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Geriatric emergency department revisits after discharge with Potentially Inappropriate Medications: A retrospective cohort study

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ABSTRACT

Objective: To determine whether Potentially Inappropriate Medications (PIMs) prescribed in an academic emergency department (ED) are associated with increased ED revisits in older adults.
Methods: A retrospective chart review of Medicare beneficiaries 65 years and older, discharged from an academic ED (January 2012 – November 2015) with any PIMs versus no PIMs. PIMs were defined using Category 1 of the 2015 Updated Beers criteria. Primary outcomes, obtained from a Medicare database linked to hospital ED subjects, were ED revisits 3 and 30 days from index ED discharge. Adjusted multiple logistic regression was used with entropy balance weighted covariates: Age in years, Gender, Race, Number of discharge medications, Charlson Comorbidity Index (CCI) score, Emergency Severity Index scores (ESI), Chief Complaint, Medicaid status, and prior 90 Day ED visits.
Results: Over the study period, there were a total of 7,591 Medicare beneficiaries 65+ discharged from the ED with a prescription; 1,383 (18%) received one or more PIMs. ED revisits in 30 days were fewer for the PIMs cohort (12% PIMs vs 16% no PIMs, OR 0.79, 95% CI 0.65 - 0.95, P value <0.005). Hospital admissions in 30 days were fewer for the PIMs cohort (4 PIMs vs 7% no PIMs, OR 0.75, 95% CI 0.56 – 1.00, P value <0.005). In addition to PIMs, covariate risk factors associated with ED revisits in 30 days included comorbidity severity, history of prior ED revisits, chief complaint, and Medicaid status. Risk factors associated with hospitalization in 30 days included those plus age and emergency severity index, but not race nor ethnicity.
Conclusions: Patients discharged from the ED receiving potentially inappropriate medications as defined by Category 1 of the 2015 updated Beers criteria had lower odds of revisiting the ED within 30 days of index visit. Sociodemographic factors such as gender and race did not predict ED revisits or hospital admissions. Clinical characteristics predicted ED revisits and hospital admissions, the strongest risk being increasing Charlson Comorbidity Index score followed by triage acuity and chief complaint. Future studies are needed to delineate the implications of our findings.

1. Introduction

1.1. Background

Potentially Inappropriate Medication (PIMs) prescribing is a global problem for older adults seeking medical attention. Prevalence rates of PIMs prescribing for older adults in the outpatient setting vary from 3% up to 83% [1-13]. In older adults, polypharmacy is correlated with an increased risk for inappropriate prescribing [6,12,14,15]. Fick et al. reported a 14% prevalence of drug-related problems in older adults receiving PIMs [16]. This is especially noticeable in the emergency department (ED) setting. In a nationwide study of urban ED's, Hustey et al. reported 32% of older adults visiting the ED were actively consuming PIMs, and 13% were discharged with at least one new PIMs [17]. PIMs prescriptions are associated with increased rates of morbidities and mortality when prescribed long-term, including unwanted drug-drug interactions, fluid retention, worsening cardiac functions, and avoidable hospital admissions [18-20].

1.2. Importance

In 1991, a geriatrician named Mark H. Beers led a consensus cohort that published the first list of PIMs commonly prescribed across geriatric

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practices nationwide. The Beers list is updated every few years [21] and is designed to guide medication prescribing in the inpatient and outpatient geriatric practice and nursing home setting. It is a list of medications that are generally recommended to be avoided in older adults when managing chronic conditions and taken with caution, especially for longer durations [18,16,19]. However, applying the Beers criteria in the ED setting for PIMs may not be applicable, where many drugs are prescribed for shorter courses to treat urgent conditions, intended to resolve within days [22-25].

1.3. Goals of this investigation

To date, very few studies have evaluated the impact of PIMs prescribing for older adults in the ED setting on patient outcomes [17,26,27]. To our knowledge, only two studies have addressed this question in the United States, with inconclusive results on ED PIMs and risk of revisits [20,28]. The goal of our study was to compare older adults discharged from the ED receiving PIMs prescriptions (PIMs cohort) to those not receiving PIMs prescriptions (no PIMs cohort) and determine if there were differences in rates of ED return visits (revisits) and hospital admissions. We hypothesize patient receiving PIMs prescriptions versus those that do not will have a higher or no difference in risk of revisits and hospitalization.

2. Methods

2.1. Study design and setting

This was a retrospective observational cohort study of ED patients at Mount Sinai Hospital in New York, between January 2012 and November 2015 who received a prescription at discharge. We defined an index visit as the first ED visit per unique patient during our study period. The visit had to end with 'Discharged' disposition and at least one medication prescribed from the ED.

2.2. Selection of participants

Patients were Medicare beneficiaries 65 years and older, discharged from the ED receiving at least one prescription. Patients were categorized to the PIMs cohort if at least one of those prescriptions was on Category 1 of the 2015 Beers list of drugs to avoid in all older adults [29]. PIMs were identified using a look-up tool designed as part of a previous study [30]. The look-up tool is an algorithm coded into an Excel sheet. It classifies discharge medications as category 1 PIMs to avoid based on drug name, class, dose, and duration. Qualifiers for certain drugs in category 1 of the Beers list were also coded into the algorithm of the look-up tool. If the algorithm identified a drug name or class with an attached qualifier, it ran the qualifier code on patient data in order to qualify the drug as a PIM [29]. All other patients discharged with a prescription were in the comparison no PIMs cohort. Patient records were linked to Medicare claims data through a Data Use Agreement (DUA # RSCH-2017-50741).

2.3. Data collection and processing

Hospital reports were created from the electronic medical record (Epic, Aurora WI) extracting demographic, clinical, and prescriptions data for all patients 65 years and older discharged from the ED. Data included age, sex, race/ethnicity (white, black, Asian, Hispanic Other), ED arrival date, ED discharge date, triage acuity as the Emergency Severity Index (ESI) score, comorbidity as the Charlson Comorbidity Index (CCI) score [31], the six most common chief complaint categories by frequency (Altered mental status (AMS), difficulty breathing, fall, weakness, psychological, and pain), total number of medications prescribed per visit, ED visits in the preceding 90 days, and Medicaid status as a socioeconomic indicator. ESI was developed specifically for the ED setting to triage patients based on acuity and urgency for medical attention [32]. CCI is a comorbidity prognostic index incorporating 19 medical conditions and is used to predict 1 year mortality risk based on the weighted cumulative comorbidity of the patient [31]. CCI has been validated for use in the ED setting [33-36]. Medicare outpatient, inpatient, and carrier claims data using Research Identifiable Files were used to identify outcomes of interest up to 30 days after the index ED visit.

Duplicate visits were removed and index ED visits when prescriptions were given at discharge were flagged. Demographic variables were then linked from the Sinai hospital reports, and CCI was calculated at the time of the index ED visits for all patients using ICD-9 diagnoses up to 1-year prior to the index ED visit date [31,37]. All ED revisits and hospital admissions were identified following the index ED visit, specifically within 3 and 30 days.

To evaluate patients who may have had ED revisits or hospital admissions outside of Sinai, Medicare claims data were linked with the Sinai administrative data using patient names, medical record number and beneficiary ID numbers. ED claims were obtained from the Medicare files using ED Revenue Center Codes 0450-0459, and 0981. ED revisits and hospital admissions (anywhere in the United States) were calculated using Medicare data within 3 and 30 days after the index ED discharge.

2.4. Outcome measures

Primary outcomes were any ED revisits in 3 and 30 days post-discharge from the index visit when an ED medication was prescribed. Secondary outcomes were hospital admissions in 3 and 30 days. All outcome measures were calculated as proportions (%) and Odds Ratios (OR) for both comparison PIMs vs. no PIMs cohorts.

2.5. Primary data analysis

Bivariate analyses compared the outcomes of ED revisits and hospital admissions at 3 and 30 days for PIMs and no PIMs cohorts using the Chi-square test of independent proportions. Entropy balance was used to account for differences in patient characteristics associated with the outcomes of ED revisits and hospital admission, and selection bias with receiving PIMs and no PIMs. Entropy balancing is a method that facilitates the creation of comparison groups that have similar covariate distributions. This method makes observed characteristics between two comparison groups as similar as possible based on observed characteristics other than the treatment [38]. Entropy balance allows the creation of comparison between the groups without loss of sample size. Covariates included in entropy balance weighing were: Age in years, Male Sex, Race (White, Black, Asian, Hispanic, Other), Number of Discharge Medications prescribed during the index visit (categorized into 1, 2, 3, 4+ medications), CCI score (CCI 0, CCI 1, CCI 2-3, CCI 4+), ESI (ESI Missing, ESI 1-2, ESI 3, ESI 4-5), Chief Complaint (Altered Mental Status, Difficulty Breathing, Psychological, Falls, Weakness, Pain), Medicaid status, and prior 90 Day ED visits. For covariates with multiple categories, reference categories used in the multivariate regression models were: Other (Race), 1-2 (ESI score), 0 (CCI), and 1 (Number of Discharge Medications). Adjusted multiple logistic regression of these entropy balanced comparison groups was used to test the association of PIMs status and odds of revisiting the ED and hospital admissions in 3 and 30 days.

Prior studies were powered to detect a difference of 20-25% in 30-day ED revisits between the two cohorts [20,28]. A sample size of 47 patients per cohort would be required to detect a difference of 25% in revisits between comparison cohort with 80% power at 95% confidence. We found no prior literature for 3-day ED revisits, so we utilized the same sample size calculation for ED revisits in 3 days.

Data organization, preparation, revisit and hospitalization calculations, and subsequent statistical analyses were performed using SAS University Edition V9.0 and STATA 16; linking of hospital visit data to Medicare claims data and calculation of revisits using Medicare claims

were performed using STATA 16. Percentages were rounded up to integer values, all other results up to two decimal places, except P values smaller than 0.005, which were reported as P value <0.005. Analyses were unadjusted for repeated testing. This study was approved by Mount Sinai Program for the Protection of Human Subjects and with a data use agreement with Medicare (DUA RSCH-2017-50741).

3. Results

3.1. Characteristics of study subjects

A total of 71,472 older adults (aged 65+) were discharged from the ED during the study period. Of those, 18,011 (25%) patients received a prescription at discharge. After excluding index visits discharged without prescriptions, 10,830 unique patients discharged from the ED with a prescription remained; 7,591 (70%) of these patients were matched to Medicare data, constituting our study cohort. Of those, 1,383 (18%) received PIMs on index discharge. Fig. 1 illustrates the CONSORT flow diagram for this study.

Differences in characteristics between the PIMs and no PIMs cohort prior to entropy balance weighing are provided in Table 1. Of note, prior to entropy balance weighing, the PIMs cohort was younger (mean ages were 74.85 for the PIMs cohort vs 77.50 for the no PIMs cohort, P value <0.005), had fewer males (33% PIMs vs 36% no PIMs, P value 0.01) and fewer comorbidities (CCI score 0 was 69% in the PIMs cohort vs 59% in the no PIMs cohort, P value <0.005). Fig. 2 provides the standardized differences of covariate distributions in the No PIM cohort to those in the PIM cohort before and after entropy balancing, while Table 2 provides the actual covariate distributions in the PIM versus No PIM cohorts before and after entropy balance. After entropy balance was performed, standardized differences between covariate distributions were nearly 0 (nearly identical in both cohorts).

3.2. Main results

When comparing the PIMs versus no PIMs cohorts, there were no differences in ED revisits in 3 days nor hospital admissions in 3 days. ED revisits in 30 days were fewer for the PIMs cohort (12% PIMs vs

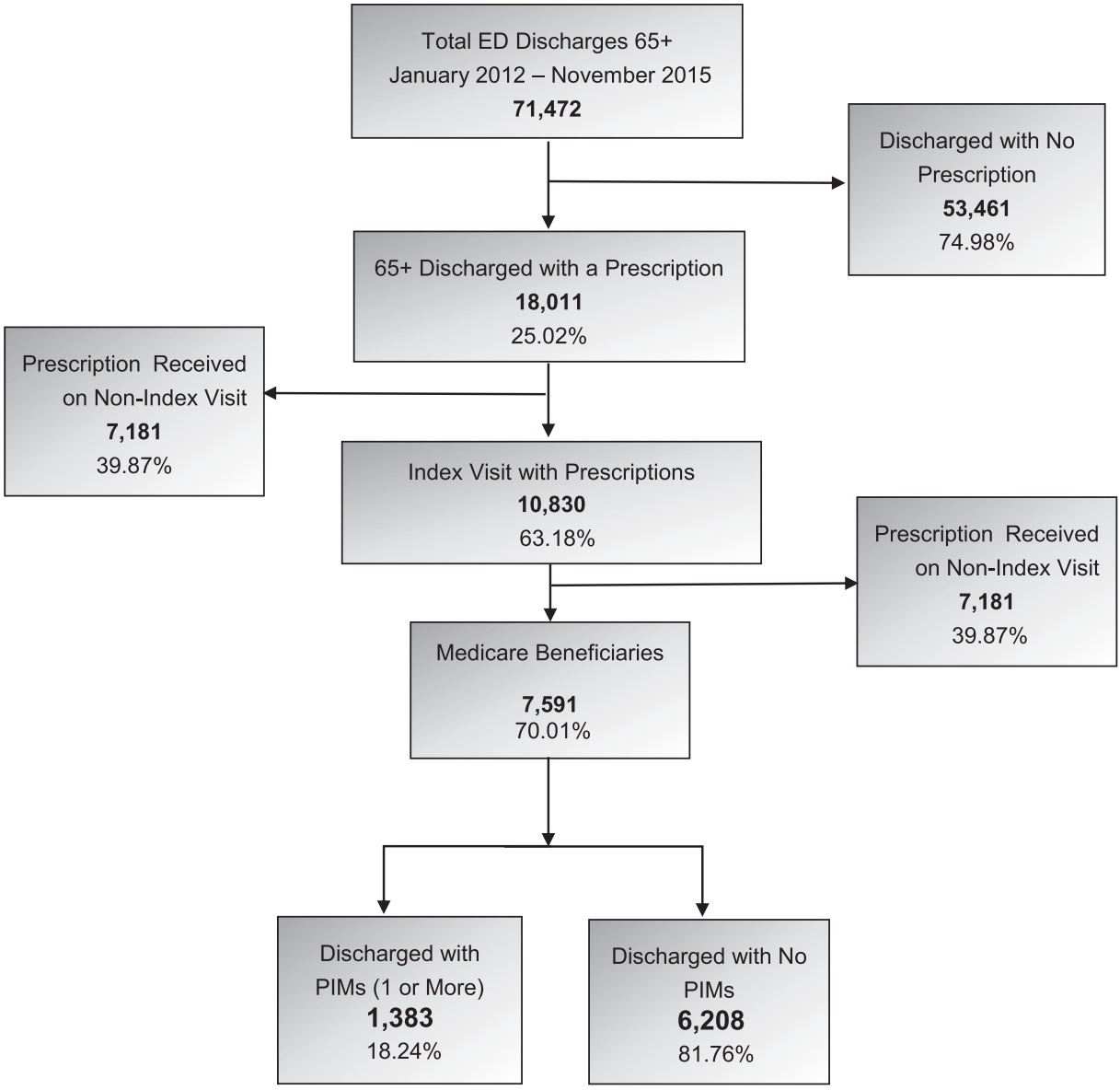

Fig. 1. Study Flow Chart

Table 1
Cohort characteristics prior to entropy balancing and results of their bivariate analyses. Data presented as n (%) unless otherwise indicated. *NA = Not Applicable

	PIM Cohort		No PIM Cohort		P value
	%	n	%	n	
Sample	18	1383	82	6208	NA*
Age *mean, SD*	74.85	7.72	77.50	8.63	<0.005
Male Gender	33	461	36	2240	0.01
Race					
White	48	670	54	3368	<0.005
Black	32	445	28	1738	<0.005
Asian	2	32	2	120	0.36
Hispanic	13	179	12	731	0.23
Other	4	56	4	241	0.77
ESI Score					
(Missing)	1	7	1	55	NA*
1-2	19	264	24	1482	<0.005
3	62	861	63	3895	0.72
4+	18	251	13	776	<0.005
CCI Score					
0	69	952	59	3686	<0.005
1	11	151	12	765	0.15
2-3	14	197	19	1177	<0.005
4+	6	83	9	580	<0.005
Chief Complaint					
Acute Mental Status	2	23	2	147	0.11
Difficulty Breathing	3	45	6	391	<0.005
Weakness	2	27	4	252	<0.005
Fall	4	59	6	379	<0.05
Psychological	1	14	1	70	0.71
Pain	24	333	13	835	<0.005
Total Discharge Medications					
1	46	633	64	3961	<0.005
2	34	468	25	1579	<0.005
3	12	165	7	418	<0.005
4+	8	117	4	250	<0.005
90 Day Prior ED Visits	12	172	17	1049	<0.005
Medicaid Status	49	677	45	2786	<0.05
ED Revisits					
3 Days	3	36	3	205	0.18
30 Days	12	163	16	985	<0.005
Hospital Admissions					
3 Days	<1	10	<1	42	0.85
30 Days	4	60	7	440	<0.005

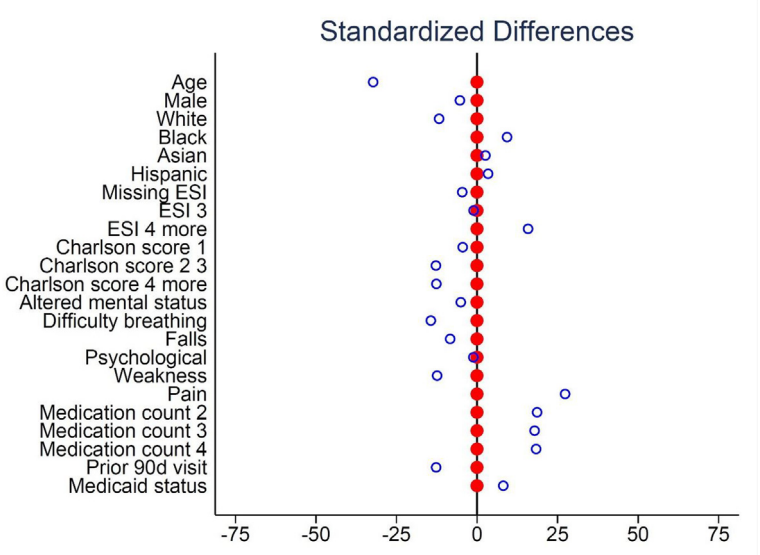

Fig. 2. Standardized difference graph of entropy balance-weighted vs non-weighted samples. The blue circles = standardized difference in covariate distribution between PIMs vs No PIMs BEFORE entropy balancing. The red dots = standardized differences AFTER entropy balancing.

Table 2
Comparison of cohort characteristics before and after entropy balance weighting of the No PIM group. Data presented as % unless otherwise indicated.

	PIM Cohort	No PIM Cohort Before Entropy Balance (Unweighted)	No PIM Cohort After Entropy Balance (Weighted)
	%	%	%
Sample	18	82	18
Mean Age (in years)	74.85	77.50	74.86
Male Gender	33	36	33
Race			
White	48	54	48
Black	32	28	32
Asian	2	2	2
Hispanic	13	12	13
Other	4	4	4
ESI Score			
(Missing)	1	1	1
1-2	19	24	19
3	62	63	62
4+	18	13	18
CCI Score			
0	69	59	69
1	11	12	11
2-3	14	19	14
4+	6	9	6
Chief Complaint			
Acute Mental Status	2	2	2
Difficulty Breathing	3	6	3
Weakness	2	4	2
Fall	4	6	4
Psychological	1	1	1
Pain	24	13	24
Total Discharge Medications			
1	46	64	46
2	34	25	34
3	12	7	12
4+	8	4	8
90 Day Prior ED Visits	12	17	12
Medicaid Status	49	45	49

16% no PIMs, OR 0.79, 95% CI 0.65 - 0.95, P value <0.005). Hospital admissions in 30 days were fewer for the PIMs cohort (4% PIMs vs 7% no PIMs, OR 0.75, 95% CI 0.56 – 1.00, P value <0.005). Results of our regression analyses for each separate outcome, along with possible predictors for each outcome, are summarized in Tables 3 and 4.

Additionally, we performed a post-hoc analysis to examine if the covariates ESI and CCI scores confounded or modified the relationship between receiving PIMs and any of our 4 outcomes. We found CCI score was a strong confounder of receiving PIMs and hospital admissions in 3 and 30 days but did not confound receiving PIMs and ED revisits in 3 or 30 days.

4. Discussion

While research has shown that long-term PIMs compounded numerous hazardous outcomes, including increased risks of ED visits and hospital admissions [9,16,39-45], previous studies evaluating PIMs prescribing from the ED had no difference in ED returns or other subsequent outcomes [20,28]. In this cohort, we found ED PIMs prescribing to be associated with a reduced risk of ED revisits within 30 days. These results were surprising as we had hypothesized either an increased risk of ED revisit or no difference for patients prescribed PIMs from the ED, and challenge previously reported findings [31,32].

4.1. Study merits

Although research on PIMs-related adverse drug events (ADE's) is mounting, only three studies reported on PIMs prescribed in the ED [20,28,46]. The studies by Chin [20] and Hastings et al [28] were underpowered to demonstrate an association with adverse outcomes, including ED returns hospital admissions. Harrison et al found no difference in chief complaint categories nor 7 Day ED revisits in PIMs vs no PIMs [46]. A fourth study, a nationwide database survey by Chen et. al. reported a significant increase in the proportions of ED visits, ambulatory care visits, and hospitalizations in Taiwanese patients receiving PIMs while visiting the ED in 2001-2004 [47]. The covariates included in that analysis were patient, physician, and drug characteristics. However, because of its cross-sectional design, that study did not evaluate the longitudinal outcomes after an index ED discharge. The study simply noted the proportions of each outcome in both cohorts and its cross-sectional designs could not evaluate temporal outcomes.

Ours is the first adequately powered study investigating adverse outcomes of PIMs prescribed in the ED. A larger sample size with 10,000 might have allowed for the ability to detect differences as little as 4% in ED revisits in 3 and 30 days at 90% power and 95% confidence. However, we adjusted for covariates that may have impacted our utilization outcomes, including Age, Race, Gender, Total Discharge Medications, Medicaid status, ESI, CCI, Chief Complaint, and Prior 90 Day ED revisits. Evaluation of outcomes using Medicare claims is a significant strength of this study and allowed us to evaluate returns to a different ED from that of the index visit. With only 36 patients returning to the ED for a revisit in the PIMs cohort, however, we were underpowered to detect a statistically significant difference in ED revisits within 3 days.

As summarized in Table 1, PIMs receivers statistically had fewer comorbidities, were of lower socioeconomic status, needed less urgent attention in the ED, and received multiple medications upon discharge (all P values were <0.005). We suspected those with higher comorbidity and ESI scores would be more likely to return to the ED. Indeed, both ESI and CCI scores were associated with increased ED revisits and hospital admissions. The relationship between comorbidity and hospital

Table 3
Multivariate regression analyses of ED revisits in 3 and 30 days, entropy balance-weighted samples. Data presented as Odds Ratio (95% Confidence Interval). N/A = Not Available. * Patients with Chief Complaint 'Psychological' were dropped from the entropy balance model due to insufficient sample size for this flag. *** p<0.01, ** p<0.05

Covariates for Multivariate Logistic Regression	Outcomes of Multivariate Logistic Regression ED Revisits (n = 7591)			
	30 Days		3 Days	
	OR	95% CI	OR	95% CI
PIMs	0.79	0.65–0.95 **	0.84	0.58–1.23
Age	1.01	1.00–1.02	0.99	0.97–1.02
Male	1.17	0.97–1.41	1.11	0.77–1.60
Race				
White	1.33	0.81–2.21	1.53	0.61–3.83
Black	1.32	0.79–2.19	1.05	0.41–2.68
Asian	0.88	0.38–2.04	1.00	0.22–4.59
Hispanic	0.99	0.57–1.72	0.89	0.31–2.52
ESI Score				
(Missing)	3.73	1.56–8.93 ***	4.75	1.24–18.19 **
3	0.89	0.71–1.12	0.99	0.63–1.56
4+	0.72	0.52–1.00	1.04	0.57–1.90
CCI Score				
1	1.37	1.04–1.81 **	0.94	0.52–1.69
2-3	1.19	0.94–1.51	0.97	0.58–1.62
4+	1.70	1.21–2.38 ***	1.81	0.94–3.48
Chief Complaint				
Altered Mental Status	1.19	0.65–2.19	0.85	0.18–4.12
Difficulty Breathing	1.06	0.68–1.65	1.29	0.57–2.96
Fall	0.89	0.60–1.31	1.13	0.50–2.59
Psychological	0.72	0.30–1.73	0.20	0.05–0.87 **
Weakness	0.78	0.47–1.30	0.92	0.32–2.70
Pain	1.13	0.89–1.42	0.82	0.50–1.36
Total Discharge Medications				
2	0.94	0.78–1.15	1.04	0.70–1.54
3	0.92	0.67–1.25	0.70	0.35–1.37
4+	1.17	0.83–1.66	0.49	0.19–1.25
90 Day Prior ED Visits	1.42	1.13–1.78 ***	1.48	0.93–2.37
Medicaid Status	1.24	1.03–1.49 **	1.20	0.81–1.78

Table 4
Multivariate regression analyses of hospital admissions in 3 and 30 days, entropy balance-weighted samples. Data presented as Odds Ratio (95% Confidence Interval). N/A = Not Available. * Patients with Chief Complaint 'Psychological' were dropped from the entropy balance model due to insufficient sample size for this flag. *** p<0.01, ** p<0.05

Covariates for Multivariate Logistic Regression	Outcomes of Multivariate Logistic Regression Hospital Admissions (n = 7591)			
	3 Days		30 Days	
	OR	95% CI	OR	95% CI
PIMs	1.29	0.62–2.67	0.75	0.56–1.00 **
Age	0.98	0.94–1.03	1.03	1.01–1.05 ***
Male	1.92	0.92–4.01	0.99	0.75–1.32
Race				
White	3.84	0.48–31.00	0.93	0.44–1.96
Black	4.35	0.52–36.43	1.08	0.51–2.30
Asian	7.86	0.43–143.6	0.80	0.21–3.03
Hispanic	4.99	0.57–43.96	0.87	0.38–2.00
ESI Score				
(Missing)	9.88	2.03–48.17 ***	2.48	0.81–7.65
3	0.84	0.39–1.82	0.78	0.57–1.08
4+	0.10	0.01–0.82 **	0.38	0.20–0.71***
CCI Score				
1	1.40	0.38–5.15	2.45	1.63–3.69 ***
2-3	1.95	0.61–6.26	2.11	1.49–2.97 ***
4+	4.14	1.43–11.94 ***	3.77	2.47–5.77 ***
Chief Complaint				
Altered Mental Status	2.15	0.31–14.81	1.13	0.56–2.25
Difficulty Breathing	1.72	0.48–6.14	1.50	0.89–2.54
Fall	0.11	0.01–0.86 **	0.82	0.53–1.27
Psychological	N/A	N/A	0.40	0.15–1.08
Weakness	1.90	0.54–6.62	1.15	0.60–2.19
Pain	0.84	0.22–3.14	1.14	0.78–1.68
Total Discharge Medications				
2	0.88	0.35–2.26	0.92	0.68–1.23
3	1.24	0.36–4.26	1.34	0.86–2.08
4+	0.44	0.09–2.11	0.96	0.54–1.69
90 Day Prior ED Visits	2.47	1.12–5.46 **	1.97	1.44–2.69 ***
Medicaid Status	0.98	0.43–2.24	0.83	0.63–1.09

admissions that we uncovered was not entirely surprising as there is mixed evidence in the literature on the link between PIMs and comorbidity [48-50]. However, this meant that PIMs prescribed in the ED may not be associated with risk of subsequent hospital admissions, which is perplexing given prior literature on the hazardous outcomes of PIMs [9,17,32-38] Future studies should explore the nature and strength of the true association between PIMs, comorbidity, and hospital admissions. While we tried to account for all potential confounders in our study such as ESI and CCI scores, it is possible we may still have undetected clinical variables impacting our results.

If clinical features do not fully explain why fewer patients who received PIM prescriptions revisit the ED or become hospitalized, we may have to look at PIMs from a different angle and reassess our own understanding of their hazards. Growing evidence suggests ED visits and hospitalization rates are associated with the total number of medications prescribed, not PIMs specifically, although we did not find that to be the case [18,27,42,51-58]. Some studies argue that PIMs defined by the STOPP/START criteria, not Beers criteria which were originally developed for use in the nursing home and long-term care setting, increased the risk of unplanned hospitalizations [53,59-67]. Budnitz et al found that many adverse events are related to drugs not on the Beers list, namely insulin regulators, anti-thrombotic, and antiarrhythmic medications [51,68]. Efforts to deprescribe and reduce the risk of negative outcomes should be directed at duration of medication rather than specific drug classes and not potentially inappropriate medications [51,68]. It is possible that patient outcomes may have a greater association with prescription duration rather than it being a potentially inappropriate drug as defined by the Beers criteria. Many of these medications are those that are for longer-term use (i.e., insulin regulators, anti-thrombotic, and antiarrhythmic medications). In contrast, ED prescriptions are typically short-term (a few days up to 1 or 2 weeks) [69]. Long-term use of PIMs may have different outcomes than short-term PIMs, although no current literature exists that compares outcomes from various PIMs durations. A Taiwanese study evaluating outcomes of PIMs and continuity of care in older diabetic patients, Lai and colleagues found increased adverse outcomes correlated with long-term PIMs use beyond 90 and 180 days [18]. Chin et al. suggest PIMs may be appropriately prescribed if used in the short-term [20].

Gender and race had no impact on our utilization outcome results. Contrary to previous reports [19,41-46], sex did not predict ED revisits or hospital admission in 3 and 30 days in our study cohort. For race, we found non-white cohorts were more likely to receive PIMs and more likely to return within 30 days (Table 2). However, race was not associated with ED revisits nor hospital admissions. Furthermore, literature suggests older age may be a stronger predictor of ED revisits than receiving a PIMs [70], but we did not find this to be the case.

4.2. Limitations

Our study has several limitations. This was a single centre study, which limits the generalizability of our results. A strength of our study, however, was the pairing of hospital data with Medicare claims data for the comprehensive evaluation of ED revisit and hospitalization outcomes at any hospital. Our study identified PIMs listed in category 1 of the 2025 updated Beers criteria [29]. We were unable to identify PIMs listed in other categories due to limited time and data. Analysing the impact of prescribing Beers PIMs identified in other categories could have yielded deeper understanding of our study results. We were unable to analyse covariates such as primary and secondary diagnosis (both on index and return visits), or past medical history (PMH). Primary and secondary diagnoses would highlight past ED revisits that were ADE-related. We were also unable to account for prior medication drug history, which would indicate if patients may have already been on long-term PIMs. CCI scores were calculated at the index visit, not at revisits. It is possible patients may have had a change in comorbidity status as a result of the ED visit or even the PIMs. Reasons for visit may have impacted risk of being prescribed PIMs and impacted patient outcomes. We were unable to analyse prescription refill orders or outpatient visits prior to returning to the ED, or reasons for ED revisits. Our results may not be directly due to PIMs but may have been confounded by refill or dispensing issues in the ED or by outpatient care. Response to PIMs was not further evaluated for the sub-category of the PIMs prescribed, perhaps results would be different under different PIMs categories (Antihistamines, Benzodiazepines, etc.). Our analyses were uncorrected for repeat testing of outcomes on the same study cohort, so the statistically significant p-value threshold remained at 0.05 throughout testing. A Bonferroni correction of the p-value could lead us to re-evaluate the statistical significance of our covariates [71-73]. However, given that most of these covariates' p-values were less than 0.005, it is doubtful their interpretation – or the overall significance of our study – would change. Finally, as an observational study, these findings only demonstrate associations and not causality between ED PIMs prescriptions and fewer returns to the ED.

In summary, patients discharged from the ED receiving potentially inappropriate medications as to avoid using category 1 of the 2015 updated Beers criteria have lower odds of revisiting the ED. This is the first adequately powered study to focus on PIMs prescription in the ED. Future studies should evaluate and account for risks for receiving PIMs, consider how PIMs in the ED may be defined, and investigate the impact of comorbidity and the duration of PIMs prescriptions on adverse health outcomes.

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Prior Presentations

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Declaration of Competing Interest

None

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