General practitioners' adoption of new drugs and previous prescribing of drugs belonging to the same therapeutic class: a pharmacoepidemiological study

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Aim

To test the hypothesis that general practitioners (GPs) with high prescribing levels of certain drugs will adopt new drugs belonging to the same therapeutic group faster than those with low prescribing levels.

Methods

The adoption of four new drugs: esomeprazol, selective cyclo-oxygenase-2 inhibitors, new triptans, and angiotensin-II receptor blockers were analysed using population-based prescription data. We used the preference proportion (prescriptions for new rather than older alternatives for the same indication) to measure GPs' adoption rate. Annual prescribing volume and prevalence were used to measure previous prescribing of older drug alternatives. We modelled the preference proportion using multiple linear regression analysis and the prescribing of older drugs as independent variables. We controlled for the GPs' general prescribing level and weighted for practice size. In the first three analyses, we dichotomized data using the median, lower and upper quartile as cut-off point. Next, we grouped data into quartiles and finally, we used continuous data.

Results

For esomeprazol and new triptans there was a higher preference for new drugs among 'high prescribers', but only when this term was defined as the upper quarter and the upper half of previous prescribing levels, respectively (mean difference in preference proportion: 10.2% (99% confidence interval = 1.3%, 19.1%) and 8.2% (0.2%, 16.2%)). For the remaining two drug classes the associations were weak and almost all statistically nonsignificant.

Conclusion

There is no consistent association between GPs' level of drug prescribing and their adoption of new drugs of the same therapeutic group.

Introduction

Increasing prescription drug expenditures is a world-wide concern [1–3]. The use of new and more expensive drugs is a major contributing factor to the rising costs.

Despite their higher cost, new drugs often offer little or no therapeutic benefits compared with older drug alternatives [3–5]. However, efforts by health managers to influence general practitioners' (GPs) prescribing of

new drugs often have had little impact [6–8]. One reason for this may be a lack of understanding of key factors influencing the decision to prescribe new drugs [9]. For example, it is a common belief that there is a relatively small group of doctors who generally prescribe (adopt) new drugs early (universal early adopter) and that this behaviour is associated with practice demography, the doctors' age and sex, and personality [10–12], but the supporting evidence is weak. The early adopters are believed to greatly influence other GPs' adoption of new drugs and many consider the early adopters to be the 'individuals to check with' [10] before using a new drug. Therefore, it has been suggested that interventions to influence prescribing of new and expensive drugs should specifically be targeted at early adopters [13–15]. In a previous study, however, we were unable to identify any universal early adopters of new drugs [16]. Rather, GPs who were early adopters of one group of new drugs were late adopters of others without any clear 'adopter trait'. Still, it is unlikely that adoption of new drugs is a purely random process, and other factors should be sought. One such factor could be clinical experience or a special interest in a particular therapeutic area. Doctors who frequently prescribe a certain therapeutic class of drugs may be more inclined to adopt new drugs belonging to the same class, either because of interest in the drug or the associated disease [17], or simply because they treat many patients with the specific disease. Although previous studies found that early adopters tend to prescribe more drugs than nonadopters from all drug classes, the association between adoption of new drugs and previous prescribing of drugs belonging to the same therapeutic class has not been studied [10, 11, 18]. Based on these considerations we hypothesized that GPs who often treat patients for one specific indication would adopt new drugs for the same indication more often than their colleagues. Hence, the aim of this study was to analyse the association between GPs' adoption of new drugs and previous prescribing of drugs belonging to the same therapeutic class.

Methods

Study design and setting

We conducted the study in the Danish county of Funen (~470 000 inhabitants) using a population based prescription register. Four groups of prescription drugs introduced into the Danish market from 1994 through 2000 were selected. These drugs were all marketed with the claim of having considerable benefits in comparison with older drug alternatives. Furthermore, all drugs are frequently used. The included drugs were the proton pump inhibitor (PPI) esomeprazol, cyclo-oxygenase-2

selective (COX-2) inhibitors, triptans other than sumatriptan (new triptans) and angiotensin II receptor blockers (ARBs) (Table 1). The older drugs all belonged to the same therapeutic drug class as the new drugs. For esomeprazol these were other PPIs, for COX-2 inhibitors these were other nonsteroidal anti-inflammatory drugs (NSAIDs), for new triptans it was sumatriptan, and for ARBs these were angiotensin converting enzyme inhibitors (Table 1). The GPs can freely prescribe any of the studied drugs.

Data sources

We retrieved data from the Odense University Pharmacoeconomic Database (OPED) comprising information on all prescriptions redeemed at pharmacies in the County of Funen since 1992 [19]. Information included date of redemption, the identity of the prescribing unit (general practice, specialist, or hospital department), the patients' identity, age and gender, the brand, Anatomical Therapeutic Chemical classification, and the quantity of the drug prescribed. In Denmark, all doctors in a practice share the same prescriber code (giving the prescribing practice but not the individual doctor).

The Danish health care system is a tax-funded state system, which follows the principle of universal, free, and equal access for health care services from hospitals and physicians outside hospitals [1]. The local Health Administration in each of 14 counties is responsible for reimbursement to the county pharmacies for drugs sold and for most health care services provided at hospitals and in general practice. Because of this reimbursement scheme, patients' copayment for most drugs is moderate.

Approximately 97% of the Danish population is listed with a GP and the Health Administration keeps records of the patients' identity, age and gender, their use of drugs and services as well as of the GPs providing or prescribing this service. From this register, we extracted information on the number, age, and gender of all patients listed with each practice (solo or group practices).

The Danish Data Protection Agency approved the study. According to Danish legislation, no ethical approval was needed.

Selection of practices

We used data from 191 practices that existed at some point in time during the period 1994–2001. Median number of patients listed with a practice was 1439 patients (10–90th percentile: 851–3627). There were 121 solo and 70 group practices with a median list size

Table 1

Selected drugs, the number of practices included in each study period, the preference proportion for the new drugs and characteristics of the patients receiving one of the selected drugs

New drugs	Old drugs	Number of practices included (total)	Median preference proportion for new drugs in percentage (IQR)	Number of patients	Patient age years median (IQR)	% female patients
<i>Proton pump inhibitor:</i> esomeprazol	<i>Other proton pump inhibitors:</i> lansoprazol, omeprazol, pantoprazol, rabeprazol	163 (181)	28 (15–42)	8797	57 (42–72)	55
<i>Selective cyclo-oxygenase-2 inhibitors:</i> celecoxib, rofecoxib	<i>Other nonsteroidal anti-inflammatory drugs:</i> acedofenac, azapropazone, dexibuprofen, didofenac, etodolac, fenbrufen, fenoprofen, flurbiprofen, ibuprofen, indometacin, ketoprofen, ketorolac, lornoxicam, meloxicam, nabumetone, naproxen, phenylbutazone, piroxicam, proquazone, sulindac, tenoxicam, tiaprofenic acid, tolfenomic acid, tolmetin <i>Triptans:</i> sumatriptan	174 (184)	17 (12–23)	28629	51 (37–65)	55
<i>Triptans:</i> almotriptan, eletriptan, naratriptan, rizatriptan, zolmitriptan <i>Angiotensin-II receptor antagonists:</i> candesartan, eprosartan, ibesartan, losartan, telmisartan, valsartan	<i>Angiotensin converting enzyme inhibitors:</i> captopril, benazepril, enalapril, fosinopril, lisinopril, moexipril, perindopril, quinopril, trondolapril	160 (177)	40 (21–53)	5040	41 (32–50)	79
		122 (149)	27 (13–46)	12896	65 (53–75)	52

of 1168 (770–1613) and 2772 (1843–4592), respectively.

For each analysis, we excluded practices established less than 1 year prior to the day the first new drug was reimbursable. Practices in which there had been changes of GPs during the study period were also excluded (Table 1). This left for the analysis of esomeprazol 108/55 (solo/group) practices, of COX-2 inhibitors 113/61 practices, of new triptans 106/54 practices, and of ARBs 78/44 practices.

Variables

For each practice and each therapeutic group, we quantified adoption of new drugs by calculating the 'preference proportion' for new drugs (Equation 1). First time (incident) users were all patients who had not purchased one of the old drugs during the 365 days preceding their first new or old drug purchase. The preference proportion was calculated from the day of entry of the new drug on the market. The study periods were 1 year for esomeprazol and COX-2 inhibitors, 2 years for new triptans, and four years for ARBs [16].

$$\frac{\text{The number of patients receiving a new drug for the first time}}{\text{The number of patients receiving a new or an old drug for the first time}} \quad (1)$$

For each practice and each drug group, we quantified GPs' previous prescribing by calculating the standardized prescribing volume and the standardized prescribing prevalence of old drugs in a 1-year period prior to entry of the new drug on the market. We defined the prescribing volume as the annual number of defined daily doses (DDD) prescribed per 1000 listed patients and the prescribing prevalence as the annual number of treated patients per 1000 listed patients. Both measures and the preference proportion were standardized according to age and sex of listed patients by means of direct standardization to the total practice population, i.e. the prevalence in each of age and sex strata was weighted with the fraction of this stratum in the population of patients listed within the county ($n \sim 466\,000$).

In order to adjust for differences in GPs' prescribing in general we also calculated the standardized prescribing volume and the standardized prescribing prevalence for GPs' total prescribing of all other drugs.

For esomeprazol and ARBs we also calculated the prescribing volume and the prescribing prevalence of related drugs having the same indication as the new drug. These were for esomeprazol H2 receptor blockers and for ARBs' thiazides, calcium channel blockers and

beta-blockers. Drugs containing ergotamine that could be considered alternatives to triptans are seldom used in Denmark and therefore not included.

Analyses

Linear regression analysis was used to explore associations between new drug uptake and GPs' previous prescribing at practice level. First, we modelled the preference proportion using univariate analysis and the standardized prescribing volume of related drug groups as independent variables. Next, we used multivariate analysis to control for the GPs' prescribing in general and weighted for the number of patients in each practice. We dichotomized the prescribing volume in three separate analyses using first the lower quartile as cut-off point, second, the median as cut-off point, and third the upper quartile. We also grouped the prescribing volume into quartiles and finally, we used the prescribing volume as a continuous variable. Analyses were repeated for solo and group practices separately. Finally, we repeated all analyses, modelling the preference proportion using the standardized prescribing prevalence as explanatory variable. Because of an increased risk of type 1 error caused by the multitude of analyses, we considered $P < 0.01$ to be statistically significant and results are presented with 99% confidence intervals (CIs).

Results

Mean preference proportions for new drugs are presented in Table 1. Mean annual prescribing volume and mean preference for new drugs for each quartile of annual prescribing volume are presented in Table 2. There were only few statistically significant associations between the preference for new drugs and previous prescribing volumes of alternative drugs (Table 3). High prescribing volume of PPIs was associated with a higher preference for esomeprazol when this variable was dichotomized using the upper quartile as cut-off point (mean difference: 10.2%; 99% CI = 1.3–19.1%). High prescribing volume of sumatriptan was associated with a higher preference for new triptans when this variable was dichotomized using the median as cut-off point (mean difference: 8.2%; 99% CI = 0.2–16.2%). Finally, high prescribing volume of nonselective nonsteroidal anti-inflammatory drugs was associated with a lower preference for COX-2 inhibitors when this variable was used as a continuous variable (−0.7%/DDD/patient; 99% CI = −1.3 to −0.1%/DDD/patient). Also, high prescribing volume of all other drugs than NSAIDs were associated with a higher preference for COX-2 inhibitors when this variable was dichotomized using

Table 2

Mean preference proportion (%) for new rather than old drugs presented for general practitioners grouped into quartiles according to their previous use of the old and other drug groups (mean DDD per 1000 listed patients presented in parenthesis)*

New drugs	Old drugs	General practitioners' previous use of	1st quartile	2nd quartile	3rd quartile	4th quartile
Esomeprazol	Proton pump inhibitors	Proton pump inhibitors	25.5 (3711)	32.4 (5240)	25.1 (6788)	36.0 (9799)
		H2-receptor blockers	30.0 (1169)	25.7 (1952)	31.8 (2672)	31.4 (4165)
		All other	27.3 (217 480)	31.1 (248 876)	31.4 (271 950)	29.0 (322 377)
Selective cyclo-oxygenase-2 inhibitors	Non-steroidal anti-inflammatory drugs	Non-steroidal anti-inflammatory drugs	19.5 (7017)	19.4 (9486)	16.8 (11 686)	17.0 (15 171)
		All other	17.1 (218 161)	16.7 (250 264)	20.1 (271 613)	18.8 (321 110)
Triptans other than sumatriptan	Sumatriptan	Sumatriptan	32.8 (120)	35.7 (244)	41.3 (347)	39.3 (667)
		All other	34.7 (207 014)	40.6 (233 608)	42.0 (260 923)	31.7 (308 899)
Angiotensin II receptor blockers	Angiotensin converting enzyme inhibitors	Angiotensin converting enzyme inhibitors	26.2 (6855)	29.2 (11 223)	28.7 (15 500)	40.0 (24 225)
		Thiazides, calcium channel blockers, beta-blockers	25.1 (30 601)	26.8 (40 443)	38.6 (49 383)	33.2 (64 166)
		All other	29.4 (207 029)	29.1 (236 022)	29.9 (267 158)	35.2 (329 193)

*The preference proportion and the prescribed volume were standardized according to patients' age and sex.

Table 3

Differences in the preference proportion for new drugs between practices with high and low prescribing volumes. Coefficients are based on multiple linear regression models weighted for the number of patients in each practice and presented with 99% (%) confidence intervals (* $P < 0.01$)

New drugs	Old drugs	General practitioners' previous use of	Upper three quartiles vs. lower first % difference	Upper two quartiles vs. lower two % difference	Upper quartile vs. lower three % difference	Trend across quartiles % difference/quartile	Continuous data % increase/DDD/patient
Esomeprazole	Proton pump inhibitors	Proton pump inhibitors	Solo 1.0 (-11.4; 13.5)	2.2 (-8.3; 12.7)	5.6 (-6.1; 17.4)	1.5 (-3.4; 6.4)	0.9 (-1.2; 3.0)
		Group 9.0 (-6.3; 24.2)	3.6 (-8.7; 15.8)	9.9 (-3.2; 23.0)	9.9 (-3.2; 23.0)	3.7 (-2.2; 9.7)	3.0 (-1.0; 7.0)
		All 6.0 (-2.9; 14.8)	1.4 (-6.4; 9.1)	10.2 (1.3; 19.1)*	10.2 (1.3; 19.1)*	2.9 (-0.8; 6.7)	1.5 (-0.4; 3.3)
		Solo -2.9 (-14.5; 8.7)	1.4 (-10.9; 13.6)	1.4 (-10.4; 13.1)	1.4 (-10.4; 13.1)	0.3 (-4.4; 4.9)	0.1 (-3.7; 3.9)
		Group -1.0 (-15.5; 13.5)	3.5 (-10.7; 17.8)	5.8 (-7.8; 19.4)	5.8 (-7.8; 19.4)	0.4 (-5.4; 6.2)	0.8 (6.9; 8.4)
Selective cyclo-oxygenase-2 inhibitors	Non-steroidal anti-inflammatory drugs	All -1.4 (-9.9; 7.2)	1.7 (-7.1; 10.5)	1.5 (-7.0; 10.0)	1.5 (-7.0; 10.0)	0.4 (-3.1; 3.8)	0.5 (-3.0; 4.0)
		Solo 4.7 (-7.6; 17.0)	-0.8 (-11.2; 9.7)	-2.2 (-14.7; 10.2)	-2.2 (-14.7; 10.2)	-0.0 (-5.1; 5.1)	-0.0 (-0.1; 0.1)
		Group -1.9 (-16.6; 12.8)	5.2 (-7.1; 17.5)	-1.4 (-14.5; 11.8)	-1.4 (-14.5; 11.8)	-0.1 (-6.1; 5.9)	0.5 (3.0; 4.0)
		All 1.3 (-7.5; 10.2)	2.6 (-5.2; 10.5)	-2.7 (-12.0; 6.6)	-2.7 (-12.0; 6.6)	-0.1 (-4.1; 3.8)	-0.0 (-0.1; 0.1)
		Solo -0.5 (-6.4; 5.3)	-5.0 (-9.6; -0.4)*	-3.4 (-8.8; 2.1)	-3.4 (-8.8; 2.1)	-2.0 (-4.3; 0.2)	-0.7 (-1.4; 0.0)
		Group -0.9 (-6.0; 4.3)	-0.0 (-4.7; 4.7)	1.9 (-4.3; 8.0)	1.9 (-4.3; 8.0)	-0.1 (-2.3; 2.0)	-0.5 (-1.7; 0.6)
		All -2.4 (-6.2; 1.4)	-2.2 (-5.4; 1.0)	-1.4 (-5.6; 2.8)	-1.4 (-5.6; 2.8)	-1.4 (-3.0; 0.2)	-0.7 (-1.3; -0.1)*
		Solo 1.5 (-4.2; 7.3)	3.6 (-1.0; 8.2)	3.4 (-2.1; 9.0)	3.4 (-2.1; 9.0)	1.9 (-0.3; 4.2)	0.1 (-0.0; 0.1)
		Group 6.6 (1.0; 12.3)*	4.9 (0.2; 9.7)*	1.7 (-4.0; 7.5)	1.7 (-4.0; 7.5)	2.3 (0.1; 4.5)*	0.1 (0.0; 0.2)*
		All 3.2 (-0.5; 7.0)	3.4 (0.2; 6.6)*	1.4 (-2.9; 5.7)	1.4 (-2.9; 5.7)	1.8 (0.2; 3.3)*	0.1 (0.0; 0.1)*
Triptans other than sumatriptan	Sumatriptan	Sumatriptan	Solo 5.4 (-8.0; 18.7)	8.6 (-2.7; 19.8)	12.5 (-0.1; 25.1)	4.3 (-0.7; 9.3)	22.1 (1.3; 42.9)*
		Group 8.3 (-6.6; 23.3)	11.9 (-0.2; 24.0)	1.4 (-12.7; 15.4)	1.4 (-12.7; 15.4)	3.7 (-1.9; 9.2)	2.4 (-36.8; 42.9)
		All 9.2 (-0.7; 19.1)	8.2 (0.2; 16.2)*	2.9 (-6.6; 12.4)	2.9 (-6.6; 12.4)	3.5 (-0.3; 7.3)	13.2 (-5.9; 32.3)
		Solo 4.4 (-8.6; 17.5)	2.0 (-9.2; 13.3)	-4.3 (-17.7; 9.0)	-4.3 (-17.7; 9.0)	0.5 (-4.6; 5.6)	-0.0 (-0.1; 0.1)
		Group 4.9 (-9.4; 19.2)	0.1 (-11.6; 12.6)	-4.7 (-19.5; 10.0)	-4.7 (-19.5; 10.0)	0.3 (-5.3; 5.9)	0.0 (-0.2; 0.3)
Angiotensin II receptor blockers	Angiotensin converting enzyme inhibitors	All 5.6 (-3.8; 15.0)	1.0 (-7.0; 9.1)	-9.1 (-19.7; 1.4)	-9.1 (-19.7; 1.4)	-0.1 (-4.0; 3.8)	-0.0 (-0.1; 0.1)
		Solo 8.3 (-6.8; 23.4)	8.8 (-4.6; 22.2)	17.6 (2.5; 32.6)*	17.6 (2.5; 32.6)*	5.4 (-0.3; 11.2)	0.9 (-0.0; 1.8)
		Group 6.5 (-11.2; 24.3)	-0.4 (-16.6; 15.9)	-1.8 (-21.1; 17.5)	-1.8 (-21.1; 17.5)	1.0 (-6.1; 8.1)	-0.1 (-1.6; 1.3)
		All 6.8 (-4.0; 17.5)	5.3 (-4.5; 15.0)	9.1 (-2.7; 20.8)	9.1 (-2.7; 20.8)	3.1 (-1.2; 7.3)	0.5 (-0.3; 1.3)
		Solo 5.2 (-10.3; 20.7)	-2.2 (-17.7; 13.4)	-3.9 (-18.5; 10.8)	-3.9 (-18.5; 10.8)	1.2 (-4.7; 7.1)	0.1 (-0.4; 0.5)
		Group 12.5 (-8.7; 33.8)	9.1 (-9.2; 27.3)	9.7 (-8.7; 28.1)	9.7 (-8.7; 28.1)	5.0 (-2.2; 12.2)	0.7 (-0.2; 1.6)
		All 9.8 (-2.1; 21.8)	3.8 (-8.9; 16.4)	3.7 (-8.6; 16.0)	3.7 (-8.6; 16.0)	4.1 (-0.5; 8.8)	0.3 (-0.2; 0.7)
		Solo 6.2 (-9.3; 21.7)	7.1 (-6.4; 20.5)	10.2 (-4.8; 25.2)	10.2 (-4.8; 25.2)	3.8 (-2.2; 9.7)	0.1 (-0.3; 0.2)
		Group -9.0 (-28.4; 10.4)	1.7 (-13.9; 17.4)	6.6 (-11.3; 24.5)	6.6 (-11.3; 24.5)	0.2 (-6.9; 7.3)	-0.0 (-0.2; 0.2)
		All -2.8 (-14.2; 8.5)	2.0 (-8.0; 12.0)	2.7 (-9.4; 14.8)	2.7 (-9.4; 14.8)	0.2 (-4.3; 4.6)	0.0 (-0.1; 0.1)
Angiotensin II receptor blockers	Thiazides, calcium channel blockers, beta-blockers	Thiazides, calcium channel blockers, beta-blockers	Solo 5.2 (-10.3; 20.7)	-2.2 (-17.7; 13.4)	-3.9 (-18.5; 10.8)	1.2 (-4.7; 7.1)	0.1 (-0.4; 0.5)
		Group 12.5 (-8.7; 33.8)	9.1 (-9.2; 27.3)	9.7 (-8.7; 28.1)	9.7 (-8.7; 28.1)	5.0 (-2.2; 12.2)	0.7 (-0.2; 1.6)
		All 9.8 (-2.1; 21.8)	3.8 (-8.9; 16.4)	3.7 (-8.6; 16.0)	3.7 (-8.6; 16.0)	4.1 (-0.5; 8.8)	0.3 (-0.2; 0.7)
		Solo 6.2 (-9.3; 21.7)	7.1 (-6.4; 20.5)	10.2 (-4.8; 25.2)	10.2 (-4.8; 25.2)	3.8 (-2.2; 9.7)	0.1 (-0.3; 0.2)
		Group -9.0 (-28.4; 10.4)	1.7 (-13.9; 17.4)	6.6 (-11.3; 24.5)	6.6 (-11.3; 24.5)	0.2 (-6.9; 7.3)	-0.0 (-0.2; 0.2)

the median as cut-off point (mean difference: 3.4%; 99% CI = 0.2–6.6%), when the variable was grouped into quartiles (mean difference: 1.8%; 99% CI = 0.2–3.3% and as a continuous variable (0.1%/DDD/patient; 99% CI = 0.0–0.1%/DDD/patient). Repeated analyses using the prescribing prevalence as well as separate analyses of solo and group practices produced similar results (Table 3).

Discussion

Although a few of the analyses indicate a positive association between adoption of new drugs and previous prescribing of older therapeutic alternatives, most of the associations were weak and not consistent across drug groups or prescribing level measures.

We have only explored a limited number of new drugs and it is possible that more robust associations exist for other drug classes. Also, patients' failure to redeem their prescriptions (primary noncompliance) could bias the results if the nonredemption rates of new and old drug prescriptions differ. The high drug reimbursement in Denmark, however, is likely to reduce the influence of drug costs on the patients' redemption rate. Furthermore, the primary nonredemption rate in the county of Funen is in general low [20].

We were able to make accurate, population-based estimates of GPs' prescribing rates because we had access to complete, valid and detailed information on drug use of all inhabitants in a well-defined area where all prescriptions are registered electronically and the health care providers and pharmacists have an economic incentive to provide accurate data [19]. Second, due to the large number of prescriptions, the study has power to detect any relevant association between adoption and previous prescribing levels.

The results presented in Table 3 indicate that there is no difference between solo and group practices with respect to the association between adoption of new drugs and previous prescribing. Future studies should look into mechanisms behind this result.

In a previous study, we found that doctors could be early adopters of some drugs and late of others with no general adoption trait [16]. In the current study, we were unable to find consistent associations between earlier prescribing (as a potential indicator of medical interest) and adoption of new drugs. The adoption process therefore may be more complex than previously assumed.

Why was the uptake of new drugs not associated with previous prescribing of older drug alternatives? Could differences in patient case-mix be the reason? We did not have access to data concerning patients' comorbid-

ity. However, others have demonstrated that adjusting for case-mix does not further reduce the variation in health care services between GPs, than adjusting for age and sex alone [21].

Deciding which drug to prescribe is a complex process that involves many different mechanisms [22]. When it comes to new drugs, physicians have to balance factors like potential side-effects, long-term effects, and likely benefits for which relatively little information is available and of which they may have little or no practical experience. This is illustrated by the introduction of the COX-2 inhibitors. It began with news of a 'break-through' new drug class designed to be safer on the stomach and later evolved into concerns about serious cardiovascular events and the withdrawal of rofecoxib [23].

Decisions are also likely to be influenced by personal, social, and situational factors. First, pharmaceutical contacts and personal experience is often regarded as having a high impact on physicians' prescribing behaviour [22, 24, 25]. Furthermore, Jacoby and Prosser both demonstrated that GPs are more likely to prescribe new drugs in particular clinical and therapeutic areas with which they feel familiar or in which they have developed a special interest [17, 26]. It is also likely that the setting in which physicians work as well as inspiration from colleagues influence the GP's decision to prescribe a new drug [10, 11, 17, 27]. In addition, specialists' prescribing patterns are likely to influence GPs' adoption of new drugs [22, 24, 28]. Finally, threats of formal complaints by patients or their relatives may also influence the outcome of which drug to prescribe [29–31].

In this study, we analysed a possible association between GPs' prescribing of a therapeutic drug group and adoption of new drugs. Associations, however, were weak and not consistent across different drug groups or prescribing level measures. The results indicate that GPs' uptake of new drugs is practically independent of their previous prescribing.

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