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Unplanned institutionalization among discharged polymedicated older inpatients: a registry-based study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-057444
Article Type:	Original research
Date Submitted by the Author:	15-Sep-2021
Complete List of Authors:	Pereira, Filipa; University of Porto, Institute of Biomedical Sciences Abel Salazar; HES-SO Valais Wallis, School of Health Sciences Verloo, Henk; HES-SO Valais Wallis, School of Health Sciences Von-Gunten, Armin; University of Lausanne Hospital Centre Meyer-Masseti, Carla; University of Bern, Institute for Primary Health Care (BIHAM) del Río Carral, María; University of Lausanne, Institute of Psychology, Research Center for the Psychology of Health, Aging and Sports Examination Martins, Maria Manuela; Escola Superior de Enfermagem do Porto, Formação&gestão Wernli, Boris; University of Lausanne, FORS, Swiss Centre of Expertise in the Social Sciences
Keywords:	GERIATRIC MEDICINE, CLINICAL PHARMACOLOGY, EPIDEMIOLOGY

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4 1 ***Unplanned institutionalization among discharged polymedicated older***
5 2 ***inpatients: a registry-based study***
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31 Abstract

32 **Objective:** To investigate patient characteristics and the available health and drug data associated
33 with unplanned institutionalization following an acute hospital admission or readmission.

34 **Design:** A population-based hospital registry study.

35 **Setting:** A public hospital in southern Switzerland (Valais Hospital).

36 **Participants:** We explored a population-based longitudinal dataset of 14,705 hospital admissions
37 from 2015–2018.

38 **Outcome measures:** Sociodemographic, health, and drug data and their interactions predicting the
39 risk of unplanned institutionalization.

40 **Results:** The mean prevalence of unplanned institutionalization after hospital discharge was 6.1%.
41 Our predictive analysis revealed that the oldest adults (OR=1.07 for each additional year of age; 95%
42 CI 1.05 to 1.08) presenting with impaired functional mobility (OR=3.22; 95% CI 2.67 to 3.87),
43 dependency in the activities of daily living (OR=4.62; 95% CI 3.76 to 5.67), cognitive impairment
44 (OR=3.75; 95% CI 3.06 to 4.59), and traumatic injuries had a higher probability of unplanned
45 institutionalization (OR=1.58; 95% CI 1.25 to 2.01). The number of ICD-10 diagnoses had no
46 significant impact on institutionalization, contrarily to the number of prescribed drugs (OR=1.17;
47 95% CI 1.15 to 1.19). Antiemetics/antinauseants (OR=2.53; 95% CI 1.21 to 5.30), digestives (OR=1.78;
48 95% CI 1.09 to 2.90), psycholeptics (OR=1.76; 95% CI 1.60 to 1.93), antiepileptics (OR=1.49; 95% CI
49 1.25 to 1.79), and anti-Parkinson's drugs (OR=1.40; 95% CI 1.12 to 1.75) were strongly linked to
50 unplanned institutionalization.

51 **Conclusions:** Numerous determinants of unplanned institutionalization were identified. To prevent
52 the adverse health outcomes that precipitate acute hospitalizations and unplanned
53 institutionalizations, ambulatory care providers should consider these determinants in their care
54 planning for older adults before they reach a state requiring hospitalization.

55
56 **Keywords:** population-based sample; functional decline; hospital discharge; risk factors; nursing
57 home

61 **Strengths and limitations of this study:**

- 62 • A hospital registry of 14,705 hospital admissions, involving 9,430 different polymedicated
63 older adults admitted from their homes, was analyzed to determine the risk of unplanned
64 institutionalization.
- 65 • Bivariate analyses were conducted on independent variables, and generalized estimating
66 equations were computed to predict how sets of predictors influenced the probability of
67 unplanned institutionalization.
- 68 • Causality analysis was not feasible based on the nature of the routinely collected data.
- 69 • Although the study considered statistical associations between drugs and unplanned
70 institutionalization, it did not use clinically diagnosed drug–drug interactions.
- 71 • Our data were unable to identify hospitalizations that might have been triggered by limited
72 home-care options or those that became necessary while older adults awaited a place in a
73 long-term care facility.

75 **Introduction**

76 The hospitalization of home-dwelling older adults, for any reason and even for a short admission,
77 can lead to substantial functional decline [1, 2]. Both their health disorder itself and the hospital
78 environment can foster such functional decline, increase the risk of future illness, and irreversibly
79 diminish their quality of life [1, 2]. Most hospitalized older adult inpatients wish to return home and
80 continue their everyday life as before. However, these different factors may hinder this wish at
81 discharge [3, 4]. Unmet patient needs related to functional decline and safety after returning home
82 can lead to a higher risk of hospital and emergency department readmissions and thus to
83 subsequent unplanned institutionalization [5]. After hospitalization, an unplanned
84 institutionalization can be a devastating and overwhelming experience for older adults and their
85 relatives, and it increases overall health-care system costs [6].

86 Whether planned or unplanned, institutionalization commonly follows two paths: (i) within the
87 community, directly from home, or (ii) from hospital, directly transitioning from hospital discharge
88 [2]. In the community, transitions to nursing homes are generally the result of thoughtful decisions
89 made by home-dwelling older adults, their families, and health- and social-care providers based on
90 their knowledge of the evolution of the person's long-term health and functional state or on an
91 acute decline and corresponding increase in care needs that cannot be met at home. Recent findings
92 have suggested that the predictors of institutionalization are mainly based on underlying cognitive

1
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3 93 and functional impairments combined with a lack of support and assistance in daily living at home
4
5 94 [7].

6
7 95 The causes of unplanned institutionalization directly after acute hospital discharge are
8
9 96 heterogeneous. There are several reasons why older adults may require long-term care—that
10
11 97 cannot be provided in a community setting—following acute hospital admission, e.g., a new medical
12
13 98 problem or the worsening of existing chronic disease(s) entailing dependency and requiring complex
14
15 99 forms of care. Furthermore, there may be a breakdown of family circumstances and/or lack of social
16
17 100 support. Some studies have noted that hospitalized older inpatients had already suffered a
18
19 101 significant deterioration in their individual scores for mobility, transfer, toileting, feeding, grooming,
20
21 102 and cognitive status by their second day in hospital [1, 4, 8].

22
23 103 Bellelli *et al.* showed that advanced age (OR=4.8; 95% CI 2.6 to 8.9, $p < 0.001$), cognitive impairment
24
25 104 (OR=2.3; 95% CI 1.4 to 3.9, $p < 0.001$), and poor functional status (OR=10.2; 95% CI 4.7 to 22.5,
26
27 105 $p < 0.001$) at discharge from a rehabilitation unit were the main predictors of subsequent
28
29 106 institutionalization [9]. The integrative review by Fogg *et al.* found a similar result for cognitive
30
31 107 impairment (OR=2.14; 95% CI 1.24 to 3.70, $p < 0.001$) [10]. A randomized controlled trial by
32
33 108 Landefeld *et al.* found that older inpatients in an acute care medical unit with a decline in their
34
35 109 ability to perform one or more of the basic activities of daily living (ADL) were more often discharged
36
37 110 to a nursing home than those with less functional decline (22% and 14 %, respectively; $p < 0.01$) [11].
38
39 111 Ferrucci *et al.* identified stroke, cancer, congestive heart failure, pneumonia, coronary heart disease,
40
41 112 and hip fractures as the leading medical precipitators of functional decline and institutionalization
42
43 113 [12]. Older adult inpatients are frequently subject to iatrogenic events during hospitalization,
44
45 114 including adverse drug reactions, nosocomial infections, and the consequences of falls, fractures,
46
47 115 and using chemical or physical restraints [13]. Such events can lengthen hospitalization, produce
48
49 116 cognitive changes, and lessen the ability to perform the ADL, all potentially leading to unplanned
50
51 117 institutionalization [13].

52
53 118 Kasper suggested that repeated cycles of atrophy and recovery may lead an older adult to lose their
54
55 119 ability to restore skeletal muscle mass, thus becoming permanently disabled and unable to remain at
56
57 120 home [14]. Indeed, functional decline may cause significant sarcopenia—which occurs more rapidly
58
59 121 in older patients—and can lead to falls, frailty, and unplanned institutionalization [1]. Using Fried's
60
122 criteria, Rosenberg *et al.* found that frail older adults were at greater risk of adverse drug events
123
124 generated by prescriptions of potentially inappropriate medication (PIM), falls, and
125
institutionalization [15]. In a prospective cohort study of 210 frail older adult inpatients (mean age
89.4; SD = 4.6; 69.5% female), Chong *et al.* found a high risk of institutionalization (OR=3.69; 95% CI

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3 126 2.31 to 5.88; $p < 0.001$), adjusted for age, sex, and severity of illness [16]. In their prospective cohort
4
5 127 study (N = 140), Troester *et al.* confirmed the significant risk of institutionalization among frail older
6
7 128 inpatients (mean age 84.1; SD = 8.6) after a mean hospital stay of about 30 days (SD = 16.5) [17].

8 129 Other investigators have found that patients with the greatest loss of independence in the ADL
9
10 130 during hospitalization were the most likely to be admitted to a nursing home [4, 15].

11
12 131 In addition to functional decline, cognitive impairment is among the strongest factors predicting
13
14 132 institutionalization [1]. Indeed, hospitalization also causes an increased risk of the onset of acute
15
16 133 cognitive decline in the form of delirium, with a prevalence of up to 60% on some surgical wards
17
18 134 [18], often leading to unplanned institutionalization [19]. Dementia, Parkinson's disease and its
19
20 135 associated risk of falls, and behavioral changes are common reasons for deciding to transfer
21
22 136 inpatients from hospital to long-term care [20, 21].

23 137 Polypharmacy has been associated with adverse health outcomes among home-dwelling older
24
25 138 adults [22]. Some prospective studies with small samples have established relationships between
26
27 139 drug treatments during acute hospitalization and unplanned institutionalization [23]. Cardiovascular
28
29 140 drugs (particularly vasodilators, diuretics, and anticoagulants), drugs against diabetes, steroids, non-
30
31 141 steroidal anti-inflammatory drugs, opiates, antibiotics, anticholinergics, and benzodiazepines have
32
33 142 all been associated with unplanned institutionalization [23].

34 143 To the best of our knowledge, and despite more frequent post-discharge institutionalization in
35
36 144 Switzerland than in other countries, there is scarce research exploring how unplanned admissions to
37
38 145 nursing homes are related to prior hospitalization [24]. The present study aimed to investigate the
39
40 146 associations between polymedicated older inpatients' sociodemographic and clinical characteristics,
41
42 147 drug data, and their interactions, and their unplanned institutionalization following an acute care
43
44 148 hospital stay.

44 149 **Materials and Methods**

46 150 ***Study design***

48 151 The present population-based hospital registry study was conducted with close regard to the
49
50 152 REporting of studies Conducted using Observational Routinely collected health Data (RECORD)
51
52 153 statement.

54 154 ***Population and data collection***

56 155 Our four-year, longitudinal, population-based hospital registry of electronic health records included
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58 156 polymedicated (five and more drugs prescribed) home-dwelling older adults admitted and

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3 157 readmitted to the Valais hospital, a multisite public teaching hospital in southern Switzerland with a
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5 158 mean annual number of hospitalizations of approximately 39,000. This registry continues to be
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7 159 analyzed as part of a larger project [25]. Ethical approval was obtained from the Human Research
8
9 160 Ethics Committee of the Canton of Vaud (2018-02196), and this permitted the partnering hospital's
10 161 data warehouse to provide the appropriate dataset. Our study defined 'unplanned
11
12 162 institutionalization' as the impossibility for a formerly home-dwelling older inpatient to return there
13
14 163 after hospital discharge, and this included any new institutionalization in a long-term residential care
15 164 facility following an acute care admission [2]. All the patients included in the study followed a home
16
17 165 to hospital to long-term residential care facility pathway. Long-term residential care facilities do not
18
19 166 expect their residents to return to independent living in the community. The extracted patient data
20 167 contained sociodemographic characteristics, medical and surgical diagnoses, routinely assessed
21
22 168 clinical data (such as gait, falls risk, hearing, or pain), and the drugs prescribed. The medical and
23
24 169 surgical diagnoses encoded diagnostic data using the WHO International Classification of Diseases,
25
26 170 tenth version (ICD-10), and the Swiss Classification of Surgical Interventions (CHOP) [26]. The
27
28 171 hospital dataset showed that discharged patients had been prescribed 2,370 different medicines.
29
30 172 The Anatomical Therapeutic Chemical (ATC) classification system's 14 top-level codes was used to
31
32 173 structure that dataset of prescribed medicines [27]. The extracted data, from multiple dataset
33
34 174 sources, were transformed and synthesized using best practices [28]. Our dataset was composed of
35
36 175 14,705 hospital admissions from home settings between 2015 and 2018. Data were without missing
37
38 176 values, and there were similar numbers of annual hospital admissions: 3,777, 3,534, 3,724, and
39
40 177 3,670, respectively.

178 ***Patient and public involvement***

41 179 Patients were not involved in the development of the research questions, study design, outcome
42
43 180 measures, or the conduct of the study.

45 181 ***Dataset customizing for predictive analysis***

47 182 *Synthesizing the extracted data*

49 183 The dataset was recoded and customized to identify the number of older inpatients admitted
50
51 184 straight from their home and then discharged to a nursing home, as presented in a previous paper
52
53 185 [29]. Each subject's unique identifier was used to distinguish different observations from 2015 to
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55 186 2018 and to account for hospital readmissions. Cases involved 9,430 different older adults, with an
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57 187 average of 1.56 hospital stays per person. Sociodemographic and clinical data were considered
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59 188 independent variables and used to compute the predictive models [29]. Unplanned
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3 189 institutionalization after discharge from our participating hospital between 2015 and 2018 was
4
5 190 identified by the difference between the abode of origin (home) and the abode of destination at
6
7 191 discharge (a long-term residential care facility), and this was recoded as the dependent variable of
8
9 192 interest.

10 193 *Sociodemographic and Hospital Variables*

11
12 194 The analysis included two sociodemographic control variables: age and sex. Fifty-five percent of the
13
14 195 population sample were women, and the total sample's mean age was 78.16 years old (SD = 7.65).
15
16 196 Age was considered a continuous variable; its progressive impact was conclusive in preliminary
17
18 197 investigations and previous studies [30]. Mean hospital length of stay was 8.63 days (SD = 7.58) [29].

19 198 *Health Variables*

20
21
22 199 Numerous variables were used to describe older adults' health status at the end of their hospital
23
24 200 stay. The modeling analysis included three of the six hierarchical clusters preliminarily computed as
25
26 201 confounding variables: mobility, dependency in the ADL, and cognitive status [29]. Cognitive status
27
28 202 was measured at an ordinal level using five categorical variables (perception–alertness, orientation,
29
30 203 attention, decision making process, and ability to learn).

31 204 At discharge, 28% of subjects presented with impaired mobility, and 6% were impaired in their ADL
32
33 205 and cognitive status. The mean number of ICD-10 diseases per subject was 4.59 (SD = 0.91), and
34
35 206 each older adult's number of ICD-10 diseases was entered into the model as a proxy for
36
37 207 multimorbidity. The mean number of surgical interventions performed (based on the Swiss surgery
38
39 208 coding system CHOP) [26] was 1.80 per hospitalization (SD = 1.77). The most prevalent medical
40
41 209 diagnoses among older inpatients were circulatory (24% of the population sample), infectious (3%),
42
43 210 and respiratory diseases (10%), as well as traumatic injuries (8%) and tumors (11%). Finally, the year
44
45 211 of hospitalization was introduced as a control variable, based on the fact that hospital admissions
46
47 212 occurring earlier in the four-year study were associated with a higher probability of unplanned
48
49 213 institutionalization [29].

50 214 *Drugs*

51 215 The WHO ATC Classification System [27] was used to select frequently prescribed drugs at discharge
52
53 216 as independent variables for the predictive model. The selection of drug class interactions was based
54
55 217 on a literature review and expert opinions [31]. A cut-off point of at least 30 subjects per drug
56
57 218 category prescribed was necessary to have a critical mass of data for computing robust statistics. The
58
59 219 number of drugs prescribed at hospital discharge was considered continuous, with an average of

220 9.07 (SD = 3.32). Supplementary Table 1 presents the descriptive statistics of selected drugs based
221 on ATC.

222

223 ***Data analysis strategy***

224 Data were extracted into a Microsoft Excel spreadsheet (Microsoft, Redmond, Washington, United
225 States) and subsequently imported into SPSS software, version 26.0 (IBM Corp, Armonk, New York,
226 United States). Associations with unplanned institutionalization were examined based on previous
227 studies: patient age and sex, hospital length of stay, the principal and secondary ICD-10 diagnoses,
228 surgical interventions (CHOP), and prescribed drugs. No causality analyses were possible because
229 data analysis was retrospective and based on routine data: there was no way of knowing medication
230 regimens or functional status before hospitalization and how these might be associated with
231 unplanned institutionalization. A bivariate analysis was conducted using cross-tabulations relating to
232 the independent variables of unplanned institutionalizations from 2015 to 2018. In a second stage, a
233 series of generalized estimating equations (GEE or population-averaged logistic regression models)
234 were computed to predict how sets of predictors influenced the probability of unplanned
235 institutionalization. The model estimated each predictor's impact, other things being equal, by
236 estimating its net impact controlling for confounding factors (adjusted odds ratios). This GEE model
237 is generally considered very robust and efficient at dealing with panel or correlated data because it
238 makes few explicit assumptions and is less vulnerable to misspecification [32]. A GEE model predicts
239 for the entire population and not a specific individual. Since the data are based on a whole
240 population, not a sample, the odds ratios' confidence intervals and statistical tests were used to
241 indicate the robustness of relationships since they normally only make sense for statistical inference.

242 **Results**

243 ***Unplanned institutionalization, sociodemographic characteristics, and the prevalence of clinical 244 and medical conditions***

245 We found a prevalence of older adults discharged to unplanned institutionalization of 6.1% over the
246 whole time period, with a slight decrease in prevalence going forward (7.3% in 2015 to 5.9% in
247 2018). Bivariate associations showed that men had a lower prevalence of unplanned
248 institutionalization than women (4.0% vs. 8.8%), as did 65–69-year-old subjects (2.2%) compared
249 with those 70–79 years old, 80–89 years old, and especially the oldest group, aged 90 or more (3.2%,
250 8.3%, and 19.7%, respectively).

1
2
3 251 Subjects with unimpaired mobility (2.0%), less dependency in their activities of daily living (3.4%),
4
5 252 and a good cognitive status (3.8%) showed much lower probabilities of unplanned
6
7 253 institutionalization than those with poor mobility, greater dependency, and a poor cognitive status
8
9 254 (16.7%, 44.8%, and 41.3%, respectively). However, a higher prevalence of unplanned
10
11 255 institutionalization was observed among older adults without a circulatory disease (6.7% vs. 4.3%),
12
13 256 unaffected by an infection (6.2% vs. 2.7%), or without a tumor (6.4% vs. 4.3%). Those affected by
14
15 257 traumatic injuries showed a significantly higher prevalence (14.9% vs. 5.3%). Being jointly affected by
16
17 258 several diseases increased the prevalence of unplanned institutionalization, from 1.8% for older
18
19 259 adults with a single disease (ICD-10) to 6.8% for those with five diseases. Furthermore, the number
20
21 260 of surgical interventions was negatively associated with the prevalence of unplanned
22
23 261 institutionalization. Patients who had not undergone surgery showed a higher probability of
24
25 262 unplanned institutionalization (7.8%) than those who had undergone several interventions (3.5% for
26
27 263 four interventions, 4.2% for five interventions) (Table 1). The number of drugs prescribed at hospital
28
29 264 discharge showed a positive linear relationship with unplanned institutionalization ($g = .368$) (Fig. 1).

27 265 **[Insert Table 1]**

29 266 **[Insert Figure 1]**

31 267 ***Unplanned institutionalization and drugs***

33 268 Bivariate associations showed that drugs were also related to unplanned institutionalization (Table
34
35 269 2). In general, older adults whose discharge to an institution was unplanned had more prescribed
36
37 270 drugs than those returning home (10.9 drugs vs. 8.9). Psycholeptics (antipsychotics, anxiolytics,
38
39 271 hypnotics, and sedatives) and psychoanaleptic drugs (antidepressants, psychostimulants, nootropics,
40
41 272 and anti-dementia drugs), antiemetics and antinauseants, anti-Parkinson's disease drugs, and drugs
42
43 273 treating constipation and the sensory organs were significantly associated with unplanned
44
45 274 institutionalization. On the contrary, patients taking lipid-modifying agents were less prone to
46
47 275 unplanned institutionalization.

48 276 **[Insert Table 2]**

50 277 ***Multivariate baseline model***

52 278 A baseline, GEE logistic regression model, including sociodemographic information, clinical data, and
53
54 279 diseases, was computed to predict unplanned institutionalization among discharged polymedicated
55
56 280 older adult patients (Fig. 2); prescribed drugs at hospital discharge were not included. If the 95%
57
58 281 confidence interval (CI) does not overlap the null value (e.g., OR = 1), then the higher the odds ratio,
59
60 282 the more the variable contributes to unplanned institutionalization. Men had a lower probability of

1
2
3 283 unplanned institutionalization than women (OR=0.62; 95% CI 0.52 to 0.73). Patients' probability of
4 284 unplanned institutionalization increased with age (OR=1.07 for each additional year of age; 95% CI
5 285 1.05 to 1.08). Impaired mobility, dependency in the ADL, and cognitive impairment revealed their
6 286 substantial impacts on unplanned institutionalization (OR=3.22; 95% CI 2.67 to 3.87; OR=4.62; 95%
7 287 CI 3.76 to 5.67; and OR=3.75; 95% CI 3.06 to 4.59, respectively). Circulatory and infectious diseases
8 288 were related to lower probabilities of unplanned institutionalization (OR=0.78; 95% CI 0.63 to 0.98,
9 289 and OR=0.38; 95% CI 0.20 to 0.70, respectively), whereas traumatic injuries were related to higher
10 290 probabilities (OR=1.58; 95% CI 1.25 to 2.01). The number of ICD-10 diagnoses alone had no
11 291 significant impact on the odds of unplanned institutionalization (OR=1.11; 95% CI 0.98 to 1.24), in
12 292 contrast to the number of surgical interventions undergone (CHOP), which was a protective factor
13 293 against unplanned hospitalization (OR=0.95; 95% CI 0.90 to 0.99). The year of hospital stay also had
14 294 a significant impact, with more recent stays having lower probabilities of unplanned
15 295 institutionalization (OR=0.88; 95% CI 0.82 to 0.94, per ensuing year).

25 296 **[Insert Figure 2]**

27 297 ***Prediction of unplanned institutionalization and drug prescription***

28 298 A higher number of prescribed drugs was associated with a higher probability of unplanned
29 299 institutionalization (OR=1.17; 95% CI 1.15 to 1.19). Figure 3 presents the baseline GEE logistic
30 300 regression model from Figure 2, completed with those drugs prescribed to older adults at discharge
31 301 that had a significant statistical association ($p < 0.05$) with unplanned institutionalization. Drugs
32 302 without a significant statistical association are not presented in Figure 3 for simplification purposes.
33 303 Antiemetics and antinauseants (OR=2.53; 95% CI 1.21 to 5.30 for each additional unit), digestives
34 304 (OR=1.78; 95% CI 1.09 to 2.90), psycholeptics (OR=1.76; 95% CI 1.60 to 1.93), antiepileptics
35 305 (OR=1.49; 95% CI 1.25 to 1.79), and anti-Parkinson's disease drugs (OR=1.40; 95% CI 1.12 to 1.75)
36 306 were strongly linked to unplanned institutionalization after controlling for other parameters. On the
37 307 contrary, taking lipid metabolism modifying agents was associated with lower probabilities of
38 308 unplanned institutionalization (OR=0.73; 95% CI 0.60 to 0.90, for each extra drug from this class
39 309 prescribed).

40 310 **[Insert Figure 3]**

42 311 ***Combined drug intake and probabilities of unplanned institutionalization***

43 312 To reduce collinearity and simplify the results, the combined intake of different ATC drug classes was
44 313 recoded as a dichotomized variable for each drug pairing and added to the previous model [27]. Only
45 314 the drugs and drug combinations prescribed to older adults at discharge that had significant

1
2
3 315 associations ($p < 0.05$) with unplanned institutionalization are presented. The combined intake of
4 316 cardiac therapy and psychoanaleptic drugs was significantly associated with unplanned
5 317 institutionalization (OR=1.87; 95% CI 1.11 to 3.16), as were psychoanaleptics and diabetes drugs
6 318 combined (OR=1.75; 95% CI 1.03 to 2.98), and psycholeptic drugs and vitamins combined (OR=1.71;
7 95% CI 1.03 to 2.84). On the contrary, the combined intake of beta-blocking agents and
8 319 antiepileptics strongly diminished the odds of unplanned institutionalization (OR=0.39; 95% CI 0.23
9 320 to 0.67).

10 321
11 322 We also investigated the risk of unplanned institutionalization for combined drug intake within the
12 323 same drug class. The combined intake of two or more antiemetic and antinauseants (OR=2.65; 95%
13 324 CI 1.26 to 5.58), psycholeptics (OR=1.64; 95% CI 1.46 to 1.85), antiepileptics (OR=1.55; 95% CI 1.23 to
14 325 1.96), or anti-Parkinson's disease drugs (OR=1.44; 95% CI 1.13 to 1.83) were strongly associated with
15 326 a higher probability of unplanned institutionalization.

16 327 Table 3 summarizes the main findings from our predictive analysis.

17 328 **[Insert Table 3]**

18 329 **Discussion**

19 330 This population-based hospital registry study used longitudinal data to examine the unplanned
20 331 institutionalization of hospitalized polymedicated older inpatients, revealing a 6.1% prevalence rate
21 332 over the four-year dataset, in agreement with previous work by Luppá *et al.* (men: 5.4%; women:
22 333 6.0%) and Goodwin *et al.* (5.5%) [7, 33]. The slight decrease in prevalence over the four years of the
23 334 study may be explained by improvements in the regional home-care services' contribution to
24 335 maintaining older adults at home, but also to planned institutionalizations without the requirement
25 336 for intermediate hospitalization [34]. Furthermore, the number of places in the region's long-term
26 337 care facilities increased in that period [35], allowing people for whom care at home became
27 338 impossible to be institutionalized more promptly.

28 339 Our predictive analysis revealed that the group of the oldest adults, presenting functional mobility
29 340 impairments, dependency in the ADL, and cognitive impairment were also at a high risk of
30 341 unplanned institutionalization, which is consistent with previous retrospective and prospective
31 342 studies [8, 36]. Very old inpatients (≥ 90 years old) had an almost tenfold higher risk of unplanned
32 343 institutionalization than those aged 65–69. This was expected and matched with previous research
33 344 [37], bearing in mind that the very oldest group presented with a high prevalence of multimorbidity
34 345 and advanced functional and cognitive impairments. Unexpectedly, regardless of age, our results
35 346 showed that older women had a higher prevalence and probability of unplanned institutionalization

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3 347 than men [38]. Yet our data could not entirely explain this result. Previous publications have
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5 348 indicated that social and life-expectancy factors may play roles in the different rates of
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7 349 institutionalization between older adult men and women[38].

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9 350 Our findings highlighted that functional and cognitive impairments were strong risk factors for
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11 351 unplanned institutionalization, which is in line with the studies by Luppá *et al.* and Goodwin *et al.*
12
13 352 [33, 38]. Likewise, our results emphasized a high risk of unplanned institutionalization among non-
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15 353 surgically treated and trauma patients This could be explained by the relationship between
16
17 354 orthopedic guidelines on traumatic injuries among older adults that suggest avoiding surgery, for
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19 355 several medical reasons (number and severity of multimorbidities), and which may lead to increased
20
21 356 functional impairment and unplanned institutionalization, as suggested by Gardner *et al.* and
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23 357 Cutugno [39, 40].

24
25 358 As might be expected, older adults who underwent an unplanned institutionalization had more
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27 359 prescribed drugs than those returning home. Our results were in line with the retrospective study by
28
29 360 Lucchetti *et al.*, which demonstrated a relationship between the prescription of cardiovascular,
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31 361 gastrointestinal, and metabolic drugs and unplanned institutionalization [41].

32
33 362 Our findings indicated that patients prescribed more than one drug from the same class of drugs—
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35 363 from the classes of antiemetics and antinauseants, psycholeptics, antiepileptics, or anti-Parkinson's
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37 364 disease drugs—had a higher risk of discharge to an institution. Although this phenomenon is still
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39 365 under-investigated, our findings are not in line with the few existing studies in this area, which have
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41 366 presented no significant relationships between drug interactions and unplanned institutionalization
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43 367 [42]. However, in hospital settings, a recent systematic review reported drug–drug interactions
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45 368 among 80% or more of older inpatients [43]. Since polymedicated older inpatients should be
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47 369 considered as a population at a high risk of adverse outcomes, further studies should investigate
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49 370 how drug–drug interactions might predict the risks of institutionalization.

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51 371 Our findings undeniably mirrored existing evidence that chronic conditions and debilitating
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53 372 comorbidities are significant determinants of unplanned institutionalization [3, 7]. However, they
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55 373 also raised questions regarding hospitalization's effects on the individual aging process, which likely
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57 374 interact to produce a cascade of factors towards functional decline and dependency [1]. The adverse
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59 375 effects of hospitalization begin immediately and progress rapidly [1]. Harrison *et al.* and Haaksma *et*
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376 *al.* described ways in which acute and exacerbated acute and chronic disorders, reinforced by
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378 existing undiagnosed geriatric syndromes (frailty, delirium, pressure sores, functional incontinence),
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discharged to a long-term residential care facility [2, 21]. Previous studies suggested that silent

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3 380 geriatric syndromes such as frailty and functional decline, together with polypharmacy, are not only
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5 381 clinically characteristic of older adults but also potential predictors of being at risk of a further loss of
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7 382 independence and subsequent institutionalization. Montes *et al.* pointed out the dramatic rise in
8
9 383 numbers of frail hospitalized older adults. This increase generates concerns about whether long-
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11 384 term residential care facilities—already suffering from long admission waiting lists of home-dwelling
12
13 385 older adults—will be able to cope with older adults' complex care needs [44].

14 386 Although some of the predisposing predictors identified cannot be treated (i.e., sex, age), they may
15
16 387 still contribute to an older adult's risk of being discharged to a long-term residential care facility and
17
18 388 subsequently exacerbate their situation there. Given that hospitalization introduces stressors that
19
20 389 may increase the chances of unplanned institutionalization [45, 46], using patients' electronic
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22 390 hospital data could help identify the high-risk older adults who would benefit from specific
23
24 391 preventive interventions. Being able to rapidly identify inpatients at a high risk of unplanned
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26 392 institutionalization may help professional caregivers to provide them with the appropriate
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28 393 community-health resources, such as community-based rehabilitation programs. This would help
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30 394 older people to remain in their community for longer.

31 395 ***Study strengths and limitations***

32 396 Although our population-based study's findings could be generalized to other regions of Switzerland,
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34 397 any interpretations should be made with caution. Nevertheless, our findings could provide
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36 398 information to help better define which integrated health-care approaches could be implemented to
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38 399 attenuate the risk factors associated with unplanned institutionalization following an acute hospital
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40 400 admission or readmission. The numerous predictors revealed in our study enabled us to
41
42 401 conceptualize an overview of hospitalized older adults' health conditions before their unplanned
43
44 402 institutionalization. As health-care moves towards ever-more personalized medicine, this result
45
46 403 could help to create more refined, tailored, future interventions via 'risk profiles' defined using each
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48 404 older adult's personal predictors.

49 405 Our study had some limitations. The absence of data on patients' functional status before hospital
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51 406 admission meant that we could not assess changes to that status during hospitalization, such as the
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53 407 influence of the development or deterioration of functional and cognitive impairment. We did not
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55 408 compute analysis on specific disorders such as neurodegenerative diseases like dementia and
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57 409 Parkinson's disease because this was beyond the scope of our study protocol. However, further
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59 410 analyses could confirm earlier studies showing that these diseases significantly affect a person's risk
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411 of institutionalization after hospitalization, with almost 90% of patients with dementia being
412 admitted into a long-term residential care facility before dying [20, 21]. Although the study

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3 413 considered statistical associations between drugs and unplanned institutionalization, it did not use
4 414 clinically diagnosed drug–drug interactions. Lastly, our data were unable to identify hospitalizations
5 415 that might have been triggered by limited care options at home or hospitalizations that were
6 416 necessary while awaiting a place in a long-term care facility. These cases of planned
7 417 institutionalization could not be distinguished from the unplanned institutionalization considered in
8 418 the study. In addition, some patients may not have been transferred directly from hospital to long-
9 419 term care facilities and may have had to stay in an intermediate structure while awaiting a place.
10 420 These patients were not included in the study due to the unavailability of this information in the
11 421 database.

18 422 **Conclusion**

21 423 The sociodemographic characteristics of hospitalized older inpatients, together with their clinical
22 424 and medical conditions and their prescribed drugs, can provide us with a significant set of risk
23 425 determinants of individuals' potential for unplanned institutionalization, sustaining our stated
24 426 hypotheses. Identifying the risk factors for unplanned institutionalization could be of great
25 427 assistance in developing predictive tools and tailored intervention programs aimed at reducing the
26 428 number of older adults placed in long-term residential care facilities. Our results showed that the
27 429 patient-related risk factors leading to institutionalization were based on declines in physical and
28 430 cognitive function. Treatment with single drugs and combinations of drugs were also associated with
29 431 unplanned institutionalization, indicating that multiple chronic health conditions are important
30 432 determinants of a non-return home. Our findings may help to identify those older inpatients at the
31 433 greatest risk of unplanned institutionalization, enabling their care to be optimized by
32 434 counterbalancing those risk factors. Further research is required across large samples of older
33 435 inpatients to investigate whether tailored interventions at early stages in chronic diseases could
34 436 delay physical and cognitive dysfunction and reduce unplanned institutionalizations among this
35 437 growing segment of the population.

36 438 **Acknowledgement**

39 439 The authors thank the partner hospital, including the hospital's data warehouse, for its valuable
40 440 contributions.

41 441 **Ethics approval and patient consent**

42 442 Ethical approval was obtained from the Human Research Ethics Committee of the Canton of Vaud
43 443 (CER-VD, 2018-02196), thus permitting our partner hospital's data warehouse to provide the
44 444 appropriate dataset. Given the retrospective data source, obtaining consent from the patients

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3 445 concerned was impossible or posed disproportionate difficulties. The present study respects the
4
5 446 legal requirements for research projects involving data re-use without consent, as set out in Art. 34
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7 447 from the Swiss Human Research Act (HTA).

8 9 448 **Conflict of Interest Statement**

10
11 449 The authors have no conflicts of interest to declare.

12 13 450 **Funding Sources**

14
15 451 This work was supported by Swiss National Science Foundation grant number 407440_183434/1.

16 17 452 **Author Contributions**

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19
20 453 BW, FP, and HV had the original idea. BW, MdRC, MMM and HV provided conceptual and
21
22 454 methodological expertise to the study design and BW, FP, CMM, AvG, and HV to data analysis and
23
24 455 interpretation. BW, FP, and HV were major contributors to writing the manuscript. All authors read,
25
26 456 edited, and approved the final manuscript.

27 28 457 **Data Availability Statement**

29
30 458 As part of the Data Use Agreement, authors are not allowed to provide raw data. Upon a reasonable
31
32 459 request, the corresponding author will provide statistical programming code used to generate
33
34 460 results.

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461 462 **Figure Legends**

Fig. 1. Relationship between unplanned institutionalization and number of prescribed drugs at discharge.

Fig. 2. Baseline, GEE logistic regression model with unplanned institutionalization as the dependent variable associated with sociodemographic, hospitalization, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

Fig. 3. The GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned institutionalization (N = 14,705 observations for 9,430 different subjects).

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26 582 probably able to ambulate, but I’m not sure”. *Jama*. 2011;306(16):1782-93.

583 Table 1. Prevalence of unplanned institutionalizations with regards to associations with
 584 sociodemographic characteristics and clinical and medical conditions among polymedicated
 585 hospitalized older adults (N = 14,705)
 586

Variables	Unplanned institutionalization %	p-value
Overall sample of older adults (n=14,705)	6.1% (n= 897)	
Sex		$p < 0.001$
Female/Male	8.8%/4.0%	
Age in years		$p < 0.001$
65–69 years	2.2%	
70–79 years	3.2%	
80–89 years	8.3%	
90 years or more	19.7%	
Mobility		$p < 0.001$
Full ability (0) / impairment (1)	2.0%/16.7%	
Dependence in the activities of daily living		$p < 0.001$
Full ability (0)/impairment (1)	3.4%/44.8%	
Mental status		$p < 0.001$
Full ability (0)/impairment (1)	3.8%/41.3%	
ICD-10 principal diagnosis: circulatory problems		$p < 0.001$
No (0)/Yes (1)	6.7%/4.3%	
ICD-10 principal diagnosis: infection		$p < 0.01$
No (0)/Yes (1)	6.2%/2.7%	
ICD-10 principal diagnosis: respiratory problems		Ns
No (0)/Yes (1)	6.1%/6.8%	
ICD-10 principal diagnosis: traumatic injuries		$p < 0.001$
No (0)/Yes (1)	5.3%/14.9%	
ICD-10 principal diagnosis: tumor		$p < 0.01$
No (0)/Yes (1)	6.4%/4.3%	
Number of ICD-10 diseases		$p < 0.001$
1	1.8%	
2	2.9%	
3	3.9%	
4	3.9%	
5 or more	6.8%	
Number of surgical interventions (CHOP)		$p < 0.001$
0	7.8%	
1	6.4%	
2	5.8%	
3	5.2%	
4	3.5%	
5 or more	4.2%	
Year of hospitalization		$p < 0.01$
2015/2016/2017/2018	7.3%/6.1%/5.2%/5.9%	

587 Note. Ns = non significant
 588

589 Table 2. Prevalence of unplanned institutionalization among polymedicated hospitalized older adults
 590 (N = 14,705) with regards to associations with different classes of prescribed drugs
 591

Drugs (ATC code)	Unplanned institutionalization		
	No drugs in this class %	Drugs in this class %	p-value
<i>First level, anatomical main group</i>			
Blood and blood-forming organ drugs (B)	5.4%	6.4%	ns
Dermatologicals (D)	5.8%	14.1%	$p < 0.001$
Genito-urinary system and sex hormones (G)	6.1%	6.3%	ns
Systemic hormonal preparations, excluding sex hormones and insulins (H)	6.1%	6.5%	ns
Anti-infectives for systemic use (J)	6.4%	5.3%	$p < 0.05$
Antineoplastic and immunomodulating agents (L)	6.3%	3.5%	$p < 0.01$
Drugs for the musculoskeletal system (M)	6.4%	4.3%	$p < .001$
Antiparasitic products, insecticides, and repellents (P)	6.2%	4.0%	Ns
Respiratory system drugs (R)	6.3%	5.5%	Ns
Sensory organ drugs (S)	5.5%	13.4%	$p < 0.001$
<i>Second level, therapeutic subgroup</i>			
Stomatological preparations (A01)	6.1%	7.5%	ns
Drugs for acid-related disorders (A02)	5.8%	6.4%	ns
Drugs for functional gastrointestinal disorders (A03)	5.9%	9.8%	$p < 0.001$
Antiemetics and antinauseants (A04)	6.1%	18.6%	$p < 0.001$
Bile and liver therapy drugs (A05)	6.1%	7.9%	ns
Drugs for constipation (A06)	4.8%	13.5%	$p < 0.001$
Antidiarrheals, intestinal anti-inflammatory/anti-infective agents (A07)	6.0%	9.4%	$p < 0.01$
Digestives, including enzymes (A09)	6.1%	8.4%	Ns
Diabetes drugs (A10)	6.6%	3.9%	$p < 0.001$
Vitamins (A11)	6.2%	5.9%	ns
Mineral supplements (A12)	4.8%	9.6%	$p < 0.001$
Other alimentary tract and metabolism products (A16)	6.1%	5.9%	ns
Cardiac therapy drugs (C01)	6.1%	6.3%	ns
Antihypertensives (C02)	6.2%	4.6%	ns
Diuretics (C03)	5.5%	8.1%	$p < 0.001$
Peripheral vasodilators (C04)	6.1%	4.2%	ns
Vasoprotectives (C05)	6.1%	7.2%	ns
Beta blocking agents (C07)	7.2%	4.8%	$p < 0.001$
Calcium channel blockers (C08)	6.1%	6.1%	ns
Agents acting on the renin-angiotensin system (C09)	7.2%	5.3%	$p < 0.001$
Lipid-modifying agents (C10)	8.2%	3.1%	$p < 0.001$
Anesthetics (N01)	6.1%	13.5%	ns
Analgesics (N02)	3.6%	7.2%	$p < 0.001$
Antiepileptics (N03)	5.7%	10.3%	$p < 0.001$
Drugs against Parkinson's disease (N04)	5.7%	18.1%	$p < 0.001$
Psycholeptics (N05)	2.4%	11.0%	$p < 0.001$
Psychoanaleptics (N06)	4.8%	11.9%	$p < 0.001$
Other nervous system drugs (N07)	6.1%	5.9%	ns

592 Note. Ns = non significant

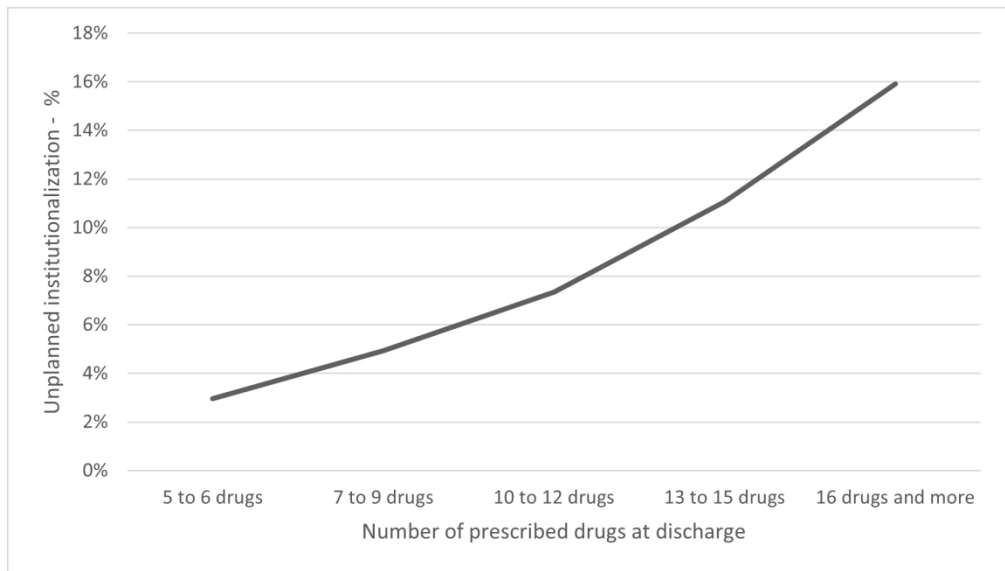
593 Table 3. Factors associated with a higher probability of unplanned institutionalization among
 594 polymedicated hospitalized older adults (N = 14,705): summary of the predictive analysis.

Determinants of a higher probability of unplanned institutionalization (risk factors)	
-	Dependency in the activities of daily living (OR = 4.62, 95% CI: 3.76–5.67)
-	Cognitive impairment (OR = 3.75, 95% CI: 3.06–4.59)
-	Functional mobility impairment (OR = 3.22, 95% CI: 2.67–3.87)
-	Antiemetics/antinauseants (OR = 2.53, 95% CI: 1.21–5.30)
-	Digestives (OR = 1.78, 95% CI: 1.09–2.90)
-	Psycholeptics (OR = 1.76, 95% CI: 1.60–1.93)
-	Traumatic injuries (OR = 1.58, 95% CI: 1.25–2.01)
-	Antiepileptics (OR = 1.49, 95% CI: 1.25–1.79)
-	Anti-Parkinson's drugs (OR = 1.40, 95% CI: 1.12–1.75)
-	Number of prescribed drugs (OR = 1.17, 95% CI: 1.15–1.19)
-	Older age (OR = 1.07, 95% CI: 1.05–1.08)
Combined intake of:	
-	cardiac and psychoanaleptic drugs (OR = 1.87, 95% CI: 1.11–3.16)
-	psychoanaleptic and diabetes drugs (OR = 1.75, 95% CI: 1.03–2.98)
-	psycholeptic drugs and vitamins (OR = 1.71, 95% CI: 1.03–2.84)
Combined intake of two or more:	
-	antiemetics and antinauseants (OR = 2.65, 95% CI: 1.26–5.58)
-	psycholeptics (OR = 1.64, 95% CI: 1.46–1.85)
-	antiepileptics (OR = 1.55, 95% CI: 1.23–1.96)
-	anti-Parkinson's drugs (OR = 1.44, 95% CI: 1.13–1.83)
Determinants of a lower probability of unplanned institutionalization (protective factors)	
-	Surgical interventions (OR = 0.95, 95% CI: 0.90–0.99)
-	Circulatory diseases (OR = 0.78, 95% CI: 0.63–0.98)
-	Lipid metabolism modifying agents (OR = 0.73, 95% CI: 0.60–0.90)
-	Male sex (OR = 0.62; 95% CI: 0.52–0.73)
-	Combined intake of beta-blocking agents and antiepileptics (OR = 0.39, 95% CI: 0.23–0.67)
-	Infectious diseases (OR = 0.38, 95% CI: 0.20–0.70)

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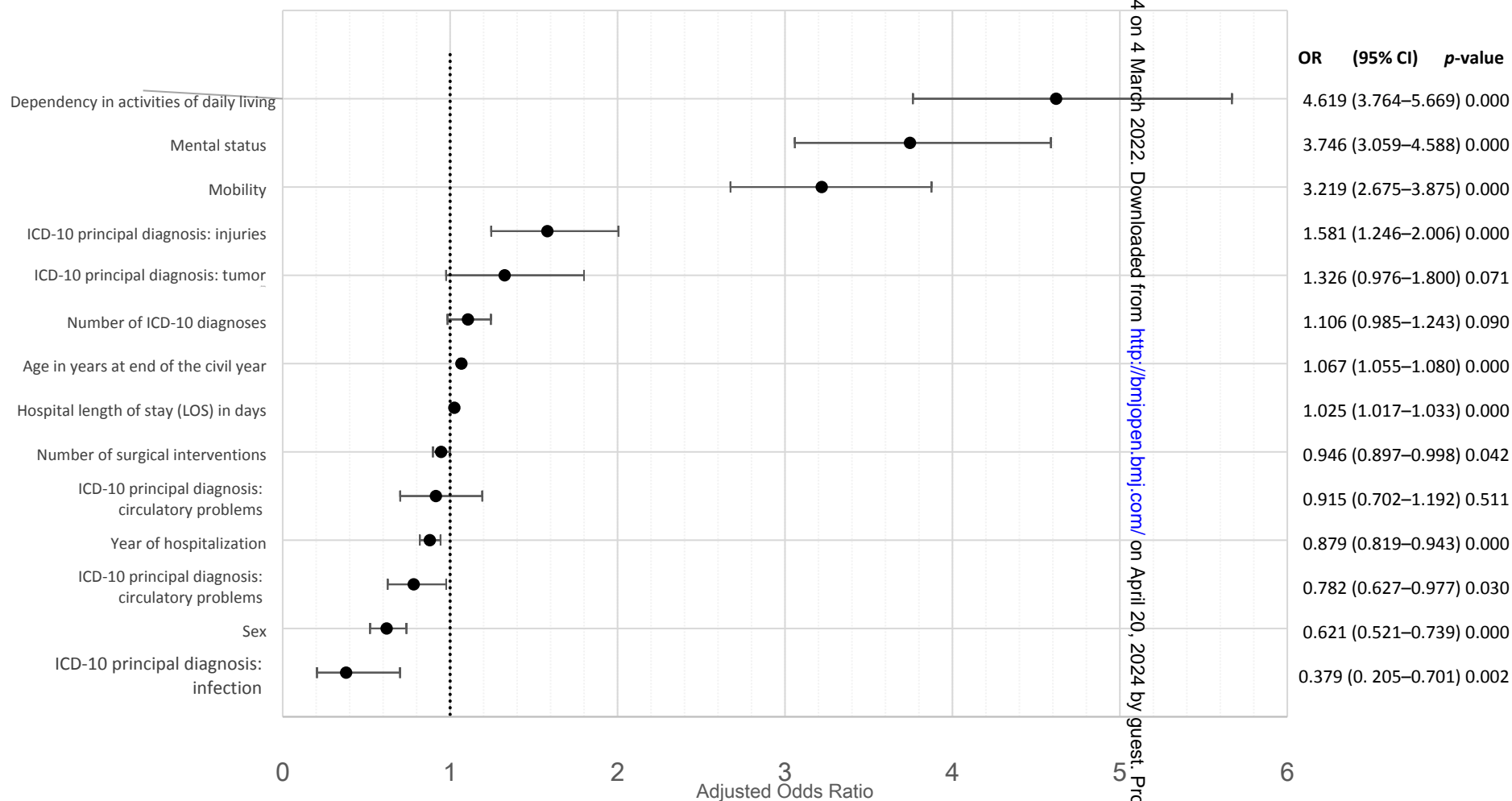
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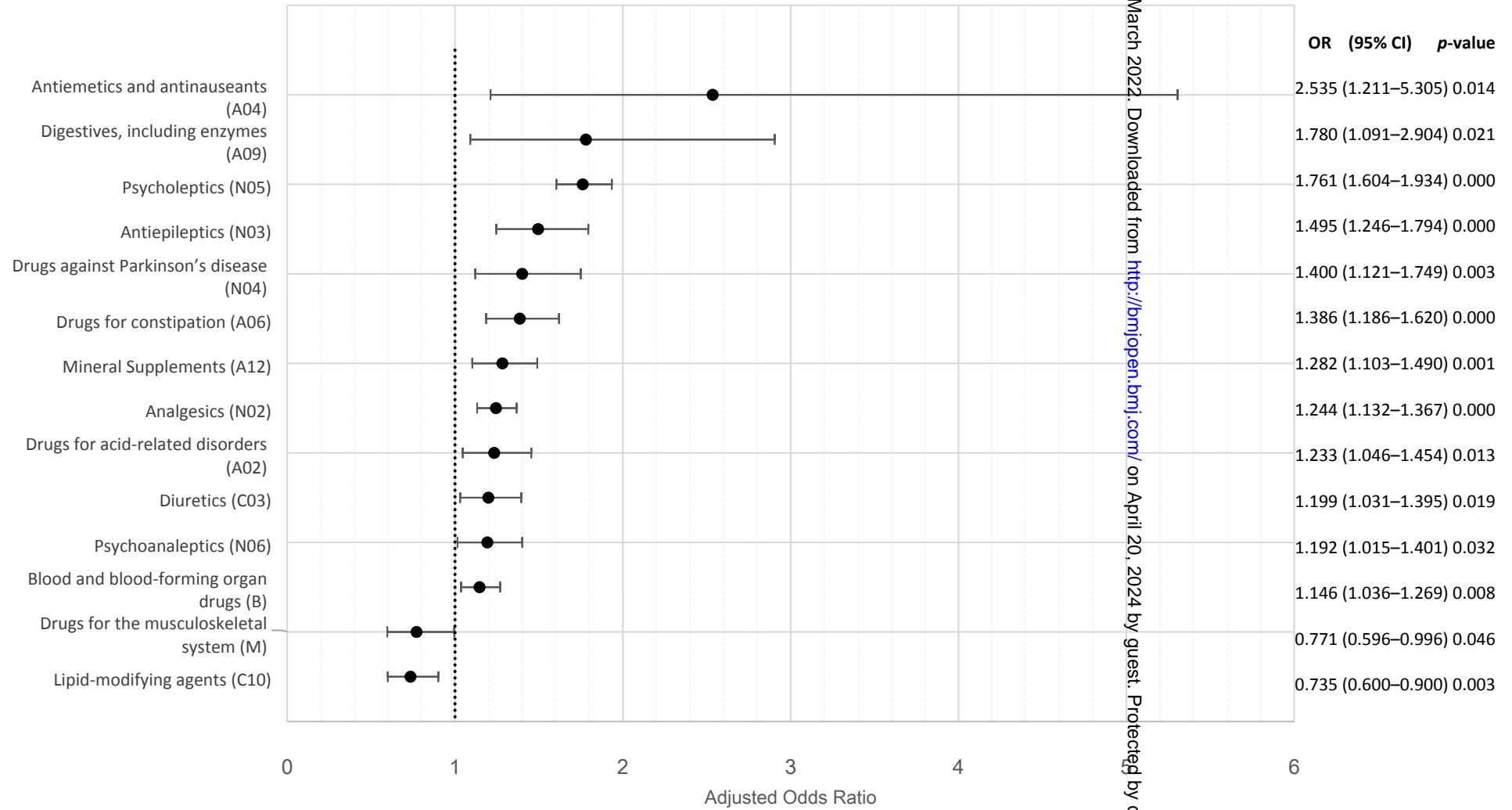


Relationship between unplanned institutionalization and number of prescribed drugs at discharge.

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Supplementary Table 1. Descriptive statistics of prescribed drugs at discharge based on the ATC among the polymedicated older inpatients (N = 14,705)

Drugs by ATC, level 2	Number of drugs per patient	
	Min-Max	Mean (S.D.)
<i>First level, anatomical main group</i>		
Blood and blood-forming organ drugs (B)	0-6	1.16 (0.86)
Dermatologicals (D)	0-3	0.04 (0.22)
Genito urinary system and sex hormones (G)	0-4	0.21 (0.47)
Systemic hormonal preparations, excl. sex hormones and insulins (H)	0-4	0.20 (0.46)
Anti-infective for systemic use (J)	0-4	0.23 (0.46)
Antineoplastic and immunomodulating agents (L)	0-5	0.05 (0.23)
Musculo skeletal system drugs (M)	0-3	0.15 (0.39)
Antiparasitic products, insecticides and repellents (P)	0-2	0.02 (0.13)
Respiratory system drugs (R)	0-7	0.27 (0.72)
Sensory organ drugs (S)	0-6	0.10 (0.40)
<i>Second level, therapeutic subgroup</i>		
Stomatological preparations (A01)	0-1	0.01 (0.06)
Drugs for acid related disorders (A02)	0-3	0.56 (0.52)
Drugs for functional gastrointestinal disorders (A03)	0-3	0.07 (0.28)
Antiemetics and anti-nauseants (A04)	0-1	0.01 (0.08)
Bile and liver therapy drugs (A05)	0-1	0.01 (0.05)
Drugs for constipation (A06)	0-4	0.17 (0.42)
Antidiarrheals, intestinal anti-inflammatory/anti-infective agents (A07)	0-2	0.03 (0.18)
Digestives, incl. enzymes (A09)	0-2	0.02 (0.13)
Drugs used in diabetes (A10)	0-5	0.25 (0.63)
Vitamins (A11)	0-4	0.15 (0.44)
Mineral supplements (A12)	0-3	0.30 (0.51)
Other alimentary tract and metabolism products (A16)	0-1	0.01 (0.05)
Cardio-therapy drugs (C01)	0-4	0.14 (0.41)
Antihypertensives (C02)	0-2	0.02 (0.17)
Diuretics (C03)	0-3	0.28 (0.54)
Peripheral vasodilators (C04)	0-1	0.01 (0.06)
Vaso-protectives (C05)	0-3	0.02 (0.14)
Beta-blocking agents (C07)	0-2	0.45 (0.51)
Calcium channel blockers (C08)	0-2	0.16 (0.37)
Agents acting on the Renin-Angiotensin system (C09)	0-3	0.63 (0.62)
Lipid Modifying agents (C10)	0-3	0.41 (0.52)
Anesthetics (N01)	0-1	0.01 (0.05)
Analgesics (N02)	0-7	1.03 (0.91)
Antiepileptics (N03)	0-5	0.11 (0.36)
Anti-Parkinson drugs (N04)	0-5	0.04 (0.25)
Psycholeptics (N05)	0-7	0.57 (0.77)
Psychoanaleptics (N06)	0-3	0.21 (0.45)
Other nervous system drugs (N07)	0-3	0.03 (0.19)
Total number of drugs	5-32	9.07 (3.32)
N valid - listwise		14,70

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title Abstract (line 34) Line 6 Lines 35 Not applicable, only one hospital register
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Lines 75-148
Objectives	3	State specific objectives, including any prespecified hypotheses			Lines 145-148
Methods					
Study Design	4	Present key elements of study design early in the paper			Lines 151-153
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Lines 155-177

<p>Participants</p>	<p>6</p>	<p>(a) <i>Cohort study</i> - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.</p> <p>RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided.</p> <p>RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.</p>	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Not applicable, only one hospital register</p>
<p>Variables</p>	<p>7</p>	<p>Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.</p>		<p>RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.</p>	<p>Lines 181-222 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
<p>Data sources/ measurement</p>	<p>8</p>	<p>For each variable of interest, give sources of data and details of methods of assessment (measurement).</p>			<p>Lines 181-222 and reported in a previous study:</p>

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		Describe comparability of assessment methods if there is more than one group			https://pubmed.ncbi.nlm.nih.gov/33973865/
Bias	9	Describe any efforts to address potential sources of bias			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Study size	10	Explain how the study size was arrived at			Lines 155-177
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical			Lines 224-241

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		methods taking account of sampling strategy (e) Describe any sensitivity analyses			
Data access and cleaning methods		..		<p>RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.</p> <p>RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.</p>	<p>Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Linkage		..		<p>RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.</p>	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Results					
Participants	13	<p>(a) Report the numbers of individuals at each stage of the study (<i>e.g.</i>, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)</p> <p>(b) Give reasons for non-participation at each stage.</p> <p>(c) Consider use of a flow diagram</p>		<p>RECORD 13.1: Describe in detail the selection of the persons included in the study (<i>i.e.</i>, study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.</p>	<p>Lines 170-177</p>
Descriptive data	14	<p>(a) Give characteristics of study participants (<i>e.g.</i>, demographic, clinical, social) and information on exposures and potential confounders</p>			<p>Lines 243-264</p>

		(b) Indicate the number of participants with missing data for each variable of interest (c) <i>Cohort study</i> - summarise follow-up time (e.g., average and total amount)			
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Lines 243-264
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Lines 277-327
Other analyses	17	Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses			Lines 268-280
Discussion					
Key results	18	Summarise key results with reference to study objectives			Lines 339-342

1 2 3 4 5 6 7 8 9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Lines 405-421
10 11 12 13 14 15 16 17 18	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Lines 333-394
19 20 21	Generalisability	21	Discuss the generalisability (external validity) of the study results			Lines 396-400
22	Other Information					
23 24 25 26 27 28	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Line 451
29 30 31 32 33 34 35	Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Lines 185, 188, 200-201 https://pubmed.ncbi.nlm.nih.gov/33973865/

*Reference: Benchimol EI, Smeeth L, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langen SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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BMJ Open

Unplanned nursing home admission among discharged polymedicated older inpatients: a single-centre, registry-based study in Switzerland

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-057444.R1
Article Type:	Original research
Date Submitted by the Author:	07-Dec-2021
Complete List of Authors:	Pereira, Filipa; University of Porto, Institute of Biomedical Sciences Abel Salazar; HES-SO Valais Wallis, School of Health Sciences Verloo, Henk; HES-SO Valais Wallis, School of Health Sciences von Gunten, Armin; Centre Hospitalier Universitaire Vaudois Département de Psychiatrie del Río Carral, María; University of Lausanne, Institute of Psychology, Research Center for the Psychology of Health, Aging and Sports Examination Meyer-Masseti, Carla; University of Bern, Institute for Primary Health Care (BIHAM) Martins, Maria Manuela; Escola Superior de Enfermagem do Porto, Formação&gestão Wernli, Boris; University of Lausanne, FORS, Swiss Centre of Expertise in the Social Sciences
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Pharmacology and therapeutics, Health informatics
Keywords:	GERIATRIC MEDICINE, CLINICAL PHARMACOLOGY, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, EPIDEMIOLOGY

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4 1 ***Unplanned nursing home admission among discharged polymedicated***
5 2 ***older inpatients: a single-centre, registry-based study in***
6 3 ***Switzerland***
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8 4

9 5 Filipa Pereira^{1,2}, Henk Verloo^{1,3}, Armin von Gunten^c, María del Río Carral⁴, Carla Meyer-Masseti⁵,
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32 Abstract

33 **Objective:** To investigate patient characteristics and the available health and drug data associated
34 with unplanned nursing home admission following an acute hospital admission or readmission.

35 **Design:** A population-based hospital registry study.

36 **Setting:** A public hospital in southern Switzerland (Valais Hospital).

37 **Participants:** We explored a population-based longitudinal dataset of 14,705 hospital admissions from
38 2015–2018.

39 **Outcome measures:** Sociodemographic, health and drug data, and their interactions predicting the
40 risk of unplanned nursing home admission.

41 **Results:** The mean prevalence of unplanned nursing home admission after hospital discharge was
42 6.1%. Our predictive analysis revealed that the oldest adults (OR = 1.07 for each additional year of
43 age; 95%CI 1.05 to 1.08) presenting with impaired functional mobility (OR = 3.22; 95%CI 2.67 to
44 3.87), dependency in the activities of daily living (OR = 4.62; 95%CI 3.76 to 5.67), cognitive
45 impairment (OR=3.75; 95%CI 3.06 to 4.59), and traumatic injuries (OR=1.58; 95%CI 1.25 to 2.01) had
46 a higher probability of unplanned nursing home admission. The number of ICD-10 diagnoses had no
47 significant impact on nursing home admissions, contrarily to the number of prescribed drugs
48 (OR=1.17; 95%CI 1.15 to 1.19). Antiemetics/antinauseants (OR=2.53; 95%CI 1.21 to 5.30), digestives
49 (OR=1.78; 95%CI 1.09 to 2.90), psycholeptics (OR=1.76; 95%CI 1.60 to 1.93), antiepileptics (OR=1.49;
50 95%CI 1.25 to 1.79) and anti-Parkinson's drugs (OR=1.40; 95%CI 1.12 to 1.75) were strongly linked to
51 unplanned nursing home admission.

52 **Conclusions:** Numerous risk factors for unplanned nursing home admission were identified. To
53 prevent the adverse health outcomes that precipitate acute hospitalisations and unplanned nursing
54 home admissions, ambulatory-care providers should consider these risk factors in their care planning
55 for older adults before they reach a state requiring hospitalisation.

56
57 **Keywords:** population-based sample; functional decline; hospital discharge; risk factors; nursing home

58
59 **Strengths and limitations of this study:**

- 60 • A hospital registry of 14,705 hospital admissions, involving 9,430 different polymedicated
61 older adults admitted from their homes, was analysed to determine the risk of unplanned
62 nursing home admission.
- 63 • Bivariate analyses were conducted on independent variables, and generalised estimating
64 equations were computed to predict how sets of predictors influenced the probability of
65 unplanned nursing home admission.
- 66 • Causality analysis was not feasible based on the nature of the routinely collected data.
- 67 • Although the study considered statistical associations between drugs and unplanned nursing
68 home admission, it did not use clinically diagnosed drug–drug interactions.
- 69 • Our data were unable to identify hospitalisations that might have been triggered by limited
70 home-care options or those that became necessary while older adults awaited a place in
71 anursing home.

73 Introduction

74 The hospitalisation of home-dwelling older adults, for any reason and even for a short admission, can
75 lead to substantial functional decline [1, 2]. Both their health disorder itself and the hospital
76 environment can foster such functional decline, increase the risk of future illness and irreversibly
77 diminish their quality of life [1, 2]. Most hospitalised older adult inpatients wish to return home and
78 continue their everyday life as before. However, these different factors may hinder this wish at
79 discharge [3, 4]. The unmet patient needs related to functional decline and safety after returning
80 home can lead to a higher risk of hospital and emergency department readmissions and thus to
81 subsequent unplanned nursing home admission [5]. After hospitalisation, an unplanned nursing home
82 admission can be a devastating and overwhelming experience for older adults and their relatives, and
83 it increases overall healthcare system costs [6].

84 Whether planned or unplanned, nursing home admission commonly follows two paths: (i) within the
85 community, directly from home, or (ii) from hospital, directly transitioning from hospital discharge [2].
86 In the community, transitions to nursing homes are generally the result of thoughtful decisions made
87 by home-dwelling older adults, their families, and health- and social-care providers based on the
88 evolution of the person's long-term health and functional state or on an acute decline and
89 corresponding increase in care needs that cannot be met at home. Recent findings have suggested
90 that the predictors of nursing home admission are mainly based on underlying cognitive and functional
91 impairments combined with a lack of support and assistance in daily living at home [7].

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3 92 The causes of unplanned nursing home admission directly after acute hospital discharge are
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5 93 heterogeneous. There are several reasons why older adults may require long-term care—that cannot
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7 94 be provided in a community setting—following acute hospital admission, e.g. a new medical problem
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9 95 or the worsening of existing chronic disease(s) entailing dependency and requiring complex forms of
10
11 96 care. Furthermore, there may be a breakdown of family circumstances and/or lack of social support.
12
13 97 Bellelli *et al.* showed that advanced age (OR = 4.8; 95% CI 2.6 to 8.9, $p < 0.001$), cognitive impairment
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15 98 (OR = 2.3; 95% CI 1.4 to 3.9, $p < 0.001$) and poor functional status (OR = 10.2; 95% CI 4.7 to 22.5,
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17 99 $p < 0.001$) at discharge from a rehabilitation unit were the main predictors of subsequent nursing home
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19 100 admission [8]. The integrative review by Fogg *et al.* found a similar result for cognitive impairment
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21 101 (OR = 2.14; 95% CI 1.24 to 3.70, $p < 0.001$) [9]. A randomised controlled trial by Landefeld *et al.* found
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23 102 that older inpatients in an acute care medical unit with a decline in their ability to perform one or
24
25 103 more of the basic activities of daily living (ADL) were more often discharged to a nursing home than
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27 104 those with less functional decline (22% and 14 %, respectively; $p < 0.01$) [10]. Ferrucci *et al.* identified
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29 105 stroke, cancer, congestive heart failure, pneumonia, coronary heart disease and hip fractures as the
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31 106 leading medical precipitators of functional decline and nursing home admission [11]. Older adult
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33 107 inpatients are frequently subject to iatrogenic events during hospitalisation, including adverse drug
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35 108 reactions, nosocomial infections, and the consequences of falls, fractures, and using chemical or
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37 109 physical restraints [12]. Such events can lengthen hospitalisation, produce cognitive changes and
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39 110 lessen the ability to perform the ADL, all potentially leading to unplanned nursing home admission
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41 111 [12]. Indeed, hospitalisation causes an increased risk of the onset of acute cognitive decline in the
42
43 112 form of delirium, with a prevalence of up to 60% on some surgical wards [13], often leading to
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45 113 unplanned nursing home admission [14]. Dementia, Parkinson's disease and its associated risk of falls,
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47 114 and behavioural changes are common reasons for deciding to transfer inpatients from hospital to
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49 115 long-term care [15, 16].
50
51 116 Polypharmacy has been associated with adverse health outcomes among home-dwelling older adults
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53 117 [17]. Some prospective studies with small samples have established relationships between drug
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55 118 treatments during acute hospitalisation and unplanned nursing home admission [18]. Cardiovascular
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57 119 drugs (particularly vasodilators, diuretics and anticoagulants), drugs against diabetes, steroids, non-
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59 120 steroidal anti-inflammatory drugs, opiates, antibiotics, anticholinergics and benzodiazepines have all
60
121 been associated with unplanned nursing home admission [18].
122
123 To the best of our knowledge, and despite more frequent post-discharge nursing home admissions in
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Switzerland than in other countries, there is scarce research exploring how unplanned admissions to
nursing homes are related to prior hospitalisation [19]. The present study aimed to investigate the

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3 125 associations between polymedicated older inpatients' sociodemographic and clinical characteristics,
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5 126 drug data and their interactions, and their unplanned nursing home admission following an acute care
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7 127 hospital stay.
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For peer review only

128 **Materials and Methods**

129 ***Study design***

130 The present population-based hospital registry study was conducted with close regard to the
131 REporting of studies Conducted using Observational Routinely collected health Data (RECORD)
132 statement.

133 ***Population and data collection***

134 Our four-year, longitudinal, population-based hospital registry of electronic health records included
135 polymedicated (five and more drugs prescribed) home-dwelling older adults admitted and readmitted
136 to the Valais hospital, a multisite public teaching hospital (1,074 beds) in southern Switzerland with a
137 mean annual number of hospitalisations of approximately 39,000. This registry continues to be
138 analysed as part of a larger project [20]. Ethical approval was obtained from the Human Research
139 Ethics Committee of the Canton of Vaud (2018-02196), and this permitted the partnering hospital's
140 data warehouse to provide the appropriate dataset. Our study defined 'unplanned nursing home
141 admission' as the impossibility for a formerly home-dwelling older inpatient to return there after
142 hospital discharge, and this included any new admission to a nursing home following an acute care
143 admission [2]. All the patients included in the study followed a home to hospital to long-term
144 residential care facility pathway. Nursing homes do not expect their residents to return to
145 independent living in the community. The extracted patient data contained sociodemographic
146 characteristics, medical and surgical diagnoses, routinely assessed clinical data (such as gait, falls risk,
147 hearing or pain) and the drugs prescribed. The medical and surgical diagnoses encoded diagnostic data
148 using the WHO International Classification of Diseases, tenth version (ICD-10), and the Swiss
149 Classification of Surgical Interventions (CHOP) [21]. The hospital dataset showed that discharged
150 patients had been prescribed 2,370 different medicines. The Anatomical Therapeutic Chemical (ATC)
151 classification system's 14 top-level codes were used to structure that dataset of prescribed medicines
152 [22]. The extracted data, from multiple dataset sources, were transformed and synthesised using best
153 practices [23]. Our dataset was composed of 14,705 hospital admissions from home settings between
154 2015 and 2018. Data were without missing values, and there were similar numbers of annual hospital
155 admissions: 3,777, 3,534, 3,724 and 3,670, respectively.

156 ***Patient and public involvement***

157 Patients were not involved in the development of the research questions, study design, outcome
158 measures, or the conduct of the study.

159 ***Dataset customising for predictive analysis***

160 *Synthesising the extracted data*

161 Since where patients had arrived from and where they were discharged to were two distinct variables,
162 the dataset was recoded and customised to identify the number of older inpatients admitted straight
163 from their home and then discharged to a nursing home, as presented in a previous paper [24]. Each
164 subject's unique identifier was used to distinguish between different observations from 2015 to 2018
165 and to account for hospital readmissions. Cases involved 9,430 different older adults, with an average
166 of 1.56 hospital stays per person. Sociodemographic and clinical data were considered independent
167 variables and used to compute the predictive models [24]. Unplanned nursing home admission after
168 discharge from our participating hospital between 2015 and 2018 was identified by the difference
169 between the original abode (home) and the destination at discharge (a nursing home), and this was
170 recoded as the dependent variable of interest.

171 *Sociodemographic and Hospital Variables*

172 The analysis included two sociodemographic control variables: age and sex. Age was considered a
173 continuous variable; its progressive impact was conclusive in preliminary investigations and previous
174 studies [25].

175 *Health Variables*

176 Numerous variables were used to describe older adults' health status at the end of their hospital stay.
177 The modelling analysis included three of the six hierarchical clusters preliminarily computed as being
178 variables significantly associated with more unplanned nursing home admissions in the descriptive
179 analysis: mobility, dependency in the ADL and cognitive status [24]. Cognitive status was measured at
180 an ordinal level using five categorical variables (perception–alertness, orientation, attention, decision-
181 making process and ability to learn). Finally, the year of hospitalisation was introduced as a control
182 variable, based on the fact that hospital admissions occurring earlier in the four-year study were
183 associated with a higher probability of unplanned nursing home admission [24].

184 *Drugs*

185 The WHO ATC Classification System [22] was used to select frequently prescribed drugs at discharge
186 as independent variables for the predictive model. The selection of drug class interactions was based
187 on a literature review and expert opinions [26]. A cut-off point of at least 30 subjects per drug category
188 prescribed was necessary to have a critical mass of data for computing robust statistics. The number
189 of drugs prescribed at hospital discharge was considered continuous.

190

191 **Data analysis strategy**

192 Data were extracted into a Microsoft Excel spreadsheet (Microsoft, Redmond, Washington, United
193 States) and subsequently imported into SPSS software, version 26.0 (IBM Corp, Armonk, New York,
194 United States). Associations with unplanned nursing home admission were examined based on
195 previous studies: patient age and sex, hospital length of stay, the principal and secondary ICD-10
196 diagnoses, surgical interventions (CHOP) and prescribed drugs. No causality analyses were possible
197 because data analysis was retrospective and based on routine data: there was no way of knowing
198 medication regimens or functional status before hospitalisation and how these might be associated
199 with unplanned nursing home admission. A multiple bivariate logistic regression analysis was
200 conducted using cross-tabulations to investigate whether the sociodemographic, health and drugs
201 data (more than one independent variable) significantly predicted unplanned nursing home admission
202 from 2015 to 2018 (our single dichotomous outcome). In a second stage, a series of generalised
203 estimating equations (GEE or population-averaged logistic regression models) were computed to
204 predict how sets of predictors influenced the probability of unplanned nursing home admission. The
205 variables included were derived from the significant associations between sociodemographic
206 characteristics, clinical and medical conditions and unplanned nursing home admission (Table 1). This
207 baseline model was completed using the drugs prescribed to older inpatients who underwent
208 unplanned nursing home admission. Lastly, based on our literature review, known drug–drug
209 interactions between different ATC drug classes were added to the baseline model. The model
210 estimated each predictor’s impact, other things being equal, by estimating its net impact controlling
211 for confounding factors (adjusted odds ratios). This GEE model is generally considered very robust and
212 efficient at dealing with panel or correlated data because it makes few explicit assumptions and is less
213 vulnerable to misspecification [27]. A GEE model predicts for the entire population and not a specific
214 individual. Since the data are based on a whole population, not a sample, the odds ratios’ confidence
215 intervals and statistical tests were used to indicate the robustness of relationships since they normally
216 only make sense for statistical inference.

217 **Results**

218 **Population description**

219 Fifty-five per cent of the population sample were men, and the total sample’s mean age was 78.16
220 years old (SD = 7.65). Mean hospital length of stay was 8.63 days (SD = 7.58) [24].

221 At discharge, 36.8% (n = 7,880) of subjects presented with impaired mobility, with 12.6% (n = 2,574)
222 impaired in their ADL and 10.2% (n = 2,083) having an impaired cognitive status. The mean number of

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3 223 ICD-10 diseases per subject was 4.59 (SD = 0.91), and each older adult's number of ICD-10 diseases
4 was entered into the model as a proxy for multimorbidity. The mean number of surgical interventions
5 224 performed (based on Switzerland's CHOP surgery coding system) [21] was 1.80 per hospitalisation
6 225 (SD = 1.77). The most prevalent medical diagnoses among older inpatients were circulatory (23.4%;
7 226 n = 4,788), infectious (2.7%; n = 559) and respiratory diseases (10.3%; n = 2,111), as well as traumatic
8 227 injuries (11.7%; n = 2,385) and tumours (10.0%; n = 2,041).
9 228

10 229 The mean number of drugs prescribed at hospital discharge was 9.07 (SD = 3.32). Supplementary
11 230 Table 1 presents descriptive statistics of the drugs prescribed at discharge.

12 231 ***Associations between unplanned nursing home admission, sociodemographic characteristics, and*** 13 232 ***the prevalence of clinical and medical conditions***

14 233 We found a prevalence of older adults discharged to unplanned nursing home admission of 6.1%
15 234 (n = 897/N = 14,705) over the whole time period, with a slight decrease in prevalence going forward
16 235 [7.3% (n = 276) in 2015 to 5.9% (n = 217) in 2018]. Bivariate associations showed that men had a lower
17 236 prevalence of unplanned nursing home admission than women [4.0% (n = 328) vs 8.8% (n = 575)], as
18 237 did 65–69-year-old subjects (2.2%; n = 49) compared with those 70–79 years old, 80–89 years old, and
19 238 especially the oldest group, aged 90 or more [3.2% (n = 192), 8.3% (n = 437) and 19.7% (n = 225),
20 239 respectively].

21 240 Being jointly affected by several diseases increased the prevalence of unplanned nursing home
22 241 admission, from 1.8% (n = 5) for older adults with a single disease (ICD-10) to 6.8% (n = 797) for those
23 242 with five diseases. Furthermore, the number of surgical interventions was negatively associated with
24 243 the prevalence of unplanned nursing home admission. Patients who had not undergone surgery
25 244 showed a higher probability of unplanned nursing home admission (7.8%; n = 379) than those who
26 245 had undergone several interventions [3.5% (n = 39) for four interventions, 4.2% (n = 84) for five
27 246 interventions] (Table 1). The number of drugs prescribed at hospital discharge showed a positive linear
28 247 relationship with unplanned nursing home admission (gamma = 0.368) (Figure 1).

29 248 **[Insert Table 1]**

30 249 **[Insert Figure 1]**

31 250 ***Associations between unplanned nursing home admission and drugs***

32 251 Bivariate associations showed that drugs were also related to unplanned nursing home admission
33 252 (Table 2). On average, older adults whose discharge to a nursing home was unplanned had more
34 253 prescribed drugs than those returning home [10.9 (SD = 3.9) drugs vs 8.9 (SD = 3.2)]. Psycholeptics

254 (antipsychotics, anxiolytics, hypnotics and sedatives) and psychoanaleptic drugs (antidepressants,
255 psychostimulants, nootropics and anti-dementia drugs), antiemetics and antinauseants, anti-
256 Parkinson's disease drugs, and drugs treating constipation and the sensory organs were significantly
257 associated with unplanned nursing home admission. On the contrary, patients taking lipid-modifying
258 agents were less prone to unplanned nursing home admission.

259 **[Insert Table 2]**

260 ***Multivariate baseline model***

261 A baseline, GEE logistic regression model, including sociodemographic information, clinical data, and
262 diseases, was computed to predict unplanned nursing home admission among discharged
263 polymedicated older adult patients (Figure 2 and Supplementary Table 2); prescribed drugs at hospital
264 discharge were not included. If the 95% confidence interval (CI) does not overlap the null value (e.g.
265 OR = 1), then the higher the odds ratio, the more the variable contributes to unplanned nursing home
266 admission. Men had a lower probability of unplanned nursing home admission than women
267 (OR = 0.62; 95% CI 0.52 to 0.73). Patients' probability of unplanned nursing home admission increased
268 with age (OR = 1.07 for each additional year of age; 95% CI 1.05 to 1.08). Impaired mobility,
269 dependency in the ADL and cognitive impairment revealed their substantial impacts on unplanned
270 nursing home admission (OR = 3.22; 95% CI 2.67 to 3.87; OR = 4.62; 95% CI 3.76 to 5.67; and OR = 3.75;
271 95% CI 3.06 to 4.59, respectively). Circulatory and infectious diseases were related to lower
272 probabilities of unplanned nursing home admission (OR = 0.78; 95% CI 0.63 to 0.98, and OR = 0.38;
273 95% CI 0.20 to 0.70, respectively), whereas traumatic injuries were related to higher probabilities
274 (OR = 1.58; 95% CI 1.25 to 2.01). The number of ICD-10 diagnoses alone had no significant impact on
275 the odds of unplanned nursing home admission (OR = 1.11; 95% CI 0.98 to 1.24), in contrast to the
276 number of surgical interventions undergone (CHOP), which was a protective factor against unplanned
277 hospitalisation (OR = 0.95; 95% CI 0.90 to 0.99). The year of hospital stay also had a significant impact,
278 with more recent stays having lower probabilities of unplanned nursing home admission (OR = 0.88;
279 95% CI 0.82 to 0.94, per ensuing year).

280 **[Insert Figure 2]**

281 ***Prediction of unplanned nursing home admission and drug prescription***

282 A higher number of prescribed drugs was associated with a higher probability of unplanned nursing
283 home admission (OR = 1.17; 95% CI 1.15 to 1.19). Figure 3 and Supplementary Table 3 present the
284 baseline GEE logistic regression model shown in Figure 2 completed with those drugs prescribed to
285 older adults at discharge that had a significant statistical association ($p < 0.05$) with unplanned nursing

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3 286 home admission. Drugs without a significant statistical association are not presented in Figure 3 for
4 simplification purposes. Antiemetics and antinauseants (OR = 2.53; 95% CI 1.21 to 5.30 for each
5 287 additional unit), digestives (OR = 1.78; 95% CI 1.09 to 2.90), psycholeptics (OR = 1.76; 95% CI 1.60 to
6 288 1.93), antiepileptics (OR = 1.49; 95% CI 1.25 to 1.79) and anti-Parkinson's disease drugs (OR = 1.40;
7 289 95% CI 1.12 to 1.75) were strongly linked to unplanned nursing home admission after controlling for
8 290 other parameters. On the contrary, taking lipid-metabolism-modifying agents was associated with
9 291 lower probabilities of unplanned nursing home admission (OR = 0.73; 95% CI 0.60 to 0.90, for each
10 292 extra drug from this class prescribed).
11 293

12 294 **[Insert Figure 3]**

13 295 ***Combined drug intake and probabilities of unplanned nursing home admission***

14 296 To reduce collinearity and simplify the results, the combined intake of different ATC drug classes was
15 297 recoded as a dichotomised variable for each drug pairing and added to the previous model [22]. Only
16 298 the drugs and drug combinations prescribed to older adults at discharge that had significant
17 299 associations ($p < 0.05$) with unplanned nursing home admission are presented. The combined intake
18 300 of cardiac therapy and psychoanaleptic drugs was significantly associated with unplanned nursing
19 301 home admission (OR = 1.87; 95% CI 1.11 to 3.16), as were psychoanaleptics and diabetes drugs
20 302 combined (OR = 1.75; 95% CI 1.03 to 2.98), and psycholeptic drugs and vitamins combined (OR = 1.71;
21 303 95% CI 1.03 to 2.84). On the contrary, the combined intake of beta-blocking agents and antiepileptics
22 304 strongly diminished the odds of unplanned nursing home admission (OR = 0.39; 95% CI 0.23 to 0.67).
23 305 We also investigated the risk of unplanned nursing home admission for combined drug intake within
24 306 the same drug class. The combined intake of two or more antiemetic and antinauseants (OR = 2.65;
25 307 95% CI 1.26 to 5.58), psycholeptics (OR = 1.64; 95% CI 1.46 to 1.85), antiepileptics (OR = 1.55; 95% CI
26 308 1.23 to 1.96) or anti-Parkinson's disease drugs (OR = 1.44; 95% CI 1.13 to 1.83) were strongly
27 309 associated with a higher probability of unplanned nursing home admission.

28 310 Supplementary Table 4 summarises the main findings from our predictive analysis.

29 311 **Discussion**

30 312 This population-based hospital registry study used longitudinal data to examine the unplanned nursing
31 313 home admission of hospitalised polymedicated older inpatients, revealing a 6.1% prevalence rate over
32 314 the four-year dataset, in agreement with previous work by Luppa *et al.* (men: 5.4%; women: 6.0%)
33 315 and Goodwin *et al.* (5.5%) [7, 28]. The slight decrease in prevalence over the four years of the study
34 316 may be explained by improvements in the regional home-care services' contribution to maintaining
35 317 older adults at home, but also to planned nursing home admissions without the requirement for

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3 318 intermediate hospitalisation [29]. Furthermore, the number of places in the region's nursing homes
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5 319 increased in that period [30], allowing people for whom care at home became impossible to be
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7 320 admitted to a nursing home more promptly.

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9 321 Our predictive analysis revealed that the group of the oldest adults, presenting functional mobility
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11 322 impairments, dependency in the ADL and cognitive impairment, was also at a high risk of unplanned
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13 323 nursing home admission, which is consistent with previous retrospective and prospective studies [31,
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15 324 32]. Very old inpatients (≥ 90 years old) had an almost tenfold higher risk of unplanned nursing home
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17 325 admission than those aged 65–69. This was expected and matched with previous research [33],
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19 326 bearing in mind that the very oldest group presented with a high prevalence of multimorbidity and
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21 327 advanced functional and cognitive impairments. Unexpectedly, regardless of age, our results showed
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23 328 that older women had a higher prevalence and probability of unplanned nursing home admission than
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25 329 men [34]. Yet, our data could not entirely explain this result. Previous publications have indicated that
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27 330 social and life-expectancy factors may play roles in the different rates of nursing home admission
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29 331 between older adult men and women [34].

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31 332 Our findings highlighted that functional and cognitive impairments were strong risk factors for
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33 333 unplanned nursing home admission, which is in line with the studies by Luppá *et al.* and Goodwin *et*
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35 334 *al.* [28, 34]. Likewise, our results emphasised a high risk of unplanned nursing home admission among
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37 335 non-surgically treated and trauma patients. This could be explained by the relationship between
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39 336 orthopaedic guidelines on traumatic injuries among older adults that suggest avoiding surgery, for
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41 337 several medical reasons (number and severity of multimorbidities), and which may lead to increased
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43 338 functional impairment and unplanned nursing home admission, as suggested by Gardner *et al.* and
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45 339 Cutugno [35, 36].

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47 340 As might be expected, older adults who underwent an unplanned nursing home admission had more
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49 341 prescribed drugs than those returning home. Our results were in line with the retrospective study by
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51 342 Lucchetti *et al.*, which demonstrated a relationship between the prescription of cardiovascular,
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53 343 gastrointestinal, and metabolic drugs and unplanned nursing home admission [37].

54
55 344 Our findings indicated that patients prescribed more than one drug from the same class of drugs—
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57 345 from the classes of antiemetics and antinauseants, psycholeptics, antiepileptics, or anti-Parkinson's
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59 346 disease drugs—had a higher risk of discharge to a nursing home. Although this phenomenon is still
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347 under-investigated, our findings are not in line with the few existing studies in this area, which have
348 presented no significant relationships between drug interactions and unplanned nursing home
349 admission [38]. However, in hospital settings, a recent systematic review reported drug–drug
350 interactions among 80% or more of older inpatients [39]. Since polymedicated older inpatients should

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3 351 be considered as a population at a high risk of adverse outcomes, further studies should investigate
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5 352 how drug–drug interactions might predict the risks of nursing home admission.
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7 353 Our findings undeniably mirrored existing evidence that chronic conditions and debilitating
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9 354 comorbidities are significant risk factors for unplanned nursing home admission [3, 7]. However, they
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11 355 also raised questions regarding hospitalisation’s effects on the individual ageing process, which likely
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13 356 interact to produce a cascade of factors towards functional decline and dependency [1]. The adverse
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15 357 effects of hospitalisation begin immediately and progress rapidly [1]. Harrison *et al.* and Haaksma *et*
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17 358 *al.* described ways in which acute and exacerbated acute and chronic disorders, reinforced by existing
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19 359 undiagnosed geriatric syndromes (frailty, delirium, pressure sores, functional incontinence),
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21 360 contributed to hospitalised older patients being unable to return home and needing to be discharged
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23 361 to a nursing home [2, 16]. Previous studies suggested that silent geriatric syndromes such as frailty
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25 362 and functional decline, together with polypharmacy, are not only clinically characteristic of older
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27 363 adults but also potential predictors of being at risk of a further loss of independence and subsequent
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29 364 nursing home admission. Montes *et al.* pointed out the dramatic rise in numbers of frail, hospitalised
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31 365 older adults. This increase generates concerns about whether nursing homes—already suffering from
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33 366 long admission waiting lists of home-dwelling older adults—will be able to cope with older adults’
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35 367 complex care needs [40].

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37 368 Although some of the predisposing predictors identified cannot be treated (i.e. sex, age), they may
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39 369 still contribute to an older adult’s risk of being discharged to a nursing home and subsequently
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41 370 exacerbate their situation there. Given that hospitalisation introduces stressors that may increase the
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43 371 chances of unplanned nursing home admission [41, 42], using patients’ electronic hospital data could
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45 372 help identify the high-risk older adults who would benefit from specific preventive interventions.
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47 373 Being able to rapidly identify inpatients at a high risk of unplanned nursing home admission may help
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49 374 professional caregivers to provide them with the appropriate community-health resources, such as
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51 375 community-based rehabilitation programmes. This would help older people to remain in their
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53 376 community for longer.

54 377 ***Study strengths and limitations***

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56 378 Although our population-based study’s findings could be generalised to other regions of Switzerland,
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58 379 any interpretations should be made with caution. Nevertheless, our findings could provide
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60 380 information to help better define which integrated healthcare approaches could be implemented to
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382 attenuate the risk factors associated with unplanned nursing home admission following an acute
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384 hospital admission or readmission. The numerous predictors revealed in our study enabled us to
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386 conceptualise an overview of hospitalised older adults’ health conditions before their unplanned

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3 384 nursing home admission. As healthcare moves towards ever-more personalised medicine, this result
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5 385 could help create more refined, tailored, future interventions via 'risk profiles' defined using each
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7 386 older adult's personal predictors.

8
9 387 Our study had some limitations. The absence of data on patients' functional status before hospital
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11 388 admission meant that we could not assess changes to that status during hospitalisation, such as the
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13 389 influence of the development or deterioration of functional and cognitive impairment. We did not
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15 390 compute analysis on specific disorders such as neurodegenerative diseases like dementia and
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17 391 Parkinson's disease because this was beyond the scope of our study protocol. However, further
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19 392 analyses could confirm earlier studies showing that these diseases significantly affect a person's risk
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21 393 of nursing home admission after hospitalisation, with almost 90% of patients with dementia being
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23 394 admitted into a nursing home before dying [15, 16]. Although the study considered statistical
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25 395 associations between drugs and unplanned nursing home admission, it did not use clinically diagnosed
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27 396 drug-drug interactions. Lastly, our data were unable to identify hospitalisations that might have been
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29 397 triggered by limited care options at home or hospitalisations that were necessary while awaiting a
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31 398 place in a nursing home. These cases of planned nursing home admissions could not be distinguished
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33 399 from the unplanned nursing home admissions considered in the study. In addition, some patients may
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35 400 not have been transferred directly from hospital to nursing homes and may have had to stay in an
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37 401 intermediate structure while awaiting a place. These patients were not included in the study due to
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39 402 the unavailability of this information in the database.

403 **Conclusion**

404 The sociodemographic characteristics of hospitalised older inpatients, together with their clinical and
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406 405 medical conditions and their prescribed drugs, can provide us with a significant set of risk factors for
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408 406 unplanned nursing home admission, sustaining our stated hypotheses. Identifying these risk factors
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410 407 for unplanned nursing home admission could be of great assistance in developing predictive tools and
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412 408 tailored intervention programmes aimed at reducing the number of older adults placed in nursing
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414 409 homes. Our results showed that the patient-related risk factors leading to nursing home admission
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416 410 were based on declines in physical and cognitive function. Treatment with single drugs and
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418 411 combinations of drugs were also associated with unplanned nursing home admission, indicating that
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420 412 multiple chronic health conditions are important risk factors of a non-return home. Our findings may
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422 413 help to identify those older inpatients at the greatest risk of unplanned nursing home admission,
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424 414 enabling their care to be optimised by counterbalancing those risk factors. Further research is required
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426 415 across large samples of older inpatients to investigate whether tailored interventions at early stages

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3 416 in chronic diseases could delay physical and cognitive dysfunction and reduce unplanned nursing
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5 417 home admissions among this growing segment of the population.

6 7 418 **Acknowledgement**

8
9 419 The authors thank the partner hospital, including the hospital's data warehouse, for its valuable
10
11 420 contributions.

12 13 421 **Ethics approval and patient consent**

14 422 Ethical approval was obtained from the Human Research Ethics Committee of the Canton of Vaud
15
16 423 (CER-VD, 2018-02196), thus permitting our partner hospital's data warehouse to provide the
17
18 424 appropriate dataset. Given the retrospective data source, obtaining consent from the patients
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20 425 concerned was impossible or posed disproportionate difficulties. The present study respects the legal
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22 426 requirements for research projects involving data re-use without consent, as set out in Art. 34 from
23
24 427 the Swiss Human Research Act (HTA).

25 428 **Conflict of Interest Statement**

26
27 429 The authors have no conflicts of interest to declare.

28 29 430 **Funding Sources**

30
31
32 431 This work was supported by Swiss National Science Foundation grant number 407440_183434/1.

33 34 432 **Author Contributions**

35
36 433 BW, FP, and HV had the original idea. BW, MdRC, MMM and HV provided conceptual and
37
38 434 methodological expertise to the study design and BW, FP, CMM, AvG, and HV to data analysis and
39
40 435 interpretation. BW, FP, and HV were major contributors to writing the manuscript. All authors read,
41
42 436 edited, and approved the final manuscript.

43 44 437 **Data Availability Statement**

45
46 438 As part of the Data Use Agreement, authors are not allowed to provide raw data. Upon a reasonable
47
48 439 request, the corresponding author will provide statistical programming code used to generate results.

49 440

50 51 **Figure Legends**

52
53 Figure 1. Relationship between unplanned nursing home admission and number of prescribed drugs
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55 at discharge.
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3 Figure 2. Baseline GEE logistic regression model with unplanned nursing home admission as the
4 dependent variable associated with sociodemographic, hospitalisation, and independent clinical and
5 medical variables (N = 14,705 observations for 9,430 different subjects).
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9 Figure 3. The GEE logistic regression model of the drugs prescribed to older adults at discharge with
10 significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705
11 observations for 9,430 different subjects).
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551 Table 1. Prevalence of unplanned nursing home admissions with regards to associations with
 552 sociodemographic characteristics and clinical and medical conditions among polymedicated
 553 hospitalised older adults (N = 14,705)

Variables	Unplanned nursing home admission, n (%)	p-value
Overall sample of older adults (n = 14,705)	897 (6.1)	
Sex		$p < 0.001$
Female/Male	575 (8.8)/328 (4.0)	
Age in years		$p < 0.001$
65–69 years	49 (2.2)	
70–79 years	192 (3.2)	
80–89 years	437 (8.3)	
90 years or more	225 (19.7)	
Mobility		$p < 0.001$
Full ability (0) / impairment (1)	214 (2.0)/689 (16.7)	
Dependence in the activities of daily living		$p < 0.001$
Full ability (0)/impairment (1)	472 (3.4)/431 (44.8)	
Mental status		$p < 0.001$
Full ability (0)/impairment (1)	531 (3.8)/ 372 (41.3)	
ICD-10 principal diagnosis: circulatory problems		$p < 0.001$
No (0)/Yes (1)	752 (6.7)/ 151 (4.3)	
ICD-10 principal diagnosis: infection		$p < 0.01$
No (0)/Yes (1)	892 (6.2)/ 11 (2.7)	
ICD-10 principal diagnosis: respiratory problems		Ns
No (0)/Yes (1)	797 (6.1)/106 (6.8)	
ICD-10 principal diagnosis: traumatic injuries		$p < 0.001$
No (0)/Yes (1)	720 (5.3)/183 (14.9)	
ICD-10 principal diagnosis: tumor		$p < 0.01$
No (0)/Yes (1)	835 (6.4)/ 68 (4.3)	
Number of ICD-10 diseases		$p < 0.001$
1	5 (1.8)	
2	17 (2.9)	
3	37 (3.9)	
4	47 (3.9)	
5 or more	797 (6.8)	
Number of surgical interventions (CHOP)		$p < 0.001$
0	379 (7.8)	
1	187 (6.4)	
2	135 (5.8)	
3	79 (5.2)	
4	39 (3.5)	
5 or more	84 (4.2)	
Year of hospitalisation		$p < 0.01$
2015	276 (7.3)	
2016	216 (6.1)	

2017	194 (5.2)	
2018	217 (5.9)	

555 Note. Ns = non significant

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557 Table 2. Prevalence of unplanned nursing home admission among polymedicated hospitalised older
558 adults (N = 14,705) with regards to associations with different classes of prescribed drugs

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Drugs (ATC code)	Unplanned nursing home admission		
	No drugs in this class n (%)	Drugs in this class n (%)	p-value
<i>First level, main anatomical group</i>			
Blood and blood-forming organ drugs (B)	180 (5.4)	723 (6.4)	ns
Dermatologicals (D)	828 (5.8)	75 (14.1)	$p < 0.001$
Genito-urinary system and sex hormones (G)	737 (6.1)	6.3%	ns
Systemic hormonal preparations, excluding sex hormones and insulins (H)	737 (6.1)	6.5%	ns
Anti-infectives for systemic use (J)	736 (6.4)	167 (5.3)	$p < 0.05$
Antineoplastic and immunomodulating agents (L)	881 (6.3)	22 (3.5)	$p < 0.01$
Drugs for the musculoskeletal system (M)	815 (6.4)	88 (4.3)	$p < .001$
Antiparasitic products, insecticides, and repellents (P)	893 (6.2)	10 (4.0)	Ns
Respiratory system drugs (R)	771 (6.3)	132 (5.5)	Ns
Sensory organ drugs (S)	752 (5.5)	151 (13.4)	$p < 0.001$
<i>Second level, therapeutic subgroup</i>			
Stomatological preparations (A01)	899 (6.1)	4 (7.5)	ns
Drugs for acid-related disorders (A02)	384 (5.8)	519 (6.4)	ns
Drugs for functional gastrointestinal disorders (A03)	805 (5.9)	98 (9.8)	$p < 0.001$
Antiemetics and antinauseants (A04)	884 (6.1)	19 (18.6)	$p < 0.001$
Bile and liver therapy drugs (A05)	900 (6.1)	3 (7.9)	ns
Drugs for constipation (A06)	605 (4.8)	298 (13.5)	$p < 0.001$
Antidiarrheals, intestinal anti-inflammatory/anti-infective agents (A07)	863 (6.0)	40 (9.4)	$p < 0.01$
Digestives, including enzymes (A09)	883 (6.1)	20 (8.4)	Ns
Diabetes drugs (A10)	804 (6.6)	99 (3.9)	$p < 0.001$
Vitamins (A11)	801 (6.2)	102 (5.9)	ns
Mineral supplements (A12)	513 (4.8)	390 (9.6)	$p < 0.001$
Other alimentary tract and metabolism products (A16)	901 (6.1)	2 (5.9)	ns
Cardiac therapy drugs (C01)	792 (6.1)	111 (6.3)	ns
Antihypertensives (C02)	888 (6.2)	15 (4.6)	ns
Diuretics (C03)	621 (5.5)	282 (8.1)	$p < 0.001$
Peripheral vasodilators (C04)	901 (6.1)	2 (4.2)	ns
Vasoprotectives (C05)	884 (6.1)	19 (7.2)	ns
Beta blocking agents (C07)	588 (7.2)	315 (4.8)	$p < 0.001$
Calcium channel blockers (C08)	762 (6.1)	141 (6.1)	ns
Agents acting on the renin-angiotensin system (C09)	472 (7.2)	431 (5.3)	$p < 0.001$
Lipid-modifying agents (C10)	720 (8.2)	183 (3.1)	$p < 0.001$
Anesthetics (N01)	898 (6.1)	5 (13.5)	ns
Analgesics (N02)	158 (3.6)	745 (7.2)	$p < 0.001$
Antiepileptics (N03)	753 (5.7)	150 (10.3)	$p < 0.001$
Drugs against Parkinson's disease (N04)	814 (5.7)	89 (18.1)	$p < 0.001$
Psycholeptics (N05)	201 (2.4)	702 (11.0)	$p < 0.001$

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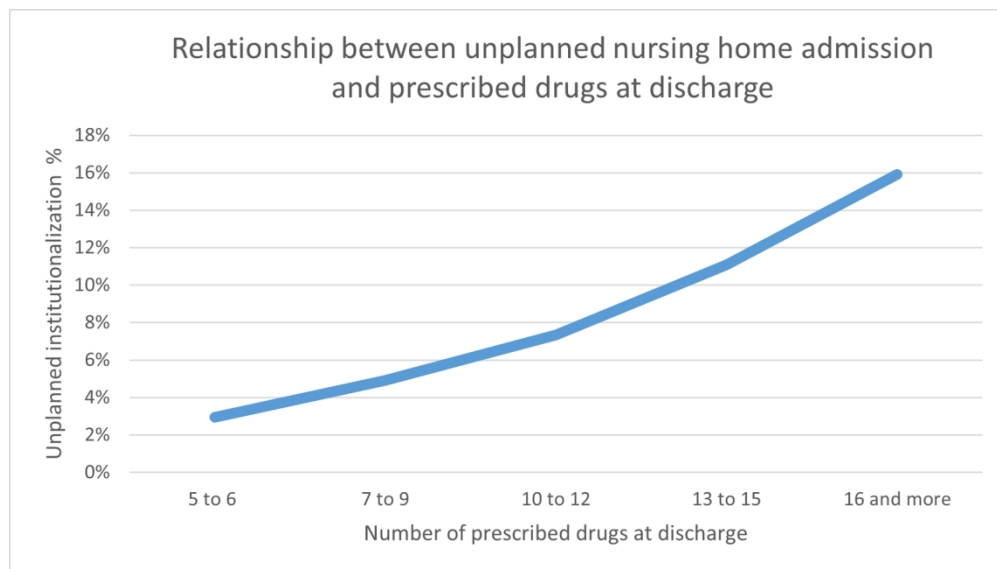
Psychoanaleptics (N06)	565 (4.8)	338 (11.9)	$p < 0.001$
Other nervous system drugs (N07)	881 (6.1)	22 (5.9)	ns

Note. Ns = non significant

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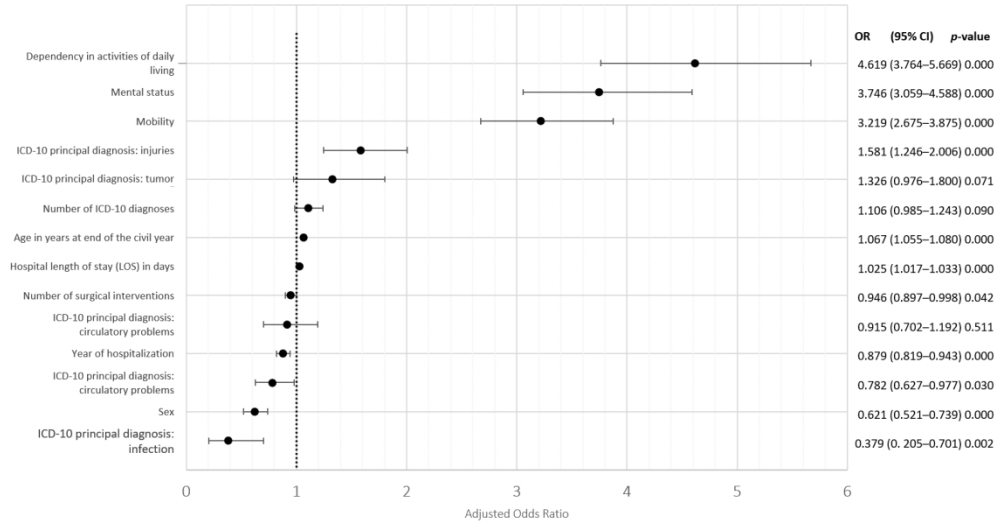
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Relationship between unplanned nursing home admission and number of prescribed drugs at discharge.

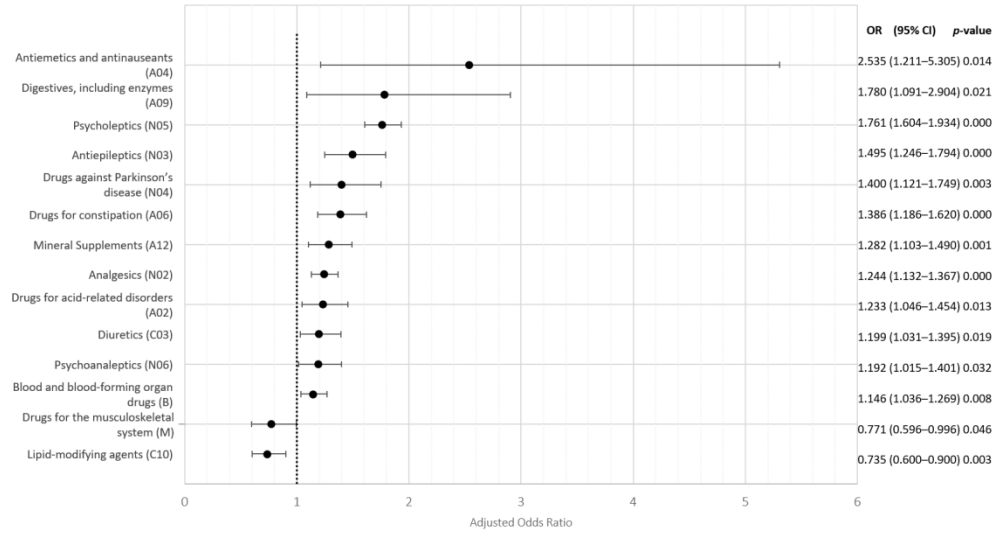
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Baseline GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

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The GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705 observations for 9,430 different subjects).

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Supplementary Table 1. Descriptive statistics of prescribed drugs at discharge based on the ATC among the polymedicated older inpatients (N = 14,705)

Drugs by ATC, level 2	Number of drugs per patient	
	Min-Max	Mean (S.D.)
<i>First level, anatomical main group</i>		
Blood and blood-forming organ drugs (B)	0-6	1.16 (0.86)
Dermatologicals (D)	0-3	0.04 (0.22)
Genito urinary system and sex hormones (G)	0-4	0.21 (0.47)
Systemic hormonal preparations, excl. sex hormones and insulins (H)	0-4	0.20 (0.46)
Anti-infective for systemic use (J)	0-4	0.23 (0.46)
Antineoplastic and immunomodulating agents (L)	0-5	0.05 (0.23)
Musculo skeletal system drugs (M)	0-3	0.15 (0.39)
Antiparasitic products, insecticides and repellents (P)	0-2	0.02 (0.13)
Respiratory system drugs (R)	0-7	0.27 (0.72)
Sensory organ drugs (S)	0-6	0.10 (0.40)
<i>Second level, therapeutic subgroup</i>		
Stomatological preparations (A01)	0-1	0.01 (0.06)
Drugs for acid related disorders (A02)	0-3	0.56 (0.52)
Drugs for functional gastrointestinal disorders (A03)	0-3	0.07 (0.28)
Antiemetics and antinauseants (A04)	0-1	0.01 (0.08)
Bile and liver therapy drugs (A05)	0-1	0.01 (0.05)
Drugs for constipation (A06)	0-4	0.17 (0.42)
Antidiarrheals, intestinal antiinflammatory/antiinfective agents (A07)	0-2	0.03 (0.18)
Digestives, incl. enzymes (A09)	0-2	0.02 (0.13)
Drugs used in diabetes (A10)	0-5	0.25 (0.63)
Vitamins (A11)	0-4	0.15 (0.44)
Mineral supplements (A12)	0-3	0.30 (0.51)
Other alimentary tract and metabolism products (A16)	0-1	0.01 (0.05)
Cardio-therapy drugs (C01)	0-4	0.14 (0.41)
Antihypertensives (C02)	0-2	0.02 (0.17)
Diuretics (C03)	0-3	0.28 (0.54)
Peripheral vasodilators (C04)	0-1	0.01 (0.06)
Vaso-protectives (C05)	0-3	0.02 (0.14)
Beta-blocking agents (C07)	0-2	0.45 (0.51)
Calcium channel blockers (C08)	0-2	0.16 (0.37)
Agents acting on the Renin-Angiotensin system (C09)	0-3	0.63 (0.62)
Lipid Modifying agents (C10)	0-3	0.41 (0.52)
Anesthetics (N01)	0-1	0.01 (0.05)
Analgesics (N02)	0-7	1.03 (0.91)
Antiepileptics (N03)	0-5	0.11 (0.36)
Anti-Parkinson drugs (N04)	0-5	0.04 (0.25)
Psycholeptics (N05)	0-7	0.57 (0.77)
Psychoanaleptics (N06)	0-3	0.21 (0.45)
Other nervous system drugs (N07)	0-3	0.03 (0.19)
Total number of drugs	5-32	9.07 (3.32)
N valid - listwise		14,70

Supplementary Table 2. Baseline, GEE logistic regression model with unplanned institutionalization as the dependent variable associated with sociodemographic, hospitalization, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

Variables	Odds Ratio	<i>p</i> > <i>z</i>	95% Confidence Interval
Sex ¹	0.62	< 0.000	0.52–0.74
Age in years	1.07	< 0.000	1.05–1.08
Hospital length of stay (LOS) in days	1.02	< 0.000	1.02–1.03
Mobility ²	3.22	< 0.000	2.67–3.87
Dependency in the activities of daily living ²	4.62	< 0.000	3.76–5.67
Mental status ²	3.75	< 0.000	3.06–4.59
ICD-10 principal diagnosis: circulatory problems ³	0.78	0.030	0.63–0.98
ICD-10 principal diagnosis: infection ³	0.38	0.002	0.20–0.70
ICD-10 principal diagnosis: respiratory problems ³	0.91	0.511	0.70–1.19
ICD-10 principal diagnosis: injuries ³	1.58	< 0.000	1.25–2.01
ICD-10 principal diagnosis: tumor ³	1.33	0.071	0.98–1.80
Number of ICD-10 diagnoses	1.11	0.090	0.98–1.24
Number of surgical interventions (CHOP)	0.95	0.042	0.90–0.99
Number of prescribed drugs	1.17	0.000	1.15–1.19
Year of hospitalization: 2015 to 2018	0.88	< 0.000	0.82–0.94

Note. 1: 0 = woman, 1 = man; 2: 0 = normal status, 1 = poor status; 3: 0 = no, 1 = yes

Supplementary Table 3. GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned institutionalization (N = 14,705 observations for 9,430 different subjects).

Drugs	Odds Ratio	$p > z$	95% Confidence Interval
Antiemetics and antinauseants (A04)	2.53	0.014	1.21–5.30
Digestives, including enzymes (A09)	1.78	0.021	1.09–2.90
Psycholeptics (N05)	1.76	0.000	1.60–1.93
Antiepileptics (N03)	1.49	0.000	1.25–1.79
Anti-Parkinson drugs (N04)	1.40	0.003	1.12–1.75
Drugs for constipation (A06)	1.39	0.000	1.19–1.62
Mineral Supplements (A12)	1.28	0.001	1.10–1.49
Analgesics (N02)	1.24	0.000	1.13–1.37
Drugs for acid related disorders (A02)	1.23	0.013	1.05–1.45
Diuretics (C03)	1.20	0.019	1.03–1.39
Psychoanaleptics (N06)	1.19	0.032	1.01–1.40
Blood and blood-forming organ drugs (B)	1.15	0.008	1.04–1.27
Drugs for the musculoskeletal system (M)	0.77	0.046	0.60–0.99
Lipid-modifying agents (C10)	0.73	0.003	0.60–0.90

Supplementary Table 4. Factors associated with a higher and lower probability of unplanned nursing home admission among polymedicated hospitalised older adults (N = 14,705): summary of the predictive analysis.

Risk factors for a higher probability of unplanned nursing home admission
- Dependency in the activities of daily living (OR = 4.62, 95% CI: 3.76–5.67)
- Cognitive impairment (OR = 3.75, 95% CI: 3.06–4.59)
- Functional mobility impairment (OR = 3.22, 95% CI: 2.67–3.87)
- Antiemetics/antinauseants (OR = 2.53, 95% CI: 1.21–5.30)
- Digestives (OR = 1.78, 95% CI: 1.09–2.90)
- Psycholeptics (OR = 1.76, 95% CI: 1.60–1.93)
- Injuries (OR = 1.58, 95% CI: 1.25–2.01)
- Antiepileptics (OR = 1.49, 95% CI: 1.25–1.79)
- Anti-Parkinson's drugs (OR = 1.40, 95% CI: 1.12–1.75)
- Number of prescribed drugs (OR = 1.17, 95% CI: 1.15–1.19)
- Older age (OR = 1.07, 95% CI: 1.05–1.08)
Combined intake of:
- cardiac and psychoanaleptic drugs (OR = 1.87, 95% CI: 1.11–3.16)
- psychoanaleptic and diabetes drugs (OR = 1.75, 95% CI: 1.03–2.98)
- psycholeptic drugs and vitamins (OR = 1.71, 95% CI: 1.03–2.84)
Combined intake of two or more:
- antiemetics and antinauseants (OR = 2.65, 95% CI: 1.26–5.58)
- psycholeptics (OR = 1.64, 95% CI: 1.46–1.85)
- antiepileptics (OR = 1.55, 95% CI: 1.23–1.96)
- anti-Parkinson's drugs (OR = 1.44, 95% CI: 1.13–1.83)
Protective factors for a lower probability of unplanned nursing home admission
- Surgical interventions (OR = 0.95, 95% CI: 0.90–0.99)
- Circulatory diseases (OR = 0.78, 95% CI: 0.63–0.98)
- Lipid metabolism modifying agents (OR = 0.73, 95% CI: 0.60–0.90)
- Male sex (OR = 0.62; 95% CI: 0.52–0.73)
- Combined intake of beta-blocking agents and antiepileptics (OR = 0.39, 95% CI: 0.23–0.67)
- Infectious diseases (OR = 0.38, 95% CI: 0.20–0.70)

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title Abstract (line 34) Line 6 Lines 35 Not applicable, only one hospital register
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Lines 75-148
Objectives	3	State specific objectives, including any prespecified hypotheses			Lines 145-148
Methods					
Study Design	4	Present key elements of study design early in the paper			Lines 151-153
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Lines 155-177

<p>Participants</p>	<p>6</p>	<p>(a) <i>Cohort study</i> - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.</p> <p>RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided.</p> <p>RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.</p>	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Not applicable, only one hospital register</p>
<p>Variables</p>	<p>7</p>	<p>Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.</p>		<p>RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.</p>	<p>Lines 181-222 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
<p>Data sources/ measurement</p>	<p>8</p>	<p>For each variable of interest, give sources of data and details of methods of assessment (measurement).</p>			<p>Lines 181-222 and reported in a previous study:</p>

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		Describe comparability of assessment methods if there is more than one group			https://pubmed.ncbi.nlm.nih.gov/33973865/
Bias	9	Describe any efforts to address potential sources of bias			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Study size	10	Explain how the study size was arrived at			Lines 155-177
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical			Lines 224-241

		methods taking account of sampling strategy (e) Describe any sensitivity analyses			
Data access and cleaning methods		..		<p>RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.</p> <p>RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.</p>	<p>Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Linkage		..		<p>RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.</p>	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Results					
Participants	13	<p>(a) Report the numbers of individuals at each stage of the study (<i>e.g.</i>, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)</p> <p>(b) Give reasons for non-participation at each stage.</p> <p>(c) Consider use of a flow diagram</p>		<p>RECORD 13.1: Describe in detail the selection of the persons included in the study (<i>i.e.</i>, study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.</p>	<p>Lines 170-177</p>
Descriptive data	14	<p>(a) Give characteristics of study participants (<i>e.g.</i>, demographic, clinical, social) and information on exposures and potential confounders</p>			<p>Lines 243-264</p>

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		(b) Indicate the number of participants with missing data for each variable of interest (c) <i>Cohort study</i> - summarise follow-up time (e.g., average and total amount)			
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Lines 243-264
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Lines 277-327
Other analyses	17	Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses			Lines 268-280
Discussion					
Key results	18	Summarise key results with reference to study objectives			Lines 339-342

1 2 3 4 5 6 7 8 9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Lines 405-421
10 11 12 13 14 15 16 17 18	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Lines 333-394
19 20 21	Generalisability	21	Discuss the generalisability (external validity) of the study results			Lines 396-400
22	Other Information					
23 24 25 26 27 28	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Line 451
29 30 31 32 33 34 35	Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Lines 185, 188, 200-201 https://pubmed.ncbi.nlm.nih.gov/33973865/

*Reference: Benchimol EI, Smeeth L, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langin SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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BMJ Open

Unplanned nursing home admission among discharged polymedicated older inpatients: a single-centre, registry-based study in Switzerland

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-057444.R2
Article Type:	Original research
Date Submitted by the Author:	16-Feb-2022
Complete List of Authors:	Pereira, Filipa; University of Porto, Institute of Biomedical Sciences Abel Salazar; HES-SO Valais Wallis, School of Health Sciences Verloo, Henk; HES-SO Valais Wallis, School of Health Sciences von Gunten, Armin; Centre Hospitalier Universitaire Vaudois Département de Psychiatrie del Río Carral, María; University of Lausanne, Institute of Psychology, Research Center for the Psychology of Health, Aging and Sports Examination Meyer-Masseti, Carla; University of Bern, Institute for Primary Health Care (BIHAM) Martins, Maria Manuela; Escola Superior de Enfermagem do Porto, Formação&gestão Wernli, Boris; University of Lausanne, FORS, Swiss Centre of Expertise in the Social Sciences
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Pharmacology and therapeutics, Health informatics
Keywords:	GERIATRIC MEDICINE, CLINICAL PHARMACOLOGY, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, EPIDEMIOLOGY

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4 1 ***Unplanned nursing home admission among discharged polymedicated***
5 2 ***older inpatients: a single-centre, registry-based study in***
6 3 ***Switzerland***
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8 4

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32 Abstract

33 **Objective:** To investigate patient characteristics and the available health and drug data associated
34 with unplanned nursing home admission following an acute hospital admission or readmission.

35 **Design:** A population-based hospital registry study.

36 **Setting:** A public hospital in southern Switzerland (Valais Hospital).

37 **Participants:** We explored a population-based longitudinal dataset of 14,705 hospital admissions from
38 2015–2018.

39 **Outcome measures:** Sociodemographic, health and drug data, and their interactions predicting the
40 risk of unplanned nursing home admission.

41 **Results:** The mean prevalence of unplanned nursing home admission after hospital discharge was
42 6.1% (n = 903/N = 14,705). Our predictive analysis revealed that the oldest adults (OR = 1.07 for each
43 additional year of age; 95%CI 1.05 to 1.08) presenting with impaired functional mobility (OR = 3.22;
44 95%CI 2.67 to 3.87), dependency in the activities of daily living (OR = 4.62; 95%CI 3.76 to 5.67),
45 cognitive impairment (OR=3.75; 95%CI 3.06 to 4.59), and traumatic injuries (OR=1.58; 95%CI 1.25 to
46 2.01) had a higher probability of unplanned nursing home admission. The number of ICD-10
47 diagnoses had no significant impact on nursing home admissions, contrarily to the number of
48 prescribed drugs (OR=1.17; 95%CI 1.15 to 1.19). Antiemetics/antinauseants (OR=2.53; 95%CI 1.21 to
49 5.30), digestives (OR=1.78; 95%CI 1.09 to 2.90), psycholeptics (OR=1.76; 95%CI 1.60 to 1.93),
50 antiepileptics (OR=1.49; 95%CI 1.25 to 1.79) and anti-Parkinson's drugs (OR=1.40; 95%CI 1.12 to
51 1.75) were strongly linked to unplanned nursing home admission.

52 **Conclusions:** Numerous risk factors for unplanned nursing home admission were identified. To
53 prevent the adverse health outcomes that precipitate acute hospitalisations and unplanned nursing
54 home admissions, ambulatory-care providers should consider these risk factors in their care planning
55 for older adults before they reach a state requiring hospitalisation.

56
57 **Keywords:** population-based sample; functional decline; hospital discharge; risk factors; nursing home

58
59 **Strengths and limitations of this study:**
60

- 60 • A hospital registry of 14,705 hospital admissions, involving 9,430 different polymedicated
61 older adults admitted from their homes, was analysed to determine the risk of unplanned
62 nursing home admission.
- 63 • Bivariate analyses were conducted on independent variables, and generalised estimating
64 equations were computed to predict how sets of predictors influenced the adjusted
65 probability of unplanned nursing home admission.
- 66 • Causality analysis was not feasible based on the nature of the routinely collected data.
- 67 • Although the study considered statistical associations between drugs and unplanned nursing
68 home admission, it did not use clinically diagnosed drug–drug interactions.
- 69 • Our data were unable to identify hospitalisations that might have been triggered by limited
70 home-care options or those that became necessary while older adults awaited a place in a
71 nursing home.

73 Introduction

74 The hospitalisation of home-dwelling older adults, for any reason and even for a short admission, can
75 lead to substantial functional decline [1, 2]. Both their health disorder itself and the hospital
76 environment can foster such functional decline, increase the risk of future illness and irreversibly
77 diminish their quality of life [1, 2]. Most hospitalised older adult inpatients wish to return home and
78 continue their everyday life as before. However, these different factors may hinder this wish at
79 discharge [3, 4]. The unmet patient needs related to functional decline and safety after returning
80 home can lead to a higher risk of hospital and emergency department readmissions and thus to
81 subsequent unplanned nursing home admission [5]. After hospitalisation, an unplanned nursing home
82 admission can be a devastating and overwhelming experience for older adults and their relatives, and
83 it increases overall healthcare system costs [6].

84 Whether planned or unplanned, nursing home admission commonly follows two paths: (i) within the
85 community, directly from home, or (ii) from hospital, directly transitioning from hospital discharge [2].
86 In the community, transitions to nursing homes are generally the result of thoughtful decisions made
87 by home-dwelling older adults, their families, and health- and social-care providers based on the
88 evolution of the person's long-term health and functional state or on an acute decline and
89 corresponding increase in care needs that cannot be met at home. Recent findings have suggested
90 that the predictors of nursing home admission are mainly based on underlying cognitive and functional
91 impairments combined with a lack of support and assistance in daily living at home [7].

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3 92 The causes of unplanned nursing home admission directly after acute hospital discharge are
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5 93 heterogeneous. There are several reasons why older adults may require long-term care—that cannot
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7 94 be provided in a community setting—following acute hospital admission, e.g. a new medical problem
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9 95 or the worsening of existing chronic disease(s) entailing dependency and requiring complex forms of
10
11 96 care. Furthermore, there may be a breakdown of family circumstances and/or lack of social support.
12
13 97 Bellelli *et al.* showed that advanced age (OR = 4.8; 95% CI 2.6 to 8.9, $p < 0.001$), cognitive impairment
14
15 98 (OR = 2.3; 95% CI 1.4 to 3.9, $p < 0.001$) and poor functional status (OR = 10.2; 95% CI 4.7 to 22.5,
16
17 99 $p < 0.001$) at discharge from a rehabilitation unit were the main predictors of subsequent nursing home
18
19 100 admission [8]. The integrative review by Fogg *et al.* found a similar result for cognitive impairment
20
21 101 (OR = 2.14; 95% CI 1.24 to 3.70, $p < 0.001$) [9]. A randomised controlled trial by Landefeld *et al.* found
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23 102 that older inpatients in an acute care medical unit with a decline in their ability to perform one or
24
25 103 more of the basic activities of daily living (ADL) were more often discharged to a nursing home than
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27 104 those with less functional decline (22% and 14 %, respectively; $p < 0.01$) [10]. Ferrucci *et al.* identified
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29 105 stroke, cancer, congestive heart failure, pneumonia, coronary heart disease and hip fractures as the
30
31 106 leading medical precipitators of functional decline and nursing home admission [11]. Older adult
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33 107 inpatients are frequently subject to iatrogenic events during hospitalisation, including adverse drug
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35 108 reactions, nosocomial infections, and the consequences of falls, fractures, and using chemical or
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37 109 physical restraints [12]. Such events can lengthen hospitalisation, produce cognitive changes and
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39 110 lessen the ability to perform the ADL, all potentially leading to unplanned nursing home admission
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41 111 [12]. Indeed, hospitalisation causes an increased risk of the onset of acute cognitive decline in the
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43 112 form of delirium, with a prevalence of up to 60% on some surgical wards [13], often leading to
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45 113 unplanned nursing home admission [14]. Dementia, Parkinson's disease and its associated risk of falls,
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47 114 and behavioural changes are common reasons for deciding to transfer inpatients from hospital to
48
49 115 long-term care [15, 16].
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51 116 Polypharmacy has been associated with adverse health outcomes among home-dwelling older adults
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53 117 [17]. Some prospective studies with small samples have established relationships between drug
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55 118 treatments during acute hospitalisation and unplanned nursing home admission [18]. Cardiovascular
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57 119 drugs (particularly vasodilators, diuretics and anticoagulants), drugs against diabetes, steroids, non-
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59 120 steroidal anti-inflammatory drugs, opiates, antibiotics, anticholinergics and benzodiazepines have all
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121 been associated with unplanned nursing home admission [18].
122
123 To the best of our knowledge, and despite more frequent post-discharge nursing home admissions in
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Switzerland than in other countries, there is scarce research exploring how unplanned admissions to
nursing homes are related to prior hospitalisation [19]. The present study aimed to investigate the

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3 125 associations between polymedicated older inpatients' sociodemographic and clinical characteristics,
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5 126 drug data and their interactions, and their unplanned nursing home admission following an acute care
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7 127 hospital stay.
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For peer review only

128 **Methods**

129 ***Study design***

130 The present population-based hospital registry study was conducted with close regard to the
131 REporting of studies Conducted using Observational Routinely collected health Data (RECORD)
132 statement.

133 ***Population and data collection***

134 Our four-year, longitudinal, population-based hospital registry of electronic health records included
135 polymedicated (five and more drugs prescribed) home-dwelling older adults admitted and readmitted
136 to the Valais hospital, a multisite public teaching hospital (1,074 beds) in southern Switzerland with a
137 mean annual number of hospitalisations of approximately 39,000. This registry continues to be
138 analysed as part of a larger project [20]. Ethical approval was obtained from the Human Research
139 Ethics Committee of the Canton of Vaud (2018-02196), and this permitted the partnering hospital's
140 data warehouse to provide the appropriate dataset. Our study defined 'unplanned nursing home
141 admission' as the impossibility for a formerly home-dwelling older adult inpatient to return there after
142 hospital discharge, and this included any new admission to a nursing home following an acute care
143 admission [2]. All the patients included in the study followed a home to hospital to nursing home
144 pathway. Nursing homes do not expect their residents to return to independent living in the
145 community. The extracted patient data contained sociodemographic characteristics, medical and
146 surgical diagnoses, routinely assessed clinical data (such as gait, falls risk, hearing or pain) and the
147 drugs prescribed. The medical and surgical diagnoses encoded diagnostic data using the WHO
148 International Classification of Diseases, tenth version (ICD-10), and the Swiss Classification of Surgical
149 Interventions (CHOP) [21]. The hospital dataset showed that discharged patients had been prescribed
150 2,370 different medicines. The Anatomical Therapeutic Chemical (ATC) classification system's 14 top-
151 level codes were used to structure that dataset of prescribed medicines [22]. The extracted data, from
152 multiple dataset sources, were transformed and synthesised using best practices [23]. Our dataset
153 was composed of 14,705 hospital admissions from home settings between 2015 and 2018. Data were
154 without missing values, and there were similar numbers of annual hospital admissions: 3,777, 3,534,
155 3,724 and 3,670, respectively.

156 ***Patient and public involvement***

157 Patients were not involved in the development of the research questions, study design, outcome
158 measures, or the conduct of the study.

159 ***Dataset customising for predictive analysis***

160 *Synthesising the extracted data*

161 Since where patients had arrived from and where they were discharged to were two distinct variables,
162 the dataset was recoded and customised to identify the number of older adult inpatients admitted
163 straight from their homes and then discharged to a nursing home (n = 903) or returning to their homes
164 (n = 13,802), as presented in a previous paper [24]. Therefore, older adults who died during
165 hospitalisation (as assessed by the Valais Hospital's healthcare staff) were automatically excluded
166 (n = 131). Each subject's unique identifier was used to distinguish between different observations
167 from 2015 to 2018 and to account for hospital readmissions. Cases involved 9,430 different older
168 adults, with an average of 1.56 hospital stays per person. Sociodemographic and clinical data were
169 considered independent variables and used to compute the predictive models [24]. Unplanned
170 nursing home admission after discharge from our participating hospital between 2015 and 2018 was
171 identified by the difference between the original abode (home) and the destination at discharge (a
172 nursing home or their own home), and this was used as the dependent variable of interest.

173 *Sociodemographic and Hospital Variables*

174 The analysis included two sociodemographic control variables: age and sex. Age was considered a
175 continuous variable; its progressive impact was conclusive in preliminary investigations and previous
176 studies [25].

177 *Health Variables*

178 Numerous variables were used to describe older adults' health status at the end of their hospital stay.
179 The modelling analysis included three of the six hierarchical clusters preliminarily computed as being
180 variables significantly associated with more unplanned nursing home admissions in the descriptive
181 analysis: mobility, dependency in the ADL and cognitive status [24]. Cognitive status was measured at
182 an ordinal level using five categorical variables (perception–alertness, orientation, attention, decision-
183 making process and ability to learn). Finally, the year of hospitalisation was introduced as a control
184 variable, based on the fact that hospital admissions occurring earlier in the four-year study were
185 associated with a higher probability of unplanned nursing home admission [24].

186 *Drugs*

187 The WHO ATC Classification System [22] was used to select frequently prescribed drugs at discharge
188 as independent variables for the predictive model. The selection of drug class interactions was based
189 on a literature review and expert opinions [26]. A cut-off point of at least 30 subjects per drug category
190 prescribed was necessary to have a critical mass of data for computing robust statistics. The number
191 of drugs prescribed at hospital discharge was considered continuous.

192

193 Data analysis strategy

194 Data were extracted into a Microsoft Excel spreadsheet (Microsoft, Redmond, Washington, United
195 States) and subsequently imported into SPSS software, version 26.0 (IBM Corp, Armonk, New York,
196 United States). Associations with unplanned nursing home admission were examined based on
197 previous studies: patient age and sex, hospital length of stay, the principal and secondary ICD-10
198 diagnoses, surgical interventions (CHOP) and prescribed drugs. No causality analyses were possible
199 because data analysis was retrospective and based on routine data: there was no way of knowing
200 medication regimens or functional status before hospitalisation and how these might be associated
201 with unplanned nursing home admission. A series of unadjusted bivariate analyses using cross-
202 tabulations were conducted to investigate whether the sociodemographic, health and drugs data
203 (more than one independent variable) were statistically significantly associated with unplanned
204 nursing home admission from 2015 to 2018 (our single dichotomous outcome). In a second stage, a
205 series of generalised estimating equations (GEE or population-averaged logistic regression models)
206 were computed to predict how sets of predictors influenced the probability of unplanned nursing
207 home admission. The variables entered at the first stage were derived from the significant associations
208 between sociodemographic characteristics, clinical and medical conditions and unplanned nursing
209 home admission (Table 1). The multivariable analysis model included 52 Level 2 ATC drug classes,
210 respecting the good practices for logistical regressions involving large population-based samples [27].
211 This adjusted baseline model was then completed by adding drugs that were found to be significantly
212 associated with unplanned nursing home admissions in the previous analysis. Lastly, based on our
213 literature review, known drug–drug interactions between different ATC drug classes were added to
214 the baseline model. The model estimated each predictor’s impact, other things being equal, by
215 estimating its net impact controlling for confounding factors (adjusted odds ratios).. Since the data
216 are based on a whole population, not a sample, the odds ratios’ confidence intervals and statistical
217 tests were used to indicate the robustness of relationships since they normally only make sense for
218 statistical inference.

219 Results**220 Population description**

221 Fifty-five per cent of the population sample were men, and the total sample’s mean age was 78.16
222 years old (SD = 7.65). Mean hospital length of stay was 8.63 days (SD = 7.58). The mean number of
223 drugs prescribed at hospital discharge was 9.07 (SD = 3.32), with means of 10.91 (SD = 3.89) drugs for

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3 224 patients discharged to a nursing home versus 8.95 (SD = 3.24) for those discharged home.
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5 225 Supplementary Tables 1 and 2 present descriptive statistics of the older adult inpatients' health
6
7 226 statuses and drugs prescribed at discharge.

8
9 227 ***Associations between unplanned nursing home admission, sociodemographic characteristics, and***
10 228 ***the prevalence of clinical and medical conditions***

11
12 229 We found a prevalence of older adults discharged to unplanned nursing home admission of 6.1%
13
14 230 (n = 903/N = 14,705) over the whole time period, with a slight decrease in prevalence going forward
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16 231 [7.3% (n = 276) in 2015 to 5.9% (n = 217) in 2018]. Bivariate associations showed that men had a lower
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18 232 prevalence of unplanned nursing home admission than women [4.0% (n = 328) vs 8.8% (n = 575)], as
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20 233 did 65–69-year-old subjects (2.2%; n = 49) compared with those 70–79 years old, 80–89 years old, and
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22 234 especially the oldest group, aged 90 or more [3.2% (n = 192), 8.3% (n = 437) and 19.7% (n = 225),
23
24 235 respectively].

25 236 Being concomitantly affected by several diseases increased the prevalence of unplanned nursing
26
27 237 home admission, from 1.8% (n = 5) for older adults with a single disease (ICD-10) to 6.8% (n = 797) for
28
29 238 those with five or more diseases. Furthermore, the number of surgical interventions was negatively
30
31 239 associated with the prevalence of unplanned nursing home admission. Patients who had not
32
33 240 undergone surgery showed a higher probability of unplanned nursing home admission (7.8%; n = 379)
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35 241 than those who had undergone several interventions [3.5% (n = 39) for four interventions, 4.2%
36
37 242 (n = 84) for five interventions] (Table 1). The number of drugs prescribed at hospital discharge showed
38
39 243 a positive linear relationship with unplanned nursing home admission (gamma = 0.368) (Figure 1).

40
41 244 **[Insert Table 1]**

42
43 245 **[Insert Figure 1]**

44
45 246 ***Associations between unplanned nursing home admission and drugs***

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47 247 Bivariate associations showed that drugs were also related to unplanned nursing home admission
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49 248 (Table 2). On average, home-dwelling older adults discharged to a nursing home had more prescribed
50
51 249 drugs than those returning to their home [10.9 (SD = 3.9) drugs vs 8.9 (SD = 3.2)]. Psycholeptics
52
53 250 (antipsychotics, anxiolytics, hypnotics and sedatives) and psychoanaleptic drugs (antidepressants,
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55 251 psychostimulants, nootropics and anti-dementia drugs), antiemetics and antinauseants, anti-
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57 252 Parkinson's disease drugs, and drugs treating constipation and the sensory organs were significantly
58
59 253 associated with unplanned nursing home admission. On the contrary, patients taking lipid-modifying
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254 agents were less prone to unplanned nursing home admission.

1
2
3 255 **[Insert Table 2]**
4

5 256 ***Multivariate baseline model***
6

7 257 A baseline, GEE logistic regression model, including sociodemographic information, clinical data, and
8 258 diseases, was computed to predict unplanned nursing home admission among discharged
9 259 polymedicated older adult patients (Figure 2 and Supplementary Table 3); prescribed drugs at hospital
10 260 discharge were not included. If the 95% confidence interval (CI) does not overlap the null value (e.g.
11 261 OR = 1), then the higher the odds ratio, the more the variable contributes to unplanned nursing home
12 262 admission. Men had a lower probability of unplanned nursing home admission than women
13 263 (OR = 0.62; 95% CI 0.52 to 0.73). Patients' probability of unplanned nursing home admission increased
14 264 with age (OR = 1.07 for each additional year of age; 95% CI 1.05 to 1.08). Impaired mobility,
15 265 dependency in the ADL and cognitive impairment revealed their substantial impacts on unplanned
16 266 nursing home admission (OR = 3.22; 95% CI 2.67 to 3.87; OR = 4.62; 95% CI 3.76 to 5.67; and OR = 3.75;
17 267 95% CI 3.06 to 4.59, respectively). Circulatory and infectious diseases were related to lower
18 268 probabilities of unplanned nursing home admission (OR = 0.78; 95% CI 0.63 to 0.98, and OR = 0.38;
19 269 95% CI 0.20 to 0.70, respectively), whereas traumatic injuries were related to higher probabilities
20 270 (OR = 1.58; 95% CI 1.25 to 2.01). The number of ICD-10 diagnoses alone had no significant impact on
21 271 the odds of unplanned nursing home admission (OR = 1.11; 95% CI 0.98 to 1.24), in contrast to the
22 272 number of surgical interventions undergone (CHOP), which was a protective factor against unplanned
23 273 hospitalisation (OR = 0.95; 95% CI 0.90 to 0.99). The year of hospital stay also had a significant impact,
24 274 with more recent stays having lower probabilities of unplanned nursing home admission (OR = 0.88;
25 275 95% CI 0.82 to 0.94, per ensuing year).

26 276 **[Insert Figure 2]**
27

28 277 ***Prediction of unplanned nursing home admission and drug prescription***
29

30 278 A higher number of prescribed drugs was associated with a higher probability of unplanned nursing
31 279 home admission (OR = 1.17; 95% CI 1.15 to 1.19). Figure 3 and Supplementary Table 4 present the
32 280 baseline GEE logistic regression model shown in Figure 2 completed with those drugs prescribed to
33 281 older adults at discharge that had a significant statistical association ($p < 0.05$) with unplanned nursing
34 282 home admission. Drugs without a significant statistical association are not presented in Figure 3 for
35 283 simplification purposes. Antiemetics and antinauseants (OR = 2.53; 95% CI 1.21 to 5.30 for each
36 284 additional unit), digestives (OR = 1.78; 95% CI 1.09 to 2.90), psycholeptics (OR = 1.76; 95% CI 1.60 to
37 285 1.93), antiepileptics (OR = 1.49; 95% CI 1.25 to 1.79) and anti-Parkinson's disease drugs (OR = 1.40;
38 286 95% CI 1.12 to 1.75) were strongly linked to unplanned nursing home admission after controlling for
39

287 other parameters. On the contrary, taking lipid-metabolism-modifying agents was associated with
288 lower probabilities of unplanned nursing home admission (OR = 0.73; 95% CI 0.60 to 0.90, for each
289 extra drug from this class prescribed).

290 **[Insert Figure 3]**

291 ***Combined drug intake and probabilities of unplanned nursing home admission***

292 To reduce collinearity and simplify the results, the combined intake of different ATC drug classes was
293 recoded as a dichotomised variable for each drug pairing and added to the previous model [22]. Only
294 the drugs and drug combinations prescribed to older adults at discharge that had significant
295 associations ($p < 0.05$) with unplanned nursing home admission are presented. The combined intake
296 of cardiac therapy and psychoanaleptic drugs was significantly associated with unplanned nursing
297 home admission (OR = 1.87; 95% CI 1.11 to 3.16), as were psychoanaleptics and diabetes drugs
298 combined (OR = 1.75; 95% CI 1.03 to 2.98), and psycholeptic drugs and vitamins combined (OR = 1.71;
299 95% CI 1.03 to 2.84). On the contrary, the combined intake of beta-blocking agents and antiepileptics
300 strongly diminished the odds of unplanned nursing home admission (OR = 0.39; 95% CI 0.23 to 0.67).

301 We also investigated the risk of unplanned nursing home admission for combined drug intake within
302 the same drug class. The combined intake of two or more antiemetic and antinauseants (OR = 2.65;
303 95% CI 1.26 to 5.58), psycholeptics (OR = 1.64; 95% CI 1.46 to 1.85), antiepileptics (OR = 1.55; 95% CI
304 1.23 to 1.96) or anti-Parkinson's disease drugs (OR = 1.44; 95% CI 1.13 to 1.83) were strongly
305 associated with a higher probability of unplanned nursing home admission.

306 Supplementary Table 5 summarises the main findings from our predictive analysis.

307 **Discussion**

308 This population-based hospital registry study used longitudinal data to examine the unplanned nursing
309 home admission of hospitalised polymedicated older inpatients, revealing a 6.1% prevalence rate over
310 the four-year dataset, in agreement with previous work by Luppa *et al.* (men: 5.4%; women: 6.0%)
311 and Goodwin *et al.* (5.5%) [7, 28]. The slight decrease in prevalence over the four years of the study
312 may be explained by improvements in the regional home-care services' contribution to maintaining
313 older adults at home, but also to planned nursing home admissions without the requirement for
314 intermediate hospitalisation [29]. Furthermore, the number of places in the region's nursing homes
315 increased in that period [30], allowing people for whom care at home became impossible to be
316 admitted to a nursing home more promptly.

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3 317 Our predictive analysis revealed that the group of the oldest adults, presenting functional mobility
4 318 impairments, dependency in the ADL and cognitive impairment, was also at a high risk of unplanned
5 319 nursing home admission, which is consistent with previous retrospective and prospective studies [31,
6 320 32]. Very old inpatients (≥ 90 years old) were much more likely to have an unplanned nursing home
7 321 admission than those aged 65–69 (19.7% vs 2.2%). This finding was expected and matched with
8 322 previous research [33], bearing in mind that the very oldest group presented with a high prevalence
9 323 of multimorbidity and advanced functional and cognitive impairments. Unexpectedly, regardless of
10 324 age, our results showed that older women had a higher prevalence and probability of unplanned
11 325 nursing home admission than men [34]. Yet, our data could not entirely explain this result. Previous
12 326 publications have indicated that social and life-expectancy factors may play roles in the different rates
13 327 of nursing home admission between older adult men and women [34].

14
15 328 Our findings highlighted that functional and cognitive impairments were strong risk factors for
16 329 unplanned nursing home admission, which is in line with the studies by Luppia *et al.* and Goodwin *et*
17 330 *al.* [28, 34]. Likewise, our results emphasised a high risk of unplanned nursing home admission among
18 331 non-surgically treated and trauma patients. This could be explained by the relationship between
19 332 orthopaedic guidelines on traumatic injuries among older adults that suggest avoiding surgery, for
20 333 several medical reasons (number and severity of multimorbidities), and which may lead to increased
21 334 functional impairment and unplanned nursing home admission, as suggested by Gardner *et al.* and
22 335 Cutugno [35, 36].

23
24 336 As might be expected, older adults who underwent an unplanned nursing home admission had more
25 337 prescribed drugs than those returning home. Our results were in line with the retrospective study by
26 338 Lucchetti *et al.*, which demonstrated a relationship between the prescription of cardiovascular,
27 339 gastrointestinal, and metabolic drugs and unplanned nursing home admission [37].

28
29 340 Our findings indicated that patients prescribed more than one drug from the same class of drugs—
30 341 from the classes of antiemetics and antinauseants, psycholeptics, antiepileptics, or anti-Parkinson's
31 342 disease drugs—had a higher risk of discharge to a nursing home. Although this phenomenon is still
32 343 under-investigated, our findings are not in line with the few existing studies in this area, which have
33 344 presented no significant relationships between drug interactions and unplanned nursing home
34 345 admission [38]. However, in hospital settings, a recent systematic review reported drug–drug
35 346 interactions among 80% or more of older inpatients [39]. Since polymedicated older inpatients should
36 347 be considered as a population at a high risk of adverse outcomes, further studies should investigate
37 348 how drug–drug interactions might predict the risks of nursing home admission.

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3 349 Our findings undeniably mirrored existing evidence that chronic conditions and debilitating
4 350 comorbidities are significant risk factors for unplanned nursing home admission [3, 7]. However, they
5 351 also raised questions regarding hospitalisation's effects on the individual ageing process, which likely
6 352 interact to produce a cascade of factors towards functional decline and dependency [1]. The adverse
7 353 effects of hospitalisation begin immediately and progress rapidly [1]. Harrison *et al.* and Haaksma *et*
8 354 *al.* described ways in which acute and exacerbated acute and chronic disorders, reinforced by existing
9 355 undiagnosed geriatric syndromes (frailty, delirium, pressure sores, functional incontinence),
10 356 contributed to hospitalised older patients being unable to return home and needing to be discharged
11 357 to a nursing home [2, 16]. Previous studies suggested that silent geriatric syndromes such as frailty
12 358 and functional decline, together with polypharmacy, are not only clinically characteristic of older
13 359 adults but also potential predictors of being at risk of a further loss of independence and subsequent
14 360 nursing home admission. Montes *et al.* pointed out the dramatic rise in numbers of frail, hospitalised
15 361 older adults. This increase generates concerns about whether nursing homes—already suffering from
16 362 long admission waiting lists of home-dwelling older adults—will be able to cope with older adults'
17 363 complex care needs [40].

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29 364 Although some of the predisposing predictors identified cannot be treated (i.e. sex, age), they may
30 365 still contribute to an older adult's risk of being discharged to a nursing home and subsequently
31 366 exacerbate their situation there. Given that hospitalisation introduces stressors that may increase the
32 367 chances of unplanned nursing home admission [41, 42], using patients' electronic hospital data could
33 368 help identify the high-risk older adults who would benefit from specific preventive interventions.
34 369 Being able to rapidly identify inpatients at a high risk of unplanned nursing home admission may help
35 370 professional caregivers to provide them with the appropriate community-health resources, such as
36 371 community-based rehabilitation programmes. This would help older people to remain in their
37 372 community for longer.

373 ***Study strengths and limitations***

374 Although our population-based study's findings could be generalised to other regions of Switzerland,
375 any interpretations should be made with caution. The Swiss Federal Statistical Office collects minimal
376 annual data from public and private hospitals (number of hospitalisations, ICD-diagnoses, length of
377 stay, place of discharge, age and sex), but these indicated that our data were similar to those from
378 other cantons with analogous healthcare structures [43]. However, we did not have access to more
379 detailed data with which to compare with our dataset and explore potential biases or significant
380 differences. Nevertheless, the Valais Hospital is the third largest hospital in Switzerland with more
381 than 1,000 beds and over 35,000 hospitalisations per year. Therefore, our findings could provide

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3 382 information to help better define which integrated healthcare approaches could be implemented to
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5 383 attenuate the risk factors associated with unplanned nursing home admission following an acute
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7 384 hospital admission or readmission. The numerous predictors revealed in our study enabled us to
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9 385 conceptualise an overview of hospitalised older adults' health conditions before their unplanned
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11 386 nursing home admission. As healthcare moves towards ever-more personalised medicine, this result
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13 387 could help create more refined, tailored, future interventions via 'risk profiles' defined using each
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15 388 older adult's personal predictors.

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16 389 Our study had some limitations. The absence of data on patients' functional status before hospital
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18 390 admission meant that we could not assess changes to that status during hospitalisation, such as the
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20 391 influence of the development or deterioration of functional and cognitive impairment. We did not
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22 392 compute analysis on specific disorders such as neurodegenerative diseases like dementia and
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24 393 Parkinson's disease because this was beyond the scope of our study protocol. However, further
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26 394 analyses could confirm earlier studies showing that these diseases significantly affect a person's risk
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28 395 of nursing home admission after hospitalisation, with almost 90% of patients with dementia being
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30 396 admitted into a nursing home before dying [15, 16]. Additionally, our dataset was based on routinely
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32 397 collected data, and we were unable to control for potential data assessment errors made by the Valais
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34 398 Hospital's healthcare staff at discharge. Moreover, we were unable to assess deceased patients' death
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36 399 certificates as these were unavailable and beyond the scope of our study. Although the study
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38 400 considered statistical associations between drugs and unplanned nursing home admission, it did not
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40 401 use clinically diagnosed drug–drug interactions. Lastly, our data were unable to identify
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42 402 hospitalisations that might have been triggered by limited care options at home or hospitalisations
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44 403 that were necessary while awaiting a place in a nursing home. These cases of planned nursing home
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46 404 admissions could not be distinguished from the unplanned nursing home admissions considered in
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48 405 the study. In addition, some patients may not have been transferred directly from hospital to nursing
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50 406 homes and may have had to stay in an intermediate structure while awaiting a place. These patients
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52 407 were not included in the study due to the unavailability of this information in the database.

48 **Conclusion**

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50 409 The sociodemographic characteristics of hospitalised older inpatients, together with their clinical and
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52 410 medical conditions and their prescribed drugs, can provide us with a significant set of risk factors for
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54 411 unplanned nursing home admission, sustaining our stated hypotheses. Identifying these risk factors
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56 412 for unplanned nursing home admission could be of great assistance in developing predictive tools and
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58 413 tailored intervention programmes aimed at reducing the number of older adults placed in nursing
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60 414 homes. Our results showed that the patient-related risk factors leading to nursing home admission

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3 415 were based on declines in physical and cognitive function. Treatment with single drugs and
4 416 combinations of drugs were also associated with unplanned nursing home admission, indicating that
5 417 multiple chronic health conditions are important risk factors of a non-return home. Our findings may
6 418 help to identify those older inpatients at the greatest risk of unplanned nursing home admission,
7 419 enabling their care to be optimised by counterbalancing those risk factors. Further research is required
8 420 across large samples of older inpatients to investigate whether tailored interventions at early stages
9 421 in chronic diseases could delay physical and cognitive dysfunction and reduce unplanned nursing
10 422 home admissions among this growing segment of the population.

17 423 **Acknowledgement**

18
19 424 The authors thank the partner hospital, including the hospital's data warehouse, for its valuable
20 425 contributions.

23 426 **Ethics approval and patient consent**

24 427 Ethical approval was obtained from the Human Research Ethics Committee of the Canton of Vaud
25 428 (CER-VD, 2018-02196), thus permitting our partner hospital's data warehouse to provide the
26 429 appropriate dataset. Given the retrospective data source, obtaining consent from the patients
27 430 concerned was impossible or posed disproportionate difficulties. The present study respects the legal
28 431 requirements for research projects involving data re-use without consent, as set out in Art. 34 from
29 432 the Swiss Human Research Act (HTA).

35 433 **Conflict of Interest Statement**

36
37 434 The authors have no conflicts of interest to declare.

39 435 **Funding Sources**

40
41 436 This work was supported by Swiss National Science Foundation grant number 407440_183434/1.

44 437 **Author Contributions**

45 438 BW, FP, and HV had the original idea. BW, MdRC, MMM and HV provided conceptual and
46 439 methodological expertise to the study design and BW, FP, CMM, AvG, and HV to data analysis and
47 440 interpretation. BW, FP, and HV were major contributors to writing the manuscript. All authors read,
48 441 edited, and approved the final manuscript.

53 442 **Data Availability Statement**

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55 443 As part of the Data Use Agreement, authors are not allowed to provide raw data. Upon a reasonable
56 444 request, the corresponding author will provide statistical programming code used to generate results.

445

Figure Legends

Figure 1. Relationship between unplanned nursing home admission and number of prescribed drugs at discharge.

Figure 2. Baseline GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

Figure 3. The GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705 observations for 9,430 different subjects)—controlled for the parameters of the baseline model.

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560 Table 1. Prevalence of unplanned nursing home admissions with regards to associations with
 561 sociodemographic characteristics and clinical and medical conditions among polymedicated
 562 hospitalised older adults (N = 14,705)

Variables	Unplanned nursing home admission, n (%)	p-value
Overall sample of older adults (n = 14,705)	903 (6.1)	
Sex		< 0.001
Female/Male	575 (8.8)/328 (4.0)	
Age in years		< 0.001
65–69 years	49 (2.2)	
70–79 years	192 (3.2)	
80–89 years	437 (8.3)	
90 years or more	225 (19.7)	
Mobility		< 0.001
Full ability (0) / impairment (1)	214 (2.0)/689 (16.7)	
Dependence in the activities of daily living		< 0.001
Full ability (0)/impairment (1)	472 (3.4)/431 (44.8)	
Mental status		< 0.001
Full ability (0)/impairment (1)	531 (3.8)/ 372 (41.3)	
ICD-10 principal diagnosis: circulatory problems		< 0.001
No (0)/Yes (1)	752 (6.7)/ 151 (4.3)	
ICD-10 principal diagnosis: infection		0.003
No (0)/Yes (1)	892 (6.2)/ 11 (2.7)	
ICD-10 principal diagnosis: respiratory problems		0.226
No (0)/Yes (1)	797 (6.1)/106 (6.8)	
ICD-10 principal diagnosis: traumatic injuries		< 0.001
No (0)/Yes (1)	720 (5.3)/183 (14.9)	
ICD-10 principal diagnosis: tumour		0.001
No (0)/Yes (1)	835 (6.4)/ 68 (4.3)	
Number of ICD-10 diseases		< 0.001
1	5 (1.8)	
2	17 (2.9)	
3	37 (3.9)	
4	47 (3.9)	
5 or more	797 (6.8)	
Number of surgical interventions (CHOP)		< 0.001
0	379 (7.8)	
1	187 (6.4)	
2	135 (5.8)	
3	79 (5.2)	
4	39 (3.5)	
5 or more	84 (4.2)	
Year of hospitalisation		0.002
2015	276 (7.3)	
2016	216 (6.1)	
2017	194 (5.2)	
2018	217 (5.9)	

Number of drugs at hospital discharge	10.91 (SD = 3.89)	< 0.001*
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564 Note. * Mann-Whitney U test

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566 Table 2. Prevalence of unplanned nursing home admission among polymedicated hospitalised older
567 adults (N = 14,705) with regards to associations with different classes of prescribed drugs

Drugs (ATC code)	Unplanned nursing home admission		
	No drugs in this class n (%)	Drugs in this class n (%)	p-value
<i>First level, main anatomical group</i>			
Blood and blood-forming organ drugs (B)	180 (5.4)	723 (6.4)	0.050
Dermatologicals (D)	828 (5.8)	75 (14.1)	< 0.001
Genito-urinary system and sex hormones (G)	737 (6.1)	6.3%	0.699
Systemic hormonal preparations, excluding sex hormones and insulins (H)	737 (6.1)	6.5%	0.403
Anti-infectives for systemic use (J)	736 (6.4)	167 (5.3)	0.020
Antineoplastic and immunomodulating agents (L)	881 (6.3)	22 (3.5)	0.005
Drugs for the musculoskeletal system (M)	815 (6.4)	88 (4.3)	< .001
Antiparasitic products, insecticides and repellents (P)	893 (6.2)	10 (4.0)	0.144
Respiratory system drugs (R)	771 (6.3)	132 (5.5)	0.147
Sensory organ drugs (S)	752 (5.5)	151 (13.4)	< 0.001
<i>Second level, therapeutic subgroup</i>			
Stomatological preparations (A01)	899 (6.1)	4 (7.5)	0.669
Drugs for acid-related disorders (A02)	384 (5.8)	519 (6.4)	0.136
Drugs for functional gastrointestinal disorders (A03)	805 (5.9)	98 (9.8)	< 0.001
Antiemetics and anti-nauseants (A04)	884 (6.1)	19 (18.6)	< 0.001
Bile and liver therapy drugs (A05)	900 (6.1)	3 (7.9)	0.652
Drugs for constipation (A06)	605 (4.8)	298 (13.5)	< 0.001
Antidiarrheals, intestinal anti-inflammatory/anti-infective agents (A07)	863 (6.0)	40 (9.4)	0.005
Digestives, including enzymes (A09)	883 (6.1)	20 (8.4)	0.148
Diabetes drugs (A10)	804 (6.6)	99 (3.9)	< 0.001
Vitamins (A11)	801 (6.2)	102 (5.9)	0.629
Mineral supplements (A12)	513 (4.8)	390 (9.6)	< 0.001
Other alimentary tract and metabolism products (A16)	901 (6.1)	2 (5.9)	0.950
Cardiac therapy drugs (C01)	792 (6.1)	111 (6.3)	0.792
Antihypertensives (C02)	888 (6.2)	15 (4.6)	0.237
Diuretics (C03)	621 (5.5)	282 (8.1)	< 0.001
Peripheral vasodilators (C04)	901 (6.1)	2 (4.2)	0.568
Vasoprotectives (C05)	884 (6.1)	19 (7.2)	0.471
Beta blocking agents (C07)	588 (7.2)	315 (4.8)	< 0.001
Calcium channel blockers (C08)	762 (6.1)	141 (6.1)	0.964
Agents acting on the renin-angiotensin system (C09)	472 (7.2)	431 (5.3)	< 0.001
Lipid-modifying agents (C10)	720 (8.2)	183 (3.1)	< 0.001
Anaesthetics (N01)	898 (6.1)	5 (13.5)	0.061
Analgesics (N02)	158 (3.6)	745 (7.2)	< 0.001
Antiepileptics (N03)	753 (5.7)	150 (10.3)	< 0.001
Drugs against Parkinson's disease (N04)	814 (5.7)	89 (18.1)	< 0.001
Psycholeptics (N05)	201 (2.4)	702 (11.0)	< 0.001
Psychoanaleptics (N06)	565 (4.8)	338 (11.9)	< 0.001

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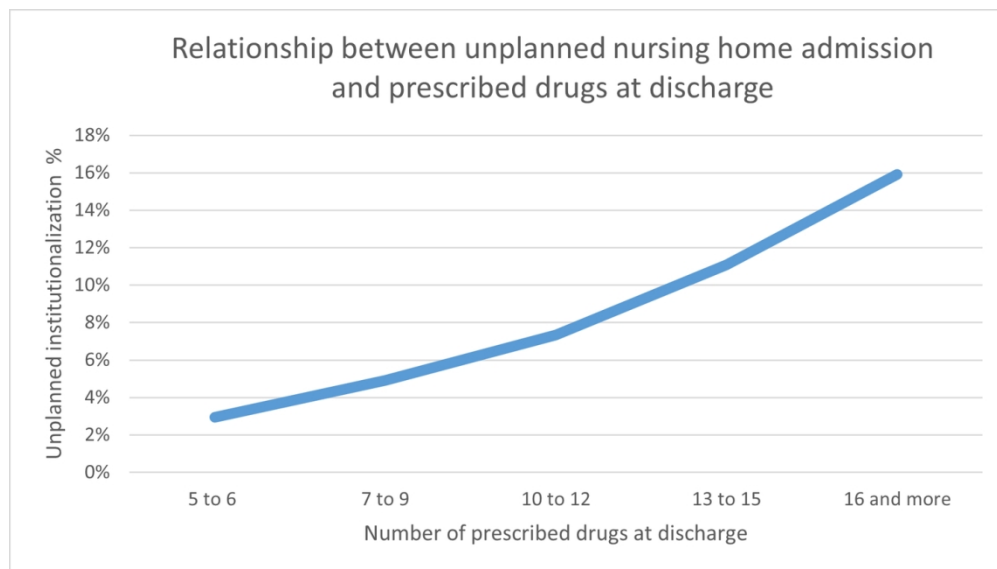
Other nervous system drugs (N07)	881 (6.1)	22 (5.9)	0.813
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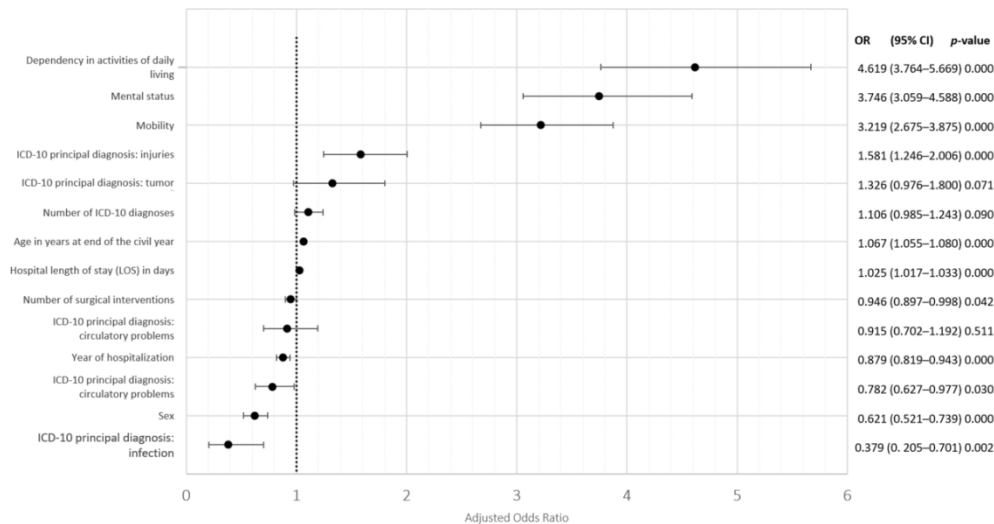
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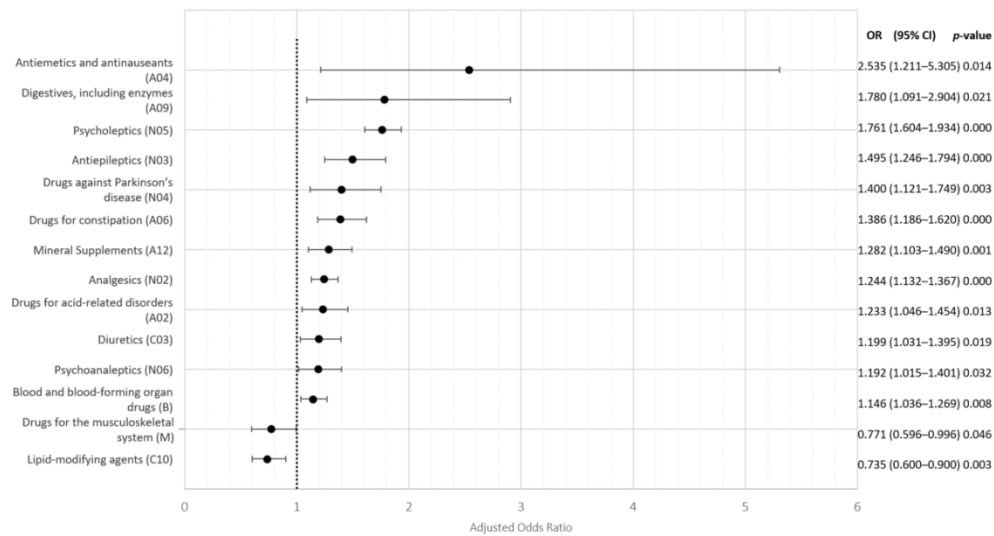
25 Relationship between unplanned nursing home admission and number of prescribed drugs at discharge.

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27 125x71mm (300 x 300 DPI)



Baseline GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

107x56mm (300 x 300 DPI)



The GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705 observations for 9,430 different subjects).

109x57mm (300 x 300 DPI)

Supplementary Table 1. Descriptive statistics of the older adult inpatients' health status (N = 14,705 observations for 9,430 different subjects).

Variables	Population description (N = 14,705)
Sex	
Men n (%)	8,088 (55)
Women n (%)	6,617 (45)
Age (years)	
Mean (SD)	78.16 (7.65)
Hospital length of stay (days)	
Mean (SD)	8.63 (7.58)
Mobility	
Full ability n (%)	6,825 (63.2)
Impairment n (%)	7,880 (36.8)
Activities of Daily Living	
Full ability n (%)	12,131 (87.4)
Impairment n (%)	2,574 (12.6)
Cognitive status	
Full ability n (%)	12,622 (89.8)
Impairment n (%)	2,083 (10.2)
ICD-10 diseases (number) ¹	
Mean (SD)	4.59 (0.91)
Surgical interventions performed (CHOP)	
Mean (SD)	1.80 (1.77)
Most prevalent ICD-10	
Circulatory diseases n (%)	4,788 (23.4)
Infectious n (%)	559 (2.7)
Respiratory diseases n (%)	2,111 (10.3)
Traumatic injuries n (%)	2,385 (11.7)
Tumours n (%)	2,041 (10.0)

¹ Each older adult's number of ICD-10 diseases was entered into the model as a proxy for multimorbidity.

Supplementary Table 2. Descriptive statistics of prescribed drugs at discharge based on the ATC among the polymedicated older inpatients (N = 14,705 observations for 9,430 different subjects).

Drugs by ATC, level 2	Number of drugs per patient	
	Min–Max	Mean (SD)
<i>First level, anatomical main group</i>		
Blood and blood-forming organ drugs (B)	0–6	1.16 (0.86)
Dermatologicals (D)	0–3	0.04 (0.22)
Genito urinary system and sex hormones (G)	0–4	0.21 (0.47)
Systemic hormonal preparations, excl. sex hormones and insulins (H)	0–4	0.20 (0.46)
Anti-infective for systemic use (J)	0–4	0.23 (0.46)
Antineoplastic and immunomodulating agents (L)	0–5	0.05 (0.23)
Musculo skeletal system drugs (M)	0–3	0.15 (0.39)
Antiparasitic products, insecticides and repellents (P)	0–2	0.02 (0.13)
Respiratory system drugs (R)	0–7	0.27 (0.72)
Sensory organ drugs (S)	0–6	0.10 (0.40)
<i>Second level, therapeutic subgroup</i>		
Stomatological preparations (A01)	0–1	0.01 (0.06)
Drugs for acid related disorders (A02)	0–3	0.56 (0.52)
Drugs for functional gastrointestinal disorders (A03)	0–3	0.07 (0.28)
Antiemetics and antinauseants (A04)	0–1	0.01 (0.08)
Bile and liver therapy drugs (A05)	0–1	0.01 (0.05)
Drugs for constipation (A06)	0–4	0.17 (0.42)
Anti-diarrhoeal, intestinal anti-inflammatory/anti-infective agents (A07)	0–2	0.03 (0.18)
Digestives, incl. enzymes (A09)	0–2	0.02 (0.13)
Drugs used in diabetes (A10)	0–5	0.25 (0.63)
Vitamins (A11)	0–4	0.15 (0.44)
Mineral supplements (A12)	0–3	0.30 (0.51)
Other alimentary tract and metabolism products (A16)	0–1	0.01 (0.05)
Cardiac therapy drugs (C01)	0–4	0.14 (0.41)
Antihypertensives (C02)	0–2	0.02 (0.17)
Diuretics (C03)	0–3	0.28 (0.54)
Peripheral vasodilators (C04)	0–1	0.01 (0.06)
Vaso-protectives (C05)	0–3	0.02 (0.14)
Beta-blocking agents (C07)	0–2	0.45 (0.51)
Calcium channel blockers (C08)	0–2	0.16 (0.37)
Agents acting on the Renin-Angiotensin system (C09)	0–3	0.63 (0.62)
Lipid Modifying agents (C10)	0–3	0.41 (0.52)
Anaesthetics (N01)	0–1	0.01 (0.05)
Analgesics (N02)	0–7	1.03 (0.91)
Antiepileptics (N03)	0–5	0.11 (0.36)
Anti-Parkinson drugs (N04)	0–5	0.04 (0.25)
Psycholeptics (N05)	0–7	0.57 (0.77)
Psychoanaleptics (N06)	0–3	0.21 (0.45)
Other nervous system drugs (N07)	0–3	0.03 (0.19)
Total number of drugs	5–32	9.07 (3.32)
N valid - listwise		14.70

Supplementary Table 3. Baseline, GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

Variables	Odds Ratio	$p > z$	95% Confidence Interval
Sex ¹	0.62	< 0.000	0.52–0.74
Age in years	1.07	< 0.000	1.05–1.08
Hospital length of stay (LOS) in days	1.02	< 0.000	1.02–1.03
Mobility ²	3.22	< 0.000	2.67–3.87
Dependency in the activities of daily living ²	4.62	< 0.000	3.76–5.67
Mental status ²	3.75	< 0.000	3.06–4.59
ICD-10 principal diagnosis: circulatory problems ³	0.78	0.030	0.63–0.98
ICD-10 principal diagnosis: infection ³	0.38	0.002	0.20–0.70
ICD-10 principal diagnosis: respiratory problems ³	0.91	0.511	0.70–1.19
ICD-10 principal diagnosis: injuries ³	1.58	< 0.000	1.25–2.01
ICD-10 principal diagnosis: tumour ³	1.33	0.071	0.98–1.80
Number of ICD-10 diagnoses	1.11	0.090	0.98–1.24
Number of surgical interventions (CHOP)	0.95	0.042	0.90–0.99
Number of prescribed drugs	1.17	0.000	1.15–1.19
Year of hospitalisation: 2015 to 2018	0.88	< 0.000	0.82–0.94

Note. 1: 0 = woman, 1 = man; 2: 0 = normal status, 1 = poor status; 3: 0 = no, 1 = yes

Supplementary Table 4. GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705 observations for 9,430 different subjects).

Drugs	Odds Ratio	$p > z$	95% Confidence Interval
Antiemetics and antinauseants (A04)	2.53	0.014	1.21–5.30
Digestives, including enzymes (A09)	1.78	0.021	1.09–2.90
Psycholeptics (N05)	1.76	0.000	1.60–1.93
Antiepileptics (N03)	1.49	0.000	1.25–1.79
Anti-Parkinson drugs (N04)	1.40	0.003	1.12–1.75
Drugs for constipation (A06)	1.39	0.000	1.19–1.62
Mineral Supplements (A12)	1.28	0.001	1.10–1.49
Analgesics (N02)	1.24	0.000	1.13–1.37
Drugs for acid-related disorders (A02)	1.23	0.013	1.05–1.45
Diuretics (C03)	1.20	0.019	1.03–1.39
Psychoanaleptics (N06)	1.19	0.032	1.01–1.40
Blood and blood-forming organ drugs (B)	1.15	0.008	1.04–1.27
Drugs for the musculoskeletal system (M)	0.77	0.046	0.60–0.99
Lipid-modifying agents (C10)	0.73	0.003	0.60–0.90

Supplementary Table 5. Factors associated with a higher and lower probability of unplanned nursing home admission among polymedicated hospitalised older adults (N = 14,705): summary of the predictive analysis.

Risk factors for a higher probability of unplanned nursing home admission
- Dependency in the activities of daily living (OR = 4.62, 95% CI: 3.76–5.67)
- Cognitive impairment (OR = 3.75, 95% CI: 3.06–4.59)
- Functional mobility impairment (OR = 3.22, 95% CI: 2.67–3.87)
- Antiemetics/antinauseants (OR = 2.53, 95% CI: 1.21–5.30)
- Digestives (OR = 1.78, 95% CI: 1.09–2.90)
- Psycholeptics (OR = 1.76, 95% CI: 1.60–1.93)
- Injuries (OR = 1.58, 95% CI: 1.25–2.01)
- Antiepileptics (OR = 1.49, 95% CI: 1.25–1.79)
- Anti-Parkinson's drugs (OR = 1.40, 95% CI: 1.12–1.75)
- Number of drugs prescribed (OR = 1.17, 95% CI: 1.15–1.19)
- Older age (OR = 1.07, 95% CI: 1.05–1.08)
Combined intake of:
- cardiac and psychoanaleptic drugs (OR = 1.87, 95% CI: 1.11–3.16)
- psychoanaleptic and diabetes drugs (OR = 1.75, 95% CI: 1.03–2.98)
- psycholeptic drugs and vitamins (OR = 1.71, 95% CI: 1.03–2.84)
Combined intake of two or more:
- antiemetics and antinauseants (OR = 2.65, 95% CI: 1.26–5.58)
- psycholeptics (OR = 1.64, 95% CI: 1.46–1.85)
- antiepileptics (OR = 1.55, 95% CI: 1.23–1.96)
- anti-Parkinson's drugs (OR = 1.44, 95% CI: 1.13–1.83)
Protective factors for a lower probability of unplanned nursing home admission
- Surgical interventions (OR = 0.95, 95% CI: 0.90–0.99)
- Circulatory diseases (OR = 0.78, 95% CI: 0.63–0.98)
- Lipid metabolism modifying agents (OR = 0.73, 95% CI: 0.60–0.90)
- Male sex (OR = 0.62; 95% CI: 0.52–0.73)
- Combined intake of beta-blocking agents and antiepileptics (OR = 0.39, 95% CI: 0.23–0.67)
- Infectious diseases (OR = 0.38, 95% CI: 0.20–0.70)

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		<p>RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.</p> <p>RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract.</p> <p>RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.</p>	<p>Title Abstract (line 34)</p> <p>Line 6</p> <p>Lines 35</p> <p>Not applicable, only one hospital register</p>
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Lines 75-148
Objectives	3	State specific objectives, including any prespecified hypotheses			Lines 145-148
Methods					
Study Design	4	Present key elements of study design early in the paper			Lines 151-153
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Lines 155-177

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<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27</p> <p>Participants</p>	<p>6</p>	<p>(a) <i>Cohort study</i> - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.</p> <p>RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided.</p> <p>RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.</p>	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p> <p>Not applicable, only one hospital register</p>
<p>28 29 30 31 32 33 34 35 36</p> <p>Variables</p>	<p>7</p>	<p>Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.</p>		<p>RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.</p>	<p>Lines 181-222 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
<p>37 38 39 40 41 42 43 44 45 46 47</p> <p>Data sources/ measurement</p>	<p>8</p>	<p>For each variable of interest, give sources of data and details of methods of assessment (measurement).</p>			<p>Lines 181-222 and reported in a previous study:</p>

		Describe comparability of assessment methods if there is more than one group			https://pubmed.ncbi.nlm.nih.gov/33973865/
Bias	9	Describe any efforts to address potential sources of bias			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Study size	10	Explain how the study size was arrived at			Lines 155-177
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical			Lines 224-241

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		methods taking account of sampling strategy (e) Describe any sensitivity analyses			
Data access and cleaning methods		..		<p>RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.</p> <p>RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.</p>	<p>Lines 224-241 and reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	<p>Reported in a previous study: https://pubmed.ncbi.nlm.nih.gov/33973865/</p>
Results					
Participants	13	<p>(a) Report the numbers of individuals at each stage of the study (<i>e.g.</i>, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)</p> <p>(b) Give reasons for non-participation at each stage.</p> <p>(c) Consider use of a flow diagram</p>		RECORD 13.1: Describe in detail the selection of the persons included in the study (<i>i.e.</i> , study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Lines 170-177
Descriptive data	14	(a) Give characteristics of study participants (<i>e.g.</i> , demographic, clinical, social) and information on exposures and potential confounders			Lines 243-264

		(b) Indicate the number of participants with missing data for each variable of interest (c) <i>Cohort study</i> - summarise follow-up time (e.g., average and total amount)			
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Lines 243-264
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Lines 277-327
Other analyses	17	Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses			Lines 268-280
Discussion					
Key results	18	Summarise key results with reference to study objectives			Lines 339-342

1 2 3 4 5 6 7 8 9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Lines 405-421
10 11 12 13 14 15 16 17 18	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Lines 333-394
19 20 21	Generalisability	21	Discuss the generalisability (external validity) of the study results			Lines 396-400
22	Other Information					
23 24 25 26 27 28	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Line 451
29 30 31 32 33 34 35	Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Lines 185, 188, 200-201 https://pubmed.ncbi.nlm.nih.gov/33973865/

*Reference: Benchimol EI, Smeeth L, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langen SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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