Telehealth Collaborative Care Led by Clinical Pharmacists for People With Psychosis or Bipolar Disorder:

A Propensity Weighted Comparison With Usual Psychiatric Care

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Abstract

Objective: People with psychosis or bipolar disorder (severe and persistent mental illness [SPMI]) are at high risk for poor psychiatric and chronic illness outcomes, which could be ameliorated through improved health care quality. This study assessed whether a telehealth, collaborative care program managed by psychiatric clinical pharmacists (SPMI Population Care) was associated with improved health care quality for adults with SPMI in a large California health system.

Methods: This retrospective cohort study used electronic health record data to compare 968 program enrollees at 6 demonstration sites (Population Care) to 8,339 contemporaneous patients with SPMI at 6 non-program sites (Usual Care). SPMI diagnoses were based on *ICD-10-CM* diagnostic codes. Primary outcomes were optimal psychotropic medication adherence, guideline-recommended glycemic screening, annual psychiatrist visit, and emergency department use. Difference-in-difference analyses assessed change in outcomes from 12 months pre- to 12 months post-enrollment using overlap weighting with high dimensional propensity scores to balance participant characteristics across groups. Participant data were collected from January 1, 2020, to June 30, 2022.

Results: From pre- to post-enrollment, Population Care was associated with greater achievement of psychotropic medication adherence and glycemic screening (+6 and +9 percentage points), but unexpectedly with a decrease in annual psychiatrist visits (−6 percentage points) and no significant change in emergency department use, relative to Usual Care. More than 75% of Population Care participants attended an intake and ≥1 follow-up visits. Participants with psychosis (26% of sample) had similar results as those with bipolar disorder.

Conclusions: Clinical pharmacist–led telehealth collaborative care has potential to improve psychopharmacologic treatment adherence and recommended disease preventive screening for people with psychosis or bipolar disorder.

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Severe and persistent mental illnesses (SPMIs), including schizophrenia, schizoaffective disorder, and bipolar disorder, often emerge early in life and are associated with poor mental and physical health outcomes.[1–3] Treatment disengagement is common.[4,5] Low adherence to psychotropic medications places individuals at higher risk for psychiatric deterioration, self-harm, and inpatient hospitalization.[6] People with SPMI also face risk for early death as a result of preventable chronic diseases.[7–9] Due to a range of biopsychosocial and treatment-related factors (eg, adverse metabolic side effects of psychotropic medications),[10–12] clinical guidelines recommend regular screening for diabetes, hypertension, and other prevalent health risks for people with SPMI.[13] Nevertheless, gaps in guideline-recommended screening and evidence-based care for cardiometabolic disease persist for people with SPMI.[14–17]

The multidisciplinary, whole-person approach required to address the multifaceted health needs of people with SPMI can strain psychiatric care systems, which face nationwide shortages of psychiatrists and other clinicians.[18,19] Typical psychiatric care may not provide the continuous monitoring and support many patients need to maintain adherence to psychotropic medications and address physical health risks.[20,21] These patients may also face discrimination and stigma within health care systems,[22–24] interfering with preventive care that would proactively manage health risks before they lead to avoidable emergency care or hospitalization.[16]

Clinical Points

- People with psychosis or bipolar disorder may benefit from consistent engagement with multidisciplinary care teams to improve overall health, but collaborative care models have been minimally studied in this population.
- A telehealth collaborative care program managed by psychiatric clinical pharmacists had strong patient participation and, compared to usual care, was associated with greater psychotropic medication adherence and guideline-concordant preventive care.

Collaborative care models use multidisciplinary treatment teams, a stepped-care approach, and population management tools (eg, patient registries) to monitor patients' progress and coordinate care according to individualized needs.[25] Although collaborative care and other integrated care models have been successfully employed to manage patients' depression, anxiety, and other chronic health conditions,[26–29] these models have been less studied for patients with schizophrenia, schizoaffective disorder, or bipolar disorder.[30–33] Clinical pharmacists with advanced clinical training and authorization in many states to adjust treatments according to established protocols are increasingly being deployed as care managers.[34–36] Telehealth approaches such as telephone or video appointments can be used by care managers to increase convenience and efficiency for patients and care systems.[37,38]

In late 2020, Kaiser Permanente Northern California (KPNC) implemented a telehealth collaborative care program, SPMI Population Care, to serve people with schizophrenia, schizoaffective disorder, and bipolar disorder.[39] Psychiatrically trained advanced practice clinical pharmacists manage the patient population and coordinate care across the multidisciplinary team, which includes patients' psychiatrists and primary care providers. Here, we present the results of a quality improvement study evaluating whether SPMI Population Care was associated with improved medication adherence and health care quality after 12 months, specifically greater health screening rates, increased routine primary care and psychiatrist visits, and reduced emergency department (ED) and inpatient hospital use, compared to usual care.

METHODS

Study Setting and Eligibility

KPNC is a large, integrated health care delivery system providing care to more than 4.4 million members who are representative of the diverse population of Northern California.[40] For this quality improvement study, the Research Determination Committee for the Kaiser Permanente Northern California region determined that the project does not meet the regulatory definition of research involving human subjects per 45 CFR 46.102(d).

For purposes of distinguishing between program and study participants, we refer to "SPMI Population Care" as the collaborative care program being examined in this study, to the "Population Care (PC) group" as the group of SPMI Population Care patients included in study analyses, and to "Usual Care (UC) group" as the comparison group of patients included in study analyses who received usual care at non-program sites (medical facilities where SPMI Population Care was not implemented). Both the PC and UC groups had electronic health record (EHR)-documented diagnoses of psychotic or bipolar disorders associated with health care services during the 2 years prior to a 6-month eligibility window (January 1, 2021–June 30, 2021) and were health plan members for ≥ 9 months during 2020. The PC group specifically included patients who were enrolled in the SPMI Population Care program at one of 6 demonstration sites during the eligibility window. Program enrollment required successful contact by a program clinical pharmacist but not necessarily attendance of an intake appointment. Program-eligible patients who were not enrolled during the eligibility window were not included in study analyses within the PC group. The UC group specifically included patients receiving contemporaneous care at 6 non-program sites (Supplementary Figure 1). We excluded from study analyses individuals who in 2020 had outside claims for outpatient mental health care or psychotropic medications, lacked medication coverage, had hospice care, or were pregnant, and those with diagnosed dementia or intellectual disability.

Study Procedures

All duties performed by SPMI Population Care clinical pharmacists were part of their program role and not conducted as part of research. To enroll patients in the SPMI Population Care program, clinical pharmacists contacted patients who were included in a patient registry of individuals with eligible SPMI diagnoses and who were seen for mental health care at one of the 6 program sites. The study enrollment (index) date for the PC group was the date when clinical pharmacists successfully contacted patients, regardless of intake visit attendance (Supplementary Figure 2). We assigned a random index date within the brief eligibility window to UC participants.

Outreach to patients was non-random: program clinical pharmacists were able to prioritize outreach using EHR variables such as SPMI diagnosis and last psychiatrist visit. We therefore used a comprehensive set of EHR variables in analyses to mitigate potential selection bias (see Statistical Analyses). Program and study design characteristics helped to reduce potential selection bias arising from unmeasured variables such as psychiatrist recommendation or patient self-advocacy. Specifically, any patients who were referred to the program by their psychiatrists but who were not

included in the SPMI Population Care registry were not included in the study, and program clinical pharmacists, none of whom were physically located in the clinics they served, initiated patient outreach through telehealth modalities using the SPMI Population Care registry.

We adhered to the recommendations of the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0).[41]

SPMI Population Care

Program design and components have been described previously.[39] Briefly, SPMI Population Care is a team-based collaborative care model that is managed by advanced practice clinical pharmacists with specialty training in psychiatry. In addition to general clinical pharmacy training, program clinical pharmacists are board-certified or board-eligible in psychiatric pharmacy based on a psychiatry-specialty postgraduate year 2 residency or equivalent clinical training.[39] All care is conducted via telehealth, with more than 75% of appointments completed through online video visits. Program clinical pharmacists work together as a team within a regional hub but are individually assigned to local psychiatry clinics, allowing them to achieve care continuity with patients.

During SPMI Population Care visits, clinical pharmacists assess current needs, such as psychopharmacologic treatment adjustment or adherence, suicide risk, smoking cessation, or metabolic syndrome screening. Working under protocol, pharmacists are then able to provide medication counseling, adjust medications, order laboratory tests, and coordinate care with psychiatric and other medical providers. Psychiatrists are apprised of their patients' progress through EHR documentation. Clinical pharmacists follow patients indefinitely: participants whose individualized needs are stabilized are followed on a maintenance schedule, typically with planned follow-up every 6 months to conduct routine assessments and care coordination.

Usual Care

SPMI Population Care was a supplement to usual care at program sites. Likewise, at non-program sites, participants were free to continue receiving standard specialty psychiatric care within the KPNC integrated care setting, including psychopharmacotherapy with a psychiatrist or other prescriber, individual or group psychotherapy, case management, and social work services. Laboratory, pharmacy, primary care, and other medical services were available at the same facilities as mental health care.

Measures

All study variables were collected in the EHR as part of routine care. For the PC group only, we assessed the proportion of participants who attended an intake appointment and the frequency of follow-up visits with program pharmacists during the 12 months post-enrollment. We counted the number of patients who re-engaged with care, ie, those who attended an intake visit after having no psychiatrist visit in the 12-month pre-enrollment period.

Outcomes of interest were measured in the 12-month pre- and post-enrollment periods. The primary psychiatric care quality outcomes were optimal psychotropic medication adherence and annual psychiatrist visit attendance. Optimal psychotropic medication adherence was a dichotomous variable measured from outpatient pharmacy dispensations, ie, medication possession ratio (MPR) ≥ 0.8 for outpatient dispensed medications.[42,43] Therefore, 12-month MPR was defined as the proportion of days a participant had medication during that period. We calculated the MPR separately per dispensed medication, not counting "take as needed" prescriptions, and selected the maximum MPR. We used the maximum MPR as opposed to the mean to reduce the influence of clinically recommended medication changes that could result in non-pickup of medications. In preliminary analyses, 81% of maximum MPRs during pre-enrollment reflected antipsychotics, lithium, or anticonvulsants/mood stabilizers, the major medication types used to treat SPMI. Annual psychiatrist visit was any versus no visit within 12 months.

The primary preventive care quality outcome was receipt of a glycemic test in 12 months (any versus no outpatient hemoglobin A_{1c} or fasting plasma glucose laboratory result). Although many health screenings are recommended for people with SPMI, we highlighted glycemic monitoring because of clinical and care quality guidelines, recognizing the elevated risk for type 2 diabetes faced by this population owing to obesogenic medications and other risk factors.[13,44,45]

A final primary outcome was all-cause ED use (any versus none in 12 months), which served as a global indicator of preventive health care gaps, given high risk for ED use among people with SPMI for psychiatric and other health conditions.[46,47]

Secondary outcomes (all dichotomized as any/none in 12 months; see Table 3) were outpatient laboratory orders (eg, any lipid test order), outpatient non-glycemic laboratory results (eg, lithium/valproic acid level), other health screening (eg, body mass index [BMI]), and health care use (eg, mental health–related ED visit).

We additionally measured participant characteristics including sex, age, race or ethnicity, non-English language preference, neighborhood deprivation index (NDI),[48] insurance type, psychiatric diagnosis, outpatient dispensed psychotropic medications, and Charlson Comorbidity Index.[49] EHR-documented cardiovascular disease risk factors were extracted from up to 24 months before the index date and included most recent smoking status and BMI, diabetes (*ICD-10* E08.x, E09.x, E10.x, E11.x, E13.x), prediabetes (*ICD-10-CM* R73.0x), dyslipidemia (*ICD-10* E71.30, E75.2,

Table 1.

Pre-Enrollment Characteristics for SPMI Population Care (N = 968) and Usual Care (N = 8,339) Participants[a]

Variable	Unweighted			With overlap weighting		
	Population care	Usual care	Standardized difference	Population care	Usual care	Standardized difference
Age, mean ± SD, y	45.5 ± 16.1	45.4 ± 16.4	0.003	45.1 ± 14.1	45.3 ± 4.7	−0.01
Sex						
Female	60.6	58.5	0.04	59.0	59.0	0
Male	39.4	41.5	−0.04	41.0	41.0	0
Race and ethnicity						
Asian or Pacific Islander, non-Hispanic	10.4	16.8	−0.19	11.5	11.5	0
Black, non-Hispanic	9.2	8.6	0.02	9.2	9.2	0
Hispanic	19.6	15.3	0.12	19.7	19.7	0
White, non-Hispanic	54.4	53.3	0.02	53.2	53.2	0
Multiple, other, or missing	6.3	6.0	0.01	6.4	6.4	0
Non-English language preference	2.6	3.9	0.04	3.0	3.0	0
Neighborhood deprivation index quartiles						
1st, least deprived	6.1	27.1	−0.59	7.6	7.6	0
2nd	21.7	25.3	−0.09	23.7	23.7	0
3rd	34.3	23.9	0.23	32.8	32.8	0
4th, most deprived	37.5	23.4	0.31	35.5	35.5	0
Missing	0.4	0.4	0.007	0.4	0.4	0
Insurance type						
Medicare	29.2	26.8	0.13	28.9	28.9	0
Medicaid	16.4	12.3	0.03	15.2	15.2	0
Commercial	54.1	60.8	0.06	55.8	55.8	0
Missing	0.2	0.1	−0.14	0.1	0.1	0
Psychiatric diagnosis						
Schizophrenia	15.0	10.1	0.15	14.4	14.4	0
Schizoaffective disorder	8.8	6.3	0.09	8.3	8.3	0
Other psychotic disorder	11.2	8.9	0.08	11.2	11.2	0
Bipolar disorder	65.0	74.7	−0.21	66.1	66.1	0
Psychotropic medications						
Antipsychotic	73.3	61.4	0.26	71.4	67.0	0.10
Lithium	14.7	16.3	−0.05	15.3	15.3	0
Other mood stabilizer	56.8	56.0	0.02	56.1	55.7	0.008
Antidepressant	56.9	49.2	0.16	55.4	52.8	0.05
Benzodiazepine	25.6	20.6	0.12	22.6	23.3	0.04
≥ 3 psychotropic medication types	40.9	32.7	0.17	38.8	36.6	0.05
Low psychotropic medication adherence	48.5	55.0	−0.13	50.4	50.4	0
Cardiovascular disease risk factors						
Diabetes	17.4	13.6	0.10	16.3	17.7	−0.04
Prediabetes	11.2	10.6	0.11	10.8	11.2	−0.02
Dyslipidemia	30.2	27.4	0.06	29.1	30.7	−0.03
Hypertension	29.4	24.4	0.02	27.9	28.7	−0.02
Smoker, current or former[b]	45.9	39.4	0.13	44.1	44.1	0
Body mass index, kg/m^2						
Underweight, <18.5	0.9	1.3	−0.04	1.0	1.0	0
Normal weight, 18.5–24.9	15.8	25.0	−0.24	17.5	17.5	0
Overweight, 25.0–29.9	23.0	26.6	−0.08	23.8	23.8	0
Obese, ≥30.0	53.0	35.2	0.36	49.4	49.4	0
Missing	7.2	11.9	−0.16	8.3	8.3	0
Charlson Comorbidity Index, mean ± SD[c]	0.9 ± 1.5	0.8 ± 1.5	0.08	0.8 ± 1.2	0.9 ± 0.4	−0.09
Prior-year routine health care use						
Psychiatrist visit	81.6	77.0	0.13	80.6	80.6	0
Primary care visit	90.4	87.6	0.09	89.7	89.7	−0.02
Glycemic or lipid laboratory result	65.1	55.2	0.20	62.5	62.5	0
Outpatient blood pressure measurement	60.5	50.9	0.20	57.6	57.6	0
Prior-year high-resource health care use						
Emergency department visit	31.2	28.1	0.07	29.2	29.2	0
Inpatient hospitalization	9.1	9.2	−0.004	8.1	8.1	0

[a]Values shown as percentages unless otherwise specified.
[b]Data missing for 61 (6.3%) and 610 (7.3%).
[c]Data missing for 9 (0.9%) and 121 (1.4%).
Abbreviation: SPMI = severe and persistent mental illness.

E75.3, E75.5, E75.6, E77.x, E78.x, E88.1, E88.2, E88.89), and hypertension (*ICD-10* I10.x–I16.x).

Statistical Analyses

We compared the PC and UC groups on the outcomes of interest using a difference-in-difference (DID) design. DID is a quasi-experimental design for observational data that estimates the effect of a specific intervention or policy by comparing the changes in outcomes before and after the intervention between the intervention group and the comparison group.[50] By combining this method with propensity score weighting, we were able to create balance between the PC and UC groups on an array of covariates and directly estimate the PC effect rather than controlling for covariates in the regression model. Specifically, we assessed changes in outcomes from the 12 months pre-enrollment to the 12 months post-enrollment for PC minus pre- to post-enrollment changes for UC (the time period × intervention group interaction effect), reported as absolute risk differences (ARDs). The size and sign of the ARD estimate signifies the magnitude and direction of change in the outcome in PC accounting for the changes among UC. For each outcome, we fit generalized estimating equations (GEE) with a binomial distribution and identity link, overlap propensity score weights (see below), and an unstructured covariance structure to account for multiple observations per participant. For participants with missing post-enrollment data, we included their pre-enrollment data only. The GEE model allows patients to contribute whatever observations are available rather than being excluded, and this available-case analysis can prevent the biases of a complete-case analysis.[51,52] Confidence intervals (CIs) were based on Huber-White Sandwich estimators.[53] We conducted additional subgroup analyses stratified by clinical and sociodemographic subgroups, adding an additional subgroup interaction term to the overall model.

Participants were not randomly assigned to the PC or UC groups. Patients were not previously known to PC clinical pharmacists, but pharmacists may have selectively contacted patients based on clinical history. Therefore, we addressed non-random treatment assignment through propensity score weighting. In a randomized design, baseline participant characteristics would be distributed evenly across the different treatment arms, allowing analyses to isolate the effect of the treatment of interest. By using baseline characteristics to calculate the propensity score, or the probability of a participant being assigned to the treatment group of interest, individuals' data can be weighted to adjust for differences in baseline characteristics.[54] To account for the potential influence of 300 covariates, we generated high-dimensional propensity scores (HDPS) from EHR data, including specific diagnosis codes, generic names of outpatient prescriptions, and outpatient health care utilization types (see details in Supplementary Table 1).[55] The HDPS algorithm is a highly efficient, empirical approach to propensity scores that addresses a priori and unanticipated confounders.[56] We employed overlap weighting: PC participants were weighted by the probability of not receiving treatment (1 – propensity score), and UC participants were weighted by the probability of receiving treatment (propensity score).[57] An absolute standard difference < 0.1 after overlap weighting indicated sufficient balancing of pre-enrollment characteristics.[58] Compared to propensity score matching or inverse probability of treatment weighting, overlap weighting is more effective at achieving balance in baseline covariates (similar to a randomized design) due to the reduced influence of extreme weights.[59]

Analyses were conducted in SAS, version 9.4. Two-sided *P* values of < .05 were considered statistically significant.

Table 2.

SPMI Population Care Attendance Among 866 Participants With Continuous Health Plan Enrollment During 12 Months Post-Enrollment

Variable	Psychotic disorder	Bipolar disorder	All
Number (%) of participants[a]	304 (35.1)	562 (64.9)	866 (100.0)
Attended intake, n (%)	263 (86.5)	500 (89.0)	763 (88.1)
Attended follow-up, of those with intakes, n (%)	218/263 (82.9)	446/500 (89.2)	664/763 (87.0)
Reengaged with care, n (%)[b]	50/59 (84.8)	99/107 (92.5)	124/166 (87.1)
Follow-up clinical pharmacist visits, median [interquartile range][c]	4 [2–6]	4 [2–6]	4 [2–6]
0–3 months	1 [0–2]	1 [0–2]	1 [0–2]
3–6 months	1 [0–2]	1 [0–2]	1 [0–2]
6–9 months	1 [0–2]	1 [0–2]	1 [0–2]
9–12 months	1 [0–1]	1 [0–2]	1 [0–1]

[a]Row percent.
[b]Participants who attended an intake visit of those who had no psychiatrist visit in the 12 months pre-enrollment.
[c]Among participants with any follow-up clinical pharmacist visits, ie, 218 with psychotic disorder, 446 with bipolar disorder, and 664 with either.
Abbreviation: SPMI = severe and persistent mental illness.

RESULTS

Descriptive Statistics and Participant Flow

The study included 9,307 participants (968 PC and 8,339 UC) with mean age 45.4 (SD = 16.4) years; 58.7% were female; 40.6% were Asian, Pacific Islander, Black, or Hispanic; 39.8% had Medicare or Medicaid insurance (Table 1). Pre-enrollment, most participants (73.7%) had bipolar disorder. Psychopharmacologic regimens included antipsychotic medications (62.7%), mood stabilizers (56.1%), antidepressants (50.0%), benzodiazepines (21.2%), and lithium (16.1%). Half of participants had low psychotropic medication adherence. A substantial proportion had cardiovascular disease risk factors (eg, 43.2% with smoking history, 37.0% with obesity). Three out of 10 had visited the ED in the prior

Table 3.

Difference in Differences Between Population Care and Usual Care on Primary and Secondary Outcomes

Outcomes	Population care			Usual care			Weighted difference-in-differences[a]		
	Pre-enrollment, weighted %[a]	Post-enrollment, weighted %[b]	Difference	Pre-enrollment, weighted %[a]	Post-enrollment, weighted %[b]	Difference	ARD	(95% CI)	*P* value
Primary									
Optimal medication adherence[c]	49.6	65.8	16.2	49.6	60.2	10.6	6.4	(2.5 to 10.4)	.001
Glycemic laboratory result, any	60.6	73.9	13.3	59.7	63.7	4.0	9.3	(5.0 to 13.7)	<.001
Psychiatrist visit, any	80.6	65.6	−15.0	80.6	71.8	−8.8	−5.8	(−10.0 to −1.5)	.007
Emergency department visit, any	29.2	31.3	2.1	29.2	31.1	1.9	0.4	(−3.8 to 4.5)	.87
Secondary									
Health screening, any									
Glycemic laboratory order[d]	59.8	70.5	10.7	59.9	58.6	−1.3	12.2	(7.8 to 16.6)	<.001
Lipid laboratory order[d,e]	50.3	61.8	11.5	50.0	47.0	−3.0	14.6	(9.6 to 19.5)	<.001
Lipid laboratory result[e,f]	50.8	65.9	15.1	49.8	52.0	2.2	13.0	(8.1 to 17.9)	<.001
Blood pressure measurement[g]	57.6	75.7	18.1	57.6	74.2	16.6	1.6	(−2.6 to 5.8)	.46
Body mass index measurement	91.7	76.4	−15.3	91.7	73.9	−17.8	2.4	(−1.1 to 5.8)	.18
Electrocardiogram measurement[g,h]	18.3	25.3	7.0	23.2	23.5	0.3	6.8	(2.0 to 11.5)	.005
Lithium or valproic acid blood level, order[d,i]	79.5	79.1	−0.4	78.3	66.9	−11.4	11.0	(−0.2 to 22.1)	.054
Lithium or valproic acid blood level result[f,i]	79.5	79.1	−0.4	78.4	66.9	−11.5	11.0	(−0.1 to 22.2)	.052
Health care use, any									
Mental health–related emergency department visit[j]	22.8	22.2	−0.6	22.9	23.1	0.2	−0.7	(−4.6 to 3.2)	.72
Inpatient hospitalization	8.1	8.1	0.0	8.1	9.0	0.9	−1.1	(−3.7 to 1.6)	.43
Psychiatric hospitalization[j]	7.9	7.6	−0.3	7.9	8.7	0.8	−1.2	(−3.8 to 1.4)	.35
Primary care visit	89.2	90.8	1.6	89.7	91.3	1.6	−0.1	(−2.8 to 2.6)	.94
Disease management program visit[k]	13.2	16.5	3.3	14.1	16.8	2.7	0.8	(−1.4 to 2.9)	.49
Missed psychiatrist visit	40.2	34.0	−6.2	42.4	36.5	−5.9	−0.2	(−4.4 to 4.1)	.93
Missed primary care visit	21.0	24.4	3.4	19.9	25.2	5.3	−2.0	(−5.9 to 1.8)	.30

[a]Population Care N = 968, Usual Care N = 8,339.
[b]Population Care N = 866, Usual Care N = 7,329 with continuous, post-enrollment health plan coverage.
[c]Medication possession ratio ≥ 80%.
[d]Outpatient laboratory orders.
[e]Includes low-density lipoprotein, high-density lipoprotein, triglycerides, or total cholesterol.
[f]Outpatient laboratory results.
[g]Non-emergency only.
[h]Electrocardiogram based on procedure code CPT 93000B; includes only participants with dispensed antipsychotic medications (total N = 5,831 [12.2% Population Care]; total post-enrollment N = 5,169 [12.3% Population Care]).
[i]Includes only participants with dispensed lithium, valproic acid, or valproate medications (total N = 1,584 [9.2% Population Care]; total post-enrollment N = 1,403 9.1% Population Care]).
[j]Visits that were coded with *International Classification of Diseases* (*ICD)-10* psychiatric diagnoses (F00-F99) or intentional-self harm (X60–X84, Y10–Y19, Y28).
[k]Includes in-person or telehealth outpatient visits with chronic health condition population managers (eg, diabetes, hypertension).
Abbreviations: ARD = absolute risk difference, CI = confidence interval.

year. Overlap weighting achieved good covariate balance (absolute standardized differences < 0.1).

Program Attendance

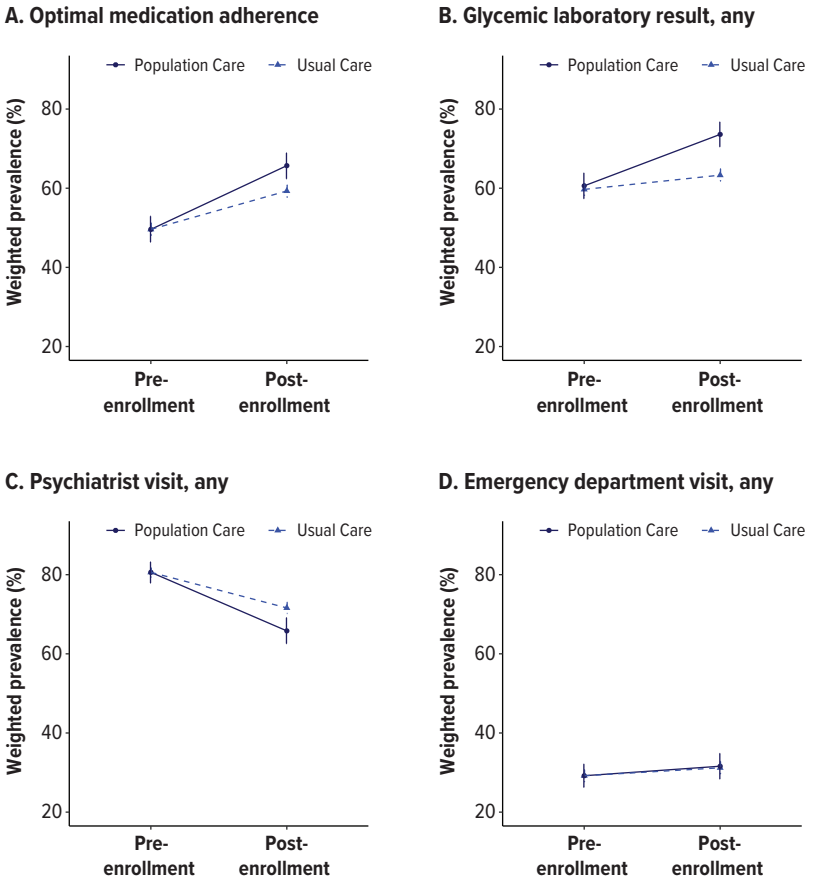
Participants engaged in the program at high levels. Most individuals in the PC group attended program visits (Table 2): 88% attended the intake visit, and of these participants, 87% attended ≥ 1 follow-up visit. As previously described,[39] patients who declined an intake visit cited reasons such as not wishing to restart psychotropic medication or preferring visits with their psychiatrist instead. Among the 166 PC participants who did not have a psychiatrist visit during pre-enrollment, 87% attended a PC visit, re-engaging them in care. Over the 12-month post-enrollment period, program attendees had a median of 4 visits (interquartile range = 2–6). Visit rates were consistent over post-enrollment at a median of 1 visit per quarter. PC participants with psychotic and bipolar disorders had similar visit rates.

Primary Outcomes

Compared to pre-enrollment and relative to UC (Table 3, Figure 1), the PC group had significantly increased post-enrollment rates of optimal psychotropic medication adherence (ARD = 6.4; 95% CI = 2.5 to 10.4). PC also had significantly increased post-enrollment rates of glycemic screening compared to pre-enrollment

Figure 1.

Overlap-Weighted Prevalence of Primary Outcomes, Pre- to Post-Enrollment



Primary Outcomes for SPMI Clinical and Sociodemographic Subgroups

In stratified models, participants with psychosis showed similar patterns of change as those with bipolar disorder from pre- to post-enrollment when comparing PC to UC on primary outcomes (Figure 2). PC versus UC comparisons were also similar for participants who had attended an intake visit and who had not attended a psychiatrist visit in the prior year, as compared to the overall cohort. Except where noted below, findings were also similar across females and males, different age groups, racial and ethnic groups, and NDI quartiles. On 2 primary outcomes, older adults (age ≥ 65 years) had distinct pre- to post-enrollment change for PC versus UC as compared to other age groups. Specifically, older adults in PC versus UC did not have significant change in glycemic screening from pre- to post-enrollment (ARD = −0.9, 95% CI = −10.4 to 8.7) unlike other age groups, which had significantly increased screening in PC versus UC; older adults in PC versus UC also had significantly increased ED visits from pre- to post-enrollment (ARD = 14.9, 95% CI = 3.6 to 26.1), whereas other age groups did not have significant relative change in ED visits.

and relative to UC (ARD = 9.3; 95% CI = 5.0 to 13.7). From pre- to post-enrollment, psychiatrist visit rates decreased for both groups, with a significantly greater decrease for PC (ARD = −5.8; 95% CI = −10.0 to −1.5). Compared to UC, there was no significant change in ED use from pre- to post-enrollment for PC.

Secondary Outcomes

Other care quality outcomes showed improvement from pre- to post-enrollment for the PC group compared to UC (Table 3). PC participants had significantly increased receipt of lipid tests (ARD = 13.0; 95% CI = 8.1 to 17.9) and glycemic and lipid test orders (glycemic order ARD = 12.2, 95% CI = 7.8 to 16.6; lipid order ARD = 14.6, 95% CI = 9.6 to 19.5). PC also had significantly increased electrocardiogram evaluations (ARD = 6.8, 95% CI = 2.0 to 11.5, for those with relevant medications). Pre- to post-enrollment changes in mental health–related ED use, hospitalization, primary care visits, and other secondary outcomes were not significantly different between PC and UC.

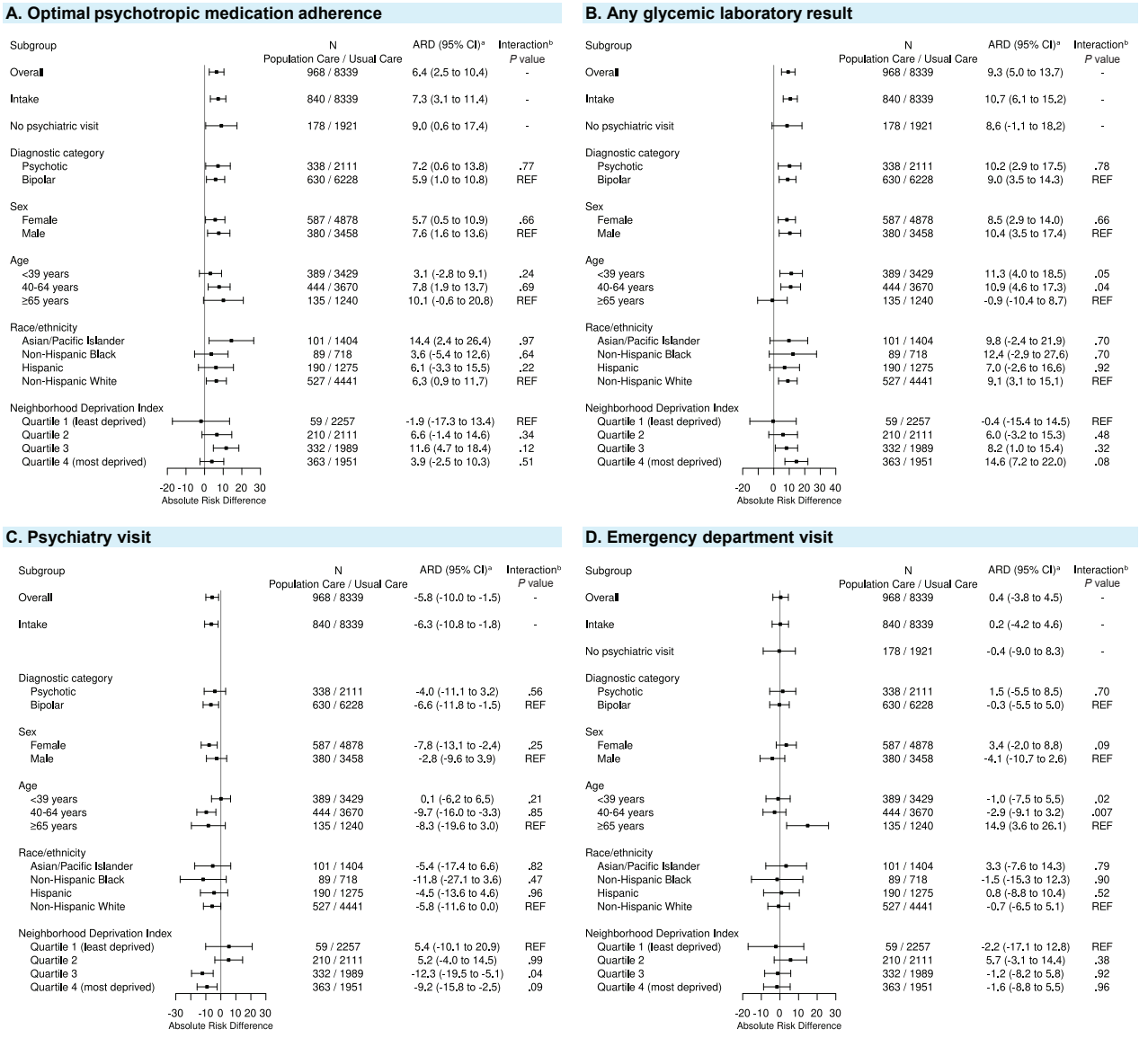
DISCUSSION

SPMI Population Care combines components of collaborative care, telehealth, and advanced practice clinical pharmacy to address the multifaceted health needs of people with SPMI. In this quality improvement study, we found that during a 12-month post-enrollment period, SPMI Population Care patients had improved psychotropic medication adherence, increased provision of recommended health screening, and reduced psychiatrist visits, compared to a 12-month pre-enrollment period and relative to a contemporaneous group of patients in usual care. Participants with schizophrenia and other psychotic disorders had similar improvement rates as those with bipolar disorder.

We expected Population Care to be associated with increased annual visiting to psychiatrists since increased engagement of patients via telehealth has been followed by greater patient use of outpatient care.[60] Instead, we found a decrease in annual psychiatrist visits associated with the program. It is possible that

Figure 2.

Difference in Differences Between Population Care and Usual Care on Primary Outcomes by Clinical and Sociodemographic Subgroups



[a]Absolute risk difference (ARD) is the difference-in-difference coefficient, ie, the interaction of time period (post- vs pre-enrollment) × intervention group (Population Care vs Usual Care).

[b]Interaction *P* value is for the time period × intervention group × subgroup interaction term, eg, time period (post- vs pre-enrollment) × intervention group (Population Care vs Usual Care) × subgroup (psychotic vs bipolar).

for some patients, the clinical pharmacist served as a clinical extender for psychiatrists, reducing the need for psychiatrist appointments. Other changes in outpatient, inpatient, and ED services did not significantly differ between Population Care and Usual Care.

One exception was that older adults in Population Care relative to those in Usual Care did significantly increase ED use from pre- to post-enrollment. As an age group with a high likelihood of physical health comorbidities, it is possible that older adults became more aware of urgent health needs after receiving care from program clinical pharmacists. Although the overall Population Care group did not have significant expected relative decreases in ED use, it is possible that differences could emerge in the future. Program benefits such as greater psychotropic medication adherence and health screening could result in prevention of psychiatric or other medical crises that drive ED use in the longer term. Trends of decreasing ED use may emerge several years after an integrated care initiative for people with behavioral health conditions.[61]

Population Care patients engaged in the program at high levels and maintained regular use over 12 months. SPMI Population Care was implemented during the COVID-19 pandemic when mental health visits transitioned dramatically from in-person to telehealth modalities.[62] Pre-pandemic data suggest that most people with SPMI use smartphones and that many find telehealth care delivery acceptable.[63–66] The current study contributes to needed data on the feasibility and impact of telehealth to treat serious mental health conditions in the post-COVID era.[67]

This study had limitations. Findings may not generalize to other settings such as those with high numbers of uninsured patients. Due to the observational design, it is possible that results were biased by unmeasured variables that would have been balanced in a randomized design. Participants whose data were analyzed in the PC group were enrolled in the SPMI Population Care program during a 6-month period; these participants may have been systematically different from the overall eligible patient population. For example, when compared to the UC group (all eligible patients at non-program sites), the PC group was more likely to have schizophrenia or another psychotic disorder. Through overlap weighting with propensity scores, we adjusted analyses to account for this and other measured differences between PC and UC but could not adjust for unmeasured differences. Lastly, the adherence measure, by taking the maximum medication possession ratio across dispensed medications, may have misclassified individuals who adhered much more to some psychotropic medications than to others. These limitations were mitigated by strengths including the large, sociodemographically diverse study population, the availability of a similar comparison group who were receiving care in distinct facilities during the same COVID-era time period, low attrition rates, the availability of many clinical variables from the EHR, and the use of propensity score weighting that accounted for a large range of potentially confounding covariates, including EHR variables that clinical pharmacists might have used to prioritize their outreach to patients.

In conclusion, this quality improvement study found that, over 12 months, a novel telehealth collaborative care program managed by clinical pharmacists was associated with significantly improved psychotropic medication adherence and preventive health screening, significantly decreased psychiatrist visiting, and no significant change in ED visits compared to usual care for patients with SPMI. To help address mental health clinician shortages, states have expanded the professional scope of clinical pharmacists, enabling them to fulfill key roles in medication management and care coordination as part of psychiatric care teams. Examination of long-term associations of collaborative care with clinical and quality-of-life outcomes in this vulnerable population is needed.

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References

1. Charlson FJ, Ferrari AJ, Santomauro DF, et al. Global epidemiology and burden of schizophrenia: findings from the Global Burden of Disease Study 2016. *Schizophr Bull.* 2018;44(6):1195–1203.
2. Merikangas KR, Jin R, He J-P, et al. Prevalence and correlates of bipolar spectrum disorder in the world mental health survey initiative. *Arch Gen Psychiatry.* 2011;68(3):241–251.
3. De Hert M, Correll CU, Bobes J, et al. Physical illness in patients with severe mental disorders, I: prevalence, impact of medications and disparities in health care. *World Psychiatry.* 2011;10(1):52–77.
4. Wade M, Tai S, Awenat Y, et al. A systematic review of service-user reasons for adherence and nonadherence to neuroleptic medication in psychosis. *Clin Psychol Rev.* 2017;51:75–95.
5. Kreyenbuhl J, Nossel IR, Dixon LB. Disengagement from mental health treatment among individuals with schizophrenia and strategies for facilitating connections to care: a review of the literature. *Schizophr Bull.* 2009;35(4):696–703.
6. Higashi K, Medic G, Littlewood KJ, et al. Medication adherence in schizophrenia: factors influencing adherence and consequences of nonadherence, a systematic literature review. *Ther Adv Psychopharmacol.* 2013;3(4):200–218.
7. Walker ER, McGee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. *JAMA Psychiatry.* 2015;72(4):334–341.
8. Olfson M, Gerhard T, Huang C, et al. Premature mortality among adults with schizophrenia in the United States. *JAMA Psychiatry.* 2015;72(12):1172–1181.
9. Iturralde E, Slama N, Kline-Simon AH, et al. Premature mortality associated with severe mental illness or substance use disorder in an integrated health care system. *Gen Hosp Psychiatry.* 2021;68:1–6.
10. Perkins R, Rinaldi M. Unemployment rates among patients with long-term mental health problems: a decade of rising unemployment. *Psychiatr Bull.* 2002;26(8):295–298.
11. Correll CU, Detraux J, De Lepeleire J, et al. Effects of antipsychotics, antidepressants and mood stabilizers on risk for physical diseases in people with schizophrenia, depression and bipolar disorder. *World Psychiatry.* 2015;14(2):119–136.
12. Chwastiak LA, Rosenheck RA, Kazis LE. Association of psychiatric illness and obesity, physical inactivity, and smoking among a national sample of veterans. *Psychosomatics.* 2011;52(3):230–236.
13. American Diabetes Association; American Psychiatric Association; American Association of Clinical Endocrinologists; North American Association for the Study of Obesity. Consensus development conference on antipsychotic drugs and

obesity and diabetes. *Diabetes Care*. 2004;27(2):596–601.
14. Mangurian C, Schillinger D, Newcomer JW, et al. Diabetes screening among antipsychotic-treated adults with severe mental illness in an integrated delivery system: a retrospective cohort study. *J Gen Intern Med*. 2018;33(1):79–86.
15. Melamed OC, Wong EN, LaChance LR, et al. Interventions to improve metabolic risk screening among adult patients taking antipsychotic medication: a systematic review. *Psychiatr Serv*. 2019;70(12):1138–1156.
16. Solmi M, Fiedorowicz J, Poddighe L, et al. Disparities in screening and treatment of cardiovascular diseases in patients with mental disorders across the world: systematic review and meta-analysis of 47 observational studies. *Am J Psychiatry*. 2021;178(9):793–803.
17. Hsueh L, Iturralde E, Slama NE, et al. Cardiometabolic monitoring and sociodemographic and clinical characteristics of youths prescribed antipsychotic medications. *Psychiatr Serv*. 2023;74(8):801–808.
18. New American Economy. The silent shortage: how immigration can address the large and growing psychiatrist shortage in the United States. 2017. Accessed February 7, 2022. http://www.newamericaneconomy.org/wp-content/uploads/2017/10/NAE_PsychiatristShortage_V6-1.pdf
19. Institute of Medicine. *Improving the Quality of Health Care for Mental and Substance-Use Conditions*. National Academy Press; 2006.
20. Totura CMW, Fields SA, Karver MS. The role of the therapeutic relationship in psychopharmacological treatment outcomes: a meta-analytic review. *Psychiatr Serv*. 2018;69(1):41–47.
21. Druss BG, von Esenwein SA, Compton MT, et al. A randomized trial of medical care management for community mental health settings: the Primary Care Access, Referral, and Evaluation (PCARE) study. *Am J Psychiatry*. 2010;167(2):151–159.
22. Jones S, Howard L, Thornicroft G. "Diagnostic overshadowing": worse physical health care for people with mental illness. *Acta Psychiatr Scand*. 2008;118(3):169–171.
23. Thornicroft G, Rose D, Kassam A. Discrimination in health care against people with mental illness. *Int Rev Psychiatry*. 2007;19(2):113–122.
24. Kisely S, Campbell LA, Wang Y. Treatment of ischaemic heart disease and stroke in individuals with psychosis under universal healthcare. *Br J Psychiatry*. 2009;195(6):545–550.
25. Katon WJ, Seelig M. Population-based care of depression: team care approaches to improving outcomes. *J Occup Environ Med*. 2008;50(4):459–467.
26. Gilbody S, Bower P, Fletcher J, et al. Collaborative care for depression: a cumulative meta-analysis and review of longer-term outcomes. *Arch Intern Med*. 2006;166(21):2314–2321.
27. Panagioti M, Bower P, Kontopantelis E, et al. Association between chronic physical conditions and the effectiveness of collaborative care for depression: an individual participant data meta-analysis. *JAMA Psychiatry*. 2016;73(9):978–989.
28. Coleman KJ, Dreskin M, Hackett DL, et al. A roadmap for institutionalizing collaborative care for depression in a large integrated healthcare system. *J Gen Intern Med*. 2020;35(suppl 2):839–848.
29. Katon WJ, Lin EH, Von Korff M, et al. Collaborative care for patients with depression and chronic illnesses. *N Engl J Med*. 2010;363(27):2611–2620.
30. Reilly S, Planner C, Gask L, et al. Collaborative care approaches for people with severe mental illness. *Cochrane Database Syst Rev*. 2013;(11):CD009531.
31. Kilbourne AM, Barbaresso MM, Lai Z, et al. Improving physical health in patients with chronic mental disorders: 12-month results from a randomized controlled collaborative care trial. *J Clin Psychiatry*. 2017;78(1):129–137.
32. Bauer MS, McBride L, Williford WO, et al; Cooperative Studies Program 430 Study Team. Collaborative care for bipolar disorder, part I: intervention and implementation in a randomized effectiveness trial. *Psychiatr Serv*. 2006;57(7):927–936.
33. Gertner AK, Grove LR, Swietek KE, et al. Enhanced primary care for people with serious mental illness: a propensity weighted cohort study. *J Clin Psychiatry*. 2023;84(3):22m14496.
34. Goldstone LW, DiPaula BA, Werremeyer A, et al. The role of board-certified psychiatric pharmacists in expanding access to care and improving patient outcomes. *Psychiatr Serv*. 2021;72(7):794–801.
35. Eaves S, Gonzalvo J, Hamm JA, et al. The evolving role of the pharmacist for individuals with serious mental illness. *J Am Pharm Assoc (Wash DC)*. 2020;60(5S):S11–S14.
36. Heisler M, Hofer TP, Schmittdiel JA, et al. Improving blood pressure control through a clinical pharmacist outreach program in patients with diabetes mellitus in 2 high-performing health systems: the adherence and intensification of medications cluster randomized, controlled pragmatic trial. *Circulation*. 2012;125(23):2863–2872.
37. Ridout KK, Ridout SJ, Alavi M, et al. Evaluating implementation and outcomes of the achieving depression and anxiety patient-centered treatment collaborative care program in a large, integrated health care system: a mixed methods observational study protocol. *Perm J*. 2022;26(4):39–48.
38. Conway SJ, Kumar P, Nothelle S. Evolution of the care manager: redefining best practices in the COVID-19 era. *Popul Health Manag*. 2022;25(1):8–10.
39. Iturralde E, Fazzolari L, Shia M, et al. Closing the care gap for people with severe and persistent mental illness: collaborative care, telehealth, and clinical pharmacy. *NEJM Catal*. 2022;3(5):CAT.21.0417.
40. Gordon N. *Similarity of adult Kaiser Permanente members to the adult population in Kaiser Permanente's Northern California service area: comparisons based on the 2017/2018 cycle of the California Health Interview Survey*. Oakland, CA: Kaiser Permanente Northern California Division of Research; 2020. Accessed July 14, 2022. https://memberhealthsurvey.kaiser.org/Documents/compare_kp_ncal_chis2017-18.pdf
41. Ogrinc G, Davies L, Goodman D, et al. Squire 2.0 (Standards for Quality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *Am J Crit Care*. 2015;24(6):466–473.
42. Peterson AM, Nau DP, Cramer JA, et al. A checklist for medication compliance and persistence studies using retrospective databases. *Value Health*. 2007;10(1):3–12.
43. Hess LM, Raebel MA, Conner DA, et al. Measurement of adherence in pharmacy administrative databases: a proposal for standard definitions and preferred measures. *Ann Pharmacother*. 2006;40(7-8):1280–1288.
44. National Committee for Quality Assurance. Diabetes and cardiovascular disease screening and monitoring for people with schizophrenia or bipolar disorder (SSD, SMD, SMC). Accessed October 31, 2022. https://www.ncqa.org/hedis/measures/diabetes-and-cardiovascular-disease-screening-and-monitoring-for-people-with-schizophrenia-or-bipolar-disorder/
45. Firth J, Siddiqi N, Koyanagi A, et al. The Lancet Psychiatry Commission: a blueprint for protecting physical health in people with mental illness. *Lancet Psychiatry*. 2019;6(8):675–712.
46. Hackman AL, Goldberg RW, Brown CH, et al. Use of emergency department services for somatic reasons by people with serious mental illness. *Psychiatr Serv*. 2006;57(4):563–566.
47. Merrick EL, Perloff J, Tompkins CP. Emergency department utilization patterns for Medicare beneficiaries with serious mental disorders. *Psychiatr Serv*. 2010;61(6):628–631.
48. Laraia BA, Karter AJ, Warton EM, et al. Place matters: neighborhood deprivation and cardiometabolic risk factors in the Diabetes Study of Northern California (DISTANCE). *Soc Sci Med*. 2012;74(7):1082–1090.
49. Charlson ME, Charlson RE, Peterson JC, et al. The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients. *J Clin Epidemiol*. 2008;61(12):1234–1240.
50. Cook TD, Campbell DT, Shadish W. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Vol 1195. Houghton Mifflin; 2002.
51. Zeger SL, Liang K-Y. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*. 1986;42(1):121–130.
52. Little RJ, Rubin DB. *Statistical Analysis With Missing Data*. Vol. 793. John Wiley & Sons; 2019.
53. Freedman DA. On the so-called "Huber sandwich estimator" and "robust standard errors." *Am Stat*. 2006;60(4):299–302.
54. Thomas L, Li F, Pencina M. Using propensity score methods to create target populations in observational clinical research. *JAMA*. 2020;323(5):466–467.
55. Schneeweiss S, Rassen JA, Glynn RJ, et al. High-dimensional propensity score adjustment in studies of treatment effects using health care claims data. *Epidemiology*. 2009;20(4):512–522.
56. Guertin JR, Rahme E, Dormuth CR, et al. Head to head comparison of the propensity score and the high-dimensional propensity score matching methods. *BMC Med Res Methodol*. 2016;16(1):22.
57. Thomas LE, Li F, Pencina MJ. Overlap weighting: a propensity score method that mimics attributes of a randomized clinical trial. *JAMA*. 2020;323(23):2417–2418.
58. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res*. 2011;46(3):399–424.
59. Li F, Thomas LE, Li F. Addressing extreme propensity scores via the overlap weights. *Am J Epidemiol*. 2019;188(1):250–257.
60. Reed M, Huang J, Graetz I, et al. Treatment and follow-up care associated with patient-scheduled primary care telemedicine and in-person visits in a large integrated health system. *JAMA Netw Open*. 2021;4(11):e2132793.
61. Iturralde E, Weisner CM, Adams SR, et al. Patterns of health care use 5 years after an intervention linking patients in addiction treatment with a primary care practitioner. *JAMA Netw Open*. 2022;5(11):e2241338.
62. Ridout KK, Alavi M, Ridout SJ, et al. Changes in diagnostic and demographic characteristics of patients seeking mental health care during the early COVID-19 pandemic in a large, community-based health care system. *J Clin Psychiatry*. 2021;82(2):20m13685.
63. Firth J, Cotter J, Torous J, et al. Mobile phone ownership and endorsement of "mHealth" among people with psychosis: a meta-analysis of cross-sectional studies. *Schizophr Bull*. 2016;42(2):448–455.
64. Robotham D, Satkunanathan S, Doughty L, et al. Do we still have a digital divide in mental health? a five-year survey follow-up. *J Med Internet Res*. 2016;18(11):e309.
65. Bauer R, Glenn T, Strejilevich S, et al. Internet use by older adults with bipolar disorder: international survey results. *Int J Bipolar Disord*. 2018;6(1):20.
66. Berry N, Lobban F, Emsley R, et al. Acceptability of interventions delivered online and through mobile phones for people who experience severe mental health problems: a systematic review. *J Med Internet Res*. 2016;18(5):e121.
67. Blanco C, Wall MM, Olfson M. Implications of telepsychiatry for cost, quality, and equity of mental health care. *JAMA Psychiatry*. 2022;79(12):1147–1148.

The Journal of Clinical Psychiatry

Supplementary Material

Article Title: Telehealth Collaborative Care Led by Clinical Pharmacists for People With Psychosis or Bipolar Disorder: A Propensity Weighted Comparison With Usual Psychiatric Care

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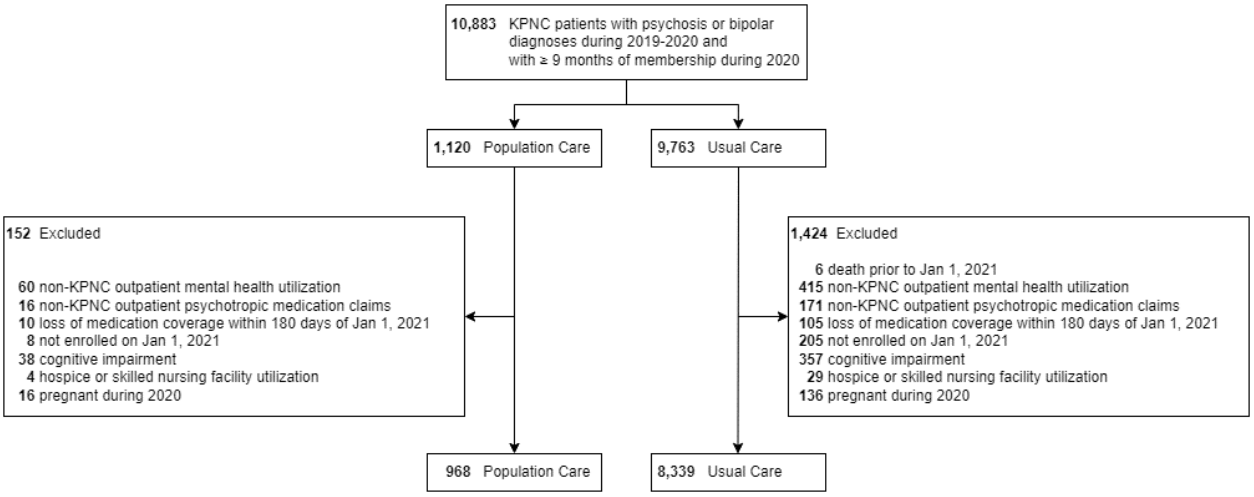
LIST OF SUPPLEMENTARY MATERIAL FOR THE ARTICLE

DISCLAIMER

This Supplementary Material has been provided by the author(s) as an enhancement to the published article. It has been approved by peer review; however, it has undergone neither editing nor formatting by in-house editorial staff. The material is presented in the manner supplied by the author.

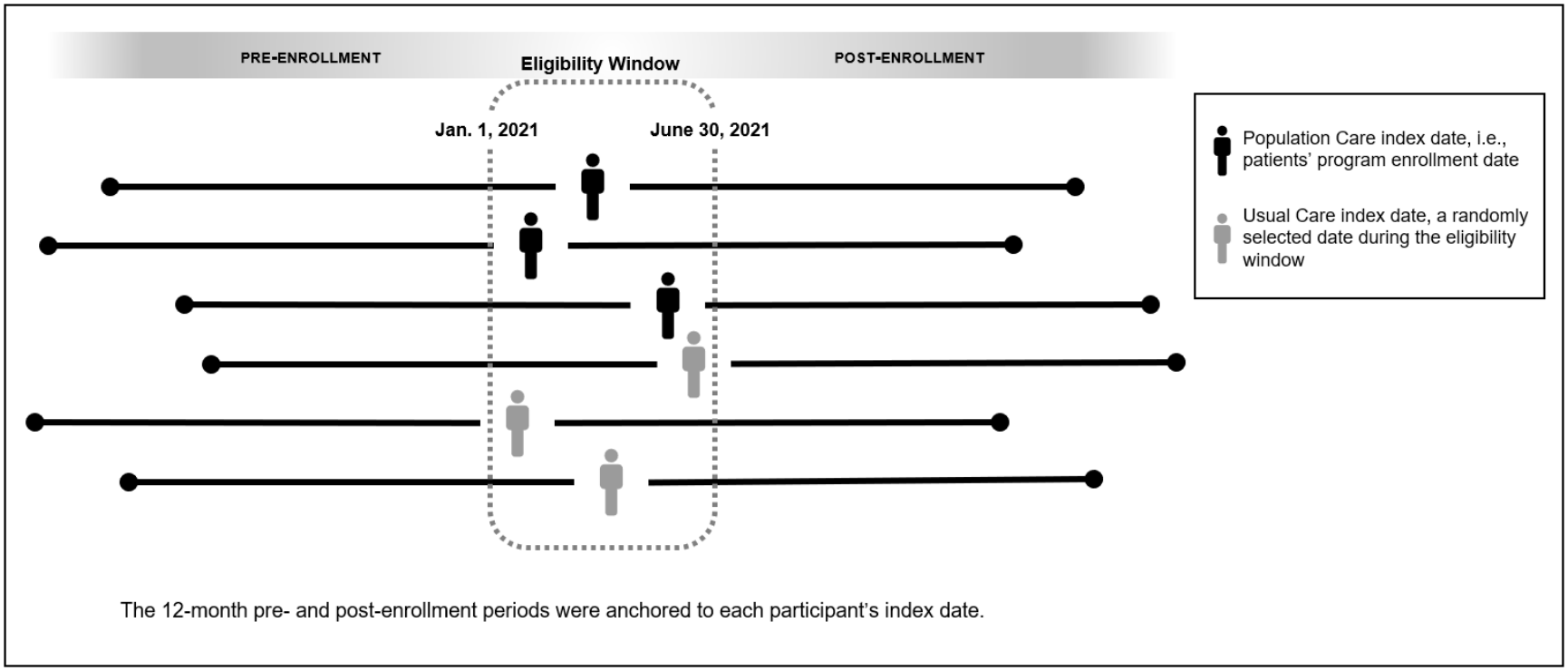
SUPPLEMENTARY MATERIALS

SUPPLEMENTARY FIGURE 1. Participant Flow



Abbreviations: KPNC, Kaiser Permanente Northern California; SNF, skilled nursing facility.
Note: psychosis ICD-10-CM diagnosis codes: F06.0, F06.2, F20.*, F23, F25.0, F25.1, F29; bipolar ICD-10-CM diagnosis codes: F30.*, F31.*

SUPPLEMENTARY FIGURE 2. Study Timeline



High Dimensional Propensity Score (HDPS) Methods

We used the HDPS algorithm as implemented in the Pharmacoepidemiology Toolbox SAS macro to identify 300 empirical covariates and selected the top 100 covariates based on their association with treatment.[1] We generated the HDPS using a logistic regression model that included 18 *a priori* variables (see below) and the top 100 empirically selected variables. Candidate predictors for the HDPS algorithm included all ICD-10 diagnosis codes from inpatient and outpatient encounters and procedure codes in the 2 years prior to enrollment, all generic names of outpatient prescriptions filled at KPNC pharmacies in the 1 year prior to enrollment, and all outpatient departments visited in the 1 year prior to enrollment. The HDPS algorithm takes p data elements (e.g., diagnosis codes), uses prevalence to choose n candidate empirical covariates, and prioritizes the top k covariates based on a selected metric (e.g., Bross formula[2] or association with treatment).

SUPPLEMENTARY TABLE 1. *A Priori* Variables Used in HDPS Model

Variable	Measure Details
Age at index date	< 35, 35-49, 50-64, 65+ years
Sex	Female, not female
Race/ethnicity	Non-Hispanic Black, Hispanic, Asian/Pacific Islander, non-Hispanic White, other/multiracial/unknown
Insurance type	Medicaid, Medicare, Commercial, Other
Non–English language preference	Yes, no
Mental health condition	Schizophrenia, Schizoaffective disorder, Bipolar I disorder, Bipolar II disorder, and Psychotic disorder
Most recent mental health visit year	Calendar year
Most recent mental health visit month	Numeric calendar month
Most recent smoking status	Current, former, never, missing
Most recent body mass index (kg/m^2)	<18.5, 18.5–24.9, 25.0–29.9, ≥ 30.0, missing
Neighborhood deprivation index based on geocoded census data[3]	Quartiles of the overall distribution, missing
Charlson comorbidity score	Based on Charlson et al.[4]
Emergency department visits, past-year	0, 1, ≥ 2
Outpatient visits, past-year	0, 1, 2-5, ≥ 6
Inpatient visits, past-year	0, 1, ≥ 2
Psychiatrist visit, past-year	Any, none
Psychotropic medication adherence	Optimal (medication possession ratio ≥ 0.8)[5,6], suboptimal
Glycemic or lipid laboratory result, past-year	Any, none
Blood pressure measurement, past-year in-person or virtual care	Any, none

References Cited in Supplement

1. Schneeweiss S, Rassen JA, Glynn RJ, Avorn J, Mogun H, Brookhart MA. High-dimensional propensity score adjustment in studies of treatment effects using health care claims data. *Epidemiology.* 2009;20(4):512.
2. Bross ID. Spurious effects from an extraneous variable. *J Chronic Dis.* 1966;19(6):637-647.
3. Laraia BA, Karter AJ, Warton EM, Schillinger D, Moffet HH, Adler N. Place matters: neighborhood deprivation and cardiometabolic risk factors in the Diabetes Study of Northern California (DISTANCE). *Soc Sci Med.* 2012;74(7):1082-1090.
4. Charlson ME, Charlson RE, Peterson JC, Marinopoulos SS, Briggs WM, Hollenberg JP. The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients. *J Clin Epidemiol.* 2008;61(12):1234-1240.
5. Peterson AM, Nau DP, Cramer JA, Benner J, Gwadry-Sridhar F, Nichol M. A checklist for medication compliance and persistence studies using retrospective databases. *Value Health.* 2007;10(1):3-12.
6. Hess LM, Raebel MA, Conner DA, Malone DC. Measurement of adherence in pharmacy administrative databases: a proposal for standard definitions and preferred measures. *Ann Pharmacother.* 2006;40(7-8):1280-1288.