How complete is the information on preadmission psychotropic medications in inpatients with dementia? A comparison of hospital medical records with dispensing data

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Abstract

Objectives: Reliable information on preadmission medications is essential for inpatients with dementia, but its quality has hardly been evaluated. We assessed the completeness of information and factors associated with incomplete recording.

Methods: We compared preadmission medications recorded in hospital electronic medical records (EMRs) with community-pharmacy dispensations in hospitalizations with discharge code for dementia at the University Hospital of Udine, Italy, 2012–2014. We calculated: (a) prevalence of omissions (dispensed medication not recorded in EMRs), additions (medication recorded in EMRs not dispensed), and discrepancies (any omission or addition); (b) multivariable logistic regression odds ratio, with 95% confidence interval (95% CI), of ≥1 omission.

Results: Among 2,777 hospitalizations, 86.1% had ≥1 discrepancy for any medication (Kappa 0.10) and 33.4% for psychotropics. When psychotropics were recorded in EMR, antipsychotics were added in 71.9% (antidepressants: 29.2%, antidementia agents: 48.2%); when dispensed, antipsychotics were omitted in 54.4% (antidepressants: 52.7%, antidementia agents: 41.5%). Omissions were 92% and twice more likely in patients taking 5 to 9 and ≥10 medications (vs. 0 to 4), 17% in patients with psychiatric disturbances (vs. none), and 41% with emergency admission (vs. planned).

Conclusion: Psychotropics, commonly used in dementia, were often incompletely recorded. To enhance information completeness, both EMRs and dispensations should be used.

KEYWORDS

dementia, electronic health databases, electronic medical records, pharmacoepidemiology, psychotropic medications

1 | INTRODUCTION

At hospital admission, incomplete recording of preadmission medication regimen is common, occurring in 50% to 70% of patients admitted to the hospital (Beers, Munekata, & Storrie, 1990; Cornish et al., 2005; Lau, Florax, Porsius, & De Boer, 2000; Slain, Kincaid, & Dunsworth, 2008; Steurbaut et al., 2010; Tam et al., 2005; Tamblyn et al., 2014), and in up to 78% of elderly patients admitted to a psychiatric clinic (Prins, Drenth-van Maanen, Kok, & Jansen, 2013). Prior studies showed that poor quality of information is mostly due to the fact that outpatient medications (i.e., taken by the patient before being admitted to the hospital) are not always recorded in hospital documentation (Beers et al., 1990; Cornish et al., 2005; Fitzsimons, Grimes, & Galvin, 2011; Hellstrom, Bondesson, Hoglund, & Eriksson, 2012; Pippins et al.,

2008; Prins et al., 2013; Warholak et al., 2009). This incomplete information may result in discontinuation of needed medications, failure in recognizing adverse drug events, inappropriate prescribing, and medication errors, in turn increasing the risk of adverse events and inadequate medication use (Cornish et al., 2005; Prins et al., 2013; Tulner et al., 2009). In about 39% (Cornish et al., 2005) to 50% (Steurbaut et al., 2010) of patients, incomplete information was deemed clinically relevant and potentially impacting on patient safety.

Incomplete recording of preadmission medications has important implications for research as well, considering that medical documentation, including electronic medical records (EMRs), is an increasingly used source of data in epidemiological and health services studies. Good data quality is indeed a prerequisite for valid assessment of important research questions on safety, quality, and appropriateness of care. Studies evaluating data quality in its multiple dimensions and using consistent methodology are thus highly needed (Weiskopf & Weng, 2013).

Several environmental- and patient-related factors contribute to hinder the quality of information on preadmission medications recorded at hospital admission. Hospital-based staff may have limited available time for taking the medication history, due to heavy workload particularly during emergency admissions, when competing patient need of acute treatment may take priority. Involvement of pharmacists and access to additional source of information, such as electronic pharmacy data, enhance the quality of medication history (Cornish et al., 2005; Henneman, Tessier, Nathanson, & Plotkin, 2014; Steurbaut et al., 2010). These resources are however not routinely available. Moreover, the patient may not be able to reliably report medication use (Pippins et al., 2008), and the usual caregiver, who often manages medications (Gillespie, Mullan, & Harrison, 2014; Riedel et al., 2012), may not be present at admission. Studies showed that patients regularly taking a high number of medications are more likely to have incomplete recording of preadmission therapy than those with less complex therapeutic regimens (Fitzsimons et al., 2011; Hellstrom et al., 2012; Tamblyn et al., 2014). The type of medication plays a role as well, as psychotropic medications and cardiovascular agents were frequently omitted (Steurbaut et al., 2010; Tamblyn et al., 2014), in addition to agents taken episodically, such as anti-infectives (Kaboli, McClimon, Hoth, & Barnett, 2004; Steurbaut et al., 2010; Tamblyn et al., 2014).

Patients with dementia may be at particularly high risk of incomplete preadmission medications recording, considering that cognitive impairment hinders their ability to report, they frequently use multiple medications, including psychotropic agents (Clague, Mercer, McLean, Reynish, & Guthrie, 2016; Fereshtehnejad, Johnell, & Eriksdotter, 2014; Lau et al., 2010; Walsh et al., 2016) and are frequently nonadherent (Smith et al., 2017), thus limiting the reliability of medication history based on lists or vials. Additionally, medications most often incompletely recorded are commonly used. About 95% of patients in a Dementia Registry used psychotropic medications and more than 75% cardiovascular agents (Turro-Garriga et al., 2015). An accurate ascertainment of medication history at hospital admission is of utmost importance in these patients, who are at increased risk for severe and potentially lethal adverse drugs events (Ray, Chung, Murray, Hall, & Stein, 2009; Trifiro et al., 2010; Wang et al., 2005) and with co-occurring medical conditions and multiple medications increasing with age.

Furthermore, patients with dementia often undergo transition of care, a critical step for medication management and continuity of therapy (Deeks, Cooper, Draper, Kurrle, & Gibson, 2016) and are often hospitalized (Davydow, Zivin, & Langa, 2014; Maxwell et al., 2015; Pimouguet et al., 2016; Timmons et al., 2015), frequently due to medication-related problems (Gnjidic et al., 2014; Gustafsson et al., 2016). Nevertheless, we are not aware of research assessing the quality of medication history recorded at hospital admission in patients with dementia. To fill this knowledge gap, we conducted a study on all hospitalizations of patients with dementia admitted to the Udine University hospital, Italy, between 2012 and 2014 with the following goals:

1. to evaluate the completeness of information on preadmission use of psychotropic and central nervous system (CNS) medications recorded in hospital EMRs through comparison with pharmacy dispensation data, and the agreement between these two sources;
2. to determine what factors are associated with incomplete recording of preadmission medications in EMRs.

2 | METHODS

2.1 | Sources of data

Sources of data for this study were the hospital registry and EMRs of the Udine University hospital and the Outpatient Prescription Database of Friuli Venezia Giulia (FVG), the Italian region served by this hospital. FVG was characterized by a stable population over the study period, with on average 1,220,000 residents, 51.7% women. Residents 64–75 years of age and those older than 75 years were 13.6% and 11.7%, respectively (Italian Statistical Institute). With on average 42,000 hospitalizations per year, this hospital is the largest of the region and provides medical and surgical care at dedicated departments as well as specialized psychiatric and neurological care at the psychiatry and neurology departments. However, psychiatric care in FVG is provided by large on outpatient basis, and only very severe cases are hospitalized. The psychiatry department at this University Hospital has only 15 beds.

These sources of data provide an opportunity to obtain patient-level correlated information, thus allowing the comparison of EMRs medication list with dispensation data, and have been used for research on use of medications (Pisa, Casetta, et al., 2015; Pisa, Logroscino, et al., 2015).

For each hospitalization, the hospital registry records information on patient demographics, dates of admission and discharge, one primary, and up to five secondary discharge diagnoses coded according to the *International Classification of Diseases Version 9* coding system. EMRs record clinical data on in-patient and out-patient encounters at the hospital. The Outpatient Prescription Database records information on all prescription reimbursed medications dispensed to residents of FVG region at the pharmacy level, including the date of dispensing, the active substance, the World Health Organization

Anatomical Therapeutic Chemical code, number of boxes, strength, and commercial name.

2.2 | Study design

Retrospective cohort study.

2.3 | Study population

From the hospital registry, we selected all records of hospitalizations with principal or secondary *International Classification of Diseases Version 9* discharge codes for dementia (Table S1) from January 1, 2012 to December 31, 2014. We included in the study only the hospitalizations of patients with residence in FVG for at least 1 year prior of the date of admission. Hospitalizations were included irrespective of the department of admission and thus admissions to the neurology department as well as to medical and surgical departments were considered. We did not find any admission to the psychiatric department.

2.4 | Data collection

For each included hospitalization, we abstracted from EMRs information on preadmission medications registered at admission in the medication list (active substance and formulation), discharge diagnosis written by the treating physician and by specialist consultants, presence of psychiatric disturbances, and further comorbidities. For each hospitalized patient, we obtained records of all prescriptions dispensed within 1 year prior to the date of each admission through record linkage with the Outpatient Prescription Database. We identified any dispensing within the 3-month period (reference period) prior to the date of admission. We defined: (a) omission: any medication dispensed within the reference period but not registered in EMR (missing information in EMR); (b) addition: any medication not dispensed within the reference period but registered in EMR; (c) discrepancy: any omission or addition. Discrepancies were defined irrespective of dose, formulation, administration frequency, or route. Psychotropic medications included all agents within the Anatomical Therapeutic Chemical group N.

2.5 | Statistical analysis

The statistical unit of analysis was the hospitalization record. We calculated the percentage of omissions, additions, and discrepancies overall and by characteristics such as type of admission (emergency and planned), sex, age, psychiatric disturbances (diagnosis in EMR of chronic and acute disturbances including depression, psychosis, bipolar disorder, delirium, and hallucinations), and number of medications of diverse classes dispensed within 3 months before admission. This number was categorized as follows: none, 1 to 4, 5 to 9 (polypharmacy) and 10 and more (hyper-polypharmacy), using cut-offs derived from prior studies (Walsh et al., 2016). We compared the percentage of omissions, additions, and discrepancies between groups defined by these characteristics through chi-square test. Level of significance was set at $\alpha = .05$.

Agreement between EMR medication list and dispensations within the reference period was assessed through the Kappa coefficient (Thompson & Walter, 1988), with 95% confidence interval. Kappa and prevalence and bias-adjusted Kappa (PABAK) values were classified as almost perfect (>0.80), substantial (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40), slight (0.00–0.20), and poor (<0.00; Landis & Koch, 1977). To account for different prevalence across therapeutic classes, we calculated prevalence and bias indexes and PABAK (Byrt, Bishop, & Carlin, 1993; Cunningham, 2009). We conducted the following sensitivity analyses: (a) excluding vitamins, minerals, and topical medications from both EMRs and dispensation data; (b) restricting the reference period to 2 months prior to the date of admission.

We calculated univariable and multivariable unconditional logistic regression odds ratio, with 95% confidence interval, to identify characteristics associated with at least (a) one omission, (b) one addition, and (c) one discrepancy. As multiple hospitalizations per patient occurred, we used generalized estimating equations with robust variance estimator, to account for correlated binary data (Smith & Hadgu, 1992). An exchangeable correlation structure was applied, yielding a better fit than other models.

The analysis was performed with SAS© software, version 9.3 (SAS, Cary, NC, USA).

2.6 | Ethics and approvals

The study was approved by the FVG Regional Ethics Committee on July 19, 2016 with determination CEUR-2016-Os-028-ASUIUD.

3 | RESULTS

Among 3,104 hospitalizations coded as dementia, EMRs were retrieved for 95.1%, and linkage with the prescription database was successful for 93.6% (Figure 1). Among 2,777 (89.5%) hospitalizations included in the study, at least one medication was registered in EMRs in 58.8%, and at least one dispensing was redeemed within 3 months before admission in 85.2% (Table 1). The overall Kappa coefficient was 0.10 and PABAK 0.22.

At least one discrepancy for psychotropic and CNS medications was found in 33.4%, for any medication in 86.1% (Table 2). Omissions were more frequent than additions for psychotropic medications (19.6% vs. 13.8%) and, particularly, for any medication (68.2% vs. 44.5%). Discrepancies were more frequent in emergency than in planned admissions: 34.2% versus 25.7% for psychotropic medications and 86.7% versus 80.6% for any medication. The frequency of omissions significantly increased with increasing number of preadmission dispensed medications.

Both omissions (21.5% vs. 19.1%) and additions (15.1% vs. 13.4%) of psychotropic medications were slightly more frequent in patients with than without psychiatric disturbances. There was no clear pattern by age and sex. The results for any medication did not change substantially excluding vitamins, minerals, and topical agents (Table S2).

Among hospitalizations with ≥1 preadmission dispensation for psychotropic medications (N = 1,267), antipsychotics were omitted in 54.4%, antidepressants in 52.7%, and antidementia agents in 41.5% (Table 3). Among hospitalizations with ≥1 psychotropic medication

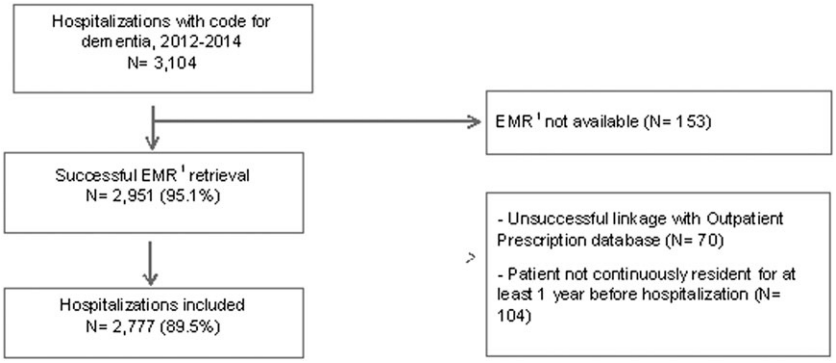

FIGURE 1 Selection of the hospitalizations included in the study. EMR = electronic medical record

TABLE 1 Medications registered in electronic medical records (EMRs) and dispensed within 3 months before hospital admission

	Medications dispensed within 3 months before hospital admission								
Medications registered in EMRs	None *N* (%[a])	At least one *N* (%[a])	Total *N* (%[a])	K (95% CI)	Agreement Positive	Agreement Negative	Prevalence index	Bias index	PABAK[b]
None	232 (8.4)	911 (32.8)	1,143 (41.2)	0.10 (0.07–0.13)	0.7278	0.2988	0.4408	−.2640	0.22
At least one	178 (6.4)	1,456 (52.4)	1,634 (58.8)						
Total	410 (14.8)	2,367 (85.2)	2,777 (100.0)	—	—	—	—	—	—

[a]Percentages of total number of hospitalizations included in the study.

[b]Prevalence-adjusted, bias-adjusted Kappa.

registered in EMR (*N* = 1,106), antipsychotics were added in 71.9%, antidepressants in 29.2%, and antidementia agents in 48.2%. For analgesic opioids, percentage of omissions was 76.9%, whereas additions were 49.2%. Percentage of omissions was high for ophthalmologicals (77.0%), antihypertensives (73.5%), medications for obstructive airway diseases (68.9%), and calcium channel blockers (59.8%), it was above 40% for most other cardiovascular agents. Percentage of additions was 53.1% for antianemic preparations and 42.3% for calcium channel blockers. For certain medications, Kappa and PABAK were consistently between 0.21 and 0.40 (psychotropic and CNS agents as a class, antacids, and antithrombotics), between 0.41 and 0.60 (diuretics, agents acting on the renin-angiotensin system), or above 0.60 (antiepileptics, antiparkinsons, and antidiabetics). Other medications had discrepant results: Kappa 0.60 to 0.21 and PABAK >0.60 or >0.80, for example, analgesic opioids (Kappa 0.27 and PABAK 0.81), antipsychotics (0.24 and 0.62), antidepressants (0.48 and 0.70), antihypertensives (0.36 and 0.94), and ophtalmologicals (0.33 and 0.93). For nonopioid analgesics and psycholeptics, Kappa was <0.20 whereas PABAK indicated much higher agreement (0.87 and 0.51, respectively). The results did not change in sensitivity analysis (Table S3).

Compared with hospitalizations of patients with 0 to 4 preadmission medications, the omission of psychotropic medications was 92% more likely when the patient was in polypharmacy (5 to 9 medications) and more than doubled when in hyper-polypharmacy (10 or more medications). Omissions were 41% and additions 35% more likely in emergency than in planned admissions; each of omission and addition was 17% more likely in patients with than without psychiatric disturbances (Table 4). For any medication, the risk of omissions greatly increased when the patient was in poly- pharmacy and hyper-polypharmacy. Omissions were 69% more likely in emergency than in planned admissions. Additions were 11% and 37% more likely when preadmission medications were 5 to 9 and 10 and more, respectively, versus 0 to 4; 15% more likely in planned versus emergency admissions and 24% more likely in men than in women. The results for any medication did not change substantially excluding vitamins, minerals, and topical agents (Table S4).

4 | DISCUSSION

Among more than 2,700 hospitalizations of patients with dementia, one third had ≥1 discrepancy for psychotropic medications and 86.1% for any medication. Unlike previous studies, this is the first study to address the quality of hospital EMRs information on preadmission medications and specifically of psychotropic agents in patients with dementia. Comparing with studies conducted in adult or elderly patients admitted to the hospital or to the emergency department (Hellstrom et al., 2011; Lau et al., 2000; Tam et al., 2005; Tamblyn et al., 2014; Warholak et al., 2009), we found a frequency of omissions and overall discrepancies for any medication in the upper range of prior estimates. Our results thus reinforce the concern that the quality of preadmission medication history is frequently low in patients with dementia. Moreover, omissions were more frequent than additions, in line with prior research in other patient population (Beers et al., 1990; Cornish et al., 2005; Fitzsimons et al., 2011; Hellstrom et al., 2012; Pippins et al., 2008; Prins et al., 2013; Warholak et al., 2009).

We found that discrepancies were common for medications specific for or common in dementia, such as antidementia agents, antidepressants, and antipsychotics. Similarly, in elderly admitted to a psychiatric clinic (Prins et al., 2013), discrepancies of antidepressants

TABLE 2 Number and distribution of omissions, additions, and overall discrepancies, by type of hospital admission, patient sex and age at admission, neuropsychiatric disturbances, and polypharmacy

	Psychotropic and CNS[a] medications						Any medication						Total
	Omissions		Additions		Discrepancies		Omissions		Additions		Discrepancies		
	N (%[b])	X^2 p	*N* (%[b])	X^2 p	*N* (%[b])	X^2 p	*N* (%[b])	X^2 p	*N* (%[b])	X^2 p	*N* (%[b])	X^2 p	*N* (%[c])
Overall	544 (19.6)		383 (13.8)		927 (33.4)		1,894 (68.2)		1,235 (44.5)		2,392 (86.1)		2,777 (100.0)
Type of admission													
Emergency	502 (20.0)	0.089	356 (14.2)	0.063	858 (34.2)	0.005	1,743 (69.5)	<.0001	1,106 (44.1)	0.204	2,176 (86.7)	0.006	2,509 (90.3)
Planned	42 (15.7)		27 (10.1)		69 (25.7)		151 (56.3)		129 (48.1)		216 (80.6)		268 (9.7)
Sex													
Women	363 (20.3)	0.177	260 (14.6)	0.109	623 (34.9)	0.021	1,214 (68.1)	0.816	755 (42.3)	0.002	1,527 (85.6)	0.268	1,784 (64.2)
Men	181 (18.2)		123 (12.4)		304 (30.6)		680 (68.5)		480 (48.3)		865 (87.1)		993 (35.8)
Age (years)													
74 or less	63 (19.1)	0.350	36 (10.9)	0.094	99 (30.1)	0.135	200 (60.8)	0.009	144 (43.8)	0.196	260 (79.0)	0.001	329 (11.8)
75 to 79	75 (22.9)		46 (14.0)		121 (36.9)		222 (67.7)		163 (49.7)		279 (85.1)		328 (11.8)
80 to 84	112 (19.1)		67 (11.4)		179 (30.5)		420 (71.7)		267 (45.6)		517 (88.2)		586 (21.1)
85 to 89	165 (20.5)		120 (14.9)		285 (35.4)		564 (70.1)		356 (44.2)		706 (87.7)		805 (29.0)
90 and more	129 (17.7)		114 (15.6)		243 (33.3)		488 (66.9)		305 (41.8)		630 (86.4)		729 (26.3)
Psychiatric disturbances													
No	413 (19.1)	0.184	291 (13.4)	0.295	704 (32.5)	0.060	1,483 (68.4)	0.620	966 (44.6)	0.833	1,872 (86.4)	0.471	2,167 (78.0)
Yes	131 (21.5)		92 (15.1)		223 (36.5)		411 (67.4)		269 (44.1)		520 (85.3)		610 (22.0)
Medications dispensed within 3 months before hospital admission[d]													
None	0 (–)	<.0001	124 (30.2)	<.0001	124 (30.2)	0.472	0 (0.0)	<.0001	178 (43.4)	0.139	178 (43.4)	<.0001	410 (14.8)
1 to 4	217 (20.4)		140 (13.2)		357 (33.5)		749 (70.4)		453 (42.6)		982 (92.3)		1,064 (38.3)
5 to 9 (polypharmacy)	288 (24.8)		107 (9.2)		395 (34.0)		1,012 (87.1)		531 (45.7)		1,096 (94.3)		1,162 (41.8)
10+ (hyper-polypharmacy)	39 (27.7)		12 (8.5)		51 (36.2)		133 (94.3)		73 (51.8)		136 (96.5)		141 (5.1)

[a]Central nervous system.

[b]Row percentage.

[c]Percentage of the total number of hospitalizations (2,777) included in the study.

[d]Number of medications of diverse therapeutic classes dispensed within 3 months before hospital admission.

TABLE 3 Agreement between medications registered in electronic medical records (EMRs) and dispensed within 3 months before hospital admission

Therapeutic class (ATC code)	Concordant use	Dispensed only (omission)	EMR only (addition)	Concordant nonuse	% omitted[b]	% added[c]	K (95% CI)[d]	Agreement		Prevalence index	Bias index	PABAK[e]
Psychotropic and CNS[f] medications	*N* (%[a])	*N* (%[a])	*N* (%[a])	*N* (%[a])				Positive	Negative			
Slight agreement												
Other analgesics (N02B)	6 (0.2)	107 (3.8)	69 (2.5)	2,595 (93.4)	94.7	92.0	0.03 (−0.02–0.08)	0.0638	0.9672	−0.9323	0.0137	0.87
Fair agreement												
Psychotropic and CNS medications (N)	723 (26.0)	544 (19.6)	383 (13.8)	1,127 (40.6)	42.9	34.6	0.32 (0.29–0.36)	0.6094	0.7086	−0.1455	0.0580	0.33
Analgesics (N02)	78 (2.8)	271 (9.8)	124 (4.5)	2,304 (83.0)	77.7	61.4	0.21 (0.16–0.26)	0.2831	0.9210	−0.8016	0.0529	0.71
Analgesics opioids (N02A)	61 (2.2)	203 (7.3)	59 (2.1)	2,454 (88.4)	76.9	49.2	0.27 (0.21–0.34)	0.3177	0.9493	−0.8617	0.0519	0.81
Psycholeptics (N05)	158 (5.7)	151 (5.4)	534 (19.2)	1,934 (69.6)	48.9	77.2	0.19 (0.15–0.23)	0.3157	0.8495	−0.6395	−0.1379	0.51
Antipsychotics (N05A)	141 (5.1)	168 (6.0)	360 (13.0)	2,108 (75.9)	54.4	71.9	0.24 (0.20–0.29)	0.3481	0.8887	−0.7083	−0.0691	0.62
Moderate agreement												
Psychoanaleptics (N06)	357 (12.9)	328 (11.8)	157 (5.7)	1,935 (69.7)	47.9	30.5	0.49 (0.45–0.53)	0.5955	0.8886	−0.5682	0.0616	0.65
Antidepressants (N06A)	269 (9.7)	298 (10.7)	111 (4.0)	2,099 (75.6)	52.7	29.2	0.48 (0.44–0.53)	0.5681	0.9112	−0.6590	0.0673	0.70
Antidementia drugs (N06D)	114 (4.1)	81 (2.9)	106 (3.8)	2,476 (89.2)	41.5	48.2	0.51 (0.45–0.57)	0.5494	0.9636	−0.8506	−0.0090	0.86
Substantial agreement												
Antiepileptics (N03)	116 (4.2)	80 (2.9)	24 (0.9)	2,557 (92.1)	40.8	17.1	0.67 (0.61–0.73)	0.6905	0.9801	−0.8790	0.0202	0.92
Anti-Parkinson drugs (N04)	86 (3.1)	68 (2.4)	23 (0.8)	2,600 (93.6)	44.2	21.1	0.64 (0.57–0.71)	0.6540	0.9828	−0.9053	0.0162	0.93
Agreement not evaluable												
Anxiolytics (N05B)	—	—	186 (6.7)	2,591 (93.3)	—	—	—	—	—	—	—	—
Hypnotics and sedatives (N05C)	—	—	102 (3.7)	2,675 (96.3)	—	—	—	—	—	—	—	—
Other medications												
Fair agreement												
Drugs for acid related disorders (A02)	666 (24.0)	534 (19.2)	297 (10.7)	1,280 (46.1)	44.5	30.8	0.38 (0.34–0.41)	0.6158	0.7549	−0.2211	0.0853	0.40
Antithrombotic agents (B01)	805 (29.0)	581 (20.9)	341 (12.3)	1,050 (37.8)	41.9	29.8	0.34 (0.30–0.37)	0.6359	0.6949	−0.0882	0.0864	0.34
Antianemic preparations (B03)	84 (3.0)	222 (8.0)	95 (3.4)	2,376 (85.6)	72.5	53.1	0.29 (0.23–0.35)	0.3464	0.9375	−0.8254	0.0457	0.77
Antihypertensives (C02)	26 (0.9)	72 (2.6)	15 (0.5)	2,664 (95.9)	73.5	36.6		0.3741	0.9839	−0.9499	0.0205	0.94

(Continues)

TABLE 3 (Continued)

Therapeutic class (ATC code)	Concordant use	Dispensed only (omission)	EMR only (addition)	Concordant nonuse	% omitted[b]	% added[c]	K (95% CI)[d]	Agreement		Prevalence index	Bias index	PABAK[e]
							0.36 (0.26–0.46)					
Obstructive airway diseases (R03)	103 (3.7)	228 (8.2)	68 (2.4)	2,378 (85.6)	68.9	39.8	0.36 (0.30–0.41)	0.4104	0.9414	−0.8192	0.0576	0.79
Ophthalmologicals (S01)	26 (0.9)	87 (3.1)	14 (0.5)	2,650 (95.4)	77.0	35.0	0.33 (0.23–0.42)	0.3399	0.9813	−0.9449	0.0263	0.93
Moderate agreement												
Cardiac therapy (C01)	289 (10.4)	254 (9.1)	116 (4.2)	2,118 (76.3)	46.8	28.6	0.53 (0.49–0.57)	0.6097	0.9197	−0.6586	0.0497	0.73
Diuretics (C03)	396 (14.3)	376 (13.5)	193 (6.9)	1,812 (65.3)	48.7	32.8	0.45 (0.41–0.49)	0.5819	0.8643	−0.5099	0.0659	0.59
Beta-blocking agents (C07)	377 (13.6)	254 (9.1)	146 (5.3)	2,000 (72.0)	40.3	27.9	0.56 (0.53–0.60)	0.6534	0.9091	−0.5844	0.0389	0.71
Calcium channel blockers (C08)	143 (5.1)	213 (7.7)	105 (3.8)	2,316 (83.4)	59.8	42.3	0.41 (0.36–0.46)	0.4735	0.9358	−0.7825	0.0389	0.77
Renin-angiotensin agents (C09)	582 (21.0)	495 (17.8)	201 (7.2)	1,499 (54.0)	46.0	25.7	0.44 (0.41–0.48)	0.6258	0.8116	−0.3302	0.1059	0.50
Lipid modifying agents (C10)	246 (8.9)	179 (6.4)	88 (3.2)	2,264 (81.5)	42.1	26.3	0.59 (0.55–0.64)	0.6482	0.9443	−0.7267	0.0328	0.81
Substantial agreement												
Drugs used in diabetes (A10)	207 (7.5)	126 (4.5)	71 (2.6)	2,373 (85.5)	37.8	25.5	0.64 (0.59–0.68)	0.6776	0.9601	−0.7800	0.0198	0.86

Note. ATC = Anatomical Therapeutic Chemical.

[a]Percentage of the total number of hospitalizations (2,777) included in the study.

[b]Percentage of hospitalizations with omitted medication among hospitalizations with ≥1 dispensation of the therapeutic class. Denominator is the number of hospitalizations with concordant use + dispensed only.

[c]Percentage of hospitalizations with added medication among hospitalizations with ≥1 EMR registration of the therapeutic class. Denominator is the number of hospitalizations with concordant use + EMR only.

[d]Kappa values were interpreted as almost perfect (>0.80), substantial (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40), slight (0.00–0.20), and poor (<0.00; 17).

[e]Prevalence-adjusted, bias-adjusted Kappa.

[f]Central nervous system.

TABLE 4 Odds ratio (OR), with 95% confidence intervals (95% CIs), of at least one omission, addition, or any discrepancy according to patient and hospitalization characteristics

	Psychotropic and CNS[a] medications				Any medication			
	OR[b]	95% CI	OR[c]	95% CI	OR[b]	95% CI	OR[c]	95% CI
Omission								
Emergency admission	1.35	0.95–1.90	1.41	0.97–2.05	1.76	1.36–2.28	1.69	1.24–2.31
Men	0.87	0.72–1.06	0.80	0.65–0.99	1.02	0.86–1.21	0.94	0.78–1.13
Age 75 to 79 years	1.25	0.86–1.82	1.03	0.70–1.53	1.35	0.98–1.86	0.89	0.62–1.28
80 to 84	0.99	0.71–1.41	0.80	0.56–1.15	1.63	1.23–2.17	1.11	0.80–1.54
85 to 89	1.09	0.79–1.50	0.85	0.60–1.21	1.51	1.16–1.97	0.98	0.71–1.35
90 and more	0.91	0.65–1.27	0.71	0.49–1.02	1.31	1.00–1.71	0.89	0.64–1.24
5 to 9 preadmission medications (polypharmacy)[d]	1.91	1.57–2.32	1.92	1.58–2.34	6.53	5.35–7.97	6.50	5.32–7.95
10+ preadmission medications (hyper-polypharmacy)[d]	2.21	1.49–3.29	2.20	1.48–3.29	16.09	7.83–33.08	16.04	7.78–33.06
Psychiatric disturbances	1.16	0.93–1.45	1.17	0.94–1.47	0.95	0.79–1.15	0.94	0.76–1.17
Addition								
Emergency admission	1.48	0.98–2.231	1.35	0.86–2.12	0.85	0.66–1.09	0.85	0.64–1.12
Men	0.83	0.66–1.043	0.90	0.71–1.14	1.28	1.09–1.49	1.24	1.06–1.46
Age 75 to 79 years	1.33	0.83–2.115	1.39	0.86–2.25	1.27	0.93–1.73	1.30	0.94–1.78
80 to 84	1.05	0.68–1.614	1.06	0.68–1.67	1.08	0.82–1.41	1.13	0.85–1.50
85 to 89	1.42	0.96–2.120	1.42	0.92–2.17	1.02	0.79–1.32	1.10	0.83–1.46
90 and more	1.51	1.01–2.249	1.43	0.92–2.21	0.92	0.71–1.20	1.04	0.78–1.39
5 to 9 preadmission medications (polypharmacy)[d]	0.46	0.37–0.591	0.46	0.36–0.58	1.12	0.96–1.31	1.11	0.95–1.30
10+ preadmission medications (hyper-polypharmacy)[d]	0.43	0.23–0.782	0.43	0.23–0.79	1.43	1.02–2.03	1.37	0.96–1.94
Psychiatric disturbances	1.14	0.89–1.476	1.17	0.90–1.51	0.98	0.82–1.18	0.96	0.80–1.16
Any discrepancy								
Emergency admission	1.50	1.13–1.99	1.48	1.09–2.02	1.57	1.14–2.17	1.20	0.82–1.74
Men	0.82	0.70–0.97	0.81	0.68–0.96	1.14	0.91–1.43	1.14	0.90–1.46
Age 75 to 79 years	1.36	0.98–1.88	1.21	0.87–1.70	1.51	1.01–2.26	1.19	0.78–1.83
80 to 84	1.02	0.76–1.37	0.88	0.65–1.20	1.99	1.38–2.87	1.62	1.09–2.41
85 to 89	1.27	0.97–1.68	1.07	0.79–1.44	1.89	1.35–2.66	1.54	1.05–2.26
90 and more	1.16	0.88–1.54	0.95	0.70–1.29	1.69	1.20–2.37	1.47	0.99–2.17
5 to 9 preadmission medications (polypharmacy)[d]	1.06	0.90–1.25	1.06	0.90–1.25	4.50	3.40–5.94	4.37	3.30–5.77
10+ preadmission medications (hyper-polypharmacy)[d]	1.17	0.82–1.68	1.17	0.81–1.68	7.36	2.99–18.13	7.12	2.89–17.58
Psychiatric disturbances	1.20	0.99–1.44	1.22	1.00–1.47	0.91	0.71–1.18	0.91	0.70–1.18

[a]Central nervous system.

[b]Univariate.

[c]Multivariate. The model included terms for type of admission (emergency and planned), sex, age, neuropsychiatric disturbances (diagnosis in EMR of chronic and acute disturbances including depression, psychosis, bipolar disorder, delirium, and hallucinations), number of medications of diverse therapeutic classes dispensed within 3 months before hospital admission (none to 4, 5 to 9 (polypharmacy) and 10 and more (hyper-polypharmacy).

[d]Number of medications of diverse therapeutic classes dispensed within 3 months before hospital admission.

accounted for 25% of all discrepancies for CNS medications and antipsychotics for 15%.

Unreliable information about these medications raises specific safety concerns. In patients with dementia, antipsychotics have been consistently associated with severe adverse outcomes (Ray et al., 2009; Trifiro et al., 2010; Wang et al., 2005); antidepressants have been reported to increase the risk of hip fractures and other adverse outcomes in the elderly (Bakken et al., 2013; Coupland et al., 2011); omissions of antidementia agents may lead to unwanted interruption of treatment. Consistently with our results, in an old age psychiatric clinic (Prins et al., 2013) one third of all discrepancies concerned psychotropic medications and two thirds somatic agents. In elderly inpatients admitted to a University Hospital (Steurbaut et al., 2010), discrepancies in psychotropic medications accounted for 20.3% of all discrepancies, representing the second most frequent group after alimentary tract medications, and for 17.6% of discrepancies deemed clinically relevant, resulting the second most frequent group after cardiovascular medications. However, in the emergency department of two Canadian University hospitals (Tamblyn et al., 2014), a higher percentage of dispensed psychotropic medications (46%) was not recorded in charts.

The overall agreement between EMRs and dispensation data was low but varied greatly between medications. We interpreted the Kappa coefficient considering PABAK, an additional index of agreement accounting for the prevalence of the medication and for bias that may influence Kappa. Both indices showed consistent results for most medications, indicating an agreement in the range of fair to moderate for psychotropic and CNS agents (as a class), antacids, antithrombotics, or diuretics, and substantial to perfect for

antiepileptics, antiparkinsons, and antidiabetics. Kappa indicated moderate to fair agreement while PABAK substantial to perfect for medications such as analgesic opioids, antipsychotics, antidepressants, antihypertensives, and ophtalmologicals, suggesting that a low prevalence of use and bias lowered the value of Kappa.

Although prior research evaluated factors associated with the risk of discrepancy concerning any medication, we are not aware of studies addressing specifically psychotropic medications in this regard. Consistently with other studies (Fitzsimons et al., 2011; Hellstrom et al., 2012; Tamblyn et al., 2014), in our results, the number of preadmission medications was a strong independent risk factor for omissions of any medication. We found furthermore that the risk of omissions of psychotropic medications is also strongly increased in patients using multiple medications. Emergency admission was an independent risk factor for omissions and additions of psychotropic medications, but only for omissions of any medication. This last finding is in line with prior research (Lindner, Slagman, Senkin, Mockel, & Searle, 2015; Tamblyn et al., 2014).

We compared with dispensings within 3 months before admission, whereas in another study (Tamblyn et al., 2014), a 2-month period was considered. Our slightly longer comparison period may have increased omissions, but this effect should be limited to medications taken episodically or short term, such as anti-infectives, benzodiazepines, antipsychotics, pain medications, or mood stabilizers. Moreover, in sensitivity analysis, using a 2-month comparison period did not change our results.

To interpret our results, it should be considered that discrepancies may partly be explained by factors other than incomplete recording. Medications prescribed on a nonreimbursable basis are not registered in the prescription database, partially explaining additions. Reimbursement rules are health care system and medication specific. In Italy (Italian Medicine Agency, http://www.agenziafarmaco.gov.it/content/note-aifa, last accessed March 19, 2018), antipsychotics and antidepressants are reimbursed medications and thus fully registered in dispensation data; other medications are reimbursed only when prescribed to patients with specific indications, for instance, antidementia agents are reimbursed only for confirmed AD but not when prescribed to patients with other dementia subtypes; a third group of medications is not reimbursed, such as anxiolytics or hypnotics and sedatives. EMR is thus an especially useful source of information for medications reimbursed only for selected indications or not reimbursed, as dispensation data alone underestimate their use. Over-the-counter, herbal preparations and in-hospital pharmacological therapy are not registered in the prescription database. Their use before admission could have been correctly registered in EMRs resulting in additions. Psychotropic medications, however, are not available over-the-counter, and it is unlikely that use of St John's Wort explains discrepancies for antidepressants, as it is very uncommon in Italy.

In institutionalized patients certain medications administered acutely and occasionally may be delivered from the institution pharmacy and be registered only in the institution documentation but not in the dispensation database. This may partially explain additions for nonopioid analgesics, anxyolitics, and for hypnotics and sedatives.

It should be also considered that dispensing data are a proxy for medications actually taken by the patient, thus dispensed medications not taken or discontinued and correctly not recorded in EMRs may have contributed to omissions.

We found that certain needed medications, such as antihypertensives, agents for obstructive airway diseases, calcium channel blockers, and other cardiovascular agents were frequently omitted. Omissions and additions were among the lowest for antidiabetic medications, consistently with another study (Tamblyn et al., 2014). A possible explanation may be that patients with diabetes carry good documentation material of their therapeutic regimen. Of note, omissions were frequent for ophthalmologicals, in line with a prior study (Steurbaut et al., 2010). As ocular topic medications contribute to polypharmacy and may concur to systemic adverse events, they should not be overlooked when medication history is collected.

Agreement between EMRs and dispensing data was generally low when measured through the Kappa coefficient. This coefficient is influenced by the prevalence of the condition and by bias. Its value, therefore, was interpreted in the light of additional indices of agreement, such as PABAK (Byrt et al., 1993; Cunningham, 2009). When prevalence and bias were taken into account, the agreement increased, indicating that for some medications the low Kappa coefficient was influenced by the low prevalence of use in the study population.

Our study did not evaluate the appropriateness of in-hospital clinical decisions regarding the suspension or modification of preadmission outpatient medication. We also did not consider modifications of pharmacological therapy after discharge. Rather, we evaluated the quality of information on preadmission medications registered in EMRs by comparing with dispensation data.

4.1 | Limitations

In some prior studies, comparisons were made with a medication list obtained by integrating information from multiple sources, including patients and family interviews, GP letters, and nursing home lists (Cornish et al., 2005; Fitzsimons et al., 2011; Lau et al., 2000). We could not complement dispensing data with other sources, due to data anonymization and the retrospective nature of the study. However, our results are consistent with studies comparing with multiple sources.

The intended dose is not registered in the prescription database; regimen and route of administration were often missing in EMRs. We could therefore not assess agreement on dose, frequency, or route of administration, possibly underestimating discrepancies.

We identified hospitalizations of patients with dementia through discharge codes. Preliminarily, we evaluated the validity of the diagnostic discharge code for dementia comparing with the diagnosis written by physicians in EMR, finding a very high positive predictive value (87.4%). Discharge codes at this University Hospital accurately identified several diseases (Berdot et al., 2009; Pisa et al., 2011) including neurodegenerative conditions (Drigo et al., 2013; Pisa, Logroscino, Battiston, & Barbone, 2016). We included secondary diagnoses to increase the completeness of ascertainment of admissions of patients with dementia, because dementia is often listed as secondary diagnosis and common medical conditions leading to admission (Phelan, Borson, Grothaus, Balch, & Larson, 2012; Pimouguet et al., 2016) as the principal diagnosis.

4.2 | Strenghts

The almost complete retrieval of EMRs and linkage with dispensing data was a major strength of this study. The large number of records included allowed us to assess discrepancies by therapeutic group focusing on psychotropic medications.

Administrative health databases provide several advantages to research on medications, as they reflect routine care information representative and complete for large populations, including vulnerable patient groups (Schneeweiss & Avorn, 2005). To ascertain preadmission medications, we used the FVG Outpatient Prescription Database recording dispensing data representative of the entire population of FVG. Use of such data allowed us to obtain complete information on all dispensations for each patient included in the study, not flawed by poor recall. Contrary to physician prescription data, dispensation data capture medications actually redeemed by the patient at the pharmacy level. Moreover, as dispensations are recorded continuously over time, we were able to conduct sensitivity analysis choosing a shorter reference period.

5 | CONCLUSIONS

In this large cohort of inpatients with dementia, the information on preadmission medication registered in EMR was frequently incomplete compared with community-pharmacy dispensation data. This incompleteness concerned also psychotropic agents, which are frequently used in these patients.

To enhance completeness of information on preadmission medications, studies should use both EMRs and dispensation data. EMRs are particularly useful to complement dispensation data for medications incompletely or not registered, such as nonreimbursed medications or those reimbursed only for specific indications.

Polypharmacy, emergency admission, and presence of psychiatric disturbances identify subgroups to be prioritized in interventions aimed at improving preadmission medication recording.

Our results prompt future research on the association between incomplete information on preadmission medication and relevant clinical outcomes in patients with dementia, also by means of linkage with emergency department and general practitioner data.

DECLARATION OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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