Recommendation for In-person and Virtual Care Delivery among U.S. Servicemembers Living with HIV[1]

Technical Report

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14. ABSTRACT

The COVID-19 pandemic introduced an unprecedented disruption in medical care. Consistent and uninterrupted care is necessary for servicemembers with chronic conditions including infection with the human immunodeficiency virus (HIV). Virtual health care, also known as telehealth, and hereafter referred to as virtual care, is a frequently employed solution to maintain medical care during disruptions such as those that occurred during the COVID-19 pandemic. This report examines the effectiveness of in-person and virtual care combinations in maintaining high-quality and cost-effective health care before and during the COVID-19 pandemic. Using medical records from the U.S. Military HIV Natural History Study for 1,294 active-duty servicemembers over Fiscal Years 2016-2021, we assessed three combinations (models) of in-person and virtual care. Model 1 consisted of virtual visits at a Center of Excellence (CoE) every year and in-person visits at the nearest Military Treatment Facility (MTF) with an infectious disease (ID) physician every 6 months, Model 2 consisted of in-person visits at a CoE every year and interim in-person or virtual visits at the nearest MTF with an ID physician, while Model 3 consisted of virtual visits at a CoE every year and interim in-person visits at a MTF or civilian clinic. The quality of care outcomes were based on the performance measures of the HIV/AIDS Bureau of the Health Resources and Services Administration and included regular periodic HIV visits, sexually transmitted infection screening, CD4 measurement, antiretroviral therapy receipt, and viral load testing and suppression. The cost outcomes included temporary duty yonder costs, lost duty time costs, and outpatient medical costs. We found that patients who had received care in the assessed models had higher quality of care than patients who did not. The higher quality of care occurred at the expense of higher costs due to lost duty time and outpatient medical care. While all patients maintained a high likelihood of receiving antiretroviral therapy and maintaining viral suppression, the higher quality of care had modest clinical implications in terms of extending survival. We recommend Model 2 for adoption, which yielded the highest incremental net monetary benefit, that is, the highest additional value in excess of the additional cost of reallocating servicemembers to Model 2.

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Abstract

The COVID-19 pandemic introduced an unprecedented disruption in medical care. Consistent and uninterrupted care is necessary for servicemembers with chronic conditions including infection with the human immunodeficiency virus (HIV). Virtual health care, also known as telehealth, and hereafter referred to as virtual care, is a frequently employed solution to maintain medical care during disruptions such as those that occurred during the COVID-19 pandemic. This report examines the effectiveness of in-person and virtual care combinations in maintaining high-quality and cost-effective health care before and during the COVID-19 pandemic. Using medical records from the U.S. Military HIV Natural History Study for 1,294 active-duty servicemembers over Fiscal Years 2016-2021, we assessed three combinations (models) of in-person and virtual care. Model 1 consisted of virtual visits at a Center of Excellence (CoE) every year and in-person visits at the nearest Military Treatment Facility (MTF) with an infectious disease (ID) physician every 6 months, Model 2 consisted of in-person visits at a CoE every year and interim in-person or virtual visits at the nearest MTF with an ID physician, while Model 3 consisted of virtual visits at a CoE every year and interim in-person visits at a MTF or civilian clinic. The quality of care outcomes were based on the performance measures of the HIV/AIDS Bureau of the Health Resources and Services Administration and included regular periodic HIV visits, sexually transmitted infection screening, CD4 measurement, antiretroviral therapy receipt, and viral load testing and suppression. The cost outcomes included temporary duty yonder costs, lost duty time costs, and outpatient medical costs. We found that patients who had received care in the assessed models had higher quality of care than patients who did not. The higher quality of care occurred at the expense of higher costs due to lost duty time and outpatient medical care. While all patients maintained a high likelihood of receiving antiretroviral therapy and maintaining viral suppression, the higher quality of care had modest clinical implications in terms of extending survival. We recommend Model 2 for adoption, which yielded the highest incremental net monetary benefit, that is, the highest additional value in excess of the additional cost of reallocating servicemembers to Model 2.

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Executive Summary

Purpose. Assess Department of Defense (DoD) human immunodeficiency virus (HIV) care in three models (combinations) of in-person and virtual care for active-duty Military Health System beneficiaries living with HIV in terms of quality and cost of care. Assess the resilience of the models of care in maintaining high quality and low cost during healthcare system disruptions such as the COVID-19 pandemic.

Methods. The sample included electronic health records for 1,294 active-duty servicemembers over Fiscal Years 2016-2021 from the U.S. Military HIV Natural History Study. Model 1 included virtual visits at a Center of Excellence (CoE) every year and in-person visits at the nearest Military Treatment Facility (MTF) with an infectious disease (ID) physician every 6 months. Model 2 included in-person visits at a CoE every year and interim in-person or virtual visits at the nearest MTF with an ID physician. Model 3 included virtual visits at a CoE every year and interim in-person visits at an MTF or civilian clinic. The quality of care outcomes were based on the performance measures of the HIV/AIDS Bureau of the Health Resources and Services Administration and included regular periodic HIV visits, sexually transmitted infection (STI) screening, CD4 measurement, antiretroviral therapy (ART) receipt, and viral load (VL) testing and suppression. The cost outcomes included temporary duty yonder (TDY) costs, lost duty time (LDT) costs, and outpatient medical costs. Trends in the outcomes were estimated while allowing for data-driven break points in the trends.

Findings. Model care exhibited higher quality of care than Non-model care (0.52 vs 0.45 [standard error (SE) 0.02]***[3] for regular periodic HIV visits, 0.95 vs 0.79 [SE 0.01]*** for STI screening, 0.93 vs 0.78 [SE 0.01]*** for CD4 measurement, 0.98 vs 0.92 [SE 0.01]*** for ART receipt, 0.91 vs 0.70 [SE 0.01]*** for VL testing and suppression). Model 2, which included in-person visits at a CoE, maintained similar or higher quality of care during the pandemic than Model 1 and Model 3 (e.g., declines of 0.05 vs 0.10 [SE 0.05] and 0.15 [SE 0.05]** for STI screening). The higher quality of care in Model 2 implies 0.56 additional years of survival. The higher quality of care in Model 2 occurred at the expense of higher LDT costs ($3,400 vs $2,664 [SE 123]***) and higher outpatient medical costs ($16,647 vs $15,757 [SE 456]**) per patient per fiscal year. All patients had a high likelihood of ART receipt 0.95 [standard deviation SD 0.21] and VL suppression 0.98 [SD 0.15].

Recommendations. While reallocating all servicemembers with HIV to Model 2 will increase DoD's TDY, LDT, and outpatient expenditures for those patients from $19,165,015 to $22,078,231 per fiscal year, we recommend Model 2 for adoption, which offers the highest incremental net monetary benefit, that is, $43,456 to $234,246 of additional value in excess of the additional cost per servicemember.

[3] ***, **, and * indicate significance at the 99%, 95%, and 90% levels respectively.

I. Background

Department of Defense Instruction (DoDI) 6485.01 "Human Immunodeficiency Virus (HIV) in Military Service Members" provides minimum standards with regard to HIV testing and care, HIV surveillance and public health measures, and administrative action, with specific guidance left to each service (Department of Defense, 2013). Variations in application of DoDI 6485.01 account for the unique operational requirements, duty limitations, and resources of each service. However, in 2018, military treatment facilities (MTFs) across all services initiated a transition of control from the services to the Defense Health Agency (DHA), with the goal to optimize healthcare delivery and support servicemember readiness across the force. The result of this initiative was joint service military health care, which has been particularly prominent at larger MTFs. As part of this joint healthcare initiative, the DHA Tri-Service HIV Working Group, comprising leaders in infectious disease (ID) from each service, provides evidence-backed advice to DHA leadership and the Joint Staff Surgeon on policy regarding the care and readiness of servicemembers living with HIV.

Once HIV infection is diagnosed, an active-duty servicemember (ADSM) is required to maintain periodic follow-up for medical care with a civilian or military infectious disease specialist at an MTF (described in Table 1). The U.S. Army (USA) and U.S. Navy (USN) require in-person follow-up visits with an infectious disease specialist at a MTF every 6 months (Department of the Army, 2014; Department of the Navy, 2018). Prior to 2014, the U.S. Air Force (USAF) required in-person follow-up visits every 6 months. In 2014, the frequency of the visits required by the USAF decreased to every year (Department of the Air Force, 2014). The USAF requires the follow-up visits to take place with the HIV Medical Evaluation Unit (MEU) at San Antonio Military Medical Center (SAMMC). The USN requires the follow-up visits to take place with the HIV Evaluation and Treatment Unit (HETU) at one of three locations: Walter Reed National Military Medical Center, Naval Medical Center Portsmouth, or Naval Medical Center San Diego. The USN required visits may be performed at smaller MTFs with ID capability if approved by the Navy Bloodborne Infection Management Center (Department of the Navy, 2018). The USA mandates the required visits to take place with an ID physician at the nearest MTF with ID subspecialty services (Department of the Army, 2014). For ADSMs living with HIV who require appointments at MTFs greater than 100 miles away, fully funded travel is provided to maintain medical standards and ensure fitness for duty (Department of Defense, 2022). When travel for required HIV follow-up care is necessary, temporary duty yonder (TDY) and lost duty time (LDT) costs can constitute a significant share of the costs of care for servicemembers living with HIV.

The onset of the COVID-19 pandemic in 2020 prompted significant changes within healthcare systems throughout the United States, including in the Military Health System (MHS). Public health safety precautions introduced in response to the pandemic restricted travel and limited in-person medical visits to urgent and emergent care. This resulted in reduced provider availability, suspension of viral load (VL) testing, and longer result turnaround times (Brazier et.al., 2022). Virtual health care in the MHS was rapidly expanded to ensure the receipt of care necessary to maintain medical readiness standards. The expansion of virtual care included care necessary to support servicemembers living with HIV.

Table 1. HIV Evaluation Requirements for Active-Duty Servicemembers with HIV by Service

	Air Force	Army	Navy/Marines
Frequency	Every year	Every 6 months	Every 6 months
Location	HIV MEU* (SAMMC)	Nearest MEDCEN with ID clinician	HETU**/comparable MTF; other MTF with ID with approval
Visit type	Virtual or in-person	In-person	In-person

* HIV medical evaluation unit

** HIV evaluation and treatment unit

The expansion of virtual care capacity in HIV MEUs (used broadly to refer to all services hereafter) forced by the COVID-19 pandemic reduced the necessity of incurring TDY travel costs. Following the first year of the pandemic, the USAF made a permanent change to allow virtual-only HIV evaluation visits. On April 22, 2021, Maj Gen Robert Miller (Director, Medical Operations, USAF) signed a memorandum lifting the travel requirement for HIV-infected USAF servicemembers. The Air Force Instruction governing care of Airmen living with HIV (44-178) is currently being updated, and the new policy of telehealth-mediated care will be reflected in the updated document (Major General Miller, 2021).

Given rising travel costs and expanding virtual care capabilities across the MHS, the DHA Tri-Service HIV Working Group introduced an initiative to unify and optimize HIV care across services. The Working Group proposed three HIV care delivery models (Table 2) to be assessed in terms of quality and cost of care. The three models constitute different combinations of in-person and virtual care necessary to meet the routine care needs of servicemembers living with HIV. We examined these three models to determine the best performing combination of in-person and virtual care in terms of quality and cost.

II. Models of Care

The proposed models of care were provided by the DHA Tri-Service HIV Working Group and are described in Table 2. An HIV Center of Excellence (CoE) was defined as an MTF that currently has an infectious disease fellowship training program (San Antonio Military Medical Center, Walter Reed National Military Medical Center, Naval Medical Center San Diego); these are also the larger MTFs that provide a substantial amount of DoD HIV care. A patient was considered to have received care under the examined models if the patient met the requirements described in Table 2. A patient in a given fiscal year received care in Model 1 if they received in-person routine care every 6 months at the closest MTF with an ID physician and received virtual follow-up at least once a year care at a CoE. A patient received care in Model 2 if the patient had at least an annual in-person visit at a CoE and a virtual or in-person interim visit at the closest MTF with an ID physician. A patient received care in Model 3 if the patient had at least an annual virtual CoE visit as well as interim in-person visits at an MTF or civilian clinic. A patient received care in Non-model care if the patient did not receive care in any of the previously described three models.

Table 2. Models of Care
Active-Duty Servicemembers with HIV

	Non-model	Model 1	Model 2	Model 3
Center of Excellence		every year virtual	every year in-person	every year virtual
Routine		every 6 months in-person nearest IDMTF**	interim* in-person/virtual nearest IDMTF**	interim* in-person MTF/civilian clinic
Patients	926	371	409	854
Patient-fiscal years	2,230	813	979	2,893

Notes:
* An interim visit is one that takes place between 120 to 240 days since the latest visit at a CoE.
** An IDMTF is a military treatment facility with a standing ID physician.
*** The models are not mutually exclusive, e.g., a patient can be in both Model 1 and Model 2 in a given fiscal year.

Distance to MTF (as-the-crow-flies) was calculated using the centroids of the 3-digit zip code areas of the beneficiary and the MTF. Visits at an MTF with a distance greater than 100 miles from the patient's residence were identified as incurring TDY costs (Department of Defense, 2022). MTFs included in the analysis are those with uniformed ID subspecialty availability in the continental United States (Table A2) where military services have conducted in-person periodic HIV evaluations.

III. Data

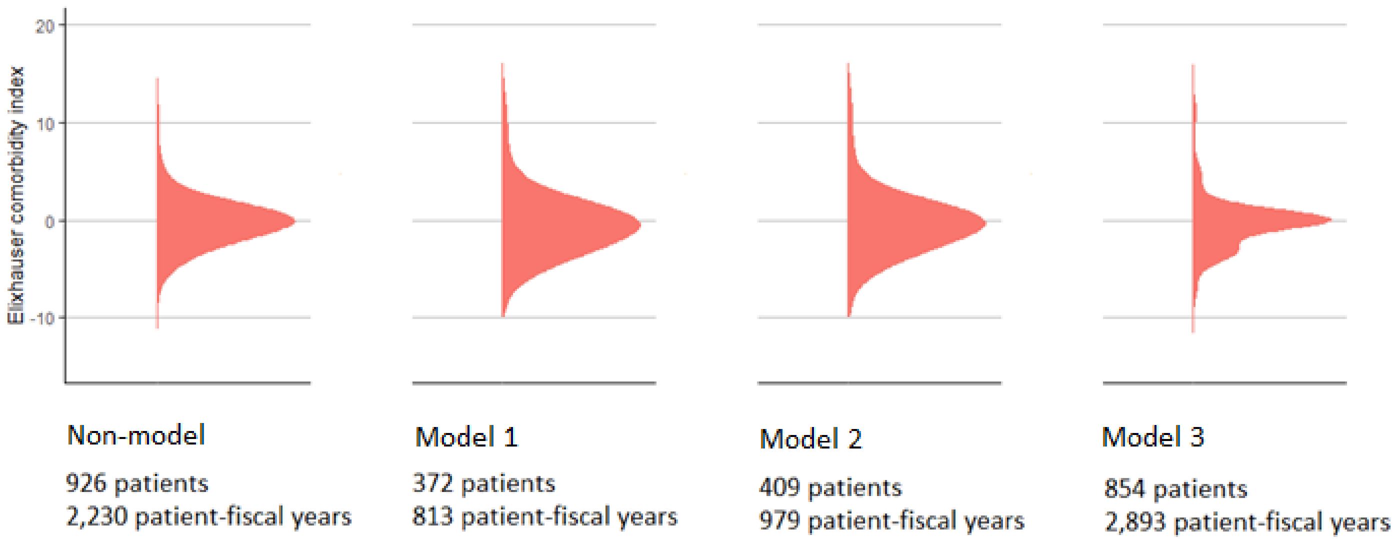
The unit of observation was patient-fiscal year. Using the U.S. Military HIV Natural History Study (NHS) population (Agan et.al., 2019), a retrospective cohort analysis was performed for FY 2016–2021 using data for 1,294 ADSMs living with HIV. Servicemembers who consented to be included in the NHS were similar to all servicemembers in terms of Elixhauser comorbidity index (FY 2016-2018, data not shown). The FY 2016-2021 year range follows the 2014 USAF change in policy that decreased the required MEU follow-up frequency, which ensures that the observed trends in the outcomes are not attributed to this policy change. The year range includes two COVID-19 pandemic fiscal years, allowing us to examine the performance of the different models of care in maintaining quality of HIV care during the pandemic. The NHS includes information from the MHS Data Repository (MDR) on medical encounters, ICD-9 and -10 diagnosis and procedure codes, laboratory and radiography results, pharmacy information, as well as costs for care, enabling us to track quality and cost of care outcomes before and during the COVID-19 pandemic. These rich patient-level data allow us to construct quality of HIV care measures based on the Ryan White Comprehensive AIDS Resources Emergency (CARE) Act performance measures of the HIV/AIDS Bureau of the Health Resources and Services Administration. The measures were modified for the patient-level data employed in the study. For instance, the sexually transmitted infection (STI) screening measure includes testing for *Neustria gonorrhea*, *Chlamydia trachomatis* (GC/CT), and syphilis. The "(number of patients with a GC/CT or syphilis test)/(number of patients with an HIV diagnosis for longer than 12 months and at least one visit in the measurement year)" was modified to a binary indicator of whether the patient has received a GC/CT or syphilis test in the measurement fiscal year. The estimated model was restricted to patients with an HIV diagnosis for longer than 12 months and at least one visit in the measurement fiscal year. The quality and cost outcomes are described in detail in Appendix Table A1.

Inclusion in the analysis required the following criteria: HIV-positive, age 18 or older; active-duty status, the availability of MHS data for at least one year. Patients exiting the dataset due to censoring were similar to patients remaining in the dataset in terms of viral suppression and Elixhauser comorbidity index. Viral suppression and Elixhauser comorbidity index in the last year that a patient was in the dataset were also stable over time. Medical encounters with no procedure codes were excluded to avoid cancelled appointments. Dollar variables were converted to 2021 dollars using the Chained Consumer Price Index for All Urban Consumers from the Federal Reserve Bank of St. Louis.

Per diem rates for TDY cost imputation were assigned based on required TDY location using the Defense Travel Management Office Per Diem Rates Query, which are summarized in Appendix Table A2 (Department of Defense, 2021). For the USAF, this was the San Antonio Military Medical Center. For the USA, the MTF was the nearest MTF with uniformed infectious disease subspecialty service. For the USN, the TDY location was the closest of either Walter Reed National Military Medical Center, Naval Medical Center Portsmouth, or Naval Medical Center San Diego. Lost Duty Time (LDT; time away from primary job duties due to medical appointments and TDY) costs were imputed using base pay rates for over 10 years of service for all ranks, E-5 and above. E-1 through E-4 have standard pay rates that are not based on time in service. Monthly and hourly base pay rates are presented in Appendix Table A3.

Figure 1 shows that patients across different models of care were similar in terms of comorbidities. Patients of different health are therefore unlikely to have selected into different models of care and the observed differences in the studied outcomes are unlikely to be attributable to patient selection.

Figure 1. Elixhauser Comorbidity Index across Models of Care



IV. Methods

The analysis explored the quality and cost of care in four combinations of in-person and virtual care: Model 1, Model 2, Model 3, and Non-model care. The Non-model category includes all care that does not fall into the three proposed models. It is important to note that patients can be in Non-model care while also following (DoDI) 6485.01. For instance, an Army servicemember who visits an MTF with an ID physician every 6 months but does not visit a CoE is in Non-model care and satisfies the DoDI and Army requirements. The models do not make up the set of all possible DoDI care but are rather specific combinations of in-person and virtual care that were assessed. The three proposed models of care are not mutually exclusive. This affects the particular statement that can be tested regarding the examined categories. For instance, although we cannot test a statement of the type “Model 2 was more effective at maintaining quality of care during the pandemic”, we can still test a statement of the type “patients who received care in Model 2 maintained higher quality of care during the pandemic than patients who did not”. The caveat to keep in mind is that patients who have received care in Model 2 may have received care in the other models as well.

The effectiveness of each model of care in maintaining high quality and low cost of care was assessed by estimating interrupted time trends in the examined quality and cost outcomes. The method allows us to estimate separate trends in the outcomes for the pre-COVID pandemic and COVID pandemic periods. This in turn enables us to assess the effectiveness of each model of care in dampening the negative effect of the pandemic on quality and cost. The method allows for both a discontinuous jump in the outcome trend at the beginning of the pandemic as well as for a different slope in the outcome trend after the beginning of the pandemic. The main specification for patient *i* in fiscal year *t* was

1) $$Y_{it} = \alpha_1 + \beta_1 t_t + \alpha_2 d_t + \beta_2 \left(t_t - t^{pandemic}\right) d_t + \varepsilon_{it}$$

$where\ d_t = 1\ if\ t \geq t^{pandemic}\ and\ d_t = 0\ if\ t < t^{pandemic}$. Y_{it} is the outcome of interest and d_t is a dummy variable indicating whether the observation takes place during the pandemic. The study employs the method of Hansen (2000) which estimates the timing of the break point $t^{pandemic}$ without arbitrary input from the researcher. This allows us to circumvent two potential issues with an arbitrary assignment. First, it avoids mismeasurement of the pandemic start. Second, it allows for anticipation effects and delayed effects of the pandemic. Hansen’s method estimates a different model for every possible break point $t^{pandemic}$ and chooses the model that best fits the data (in terms of minimal sum of squared residuals). This analysis was supplemented by event-study specifications that allowed us to confirm the linearity of the interrupted outcome trends and the estimated timing of the interruption in the trends[4]. For patient *i* in fiscal year *t*

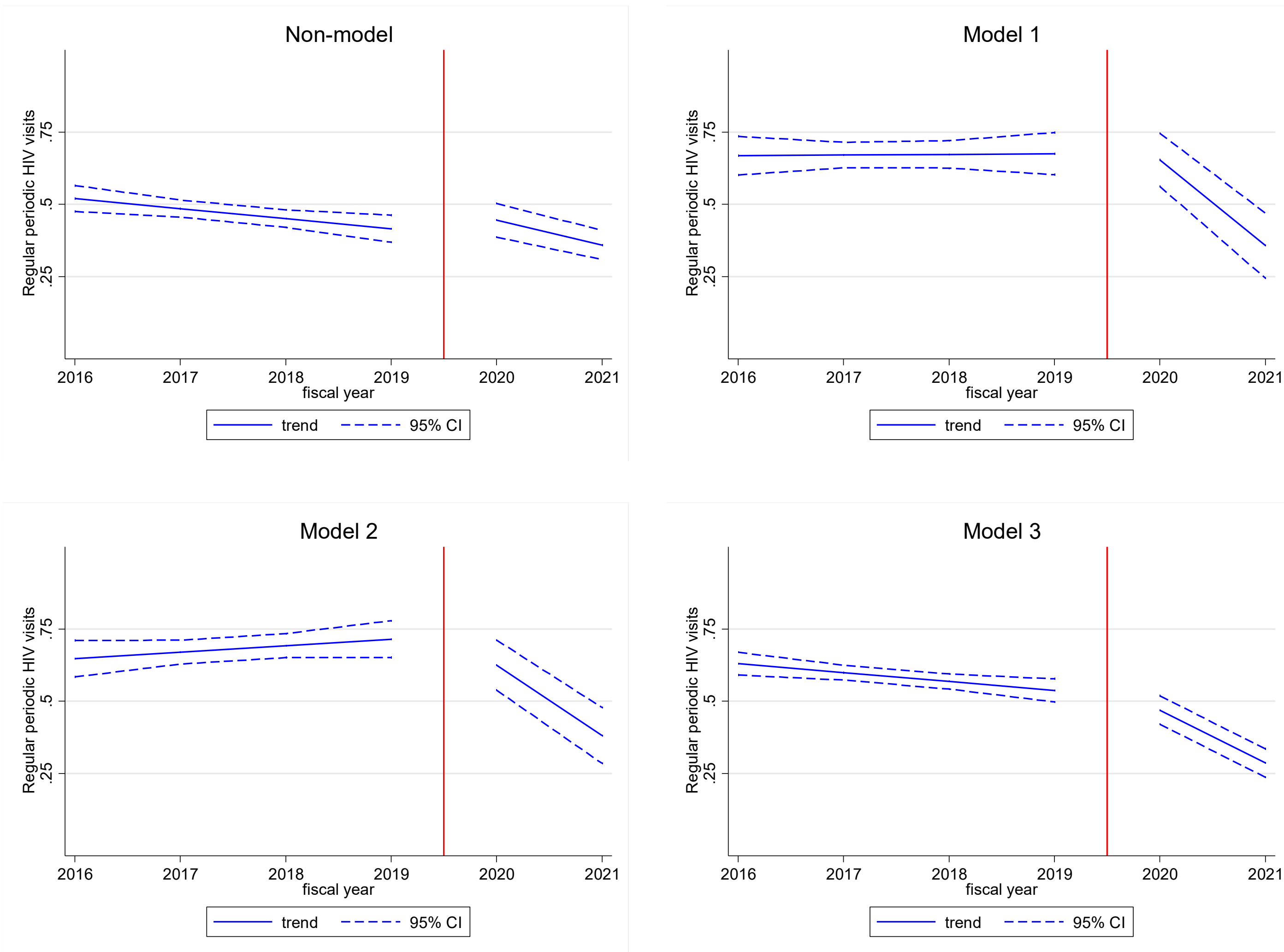
(2) $$Y_{it} = \alpha + \sum_{t=2017}^{2021} (\beta_t\ Fiscal\ Year_t) + \theta X'_{it} + \varepsilon_{it}$$

where Y_{it} is the outcome of interest and β_1 through β_5 are the estimated changes in the outcome relative to the Fiscal Year 2016 baseline. Patient characteristics X'_{it} had little influence on the results, indicating similar time dynamics in the outcomes of patients with different characteristics. Eicker-Huber-White standard errors were employed to account for heteroscedasticity.

[4] Results not presented but available upon request.

V. Results: Evaluation of Models (Combinations) of Care

Figure 2. Regular Periodic HIV Visits

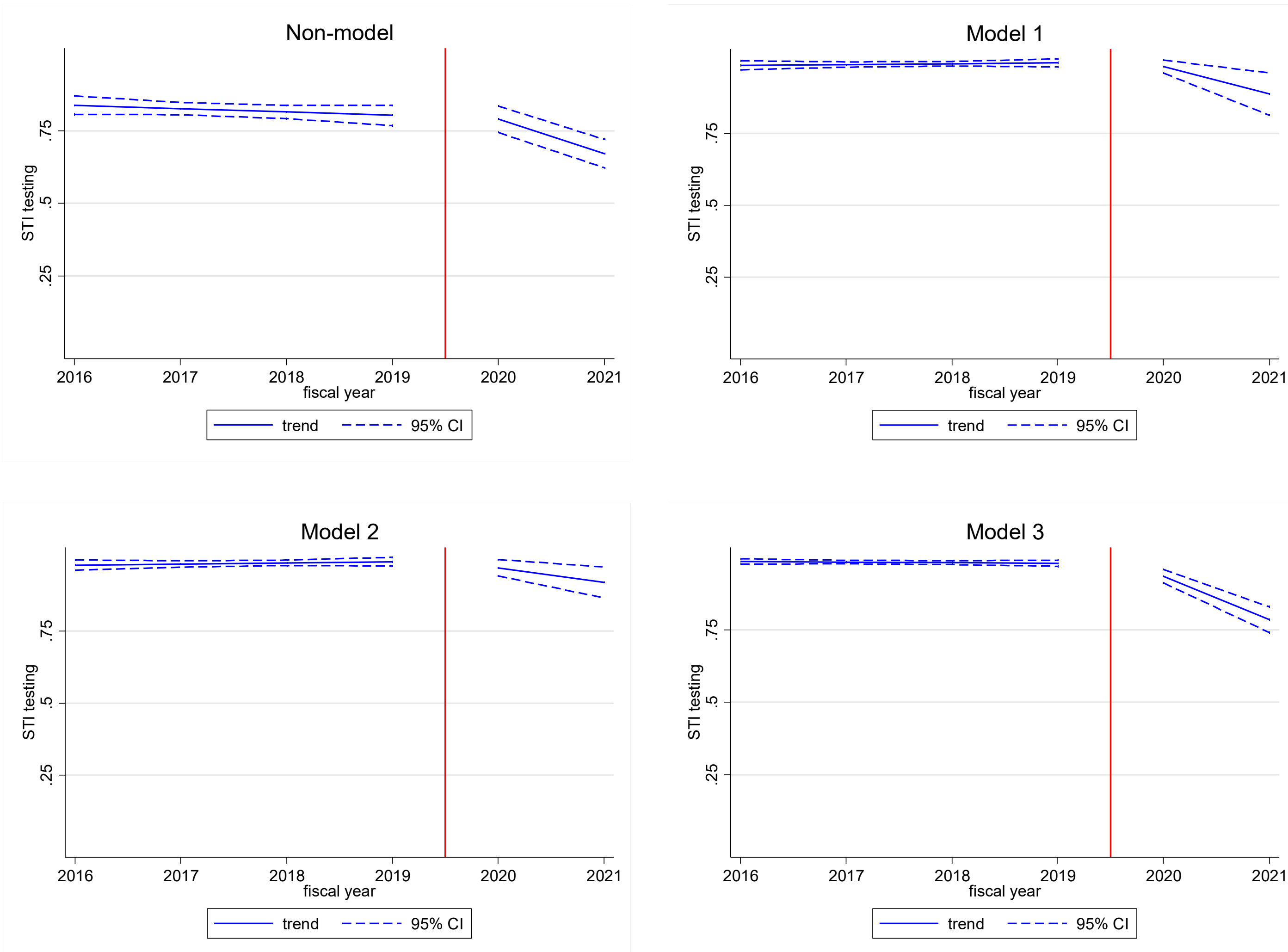


This outcome is a trailing indicator of whether the patient had an HIV visit in every half of the current and previous fiscal years. Although being in Model care in the current fiscal year nearly ensures the patient had an HIV visit in every half of the current fiscal year[5], this is not necessarily true for the previous fiscal year. Patients in Model care were more likely to have had regular periodic HIV visits in both the current and previous fiscal years, indicating a relationship between consistent HIV care and the in-person and virtual care combinations of the proposed models. The timing of the trend breaks coincides with the beginning of the pandemic. Prior to the pandemic, trends in the likelihood of regular periodic HIV visits declined by 0.03 [standard error (SE) 0.01]***[6] and 0.03 [SE 0.01]*** per year in Non-model and Model 3 care. During the pandemic, patients experienced a 0.09 [SE 0.04]** to 0.30 [SE 0.07]*** decline. The potential downstream implications of this decline are explored in the following sections.

[5] Differences in the intervals between visits of the measure and the proposed models prevent this from being always true.

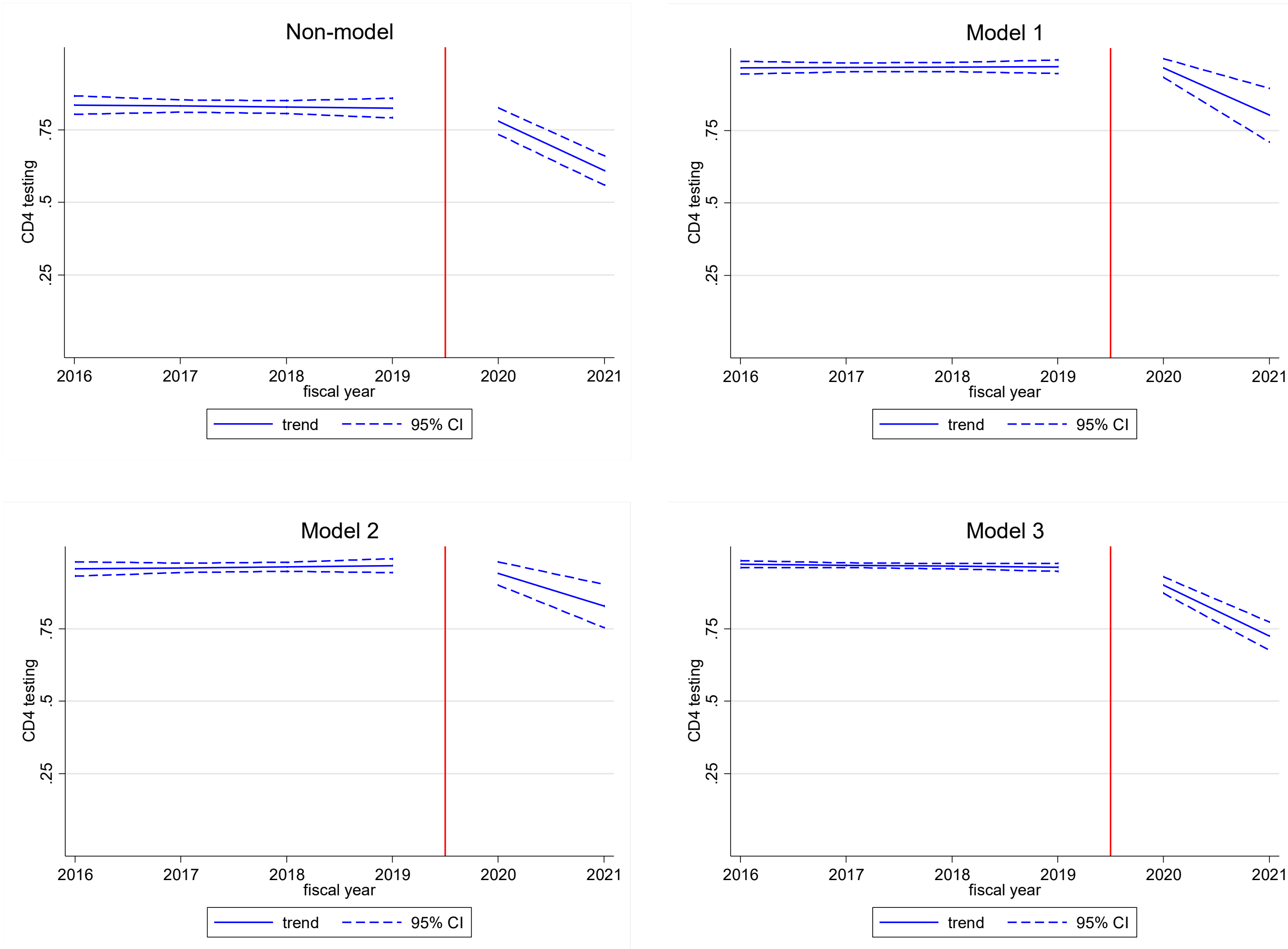
[6] ***, **, and * indicate significance at the 99%, 95%, and 90% levels respectively.

Figure 3. STI Screening



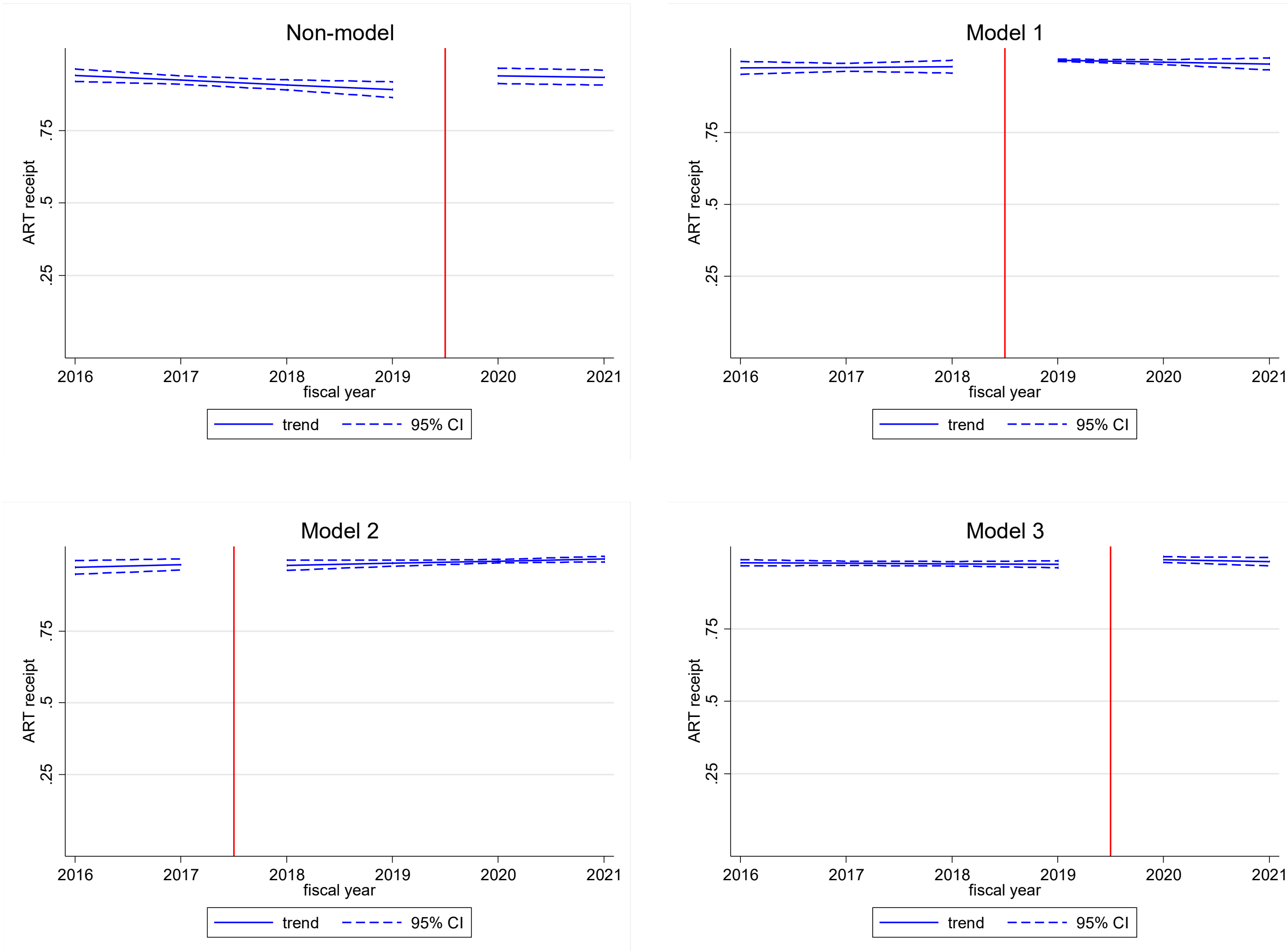
All categories exhibited high likelihood of STI screening and Model 2 was the overall best performing. As was the case for regular periodic HIV visits, STI screening was higher across the proposed models of care than in the Non-model category. Model 2 exhibited 0.14 [SE 0.02]*** to 0.19 [SE 0.02]*** higher likelihood of STI screening than Non-model care in a given fiscal year prior to the pandemic. Across all categories, the break in the trend of STI screening occurred at the same time as the beginning of the COVID pandemic. Prior to the pandemic, trends in STI screening were flat. While patients in all categories of care experienced a decline in the likelihood of receiving STI screening, patients in Model 2 maintained their flat pre-pandemic trend. All three of the proposed models of care include in-person or virtual annual visits at a CoE, which is the likely reason for the higher STI screening in the three models than in the Non-model category. Only Model 2, however, includes in-person visits at a CoE, which may be the reason why patients in Model 2 were able to maintain their pre-pandemic trend in STI screening unlike patients in the other models of care.

Figure 4. CD4 Measurement



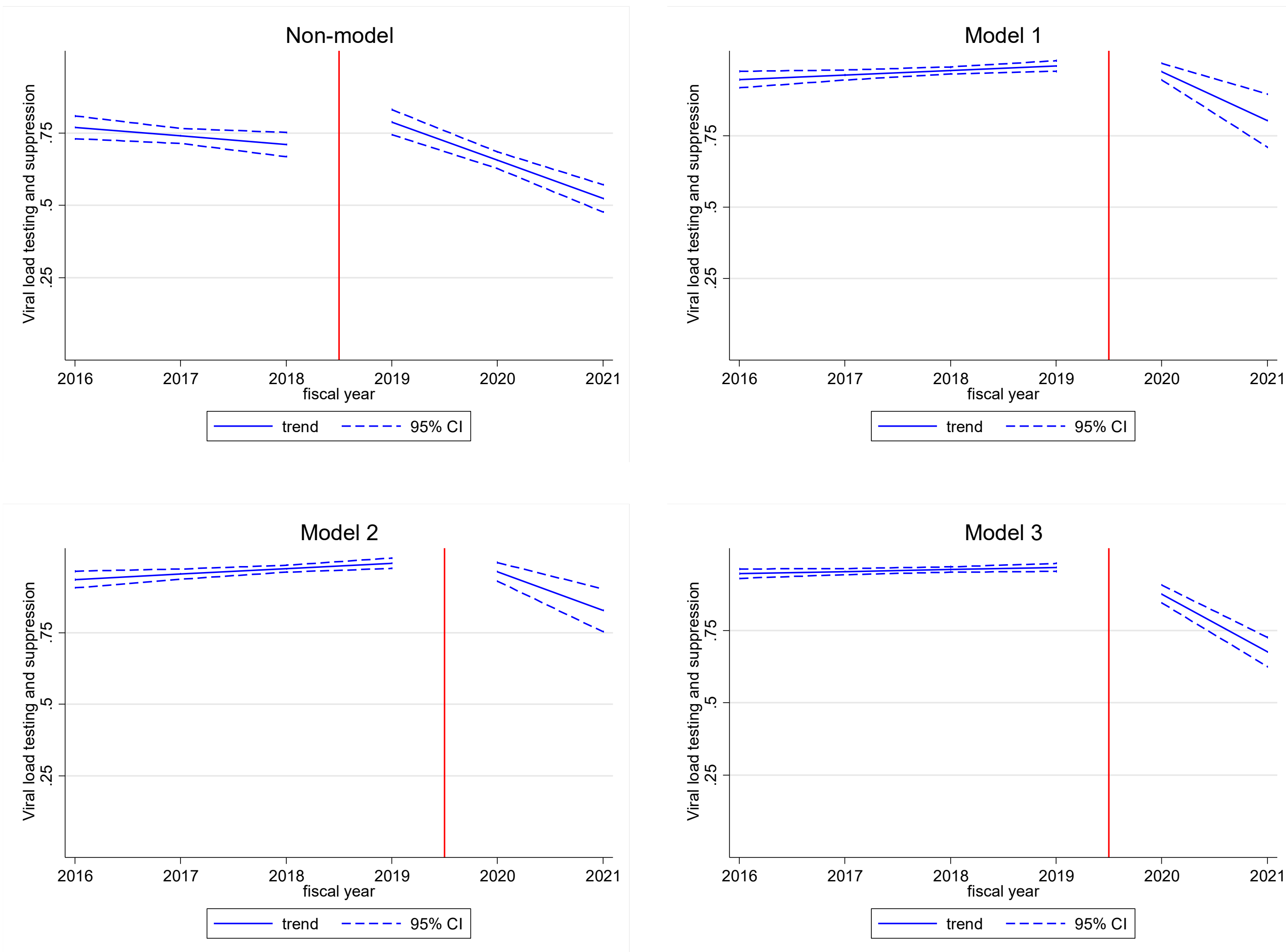
The results for CD4 testing largely mirror those for STI screening. Patients had a higher likelihood of receiving CD4 testing in the three proposed models than in the Non-model category and Model 2 was once again the best performing. Patients in Model 2 had 0.12 [SE 0.02]*** to 0.14 [SE 0.02]*** higher likelihood of CD4 testing than patients in Non-model care. This difference is likely to have occurred due to the proposed models of care consisting of a combination of care received at a CoE and care received at local clinics. The breaks in the trends of CD4 testing occurred at the same time as the beginning of the COVID pandemic. Prior to the pandemic, patients in all categories exhibited high levels of CD4 testing, which did not significantly change over time. During the pandemic, patients in all categories of care experienced a significant drop. Similarly to the previously examined quality of care measures, the drop was the least pronounced in Model 2. While patients in the other categories of care experienced an up to 0.17 [SE 0.04]*** drop in the likelihood of receiving CD4 testing, patients in Model 2 experienced a smaller 0.11 [SE 0.04]** decline (although the differences in the decline were not significant 0.06 [SE 0.06] from Non-model, 0.05 [SE 0.07] from Model 1, and 0.06 [SE 0.06] from Model 3).

Figure 5. ART Receipt



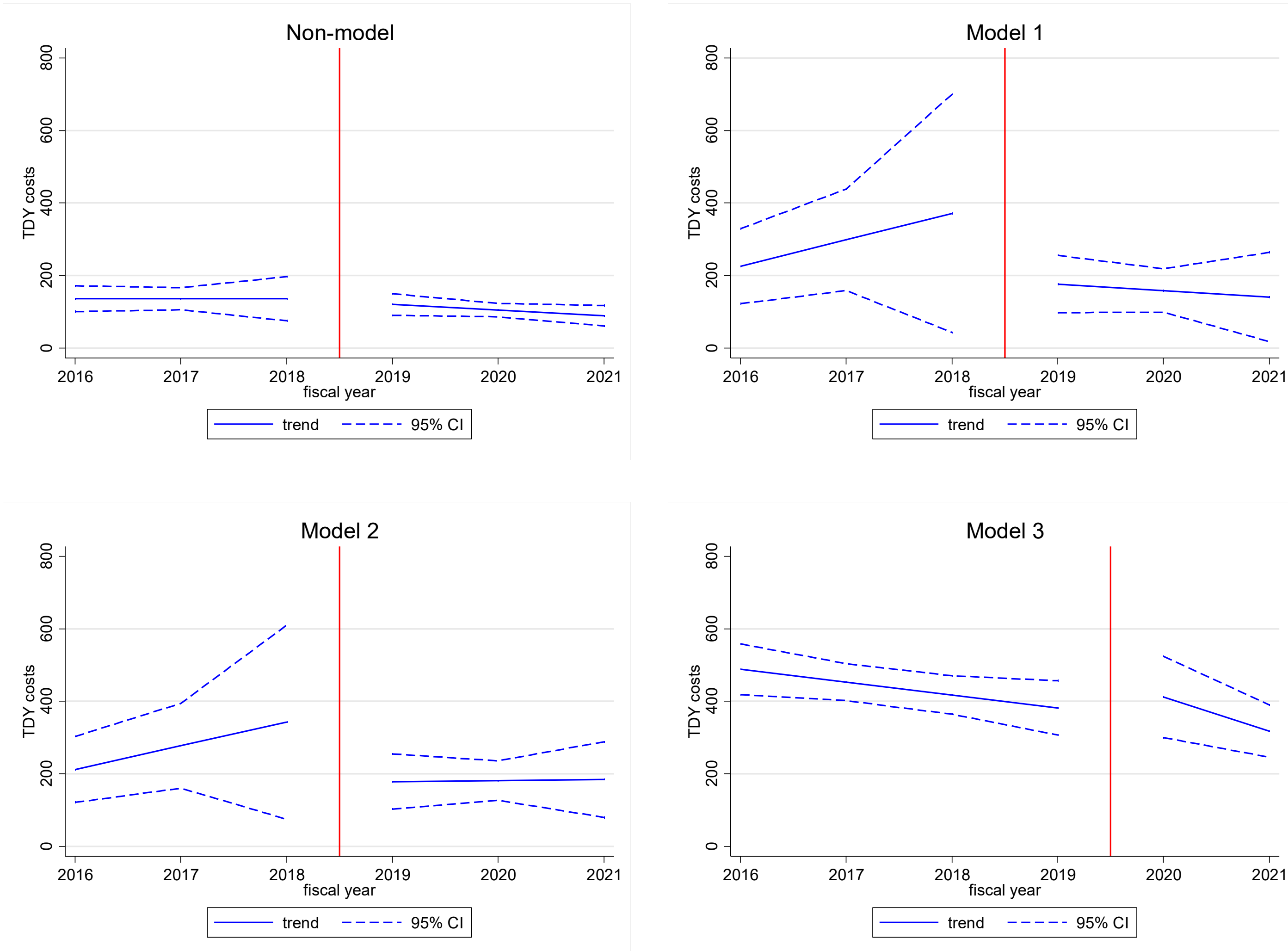
The results for ART receipt are the most reassuring out of the results for the quality of care measures explored so far. Patients in all models of care maintained high ART receipt both before and during the COVID-19 pandemic. The mean likelihood of ART receipt was 0.92 [standard deviation (SD) 0.27] in Non-model, 0.99 [SD 0.12] in Model 1, 0.98 [SD 0.12] in Model 2, and 0.98 [SD 0.15] in Model 3 care. Non-model care exhibited lower likelihood of ART receipt than Model 1 [SE 0.01]***, Model 2 [SE 0.01]***, and Model 3 [SE 0.01]***. Differences among patients in Model care were not significant. The timing of the trend breaks is sporadic and unrelated to the pandemic. While meeting the previously explored quality of care measures requires in-person medical visits, meeting the ART receipt measure does not. In-person visits during the pandemic were hampered by clinic closures for nonessential care as well as by lockdowns and travel restrictions. While the previously examined measures may have declined during the pandemic due to these restrictions, ART receipt can be fulfilled over mail without the need for in-person visits. If this difference in the ability to maintain quality of care during the pandemic is indeed attributable to the need for in-person care, the success in maintaining ART receipt could have implications for a wider use of mail-in laboratory testing.

Figure 6. Viral Load (VL) Testing and Suppression



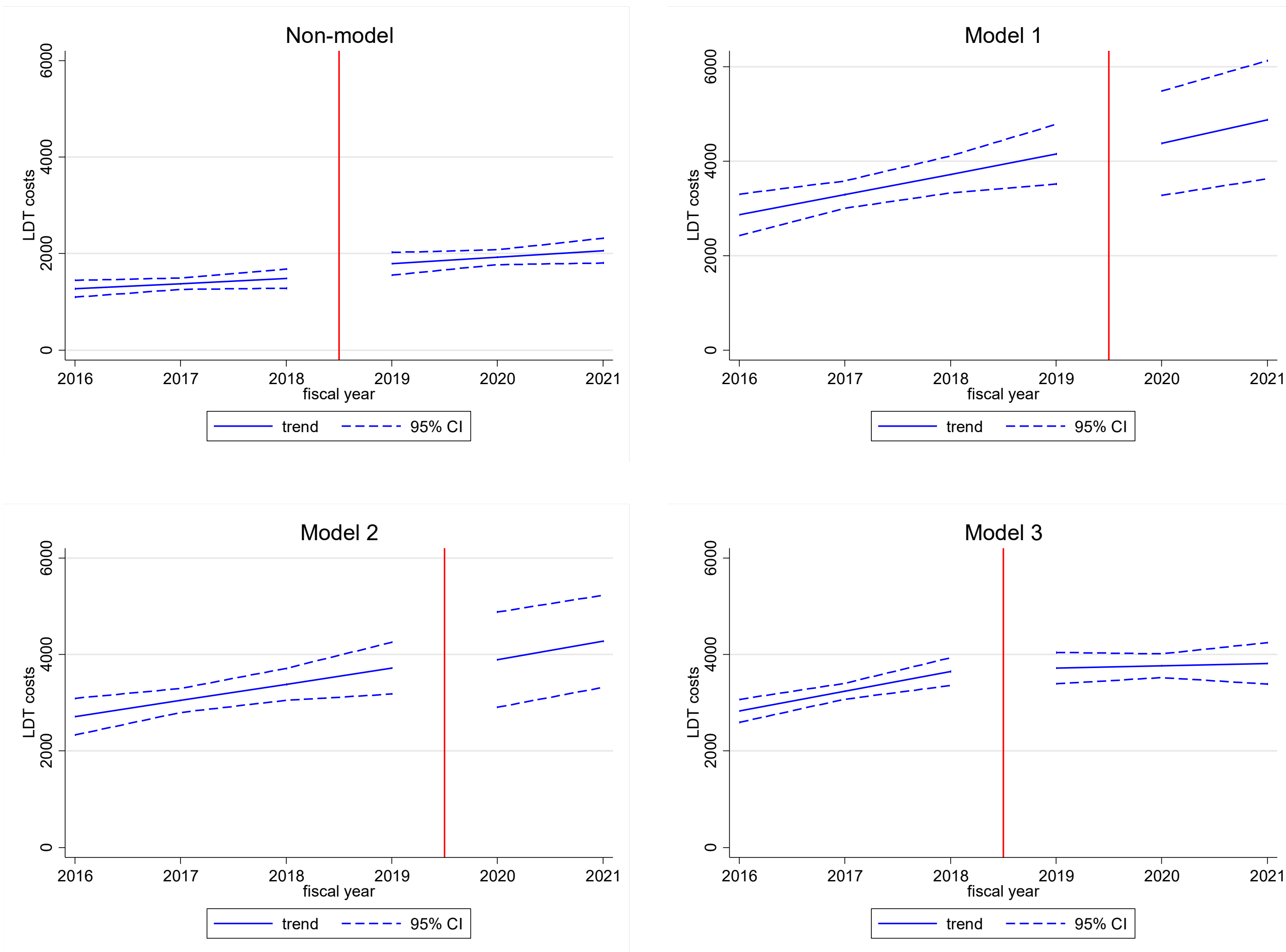
This measure captures both VL testing and suppression. A patient is considered to have met the measure if the patient had a VL test in the measurement fiscal year and the test resulted in HIV VL of less than 200 copies/ml. Differences in the measure can therefore occur due to differences in both testing and suppression. Before the pandemic, the measure was lowest among patients in the Non-model category due to less testing taking place in this category. In comparison, patients in Model 2 had 0.17 [SE 0.02]*** to 0.26 [SE 0.02]*** higher likelihood of meeting the measure. The timing of the trend break for the three proposed models of care coincides with the timing of the pandemic start, which supports attributing changes in the trend to the pandemic. The decline in the measure at the pandemic start occurred due to a decline in VL testing. Viral load suppression among the tested was maintained as shown in Appendix Figure A1. All models showed a decline in VL testing during the pandemic. The decline was once again the lowest 0.13 [SE 0.04]*** for Model 2 and as high as 0.20 [SE 0.03]*** for Model 3, although the differences in the declines between the different models were not statistically significant.

Figure 7. TDY Costs



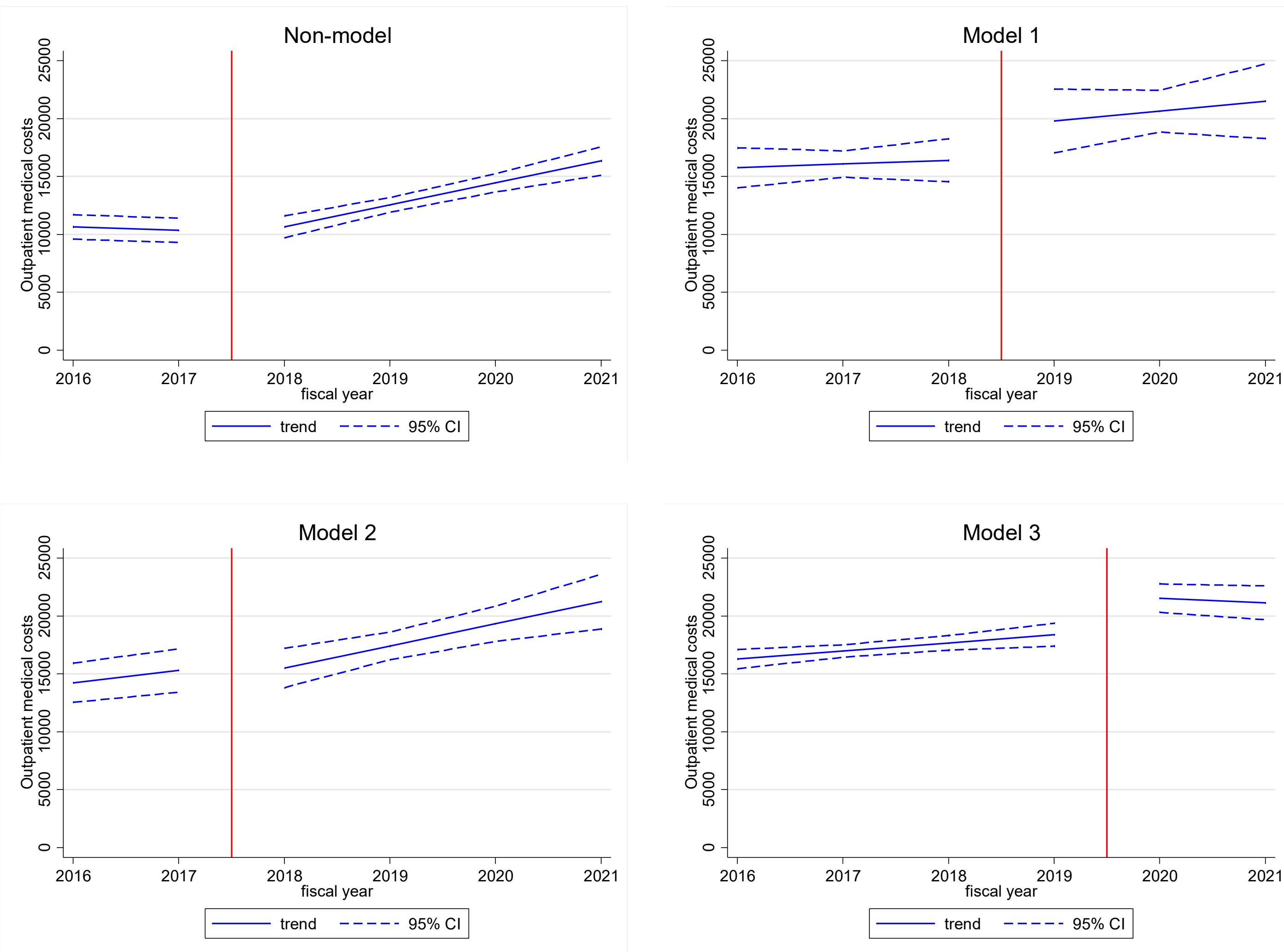
The results for TDY costs are not informative. Patients in only 35% of patient-fiscal years incurred TDY. The large amount of variation across patients results in wide confidence intervals and trend estimates which are not statistically significant at the 95% confidence level. This includes the timing of the trend breaks, which is random. Moreover, TDY costs constituted only a small fraction of costs of care, suggesting that cost-saving efforts should focus elsewhere. Mean TDY cost per patient across the different categories of care ranged from $121 [SD 444] for Non-model care to $419 [SD 1,112] for Model 3 care per fiscal year (all patients included to reflect population cost). While not null, these values are several magnitudes smaller than the costs explored further in this report and therefore more attention should be devoted to those higher costs instead.

Figure 8. LDT Costs



Patients in the proposed models had a higher $3,458 [SD 3,850] level of LDT costs than the $1,627 [SD 2,319] in Non-model care due to having to receive care at a CoE or local facility [SE 92]***. LDT costs across all models of care exhibit a similar increasing pattern. The annual increases in LDT cost per patient were $168 [SE 29]*** for Non-model, $394 [SE 104]*** for Model 1, $307 [SE 86]*** for Model 2, and $200 [SE 44]*** for Model 3 care. The timing of the trend breaks is random and unlikely to have occurred due to the pandemic. There are several potential explanations for the increasing trend. The cost per lost day of duty during the year range was constant and does not explain the increasing trends. Servicemembers of different rank are compensated different amounts but the shares of patients of each rank were also largely constant. The increasing trends likely occurred due to increasing trends in the number of lost duty days. While Appendix Figure A2 shows that the number of outpatient procedures in direct care did not increase over time, Appendix Figure A3 shows that the number of outpatient procedures in purchased care more than doubled for some categories during Fiscal Years 2016 though 2021. The upward trend in LDT costs, therefore, appears to have occurred largely due to increasing care utilization among ADSMs treated in purchased care.

Figure 9. Outpatient Medical Costs



As was the case for LDT costs, the level of outpatient medical costs was higher $18,377 [SD 12,871] among patients in the proposed models of care than the $12,332 [SD 12,020] in the Non-model category [SE 352]***. Outpatient medical costs exhibit an increasing pattern similarly to LDT costs. The annual increases per patient were $1,203 [SE 156]*** for Non-model, $1,302 [SE 317]*** for Model 1, $1,342 [SE 279]*** for Model 2, and $1,106 [SE 144]*** for Model 3 care. The timing of the trend breaks is random and not attributable to the pandemic. The previously observed increasing trends in LDT and outpatient procedures undoubtedly also led to the increases in outpatient costs, which are reflected here. Appendix Figure A2 and Figure A4 show that both outpatient procedures and costs in direct care did not increase during the year range. Appendix Figure A3 and Figure A5, on the other hand, show that the observed increasing trends in outpatient costs are largely attributable to increasing trends in outpatient procedures and outpatient costs in purchased care. This distinction between direct and purchased care and the difference in the medical care utilization and cost in direct and purchased care raises the question whether the higher costs in purchased care were worth the high levels of quality of care observed so far.

VI. Discussion: Clinical and Cost Implications

The results suggest that Model 2 is the best candidate for recommendation in terms of maintaining quality of care. However, Model 2 was also associated with higher costs. In this section we explore the viability of recommending Model 2 for widescale adoption in terms of clinical and budgetary implications.

VI.1. Clinical Implications

Allocating servicemembers to Model 2 will reduce mortality. Figure A6 in the appendix illustrates that patients who received care in Model 2 exhibited high likelihood of meeting 80% or more of the quality of care measures. Using a sample of mostly male veterans, Korthius et.al. (2016) estimated that patients who met 80% or more of quality of care measures experienced lower mortality. The mortality rates were 4.1/100 for patients meeting less than 80% of quality of care measures and 3.5/100 for patients meeting 80% or more of quality of care measures. Assuming a constant rate and an exponential distribution, this translates to expected survival of 24.4 years for patients meeting less than 80% of measures and 28.6 years for patients meeting 80% or more of measures. This implies an expected survival of 27.7 years under the current allocation across categories of care. Allocating all servicemembers with HIV to Model 1, Model 2, or Model 3 will improve the likelihood of meeting 80% or more of quality of care measures and is expected to modestly improve survival up to 28.3 years for Model 1, 28.3 years for Model 2, and 28.1 years for Model 3. Model 2 and Model 1 exhibit similar expected survival; therefore, in the next section we assess the cost-effectiveness of the models.

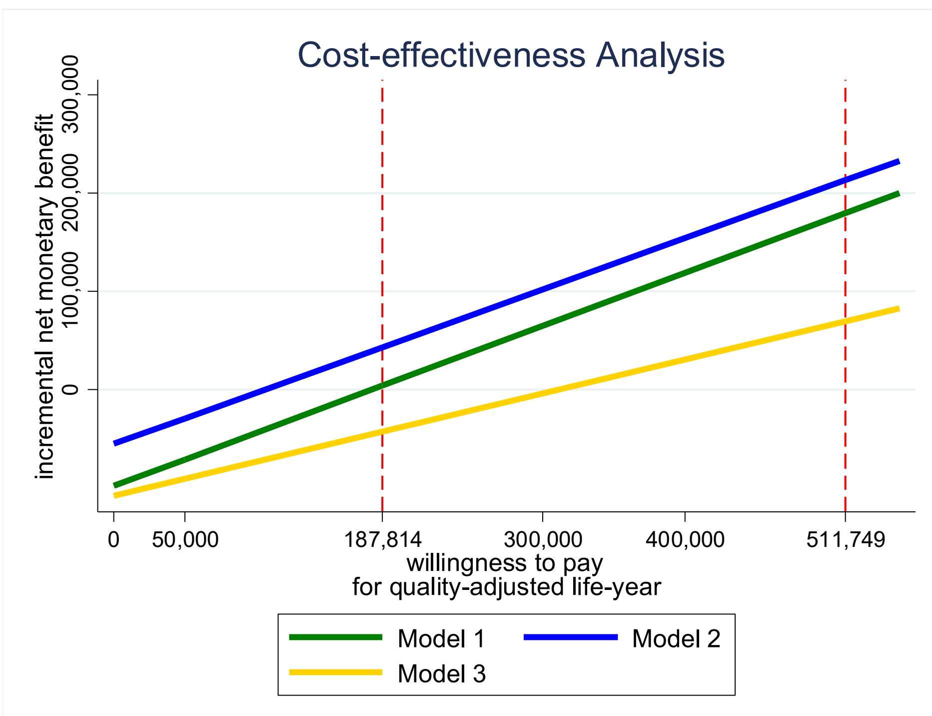
VI.2. Cost-effectiveness Analysis

Model 2 is cost-effective. Given the expected survival reported in the previous section, expected lifetime TDY, LDT, and outpatient cost per patient in the current allocation is $518,841. Similarly, expected lifetime costs for Model care are $616,666 for Model 1, $573,828 for Model 2, and $626,515 for Model 3. Incremental net monetary benefit was calculated as

(3) $$\Delta NMB = \Delta QALY * WTP - \Delta C$$

where $\Delta QALY$ is the difference in quality-adjusted life-years due to being in a given model rather than the current allocation, WTP is the willingness to pay for an additional quality-adjusted life-year, ΔC is the additional lifetime TDY, LDT, and outpatients costs due to being in a given model rather than the current allocation, while ΔNMB is the additional value in excess of additional costs due to being in a given model of care rather than the current allocation. Assigning a 0.94 health state utility for asymptomatic HIV (Tengs and Lin, 2002) to all patients and considering commonly estimated ranges of willingness to pay for a quality-adjusted life-year, the figure below illustrates the incremental net monetary benefit of switching all servicemembers with HIV from the current allocation to either Model 1, Model 2, or Model 3. Model 2 exhibits higher incremental net monetary benefit than Model 3 at the examined range of willingness to pay (differences of 52,687 [SE 8,366]***, 61,583 [SE 8,613]***, 86,104 [SE 12,251]***, and 143,740 [SE 26,467]*** for willingness to pay for a quality-adjusted life-year of $0, $50,000, $187,814, and $511,749[7] respectively). Model 2 also exhibits statistically significantly higher incremental net monetary benefit than Model 1 at lower levels of willingness to pay (differences of 42,838 [SE 8,366]***, 41,917 [SE 8,697]***, 39,380 [SE 13,063]***, and 33,415 [SE 29,214] for willingness to pay for a quality-adjusted life-year of $0, $50,000, $187,814, and $511,749 respectively). Model 2 maintains positive incremental net monetary benefit across the $187,814 to $511,749[8] range of willingness to pay estimated by Braithwaite et.al. (2008) for healthcare in the modern era (43,456 [SE 9,117]*** to 213,248 [SE 20,256]***). Given this range, redistributing all servicemembers with HIV from the current allocation to Model 2 yields the highest incremental net monetary benefit ranging from $43,456 to $213,248 per patient.

Figure 10. Cost-effectiveness Analysis



[7] $187,814 to $511,749 is the range of willingness to pay estimated by Braithwaite et.al. (2008) for health care in the modern era.
[8] Converted to 2021 dollars using the Chained Consumer Price Index for All Urban Consumers from the Federal Reserve Bank of St. Louis.

This incremental net monetary benefit calculation includes lifetime TDY, LDT, and outpatient cost. However, servicemembers who leave active-duty status and remain in the MHS as dependents or retirees do not incur TDY or LDT costs. Therefore, Figure A7 in the appendix illustrates the result of repeating the incremental net monetary benefit calculation including outpatient costs only. Model 2 remains the category with highest incremental net monetary benefit across conventional ranges of willingness to pay. The incremental net monetary benefit of reallocating servicemembers to Model 2 while accounting for outpatient costs only for the willingness to pay range estimated by Braithwaite et.al. (2008) is $ 64,454 to $234,246. Adopting the lower bound of the calculation which includes TDY, LDT, and outpatient costs in order to allow for servicemembers who remain in active-duty status throughout their lifetime and adopting the upper bound of the calculation, which includes outpatient costs only to allow for patients who spend only a negligible amount of time in active-duty status, yields a more conservative Model 2 incremental net monetary benefit range of $43,456 to $234,246. Model 2 remains the category with highest incremental net monetary benefit out of the examined models.

VI.3. Budget Impact Analysis

Allocating servicemembers to Model 2 will increase costs. Given the current allocation of servicemembers across Non-model and model care, the DoD expended an average of $19,165,015 per fiscal year in TDY, LDT, and outpatients costs for all ADSMs with HIV[9]. Allocating all servicemembers to Model 1, Model 2, or Model 3 would have resulted in respectively $23,652,421, $22,078,231, or $24,296,834 per fiscal year for all servicemembers with HIV. Although allocating servicemembers to Model 2 would have increased costs by $2,913,216, Model 2 had the lowest cost out of the examined models.

VII. Limitations and Additional Checks

This analysis is not causal and the estimated changes in the trends of the examined outcomes should not be interpreted as the causal effect of the COVID-19 pandemic. A trend break that coincides with the beginning of the pandemic enables us to attribute breaks in the trend to the pandemic, but it does not enable us to interpret the magnitude of the change during the pandemic as the causal effect. The lack of a counterfactual prevents us from estimating the accurate size of the causal effect of the pandemic. In other words, while we know what happened to the studied outcomes during the pandemic, we do not know what would have happened had the pandemic not occurred. We are, however, still able to make more general

[9] Using data for all ADSMs from "A Cohort Study of Clinical Outcomes among Military HIV+ Beneficiaries and Stratified HIV Controls" for the Fiscal Years 2016–2020.

statements. We are not able to state what the pandemic caused, but we are able to state what happened during the pandemic without attributing the magnitude of the changes to the pandemic.

The proposed models of care are not mutually exclusive and therefore we cannot attribute differences in the outcomes of the different models of care exclusively to being in one model or another. A given patient in a given fiscal year can be in several of the proposed models at once. This prevents us from stating that a given model caused higher or lower levels of an outcome but still enables us to state that having been in given model resulted in a higher or lower outcome. Additionally, inclusion of some subjects in multiple models might bias results toward the null; however, significant findings were evidenced.

TDY and LDT costs are imputed. Because no data for TDY and LDT costs exist, the values were imputed in the most reasonable available manner. The analysis of costs was further supplemented with actual data for direct and purchased outpatient care utilization and costs. The results for this supplemental medical cost data are consistent with the results for TDY and LDT costs.

The time range is limited. Although the year range for the analysis consists of only 6 fiscal years, this enables us to ensure the consistency of HIV care policy and HIV clinical guidelines during the study period. This enables us to more confidently attribute changes in the examined outcomes to events studied during the year range such as the COVID-19 pandemic.

The cost-effectiveness analysis assumes that servicemembers remain in the MHS throughout their lifetime at the current cost per fiscal year. The cost-effectiveness analysis therefore pertains to ADSMs who remain in the MHS as active-duty, retirees, or dependents. Non-active-duty MHS beneficiaries have slightly lower costs than active-duty beneficiaries (Topal et.al., 2022). For this reason, the cost-effectiveness analysis underestimates incremental net monetary benefit and can be interpreted as yielding conservative values.

VIII. Conclusion and Recommendations

Based on these findings, to optimize outcomes among ADSMs living with HIV, of the evaluated models, we recommend adoption of Model 2 as a standard, which exhibited the highest incremental net monetary benefit out of the assessed models of care. Incremental net monetary benefit is a comprehensive measure that incorporates quality of care dependent survival, TDY costs, LDT costs, outpatient costs, and societal preferences for survival vs costs.

The results of our analyses reveal that patients who had received care in one of the proposed models tended to have received higher quality of care in terms of regular periodic HIV visits, STI screening, CD4 measurement, and VL testing and suppression compared to patients in Non-model care. Patients across all categories of care maintained high levels of ART receipt and HIV viral load suppression. Differences in the VL testing and suppression quality of care measure occurred almost entirely due to differences in VL testing. All the proposed models included a combination of in-person and virtual care at a remote CoE as well as at a local military or civilian clinic. Having received care in Model 2 was associated with high or higher quality of care than the other models in terms of regular periodic HIV visits, STI screening, and CD4 measurement. Patients who had received care in Model 2 also consistently experienced similar or smaller declines in quality of care during the pandemic. Model 2 is the only of the considered models that includes in-person visits at a CoE, which were likely instrumental in maintaining quality of care during the pandemic.

The higher quality of care among patients who used the proposed models occurred at the expense of higher LDT costs and higher direct care outpatient costs. The COVID-19 pandemic had no discernable influence on average costs and the general upward cost trends were preserved during the pandemic. While direct care costs remained steady from Fiscal Year 2016 to Fiscal Year 2021, purchased care procedures and costs increased. Mental health care was among both the highest number and the fastest growing procedures in purchased care both before and during the pandemic, emphasizing the need for such services among ADSMs with HIV. COVID-19 testing and telehealth were among the fastest growing procedures in purchased care during the pandemic.

The clinical implications of the higher quality of care in the proposed models translate into modest improvements in survival. For recently estimated ranges of societal willingness to pay per quality-adjusted life-year, allocating all ADSMs with HIV to Model 2 will result in incremental net monetary benefit of $43,456 to $234,246 per servicemember with HV.

XIX. References

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XX. Appendix

Table A1. Quality and Cost of Care Outcomes.

Quality of Care		
Regular periodic HIV visits		
	eligible	has had an HIV diagnosis for at least 2 fiscal years
	met	had at least one medical visit in each half of the current and previous fiscal years and the visits were at least 30 days apart
STI screening		
	eligible	has had an HIV diagnosis for at least 1 fiscal year and had at least one medical visit in the measurement fiscal year
	met	had a GC/CT or syphilis test in the measurement fiscal year
ART receipt		
	eligible	has had an HIV diagnosis for at least 1 fiscal year and had at least one medical visit in the measurement fiscal year
	met	had antiretroviral therapy dispensed
CD4 measurement		
	eligible	has had an HIV diagnosis for at least 1 fiscal year and had at least one medical visit in the measurement fiscal year
	met	received 2 or more CD4 tests in the measurement fiscal year
Viral load testing and suppression		
	eligible	has had an HIV diagnosis for at least 1 fiscal year and had at least one medical visit in the measurement fiscal year
	met	had an HIV viral load less than 200 copies/ml on the last test of the measurement fiscal year
Cost of Care		
TDY costs		temporary duty yonder, incurred during a medical visit more than 100 miles away
LDT costs		lost duty time, lost personnel pay incurred during a medical visit
Outpatient medical costs		incurred during an ambulatory visit

Notes: All quality of care outcomes are binary. The table includes conditions for eligibility for inclusion in each measure as well as conditions for meeting the measure. All cost of care outcomes are in 2021 USD.

Table A2. TDY Cost Imputation
per diem rates by MTF location

Site	Lodging	Meals/ Incidentals	Max per diem	Service(s)
San Antonio Military Medical Center	$124	$61	$185	Air Force, Army
Walter Reed National Military Medical Center	$172-257	$76	$302*	Army, Navy
Navy Medical Center San Diego	$161-181	$71	$239*	Navy
Navy Medical Center Portsmouth	$96	$55	$151	Navy
Madigan Army Medical Center	$126	$71	$197	Army
Tripler Army Medical Center	$177	$149	$326	Army
William Beaumont Army Medical Center	$98	$61	$159	Army
Eisenhauer Army Medical Center	$107	$61	$168	Army
Womack Army Medical Center	$109	$56	$165	Army
Ft. Belvoir Community Hospital	$172-258	$76	$302*	Army
Standard CONUS rate	$96	$55	$151	

* average maximum per diem for the location

Table A3. LDT Cost Imputation
base pay rates for 10 years of service (E-5 and above)

Pay Grade	Monthly Base Pay	Hourly Pay	Pay Grade	Monthly Base Pay	Hourly Pay
E-1	1785	11.16	O-1	4260.6	26.63
E-2	2000.7	12.5	O-2	5398.5	33.74
E-3	2371.8	14.82	O-3	6832.8	42.71
E-4	2829	17.68	O-4	7684.2	48.03
E-5	3585.3	22.41	O-5	8099.4	50.62
E-6	3882.9	24.27	O-6	8796.9	54.98
E-7	4323.9	27.02	W-1	4720.2	29.5
E-8	4818.6	30.12	W-2	5125.2	32.03
E-9	5637	35.23	W-3	5637.3	35.23
			W-4	6035.1	37.72

Figure A1. Viral load Suppression, Conditional on Being Tested

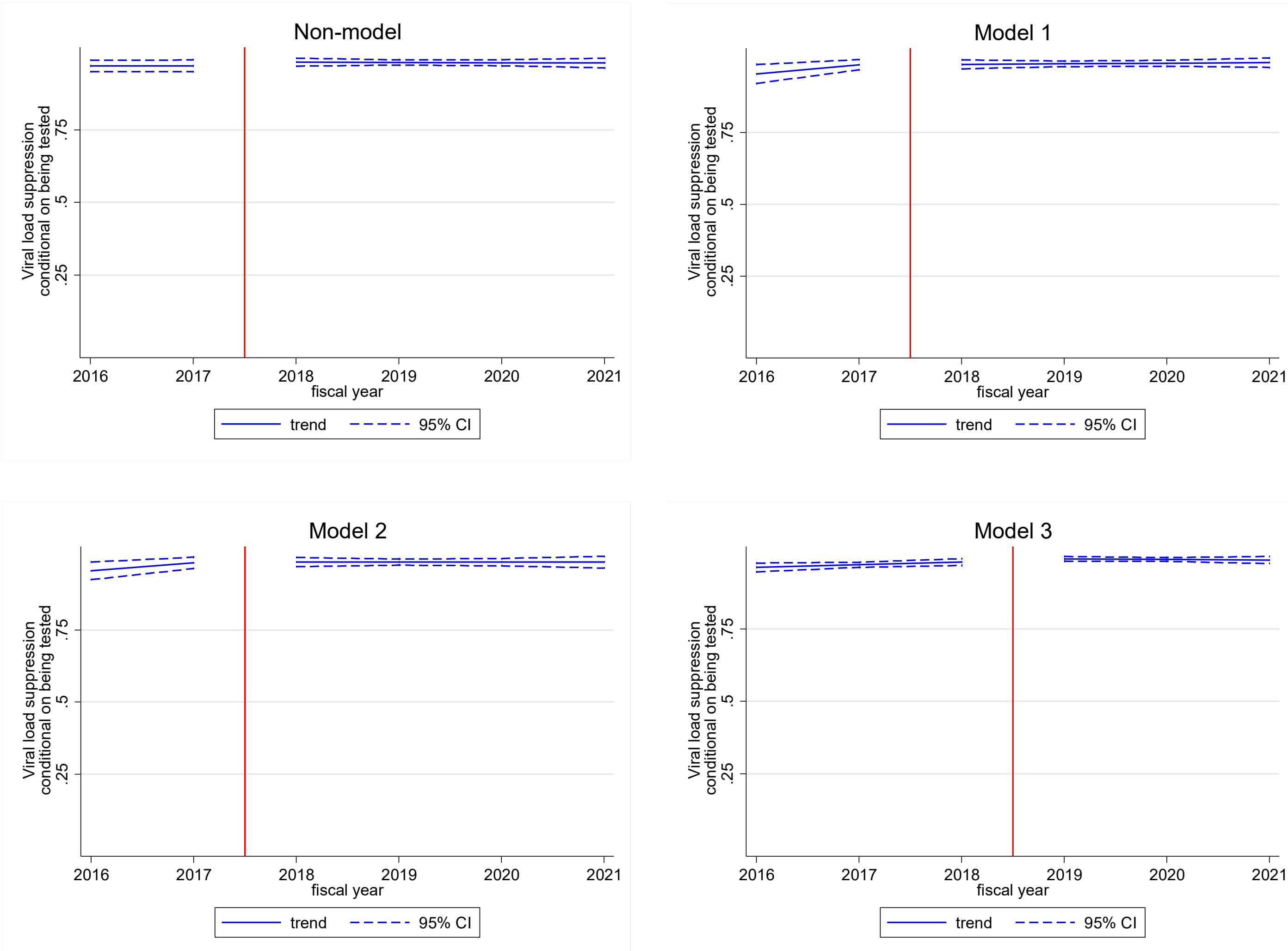


Figure A2. Outpatient Direct Care Procedures

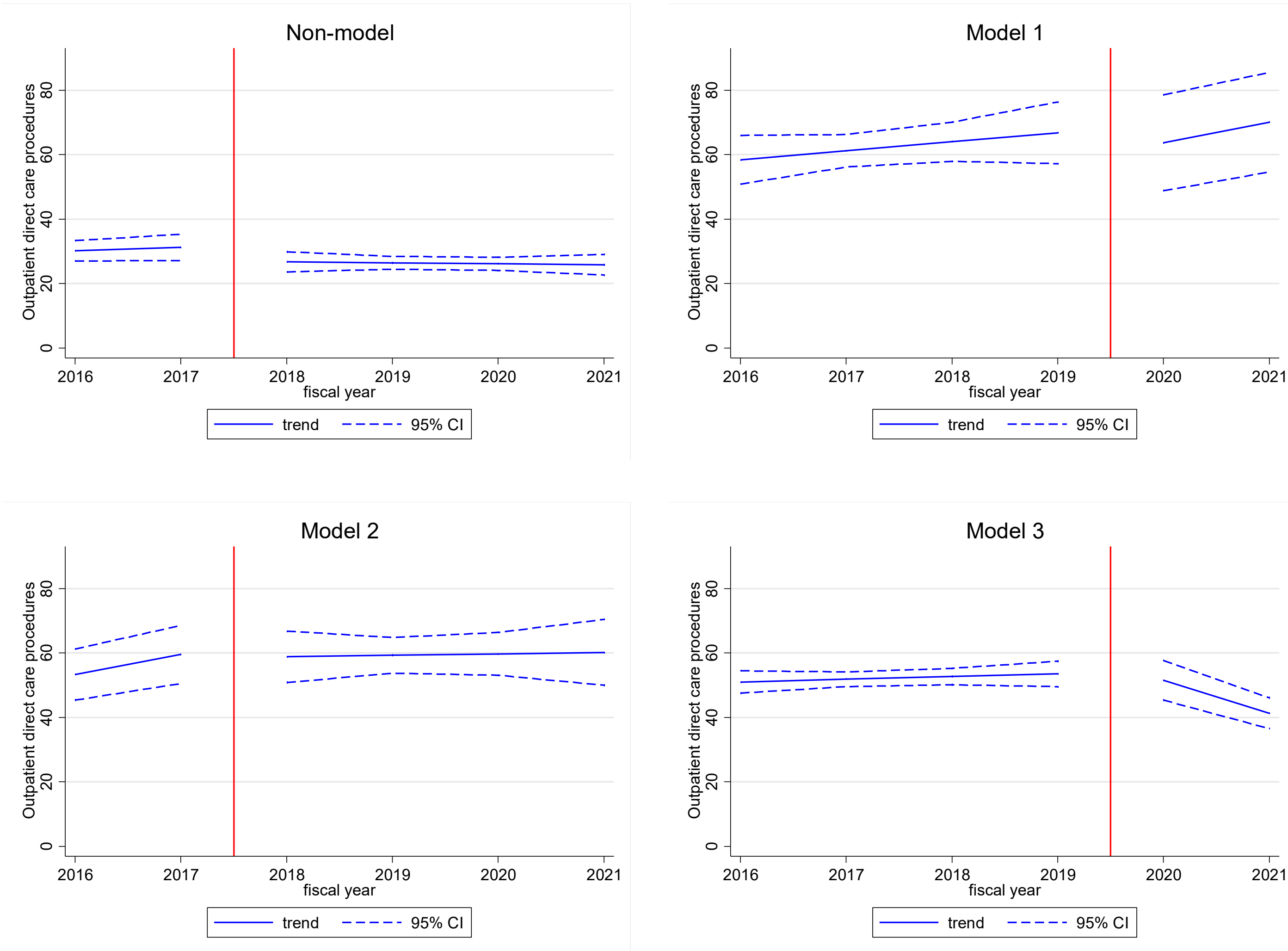


Figure A3. Outpatient Purchased Care Procedures

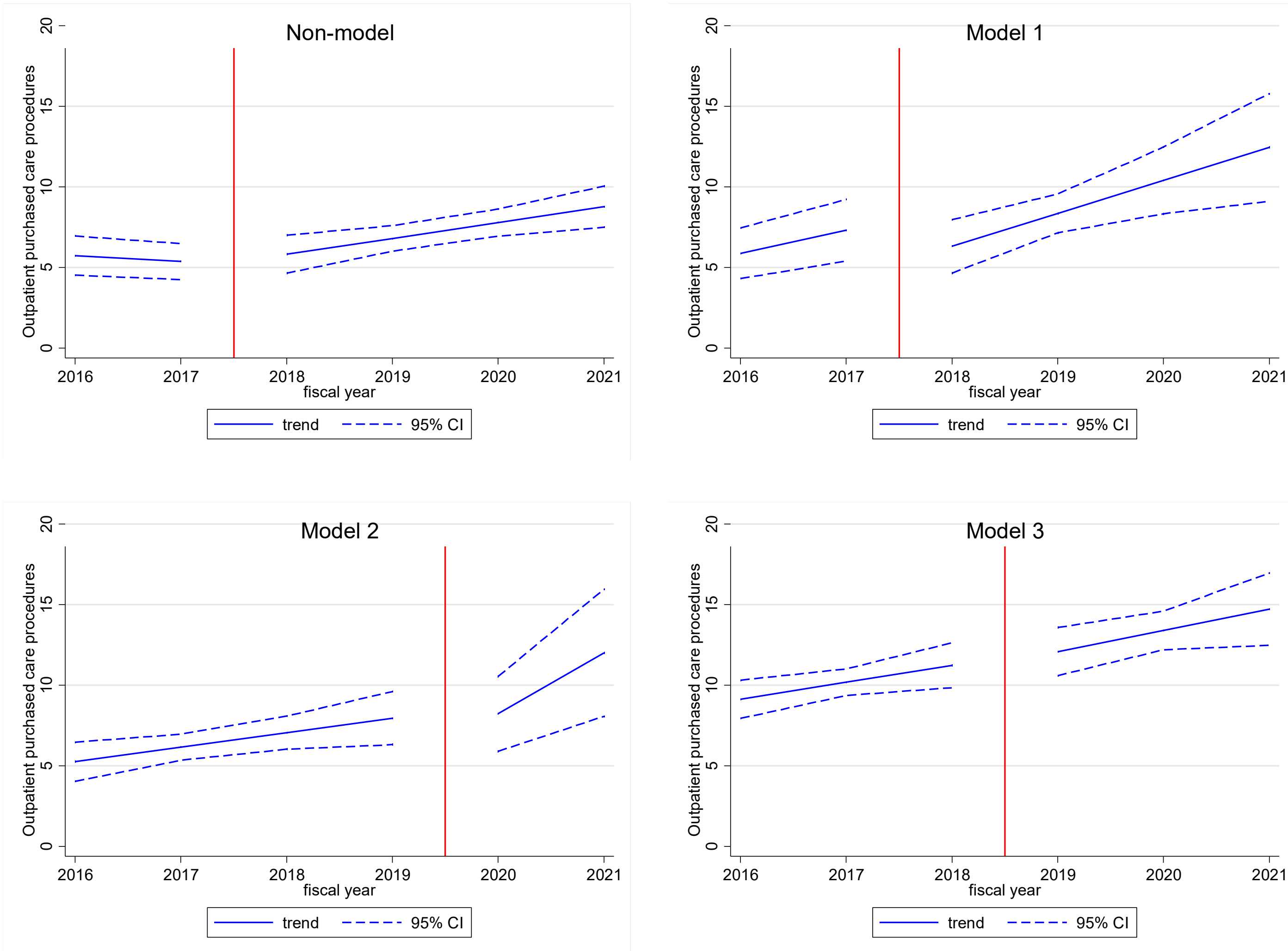


Figure A4. Outpatient Direct Care Costs

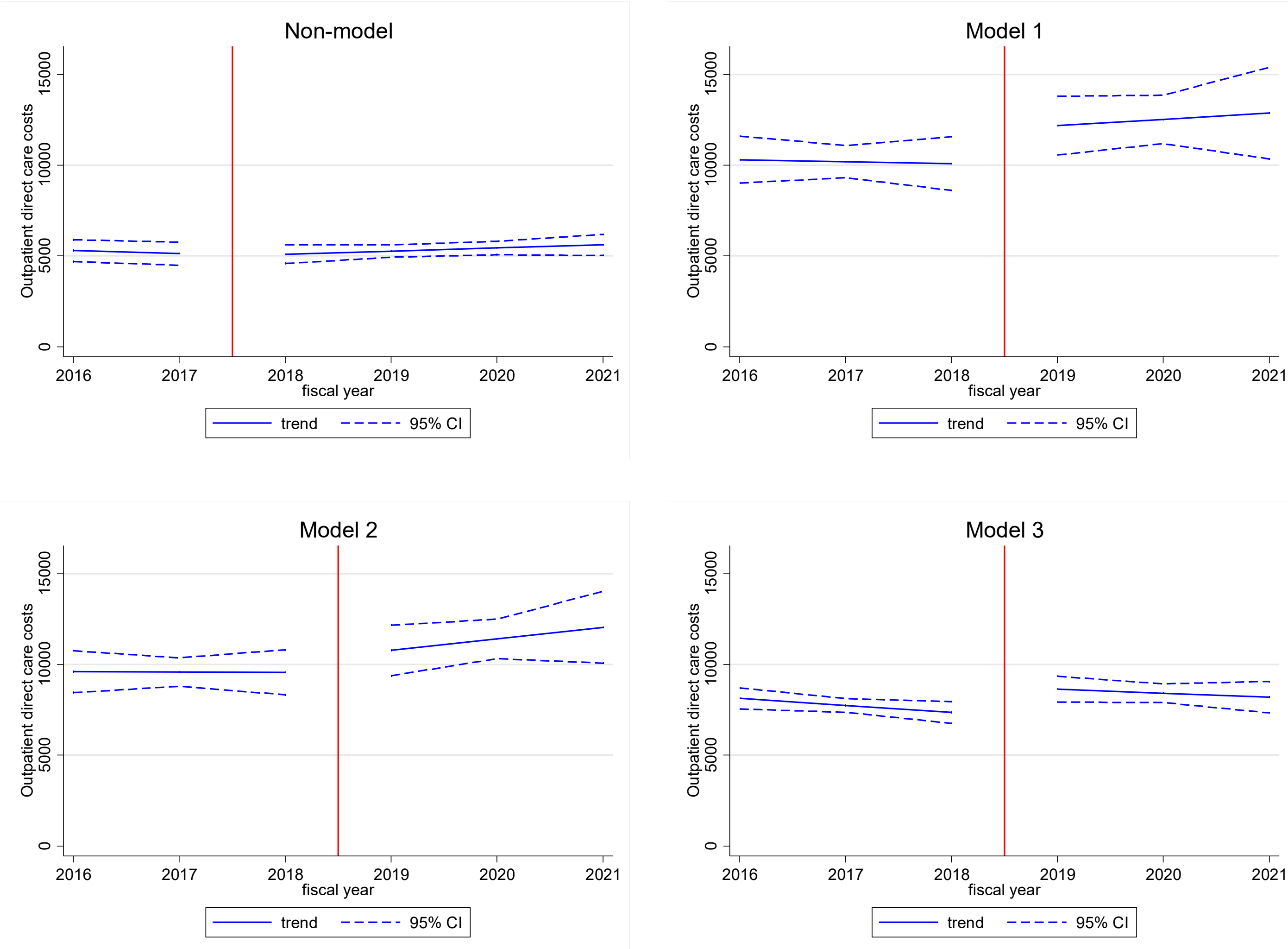


Figure A5. Outpatient Purchased Care Costs

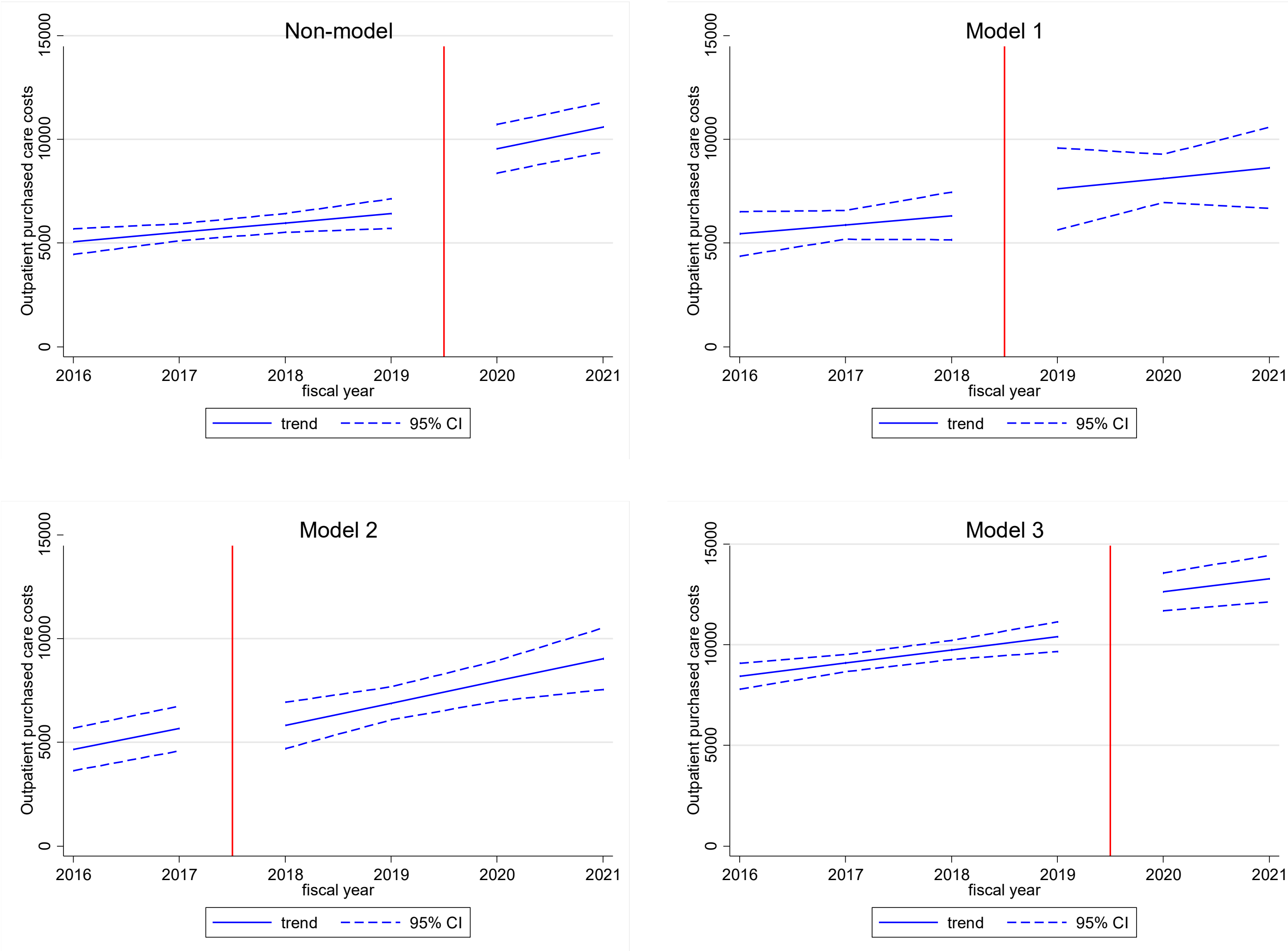


Figure A6. Composite Quality of Care

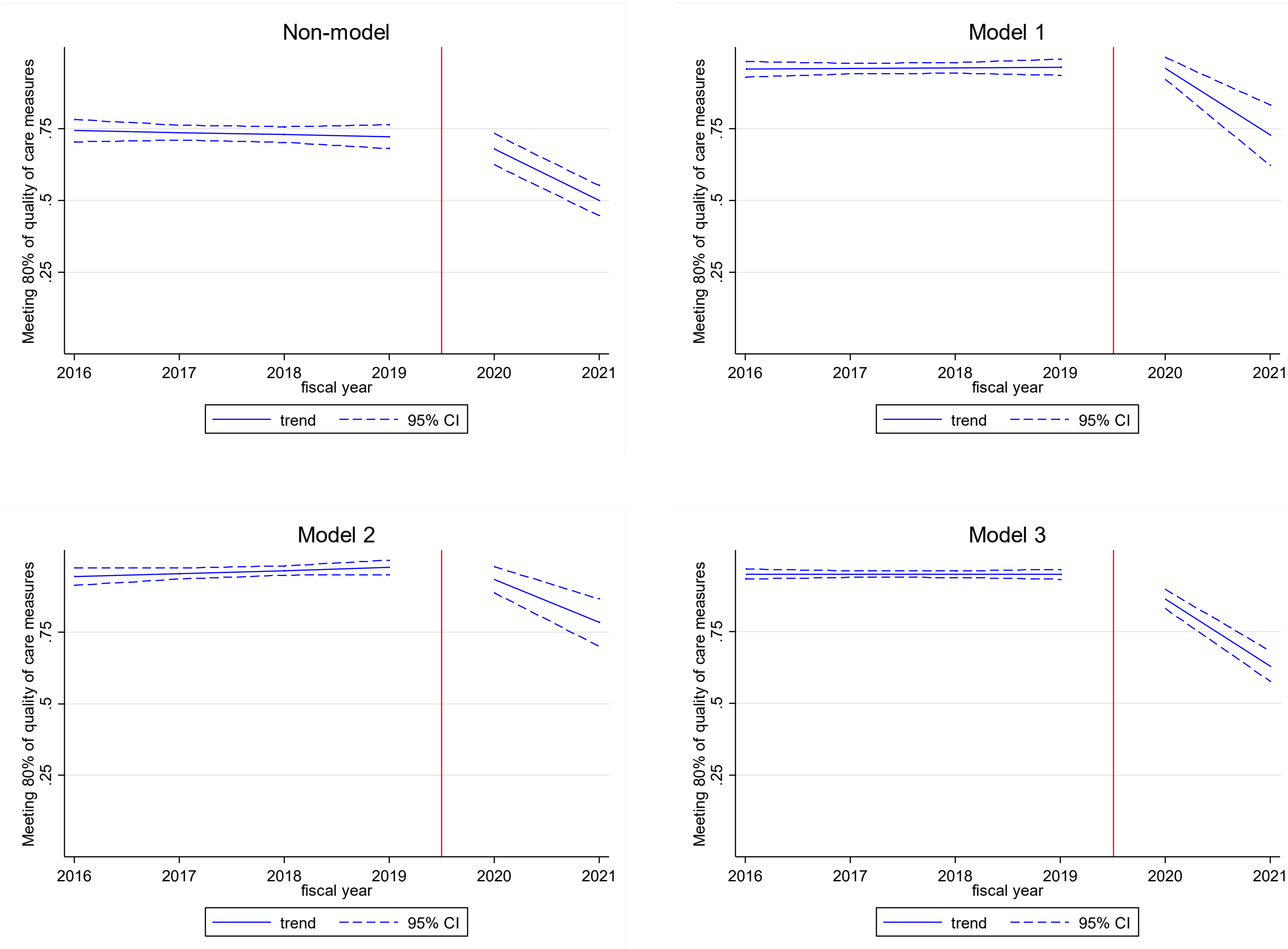
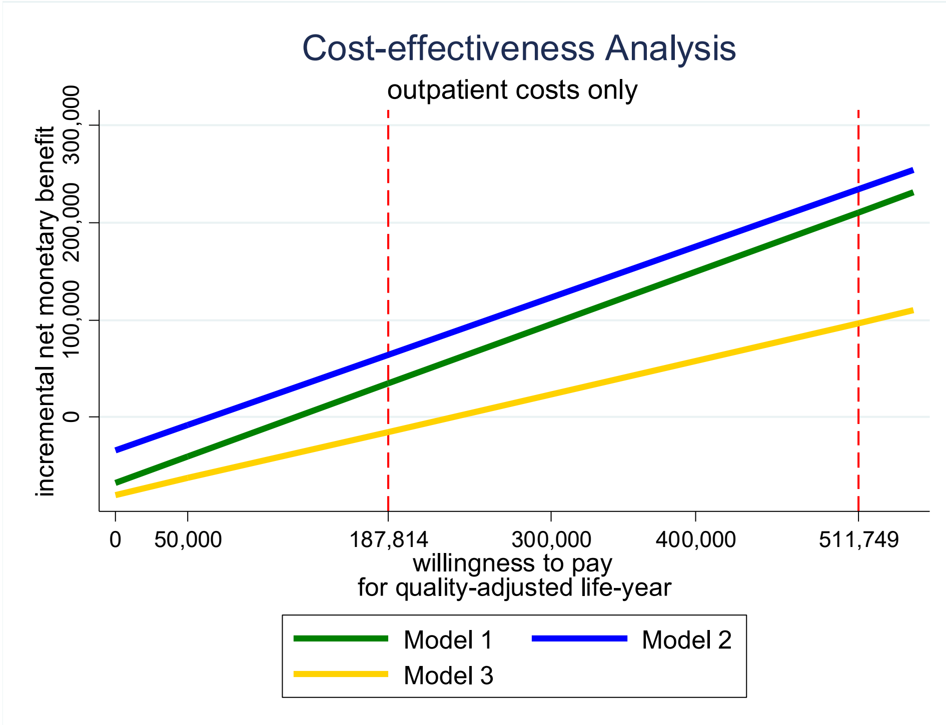


Figure A7. Cost-effectiveness Analysis, Including Outpatient Costs Only



XXI. List of Symbols and Abbreviations

*	statistically significant at the 90% level
**	statistically significant at the 95% level
***	statistically significant at the 99% level
ART	antiretroviral therapy
CD4	CD4 lymphocyte
CoE	center of excellence
DHA	Defense Health Agency
DoD	Department of Defense
GC/CT	Neisseria gonorrhea/Chlamydia trachomatis
HETU	HIV evaluation and treatment unit
HJF	Henry M. Jackson Foundation for the Advancement of Military Medicine
ID	Infectious disease
IDCRP	Infectious Disease Clinical Research Program
LDT	lost duty time
MDR	Military Health System Data Repository
MEU	HIV medical evaluation unit
MHS	Military Health System
MTF	military treatment facility
NIH	National Institutes of Health
NHS	HIV Natural History Study
SAMMC	San Antonio Military Medical Center
SD	standard deviation
SE	standard error (of difference)
STI	sexually transmitted infection
TDY	temporary duty yonder
USA	U.S. Army
USAF	U.S. Air Force
USN	U.S. Navy
USU	Uniformed Services University of the Health Sciences
VL	viral load