J Antimicrob Chemother 2021; **76**: 758–764
doi:10.1093/jac/dkaa505 Advance Access publication 5 December 2020

Journal of Antimicrobial Chemotherapy

Analysis of inappropriate prescribing in elderly patients of the Swiss HIV Cohort Study reveals gender inequity

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Received 24 September 2020; accepted 4 November 2020

Background: The extent of inappropriate prescribing observed in geriatric medicine has not been thoroughly evaluated in people ageing with HIV. We determined the prevalence of and risk factors for inappropriate prescribing in individuals aged ≥75 years enrolled in the Swiss HIV Cohort Study.

Methods: Retrospective review of medical records was performed to gain more insights into non-HIV comorbidities. Inappropriate prescribing was screened using the Beers criteria, the STOPP/START criteria and the Liverpool drug–drug interactions (DDIs) database.

Results: For 175 included individuals, the median age was 78 years (IQR 76–81) and 71% were male. The median number of non-HIV comorbidities was 7 (IQR 5–10). The prevalence of polypharmacy and inappropriate prescribing was 66% and 67%, respectively. Overall, 40% of prescribing issues could have deleterious consequences. Prescribing issues occurred mainly with non-HIV drugs and included: incorrect dosage (26%); lack of indication (21%); prescription omission (drug not prescribed although indicated) (17%); drug not appropriate in elderly individuals (18%) and deleterious DDIs (17%). In the multivariable logistic regression, risk factors for prescribing issues were polypharmacy (OR: 2.5; 95% CI: 1.3–4.7), renal impairment (OR: 2.7; 95% CI: 1.4–5.1), treatment with CNS-active drugs (OR: 2.1; 95% CI: 1.1–3.8) and female sex (OR: 8.3; 95% CI: 2.4–28.1).

Conclusions: Polypharmacy and inappropriate prescribing are highly prevalent in elderly people living with HIV. Women are at higher risk than men, partly explained by sex differences in the occurrence of non-HIV comorbidities and medical care. Medication reconciliation and periodic review of prescriptions by experienced physicians could help reduce polypharmacy and inappropriate prescribing in this vulnerable, growing population.

Introduction

Potent ART has transformed HIV infection from a deadly condition into a chronic condition.[1] As a consequence, people living with HIV (PLWH) are ageing, which brings new challenges as elderly people have a higher burden of age-related chronic comorbidities,[2] leading to complex polypharmacy and the related risk of drug–drug interactions (DDIs).[3,4] Prescription problems go beyond the issue of DDIs as the presence of age-related comorbidities also increases the risk of drug–disease interactions whereby the prescription of a drug to treat one medical problem may worsen a coexisting condition.[5] Another issue relates to the age-dependent physiological changes that can alter drug pharmacodynamics and

pharmacokinetics thereby predisposing elderly PLWH to inappropriate prescribing and the related risk of adverse drug reactions.[6] The risk of prescribing errors may be further increased due to care coordination or communication issues among healthcare providers.

The extent of inappropriate prescribing observed in geriatric medicine has not been thoroughly evaluated in elderly PLWH. Available studies have mostly reported the prevalence of benzodiazepines and/or drugs characterized by a high anticholinergic burden.[3,7–9] These drugs are considered to be inappropriate for use in the elderly as they may cause cognitive impairment and increase the risk of falls.[10,11] The existing studies did not give information on comorbidities, drug dosage or treatment duration, which prevented a detailed analysis of prescriptions including drug indication, prescription omission, dosing adjustment, duration of treatment and management of DDIs. Another limitation was the inclusion of participants mostly up to the age of 65 years (the age cut-off defining an elderly person, based on the WHO definition)[12] thus available data are not fully representative of prescribing issues encountered in elderly PLWH.[7,9,13]

This work aimed to assess the prevalence of and risk factors for inappropriate prescribing in individuals aged ≥75 years enrolled in the Swiss HIV Cohort Study (SHCS). In order to perform a thorough analysis of prescribing issues, a comprehensive list of non-HIV comorbidities was obtained by retrospective review of medical records, whereas drugs were extracted from the SHCS database.

Methods

Participant selection and data collection

This study included all individuals aged ≥75 years registered in the SHCS, a nationwide prospective cohort enrolling PLWH aged >16 years.[14] Sociodemographic characteristics and clinical course, as well as immunological, virological and clinical chemistry laboratory data, antiretroviral (ARV) treatment and non-HIV drugs are collected at enrolment into the SHCS and at routine follow-up visits every 6 months. Comorbidities are not collected comprehensively in the SHCS database therefore these data were obtained by a retrospective review of medical records. The hospital discharge letters were used to obtain a detailed medical history and, when needed, missing information was obtained by reaching the responsible physician. Past medical history without expected subsequent impact was not counted (e.g. resolved gastrointestinal reflux). This analysis was performed using the patient's clinical and treatment data reported at the latest SHCS follow-up visit during the study period between January 2015 and December 2017.

Data management

Comorbidities were categorized by systems, using the ICD,[15] and drugs were classified by therapeutic classes, according to the Anatomical Therapeutic Chemical (ATC) system.[16] Sociodemographic characteristics, living situation, laboratory values, data on treatment adherence and neurocognitive complaints were extracted from the SHCS database. These data were entered in a standardized patient chart for the analysis of prescribing issues by two pharmacologists (F.L. and C.M.).

Analysis of inappropriate prescribing

Inappropriate prescribing was screened using the Beers criteria,[10] the STOPP/START[11] criteria and considering various treatment guidelines.[17,18] Target values for glycaemic control were set at 5.0–7.2 mmol/L (HbA1c <7.5%) for healthy elderly individuals, 5.0–8.3 mmol/L (HbA1c <8.0%) for elderly patients with multiple coexisting chronic illnesses and 5.6–10 mmol/L (HbA1c <8.5%) for elderly individuals with end-stage chronic illnesses, based on the American treatment recommendations.[17] The target value for LDL cholesterol in high-risk individuals (i.e. history of a cardiovascular event) was set at <1.8 mmol/L based on the European Society of Cardiology guidelines.[18] The anticholinergic risk scale score[19] was used to assess the anticholinergic burden. Finally, DDIs between HIV and non-HIV drugs were screened using the Liverpool HIV DDI database.[20] The database categorizes DDIs by levels of clinical relevance using flags: red flag for contraindicated DDIs, amber flag for potential clinically significant DDIs manageable by dose adjustment or clinical monitoring, yellow flag for DDIs of weak clinical relevance with no need of *a priori* dosage adjustment or monitoring and a green flag for no interactions. DDIs between non-HIV drugs were identified from published DDI studies and package inserts. DDIs were not counted if the dosage had been adjusted to overcome the DDI and/or if an adequate clinical response was documented without any adverse drug reaction.

Prescribing issues were classified into the following categories: incorrect drug dosage; drugs prescribed without evidence of clinical indication or demonstrated benefit (based on the participant's medical history); prescription omission (i.e. drug not prescribed although indicated); drugs not appropriate in elderly individuals (based on two validated screening tools developed by geriatricians: the STOPP/START criteria and the Beers criteria); deleterious DDIs (i.e. red flag DDIs or amber flag DDIs not managed correctly); and treatment duration exceeding recommendations.

Statistical analysis

We used absolute numbers, percentages, medians and IQRs to report sociodemographic characteristics, treatment data and prevalence of inappropriate prescribing. The association between age, sex, duration of known HIV infection, polypharmacy, renal impairment, treatment with tenofovir disoproxil fumarate, treatment with a CNS drug and the probability of having ≥1 prescribing issue was evaluated using a multivariable logistic regression estimated with the Generalized Estimating Equations (GEE) approach to account for clustering of HIV clinics. The number of non-HIV comorbidities was not retained in the model due to collinearity with the variable polypharmacy. The statistical analysis was performed using SAS 9.4.

Results

Study population

The study population included 175 elderly SHCS participants. The majority were male ($n = 125$, 71%) with a median age of 78 years (IQR 76–80). Female participants were slightly older, with a median age of 78.5 years (IQR 77–82). Study participants were mostly virologically suppressed ($n = 159$, 91%), with a median duration of known HIV infection (since first positive HIV test) of 18 years (IQR 13–23). As expected, the number of non-HIV comorbidities was elevated, with a median of 7 (IQR 5–10) comorbidities per individual. Overall, the most prevalent non-HIV comorbidities belonged to the cardiovascular (29%), alimentary and metabolism (18%) and musculoskeletal systems (14%) (Table S1, available as Supplementary data at *JAC* Online). The top five most frequent comorbidities (participant level) were hypertension (61%), renal impairment (56%), dyslipidaemia (44%), neurocognitive complaints (39%) and osteoporosis (30%) (Table 1). Female participants tended to have more comorbidities than male participants, with a median of 8 comorbidities (IQR 6–10) versus 7 (IQR 5–10) in male participants (Figure 1). Comorbidities more frequently observed in female than male participants were: CNS disorders

Table 1. Characteristics of the study population ($n = 175$)

Characteristic	Frequency
Sociodemographic data	
Median age, years (IQR)	78 (76–81)
Male sex, *n* (%)	125 (71)
Median BMI, kg/m^2 (IQR)	24.5 (22.2–27.8)
White ethnicity, *n* (%)	171 (98)
HIV acquisition mode, *n* (%)	
Heterosexual	95 (54)
MSM	65 (37)
Other or unknown	15 (9)
Geriatric features, *n* (%)	
Living in a nursing home	11 (6)
Neurocognitive complaints	69 (39)
Urinary incontinence	9 (5)
Polypharmacy (≥5 non-HIV drugs)	115 (66)
Virological data	
Median duration of HIV infection since diagnosis, years (IQR)	18 (13–23)
Median CD4 count, cells/mm^3 (IQR)	542 (383–721)
HIV-1 RNA, <20 copies/mL, *n* (%)	159 (91)
Non-HIV comorbidities	
Median number (IQR)	7 (5–10)
Median Charlson Comorbidity Index score (IQR)	2 (1–4)
Most frequent non-HIV comorbidities, *n* (%)	
Hypertension	107 (61)
Renal impairment	98 (56)
Dyslipidaemia	77 (44)
Neurocognitive complaint	69 (39)
Osteoporosis	52 (30)
Polyneuropathy	46 (26)
Neoplasm	42 (24)
Ischaemic heart disease	40 (23)
Arthrosis	40 (23)
Diabetes	34 (19)
ART	
Unboosted INI[a], *n* (%)	51 (29)
NNRTI, *n* (%)	50 (29)
Boosted ARV[b], *n* (%)	36 (21)
Boosted ARV + INI, *n* (%)	18 (10)
Boosted ARV + NNRTI, *n* (%)	4 (2)
NNRTI + INI, *n* (%)	10 (6)
Others, *n* (%)	6 (3)
Non-HIV medications	
Median number (IQR)	5 (3–8)
Most frequent non-HIV comedications, *n* (%)	
Vitamin D	110 (63)
Statins	88 (50)
Antiplatelets	74 (42)
β-Blockers	61 (35)
Calcium	56 (32)
Diuretics	48 (27)
Proton pump inhibitors	46 (26)
ACE inhibitors	43 (25)
Angiotensin II antagonists	35 (20)
Sedatives	32 (18)

ACE, angiotensin-converting enzyme; INI, integrase inhibitor.
[a]Unboosted INIs include dolutegravir and raltegravir.
[b]Boosted ARVs include PIs boosted with ritonavir or cobicistat, and elvitegravir boosted with cobicistat.

(62% versus 45%), renal impairment (62% versus 54%) and musculoskeletal disorders (72% versus 61%). Individuals with a longer duration of HIV infection tended to have more comorbidities: 8 (IQR 6–11) comorbidities in individuals diagnosed >20 years ago versus 7 (IQR 5–10) in those diagnosed 10–20 years ago versus 6 (IQR 4–8.5) in those diagnosed <10 years ago.

HIV and non-HIV drugs

All study participants, except 4 (2%), received ARV treatment consisting mostly of triple ($n = 137$, 78%) and dual ($n = 24$, 14%) regimens. A large part of the study population ($n = 107$, 61%) received an ARV drug acting as a perpetrator of DDI (i.e. boosted ARV, efavirenz, etravirine or nevirapine). The most frequently prescribed NRTI backbone included lamivudine + abacavir ($n = 51$, 29%) and tenofovir disoproxil fumarate + emtricitabine ($n = 49$, 28%). Only 15 (9%) participants were on an NRTI-sparing regimen.

All participants, except 4 (2%), received non-HIV drugs. The median number of drugs was 5 (IQR 3–8) per individual, with polypharmacy (i.e. ≥5 non-HIV drugs) reaching a prevalence of 66%. In line with observed comorbidities, the most frequently prescribed drugs belonged to the cardiovascular (30%), alimentary and metabolism (27%) and CNS (12%) therapeutic classes (Table S2). The top five most frequently prescribed drugs (participant level) were vitamin D (63%), statins (50%), antiplatelets (42%), β-blockers (35%) and calcium supplements (32%) (Table 1). Female participants tended to be more polymedicated than male participants (Figure 1). Female participants were notably prescribed benzodiazepines more frequently than male participants (32% versus 13%). Individuals with a longer duration of HIV infection tended to have more non-HIV drugs: 7 (IQR 4–11) drugs in individuals diagnosed >20 years ago versus 5 (IQR 4–8) in those diagnosed 10–20 years ago versus 4 (IQR 2–7) in those diagnosed <10 years ago.

Inappropriate prescribing

Inappropriate prescribing was identified in 117 (67%) participants, with 72 (41%) having more than one prescribing issue. As expected, the proportion of individuals with ≥1 prescribing issue increased with the number of non-HIV comorbidities or non-HIV drugs (Figure 2). The most common prescribing issue related to dosing errors (26%) with drugs not adjusted to the renal function or the use of high doses of vitamin D leading to an increased risk of falls in elderly participants.[21] Other common prescribing issues included drugs prescribed without indication or demonstrated clinical utility (21%) as well as prescription omission (17%) such as lack of aspirin or a statin in patients with a high risk of cardiovascular diseases. Finally, drugs not appropriate in elderly individuals and deleterious DDIs represented 18% and 17% of the overall prescribing issues, respectively (Table 2). Prescribing issues occurred mainly with non-HIV drugs, of which 40% could possibly have deleterious clinical consequences. These included, for instance, omission of a statin or aspirin in patients with a high risk of cardiovascular diseases, the use of drugs increasing the risk of falls or any deleterious DDIs. Of interest, prescribing issues were more frequent in female than male participants, notably dosing errors (44% versus 28%), drugs prescribed without indication or demonstrated benefit (34% versus 17%) or inappropriate drugs for elderly individuals (36% versus 15%) (Figure 3). Dosing errors also

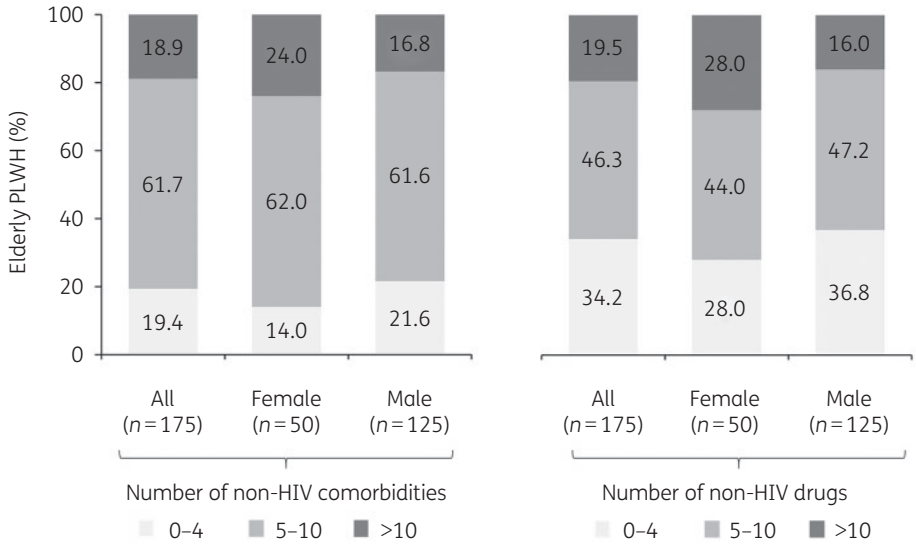

Figure 1. Distribution of elderly PLWH by number of non-HIV comorbidities and non-HIV drugs, stratified by sex.

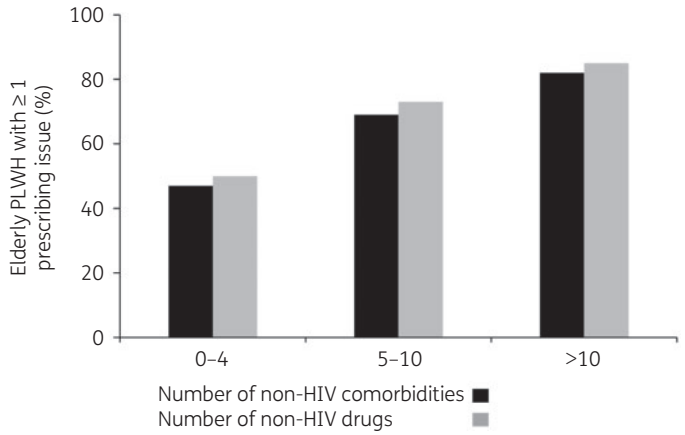

Figure 2. Prevalence of elderly PLWH with ≥1 prescribing issue according to the number of non-HIV comorbidities and prescribed non-HIV drugs.

occurred more frequently in individuals with renal impairment [i.e. estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2] compared with those with no renal impairment (47% versus 14%).

Factors associated with prescribing issues

In the multivariable logistic regression, factors statistically associated with increased OR of having ≥1 prescribing issue were female sex (OR: 8.3; 95% CI: 2.4–28.1), polypharmacy (OR: 2.5; 95% CI: 1.3–4.7), renal impairment (OR: 2.7; 95% CI: 1.4–5.1) and treatment with CNS-active drugs (OR: 2.1; 95% CI: 1.1–3.8) (Table 3). The small sample size and wide CI do not allow for quantification of the sex effect precisely.

Discussion

We showed that two-thirds of elderly individuals enrolled in the SHCS have prescribing issues. Risk factors for inappropriate prescribing included polypharmacy, renal impairment, treatment with CNS-active drugs and female sex.

As expected, our study population had a high prevalence of age-related non-HIV comorbidities, with a similar distribution to that reported in previous studies conducted in elderly uninfected individuals[22,23] or elderly PLWH.[23,24] Of interest, our data showed that individuals with a longer duration of HIV infection tended to have more non-HIV comorbidities, as also observed in the geriatric Italian HIV cohort GEPPO.[25] This finding could partly be explained by metabolic toxicities related to the long-term exposure to ARVs, particularly the first generation of ARV drugs. HIV-related chronic immune activation could also favour the occurrence of certain comorbidities such as atherosclerotic cardiovascular disease.

The majority of our study population were on triple ARV regimens (78%). Conversely, the GEPPO cohort reported a higher use of non-conventional ARV regimens (notably dual therapies) as clinicians were wanting to limit the risk of ARV-related adverse effects in elderly patients.[26]

Consistent with the elevated number of non-HIV comorbidities, polypharmacy was common in our study population, with a prevalence of 66%, comparable with other cohorts of elderly PLWH.[27] This finding is in line with observations from a Spanish HIV cohort.[28] Inappropriate prescribing was highly prevalent, with 67% of our participants having at least one prescribing issue. Nearly half of the issues related to dosing adjustment and indication. Interestingly, DDIs did not represent the main prescribing issue even though a large proportion of our population was polymedicated and received an ARV drug that may perpetrate DDIs (61%). A comparable prevalence of deleterious DDIs has been reported in elderly PLWH.[7,13] Altogether, these data suggest that DDIs are mostly well managed and physicians are aware of the risk of DDIs with ARVs.

Of interest, prescribing issues occurred mainly with non-HIV drugs. The limited number of HIV drugs, being prescribed by HIV specialists and on the basis of regularly updated guidelines are conditions that tend to limit the risk of error. Conversely, there is a huge selection of non-HIV drugs, which are usually prescribed

Table 2. Common prescribing issues ($n = 273$)

Description of prescribing error	*n* (%)
Incorrect drug dosage	72 (26)
Dosage not adapted to renal function	46 (17)
High dose vitamin D (associated with risk of falls)	15 (5)
Suboptimal statin dose/response in patients at high risk of CVD	8 (3)
Underdosage	3 (1)
No indication (e.g. statin in primary prevention—no proof of benefit)	57 (21)
Prescription omission	46 (17)
Aspirin or statin in patients with high CVD risk	17 (6)
Calcium and vitamin D in patients with osteoporosis	16 (6)
Other drug omission	13 (5)
Drug not appropriate in elderly individuals	48 (18)
Long-term use of benzodiazepines (risk of falls, cognitive impairment)	36 (13)
Drugs with anticholinergic properties (≥3 points)[a]	12 (4)
Deleterious DDIs	46 (17)
HIV/non-HIV drugs (of these, 4% included PI + DAA or clopidogrel)	37 (14)
Non-HIV/non-HIV drugs	9 (3)
Treatment duration exceeding recommendations	4 (1)

CVD, cardiovascular disease; DAA, direct-acting anticoagulant.
[a]Anticholinergic score was calculated using the anticholinergic risk scale score.[19] A total score of ≥3 has been shown to increase the risk of falls or delirium.

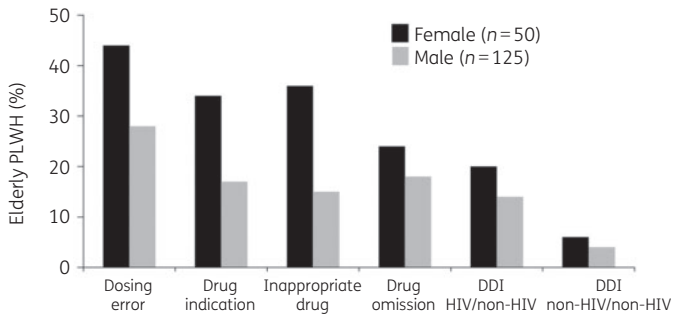

Figure 3. Prevalence of prescribing issues according to sex in elderly PLWH.

separately by different healthcare providers. The principal clinician in charge of the patient is expected to keep an overview of these prescriptions and review them periodically. However, this coordination role is not always clearly defined and the principal physician may not always feel entitled to change a prescription from a specialist. Given the retrospective nature of the study, the clinical consequences of prescribing issues could not be assessed, but on a theoretical basis about 40% could have deleterious clinical consequences.

As expected, polypharmacy was one independent risk factor as intuitively the more drugs that are used, the greater the risk of

Table 3. Multivariable logistic regression for risk factors of having ≥1 prescribing issue

Factors	Adjusted OR	95% CI
Age	1.03	0.97–1.08
Female sex	8.28	2.44–28.08
Duration of known HIV infection	1.02	0.98–1.06
Polypharmacy[a]	2.50	1.34–4.65
Renal impairment[b]	2.68	1.42–5.05
HIV treatment containing TDF	1.38	0.77–2.49
Treatment with CNS-active drug	2.09	1.14–3.82

TDF, tenofovir disoproxil fumarate. ORs are adjusted for all listed variables.
[a]Polypharmacy is defined as receiving ≥5 non-HIV drugs.
[b]Renal impairment is defined as eGFR < 60 mL/min/1.73 m^2.

prescribing issues. In addition, comorbidities are drivers of polypharmacy and prescribing to polymorbid patients is highly complex, requiring both knowledge and expertise. In such a context, prescribing requires more time to adequately address issues related to dosage adjustment, management of DDIs, evaluation of drug–disease interactions and the benefit–risk ratio, but time devoted to prescribing is usually too short due to tightly timed medical visits.

Renal impairment was another independent risk factor for inappropriate prescribing. Renal function progressively declines with ageing[29] and is usually impaired to some extent in elderly individuals, even in the absence of a specific kidney disease. About 25% of drugs on the market are principally excreted unchanged via the kidneys, thus requiring a dosage adjustment in the case of renal impairment.[30] However, renal function is difficult to estimate, especially in elderly people. Plasma creatinine is often used as a quick estimate, although it is well established that it does not adequately reflect the renal function in elderly individuals, whose muscle mass is reduced.[31] The various formulae used to evaluate renal function, such as Cockcroft–Gault or eGFR CKD-EPI, are more valuable than plasma creatinine, yet they may provide conflicting values and remain sheer estimates.

Being treated with CNS-active drugs was another independent risk factor for prescribing issues, mainly driven by benzodiazepines and drugs with anticholinergic properties, both considered inappropriate in elderly individuals.[10,11] Benzodiazepines and other sedative-hypnotics, such as Z-drugs, can cause memory loss, falls, fractures and motor vehicle accidents. Anticholinergic drugs are associated with multiple adverse effects to which elderly people are particularly susceptible, such as memory impairment, confusion, hallucinations, constipation, urinary retention and tachycardia. Other CNS-active drugs are also best avoided in elderly people, unless strongly indicated.

Finally, female sex constituted another risk factor. In our study, female participants tended to be more polymedicated, had a higher prevalence of renal impairment and were more frequently prescribed benzodiazepines, consistent with previous observations in uninfected elderly women.[32,33] These three factors could partly explain the prescribing issues in female individuals outnumbering those in male individuals. However, other factors are contributing

given that female sex was an independent risk factor in the multivariable logistic regression.

Of interest, our study showed sex differences in the occurrence and distribution of comorbidities leaning towards a higher prevalence of comorbidities with notably more CNS, musculoskeletal and renal disorders in female compared with male participants. These differences did not relate to age since the median age of female and male participants was comparable (78.5 versus 78 years). Our observations are consistent with other analyses showing a higher prevalence of renal impairment,[34] depression, anxiety, osteoarthritis and osteoporosis[23] in elderly female PLWH compared with elderly male PLWH. Thus, sex differences in health status may result in different patterns of health service use, including the number of care providers, thereby impacting the risk of prescribing issues. Gender has also been shown to have an effect on the patient–healthcare interaction and prescribing pattern. We showed for instance that benzodiazepines were more frequently prescribed to female than male participants (32% versus 13%). This finding is in line with observations in the general elderly Swiss population reporting a prevalence of benzodiazepine use of 25% in female individuals compared with 15% in male individuals.[35] Of interest, psychotropic drugs (i.e. anxiolytics or antidepressants) have been shown to be more often prescribed to female than male individuals with similar problems and diagnoses.[36,37] This observation has been attributed to the fact that women consult more and talk more about their symptoms, leading to a higher prescription rate, notably of psychotropic drugs or analgesics.[38] A sex bias whereby healthcare providers tend to diagnose more disorders and prescribe more in female than in male individuals could constitute another explanation. Sex bias can also result in female patients being undertreated compared with male patients, as demonstrated for the secondary prevention of ischaemic heart disease.[39]

Finally, patients with low socioeconomic status have been shown to be at higher risk of receiving potentially inappropriate prescriptions.[40] In our study, female participants had a lower level of education compared with male participants (mandatory school or less: 46% versus 9%).

Larger studies are warranted to better quantify the sex risk factor for inappropriate prescribing. Furthermore, studies are needed to assess the impact of other factors such as ethnicity.

Several study limitations should be acknowledged. The analysis was retrospective, therefore the clinical consequences of inappropriate prescribing are unknown. The reason for drug omission was not specified but could possibly relate to the patient's refusal or inability to take the medicine, lack of responsiveness to a medication or adverse effects, rather than the failure to prescribe a drug. The drug-seeking behaviour of some patients could have influenced the prescription of inappropriate drugs, such as long-term benzodiazepine use. Furthermore, the number of over-the-counter drugs could possibly be underreported. Finally, we did not include an uninfected control group.

Several strengths should be acknowledged. The multicentre study with review of patient charts and the use of several prescription tools allowed for the comprehensive analysis of prescribing issues.

In conclusion, prescribing issues are common in elderly PLWH, consistent with reports in uninfected elderly individuals. Inappropriate prescribing represents a risk for the patient, although it should be noted that it does not necessarily lead to harm. Medication reconciliation and periodic review of prescriptions by experienced physicians, ideally as part of multidisciplinary consultations, could reduce the risk of inappropriate prescribing. However, in clinical practice, this approach can be difficult to implement due to the pressure from hospitals and healthcare systems to reduce consultation times. Finally, our study shows that female individuals are at higher risk of inappropriate prescribing, thus doctors should be careful to avoid bias and attention is needed when prescribing for women.

Acknowledgements

Members of the SHCS

K. Aebi-Popp, A. Anagnostopoulos, M. Battegay, E. Bernasconi, J. Böni, D. L. Braun, H. C. Bucher, A. Calmy, M. Cavassini, A. Ciuffi, G. Dollenmaier, M. Egger, L. Elzi, J. Fehr, J. Fellay, H. Furrer, C. A. Fux, H. F. Günthard (President), D. Haerry (deputy of 'Positive Council'), B. Hasse, H. H. Hirsch, M. Hoffmann, I. Hösli, M. Huber, C. R. Kahlert (Chairman of the Mother and Child Substudy), L. Kaiser, O. Keiser, T. Klimkait, R. D. Kouyos, H. Kovari, B. Ledergerber, G. Martinetti, B. Martinez de Tejada, C. Marzolini, K. J. Metzner, N. Müller, D. Nicca, P. Paioni, G. Pantaleo, M. Perreau, A. Rauch (Chairman of the Scientific Board), C. Rudin, A. U. Scherrer (Head of Data Centre), P. Schmid, R. Speck, M. Stöckle (Chairman of the Clinical and Laboratory Committee), P. Tarr, A. Trkola, P. Vernazza, G. Wandeler, R. Weber and S. Yerly.

Funding

This study has been financed within the framework of the SHCS, supported by the Swiss National Science Foundation (grant #177499) (SHCS project #807). C.M. was supported by a grant of the Swiss National Science Foundation (grant #166204). The data are gathered by the five Swiss University Hospitals, two Cantonal Hospitals, 15 affiliated hospitals and 36 private physicians (listed in www.shcs.ch/180-health-care-providers).

Transparency declarations

D.L.B. has received honoraria and travel grants from ViiV, Gilead and Merck. M.C. has received research grants from Gilead and ViiV as well as expert opinion fees from AbbVie, Gilead, ViiV and Sandoz for his institution. A.H. has received travel grants from ViiV, Gilead and MSD. A.C. has received financial support for the day hospital of Geneva University Hospital (HIV/AIDS unit) from MSD, AbbVie, Gilead and ViiV as well as unrestricted educational grants from MSD, ViiV and Gilead. P.E.T.'s institution has received research grants and advisory fees from Gilead and ViiV. C.M. has received a research grant from Gilead and speaker honoraria for her institution from MSD. All other authors report no potential conflicts of interest.

Supplementary data

Tables S1 and S2 are available as Supplementary data at *JAC* Online.

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