VOLUME 33 · NUMBER 13 · MAY 1 2015

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

Evaluation of a Pharmacist-Led Medication Assessment Used to Identify Prevalence of and Associations With Polypharmacy and Potentially Inappropriate Medication Use Among Ambulatory Senior Adults With Cancer

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Published online ahead of print at www.jco.org on March 23, 2015.

Supported by an American Association of Colleges of Pharmacy 2013 New Investigator Award Grant (G.N., principal investigator and award recipient).

The sponsor did not play any role in the design or conduct of the study including data collection, management, analysis, interpretation of the data or preparation, review, or approval of the manuscript.

Authors' disclosures of potential conflicts of interest are found in the article online at www.jco.org. Author contributions are found at the end of this article.

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0732-183X/15/3313w-1453w/$20.00

DOI: 10.1200/JCO.2014.58.7550

ABSTRACT

Purpose
The use of multiple and/or inappropriate medications in seniors is a significant public health problem, and cancer treatment escalates its prevalence and complexity. Existing studies are limited by patient self-report and medical record extraction compared with a pharmacist-led comprehensive medication assessment.

Patients and Methods
We retrospectively examined medication use in ambulatory senior adults with cancer to determine the prevalence of polypharmacy (PP) and potentially inappropriate medication (PIM) use and associated factors. PP was defined as concurrent use of five or more and less than 10 medications, and excessive polypharmacy (EPP) was defined as 10 or more medications. PIMs were categorized by 2012 Beers Criteria, Screening Tool of Older Person's Prescriptions (STOPP), and the Healthcare Effectiveness Data and Information Set (HEDIS).

Results
A total of 248 patients received a geriatric oncology assessment between January 2011 and June 2013 (mean age was 79.9 years, 64% were women, 74% were white, and 87% had solid tumors). Only 234 patients (evaluated by pharmacists) were included in the final analysis. Mean number of medications used was 9.23. The prevalence of PP, EPP, and PIM use was 41% (n = 96), 43% (n = 101), and 51% (n = 119), respectively. 2012 Beers, STOPP, and HEDIS criteria classified 173 occurrences of PIMs, which were present in 40%, 38%, and 21% of patients, respectively. Associations with PIM use were PP ($P < .001$) and increased comorbidities ($P = .005$).

Conclusion
A pharmacist-led comprehensive medication assessment demonstrated a high prevalence of PP, EPP, and PIM use. Medication assessments that integrate both 2012 Beers and STOPP criteria and consider cancer diagnosis, prognosis, and cancer-related therapy are needed to optimize medication use in this population.

J Clin Oncol 33:1453-1459. © 2015 by American Society of Clinical Oncology

INTRODUCTION

The American Cancer Society estimates that by the year 2030, 70% of all cancers in United States will be diagnosed in senior adults.[1] The multiple layers of specialists (ie, oncologists, radiation oncologists, surgeons, geriatricians), primary care, and allied health professionals in the continuum of care makes this population a challenge to manage. Older adults with cancer are particularly prone to medication errors attributed to medication changes, complex regimens, and incomplete information handoff between providers.[2,3] Polypharmacy (PP) and potentially inappropriate medication (PIM) use warrant substantial interest and concern on behalf of medical oncologists and oncology health providers because of the perils associated with their use in this vulnerable population; vulnerabilities include increased risk of falls and/or fractures, cognitive impairment, and delirium, all of which can lead to compromised cancer management plans (eg, treatment delays and/or premature treatment discontinuation). Cancer-related therapy adds to the prevalence of the use of multiple medications and/or the consumption of inappropriate medications because new medications escalate their prevalence and

Table 1. Patient Demographic and Clinical Characteristics

Characteristic	No.	%
Age, years		
Mean	79.91	
SD	6.84	
Range	61-98	
Age range, years		
60-69	16	6
70-79	91	37
80-89	122	49
90-99	19	8
Sex		
Female	159	64
Male	89	36
Race/ethnicity		
White	184	74.2
African American	48	19.4
Asian	9	3.6
Hispanic	6	2.4
Other	1	0.4
Cancer type		
Solid malignancies		
Colorectal	46	19
Breast	45	18
Lung*	39	16
Urinary tract (bladder, renal, urethral, urothelial)	18	7.3
Upper GI (pancreatic, bile duct, gall bladder)	15	6
Esophageal	9	3.6
Neuroendocrine	8	3.2
Gastric	7	2.8
Prostate	7	2.8
Sarcoma	6	2.4
Head and neck*	5	2
Gynecologic	5	2
Duodenal	2	0.8
Melanoma/skin cancer	2	0.8
Unknown primary	2	0.8
Mesothelioma	1	0.4
Hematologic malignancies		
Lymphoma	13	5.2
Myeloma	8	3.2
Leukemia	5	2
Myelodysplastic syndrome	2	0.8
Other		
Polycythemia vera	2	0.8
Amyloidosis	1	0.4
Waldenström macroglobulinemia	1	0.4
Cancer stage		
0	4	1.6
I	31	12.5
II	59	23.8
III	46	18.6
IV	65	2.6
Unknown	1	0.4
Recurrence		
Local	5	2
Metastatic	29	11.7
Staging not applicable	8	3.2
Functionality status†		
Fit	57	23.3
Vulnerable	120	49
Frail	68	27.8
Comorbidity count		
Mean	7.69	
SD	3.47	
ECOG performance score (n = 247)		
0	71	29
1	108	44
2	58	23
3	9	4
4	1	0.4

Abbreviations: ECOG, Eastern Cooperative Oncology Group; SD, standard deviation.
*Dual primary (lung and head and neck) malignancy.
†Functionality status (n = 245).

complexity, which consequently increases the risk for adverse drug effects, drug-drug interactions, and nonadherence as a result of increased pill burden and regimen complexity.[4-8] Increased pill burden increases the risk of drug-drug, drug-food, and drug-herbal interactions, and medical oncologists may not know how to manage such issues.

A comprehensive medication review is considered to be an integral part of the geriatric oncology assessment.[9,10] Extermann et al[9] and the National Comprehensive Cancer Network Older Adult Oncology Guidelines[10] both recommend a comprehensive medication assessment, which includes a thorough a review of patients' medications with subsequent discontinuation of any nonessential medications and evaluation for drug interactions, adverse effects, and patient adherence; however, such guidelines do not state which health care professional should be performing the medication assessment. Existing studies that report on the prevalence of PP and PIM use, specifically in ambulatory senior adults with cancer, report the prevalence of PP as 48% to 80% and PIM use as 8% to 41%. These studies are scarce and are limited by antiquated criteria and/or screening tools for defining PP and PIM use, and excessive polypharmacy (EPP) has never been examined.[11-14] In addition, the methodologies used in previous studies were flawed by the inherent pitfalls in measuring medication use by using patient self-reports and medical records extraction compared with using a pharmacist-led comprehensive medication assessment, which should be recognized as a best practice benchmark. On that basis, we designed this study to examine the prevalence of PP, EPP, and PIM use and factors influencing their use on the basis of a pharmacist-led comprehensive medication assessment in ambulatory senior adults with cancer at our institution.

PATIENTS AND METHODS

This protocol was approved by the institutional review board at our institution before initiation. This was a retrospective study (data were collected from physicians' and clinical pharmacists' electronic progress notes documented in the electronic medical record). All patients who received an initial geriatric oncology assessment at our senior adult oncology ambulatory center between January 2011 and June 2013 and had a diagnosis of cancer (all cancer types and all cancer stages) were included in the study. Our center is an outpatient ambulatory center that provides half-day services (5 hours) twice per week at two sites within the health care system. The core Older Adult Oncology

multidisciplinary team consisted of a medical oncologist, geriatrician, patient navigator, clinical pharmacist, social worker, and a registered dietician.

As a standard of care at our center, patients were instructed to bring in all medications (prescription, nonprescription, herbals, and supplements) for the pharmacist-patient session. During the session, the pharmacist evaluated each medication with the patient and/or caregiver to confirm medication possession and/or self-administration, indication, and adverse effects; in addition, the pharmacist assessed the patient's ability to read medication label directions and to manage medications in an organized manner. The pharmacist provided medication-related education, addressed medication-related problems with the patient and the interdisciplinary health care team, updated the medication record, and documented a progress note in the electronic medical record. The pharmacist's medication-related recommendations (eg, discontinuation of unnecessary and/or inappropriate medications, recommendation of alternatives) were part of the comprehensive assessment and were forwarded to the primary oncologist and/or medical provider for evaluation and follow-up. PP was defined as concurrent use of five or more and less than 10 medications, and EPP was defined as concurrent use of 10 or more medications, including prescription, nonprescription, herbal, and supplement medications.[15-18]

PIM use was categorized on the basis of three screening tools, including the 2012 Beers criteria, the Screening Tool of Older Person's Prescriptions (STOPP) criteria, and the Healthcare Effectiveness Data and Information Set (HEDIS) criteria for drugs to avoid in the elderly.[19-23] These three screening tools were used in this study because they represent the most current, evidence-based, clinically validated criteria in the literature. There is no head-to-head trial that recommends the use of one screening tool over another, so each of these tools is considered a viable option for use in clinical practice. The 2012 Beers criteria is the screening tool used in clinical practice in the United States and is supported and endorsed by the American Geriatrics Society. The STOPP criteria is a European screening tool developed on the basis of expert consensus and evidence-based criteria, and it incorporates commonly encountered instances of potentially inappropriate prescribing in senior adults, and it includes drug-drug and drug-disease interactions, drugs that adversely affect seniors at risk of falls, and duplicate drug class prescriptions. HEDIS is a health care quality measure used in the United States that was created by the National Committee on Quality Assurance to examine the quality of prescribing for older patients. The American Geriatrics Society stated that the STOPP criteria should be used in a complementary manner with 2012 Beers criteria to guide clinicians in making decisions about safe medication use in senior adults, largely because there are some notable differences between these screening tools.

Demographic and clinical patient information was collected from medical records and included age, sex, race, cancer type and cancer stage, comorbidities (number and type), and Eastern Cooperative Oncology Group (ECOG) performance status[24] and functional status by using stages of aging described as fit, vulnerable, or frail as determined by the geriatrician. Balducci et al[25] defined "fit" patients as those who lacked serious comorbidity and were functionally independent without evidence of geriatric syndromes. "Vulnerable" patients were dependent in one or more instrumental activities of daily living and had several more significant comorbid conditions. "Frail" patients were dependent in activities of daily living, had evidence of geriatric syndromes, and had significant comorbidities. PP and PIM factors that influenced or were associated with age, sex, PP, comorbidities, ECOG performance status, and functional status were analyzed. Descriptive statistics were calculated by using Fisher's exact test, Pearson's χ^2 test for categorical variables, Wilcoxon's test for continuous variables, and the Kruskal-Wallis test for assessments between groups.

RESULTS

Data were collected from 248 consecutive patients who received an initial geriatric oncology assessment at our institution between January 2011 and June 2013. The mean age was 80 years, 159 patients (64%) were women, and the mean number of comorbidities was 7.69 (excluding primary cancer). Two hundred sixteen patients (87%) had solid tumors, and 32 patients (13%) had hematologic malignancies. A majority with solid tumors had advanced-stage or metastatic disease. Table 1 displays the distribution of patients' baseline characteristics and Table 2 identifies patient characteristics by comorbidity type. Of the 248 patients evaluated at our center, 234 (94%) were seen by a clinical pharmacist for a comprehensive medication assessment and were included in the final analysis (the remaining 14 patients were evaluated on days on which pharmacist coverage was not readily available). Evaluation of the 234 patients by a clinical pharmacist

Table 2. Prevalence of Comorbidities by Disease Status (n = 248)

Comorbidity	No.	%
Cardiovascular	230	92.7
Hypertension	187	75.4
Dyslipidemia	147	59.3
Arrhythmias	58	23.4
Congestive heart failure	51	20.6
Coronary artery disease	43	17.3
Stroke	40	16.1
Venous thromboembolism	26	10.5
Ischemic heart disease	12	4.8
Endocrine	117	47.2
Diabetes	77	31.1
Thyroid disease	62	25
Respiratory	88	35.5
Chronic obstructive pulmonary disease	56	22.6
Asthma	18	7.3
GI	108	43.6
Gastroesophageal reflux	68	27.4
Constipation/diarrhea	36	14.5
Peptic ulcer	21	8.5
Irritable bowel syndrome	12	4.8
Renal	43	17.3
Chronic kidney disease	33	13.3
Electrolyte disorders	4	1.6
Neurologic	89	35.9
Pain management	63	25.4
Alzheimer's disease	25	10.1
Epilepsy	5	2
Headache	4	1.6
Psychiatric	91	36.7
Anxiety	58	23.4
Depression	54	21.8
Sleep disorder	15	6.1
Schizophrenia	4	1.6
Urologic	68	27.42
Benign prostatic hypertrophy	32	12.9
Urinary incontinence	42	16.94
Rheumatologic	162	65.32
Osteoarthritis	127	51.2
Osteoporosis	61	24.6
Gout	15	6.1
Rheumatoid arthritis	4	1.6
Ophthalmic	68	27.4
Cataract	68	27.4
Glaucoma	28	11.3
Macular degeneration	13	5.2
Hematologic	82	33.1
Anemia	82	33.1

Table 3. Prevalence of Prescription Medications by Pharmacologic Category (n = 234)

Pharmacologic Category	Prescription Medication	No.	%
Cardiovascular	Alpha-adrenergic agonists/antagonists, antiarrhythmics, beta-adrenergic antagonist, calcium channel antagonists, digoxin, renin-angiotensin aldosterone antagonists, vasodilators	180	76.9
Dislipidemics	Statins, ezetimibe, niacin, fenofibrate, colesevelam	124	53
GI	Antiemetics, antispasmodics, constipation/diarrhea, histamine-2 antagonist, protectants, irritable bowel syndrome, proton pump inhibitors	96	41
Diuretic		94	40.2
Endocrine	Antidiabetic oral/injectable, thyroid replacement, antithyroid agents	87	37.2
Analgesic	Nonsteroidal anti-inflammatory drugs, opioids/nonopioids, neuropathic pain drugs, topical anesthetics	69	29.5
Antiplatelet/anticoagulant		53	22.7
Neuropsychiatric	Antidepressants, anti-Parkinson agents, antipsychotics, anticonvulsants	51	21.8
Vitamin/minerals		45	19.2
Pulmonary/respiratory	Inhalers, oral tablets	44	18.8
Genitourinary		40	17.1
Benzodiazepine/barbiturate		39	16.7
Ophthalmic		31	13.2
Antimicrobial	Antibacterials, antifungals, antivirals	22	9.4
Bone health	Bishphosphonates (oral), parathyroid hormone analog, calcium, vitamin D agent	20	8.6
Glucocorticoid		17	7.3
Gout		11	4.7
Sedative hypnotic		10	4.3
Hormonal	Hormonal estrogens, androgens	8	3.4
Dermatologic topicals		5	2.1
Anti-neoplastic	Oral antineoplastics including conventional, targeted agents	4	1.7
Central nervous system stimulant		1	0.4
Otic		1	0.4

showed that they took 2,163 total medications, 1,430 prescription medications, 647 nonprescription medications, and 86 herbal medications. The mean number of medications used by patients was 9.23 (standard deviation [SD], 4.79; range, 1 to 30 medications). The medications were as follows: 6.1 prescription medications (SD, 3.58; range, 0 to 20 prescription medications), 2.76 nonprescription medications (SD, 2.11; range, 0 to 10 nonprescription medications), and 0.38 herbal medications (SD, 0.88; range, 0 to 10 herbal medications;). The prevalence of PP, EPP, and PIM use was 41%, 43%, and 51%, respectively. Table 3 shows that the most common prescription medications were drugs that act on the cardiovascular system at a prevalence of 77%, dyslipidemics at 53%, GI medications at 41%, diuretic medications at 40%, and endocrine-related medications at 37%. Appendix Table A1 (online only) lists comorbidity types associated with PP category.

2012 Beers, STOPP, and HEDIS criteria classified 173 occurrences of PIMs present in 40% (n = 94), 38% (n = 88), and 21% (n = 49) of patients, respectively. BEERs and STOPP criteria were most inclusive, each detecting 118 occurrences, and HEDIS detected 58 occurrences (of 173 occurrences). Mutual overlap between Beers and STOPP criteria occurred in 38% of PIM use (66 of 173 occurrences). The mean number of inappropriate medications used by patients was 0.74 (SD, 0.89; range, 0 to 4 inappropriate medications). The proportion of study participants who were prescribed 0, 1, 2, 3, and 4 PIMs was 49%, 34%, 12%, 4%, and 1%, respectively. The most prevalent PIMs are listed in Table 4 and include benzodiazepines (16%), GI medications (9.4%), nonsteroidal anti-inflammatory drugs (8.5%), antiplatelet medications (8%), and first-generation antihistamines (6%). The most common medications detected by 2012 Beers (but not by STOPP) criteria were short- and intermediate-acting benzodiazepines and sedative hypnotics. The most common medications detected by STOPP (but not by 2012 Beers) criteria were antiplatelet medications (specifically, aspirin at doses above 150 mg per day), beta-blockers (noncardioselective beta-blocker with chronic obstructive pulmonary disease), and proton pump inhibitors (for peptic ulcers at the full therapeutic dose for more than 8 weeks). In Table 5, patient characteristics associated with PP were increased number of comorbidities, increased PIM use, reduced ECOG performance status at baseline, and reduced functional status at baseline. Patient characteristics associated with PIM use (v no PIMs) were PP ($P < .001$) and increased number of comorbidities ($P = .005$), as listed in Table 6. Specific comorbidities that were associated with PIM use were cardiovascular ($P = .014$), GI ($P = .013$), neurologic ($P = .020$), and psychiatric ($P < .001$) conditions, as summarized in Appendix Table A2 (online only). The rate of PIM use differs between PP categories, as illustrated in Appendix Figure A1 (online only). The mean number of PIMs used between no PP, PP, and EPP is 0.19, 0.6, and 1.07, respectively. The PIM use rate between no PP and PP is 6% versus 9% ($P < .001$).

DISCUSSION

In this cohort of senior adult oncology patients, a pharmacist-led medication assessment identified a high prevalence of PP, EPP, and PIM use compared with previously reported methodologies. Studies reporting on the prevalence of PP and PIM use, specifically in ambulatory older adults with cancer, are limited. Lichtman et al[11] published an abstract on PIM use in older patients with cancer in the outpatient setting. The investigation identified PIM use in 11% of patients on the

Table 4. Prevalence of PIMs by Pharmacologic Category (n = 234)

Pharmacologic Category	PIMs	No.	%
Benzodiazepine		38	16.2
GI	Antiemetics, anticholinergic/antispasmodics, constipation/diarrhea, proton pump inhibitors	22	9.4
Nonsteroidal anti-inflammatory drugs		20	8.6
Antiplatelet		19	8.1
Antihistamine		14	6
Beta-adrenergic antagonist		13	5.6
Sedative hypnotic		7	3
Neuropsychiatric	Antipsychotics	6	2.6
Cardiovascular	Antiarrhythmics, calcium channel antagonists	6	2.6
Endocrine	Long-acting sulfonylureas, sliding-scale insulin, dessicated thyroid	6	2.6
Diuretic	Hydrochlorothiazide	4	1.7
Hormonal	Conjugated estrogens, megesterol	4	1.7
Muscle relaxant		2	0.9
Antibiotic	Nitrofurantoin	1	0.4
Anticholinergic	Benztropine	1	0.4
CNS stimulant		1	0.4
Genitourinary	Oxybutinin	1	0.4

Abbreviation: PIM, potentially inappropriate medication.

basis of 2003 Beers criteria, and the median number of medications used was 8 (range, 0 to 23 medications). Maggiore et al[12] published an abstract on PP, PIM use, and chemotherapy-related adverse events among older adults with cancer. That study evaluated 500 patients with a mean age of 73 years, and the mean number of daily medications used was five. The prevalence of PP was 48% (239 of 500), and the prevalence of PIM use ranged from 11% (53 of 500) to 18% (89 of 500), depending on the tool used to classify PIM use (2003 Beers criteria

Table 5. Patient Characteristics Associated With PP (n = 234)

	No PP (< 5 medications) (n = 37)		Any PP (≥ 5 medications) (n = 197)			PP (≥ 5 and < 10 medications) (n = 96)		EPP (≥ 10 medications) (n = 101)		
Characteristic	No.	%	No.	%	*P*	No.	%	No.	%	*P*
Age, years					.491					.397
Mean	79.03		79.93			80.34		79.53		
SD	7.4		6.65			7.32		5.95		
Sex					.265					.986
Female	27	72.97	123	62.44		60	62.5	63	62.38	
Male	10	27.03	74	37.56		36	37.5	38	37.62	
Race/ethnicity					.861					.109
White	25	67.57	148	75.13		67	69.79	81	80.2	
African American	9	24.32	36	18.27		18	18.75	18	17.82	
Asian	2	5.41	7	3.55		6	6.25	1	0.99	
Hispanic	1	2.70	5	2.54		4	4.17	1	0.99	
Other	0	0.00	1	0.51		1	1.04	0	0	
Functional status (n = 232)					< .001					< .001
Fit	21	58.33	33	16.84		25	26.32	8	7.92	
Frail	3	8.33	60	30.61		22	23.16	38	37.62	
Vulnerable	12	33.33	103	52.55		48	50.53	55	54.46	
No. of comorbidities					< .001					< .001
Mean	4.59		8.60			7.21		9.93		
SD	2.19		3.40			2.86		3.36		
Median	5		8			6		6		
Range	1-10		2-21			2-15		3-21		
PIM use	7	18.92	112	56.85	< .001	42	43.75	70	69.31	< .001
ECOG performance status (n = 233)					.005					.048
0-1	34	91.89	136	69.39		73	76.04	63	63	
2-4	3	8.11	60	30.61		23	23.96	37	37	

Abbreviations: ECOG, Eastern Cooperative Oncology Group; EPP, excessive polypharmacy; PIM, potentially inappropriate medication; PP, polypharmacy; SD, standard deviation.

Table 6. Patient Characteristics Associated With PIM Use (n = 234)

Characteristic	No PIM (n = 115) No.	%	PIM (n = 119) No.	%	P
Age, years					.260
Mean	80.3		79.3		
SD	7.2		6.3		
Sex					.534
Female	76	66	74	62	
Male	39	34	45	38	
Race/ethnicity					.437
White	80	70	93	78	
African American	24	21	21	18	
Asian	6	5	3	3	
Hispanic	4	3	2	2	
Other	1	0.8	0		
Functional status (n = 232)					.094
Fit	33	29	21	17	
Frail	26	23	37	31	
Vulnerable	55	48	60	51	
PP					< .001
None	30	26.09	7	5.88	
PP	54	46.96	42	35.29	
EPP	31	26.96	70	58.82	
No. of comorbidities					.005
Mean	7.26		8.66		
SD	3.4		3.6		
Median	7		8		
Range	1-16		2-21		
ECOG performance status (n = 233)					.361
0-1	87	76	83	70	
2-4	28	24	35	30	

Abbreviations: ECOG, Eastern Cooperative Oncology Group; EPP, excessive polypharmacy; PIM, potentially inappropriate medication; PP, polypharmacy; SD, standard deviation.

or 2001 Zhan criteria). In 2013, Maggiore et al[14] published a modified abstract on PIM use and chemotherapy-related adverse events using the 2012 Beers criteria. The prevalence of PIM use ranged from 11% to 29%, depending on the tool used to classify PIM use (2001 Zhan criteria or 2012 Beers criteria). Prithviraj et al[13] evaluated patient characteristics associated with PP and inappropriate prescribing of medications among older adults with cancer, which included 117 patients with a mean age of 74.6 years. The mean number of daily medications was 7.3, the prevalence of PP was 80%, and the prevalence of PIM use was 41% (2003 Beers criteria). Finally, a study by Sokol et al[26] retrospectively evaluated medication use in senior adults with cancer (mean age, 79 years) at a large community oncology facility in an academic practice setting. Sokol et al identified a mean number of 9.1 medications used by patients in their cohort; however, the majority of patients were receiving concurrent chemotherapeutic agents. PIM use was not reported.

Our study shows a mean number of 9.2 medications used by the cohort, 41% prevalence of PP, and 43% prevalence of EPP, which is slightly higher than in previous publications. The reduced prevalence of PP reported by previous publications may be associated with the fact that previous investigations were based on antiquated criteria and/or screening tools for defining PP and PIM use in the elderly, and EPP was not defined or examined in any of these studies. The majority of these investigations assessed medications and medication use on the basis of usual care standards, defined as physician- or prescriber-directed medication assessments documented in medical records and/or medication databases compared with a pharmacist-directed comprehensive medication assessment, which may explain a higher prevalence of PP in our study compared with that in previous publications. Similarities between 2012 Beers and STOPP criteria include nonsteroidal anti-inflammatory drugs, tricyclic antidepressant medications, and long-acting benzodiazepine medications. Differences include items in the STOPP criteria such as the use of noncardioselective beta blockers in chronic obstructive pulmonary disease, the use of aspirin at dosages greater than 150 mg per day, and the use of proton pump inhibitors for treatment durations of greater than 8 weeks, which are not included in 2012 Beers criteria. The American Geriatrics Society highlights the notion that the STOPP criteria be used in a complementary manner with 2012 Beers criteria to guide clinicians in making decisions about safe medication use in senior adults. This recommendation is accurate and is reinforced by the fact that in our study, there was insufficient overlap between the 2012 Beers and STOPP criteria, because both tools combined mutually identified 66 (38%) occurrences of PIM use, further supporting the fact that use of both tools may be seen as complementary.

In this study, patient characteristics associated with PP (*v* no PP) were increased number of comorbidities ($P < .001$), increased PIM use ($P < .001$), reduced ECOG performance status at baseline ($P = .005$), and reduced functional status at baseline ($P < .001$). Prithviraj et al[13] found that patients who were taking five or more medications (compared with < 5 concurrent medications) were statistically significantly more likely to have poor functional status, have five or more comorbidities, and be prescribed a PIM per 2012 Beers criteria. The authors found an association between medication use and ECOG performance scores, with patients taking multiple medications more likely to have poorer performance status, which was also found in our study. Finally, our study found associations between PIM use (*v* no PIM use) and PP ($P < .001$) and increased number of comorbidities ($P = .005$), specifically cardiovascular, GI, neurologic, and psychiatric conditions.

To the best of our knowledge, our study is the first of its kind to incorporate a pharmacist-led comprehensive medication assessment using the most current, evidence-based, clinically validated criteria and screening tools to examine the prevalence of PP, EP, and PIM use in this complex population. Studies show that when pharmacists are involved in care transitions and take measures to decrease the prevalence of multiple medication use and medication-related problems, hospital readmission rates and preventable adverse drug events are reduced; however, these studies are mostly limited to the inpatient setting in the area of medication reconciliation and discharge programs.[3,27-33] Although these inpatient programs provide a robust framework, identifiable gaps exist because the literature does not focus on the ambulatory care setting or the oncology population. Integrating clinical pharmacy services in this multidisciplinary team may have the potential to optimize patient medication use and health outcomes by providing comprehensive medication assessment and planning (for both oncology and medicine issues), all before initiating cancer and/or supportive care treatment.

This study has some shortcomings that limit its clinical applicability to the larger population. This was a single-institution study with a small sample size compared with some previous studies. Medication use was assessed at a single (initial) visit in which most patients were

not receiving any anticancer treatments or cancer-related therapies. Medication use in this population changes continuously, especially for the patients who will begin anticancer and/or supportive care–related therapies, so follow-up data on acceptance of pharmacist interventions would strengthen study findings. Finally, patient outcomes associated with excessive and inappropriate medication use—increased use of health care resources (eg, hospitalizations) and adverse events that compromised cancer management plans—were not captured.

A pharmacist-led comprehensive Older Adult Oncology medication assessment demonstrated a high prevalence of PP, EPP, and PIM use versus previously reported methodologies. The prevalence of PIMs varied depending on the screening tool applied, yet the 2012 Beers criteria detected the highest prevalence of PIM use in this population. Because of the minimal overlap between 2012 Beers and STOPP criteria, a modified PIM tool that integrates 2012 Beers and STOPP criteria and considers cancer diagnosis, prognosis, and cancer-related therapy is needed to identify and minimize PIM use. Additional follow-up studies are needed to longitudinally evaluate medication use to identify associations with increased risk of adverse events that compromise cancer management plans and worsen patient outcomes in this complex and vulnerable population.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at www.jco.org.

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Conception and design: Ginah Nightingale, Emily Hajjar, Kristine Swartz, Andrew Chapman
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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Evaluation of a Pharmacist-Led Medication Assessment Used to Identify Prevalence of and Associations With Polypharmacy and Potentially Inappropriate Medication Use Among Ambulatory Senior Adults With Cancer

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or jco.ascopubs.org/site/ifc.

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No relationship to disclose

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Honoraria: Prime Therapeutics, Kaplan Medical
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Appendix

Table A1. Comorbidity Types Associated With PP Category (n = 234)

Comorbidity Type	No PP (< 5 medications) (n = 37)		Any PP (≥ 5 medications) (n = 197)			PP (≥ 5 and < 10 medications) (n = 96)		EPP (≥ 10 medications) (n = 101)		
	No.	%	No.	%	*P*	No.	%	No.	%	*P*
Cardiovascular	30	81.08	186	94.42	.012	86	89.6	100	99.0	.004
Endocrine	11	29.73	99	50.25	.030	41	42.7	58	57.4	.046
GI	8	21.62	97	49.24	.002	43	44.8	54	53.5	.255
Hematologic	9	24.32	69	35.03	.256	29	30.2	40	39.6	.181
Neurologic	6	16.22	77	36.09	.008	37	38.5	40	39.6	.885
Nutritional	7	18.92	29	14.72	.468	12	12.5	17	16.8	.427
Ophthalmologic	7	18.92	84	42.64	.006	35	36.5	49	48.5	.113
Psychiatric	12	32.43	76	38.58	.580	31	32.3	45	44.6	.081
Renal	3	8.11	40	20.30	.104	12	12.5	28	27.7	.008
Respiratory	5	13.51	79	40.10	.002	32	33.3	47	46.5	.081
Rheumatologic	21	56.76	125	63.45	.463	57	59.4	68	67.3	.300
Urologic	3	8.11	63	31.98	.002	26	27.1	37	36.6	.171

Abbreviations: EPP, excessive polypharmacy; PP, polypharmacy.

Table A2. Comorbidity Types Associated With PIM Use (n = 234)

Comorbidity Type	No PIM (n = 115)		PIM (n = 119)		
	No.	%	No.	%	*P*
Cardiovascular	101	87.8	115	96.6	.014
Endocrine	57	49.6	53	44.5	.513
GI	42	36.5	63	52.9	.013
Hematologic	42	36.5	36	30.3	.334
Neurologic	32	27.8	51	42.9	.020
Nutritional	22	19.1	14	11.8	.147
Ophthalmologic	48	41.7	43	36.1	.422
Psychiatric	29	25.2	59	49.6	< .001
Renal	22	19.1	21	17.7	.866
Respiratory	38	33.0	46	38.7	.414
Rheumatologic	72	62.6	74	62.2	1.000
Urologic	33	28.7	33	27.7	.886

Abbreviation: PIM, potentially inappropriate medication.

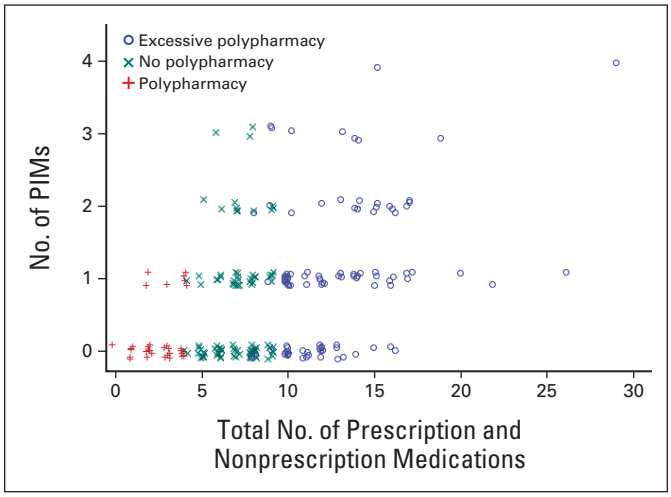

Fig A1. Rate of potentially inappropriate medication (PIM) use between polypharmacy categories.