association, and in some cases a causal relationship, between the PCMH model and a reduction of hospitalization and ED utilization rates.^{5,11} Limiting the study to hospitalizations and ED utilization also serves to reduce the possibility of Type I error that arises when testing the effect of an intervention on multiple outcome measures.¹² Secondly, these two outcome are significant cost drivers at the VHA¹³ and are evidence of effective PCMH models because they reflect high-

quality primary care.⁶ The study population is limited to Veterans with Post-Traumatic Stress Disorder (PTSD) at the VHA, building on previous research that explored the effect of PACT on Veterans with PTSD, because of the unique potential for PACT to improve outcomes for Veterans with mental illness through integration of physical and behavioral health services and intensified primary care of comorbid chronic illnesses that are often exacerbated by mental illness.^{9,14,15}

The goal of this study is to assess which specific elements of the PACT model are associated with changes in utilization, to assist policymakers and health system leaders in the implementation of high-impact PCMH initiatives. In response to the widespread call for research investigating the PCMH model's effect on utilization, cost and quality for vulnerable patient populations, studies have focused on the effect of the PCMH model on outcomes for these groups. This paper builds on previous work that explored the effect of PACT implementation on the utilization patterns of Veterans with PTSD at the VHA.²¹ Previous studies have employed various designs and methodological approaches to estimate the association between PACT and utilization, and then estimated the association between PACT and utilization with a validated instrument to measure heterogeneity in PACT implementation across clinics.^{21,22}

4.3 Methods

Data and Subjects

Patient characteristic and utilization data were collected from VHA clinical and administrative databases for the period between April 1, 2005 and March 31, 2014. Data on VHA clinics' PACT implementation levels were obtained from administrative data based on 2014 clinic performance, and clinic-level data on PCMH implementation were obtained from

VHA administrative data. All data were accessed through the VHA Informatics and Computing Infrastructure (VINCI) research portal. Data were collected on Veterans assigned to 1,006 VHA clinics, and we then combined clinical, and administrative data from those clinics to screen for PTSD diagnoses.

We screened records from 11,546,562 unique Veterans to determine whether they were diagnosed with PTSD. ICD-9 codes were used to identify patients with PTSD: Veterans with at least one inpatient or two outpatient encounters that included the PTSD ICD-9 code (309.81) within one year of a respective quarter were identified as having PTSD in that quarter. Out of all Veterans screened, 1,455,295 were identified as having PTSD in at least one quarter of the period from April 1, 2005 to March 31, 2014. The sample was an imbalanced longitudinal sample. Utilization data were then aggregated to the clinic level for each quarter in the study time period. For each model, we limited the study sample to clinics in the top and bottom quartiles of the distribution for individual PACT elements. The unit of analysis was the clinic-quarter dyad.

Measuring PACT: The PACT Implementation Progress Index (PI²)

While there are multiple instruments available to measure PCMH implementation, each instrument has limitations that render it inappropriate to measure PACT implementation at VHA clinics. Existing instruments do not contain domains and items directly relevant to the VHA's unique patient population, which is older, sicker and lower income than the general population.²³ For example, commentators have noted that the National Committee for Quality Assurance (NCQA) Physician Practice Connections Patient-Centered Medical Home™ (NCQA PPC-PCMH) may overemphasize health information technology at the expense of measuring specific

operational innovations.²⁴ Existing instruments also require dichotomous responses as opposed to scaled responses, limiting the ability to detect incremental differences in the implementation of specific PACT domains,^{25,26} or exclude key domains.²⁷

In response, VHA researchers created a validated instrument to measure the nature and extent of PACT implementation at VHA clinics. The PI² measures the extent of PACT implementation across eight domains using data from a VHA PACT Personnel Survey, a CAHPS-PCMH patient survey, and demographic, clinical and utilization data from the VHA's Corporate Data Warehouse (CDW).²⁸ PI² scores for each clinic were calculated by summing: 1) the number of domains in which the clinic scored in the top quartile; and, 2) the number of domains in which the clinic scored the bottom quartile. Thus, scores ranged from 8 (all domain scores in the top quartile) to -8 (all domain scores in the bottom quartile).²⁹

Higher composite scores on the PI² correlate with higher patient satisfaction, higher clinical quality measures scores, lower staff burnout, and lower hospitalization and ED utilization rates.²⁸ The PI² consisted of 53 individual items assigned to the eight overarching PACT elements: 1) Access, 2) Continuity, 3) Care Coordination, 4) Comprehensiveness, 5) Self-Management Support, 6) Patient-Centered Care and Communication, 7) Shared Decision Making, and 8) Delegation, Staffing and Team Functioning. See Figure 4.1 for more detail on PACT domains and items.

There was significant variation in overall PI² scores across clinics and within individual PACT domains. The PI² performed well on standard psychometric tests, with Cronbach's $\alpha = 0.89$, indicating strong internal consistency. Individual PI² domains also had satisfactory Cronbach's α scores: Access (0.63), Continuity (0.67), Comprehensiveness (0.81), Self-Management Support (0.68), Patient-Centered Care and communication (0.95), Shared-Decision

Making (0.75), and Team-Based Care (0.91). The Care Coordination domain had lower internal consistency (0.51). Higher PI2 were associated with high patient satisfaction and quality of care, and lower staff burnout and use of health care services. See Table 4.1 for more detail on variation with PI² domains.

Estimating the association between PACT elements and utilization

We identified clinics that scored in the top and bottom quartiles of each PACT domain. A clinic with a score in the top quartile on a particular domain reflected better performance on that domain. For each element, we then tested the association between whether a clinic was in the top or bottom quartile, and the clinic-level rate of hospitalizations and ED encounters. High hospitalization and ED utilization rates may represent sub-optimal care and care discontinuities that could have been prevented with coordinated primary care.²⁶ The outcomes were thus the quarterly mean clinic-level rate of hospitalizations and the quarterly mean clinic-level rate of ED encounters.

To determine the functional form, we first tested a random effects Poisson model. We then tested for over-dispersion to determine if the mean-variance equality assumption held, as violation of this assumption may produce biased estimates.³⁰ Over-dispersion tests were significant, indicating that the Poisson model was not a good fit.³¹ We then tested a random effects negative binomial model and assessed goodness of fit using the Pearson Correlation, Pregibon's Link and Hosmer-Lemshov tests and found goodness of fit was somewhat improved.

Building on previous VHA research investigating PACT,²² we utilized an Interrupted Time Series study design featuring case and control groups to enable a strong quasi-experimental study design that approximates a randomized controlled trial and further enables causal inference

from estimated effects.^{32,33} The imbalanced longitudinal sample data used for this analysis contains correlated observations at the clinic level. To account for the intra-cluster correlation at the clinic level, we fit random effects models that estimate a random intercept and slope for each clinic.

Post-estimate Wald tests were used to identify significant estimates. Results were considered significant at $\alpha=0.05$. We utilized the recycled predictions method to estimate the marginal effect on utilization.³⁴ To estimate the association between a clinic's performance on PACT elements and utilization rates, we interpreted a model parameter that interacts: 1) a binary indicator of whether the clinic is a high or low performing clinic in a PI² domain, 2) a binary indicator of whether the care was received before or after PACT implementation, and 3) a quarter term centered at PACT implementation in 2010.

4.4 Results

The estimated prevalence of Veterans with PTSD was 8.7% in the pre-PACT period and 12.2% in the post-PACT period. 642,660 Veterans were assigned to either the case or control groups based on their VA clinic affiliation and were included in this research. Characteristics of individuals in low-PACT and high-PACT implementation clinics are shown in Table 4.2. Before conducting multivariable regression modeling, we calculated the pre- and post-PACT utilization rates for the outcomes of interest in this study. Unadjusted hospitalizations and ED utilization rates were higher in the post-PACT period than the pre-PACT period. See Table 4.3 for pre- and post-PACT unadjusted utilization rates.

Estimating the association between PACT elements and utilization rates

For each PACT domain, we estimated the incidence rate ratio and the average marginal effect of receiving care in a clinic that placed in the top quartile of a particular PACT domain, compared to receiving care in a clinic that placed in the bottom quartile of a that PACT domain. We fit separate models for the hospitalization and ED utilization rates. Thus, we ultimately fitted 16 distinct multivariable models. The marginal effects can be interpreted as the adjusted average marginal effect of a Veteran receiving care at a clinic in the top quartile of a particular domain on the count of encounters for a particular utilization outcome. The estimated incidence rate ratio effects and marginal effects are presented below in Table 4.4 for hospitalization rates and Table 4.5 for ED rates.

Results from this study indicate that none of the VHA PACT elements was associated with significant changes in the rate of hospitalizations. There were three elements associated with significant decreases in ED utilization rates: Access (IRR: -4.35%, 95% CI: 0.917, 0.994), Comprehensiveness ((IRR: -4.79%, 95% CI: 0.914, 0.992), and Self-Management Support (IRR: -4.35%, 95% CI: 0.917, 0.994).

4.5 Discussion

The implementation of PACT was a key driver of the VHA's transition from a system of loosely connected inpatient clinics and hospitals to an integrated system of care providing inpatient, ambulatory and behavioral health services. PACT represented an investment of approximately \$3B to transform the VHA's delivery system with a goal of completing PACT implementation by the end of 2014.³⁵ Previous research has identified certain characteristics that are conducive to successful delivery system reform, such as readiness for change and a

successful history of change.³⁶ Research has also investigated how heterogeneous PCMH implementation of team structure, team process and team effectiveness elements impacted improvements in patient-centered care. This research found that elements, such as shared decision making and a history adopting change in the clinic, were associated with improvements in patient centered care, while a chaotic and/or stressful environment was associated with declines in performance.³ However, there is limited research exploring which operational elements of PACT are associated with observed changes in utilization. The purpose of this research was to shed light on which PACT elements may be driving observed changes in utilization after PACT was implemented, both to identify promising areas for further research and to provide guidance to providers who are working to implement the highest-impact elements of PCMH within resource-constrained environments.

While the study's findings are modest—we found only three elements associated with decreased ED utilization rates, and no elements associated with hospitalizations—they do indicate potential causal relationships between achieving higher levels of Access, Comprehensiveness and Self-Management Support, and reductions in hospitalizations. A review of the items included in the Access element indicates that clinical teams that provide timely appointment access, responsive in-person and telephonic clinical advice, and evening and weekend access, have lower ED utilization rates. Significant associations between utilization rates and Comprehensiveness indicate that clinical teams that help patients address substance use, mental illness or social stressors are more successful in reducing ED utilization rates. Finally, clinical teams that develop goals in conjunction with patients and identify barriers to care have experienced reduced ED utilization rates in the post-PACT period.

Limitations

We acknowledge several limitations with this research. First, because the PI² contains eight elements, measuring the effect of a single domain on utilization outcomes allows other elements to confound the estimate. To mitigate this confounding factor, we included a facility's overall PI² score as a covariate to adjust for its overall performance as a low- or high-PACT implementer. Yet this limits the ability to infer causality from the findings of this study. Second, the PI² measured PACT implementation in 2014, creating a time period of 3 years between the 2010 implementation start date and the point at which clinics were measured to assess the level of PACT implementation. However, initial plans called for PACT to be fully implemented by the end of 2014, so the full extent of PACT implementation would not have been captured in the PI² measurement. Moreover, anecdotal evidence from the VHA indicates that PACT implementation efforts continued into 2015 and 2016, so full PACT implementation was not fully captured in the PI² measure. Lastly, these findings are not necessarily generalizable to the general population because the VHA population is older, disproportionately male, and has high rates of mental illness and physical and mental comorbidities.²³

Conclusion

This study provides an important complement to previous implementation science research exploring how health delivery system innovations arise, what mix of organizational factors engenders “adoptable” innovations, and how the organization's systemic readiness to change impacts the ultimate success of an innovation. Future research should explore both the causal relationship between the elements of the PACT model and Triple Aim outcomes, but also explore what allows individual clinics to successfully implement key PACT elements and

ultimately implement a successful PCMH innovation in the clinical setting. We recommend that future research focus on these elements to explore whether these constructs are reflective of a causal relationship, and we also recommend that future PCMH implementations consider implementing randomized controlled trials to test whether the implementation of certain PACT elements has a causal effect on patient outcomes such as utilization or cost.

Figure 4.1 Variables used to construct PACT Implementation Progress Index

Access

Patient Survey N = 75,101	CAHPS-PCMH Questions. “In the last 12 months...”	Patient-level response			Clinic-level mean (SD) n-913
		Values	N	%	
Asked only of those who phoned their providers office, n=28,154	When you phoned this provider’s office to get an appointment for care you needed right away, how often did you get an appointment as soon as you needed?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	2,809 3,973 7,293 13,771	10.09 14.27 26.19 49.45	3.14 (0.46)
Asked only of those who phoned their providers office, n=28,154	How many days did you usually have to wait for an appointment when you needed care right away?	1 = Same day 2 = 1 day 3 = 2 to 3 days 4 = 4 to 7 days 5 = More than 7 days	6750 4551 5429 4031 6070	25.16 16.96 20.23 15.02 22.62	2.90(0.68)
Asked only if they made an appointment, n=53,633	When you made an appointment for a check-up or routine care with this provider, how often did you get an appointment as soon as you needed?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	2,391 5,030 14,918 30,520	4.52 9.52 28.22 57.74	3.41 (0.32)
Asked only those who reported needing this type of care, n=16,287	How often were you able to get the care you needed from this provider’s office during evenings, weekends, or holidays?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	9,313 1,336 1,665 3,312	59.60 8.55 10.66 21.20	1.71 (0.61)
Asked only if they phoned their providers office, n=33,660	When you phoned this provider’s office during regular office hours, how often did you get an answer to your medical question that same day?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	3,291 4,830 8,781 16,399	9.88 14.50 26.37 49.24	3.18 (0.44)
Asked only if they phoned after hours, n=5,007	When you phoned this provider’s office after regular office hours, how often did you get an answer to your medical question as soon as you needed?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,040 754 1,101 1,991	21.29 15.43 22.53 40.75	2.70 (0.89)
Wait time includes time spent in the waiting room and exam room n=69,906	How often did you see this provider within 15 minutes of your appointment time?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	8,244 12,071 27,144 22,447	11.79 17.27 38.83 32.11	3.01 (0.37)
Administrative Data	Domain	Measure	Values		Clinic level mean (SD)

				range, n=913
Corporate Data Warehouse (CDW) facility-level means n=913	Clinic Access	Same-day access	Proportion of total primary care appointment	0.71 (0.97), 0.065-0.99
	Use of non face-to-face modalities	Telephone clinics	Proportion of total primary care encounters, 0-1	0.36 (0.17), 0.018-1
	Electronic access	Secure messaging, % use	Proportion of patients who either sent or received a message in the past year, 0-1	0.035 (0.03), 0-0.23

Continuity

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	
Sustained relationship	How long have you been going to this provider?	1 = Less than 6 months	8,001	10.94 11.27 32.32 20.88 24.59	3.18 (0.60), 1-5
		2 = At least 6 months but less than 1 year	8,248		
		3 = At least 1 year but less than 3 years	23,64		
		4 = At least 3 years but less than 5 years	4		
		5 = 5 years or more	15,27		
			2		
	17,99	1			
Administrative Data	Domain	Measure	Values	Clinic level mean (SD) range, n=913	
Continuity	Continuity	Proportion of visits to assigned Primary Care provider	Proportion	0.83 (0.11), 0.16-0.99	
	Discontinuity	Number of assigned Primary Care providers	Count	1.32 (0.34), 1-3.75	

Care Coordination

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	
Reminders between visits	Some offices remind patients between visits about tests, treatment or appointments, did you get any reminders from this provider's office between visits?	1 = Yes 0 = No	56,114 13,810	80.25 19.75	0.80 (0.14)
Coordinated Care	When this provider ordered a blood test, x-ray, or other test for you, how often did someone from this provider's office follow up to give you those results? (Asked if	1 = Never 2 = Sometimes 3 = Usually 4 = Always	7,472 5,782 10,676 39,252	11.83 9.15 16.90 62.13	3.33 (0.38)

	they had something ordered, n=64,317)				
	How often did the provider seem informed and up-to-date about the care you got from specialists? (Asked if they saw a specialist, n=48,103)	1 = Never 2 = Sometimes 3 = Usually 4 = Always	3,750 4,244 11,170 27,652	8.01 9.07 23.86 59.07	3.29 (0.39)
	Did you and anyone in this provider's office talk at each visit about all the prescription medicines you were taking?	1 = Yes 0 = No	55,911 11,027	83.53 16.47	0.84 (0.11)
Information	Did this provider's office give you information about what to do if you needed care during evenings, weekends, or holidays?	1 = Yes 0 = No	50,057 19,376	72.09 27.91	0.70 (0.15)
	Did you see a specialist for a particular health problem?		48,103 20,840	69.77 30.23	0.67(0.15)
Administrative Data	Measure	Values		Clinical Level Mean (SD), range, n=913	
CDW facility-level means n=913	% of high risk patients enrolled in CCHT*	Proportion, 0-1		0.08 (0.05); 0-0.5	
	% contacted within 2 days post-hospital follow-up	Proportion, 0-1		0.19 (0.16); 0-0.89	

Comprehensiveness

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	
	Did anyone in this provider's office ask you if there was a period of time when you felt sad, empty or depressed?	1 = Yes 0 = No	51,676 17,953	74.22 25.78	0.75 (0.15)
	Did you and anyone in this provider's office talk about things in your life that worry you or cause you stress?	1 = Yes 0 = No	38,803 30,738	55.80 44.20	0.57 (0.16)
	Did you and anyone in this provider's office talk about a personal problem, alcohol use, drug use or a mental or emotional illness?	1 = Yes 0 = No	33,051 36,426	47.57 52.43	0.49 (0.16)

Self-Management Support

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	

	Did anyone in this provider's office talk with you about specific goals for your health?	1 = Yes 0 = No	45,692 23,543	66.00 34.00	0.66 (0.15)
	Did anyone in this provider's office ask you if there are things that make it hard for you to take care of your health?	1 = Yes 0 = No	32,961 36,029	47.78 52.22	0.47 (0.16)

Patient-Centered Care and Communication

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	
	How often did this provider explain things in a way that was easy to understand?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,533 3,855 11,738 53,036	2.18 5.49 16.73 75.59	3.66 (0.22)
	How often did this provider listen carefully to you?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,611 4,190 10,313 53,976	2.30 5.98 14.71 77.01	3.65 (0.24)
	How often did this provider give you easy to understand information about these health questions or concerns? (asked if they had a health concern, n = 61,020)	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,520 3,957 10,648 44,179	2.52 6.56 17.66 73.26	3.60 (0.26)
	How often did this provider seem to know the important information about your medical history?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	2,310 4,809 15,477 47,199	3.31 6.89 22.17 67.63	3.50 (0.27)
	How often did this provider show respect for what you had to say?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,521 3,362 8,459 56,882	2.17 4.79 12.05 81.00	3.71 (0.22)
	How often did this provider spend enough time with you?	1 = Never 2 = Sometimes 3 = Usually 4 = Always	1,756 3,940 11,894 52,556	2.50 5.62 16.96 74.92	3.63 (0.24)

Shared Decision Making

Patient Survey n=75,101	CAHPS-PCMH questions In the last 12 months...	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	

Medication Decisions, asked if they were starting or stopping a medication, n=46,318	When you talked about starting or stopping a prescription medicine, how much did this provider talk about the reasons you might want to take a medicine?	1 = Not at all 2 = A little 3 = Some 4 = A lot	1,106 2,851 13,232 28,670	2.41 6.22 28.85 62.52	3.51 (0.26)
	When you talked about starting or stopping a prescription medicine, how much did this provider talk about the reasons you might not want to take a medicine?	1 = Not at all 2 = A little 3 = Some 4 = A lot	5,518 3,880 15,163 21,081	12.09 8.50 33.22 46.19	3.12 (0.36)
	When you talked about starting or stopping a prescription medicine, did this provider ask you what you thought was best for you?	1 = Yes 0 = No	35,626 10,001	79.08 21.92	0.78 (0.15)

Team-Based Care

Patient Survey n=75,101	Provider Survey Questions	Patient-level responses			Clinic level mean (SD) range, n=913
		Values	N	%	
Delegation of care management tasks to RN care manager	Delegation of activities (% responding 'a great deal'):				
	a. Gathering patient preventive services utilization history (e.g., immunization history)				
	b. Screening patients for diseases (e.g., doing a depression screen)				
	c. Responding to prescription refill requests		2,567	47.50	3.09 (0.64)
	d. Receiving messages from patients (other than requests for prescriptions)		2,875	53.20	3.16 (0.68)
	e. Resolving messages from patients (other than requests for prescriptions)		2,760	51.07	3.19 (0.66)
	f. Evaluating patients and making treatment decisions		3,674	67.99	3.56 (0.46)
	g. Assessing patient lifestyle factors (e.g., diet, smoking cessation)	1 = Not at all	3,273	60.57	3.43 (0.52)
	h. Encouraging lifestyle modifications (e.g., diet, smoking cessation)	2 = Slightly	1,685	31.18	2.61 (0.73)
	i. Educating patients about disease-specific self-care activities (e.g., foot care in diabetes)	3 = Somewhat	2,666	49.33	3.10 (0.67)
	j. Educating patients about medications	4 = A great deal	2,642	48.89	3.12 (0.66)
	k. Completing forms for patients (e.g., disability documentation)		2,622	48.52	3.09 (0.67)
	l. Responding to requests for Home Health Care orders		2,231	41.28	2.97 (0.69)
	m. Tracking patient diagnostic data		1,111	20.56	2.28 (0.75)
		1,320	24.43	2.43 (0.75)	
		1,591	29.44	2.61 (0.74)	
		1,594	29.50	2.58 (0.74)	
		1,387	25.67	2.54 (0.72)	

	(e.g., labs, radiology studies) n. Responding to patient diagnostic and treatment data (e.g., labs, radiology studies) o. Following-up on referrals (e.g., to specialists)				
Membership in PACT teamlet	% assigned to a teamlet, 0-100%		4,646	85.97	0.85 (0.23)
Time spent in team huddles	% spending ≥ 0.5 hours daily huddles, 0-100%	Proportion, 0-1	2,767	51.20	0.49 (0.31)
Perception of staffing levels	% staffed to recommended ratio of 3 support staff per FTE provider, 0-100%		2,314	49.81	0.51 (0.36)

Table 4.1 Mean domain scores by PI² score²⁸

PI ² score	PACT Domains							
	Access	Continuity	Care Coordination	Team Function	Comprehensive -ness	Self-Management Support	Patient-Centered Care & Communication	Shared Decision Making
5 to 8	0.44	0.47	0.56	0.11	0.88	1.00	0.90	0.89
2 to 4	0.27	0.20	0.29	0.14	0.35	0.59	0.55	0.44
-1 to 1	0.03	0.04	0.02	0.03	0.00	0.04	0.11	0.03
-2 to -4	-0.25	-0.16	-0.28	-0.09	-0.39	-0.48	-0.55	-0.39
-5 to -7	-0.61	-0.73	-0.68	-0.19	-0.78	-1.15	-1.40	-1.15

Table 4.2 Patient characteristics, Low- and High-PACT Implementation Clinics

Characteristic	Low PACT Implementation Clinics (N=202)	High PACT Implementation Clinics (N=207)
No copay (%)	0.91 (0.04)	0.92 (0.03)
Married (%)	0.54 (0.09)	0.57 (0.07)
Age	59.9 (4.51)	59.7 (4.58)
Elixhauser Score	0.76 (0.01)	0.78 (0.01)
Male (%)	0.93 (0.05)	0.93 (0.05)
Black Race (%)	0.04 (0.07)	0.06 (0.07)
Other Race (%)	0.01 (0.03)	0.01 (0.02)
% Service Connected Disability	55.7% (7.50%)	57.8% (6.40%)

Table 4.3 Unadjusted utilization rates, Pre-PACT and Post-PACT periods

Outcome	Pre-PACT	Post-PACT
Hospitalizations	0.026 (0.198)	0.029 (0.2066)
ED encounters	0.015 (0.174)	0.022 (0.205)

Table 4.4 Multivariable Results: Average Marginal Effects and Incidence Rate Ratios, Hospitalizations

PACT Domain	Incidence Rate Ratio (95% CI)	ME	Delta Method Standard Error
Access	- 0.01% (0.925, 1.062)	-0.006	0.032
Continuity	-4.50% (0.896, 1.0174)	-0.046	0.031
Care Coordination	0.13% (0.935, 1.068)	0.001	0.034
Comprehensiveness	-0.01% (0.939, 1.065)	-0.001	0.039
Self-Management Support	-0.88% (0.926, 1.051)	-0.009	0.029
Patient-Centered Care and Communication	0.60% (0.899, 1.081)	0.006	0.0324
Shared Decision Making	-2.02% (0.914, 1.046)	-0.022	0.034
Delegation, Staffing and Team Functioning	1.12% (0.928, 1.098)	0.0114	0.043

ME: Margin Effect; CI: Confidence Interval

* Denotes statistically significant difference in means, results were considered significant at $\alpha=0.05$.

Table 4.5 Multivariable Results: Average Marginal Effects and Incidence Rate Ratios, Emergency Department

PACT Domain	Incidence Rate Ratio (95% CI)	ME	Delta Method Standard Error
Access	- 4.35% * (0.917, 0.994)	-0.044	0.020
Continuity	-4.50% (0.896, 1.0174)	-0.046	0.031
Care Coordination	-3.28% (0.928, 1.006)	-0.033	0.034
Comprehensiveness	-4.79% * (0.914, 0.992)	-0.049	0.020
Self-Management Support	-3.78% * (0.927, 0.999)	-0.038	0.019
Patient-Centered Care and Communication	-2.23% (0.941, 1.016)	-0.023	0.019
Shared Decision Making	-2.12% (0.939, 1.021)	-0.021	0.020
Delegation, Staffing and Team Functioning	-0.96% (0.942, 1.041)	-0.009	0.025

ME: Margin Effect; CI: Confidence Interval

* Denotes statistically significant difference in means, results were considered significant at $\alpha=0.05$.

4.6 References

1. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation's Largest Integrated Delivery System. 2011;16(September).
2. Rosland A-M, Nelson K, Sun H, et al. The Patient-Centered Medical Home in the Veterans Health Administration. *Am J Manag Care*. 2013;19(7):e263-72.
3. Helfrich CD, Dolan ED, Fihn SD, et al. Association of medical home team-based care functions and perceived improvements in patient-centered care at VHA primary care clinics. *Healthcare*. 2014;2(4):238–244.
4. Solimeo SL, Hein M, Paez M, Ono S, Lampman M, Stewart GL. Medical Homes Require More Than an EMR and Aligned Incentives. *Am J Manag Care*. 2013;19(2):132–141.
5. Nielsen M, Gibson A, Patel K, Nichols L. The Patient-Centered Medical Home's Impact on Cost and Quality: Annual Review of Evidence 2014-2015.; 2016.
6. Crosby J, Grundy P. Putting Theory into Practice: A Practical Guide to PCMH Transformation Resources.
7. Tirodkar MA, Morton S, Whiting T, et al. There's More Than One Way to Build a Medical Home. *Am J Manag Care*. 2014;20(December):582–589.
8. O'Kane M. NCQA Public Letter to CMS.; 2016.
9. Jackson G, Powers B, Chatterjee R, Bettger JP. The Patient-Centered Medical Home: A Systematic Review. *Ann Intern Med*. 2013;158(3):169–178.
10. Nielsen M, Gibson A, Buelt L, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost and Quality Quality: Annual Review of Evidence 2013-2014.; 2015.
11. Hoff T, Weller W, DePuccio M. The patient-centered medical home: a review of recent research. *Med Care Res Rev*. 2012;69(6):619–44.
12. Smith RA, Levine TR, Lachlan KA, Fediuk TA. The high cost of complexity in experimental design and data analysis: type I and type II error rates in multiway ANOVA. *Hum Comm Res*. 2002;28(4):515–530.
13. Auerbach D, Weeks W, Brantley I. Health Care Spending and Efficiency in the U.S. Department of Veterans Affairs.; 2013.
14. Nielsen M, Olayiwola JN, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost & Quality: Annual Update of the Evidence, 2012-2013.; 2014.
15. Stange KC, Nutting P a, Miller WL, et al. Defining and measuring the patient-centered medical home. *J Gen Intern Med*. 2010;25(6):601–12.
16. Kaushal R, Edwards A, Kern L. Association between the patient-centered medical home and healthcare utilization. *Am J Manag Care*. 2015;21(5):378–386.
17. Kearney LK, Post EP, Zeiss A, Goldstein MG, Dundon M. The role of mental and behavioral health in the application of the patient-centered medical home in the Department of Veterans Affairs. *Transl Behav Med*. 2011;1(4):624–8.
18. McCormick D, Bor DH, Woolhandler S, Himmelstein DU. Giving Office-Based Physicians Electronic Access To Patients' Prior Imaging And Lab Results Did Not Deter Ordering Of Tests. *Health Aff*. 2012;31(3):488–496.
19. Reid RJ, Coleman K, Johnson E a, et al. The group health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health Aff (Millwood)*. 2010;29(5):835–43.
20. Liss D. Patients With Chronic Illness in the Patient-Centered Medical Home: Costs, Use,

- Quality and Morbidity-Based Variation.; 2012.
21. Randall I, Mohr DC, Maynard C. VHA Patient-Centered Medical Home Associated With Lower Rate of Hospitalizations and Specialty Care Among Veterans With Posttraumatic Stress Disorder Abstract : *J Healthc Qual.* 2014;0(0):1–8.
 22. Randall I, Maynard C, Chan G, Devine B, Johnson C. Assessing the effect of the VHA PCMH on utilization among Veterans with PTSD.; 2016.
 23. Kessler CS, Bhandarkar S, Casey P, Tenner A. Predicting patient patterns in veterans administration emergency departments. *West J Emerg Med.* 2011;12(2):204–7.
 24. Berenson R a, Ginsburg PB, Christianson JB, Yee T. The growing power of some providers to win steep payment increases from insurers suggests policy remedies may be needed. *Health Aff (Millwood).* 2012;31(5):973–81.
 25. Birnberg JM, Drum ML, Huang ES, et al. Development of a Safety Net Medical Home Scale for Clinics. *JGIM.* 2011;26(12):1418–1425.
 26. Reid RJ, Fishman P a, Yu O, et al. Patient-centered medical home demonstration: a prospective, quasi-experimental, before and after evaluation. *Am J Manag Care.* 2009;15(9):e71-87.
 27. Birnberg JM, Drum ML, Huang ES, et al. Development of a safety net medical home scale for clinics. *J Gen Intern Med.* 2011;26(12):1418–1425.
 28. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med.* 2014;174(8):1350–8.
 29. Trivedi RB, Post EP, Sun H, et al. Prevalence, comorbidity, and prognosis of mental health among US veterans. *Am J Public Health.* 2015;105(12):2564–2569.
 30. Cameron AC, Trivedi PK. Regression-Based Tests For Overdispersion In the Poisson Model. *J Econom.* 1990;46:347–364.
 31. Gardner W, Mulvey EP, Shaw EC. Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychol Bull.* 1995;118(3):392–404.
 32. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. *Acad Pediatr.* 2013;13(6 SUPPL.):S38–S44.
 33. Hebert PL, Liu C-F, Wong ES, et al. Patient-Centered Medical Home Initiative Produced Modest Economic Results For Veterans Health Administration, 2010-12. *Health Aff.* 2014;33(6):980–987.
 34. Kleinman LC, Norton EC. What’s the Risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res.* 2009;44(1):288–302.
 35. True G, Butler AE, Lamparska BG, et al. Open access in the patient-centered medical home: lessons from the Veterans Health Administration. *J Gen Intern Med.* 2013;28(4):539–45.
 36. Wise C, Alexander J, Green L, Cohen G, Koster C. *Milbank Quarterly.* *Milbank Q.* 2011; 89(3):450–502.

Chapter 5: Conclusion

5.1 Summary

The objective of this dissertation research was to explore the relationship between the VHA 2010 PACT implementation and the utilization of key health services among Veterans with PTSD. The driving motivation for the research was the hypothesis that essential PACT elements—including multi-disciplinary team-based care, enhanced patient access and education activities, and timely access to mental health providers—hold potential to improve treatment for Veterans with PTSD and limit the unnecessary utilization of avoidable downstream health services. If such changes in utilization patterns were observed, there is ample reason to believe they would be accompanied by improved health outcomes.^{1,2} In its entirety, this research explored the relationship between the presence and level of PACT implementation and the utilization of key health services—namely hospitalizations, and primary care, specialty care, mental health, ED and urgent care—and explored how heterogeneity in the implementation of different PACT elements was associated with clinic-level utilization rates among Veterans with PTSD.

In Chapter 2, we explored the association between whether the care was received before or after PACT implementation and the quarterly utilization rate of health services, employing a pre-post study design. In Chapter 3, we utilized a newly constructed instrument that measured the extent of PACT implementation at VHA clinics to conduct an interrupted time series study that estimates the effect of high-PACT implementation on utilization rates for the same set of outcomes, compared to low-PACT implementation. Finally, in Chapter 4 we measured the association between PACT elements and utilization rates of hospitalizations and ED encounters, comparing the relationship between low- and high-implementation of eight distinct PACT

elements.

Chapter 2 outlined this dissertation's principal hypothesis that the PACT intervention holds the potential to intensify primary care by mitigating traumatogenic effects of PTSD that often result in exacerbations of physical and mental illness and lead to emergent illness.³ Consistent with other research, we found that Veterans do suffer from a higher prevalence of PTSD than the general population, a key rationale for this dissertation. Results from both negative binomial regression and extended estimating equation models to estimate the association between pre- and post-PACT time period and utilization rates indicate that Veterans receiving care in the post-PACT period experienced significantly lower utilization rates of hospitalizations and specialty care, and higher rates of primary care. This research also stratified the multivariable regression models by Medicare eligibility status and found that results were largely consistent, but that PACT was less effective in reducing hospitalizations for Veterans 65 years and older. The findings from this research are largely optimistic for the future of the VHA PACT initiative and add to the growing body of evidence that the PCMH model holds promise to improve outcomes for patients with mental illness.

Chapter 2 findings informed the methods and study design employed for the Chapter 3 research. Chapter 3 research utilized a newly developed instrument that measured PACT implementation at VHA clinics—the Pact Implementation Progress Index (PI²)—to develop case and control groups. We subsequently utilized an interrupted time series design that enabled causal inference by estimating the effect of high-PACT implementation on utilization rates, compared to low-PACT implementation. We also obtained included additional years of data, allowing for a longer post-PACT implementation period, and controlled for the previous PCMH initiative at a subset of clinics. Results from Chapter 3 research show that patients that received

care in VHA clinics with high levels of PACT implementation experienced decreased utilization rates for hospitalizations, specialty mental health, urgent care and ED utilization, compared to a low-level of PACT implementation. These results provide even stronger evidence that PACT has a causal effect on the reduction of resource-intensive inpatient and specialty services for Veterans with PTSD, a finding consistent with broader findings of the effect of the PCMH model and PACT specifically.^{4,5,6,7}

While the PCMH model has become a key plank in health delivery system reform efforts, implementation efforts have proven challenging.⁸ To inform implementation efforts, in Chapter 4 we transitioned to an implementation science perspective by investigating the association between eight separate PACT elements and clinic-level hospitalization and ED utilization rates among Veterans with PTSD. This study sought to identify potential high-impact interventions within the PACT initiative to provide VHA leaders and policymakers additional evidence about how to efficiently implement the PCMH model in resource-constrained environments. The eight PACT elements we tested for associations with utilization rates were: 1) Access, 2) Continuity, 3) Care Coordination, 4) Comprehensiveness, 5) Self-Management Support, 6) Patient-Centered Care and Communication, 7) Shared Decision Making, and 8) Delegation, Staffing and Team Functioning. We found that high levels of Access, Comprehensive Care and Self-Management Support were associated with significantly lower ED utilization rates. We did not find any significant associations between PACT elements and hospitalization rates.

5.2 Future Research

While this research provides salient new evidence about the effectiveness of PACT and the broader PCMH model in treating with Veterans with PTSD, we recognize there are many

questions left unanswered with regard to PACT and PCMH. First, we acknowledge that measuring utilization patterns—and specifically, the rates of primary, specialty, and inpatient care—serves as a proxy for high-quality primary care, but does not by itself constitute high-quality primary care. Ultimately, the effect of the PACT model on Veterans with PTSD needs to measure clinical process and outcome measures, and patient satisfaction measures, to assess the model’s overall effectiveness for this patient population. Future research should address this question not only for Veterans with PTSD but other vulnerable patient subpopulations with unique health needs. In addition to measuring clinical outcomes and patient satisfaction, future research should also explicitly measure the broader effect of PCMH on total cost of care. Findings about post-PACT utilization patterns indicate beneficial cost effects, but future research could measure total cost of care more comprehensively by utilizing comprehensive claims or encounter data about care received both within and outside the VHA system.

Our research exploring the association between PACT elements and inpatient and ED care revealed statistically significant associations between ED utilization rates and three PACT elements: Access, Comprehensiveness and Self-Management Support. However, we recognize that the underlying research question does not isolate the effect of a singular PACT element on utilization rates, but rather assess the association of a single PACT element while controlling for a clinic’s overall PI² score. There remains the potential for confounding introduced by systematic differences between those clinics that score in the top quartile and bottom quartile of a specific PACT element. To remove this source of endogeneity, researchers should explore opportunities to test the effectiveness of different PACT elements in either randomized trials or in quasi-experimental designs where individual provider sites implement different sets of PCMH elements.

5.3 Policy Implications

As the PCMH model and its team-based care precepts continue to gain prominence in health reform efforts, it is important to understand how well the model improves care for Veterans with PTSD. For the VHA, this is imperative because the prevalence of PTSD in Veterans is significantly higher than the general population, and studies have consistently linked PTSD to combat violence.⁹ The continued presence of US armed services in combat suggests PTSD rates will remain elevated among US Veterans, and the US Department of Defense designated PTSD as a “signature injury” caused by conflict in Iraq and Afghanistan.¹⁰ Additionally, effectively treating comorbid mental and physical illnesses requires coordinated, integrated care that addresses the traumatogenic effects and poor health status found in Veterans with PTSD.¹¹ Finally, PTSD is also associated with lower productivity, more physical symptoms and high somatic symptom severity compared to the broader Veteran population.¹⁰ There is a compelling case to focus on the sustained improvement of care for Veterans with PTSD.

Findings from this dissertation are relevant to VHA leaders and policymakers because they provide salient evidence about how well the PACT model is improving care for this key VHA patient population. First, they indicate that the PACT model can effectively intensify primary care treatment for Veterans and reduce the utilization of high-cost inpatient and specialty services through team-based, coordinated care. These individual studies increasingly strengthen that assertion by utilizing stronger study designs and more data to fully capture the post-PACT experience. We also found that stratifying the PTSD population by Medicare eligibility resulted in largely consistent results, although the decrease in hospitalizations was non-significant among Medicare-eligible Veterans. The combination of intensified primary care and simultaneous reductions in inpatient and specialty care indicate that the PACT model assists

Veterans in avoiding the expensive and dangerous cycle of illness caused by lack of care coordination and discontinuities in care.¹² Various commentators have observed that real improvements in system change will only materialize when clinical systems evolve to specifically address the needs and concerns of chronically ill patients,¹² underlining the important of this finding.

While existing research explored the effect of PACT on utilization for the broader VHA population,^{6,13} there is limited information about PACT's effect on Veterans with PTSD that utilizes rigorous methods that enable causal inference. We started with the hypothesis that the intensified provision of primary care team-based primary care approach would result in lower utilization of specialty services. There is also evidence that shifting from specialty care to primary care-centric models will lower patient morbidity.² Characteristics of PACT that could potentially impact Veterans with PTSD differentially include same-day specialist access, coordinated and longitudinal team-based care with specialists including mental health specialists, and proactive outreach to high-need patients through phone and shared medical appointments.^{14,15} The availability of more timely, accessible and clinically appropriate care through PACT presents an opportunity to improve the provision of both cognitive and pharmacotherapy treatments. The team-based care model also utilizes clinical pharmacists to manage patients with chronic illness through separate patient outreach,¹⁵ creating the potential for better medication management and adherence.¹⁶

This research also indicates that a subset of PACT elements—namely Access, Comprehensive Care and Self-Management Support—were individually associated with decreases in ED utilization, an intriguing finding that offers helpful operational insights into how VHA clinics and other PCMH adopters can focus resources on high-impact interventions. PCMH

implementation science researchers have emphasized the need for primary care communities to focus on high-impact interventions and to innovate primary care models in ways that meet their patients' specific needs.¹⁷ Our findings open up new avenues of research to more precisely identify high-impact interventions, and also provide evidence to allow clinical organizations and teams to develop targeted care management interventions that are tailored to meet a patient's specific clinical and social needs. Chapter 4's assessment of the association between PACT elements and utilization effects at the clinic level provides cogent operational information to VHA clinics that continue to pursue the PCMH model, as well as external clinical leaders and policymakers. Health care organizations face very real resource constraints when implementing large-scale delivery system innovations,¹⁸ and there is a pressing need to identify high-impact interventions to ensure effective implementation of the PCMH model.¹⁹

5.4 Contributions

This dissertation provides numerous contributions to the body of research about the PCMH model, the VHA PACT experience, and the effectiveness of the PACT model in improving primary care and modifying utilization patterns among Veterans with PTSD, a unique and vulnerable patient population. Various studies have investigated the effect of PACT on utilization and costs at the VHA on the broader population,^{1,7} but to our knowledge there are no existing studies that evaluate the association between PACT implementation and health services utilization among Veterans with PTSD that include a control group, use several years of post-PACT data to fully capture the effect of PACT, or investigate the impact across the full range of outcomes in this research. Moreover, there are no specific studies that examine how specific PACT elements are associated with estimated utilization effects among Veterans with PTSD. All

of these attributes strengthen the ability to infer causality from this research and provide insights for clinical leaders and policymakers about PACT's effectiveness. This innovation is important because even the most sophisticated research conducted thus far has estimated PACT's effect in conjunction with the broader VHA Transformation Initiative that includes the PCMHI initiative.¹³ Previous studies that have estimated the effects of the Transformation Initiative are highly valuable, but ask different research questions than the ones proposed herein.

5.5 References

1. Yoon J, Rose DE, Canelo I, et al. Medical home features of VHA primary care clinics and avoidable hospitalizations. *J Gen Intern Med.* 2013;28(9):1188–1194.
2. Starfield B, Lemke KW, Herbert R, Pavlovich WD, Anderson G. Comorbidity and the Use of Primary Care and Specialist Care in the Elderly. *Ann Fam Med.* 2005;3(3):215–222.
3. Alonzo A. The experience of chronic illness and posttraumatic stress disorder: the consequences of cumulative adversity. *J Cardiovasc Nurs.* 1999;13(3):33–45.
4. Peikes DN, Reid RJ, Day TJ, Dale SB, Brown RS, Shapiro RJ. Staffing Patterns of Primary Care Practices in the Comprehensive Primary Care Initiative. *Ann Fam Med.* 2014;12(2):142–149.
5. Nielsen M, Gibson A, Patel K, Nichols L. The Patient-Centered Medical Home’s Impact on Cost and Quality: Annual Review of Evidence 2014-2015.; 2016.
6. Yoon J, Rose D, Canelo I, et al. Medical Home Features of VHA Primary Care Clinics and Avoidable Hospitalizations. *J Gen Intern Med.* 2013;9:1188–94.
7. Hebert PL, Liu C-F, Wong ES, et al. Patient-Centered Medical Home Initiative Produced Modest Economic Results For Veterans Health Administration, 2010-12. *Health Aff.* 2014;33(6):980–987.
8. Nutting P, Crabtree BF, Miller WL, Stewart EE, Stange K, Jaen C. Journey to the Patient-Centered Medical Home : A Qualitative Analysis of the Experiences of Practices in the National Demonstration Project. *Ann Fam Med.* 2010;8(1):45–56.
9. Blake DD, Keane TM, Wine PR, Mora C, Taylor KL, Lyons J a. Prevalence of PTSD symptoms in combat veterans seeking medical treatment. *J Trauma Stress.* 1990;3(1):15–27.
10. Charles W. Hoge MD, Artin Terhakopian MD, Carl A. Castro PD, Stephen C. Messer PD, Charles C. Engel MD. MPH. Association of Posttraumatic Stress Disorder With Somatic Symptoms, Health Care Visits, and Absenteeism Among Iraq War Veterans. *Am J Psychiatry.* 2007;15(January):150–153.
11. David D, Woodward C, Esquenazi J, Mellman T a. Comparison of comorbid physical illnesses among veterans with PTSD and veterans with alcohol dependence. *Psychiatr Serv.* 2004;55(1):82–85.
12. Wagner EH. Chronic Disease Management : What Will It Take To Improve Care for Chronic Illness. *Eff Clin Pract.* 1998;1(1):2–4.
13. Hebert PL, Liu C, Wong S, et al. The economic effects and return on investment of the Veterans Health Administration’s Patient Centered Home Initiative, 2010 through 2012.; 2013.
14. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation’s Largest Integrated Delivery System. 2011;16(September).
15. Rosland A-M, Nelson K, Sun H, et al. The patient-centered medical home in the Veterans Health Administration. *Am J Manag Care.* 2013;19(7):e263-72.
16. Burton L, Anderson G, Kues I. Using electronic health records to help coordinat care. *Hum Resour Abstr.* 2005;4:2005.
17. Nutting P, Miller W, Crabtree B. Initial Lessons From the First National Demonstration Project on Practice Transformation to a Patient-Centered Medical Home. *Ann Fam Med.* 2004.
18. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander J a, Lowery JC. Fostering

- implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci.* 2009;4:50.
19. Tirodkar MA, Morton S, Whiting T, et al. There's More Than One Way to Build a Medical Home. *Am J Manag Care.* 2014;20(December):582–589.

Bibliography

1. Alonzo A. The experience of chronic illness and posttraumatic stress disorder: the consequences of cumulative adversity. *J Cardiovasc Nurs.* 1999;13(3):33–45.
2. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc.* 1973;51(1):95–124.
3. Andersen RM. Revisiting the Behavioral Model and Access to Medical Care: Does It Matter? *J Health Soc Behav.* 1995;36(March):1–10.
4. Auerbach D, Weeks W, Brantley I. *Health Care Spending and Efficiency in the U.S.* Department of Veterans Affairs.; 2013.
5. Backer LA. The Medical Home: An Idea Whose Time Has Come ... Again. *Fam Pract Manag.* 2007;14(8):38–41.
6. Berenson R a, Ginsburg PB, Christianson JB, Yee T. The growing power of some providers to win steep payment increases from insurers suggests policy remedies may be needed. *Health Aff (Millwood).* 2012;31(5):973–81.
7. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood).* 2008;27(3):759–69.
8. Birnberg JM, Drum ML, Huang ES, et al. Development of a safety net medical home scale for clinics. *J Gen Intern Med.* 2011;26(12):1418–1425.
9. Blake DD, Keane TM, Wine PR, Mora C, Taylor KL, Lyons J a. Prevalence of PTSD symptoms in combat veterans seeking medical treatment. *J Trauma Stress.* 1990;3(1):15–27.
10. Bodenheimer T, Pham HH. Primary care: Current problems and proposed solutions. *Health Aff.* 2010;29(5):799–805.
11. Bodenheimer MD T, Grumbach MD K, Berenson MD R. A Lifeline for Primary Care. *N Engl J Med.* 2009;26(26):2693–2696.
12. Boudreaux ED, Clark S, Camargo CA. Mood disorder screening among adult emergency department patients: a multicenter study of prevalence, associations and interest in treatment. *Gen Hosp Psychiatry.* 2008;30(1):4–13.
13. Bower P, Gilbody S. Managing Common Mental Health Disorders In Primary Care : Conceptual Models And Evidence Base. *Br Med J.* 2005;330(7495):839–842.
14. Brawer P a, Brugh AMT, Martielli RP, et al. Enhancing entrance into PTSD treatment for post-deployment veterans through collaborative/integrative care. *Transl Behav Med.* 2011;1(4):609–14.
15. Brooks E, Novins DK, Thomas D, et al. Personal characteristics affecting veterans' use of services for posttraumatic stress disorder. *Psychiatr Serv.* 2012;63(9):862–7.
16. Burton L, Anderson G, Kues I. Using electronic health records to help coordinat care. *Hum Resour Abstr.* 2005;4:2005.
17. Cameron AC, Trivedi PK. *Microeconomics Using Stata: Revised Edition.* Revised Ed. Stata Press; 2010.
18. Cameron AC, Trivedi PK. Regression-Based Tests For Overdispersion In the Poisson Model. *J Econom.* 1990;46:347–364.
19. Caminal J, Starfield B, Sánchez E, Casanova C, Morales M. The role of primary care in preventing ambulatory care sensitive conditions. *Eur J Public Health.* 2004;14(3):246–51.
20. Cassidy A. Patient-Centered Medical Homes. A new way to deliver primary care may be more affordable and improve quality. But how widely adopted will the model be?; 2010.

21. Croghan T, Brown J. Integrating Mental Health Treatment Into the Patient Centered Medical Home. *AHRQ Publ.* 2010;10:1–23.
22. Cronin-Stubbs D, Leon CFM De, Beckett LA, Field TS, Glynn RJ, Evans DA. Six-Year Effect of Depressive Symptoms on the Course of Physical Disability in Community-Living Older Adults. *Arch Intern Med.* 2000;160:3074–3080.
23. Crosby J, Grundy P. Putting Theory into Practice: A Practical Guide to PCMH Transformation Resources.
24. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander J a, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci.* 2009;4:50.
25. David D, Woodward C, Esquenazi J, Mellman T a. Comparison of comorbid physical illnesses among veterans with PTSD and veterans with alcohol dependence. *Psychiatr Serv.* 2004;55(1):82–85.
26. Davis K, Abrams M, Stremikis K. How the Affordable Care Act Will Strengthen the Nation’s Primary Care Foundation. *J Gen Intern Med.* 2011;26(10):1201–1203.
27. Davis K, Stremikis K, Squires D, Schoen C. Mirror, mirror on the wall: How the performance of the U.S. health care system compares internationally. *Commonw Fund.* 2014;(June):1–32. doi:10.1002/uog.1825.
28. Dimatteo MR, Lepper HS, Croghan TW. Depression Is a Risk Factor for Noncompliance With Medical Treatment. *Arch Intern Med.* 2000;160:2101–2107.
29. Donabedian A. Evaluating the quality of medical care. 1966. *Milbank Q.* 2005;83(4):691–729.
30. Donabedian A. Basic Approaches to Assessment: Structure, Process, and Outcome. Explorations in quality assessment and monitoring: The definition of quality and approaches to its assessment. *Heal Adm Press.* 1980;1.
31. Gardner W, Mulvey EP, Shaw EC. Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychol Bull.* 1995;118(3):392–404.
32. Ginsburg J, Doherty R, Ralston F, Senkeeto N. Achieving a High-Performance Health Care System with Universal Access: What the United States Can Learn from Other Countries. *Ann Intern Med.* 2008;148:55–75.
33. Gradus J. Epidemiology of PTSD.; 2016.
34. Hamner M. Exacerbation of posttraumatic stress disorder symptoms with medical illness. *Gen Hosp Psychiatry.* 1994;16(2):135–137.
35. Hebert PL, Liu C-F, Wong ES, et al. Patient-Centered Medical Home Initiative Produced Modest Economic Results For Veterans Health Administration, 2010-12. *Health Aff.* 2014;33(6):980–987.
36. Hebert PL, Liu C, Wong S, et al. The economic effects and return on investment of the Veterans Health Administration’s Patient Centered Home Initiative, 2010 through 2012.; 2013.
37. Hedeker D. A mixed-effects multinomial logistic regression model. 2003;1446:1433–1446.
38. Helfrich CD, Dolan ED, Fihn SD, et al. Association of medical home team-based care functions and perceived improvements in patient-centered care at VHA primary care clinics. *Healthcare.* 2014;2(4):238–244.
39. Hernandez SE. A First Look at the Patient-Centered Medical Home for Minority Veterans : Implementation and Utilization. 2015.

40. Hoff T, Weller W, DePuccio M. The patient-centered medical home: a review of recent research. *Med Care Res Rev.* 2012;69(6):619–44.
41. Hoge C, Terhakopian A, Castro C, Messer S, Engel C. Association of Posttraumatic Stress Disorder With Somatic Symptoms, Health Care Visits, and Absenteeism Among Iraq War Veterans. *Am J Psychiatry.* 2007;15(January):150–153.
42. Jackson G, Powers B, Chatterjee R, Bettger JP. The Patient-Centered Medical Home: A Systematic Review. *Ann Intern Med.* 2013;158(3):169–178.
43. Katon W, Unutzer J, Fan M-Y, Williams J. Cost-Effectiveness and Net Benefit of Enhanced Treatment of Depression for Older Adults With Diabetes and Depression. *Diabetes Care.* 2006;29(2):265–270.
44. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. *Biol Psychiatry.* 2003;54(3):216–226.
45. Kaushal R, Edwards A, Kern L. Association between the patient-centered medical home and healthcare utilization. *Am J Manag Care.* 2015;21(5):378–386.
46. Kearney LK, Post EP, Zeiss A, Goldstein MG, Dundon M. The role of mental and behavioral health in the application of the patient-centered medical home in the Department of Veterans Affairs. *Transl Behav Med.* 2011;1(4):624–8.
47. Kessler CS, Bhandarkar S, Casey P, Tenner A. Predicting patient patterns in veterans administration emergency departments. *West J Emerg Med.* 2011;12(2):204–7.
48. Kinnunen T, Haukkala A, Korhonen T, Quiles ZN, Spiro A, Garvey AJ. Depression and smoking across 25 years of the Normative Aging Study. *Int J Psychiatry Med.* 2006;36(4):413–26.
49. Klein B, Leffler KB, Journal T, Aug N. The Role of Market Forces in Assuring Contractual Performance. *J Polit Econ.* 2006;89(4):615–641.
50. Klein S. The VHA: Implementing Patient-Centered Medical Homes in the Nation’s Largest Integrated Delivery System. 2011;16 (September).
51. Kleinman LC, Norton EC. What’s the Risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res.* 2009;44(1):288–302.
52. Kronish IM, Edmondson D, Goldfinger JZ, Fei K, Horowitz CR. Posttraumatic stress disorder and adherence to medications in survivors of strokes and transient ischemic attacks. *Stroke.* 2012;43(8):2192–2197.
53. Landon BE, Gill JM, Antonelli RC, Rich EC. Prospects for rebuilding primary care using the Patient-Centered Medical Home. *Health Aff.* 2010;29(5).
54. Landon BE, Gill JM, Antonelli RC, Rich EC. Prospects for rebuilding primary care using the patient-centered medical home. *Health Aff.* 2010;29(5):827–834.
55. Li B, Evans D, Faris P, Dean S, Quan H. Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases. *BMC Health Serv Res.* 2008;8:12.
56. Liss D. Patients With Chronic Illness in the Patient-Centered Medical Home: Costs, Use, Quality and Morbidity-Based Variation.; 2012.
57. Litz B. PTSD in Service Members and New Veterans of the Iraq and Afghanistan Wars: A Bibliography and Critique. *PTSD Res Q.* 2009;20(1):1–8.
58. M.B. H, Hamner MB. Exacerbation of posttraumatic stress disorder symptoms with medical illness. *Gen Hosp Psychiatry.* 1994;16(2):135–137.
59. Magruder KM, Frueh BC, Knapp RG, et al. Prevalence of posttraumatic stress disorder in

- Veterans Affairs primary care clinics. *Gen Hosp Psychiatry*. 2005;27(3):169–79..
60. McCormick D, Bor DH, Woolhandler S, Himmelstein DU. Giving Office-Based Physicians Electronic Access To Patients' Prior Imaging And Lab Results Did Not Deter Ordering Of Tests. *Health Aff*. 2012;31(3):488–496. d
 61. Murray M, Berwick DM. Advanced Access. *JAMA*. 2003;289(8):1035–1040.
 62. Nelson K, Helfrich C, Sun H, et al. Validation of a Method to Assess Implementation of the Patient Centered Medical Home (PCMH) in the Veterans Health Administration (VHA).; 2014.
 63. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med*. 2014;174(8):1350–8.
 64. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout, and hospital and emergency department use. *JAMA Intern Med*. 2014;174(8):1350–8. doi:10.1001/jamainternmed.2014.2488.
 65. Nielsen M, Gibson A, Buelt L, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost and Quality Quality: Annual Review of Evidence 2013-2014.; 2015.
 66. Nielsen M, Gibson A, Patel K, Nichols L. The Patient-Centered Medical Home's Impact on Cost and Quality: Annual Review of Evidence 2014-2015.; 2016.
 67. Nielsen M, Olayiwola JN, Grundy P, Grumbach K. The Patient-Centered Medical Home's Impact on Cost & Quality: Annual Update of the Evidence, 2012-2013.; 2014.
 68. Nutting P, Crabtree BF, Miller WL, Stewart EE, Stange K, Jaen C. Journey to the Patient-Centered Medical Home : A Qualitative Analysis of the Experiences of Practices in the National Demonstration Project. *Ann Fam Med*. 2010;8(1):45–56.
 69. Nutting P, Miller W, Crabtree B. Initial Lessons From the First National Demonstration Project on Practice Transformation to a Patient-Centered Medical Home. *Ann Fam Med*. 2004.
 70. O'Kane M. NCQA Public Letter to CMS.; 2016.
 71. O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. *Health Serv Res*. 2005;40(5 Pt 2):1620–39.
 72. Obama BJ. United States Health Care Reform. *JAMA J Am Med Assoc*. 2016;316(5):525–532.
 73. Outcalt SD, Yu Z, Hoen HM, Pennington TM, Krebs EE. Health Care Utilization Among Veterans with Pain and Posttraumatic Stress Symptoms. *Pain Med*. 2013.
 74. Panangala SV. Health care for veterans: Answers to frequently asked questions.; 2015.
 75. Peikes D, Chen A, Schore J, Brown R. Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries: 15 randomized trials. *JAMA*. 2009;301(6):603–18.
 76. Peikes D, Zutshi A, Genevro J, Smith K, Parchman M, Meyers D. Early Evidence on the Patient-Centered Medical Home.; 2012.
 77. Peikes DN, Reid RJ, Day TJ, Dale SB, Brown RS, Shapiro RJ. Staffing Patterns of Primary Care Practices in the Comprehensive Primary Care Initiative. *Ann Fam Med*. 2014;12(2):142–149.
 78. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care

- quality improvements. *Acad Pediatr.* 2013;13(6 SUPPL.):S38–S44.
79. Pincus T, Esther R, DeWalt D a, Callahan LF. Social conditions and self-management are more powerful determinants of health than access to care. *Ann Intern Med.* 1998;129(5):406–11.
 80. Post E. VA PCMH Integration Update.
 81. PTSD NC for. Using the PTSD Checklist (PCL).; 2012.
 82. Rabe-Hesketh, Skrondal. Multilevel and longitudinal modeling using Stata.; 2012.
 83. Randall I, Maynard C, Chan G, Devine B, Johnson C. Assessing the effect of the VHA PCMH on utilization among Veterans with PTSD.; 2016.
 84. Randall I, Mohr DC, Maynard C. VHA Patient-Centered Medical Home Associated With Lower Rate of Hospitalizations and Specialty Care Among Veterans With Posttraumatic Stress Disorder Abstract : *J Healthc Qual.* 2014;0(0):1–8.
 85. Reid RJ, Coleman K, Johnson E a, et al. The group health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health Aff (Millwood).* 2010;29(5):835–43.
 86. Reid RJ, Fishman P a, Yu O, et al. Patient-centered medical home demonstration: a prospective, quasi-experimental, before and after evaluation. *Am J Manag Care.* 2009;15(9):e71-87.
 87. Rich E, Lipon D, Libersky J, Parchman M. Coordinating-Care-for-Adults-With-Complex-Care-Needs-White-Paper.; 2012.
 88. Richardson L, Frueh BC, Acierno R. Prevalence Estimates of Combat-Related PTSD: A Critical Review. *Aust N Z J Psychiatry.* 2010;44:4–19.
 89. Rosland A-M, Nelson K, Sun H, et al. The Patient-Centered Medical Home in the Veterans Health Administration. *Am J Manag Care.* 2013;19(7):e263-72.
 90. Rosland A-M, Nelson K, Sun H, et al. The patient-centered medical home in the Veterans Health Administration. *Am J Manag Care.* 2013;19(7):e263-72.
 91. Scott KM, Bruffaerts R, Tsang A, et al. Depression-anxiety relationships with chronic physical conditions: Results from the World Mental Health surveys. *J Affect Disord.* 2007;103(1–3):113–120.
 92. Sharabiani MT a, Aylin P, Bottle A. Systematic review of comorbidity indices for administrative data. *Med Care.* 2012;50(12):1109–18.
 93. Simon, GE, VonKoff M BW. Health care costs of primary care patients with recognized depression. *Arch Gen Psychiatry.* 1995;52(10):850–856.
 94. Smith RA, Levine TR, Lachlan KA, Fediuk TA. The high cost of complexity in experimental design and data analysis: type I and type II error rates in multiway ANOVA. *Hum Comm Res.* 2002;28(4):515–530.
 95. Solimeo SL, Hein M, Paez M, Ono S, Lampman M, Stewart GL. Medical Homes Require More Than an EMR and Aligned Incentives. *Am J Manag Care.* 2013;19(2):132–141.
 96. Stange KC, Nutting P a, Miller WL, et al. Defining and measuring the patient-centered medical home. *J Gen Intern Med.* 2010;25(6):601–12.
 97. Starfield B, Lemke KW, Herbert R, Pavlovich WD, Anderson G. Comorbidity and the Use of Primary Care and Specialist Care in the Elderly. *Ann Fam Med.* 2005;3(3):215–222.
 98. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *Milbank Q.* 2005;83(3):457–502.
 99. Tenhave TR, Kunselman AR, Tran L. A Comparison of Mixed Effects Logistic

- Regression Models for Binary Response Data With Two Nested Levels of Clustering. *Stat Med.* 1999;18:947–960.
100. Thielke S, Vannoy S, Unutzer J. Integrating Mental Health and Primary. *Prim Care Clin Off Pract.* 2007;34(3):571–592.
 101. Tirodkar MA, Morton S, Whiting T, et al. There’s More Than One Way to Build a Medical Home. *Am J Manag Care.* 2014;20(December):582–589.
 102. Trivedi RB, Post EP, Sun H, et al. Prevalence, comorbidity, and prognosis of mental health among US veterans. *Am J Public Health.* 2015;105(12):2564–2569.
 103. True G, Butler AE, Lamparska BG, et al. Open access in the patient-centered medical home: lessons from the Veterans Health Administration. *J Gen Intern Med.* 2013;28(4):539–45.
 104. Unützer J, Harbin H, Schoenbaum M, Druss BG. The Collaborative Care Model: An Approach for Integrating Physical and Mental Health Care in Medicaid Health Homes. *Heal Home Inf Resour Cent.* 2013;(May):1–13.
 105. VA, DOD to Fund \$100 Million PTSD and TBI Study. American Forces Press Service. 2012.
 106. Wagner EH. Chronic Disease Management : What Will It Take To Improve Care for Chronic Illness. *Eff Clin Pract.* 1998;1(1):2–4.
 107. Wang PS, Demler O, Olfson M, Pincus H a, Wells KB, Kessler RC. Changing profiles of service sectors used for mental health care in the United States. *Am J Psychiatry.* 2006;163(7):1187–98.
 108. Wise C, Alexander J, Green L, Cohen G, Koster C. *Milbank Quarterly.* Milbank Q. 2011;89(3):450–502.
 109. Yoon J, Rose D, Canelo I, et al. Medical Home Features of VHA Primary Care Clinics and Avoidable Hospitalizations. *J Gen Intern Med.* 2013;9:1188–94.
 110. Yoon J, Rose DE, Canelo I, et al. Medical home features of VHA primary care clinics and avoidable hospitalizations. *J Gen Intern Med.* 2013;28(9):1188–1194.

Vita

Ian Randall received a Bachelor of Arts degree with Honors in International Relations from the James Madison College of Public Affairs at Michigan State University in 2005 and a Master of Health Administration degree from the University of Michigan School of Public Health, Department of Health Management and Policy in 2008. Ian began his doctoral work at the University of Washington School of Public Health, Department of Health Services Research in 2011 and completed his PhD in 2016. Before beginning the PhD, Ian worked in a number of positions related to health care policy, research and consulting, including roles with a multi-client lobbyist firm and a large international management consulting firm where he worked with multi-sector clients on strategy, operations and policy engagements.

While pursuing his doctorate, Ian worked as an independent consultant and helped the Washington State Office of the Insurance Commissioner convene a diverse stakeholder coalition to develop stabilization programs for the Washington Health Benefits Exchange, and with King County to develop a framework to measure the impact of the ACA on a range of outcomes. In his current role as a Senior Consultant at Health Management Associates, Ian has led and contributed to various client engagements in the state and federal government, provider and payer sectors. Notable project roles include: redesigning and expanding Medicaid payment and delivery systems; redesigning state value-based purchasing initiatives with safety net providers; conducting financial and programmatic assessments of behavioral health programs; spearheading MCO business development, care management and provider network development efforts; and, supporting health system efforts to redesign financial and clinical systems, among others.