Physicians' and pharmacies' overview of patients' medication. An analysis of fidelity coefficients

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Abstract

Background

Having an overview of patient medication is essential in preventing drug interactions, unintentional co-prescribing, unnecessary polypharmacy as well as underprescribing. We have assessed the overview of the pharmacies and the prescribers by measuring the 'Fidelity Coefficient', a measure of the extent to which a drug user has a preference for a one prescriber or pharmacy.

Methods and setting

We used the Odense University Pharmacoepidemiological Database (OPED) and extracted all prescriptions for the population in Southern Denmark (pop 1.2 Million) in 2009. We subsequently limited the analysis to persons with at least ten prescriptions within the year. The analysis included 8,246,064 prescriptions issued to 283.388 individuals. For each individual, we identified the most used prescriber and calculated the proportion of all prescription account for by that prescriber, FC_{presc}. We also identified the individual users' most used pharmacy and calculated the FC_{pharm} in a similar fashion.

Results

The average FC_{Presc} was 0.883 (SD 0.158) and the average FC_{Pharm} was 0.927 (SD 0.139). The estimated difference was 0.0446 (95% CI 0.0439-0.0453). Among the factors associated with a high FC_{pres}c and a high FC_{pharm} were high age, male gender and a high volume of prescriptions.

The major drug classes that were most often prescribed by a non-main prescriber were beta-lactams, antidepressants and opioids. Similarly, the major drug classes associated with use of non-main pharmacy were beta-lactams, antidepressants and inhaled beta-agonists.

Conclusion

While both prescribers and pharmacies generally have potential for excellent overview of their patients' medication, the pharmacies account for a slightly higher proportion.

Introduction

The risk of adverse drug reactions, polypharmacy, drug interactions and unintentional co-prescribing has increasingly become a problem, following the rise in intake of medicine (1;14). Many interventions aim to decrease these adverse events. To do so, an overview of the individual patient's medicine intake is necessary. However, several studies have revealed enormous discrepancies between the general practitioner's records, hospital admission papers, pharmacy records and the patient's own medicine cabinet (2; 3; 4; 5; 6; 7; 8; 9).

It has been shown, among elder patients, that the number of prescribing physicians is an independent risk factor for experiencing an adverse drug event (11; 12; 6). Already in 1987 Gilchrist et al. showed up to two thirds of patient's drug history obtained from the general practitioner to be inaccurate (9). It has since then repeatedly been proven that GP records (5; 6; 8; 2; 4) as well as hospital records (3; 4) and even patient reporting (5; 7; 3; 4) shows major discrepancies when compared to more thorough medication reviews, with up to 25 % of prescribed drugs being used without the general practitioners knowledge (2). A Danish study suggests that the use of a nationwide database may prove to be the most accurate measure of actual drug use (3).

The two central players in this field are the prescriber and the pharmacy. We attempted to assess their overview by the 'Fidelity Coefficient', a measure of what proportion of individual patients' medication that are accounted for by their most used prescriber and pharmacy.

Materials and setting

The data for this study was drawn from the Odense University Pharmacoepidemiological Database (OPED). In brief, it is a research database with full coverage of all reimbursed prescriptions in the Region of Southern Denmark (1.2 million inhabitants). The data included in each prescription record includes the prescription holder, the prescriber, the pharmacy, the date of dispensing and a full account of the

dispensed product, including substance, brand name, route of administration, ATC-code and Defined Daily Dose (DDD) (10).

Some drugs are completely exempt from re-imbursement and thus not covered by the database, including benzodiazepines, oral contraceptives, laxatives and certain antibiotics. Drugs with any degree of co-payment are covered by the database.

All prescription redeemed by citizens of the Region of Southern Denmark (population 1.2 million) during 2009 were eligible for the analysis.

Analysis

We restricted the analysis to individuals who had redeemed 10 or more prescriptions during 2009. For each individual, we identified the prescriber who occurred most frequently on that individual's prescription list. We defined the prescriber fidelity coefficient, FC_{Presc}, as the proportion of an individual's redeemed prescriptions that were issued by the most frequent prescriber for that individual. Similarly, we defined the pharmacy fidelity coefficient, FC_{Pharm}, as the proportion of an individual's prescriptions that were redeemed at the most used pharmacy. Unless otherwise stated, the FC_{Pharm} and FC_{Presc} are interpreted as a characteristic of a person. E.g., when calculating the average FC_{Pharm}, we have calculated the average value for FC_{Pharm} for all individual subjects in the study.

The FC_{Presc} and FC_{Pharm} are presented using standard descriptive statistics. Furthermore, we explored the dependency of FC_{Presc} and FC_{Pharm} on such variables as age, gender, number of prescriptions, whether the most frequent prescriber was a GP, whether the main pharmacy had more than one dispensing site and whether the most used pharmacy was urban. We defined urban pharmacies as those that were located in the Odense or Esbjerg municipalities (186,000 and 115,000 inhabitants) or who shared zip-code with another pharmacy. We analysed these associations by two linear regression models, one with FC_{Presc} as dependant variable and one with FC_{Pharm} as dependant variable. We excluded from this part of the analysis all subjects who had two or more pharmacies sharing position as the preferred and where at least one was

near a competitor and at least one was not (N= 2246). Similarly, we excluded all subjects who had both a GP and a non-GP in a tied position among the preferred prescribers (N= 1779).

Finally we tabulated the proportion of prescriptions that were either issued by a non-main prescriber or redeemed at a non-main pharmacy within major drug classes. We grouped the drug classes according to the third level of the ATC code (e.g. M01A = NSAIDs). Only groups with more than 50,000 prescriptions (covering 88.7 % of the data) were reported.

Finally, we determined the proportion of prescription that were issued by a non-main prescriber or redeemed at a non-main pharmacy as a function of the month, thereby constructing a seasonality curve for FC_{Presc} and FC_{Pharm}.

Results

We extracted 10,067,798 prescriptions issued to 853,217 different individuals from the Region of Southern Denmark in 2009. After restriction to subject with 10 or more prescriptions, we had 8,246,064 prescriptions issued to 283.388 individuals. Of these subjects 121,734 (42.8%) were men, and their median age was 64 years (interquartile range 52 - 75).

The average FC_{Presc} was 0.882 (SD 0.158) and the average FC_{Pharm} was 0.927 (SD 0.139). The average difference was 0.0446 (95% CI 0.0439-0.0453). 116,918 persons (41.2%) had an FC_{Presc} of 1.00 and 182,030 (64.2%) had an FC_{Pharm} of 1.00. Of those, 91,665 (32.3%) had a value of 1.00 for both parameters. 126,585 persons (44.7%) had a higher FC_{Pharm} than FC_{Presc}, while 50,640 persons (17.7%) had the opposite pattern. There were 1,683 unique main prescribers and 242 unique main pharmacies.

Among the variables that were significantly associated with high FC_{Pharm}, we found high age, male gender, high volume of prescriptions, main pharmacy having more than one dispensing site and use of a pharmacy with no competing pharmacies nearby (Table 1). Use of a pharmacy near a competitor was associated with a 0.053 lower FC_{Pharm} than use of other pharmacies. When we restricted the analysis to only pharmacies near a competitor, the crude FC_{Pharm} was 0.894. The variables that were associated with high FC_{Presc} was

high age, male gender, high number of prescriptions and use of a general practitioner as main prescriber (table 2). The dependency of FC_{Pharm} and FC_{Presc} on age and sex is shown in figure 1. In figure 2, we have shown the seasonality of both measures.

The major drug classes that were most often prescribed by a non-main prescriber were beta-lactams, antidepressants and opioids. Similarly, the major drug classes associated with use of non-main pharmacy were beta-lactams, antidepressants and adrenergics (inhalants), see table 3.

Discussion

The average FC_{Pharm} was 0.927 and the average FC_{Presc} was 0.882. Thus there is a slightly higher fidelity towards the pharmacy than towards the main prescriber. However, both have the possibility to have an excellent overview of their clients' medication. The actual overview also depends on factors such as the structure and the interface of the IT-solutions used by the prescriber and the pharmacies and the training of the prescribers and pharmacist. Also, our analysis is based on the actual dispensing of drugs, and as such we have no means of assessing to which extent the main prescriber is made aware of the prescriptions issued by specialists or other doctors to his patients.

The primary strength of the study is the high internal validity due to a high quality of the prescription data (10). Furthermore there is little selection bias, since all residents of Region of Southern Denmark were included in the analysis.

The primary weakness of the study is that the FC_{Pharm} and the FC_{Presc} are to a large extent determined by the underlying healthcare structure. Our result may thus not necessarily apply equally to other setting.

There are several factors in our setting that would favor a high FC_{Pharm} over the FC_{Presc}. First of all the pharmacies in Denmark are large units, often covering a substantial area, especially in comparison with the average pharmacy as seen in e.g. southern Europe. In our region there are 56 community pharmacies corresponding to a density of 1 pharmacy per 21.400 citizens. It is noteworthy however that the FC_{Pharm} only shows a minor dependency on having multiple pharmacies nearby (table 1). Furthermore many doctors are specialists and thus only maintain a minor part of a patient's total medication. Other factors favour the FC_{Presc} over the FC_{Pharm}. The pharmacies are completely liberalised in Denmark, allowing patients to choose freely between pharmacies. On the other hand, each citizen is assigned a regular general practitioner that serves as a gate keeper, meaning that all medical contact, excluding emergencies, should go through the assigned general practitioner. Although it is possible to change general practitioner, this happens relatively rarely. Furthermore, there is a tendency in Denmark also among general practitioners to

form larger units consisting of several practitioners under the same roof and using the same prescriber identifier. As such the single prescriber ID in our analysis can cover more than one individual prescriber. As these prescribers can see each other's prescribing to the individual patient within the group practice , they have the opportunity to avoid the problems that relate to multiple prescribers. Furthermore repeat prescriptions are registered as multiple single prescriptions in our analyses, even though they only represent a single prescription decision. By definition, repeat prescriptions are issued by the same prescriber, but not necessarily redeemed at the same pharmacy, again a factor that would favour a high FC_{Presc} relatively to the FC_{Pharm}. Finally, general practitioners frequently take over the prescribing of specialised drug regimes as soon as the medication is stable. In conclusion the fidelity coefficient is highly dependent on the health care structure. Most of the factors in our setting point towards a higher FC_{Presc}. than FC_{pharm}. It is therefore surprising to find a FC_{Pharm} greater than the FC_{Presc}.

Our analysis in table 3 shows that antibiotics account for most of the infidel prescriptions, which hardly comes as a surprise. It is more interesting to find the groups of 'antidepressants', 'antipsychotics' and 'antithrombotic agents' being so highly represented. These three groups are known to often represent long term treatments and also show a wide range of possibly dangerous drug-drug-interactions, especially regarding the antithrombotic agents [15]. Combining the numbers for these three groups show that while 111,733 of these prescriptions where made by others than the most used prescriber only 57,671 where redeemed away from the most used pharmacy. While both numbers are higher than desired, this emphasizes the central role of the pharmacy in discovering and preventing drug-drug-interactions.

The importance ofthe Fidelity Coefficient for monitoring medication profiles, avoiding doubling or interations is most obvious in a setting where a data on the medication of the single individual are not readily available for the health service practitioner. This is still the case in most countries. In Denmark, each redemption of a prescription is registered but no complete list of 'current treatment' is produced for routine care. This will probably change in the coming years, with new IT-solutions.

Several questions arise from this study. First, it would be interesting to explore how the 'fidelity coefficient' differs across different populations and different health care models. It might even be possible, through subsequent studies, to link the 'fidelity coefficient' to other parameters such as ADE-rates on a population scale. Lastly the 'fidelity coefficient' could be used as a tool to refine future population based analyses, for example by having a high fidelity as an exclusion or inclusion criteria.

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Legend to figure 1:
The dependency of the Fidelity Coefficient on age and sex

Legend to figure 2
Season variability of the Fidelity Coefficient

Table 1: The dependency of the pharmacy fidelity coefficient on explanatory variables.

Base FC_{Pharm}	0.838 [0.836 ; 0.839]
Age*	0.018 [0.017 ; 0.018]
Male gender	0.011 [0.010 ; 0.012]
Number of prescriptions †	0.003 [0.003 ; 0.003]
Main pharmacy near competing pharmacy ‡	-0.053 [-0.053 ; -0.052]
Main pharmacy having more than one dispensing site	0.006 [0.005 ; 0.007]

*** The influence of age over FC_{Pharm} is given as the change per 10 years. † The influence of number of prescriptions over FC_{Pharm} is given as the change per 10 prescriptions. ‡ The classification of 'nearby pharmacies' is given in the method section.**

Table 2: The dependency of the prescriber fidelity coefficient on explanatory variables.

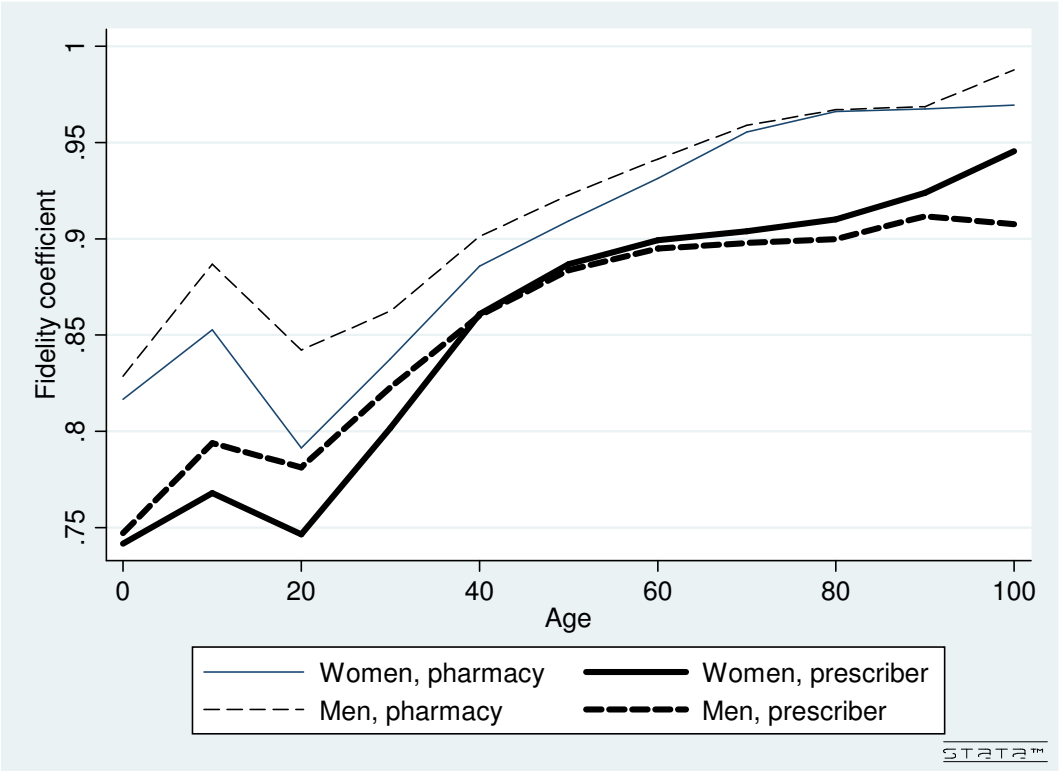
Base FC_{Presc}	0.627 [0.625 ; 0.630]
Main prescriber being a general practitioner	0.200 [0.198 ; 0.202]
Age*	0.012 [0.011 ; 0.012]
Male gender	0.002 [0.001 ; 0.003]
Number of prescriptions †	0.002 [0.002 ; 0.002]

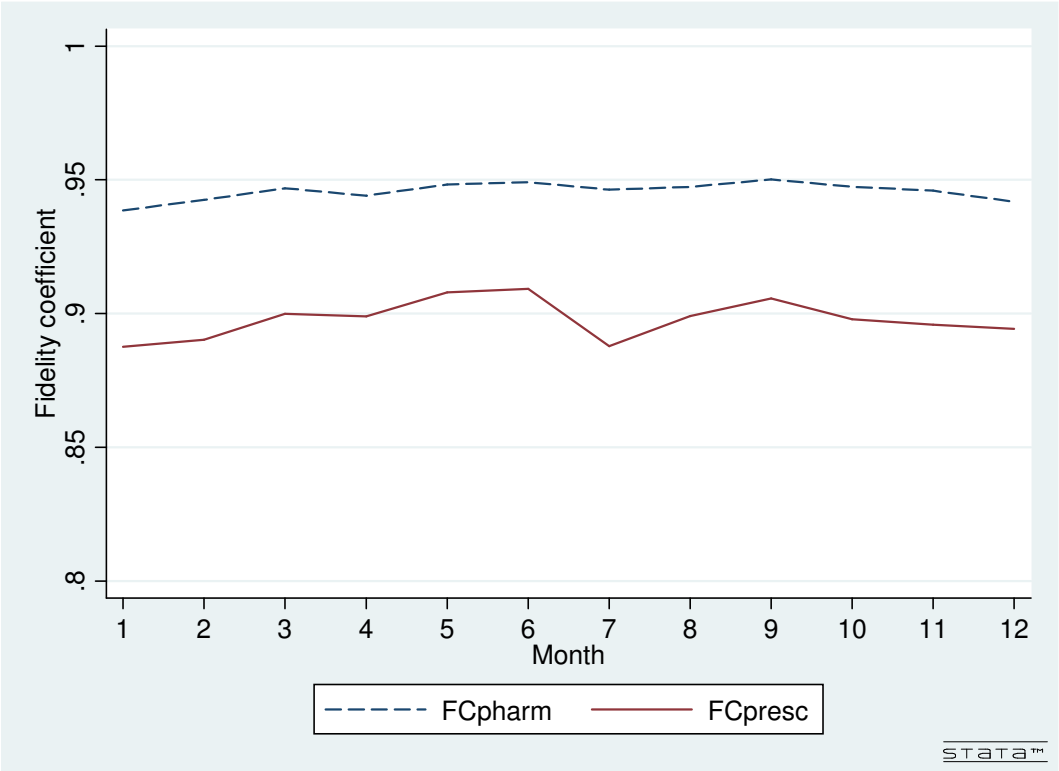
*** The influence of age over FC_{Pharm} is given as the change per 10 years. † The influence of number of prescriptions over FC_{Pharm} is given as the change per 10 prescriptions.**

Table 3: The major drug classes to be prescribed by other than main prescriber and redeemed at other than main pharmacy.

ATC	ATC-Text	Total number of prescript-tions	Prescriptions issued by other prescriber than main prescriber [% (number)]	Prescriptions redeemed at other pharmacy than main pharmacy [% (number)]
B01A	Antithrombotic agents	545,541	6.42 (35,021)	3.26 (17,784)
N06A	Antidepressants	531,388	8.68 (46,126)	5.57 (29,622)
N02A	Opioids	449,645	8.87 (39,888)	5.42 (24,353)
C10A	Cholesterol and triglyceride reducers	409,749	6.31 (25,851)	3.78 (15,503)
N02B	Non-opioid analgesics and antipyretics	392,559	4.82 (18,923)	3.51 (13,774)
R03A	Adrenergics, inhalants	355,135	7.96 (28,282)	7.03 (24,957)
A02B	Drugs for peptic ulcer and gastro-oesophageal reflux disease	343,252	8.27 (28,381)	4.98 (17,077)
M01A	Antiinflammatory and antirheumatic products, non-steroids	327,479	8.86 (29,016)	6.55 (21,465)
C07A	Beta blocking agents	319,839	6.83 (21,839)	3.68 (11,775)
C09A	ACE inhibitors, plain	272,042	6.32 (17,187)	4.00 (10,887)
C08C	Selective calcium channel blockers with mainly vascular effect	250,901	6.39 (16,031)	3.90 (9,795)
A10B	Oral blood glucose lowering drugs	247,964	6.25 (15,500)	4.33 (10,735)
N05A	Antipsychotics	232,120	13.18 (30,586)	4.42 (10,265)
C03C	High-ceiling diuretics	213,882	6.01 (12,846)	2.54 (5,423)
J01C	Beta-lactam antibacterials, penicillins	210,077	31.28 (65,710)	15.29 (32,127)
C03A	Low-ceiling diuretics, thiazides	207,753	4.93 (10,241)	3.63 (7,547)
N03A	Antiepileptics	199,453	10.69 (21,322)	5.25 (10,467)
A12B	Potassium	170,159	5.45 (9,271)	2.68 (4,568)
R03B	Other drugs for obstructive airway diseases, inhalants	157,373	8.04 (12,654)	6.46 (10,162)
A10A	Insulins and analogues	144,746	15.68 (22,693)	6.23 (9,024)
C09C	Angiotensin II antagonists, plain	114,579	6.85 (7,848)	4.38 (5,017)
G03C	Estrogens	100,345	11.68 (11,721)	6.67 (6,688)
H03A	Thyroid preparations	87,781	6.39 (5,611)	4.84 (4,249)
S01E	Antiglaucoma preparations and miotics	84,547	43.24 (36,562)	6.56 (5,547)
R06A	Antihistamines for systemic use	81,832	10.7 (28,773)	8.02 (6,560)
D07A	Topical corticosteroidss, plain	81,743	21.03 (17,189)	9.17 (7,495)
C09D	Angiotensin II antagonists, combinations	80,269	5.45 (4,376)	4.35 (3,489)
H02A	Corticosteroids for systemic use, plain	77,459	16.56 (12,828)	7.95 (6,156)
C09B	ACE inhibitors, combinations	73,710	5.57 (4,107)	4.43 (3,262)
R01A	Decongestants and other nasal preparations for topical use	72,413	21.84 (15,818)	10.33 (7,483)
M05B	Drugs affecting bone structure and mineralization	68,863	6.66 (4,585)	3.16 (2,173)
N02C	Antimigraine preparations	68,245	8.08 (5,512)	11.15 (7,612)
C01A	Cardiac glycosides	64,522	5.75 (3,711)	2.75 (1,774)
C01D	Vasodilators used in cardiac diseases	59,812	7.22 (4,319)	2.97 (1,776)
N04B	Dopaminergic agents	57,270	12.26 (7,024)	3.81 (2,184)
G04B	Other urologicals, incl. antispasmodics	52,594	11.40 (5,997)	5.15 (2,708)
J01F	Macrolides, lincosamides and streptogramins	52,457	23.26 (12,202)	14.43 (7,571)
G04C	Drugs used in benign prostatic hypertrophy	52,377	9.87 (5,169)	3.74 (1,957)

Only groups with more than 50,000 prescriptions are included (covering 88.7 % of our data). The data have been sorted by number of prescriptions.


Fidelity coefficient
.75
.8
.85
.9
.95
1
0
20
40
60
80
100
Age
Women, pharmacy
Men, pharmacy
Women, prescriber
Men, prescriber


Fidelity coefficient
.8
.85
.9
.95
1
1
2
3
4
5
6
7
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Month
FCpharm
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