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Electronic Patient-Reported Outcome-Driven Symptom Management by Oncology Pharmacists in a Majority-Minority Population: An Implementation Study

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ABSTRACT

PURPOSE There is a lack of systematic solutions to manage supportive care issues in racial/ethnic minorities (REM) receiving treatment for cancer. We developed and implemented an electronic patient-reported outcome (ePRO)–driven symptom management tool led by oncology pharmacists in a majority-minority cancer center located in Southern California. This study was designed to evaluate the implementation outcomes of our multilevel intervention.

METHODS This was a prospective, pragmatic, implementation study conducted between July 2021 and June 2023. Newly diagnosed adult patients with cancer receiving intravenous anticancer therapies completed symptom screening using ePRO that consists of the Patient-Reported Outcomes Measurement Information System measures at each infusion visit during the study. ePRO results were presented to an oncologist pharmacist for personalized symptom management and treatment counseling. The RE-AIM framework was used to guide implementation outcomes. Differences in symptom trajectories and clinical outcomes between groups were tested using generalized estimating equations.

RESULTS We screened 388 patients of whom 250 were enrolled (acceptance rate: 64.4%), with 564 assessments being completed. The sample consisted of non-Hispanic White (NHW, 42.4%), Hispanic/Latinx (H/L, 30.8%), and non-Hispanic Asian (20.4%), with one (21.6%) of five participants preferring speaking Spanish. Compared with NHW, H/L participants had greater odds of reporting mild to severe pain interference (odds ratio [OR], 1.91 [95% CI, 1.18 to 3.08]; $P = .008$) and nausea and vomiting (OR, 2.08 [95% CI, 1.21 to 3.58]; $P = .008$), and higher rates of urgent care utilization (OR, 1.92 [95% CI, 1.04 to 3.61]; $P = .04$) within 30 days. Nausea and vomiting (n = 131, 23.2%), pain (n = 91, 16.1%), and fatigue (n = 72, 12.8%) were most likely to be intervened, with 90% of the participants expressing satisfaction across all visits.

CONCLUSION Our multilevel ePRO-driven intervention led by oncology pharmacists helps facilitate symptom assessments and management and potentially reduce health disparities among REM.

ACCOMPANYING CONTENT

Appendix

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INTRODUCTION

Studies have reported that racial and ethnic disparities can affect clinical outcomes related to symptom burden and severity, causing minoritized patients to perceive unmet needs for supportive care services.[1] These disparities persist, although supportive care is increasingly recognized as an essential component of cancer care.[2] Current solutions to improve cancer supportive care and related outcomes in racial/ethnic minorities (REM) mainly focus on targeting a specific factor in silo.[3] However, these solutions do not tackle health disparity issues on both individual and interprofessional levels and seldom engage oncology pharmacists as a resource.

Oncology pharmacists play a critical role in caring for patients with cancer as they provide education to patients and their caregivers on the respective anticancer regimen.[4] Studies have demonstrated that pharmacist-led clinical interventions improve patients' understanding of their

CONTEXT

Key Objective

Can the utilization of a multilanguage electronic patient-reported outcome (ePRO)–driven symptom management tool, led by oncology pharmacists, address supportive care issues among patients undergoing anticancer treatment in a racial/ethnic majority-minority cancer center?

Knowledge generated

Through implementing this ePRO intervention, we found that Hispanic/Latinx participants showed increased odds of reporting pain interference and nausea/vomiting compared with non-Hispanic White participants, prompting corresponding interventions by pharmacists. Across race/ethnicities, most participants expressed satisfaction with the intervention.

Relevance

The use of this monitoring tool shows potential in facilitating symptom assessment and management, which may mitigate disparities in health care outcomes among racial/ethnic minorities.

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treatment and their ability to effectively manage side effects, ultimately improving quality of life and decreasing anxiety and depression.[5-7] However, early recognition of these health issues by pharmacists is often impeded by patients' limited health literacy or poor communication due to language barriers, issues that are highly prevalent among REM.[8,9] Improving early recognition of health issues among REM may also facilitate timely interventions.[10]

There are few solutions developed to improve symptom identification to reduce health disparities in newly diagnosed patients with cancer undergoing anticancer treatment. In this study, we developed and implemented a multilevel intervention involving the incorporation of electronic patient-reported outcome (ePRO) tools and active personalization to guide symptom management. We hypothesize that a multilanguage ePRO-driven symptom management tool led by oncology pharmacists will help reduce health disparities at a majority-minority county in Southern California. We also hypothesize that REM patients undergoing anticancer treatment will find the program satisfactory and acceptable.

METHODS

Study Design

This prospective, pragmatic, implementation study was conducted at the Chao Family Comprehensive Cancer Center (CFCCC) infusion unit from July 2021 to June 2023. This study was designed to evaluate a clinical intervention in a real-world setting.[11] CFCCC is located in Orange County, California, a majority-minority county (ie, >50% in terms of ethnic representation) with Hispanic/Latinx (H/L) and Asian Americans accounting for 35.0% and 21.1% of the population, respectively.[12] With such diversity, CFCCC serves as an excellent environment to evaluate interventions aimed at reducing health disparities in REM. The study protocol received ethics approval from the University of California Irvine Institutional Review Board (#2021-6431), and all study participants provided written informed consent before participation.

Eligibility Criteria

Adult patients (age ≥18 years) newly diagnosed with cancer and receiving intravenous anticancer treatment at CFCCC were selected for inclusion in the study. Eligible patients were screened through the pharmacy schedule by oncology pharmacists within the electronic health record (EHR). Patients of all race/ethnic groups were included. Patients who did not wish to perform the research procedures or were physically and/or mentally incapable of providing written consent were excluded.

Intervention

Our multilevel intervention incorporates ePRO measures to assist oncology pharmacists with symptom management in patients undergoing anticancer treatment. There were three components for our intervention (Fig 1):

1. *Screening of symptoms using ePRO:* Standardized ePRO assessments were administered through REDCap using computer adaptive tests (CAT). Patients were provided a dedicated iPad before or during their infusion and completed their assessments at their infusion chair. The ePRO comprised the Patient-Reported Outcomes Measurement Information System (PROMIS) measures developed by the National Institutes of Health. Our ePRO measured seven health domains: nausea and vomiting, physical impairment, anxiety, depression, fatigue, cognitive impairment, and pain interference. All domains were administered as CAT, except nausea and vomiting (short form of four items used; CAT version unavailable). Measures were chosen to holistically assess toxicities of treatment and physical, mental, and social health. Patients' sociodemographic characteristics, responses to individual PROMIS items,

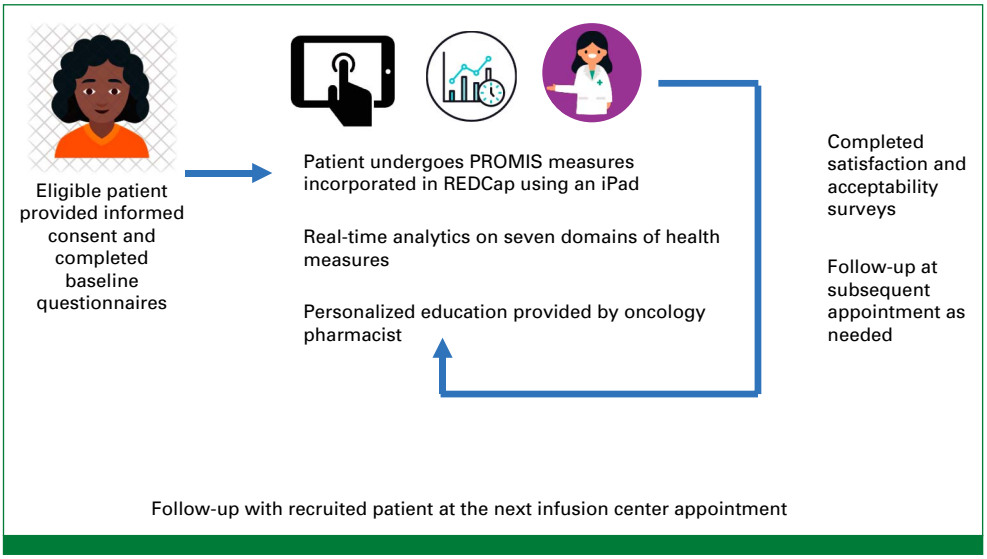

FIG 1. An overview of the study procedures. PROMIS, Patient-Reported Outcomes Measurement Information System.

and metrics of PROMIS utilization (eg, duration of completion) were also captured. Both English and Spanish versions were available. When a specific language (eg, Vietnamese or Korean) was unavailable, we engaged medical interpreters through video remote technology. After a patient completed the ePRO, raw scores were transformed to degrees of severity (normal, mild, moderate, and severe) on the basis of normative thresholds in real time.[13]

2. *Symptom management provided by trained oncology pharmacists:* An oncology pharmacist immediately reviewed the results from symptom screening and delivered personalized symptom management and treatment counseling to the patient, with content that aligns with current requirements provided by the ASCO QOPI certification program standards. Participating pharmacists attended an in-person training session to understand the workflow and to review existing care pathways. In addition, pharmacists could communicate and document treatment decisions, including ordering prescriptions, with other members of the oncology care team via the EHR.
3. *Study wrap-up and patients' follow-up:* After each visit, patients were asked about their satisfaction and acceptability of the program. Satisfaction was assessed using a single item: How satisfied are you with the counseling provided by your pharmacist? on a five-point Likert scale (very dissatisfied to very satisfied) as adapted from similar studies.[14,15] Acceptability of the length of the ePRO and education session was similarly assessed. Finally, on the basis of pharmacist's assessment of patients' symptomatology, participants would either be discharged from the study on the basis of mutual agreement or followed up at a subsequent visit. This allowed the pharmacist to provide reassessment of patients' symptoms, additional interventions, and/or counseling as necessary.

Outcomes

To assess the success of our intervention, we applied the RE-AIM framework[16] (Appendix Table A1, online only) to formulate the primary outcomes. RE-AIM guides the planning and evaluation of programs according to five key outcomes: Reach, Effectiveness, Adoption, Implementation, and Maintenance. For the secondary outcomes, we investigated differences in the following outcomes across racial/ethnic groups: (1) duration to complete ePRO, (2) symptom severity, (3) worsening and improving symptoms, (4) urgent care utilization within 30 days of assessment, (5) education delivery and patients' satisfaction, and (6) clinical interventions.

Statistical Analysis and Sample Size Calculation

All hypotheses were tested at a 5% significance level, and analysis was completed using Stata v16.1 and R v4.3.2. Descriptive statistics were used to summarize implementation science outcomes: medians and IQR or mean and standard deviations (SD) for continuous variables, and counts and percentages for categorical variables. We performed a chi-square test to compare our study's distribution of race/ethnicity with our catchment area demographics in Orange, California.[12] Four health and implementation science outcomes were compared between non-Hispanic White (NHW) participants and other racial/ethnic groups (H/L, non-Hispanic Asian [NHA], Others [OTH]):

1. Time to complete the PROMIS tool was compared between groups with linear mixed models adjusted for visit number (categorical) with random intercepts for individual participants.
2. Differences in symptom severities (proportions of mild to severe symptoms), as well as worsening and improving symptoms, between groups were tested using generalized

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estimating equations (GEE) with a sandwich variance estimator, binomial family, logit link function, and an exchangeable correlation matrix, adjusted for visit number (categorical). Sources of differences were evaluated with cross-sectional logistic regression at each visit, given significant findings from GEE longitudinal analyses. Context for observed differences in symptom severities was further explored using chi-square comparisons in primary cancer diagnoses between the groups.

3. Urgent care utilization was evaluated using Poisson regression, with person-days as the offset variable.
4. Delivery of education was compared between groups in two domains: frequency of completed visits using Poisson regression and patient satisfaction with pharmacists' education using GEE analysis as described in 2.
5. Clinical interventions were descriptively evaluated, stratified by symptom types and race/ethnicity groups. The proportion of intervened visits for each symptom was compared across different race/ethnicity groups (NHW being the reference) using GEE as described in 2 and 4.

Sample size was calculated on the basis of the expected number of newly diagnosed patients at CFCCC in a single year. We anticipated that 295 patients were eligible in 1 year. With an estimated nonparticipation rate of 15%, our final sample size was 250.

RESULTS

Participant Characteristics

A total of 250 patients were recruited. Participants had a median age of 61 years, with half being female (51.6%) and NHW (42.4%). Most participants preferred speaking in English (69.6%) or Spanish (29.6%; Table 1). Reasons for stopping study participation included treatment cessation (n = 171, 68.4%), discharge by pharmacists (n = 43, 17.2%), patient declined continuation (n = 18, 7.2%), and death (n = 16, 6.4%).

Symptoms Severities

Of the 250 participants, 193 (77.2%) completed two visits, 89 (35.6%) completed three, 28 (11.2%) completed four, and four (1.6%) completed five. A total of 564 unique visits were conducted. The median (days) duration between the baseline (first visit, V1) and subsequent follow-up visits (V2, V3, V4, and V5) is as follows: 21, 43, 68, and 120 days, respectively.

Before chemotherapy initiation (V1), the counts and prevalence of mild to severe symptoms were as follows: physical impairment (n = 138, 55.4%), anxiety (n = 115, 46.3%), pain interference (n = 112, 45.3%), fatigue (n = 74, 30.0%), depression (n = 66, 26.6%), nausea and vomiting (n = 49, 19.8%), and cognitive impairment (n = 49, 19.7%). From V1 to V3, the proportions of participants with mild to severe symptoms increased for physical impairment, cognitive

TABLE 1. Sociodemographic and Clinical Characteristics of Participants (N = 250)

Characteristics	Participants (N = 250)
Age at recruitment, median (Q1, Q3)	61.0 (50.0, 70.8)
Female, No. (%)	129 (51.6)
Race/ethnicity, No. (%)	
Non-Hispanic White	106 (42.4)
Hispanic/Latinx	77 (30.8)
Non-Hispanic Asian	51 (20.4)
Other racial/ethnic groups[a]	16 (6.4)
Education attainment, No. (%)	
Less than high school	71 (28.5)
High school diploma	54 (21.7
College/associate's degree/technical school	34 (13.7)
Bachelor	60 (24.1)
Master or more	30 (12.0)
Employment before cancer diagnosis, No. (%)	
Unemployed/student/homemaker/retired/ disabled	129 (51.6)
Full-time employment	86 (34.4)
Part-time employment or freelance	24 (9.6)
Self-employed	11 (4.4)
Health insurance, No. (%)	
Private	83 (33.2)
Medicare/dual eligibility	90 (36.0)
Medicaid	66 (26.4)
Others	8 (3.2)
Own but unsure	2 (0.8)
Uninsured	1 (0.4)
Has caregiver, No. (%)	85 (34.0)
Preferred language, No. (%)	
English	174 (69.6)
Spanish	54 (21.6)
Vietnamese	13 (5.2)
Others[b]	14 (5.6)
Primary cancer, No. (%)	
Gynecological	49 (19.6)
Head and Neck	31 (12.4)
Melanoma	28 (11.2)
Breast	27 (10.8)
Upper GI[c]	26 (10.4)
Genitourinary	24 (9.6)
Lower GI[d]	23 (9.2)
Lung and Bronchus	22 (8.8)
Lymphoma	9 (3.6)
Bone	8 (3.2)
Others[e]	3 (1.2)
Metastatic disease, No. (%)	50 (20.0)
Treatment agents, No. (%)	
Cisplatin-containing	67 (26.8)
Carboplatin-containing	54 (21.6)
Doxorubicin-containing	24 (9.6)

(continued on following page)

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TABLE 1. Sociodemographic and Clinical Characteristics of Participants (N = 250) (continued)

Characteristics	Participants (N = 250)
Immunotherapy combination	39 (15.6)
Immunotherapy-containing	74 (29.6)
Oxaliplatin-containing	27 (10.8)
Taxane-containing	59 (23.6)
Comorbidities, No. (%)	
Hypertension	69 (27.6)
Hyperlipidemia	42 (16.8)
Diabetes	33 (13.2)
Depression	12 (4.8)
Anxiety	11 (4.4)
Hypothyroidism	8 (3.2)

Abbreviations: n, counts; Q1, quartile 1; Q3, quartile 3.
[a]Other racial/ethnic groups include Black or African American (5), Native Hawaiian or Other Pacific Islander (3), American Indian or Alaska Native (1), Mexican (1), Filipino/Mexican (1), North African (1), Mediterranean (1), Persian (1), Middle Eastern (1), and Unknown (1).
[b]Other preferred languages include Mandarin (three participants), Korean (2), Tagalog (1), Hindi (1), Tongan (1), Russian (1), Farsi (1), Burmese (1), and Ukrainian (1).
[c]Upper GI cancers: stomach cancer, pancreatic cancer, hepatobiliary cancer.
[d]Lower GI cancers: colon cancer, rectal cancer, anal cancer.
[e]Other primary cancers include peritoneal carcinomatosis, multiple myeloma, and acute myeloblastic leukemia.

impairment, depression, fatigue, and nausea and vomiting (Appendix Fig A1).

Implementation Science Outcomes (RE-AIM)

Reach

A total of 138 patients did not enroll in the study. Common reasons for nonparticipation included lack of interest (n = 61, 44.2%), not eligible (n = 26, 18.8%), and feeling overwhelmed, stressed, tired, sick, or uncomfortable (n = 23, 16.7%). The average age of nonparticipants was 61.4 years (SD = 14.6), with an even distribution of male and female patients. None of these characteristics were significantly different from recruited patients ($P > .05$). There was also no significant difference in race/ethnicity distribution of our participants (NHW = 42.4%, H/L = 30.8%, NHA = 20.4%, OTH = 6.4%) when compared with our catchment area demographics (NHW = 38.6%, H/L = 35.0%, NHA = 21.1%, OTH = 5.3%, $P = 1.000$).

Effectiveness

Regarding participants' satisfaction with pharmacists' counseling, over 90% reported satisfied or very satisfied with their pharmacists across all visits (Table 2).

Of the 564 visits, 311 (55.1%) had one or more documented pharmacist interventions. The most intervened PROMIS-measured symptoms were nausea and vomiting (n = 131, 23.2%), followed by pain (n = 91, 16.1%), fatigue (n = 72, 12.8%), physical impairment (n = 67, 11.9%), anxiety (n = 58, 10.3%), depression (n = 24, 4.3%), and cognitive impairment (n = 15, 2.7%). A total of 153 visits (27.1%) recorded interventions of symptoms not captured by the PROMIS tool; these included neuropathy (n = 32, 5.7%), constipation (n = 23, 4.1%), diarrhea (n = 15, 4.8%), rash (n = 11, 2.0%), appetite loss (n = 9, 1.6%), and edema (n = 9, 1.6%).

The types of interventions included pharmacist education/re-education (n = 311, 100%), pharmacologic interventions (n = 107, 34.4%), and communication with other health care providers (n = 54, 17.4%).

Among 314 visits with a follow-up visit, the top three worsening symptoms were nausea and vomiting (n = 86, 27.4%), physical impairment (n = 86, 27.4%), and fatigue (n = 69, 22.0%). On the other hand, the top three improved symptoms were anxiety (n = 76, 24.2%), pain interference (n = 76, 24.2%), and physical impairment (n = 64, 20.4%).

During the study duration, there were 64 unplanned urgent care (including emergency department) visits within 30 days from PROMIS assessment; 40 (62.5%) required overnight admission. Infection-related visits were most common (n = 28, 43.8%), followed by GI complications (n = 12, 18.8%) and cardiovascular complications (n = 11, 17.2%), which were the top three reasons for unplanned medical care.

Adoption

Five pharmacists were actively involved in the program. The median (IQR) number of years of experience in oncology pharmacy was 8 (3-12) years. All participating pharmacists have professional (or greater) working proficiency in English, and three pharmacists have also reported proficiency in Vietnamese.

Implementation

Each patient participated in a median (IQR) of two (2-3) visits, and the median (IQR) duration for completion of the PROMIS tool was 7 (5-9) minutes. Over 90% of participants stated that the length of the PROMIS tool was acceptable across all visits (Table 2). The completion rate across all visits was 91.1%.

Maintenance

When asked for their opinions on the use of the PROMIS tool on every visit to the infusion center, more than 70% of participants felt that the frequency was just right across the five visits (Table 3).

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TABLE 2. Patient Satisfaction and Acceptability From Visit 1 to 5 (V1-V5)

	V1 (N = 250), No. (%)	V2 (n = 193), No. (%)	V3 (n = 89), No. (%)	V4 (n = 28), No. (%)	V5 (n = 4), No. (%)
Effectiveness: How satisfied are you with the counseling (education) provided by your pharmacist?					
Very satisfied	182 (77.5)	130 (72.6)	66 (77.7)	19 (73.1)	4 (100.0)
Satisfied	51 (21.7)	48 (26.8)	19 (22.5)	7 (26.9)	0 (0.0)
Dissatisfied	1 (0.4)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Very dissatisfied	1 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Implementation: How do you find the length of the electronic survey tool (PROMIS tool)?					
Acceptable	219 (92.8)	166 (91.7)	81 (95.3)	25 (96.2)	4 (100.0)
Too long	15 (6.4)	14 (7.7)	3 (3.5)	1 (3.9)	0 (0.0)
Too short	2 (0.9)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Maintenance: What do you think if this electronic survey (PROMIS tool) is offered to you during every visit to the infusion center?					
Just right	192 (81.7)	136 (75.1)	67 (78.8)	22 (84.6)	3 (75.0)
Too frequent	39 (16.6)	43 (23.8)	18 (21.2)	4 (15.4)	1 (25.0)
Too infrequent	4 (1.7)	2 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System.

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Outcomes Comparison On the Basis of Racial/Ethnic Differences

Cancer Types

The distribution of primary cancer types was significantly different across race/ethnicity ($P < .001$; Table 3). The two most prevalent cancers for each group were melanoma (21.6%) and head and neck (17.9%) cancers among NHW, gynecological (29.9%) and breast (18.2%) cancers among H/L, lung and bronchus (21.6%) and gynecological (19.6%) cancers among NHA, and lung and bronchus (37.5%) and breast (25.0%) cancers among OTH (Table 3).

Duration to Complete ePRO

Compared with NHW, H/L patients spent an additional 2.2 minutes (95% CI, 1.0 to 3.4, $P < .001$), NHA patients spent an additional 1.7 minutes (95% CI, 0.3 to 3.0, $P = .016$), and OTH patients spent an additional 2.7 minutes (95% CI, 0.5 to 4.8, $P = .017$) to complete the PROMIS tool (Table 4).

Symptoms Severities

Compared with NHW, H/L participants had greater odds of reporting mild to severe pain interference (odds ratio [OR], 1.91 [95% CI, 1.18 to 3.08]; $P = .008$) and nausea and vomiting (OR, 2.08 [95% CI, 1.21 to 3.58]; $P = .008$), whereas OTH participants had greater odds of pain interference (OR, 3.17 [95% CI, 1.22 to 8.25]; $P = .018$; Table 3). The above-mentioned disparities in symptoms (nausea and vomiting, and pain interference) among H/L and OTH participants were statistically significant ($P < .05$) at V1 and V2 (Table 5).

Changes of Symptoms Over Visits

Compared with NHW, H/L (OR, 2.16 [95% CI, 1.16 to 4.00]; $P = .015$) and NHA (OR, 2.09 [95% CI, 1.06 to 4.12]; $P = .033$) participants had greater odds of reporting the worsening of pain interference symptoms. Nevertheless, H/L also reported greater odds of improving pain symptoms (OR, 2.49 [95% CI, 1.38 to 4.50]; $P = .003$) compared with NHW. We observed near significance for improving pain symptoms among NHA compared with NHW (OR, 1.83 [95% CI, 0.93 to 3.62]; $P = .080$; Table 3). Further stratified analysis found that these significant differences between the racial/ethnic groups were concentrated between V1 and V2 (Appendix Table A2).

Urgent Care Utilization

Compared with NHW, H/L and OTH participants were 1.92 times (95% CI, 1.04 to 3.61, $P = .04$) and 4.82 times (95% CI, 2.25 to 10.03, $P < .001$) more likely to receive urgent care within 30 days from assessments, respectively. OTH were associated with a higher rate of urgent care utilization with overnight admissions than NHW participants (rate ratio [RR], 3.42 [95% CI, 1.19 to 8.80]; $P = .014$; Table 3). Further analysis revealed that these disparities were largely found from V1 to V2 (Appendix Table A2).

Symptom Management and Satisfaction

Across racial/ethnic groups, pharmacists performed interventions most frequently among OTH for other symptoms, fatigue, depression, and cognitive impairment; among H/L for nausea and vomiting, pain interference, and anxiety; and among NHW for physical impairment (Appendix Fig A2). Compared with NHW participants, pharmacists were more likely to intervene for nausea and vomiting (OR, 1.93 [95%

TABLE 3. Comparison of Primary Cancer Types and Longitudinal Mild-Severe Symptoms Among Racial/Ethnic Minorities Compared With NHW Participants

Primary Cancer	NHW (n = 106)	H/L (n = 77)	NHA (n = 51)	OTH (n = 16)
	No. (%)	No. (%)	No. (%)	No. (%)
Gynecological	16 (15.1)	23 (29.9)	10 (19.6)	0 (0.0)
Head and Neck	19 (17.9)	5 (6.5)	6 (11.8)	1 (6.3)
Melanoma	24 (21.6)	3 (3.9)	0 (0.0)	1 (6.3)
Breast	4 (3.8)	14 (18.2)	5 (9.8)	4 (25.0)
Upper GI	9 (8.5)	10 (13.0)	5 (9.8)	2 (12.5)
Genitourinary	10 (9.4)	9 (11.7)	4 (7.8)	1 (6.3)
Lower GI	9 (8.5)	8 (10.4)	6 (11.8)	0 (0.0)
Lung and bronchus	4 (3.8)	1 (1.3)	11 (21.6)	6 (37.5)
Lymphoma	7 (6.6)	1 (1.3)	0 (0.0)	1 (6.3)
Bone	3 (2.8)	1 (1.3)	4 (7.8)	0 (0.0)
Others[b]	1 (0.9)	2 (2.6)	0 (0.0)	0 (0.0)

Association Analyses

Outcomes	Ratio (95% CI)	Ratio (95% CI)	Ratio (95% CI)	Ratio (95% CI)
Mild to severe[c]				
Physical impairment	1.0 (ref)	1.24 (0.75 to 2.06)	1.05 (0.86 to 0.59)	2.60 (0.86 to 7.82)
Cognitive impairment	1.0 (ref)	0.93 (0.52 to 1.64)	1.12 (0.58 to 2.17)	1.89 (0.72 to 4.95)
Pain interference	1.0 (ref)	1.91** (1.18 to 3.08)	1.51 (0.85 to 2.66)	3.17* (1.22 to 8.25)
Depression	1.0 (ref)	1.28 (0.72 to 2.28)	1.47 (0.78 to 2.77)	0.88 (0.29 to 2.70)
Anxiety	1.0 (ref)	1.20 (0.73 to 1.96)	1.10 (0.62 to 1.96)	0.89 (0.39 to 2.01)
Fatigue	1.0 (ref)	0.97 (0.57 to 1.67)	1.37 (0.77 to 2.44)	1.70 (0.68 to 4.25)
Nausea and vomiting	1.0 (ref)	2.08** (1.21 to 3.58)	1.30 (0.70 to 2.41)	2.29 (0.91 to 5.75)
Worsening symptoms[c]				
Physical impairment	1.0 (ref)	1.46 (0.82 to 2.58)	1.21 (0.65 to 2.27)	0.60 (0.18 to 1.96)
Cognitive impairment	1.0 (ref)	0.84 (0.43 to 1.64)	0.94 (0.46 to 1.92)	2.12 (0.81 to 5.58)
Pain interference	1.0 (ref)	2.16* (1.16 to 4.00)	2.09* (1.06 to 4.12)	1.96 (0.70 to 5.50)
Depression	1.0 (ref)	0.91 (0.43 to 1.91)	0.88 (0.36 to 2.15)	0.62 (0.13 to 2.92)
Anxiety	1.0 (ref)	1.28 (0.60 to 2.73)	0.92 (0.40 to 2.14)	1.69 (0.51 to 5.61)
Fatigue	1.0 (ref)	1.17 (0.62 to 2.23)	1.34 (0.70 to 2.23)	1.03 (0.34 to 3.13)
Nausea and vomiting	1.0 (ref)	1.30 (0.71 to 2.38)	1.50 (0.77 to 2.89)	1.51 (0.49 to 4.70)
Improving symptoms[c]				
Physical impairment	1.0 (ref)	1.11 (0.59 to 2.10)	1.09 (0.49 to 2.41)	0.76 (0.23 to 2.54)
Cognitive impairment	1.0 (ref)	1.61 (0.72 to 3.60)	1.01 (0.40 to 2.53)	1.17 (0.27 to 5.13)
Pain interference	1.0 (ref)	2.49** (1.38 to 4.50)	1.83 (0.93 to 3.62)	0.98 (0.35 to 2.75)
Depression	1.0 (ref)	1.09 (0.49 to 2.45)	2.16 (0.99 to 4.72)	0.37 (0.05 to 2.89)
Anxiety	1.0 (ref)	1.48 (0.83 to 2.66)	1.19 (0.59 to 2.37)	0.94 (0.32 to 2.76)
Fatigue	1.0 (ref)	1.37 (0.60 to 3.16)	2.11 (0.86 to 5.16)	1.74 (0.41 to 7.49)
Nausea and vomiting	1.0 (ref)	0.94 (0.44 to 2.05)	1.45 (0.69 to 3.04)	0.76 (0.13 to 4.28)
Urgent care within 30 days from PROMIS assessment[d]	1.0 (ref)	1.92* (1.04 to 3.61)	1.11 (0.49 to 2.39)	4.82*** (2.25 to 10.03)
Urgent care with admission[d]	1.0 (ref)	1.62 (0.76 to 3.55)	1.10 (0.41 to 2.74)	3.42* (1.19 to 8.80)

Abbreviations: H/L, Hispanic/Latinx; NHA, non-Hispanic Asian; NHW, non-Hispanic White; OTH, other racial/ethnic groups; PROMIS, Patient-Reported Outcomes Measurement Information System; ref, reference group.

[a]Differences across the racial/ethnic groups were tested using the chi-square test.

[b]Other primary cancers include peritoneal carcinomatosis, multiple myeloma, and acute myeloblastic leukemia.

[c]Generalized estimating equations with a sandwich variance estimator, binomial family, logit link function, and an exchangeable correlation matrix, adjusted for visit number (categorical). Effect size was presented as odds ratio.

[d]Poisson regression, with person-days as the offset variable. Effect size was presented as rate ratio.

*P < .05, **P < .01, ***P < .001.

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TABLE 4. Comparison of Implementation Science Outcomes by Race/Ethnicity

Variables	NHW (n = 106)	H/L (n = 77)	NHA (n = 51)	OTH (n = 16)	*P*
No. of visits					>.05[a]
Total	223	184	122	35	
Median per patient (Q1, Q3)	2 (1, 3)	2 (2, 3)	2 (2, 3)	2 (1.75, 3)	
PROMIS duration (in minutes)					<.05[b]
Median per visit (Q1, Q3)	6 (5, 7)	8 (6, 12)	7 (5, 9)	7 (6, 11.25)	
Satisfaction with pharmacist's education, No. (%)					<.05 (NHW *v* OTH only)[c]
Very satisfied	170 (80.2)	122 (71.8)	90 (78.3)	19 (59.4)	
Satisfied	41 (19.3)	48 (28.2)	24 (20.9)	12 (37.5)	
Dissatisfied	1 (0.5)	0 (0.0)	0 (0.0)	1 (3.1)	
Very dissatisfied	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	

Abbreviations: H/L, Hispanic/Latinx; NHA, non-Hispanic Asian; NHW, non-Hispanic White; OR, odds rartio; OTH, other racial/ethnic groups; PROMIS, Patient-Reported Outcomes Measurement Information System; Q1, quartile 1; Q3, quartile 3.

[a]Poisson regression. There is no statistically significant difference when comparing the number of completed visits per patient of H/L ($P = .201$), NHA ($P = .254$), and OTH ($P = .830$) against NHW.

[b]Linear mixed modeling, adjusted for visit number (categorical) with random intercepts for individual participants. On average, compared with NHW, H/L, NHA, and OTH groups, respectively, spent 2.2 minutes (95% CI, 1.0 to 3.4, $P < .001$), 1.7 minutes (95% CI, 0.3 to 3.0, $P = .016$), and 2.7 minutes (95% CI, 0.5 to 4.8, $P = .017$) longer to complete the PROMIS tool.

[c]Generalized estimating equations with a sandwich variance estimator, binomial family, logit link function, and an exchangeable correlation matrix, adjusted for visit number (categorical). OTH participants were less likely to rate pharmacist's education as very satisfied compared with NHW participants (OR, 0.37 [95% CI, 0.14 to 0.98]; $P = .045$). No statistically significant association was observed for H/L ($P = .203$) or NHA ($P = .584$) participants when compared with NHW participants.

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TABLE 5. Association of Mild to Severe Pain Interference and Nausea and Vomiting Among Racial/Ethnic Minorities Compared With Non-Hispanic White Participants, Analyzed Cross-Sectionally From Visit 1 to 3 With Logistic Regression

Variables	Visit 1 (N = 250)	Visit 2 (n = 193)	Visit 3 (n = 89)
Race/ethnicity, No. (%)			
NHW	106 (42.4)	77 (39.9)	31 (34.8)
H/L	77 (30.8)	63 (32.6)	30 (33.7)
NHA	51 (20.4)	41 (21.2)	22 (24.7)
OTH	16 (6.4)	12 (6.2)	6 (6.7)

Cross-Sectional Logistic Regression

Outcomes	OR (95% CI)	OR (95% CI)	OR (95% CI)
Mild to severe pain interference			
Race/ethnicity			
NHW	1.0 (ref)	1.0 (ref)	1.0 (ref)
H/L	2.28** (1.25 to 4.20)	2.09* (1.06 to 4.19)	1.21 (0.43 to 3.40)
NHA	1.41 (0.71 to 2.79)	1.87 (0.86 to 4.07)	1.32 (0.43 to 4.03)
OTH	2.98* (1.03 to 9.37)	3.92* (1.13 to 15.84)	1.58 (0.26 to 9.84)
Mild to severe nausea and vomiting			
Race/ethnicity			
NHW	1.0 (ref)	1.0 (ref)	1.0 (ref)
H/L	2.73** (1.30 to 5.89)	1.71 (0.86 to 3.44)	1.39 (0.51 to 3.85)
NHA	1.41 (0.55 to 3.47)	1.63 (0.74 to 3.56)	0.84 (0.27 to 2.54)
OTH	2.19 (0.55 to 7.35)	2.08 (0.60 to 7.29)	2.43 (0.41 to 19.44)

Abbreviations: H/L, Hispanic/Latinx; NHA, non-Hispanic Asian; NHW, non-Hispanic White; OTH, other racial/ethnic groups; OR, odds ratio; ref, reference group.

*$P < .05$, **$P < .01$.

CI, 1.13 to 3.30]; $P = .017$) and pain (OR, 1.79 [95% CI, 1.03 to 3.13]; $P = .041$) in H/L participants (Appendix Fig A2).

Across the four race/ethnicity groups, the number of completed pharmacist visits did not differ (median = 2 visits for all groups, $P > .05$ for all comparisons). Although we observed little to no dissatisfied or very dissatisfied responses across groups (Table 4), OTH participants were less likely to rate pharmacist's education as very satisfied compared with NHW participants (OR, 0.37 [95% CI, 0.14 to 0.98]; $P = .045$). No association was observed for H/L ($P = .203$) or NHA ($P = .584$) compared with NHW participants.

DISCUSSION

This is one of few studies that has implemented on-site ePRO-driven symptom management in an infusion center heavily serving REM patients. Our approach is innovative as we shift the current practice paradigm by elucidating allied health professionals' role in personalizing care by leveraging ePRO. Coupled with real-time assessments, availability of translated tools, and oncology pharmacists' interventions, assessing ePRO provided opportunities to intervene for various symptoms. Our multilevel approach was found to be satisfactory, and the length of assessments was acceptable. The majority of the unplanned hospitalization and urgent care visits were infection-related, which are unlikely to be preventable through ePRO assessments. By inviting all newly diagnosed patients at the infusion center to participate, we were able to enroll a sample that mimics the racial/ethnic distribution of our catchment area. Our analysis of ePRO assessment among different REM provides information on how to enhance ePRO-guided clinical care within a majority-minority population.

There are several implications of our findings. First, although it is well known that treatment could lead to worsening of symptoms, it is also possible that patients' symptoms may be inadequately managed before receiving treatment. In both cases, our program facilitated uncovering clinically significant symptoms that necessitated timely interventions by assessing physical and psychological symptoms commonly observed in patients receiving anticancer therapies. Furthermore, other treatment-related toxicities (ie, neuropathy, constipation, diarrhea) that were not preconfigured within our ePRO were also intervened as appropriate. Second, our program facilitated pharmacist-patient discussions to mutually agree on whether stable patients could be discharged from further ePRO assessments. This allowed pharmacists to prioritize care of patients who were having inadequate symptom control, preventing a higher patient load. Although innovative, our approach requires further refinement, including investigation into whether participants discharged early from our study may benefit from assessments for future symptoms.

Our intervention builds on the scientific framework backed by the National Institute on Minority Health and Health Disparities,[17] which advocates for a multidomain and multilevel approach to address health disparity. On the individual level, the incorporation of ePRO facilitated patients' active reporting of symptoms and hence symptom identification, allowing pharmacists to address variations in health-seeking behaviors. Similarly, the avail of translated tools reduced language barriers. On the interpersonal level, the use of ePRO improved pharmacist-patient communication, enhancing relevance and person-centricity,[18] in agreement with previous findings.[19-21] The potential of ePRO to facilitate patient-centered care is essential, considering that REM are routinely experiencing poorer quality person-centered care.[22,23] This adds to the findings suggesting that the incorporation of an ePRO tool can improve early identification of symptoms and thus address health issues among REM diagnosed with cancer.

Our implementation approach has also potentially addressed health disparity issues in several ways. First, our sample's racial/ethnic distribution matched the distribution of the county in which the study took place. Second, our approach was accepted by our participants, as evidenced by patients' willingness to continue with our study throughout multiple visits at a comparable rate across racial/ethnic groups. Moreover, our results show that REM patients were more likely to report certain symptoms compared with NHW, highlighting potential disparities in symptom severity and management. In response, pharmacists provided interventions at a greater propensity for REM patients. Although we were unable to evaluate the direct impact of ePRO assessments on unplanned urgent care utilization and hospitalization due to our study design, we observed that the majority of unplanned medical care were linked to acute infections, and as such would not be preventable with ePRO assessments alone. Relatedly, REM were more likely to receive urgent care compared with NHW despite being monitored using ePRO assessments. Moving forward, it is important to consider additional strategies, such as the use of navigation[24] or remote monitoring,[25] on top of on-site symptom assessments to identify REM patients at high risk of adverse events.

Although integration of ePRO in routine care seems promising, there are several foreseeable challenges. First, patients' and providers' perceptions of the process must be considered. As such, we evaluated process indicators (ie, acceptability of the tools and sessions). Relatedly, with near-identical t-scores obtained with PROMIS short forms and CAT, we chose to use CAT to reduce time burden for patients.[26] Likewise, we are currently evaluating provider burden in a qualitative study. Second, as our ePRO tools were only available to patients while at the infusion center, pharmacists manually documented results into EHR. We hope that, in the future, ePRO tools can be integrated into the EHR and patients can complete the instrument before their appointment. Finally, we observed that REM required additional time to complete the ePRO. Unfortunately, we did

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not capture technological and health literacy levels; future studies should evaluate whether ePRO is tailored adequately for populations with poorer health literacy.

In conclusion, we have successfully developed and implemented a multilevel ePRO-driven intervention that allows oncology pharmacists to intervene on patients' symptoms. In the process, we found a higher prevalence of symptoms and urgent care visits during anticancer treatment among REM compared with NHW participants. Future studies should evaluate whether such monitoring systems can prevent morbidity and mortality in REM, as well as reduce unwanted health care utilization.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Electronic Patient-Reported Outcome-Driven Symptom Management by Oncology Pharmacists in a Majority-Minority Population: An Implementation Study

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APPENDIX

TABLE A1. Implementation Science Outcomes Defined Following the RE-AIM Framework

RE-AIM Dimensions	Explanation	Outcomes
Reach	Concerns the characteristics of the patients who are willing to participate in the program (patients' completion of the ePRO tool and clinicians' intervening on them), as well as reasons (why or why not) patients would participate	Participation rate Documented reasons for not participating in the study Comparing characteristics between participants and nonparticipants Comparing distribution of race/ethnicity of participants with catchment area demographics
Effectiveness	Concerns the impact of the program on patients at the individual and broader level (includes quality of life and economic outcomes, among others), including potential negative effects	Participants' satisfaction regarding the pharmacists' counseling Interventions completed by pharmacists Counts and proportions of worsened and improved symptoms
Adoption	Concerns intervention agents (people who deliver the program) who are willing to administer ePRO and intervene on the scores, and why or why not	Characteristics of pharmacists who administered the program
Implementation	Concerns the fidelity to the various elements of functions or components of the program, including consistency of delivery as intended, time, and cost of the implementation. Includes adaptations made to interventions and implementation	Time taken to complete the ePRO tool Participants' acceptability of the length of the ePRO tool Rate of completing all seven symptom domains across all visits Rate of urgent care utilization within 30 days of visit
Maintenance	Concerns the extent to which the program becomes institutionalized or part of the routine clinical practices. Includes perceived long-term effects of the program on outcomes (eg, in patient care)	Participants' acceptability of the frequency of completing the ePRO tool

Abbreviation: ePRO, electronic patient-reported outcome.

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TABLE A2. Effectiveness Outcomes Stratified by PROMIS Visits and Compared Across Racial/Ethnic Backgrounds

	Within V1 and V2	Within V3, V4, and V5
Outcome	Ratio (95% CI)	Ratio (95% CI)
Worsened pain interference[a]		
NHW	Reference	Reference
H/L	2.96* (1.26 to 6.97)	1.21 (0.40 to 3.64)
Non-Hispanic Asian	2.77* (1.08 to 7.14)	1.18 (0.37 to 3.79)
Others	3.35 (0.85 to 13.21)	0.79 (0.11 to 5.49)
Improved pain interference[a]		
NHW	Reference	Reference
H/L	2.65* (1.15 to 6.12)	2.07 (0.81 to 5.27)
Non-Hispanic Asian	1.94 (0.74 to 5.04)	1.74 (0.65 to 4.68)
Others	(no improvement observed)	2.95 (0.74 to 11.74)
Urgent care within 30 days from PROMIS assessment[b]		
NHW	Reference	Reference
H/L	2.50* (1.25 to 5.23)	0.96 (0.23 to 4.06)
Non-Hispanic Asian	1.55 (0.63 to 3.67)	1.39 (0.33 to 5.89)
Others	7.27*** (3.23 to 16.37)	4.09 (0.81 to 18.57)
Urgent care with admission[b]		
NHW	Reference	Reference
H/L	2.22 (0.97 to 5.33)	0.96 (0.18 to 5.18)
Non-Hispanic Asian	1.38 (0.46 to 3.83)	1.39 (0.26 to 7.52)
Others	4.85*** (1.63 to 13.45)	(no admissions recorded)

Abbreviations: H/L, Hispanic/Latinx; NHW, non-Hispanic White; PROMIS, Patient-Reported Outcomes Measurement Information System.
[a]Generalized estimating equations with a sandwich variance estimator, binomial family, logit link function, and an exchangeable correlation matrix, adjusted for visit number (categorical). Effect size was presented as odds ratio.
[b]Poisson regression, with person-days as the offset variable. Effect size was presented as rate ratio.
*P < .05, **P < .01, ***P < .001.

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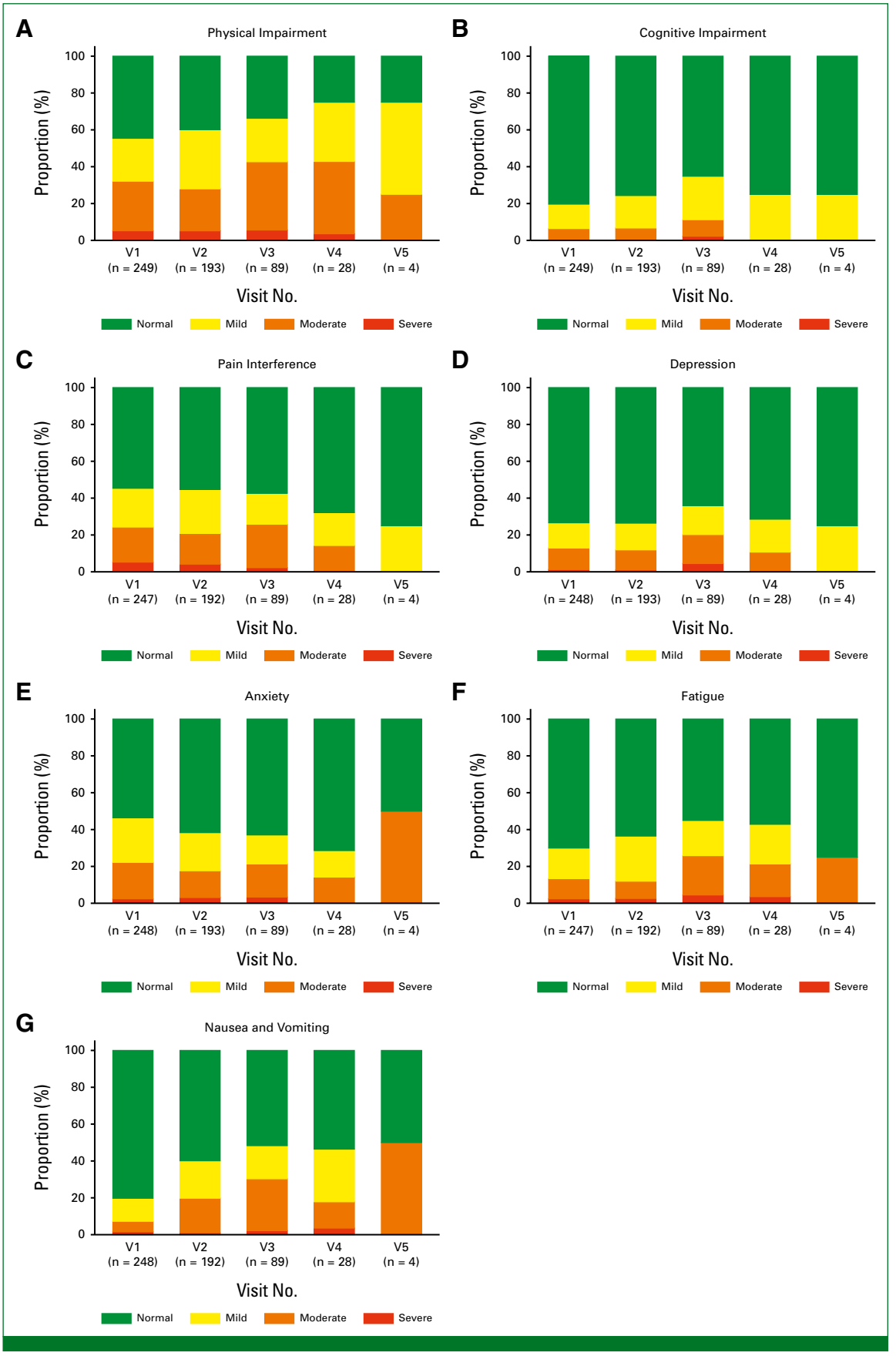

FIG A1. Symptom trajectories as captured by the PROMIS tool from visit 1 to 5 (V1-V5). PROMIS, Patient-Reported Outcomes Measurement Information System.

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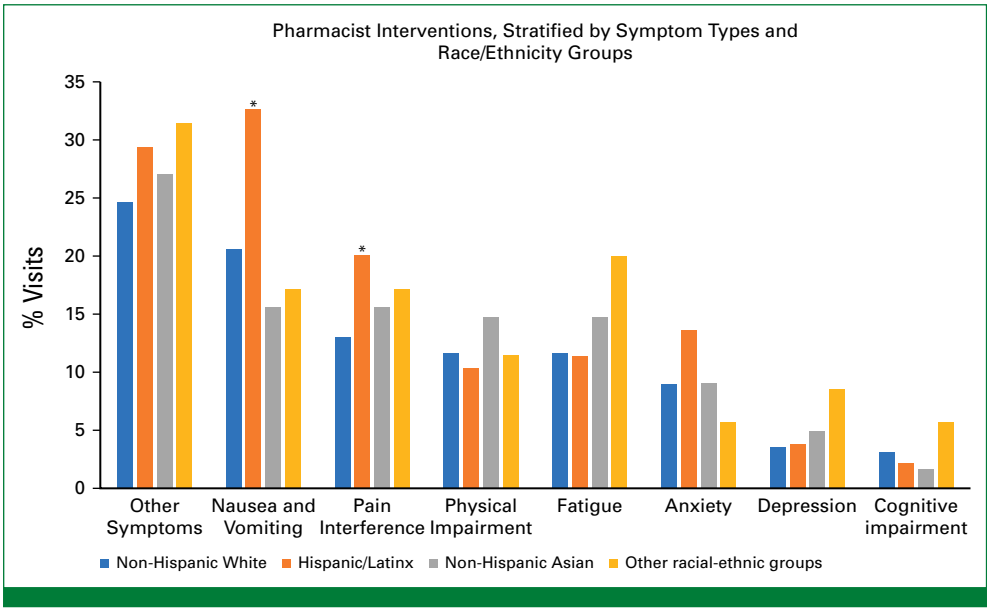

FIG A2. The proportion of visits intervened by pharmacists, stratified by symptom types and race/ethnicity groups. *P* values were calculated by testing for differences in the proportions across race/ethnicity groups (non-Hispanic White being the reference) using generalized estimating equations with a sandwich variance estimator, binomial family, logit link function, and an exchangeable correlation matrix, adjusted for visit number (categorical). *$P < .05$.

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