

PHYSICIAN CHARACTERISTICS AND PRESCRIBING FOR ELDERLY PEOPLE IN NEW BRUNSWICK: RELATION TO PATIENT OUTCOMES

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Abstract • Résumé

Objective: To examine the relation between physician characteristics, prescribing behaviour and patient outcomes.

Design: Descriptive study linking four provincial databases.

Setting: New Brunswick.

Participants: All 366 general practitioners (GPs) (accounting for 40% of all physicians with a general licence in New Brunswick) who ordered at least 200 prescriptions for elderly beneficiaries of the New Brunswick Prescription Drug Program and saw at least 20 elderly patients in an office setting between Apr. 1, 1990, and Mar. 31, 1991. Physicians with palliative care practices were excluded.

Outcome measures: GPs' personal, professional and practice characteristics, their prescribing patterns, and mortality, morbidity (number of days in hospital per patient) and hip-fracture rates among their elderly patients.

Results: Compared with the GPs who had a lower mortality rate, those with a higher mortality rate prescribed more drugs overall ($p < 0.001$), specifically antidepressants, bronchodilators, cholesterol-lowering agents, gastrointestinal drugs, neuroleptics and nonsteroidal anti-inflammatory drugs (NSAIDs). They also were more likely to be male ($p < 0.01$), had larger practices ($p < 0.001$), saw more patients per day ($p < 0.05$) and billed more per year ($p < 0.001$). Compared with the GPs who had a lower morbidity rate, those with a higher morbidity rate prescribed more drugs overall ($p < 0.005$), specifically bronchodilators, gastrointestinal drugs and NSAIDs. They also were more likely to be younger ($p < 0.005$) and male ($p < 0.01$), had fewer years in practice ($p < 0.001$), saw more patients per day ($p < 0.05$) and billed more per patient ($p < 0.01$). The GPs who had a higher hip-fracture rate prescribed more drugs overall ($p < 0.001$), notably antihypertensives, bronchodilators, cholesterol-lowering agents, gastrointestinal drugs and NSAIDs, than those who had a lower hip-fracture rate. They also had a larger practice ($p < 0.001$), practised more days per year ($p < 0.005$), had more patient visits per year ($p < 0.05$) and billed more per year ($p < 0.001$). Younger male GPs who practised with relatively more intensity and prescribed more drugs per patient had practices with higher morbidity, mortality and hip-fracture rates among their elderly patients than the other GPs.

Conclusions: There is a significant relation between certain physician characteristics, their prescribing behaviour and patient outcomes. Further study is required to determine what physician characteristics and prescribing behaviours for specific illnesses contribute to patient outcomes. Regional differences should also be examined, as should incentives in this fee-for-service system. Linkage of these types of provincial databases may help in the evaluation of physicians' performance and in the development of strategic interventions and practice guidelines.

Objectif : Examiner le lien entre les caractéristiques des médecins, leurs habitudes d'ordonnance et les résultats chez les patients.

Conception : Étude descriptive portant sur quatre bases de données provinciales.

Contexte : Nouveau-Brunswick.

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Participants : Les 366 omnipraticiens (qui représentaient 40 % de l'ensemble des médecins détenant un permis général au Nouveau-Brunswick) qui ont établi au moins 200 ordonnances pour des prestataires âgés du Plan de médicaments sur ordonnance du Nouveau-Brunswick et ont accueilli au moins 20 patients âgés dans un cabinet entre le 1^{er} avril 1990 et le 31 mars 1991. On a exclu les médecins qui avaient une pratique de soins palliatifs.

Mesures des résultats : Caractéristiques personnelles et professionnelles des omnipraticiens et caractéristiques de leur pratique, tendances des ordonnances et taux de mortalité, de morbidité (nombre de jours d'hospitalisation par patient) et de fractures de la hanche chez leurs patients âgés.

Résultats : Comparativement aux omnipraticiens à l'égard desquels on a enregistré un taux de mortalité moins élevé, ceux à l'égard desquels on a enregistré un taux de mortalité plus élevé ont prescrit plus de médicaments dans l'ensemble ($p < 0,001$), et plus particulièrement d'antidépresseurs, de bronchodilatateurs, d'hypocholestérolémiants, de médicaments pour les voies gastro-intestinales, de neuroleptiques et d'anti-inflammatoires non stéroïdiens (AINS). Il y avait plus de probabilités aussi qu'ils soient de sexe masculin ($p < 0,01$), qu'ils aient une pratique plus importante ($p < 0,001$), accueillent plus de patients par jour ($p < 0,05$) et facturent plus par année ($p < 0,001$). Comparativement aux omnipraticiens à l'égard desquels on a enregistré un taux de morbidité moins élevé, ceux à l'égard desquels le taux de morbidité enregistré était plus élevé prescrivait plus de médicaments dans l'ensemble ($p < 0,005$) et plus particulièrement de bronchodilatateurs, de médicaments pour les voies gastro-intestinales et d'AINS. Il y avait en outre plus de chance qu'ils soient plus jeunes ($p < 0,005$) et de sexe masculin ($p < 0,01$), pratiquent depuis moins longtemps ($p < 0,001$), accueillent plus de patients par jour ($p < 0,05$) et facturent plus par patient ($p < 0,01$). Les omnipraticiens à l'égard desquels on a enregistré un taux plus élevé de fractures de la hanche prescrivait plus de médicaments dans l'ensemble ($p < 0,001$), et notamment d'antihypertenseurs, de bronchodilatateurs, d'hypocholestérolémiants, de médicaments pour les voies gastro-intestinales et d'AINS, que ceux à l'égard desquels on a enregistré un taux de fracture de la hanche moins élevé. Ils avaient aussi une pratique plus importante ($p < 0,001$), pratiquaient plus de jours par année ($p < 0,005$), enregistraient plus de visites-patient par année ($p < 0,05$) et facturaient plus par année ($p < 0,001$). Les omnipraticiens masculins plus jeunes qui pratiquaient avec un peu plus d'intensité et prescrivait plus de médicaments par patient travaillaient dans une pratique où l'on a enregistré des taux de morbidité, de mortalité et de fracture de la hanche plus élevés chez les patients âgés que dans le cas des autres omnipraticiens.

Conclusions : Il y a un lien important entre certaines caractéristiques des médecins, leurs habitudes d'ordonnance et les résultats chez les patients. Une étude plus poussée s'impose si l'on veut cerner les caractéristiques des médecins et leurs habitudes d'ordonnance à l'égard de certaines affections en particulier qui contribuent aux résultats chez les patients. Il faudrait aussi examiner les différences entre les régions, tout comme l'incitation que représente ce service rémunéré à l'acte. L'établissement de liens entre ces bases de données provinciales peut aider à évaluer le rendement des médecins et à élaborer des interventions stratégiques et des guides de pratique.

Elderly people respond to medications differently than younger people do. Because of advanced age, changes in renal and hepatic function, the presence of multiple disease and polypharmacy, this group suffers up to seven times the incidence of adverse drug reactions that younger people do.¹⁻⁵

It is difficult to determine accurately the extent of morbidity and mortality from adverse drug reactions and inappropriate medication use among elderly patients. Adverse reactions have been implicated in hospital admissions of elderly patients and linked to increased hospital stays and increased morbidity and mortality rates.⁶⁻¹⁰ For all age groups in the United States, for example, 20% of reported adverse drug reactions resulted in either death or admission to hospital.¹¹ Up to 20% of admissions of elderly people to acute care hospitals may result directly from adverse effects of medications.¹⁰⁻¹⁵

In a study involving 53 elderly patients not in institutions who had on average five distinct chronic illnesses and took a mean of 11 different drugs, three problem

categories were described: drug toxicity, patient compliance and physician prescribing.² The strongest predictor of potential drug-related problems was the number of medications. At least one potential misjudgement in prescribing (suboptimal product selection or dosage) was identified for 81% of the patients. Prescribing errors are a factor in drug-induced iatrogenic disease in elderly people.¹⁶⁻¹⁹ Included in the multiple causes of adverse reactions in elderly patients are inadequate clinical assessment, excessive prescribing and inadequate supervision of long-term drug use.²⁰⁻²² Of 174 elderly veterans admitted to a Veterans' Administration centre in the United States 45% suffered iatrogenic conditions, as compared with 29% of those under 65 years of age, and 23% had drug-related complications.²³

Morbidity and mortality associated with drug use involve errors in prescribing, idiosyncratic responses to medications and delivery-system errors.^{6,7} Unfortunately, no valid or reliable method measures adverse drug reactions to differentiate between these three potential

causes. In addition, no epidemiologic technique has been identified that would help to determine, for example, the effects of prescribing errors on the morbidity and mortality rates in the elderly population or any other age group. Thus, the prevalence and incidence rates of adverse drug reactions and of associated morbidity and mortality have not been clearly defined.

In a previous study we described the relation between general practitioners' personal and practice characteristics and prescribing for elderly patients living in the community.²⁴ Using data from the New Brunswick Prescription Drug Program (NBPDP) and Medicare Program (NBMP) databases we described positive correlations between practice intensity, billing intensity and prescribing intensity for 11 categories of drugs. Despite similarities in practice size and sex, physicians who saw more patients per day provided more services per patient, had more practice days per year, billed more per patient annually and prescribed more drugs per patient. It was unclear whether there was any association between these characteristics and the patients' outcomes in terms of morbidity and mortality, nor was it clear whether patients in the high prescribers' practices were sicker and required relatively more medical attention. If there were associations, it would be possible to make some tentative predictions about the quality of care each patient received.

This follow-up study was performed to describe further the association between the physicians' characteristics and prescribing and patient outcomes. The hypothesis tested was that physicians who have more intense practices and prescribe relatively more drugs per elderly patient have higher rates of morbidity and mortality among these patients.

METHODS

This study was nonexperimental. Rather, four provincial databases were linked: the NBMP (billing information), the NBPDP (prescribing information on senior beneficiaries), the New Brunswick Hospital database (hospital admissions) and the New Brunswick Vital Statistics database (mortality data). Data for Apr. 1, 1990, to Mar. 31, 1991, were examined.

DATABASE LINKAGE

The NBMP database included the records for all physicians' fee-for-service billings. All GPs who saw at least 20 elderly patients (i.e., aged 65 years or more) in their office and ordered at least 200 prescriptions for elderly beneficiaries during the study period (standard audit criteria for the NBPDP) and were not in a palliative care practice were included in the analysis. A total of

366 (40%) of the GPs met these criteria. All but two of the GPs were successfully linked on all variables.

The NBPDP database included specific information on each prescription dispensed, on a claim-by-claim basis. We obtained the records of every prescription dispensed to elderly patients residing outside of nursing homes during the study period. Data included the date the prescription was dispensed, the dispensing pharmacy, the prescribing physician, the drug name, the dosage and quantity dispensed, and the cost to the program.

All drugs dispensed were classified into 11 categories: antibiotics, antidepressants, antihypertensives, barbiturates, benzodiazepines, bronchodilators, cholesterol-lowering agents, gastrointestinal drugs, narcotics, neuroleptics and nonsteroidal anti-inflammatory drugs (NSAIDs). A weighing formula was developed *a priori* to calculate each GP's prescribing ratio by category of drug and the total number of drugs prescribed per patient relative to the other GPs. (Details of the weighing formula can be obtained from the corresponding author upon request.) This formula accounted for the number and strength of each unit prescribed by each GP. The mean score for each category was unity. Values less than unity identified GPs who prescribed less than the mean (low prescribers). Values greater than unity identified those who prescribed more than the mean (high prescribers). The NBMP and NBPDP databases were linked using unique physician identification numbers.

The New Brunswick Hospital database contained information on the length of hospital stay and diagnosis for each of the GP's patients. The New Brunswick Vital Statistics database contained information on each of the GP's patients who died during the study period.

GPs were separated into groups by quartile according to the morbidity (number of hospital days per patient), mortality and hip-fracture rates among their elderly patients. Physicians in the first quartile had the lowest rates, and those in the fourth had the highest.

OUTCOME MEASURES

We examined the relation between mortality, morbidity and hip-fracture rates and physicians' prescribing patterns and personal, professional and practice characteristics. We compared overall prescribing patterns (all drugs) and those for each of the 11 categories of drugs. GPs' personal and professional characteristics included age, sex, family practice accreditation, country of training and number of years in practice. Practice characteristics included practice size, number of practice days, number of patients seen and medical services provided per day, number of patients seen during the study year, average amount billed per patient and total amount billed during the study year.

STATISTICAL ANALYSIS

As one would assume, mortality, morbidity and hip-fracture rates were higher in practices with older patients. To minimize the effect of this confounding factor, we used the analysis of covariance (ANCOVA) for parametric data. The ANCOVA is similar to the analysis of variance except that it attempts to parcel out the effect of the covariates on the dependent variable. A significant F value denotes differences between the group means after adjustment for the covariates.²⁵ We used the mean age of the female and male patients as covariates because preliminary analysis showed significant relations between our dependant variables and these variables (Table 1). Frequency data were analysed with the χ^2 test. Significance was set at a p value of less than 0.05.

RESULTS

Compared with the GPs with a lower mortality rate

among their elderly patients, those with a higher mortality rate prescribed more drugs overall ($p < 0.001$), specifically antidepressants, bronchodilators, cholesterol-lowering agents, gastrointestinal drugs, neuroleptics and NSAIDs (Table 2). They also were more likely to be male, had a larger practice, saw significantly more patients per day, and billed more per year (Table 3).

The GPs with a higher morbidity rate among their elderly patients prescribed more drugs overall than those with a lower morbidity rate ($p < 0.005$); the difference was significant for bronchodilators, gastrointestinal drugs and NSAIDs (Table 4). These GPs also were younger, were more likely to be male, had fewer years in practice, saw more patients per day and billed more per patient (Table 5).

The GPs with a higher hip-fracture rate among their elderly patients prescribed more drugs overall than those with a lower rate ($p < 0.001$); the difference was significant for antihypertensives, bronchodilators, cholesterol-lowering agents, gastrointestinal drugs and NSAIDs (Table 6). These GPs also had a larger practice, had

Table 1: Mean age of patients of general practitioners (GPs) in New Brunswick from Apr. 1, 1990, to Mar. 31, 1991, by mortality rate quartile*

Age, † yr	Quartile				ANOVA‡		Pearson correlation	
	First <i>n</i> = 91	Second <i>n</i> = 94	Third <i>n</i> = 90	Fourth <i>n</i> = 91	F	<i>p</i>	<i>r</i>	<i>p</i>
Male patients	31.54 (7.09)	32.77 (4.73)	36.12 (4.90)	40.49 (9.48)	31.55	< 0.001	0.47	< 0.001
Female patients	34.38 (5.27)	34.89 (4.33)	38.02 (4.76)	43.12 (9.52)	37.01	< 0.001	0.55	< 0.001

*First quartile represents GPs with the lowest mortality rate among their elderly patients, and the fourth represents those with the highest.

†Mean (and standard deviation).

‡ANOVA = analysis of variance.

Table 2: Prescribing patterns of GPs by drug category and mortality rate quartile

Category	Quartile; prescribing ratio* per GP				ANCOVA†	
	First <i>n</i> = 91	Second <i>n</i> = 94	Third <i>n</i> = 90	Fourth <i>n</i> = 91	F	<i>p</i>
Antibiotic	1.18 (1.18)	1.18 (1.18)	1.20 (1.20)	1.25 (1.25)	0.97	0.41
Antidepressant	0.97 (0.97)	1.03 (1.04)	1.25 (1.25)	1.24 (1.22)	6.07	< 0.001
Antihypertensive	1.12 (1.17)	1.13 (1.16)	1.25 (1.24)	1.27 (1.21)	2.52	0.06
Barbiturate	1.04 (1.05)	0.94 (0.93)	1.09 (1.09)	0.98 (0.99)	1.48	0.22
Benzodiazepine	1.26 (1.25)	1.30 (1.30)	1.42 (1.43)	1.41 (1.41)	2.53	0.06
Bronchodilator	1.42 (1.44)	1.48 (1.51)	1.68 (1.68)	1.68 (1.63)	3.03	< 0.05
Cholesterol-lowering agent	0.94 (0.96)	1.08 (1.09)	1.15 (1.15)	1.20 (1.19)	3.19	< 0.05
Gastrointestinal drug	1.19 (1.19)	1.24 (1.26)	1.34 (1.33)	1.48 (1.46)	5.95	< 0.001
Narcotic	0.96 (0.94)	1.02 (1.01)	1.06 (1.07)	1.05 (1.07)	0.63	0.59
Neuroleptic	0.88 (0.88)	0.96 (0.95)	1.08 (1.08)	1.12 (1.14)	3.12	< 0.05
NSAID‡	1.16 (1.17)	1.17 (1.17)	1.25 (1.25)	1.33 (1.33)	3.34	< 0.05
All	1.10 (1.11)	1.14 (1.15)	1.25 (1.25)	1.28 (1.26)	7.50	< 0.001

*Adjusted (and observed) mean.

†ANCOVA = analysis of covariance.

‡NSAID = nonsteroidal anti-inflammatory drug.

Table 3: Characteristics of GPs by mortality rate quartile

Characteristic	Quartile				χ^2 test		ANCOVA	
	First n = 91	Second n = 94	Third n = 90	Fourth n = 91	χ^2	p	F	p
Age,* yr	45.8 (42.5)	43.5 (40.9)	42.8 (43.4)	41.3 (46.7)			2.40	0.07
Male:female ratio	2.1 (62/29)	4.5 (77/17)	9.0 (81/9)	14.2 (85/6)	24.8	< 0.01		
Ratio of GPs qualified by CCFP to those not qualified by CCFP†	0.4 (27/61)	0.4 (24/67)	0.4 (25/64)	0.2 (17/70)	3.1	> 0.25		
Ratio of GPs trained in Canada to those not trained in Canada	6.2 (75/12)	7.3 (80/11)	6.4 (77/12)	6.9 (76/11)	0.1	> 0.99		
No. of years in practice*	20.2 (16.8)	18.5 (16.0)	17.2 (17.8)	16.1 (21.4)			2.20	0.09
No. of patients in practice*	1 862 (2 068)	2 587 (2 787)	2 318 (2 307)	2 130 (1 734)			8.96	< 0.001
No. of practice days*	200.8 (209.1)	208.8 (216.6)	200.9 (200.3)	210.2 (194.7)			0.67	0.57
No. of visits per day*	21.9 (23.5)	25.9 (27.4)	25.1 (25.0)	26.0 (22.9)			3.10	< 0.05
No. of services per day*	31.3 (33.3)	37.6 (39.6)	39.7 (39.6)	35.6 (31.8)			2.45	0.06
No. of visits per year*	4 772.0 (5 191.3)	5 768.3 (6 195.4)	5 263.6 (5 253.7)	5 671.2 (4 834.7)			2.14	0.10
Amount billed per patient,* \$	65.9 (63.3)	64.2 (62.6)	68.3 (69.0)	73.9 (77.4)			2.20	0.09
Amount billed per year,* \$	117 930 (128 096)	160 001 (171 185)	152 045 (152 343)	153 989 (132 340)			6.88	< 0.001

*Adjusted (and observed) mean.

†CCFP = Canadian College of Family Physicians.

Table 4: Prescribing patterns of GPs by drug category and morbidity rate quartile*

Category	Quartile; prescribing ratio† per GP				ANCOVA	
	First n = 91	Second n = 92	Third n = 92	Fourth n = 91	F	p
Antibiotic	1.17 (1.17)	1.19 (1.19)	1.23 (1.23)	1.23 (1.22)	0.72	0.54
Antidepressant	1.02 (1.02)	1.10 (1.11)	1.14 (1.14)	1.22 (1.22)	1.64	0.18
Antihypertensive	1.15 (1.18)	1.20 (1.22)	1.26 (1.26)	1.16 (1.12)	1.43	0.23
Barbiturate	0.98 (1.00)	0.95 (0.95)	1.07 (1.08)	1.04 (1.03)	0.98	0.40
Benzodiazepine	1.26 (1.25)	1.35 (1.35)	1.38 (1.39)	1.41 (1.41)	1.39	0.24
Bronchodilator	1.35 (1.40)	1.48 (1.50)	1.70 (1.70)	1.72 (1.65)	5.10	< 0.005
Cholesterol-lowering agent	1.03 (1.03)	1.05 (1.05)	1.18 (1.17)	1.12 (1.12)	1.12	0.34
Gastrointestinal drug	1.16 (1.20)	1.27 (1.28)	1.39 (1.37)	1.44 (1.41)	5.38	< 0.001
Narcotic	0.95 (0.93)	1.04 (1.03)	1.02 (1.03)	1.08 (1.10)	0.64	0.59
Neuroleptic	0.96 (0.93)	1.07 (1.05)	1.04 (1.04)	0.97 (1.03)	0.90	0.44
NSAID	1.13 (1.14)	1.20 (1.20)	1.30 (1.30)	1.28 (1.27)	3.14	< 0.05
All	1.11 (1.11)	1.17 (1.18)	1.25 (1.25)	1.24 (1.23)	4.39	< 0.005

*First quartile represents GPs with the lowest morbidity rate among their elderly patients, and the fourth represents those with the highest.

†Adjusted (and observed) mean.

Table 5: Characteristics of GPs by morbidity rate quartile

Characteristic	Quartile				χ^2 test		ANCOVA	
	First <i>n</i> = 91	Second <i>n</i> = 92	Third <i>n</i> = 92	Fourth <i>n</i> = 91	χ^2	<i>p</i>	F	<i>p</i>
Age,* yr	46.1 (41.2)	44.4 (42.1)	43.3 (44.2)	39.7 (46.0)			4.50	< 0.005
Male:female ratio	2.1 (62/29)	3.2 (70/22)	17.4 (87/5)	17.2 (86/5)	35.2	< 0.01		
Ratio of GPs qualified by CCFP to those not qualified by CCFP	0.4 (27/61)	0.4 (25/61)	0.4 (24/67)	0.2 (17/73)	3.8	> 0.25		
Ratio of GPs trained in Canada to those not trained in Canada	5.8 (75/13)	9.6 (77/8)	6.6 (79/12)	5.9 (77/13)	1.4	> 0.50		
No. of years in practice*	20.3 (15.5)	19.4 (17.2)	18.2 (19.0)	13.9 (20.1)			5.40	< 0.001
No. of patients in practice*	2 175 (2 473)	2 319 (2 468)	2 274 (2 253)	2 143 (1 717)			0.58	0.63
No. of practice days*	202.0 (213.3)	211.1 (216.5)	203.6 (202.7)	204.6 (188.7)			0.45	0.72
No. of visits per day*	23.8 (25.9)	25.1 (26.1)	25.6 (25.5)	24.3 (21.3)			0.65	< 0.05
No. of services per day*	32.7 (35.7)	36.9 (38.4)	37.0 (37.8)	36.8 (32.4)			0.41	0.06
No. of visits per year*	5 311.8 (5 846.4)	5 632.1 (5 896.3)	5 403.5 (5 390.9)	5 163.9 (4 377.7)			0.37	0.77
Amount billed per patient,* \$	65.1 (62.2)	64.6 (63.4)	65.9 (66.7)	76.6 (79.9)			3.90	< 0.01
Amount billed per year,* \$	130 061 (146 032)	150 559 (158 836)	148 638 (148 281)	155 301 (131 411)			1.90	0.13

*Adjusted (and observed) mean.

Table 6: Prescribing patterns of GPs by drug category and hip-fracture rate quartile*

Category	Quartile; prescribing ratio† per GP				ANCOVA	
	First <i>n</i> = 92	Second <i>n</i> = 95	Third <i>n</i> = 88	Fourth <i>n</i> = 91	F	<i>p</i>
Antibiotic	1.14 (1.14)	1.20 (1.20)	1.21 (1.21)	1.26 (1.26)	2.53	0.06
Antidepressant	1.11 (1.11)	1.09 (1.08)	1.05 (1.05)	1.24 (1.24)	2.14	0.10
Antihypertensive	1.09 (1.09)	1.18 (1.21)	1.24 (1.24)	1.27 (1.24)	3.39	< 0.05
Barbiturate	0.95 (0.95)	1.04 (1.04)	1.09 (1.09)	0.97 (0.98)	1.21	0.30
Benzodiazepine	1.24 (1.24)	1.39 (1.37)	1.37 (1.38)	1.40 (1.41)	2.49	0.06
Bronchodilator	1.40 (1.40)	1.57 (1.58)	1.63 (1.64)	1.67 (1.65)	2.84	< 0.05
Cholesterol-lowering agent	0.91 (0.91)	1.19 (1.19)	1.11 (1.11)	1.16 (1.17)	5.05	< 0.005
Gastrointestinal drug	1.13 (1.14)	1.31 (1.32)	1.35 (1.34)	1.47 (1.46)	8.87	< 0.001
Narcotic	0.93 (0.92)	1.06 (1.05)	1.00 (1.01)	1.10 (1.12)	1.78	0.15
Neuroleptic	0.93 (0.92)	0.97 (0.96)	1.05 (1.04)	1.10 (1.13)	1.76	0.16
NSAID‡	1.15 (1.15)	1.20 (1.21)	1.23 (1.23)	1.33 (1.34)	3.51	< 0.05
All	1.09 (1.09)	1.20 (1.20)	1.21 (1.21)	1.27 (1.27)	7.33	< 0.001

*First quartile represents GPs with the lowest hip-fracture rate among their elderly patients, and the fourth represents those with the highest.

†Adjusted (and observed) mean.

more practice days, saw more patients per year and billed more per year (Table 7).

DISCUSSION

Although our methodology only allowed for a rather crude estimate of morbidity in each practice, our results suggest that the physicians' practice characteristics and their prescribing behaviour were related to patient outcomes. The GPs with higher morbidity, mortality and hip-fracture rates among their elderly patients prescribed more drugs and practised with more intensity than those with lower rates. Interpretation of these data is difficult because information on numerous important variables that may affect the results was unavailable. For example, the actual health status of patients may have influenced the physicians' prescribing habits. Some of the practices in our study clearly had sicker patients than others; this was related to the physicians' billing and prescribing habits as well as to some of their personal characteristics.

There are two possible explanations for these observations. First, it is possible that sicker patients chose specific practices. Second, the physicians' prescribing habits may have made their patients sicker. If the first is the case, the physicians with sicker patients would be over-

represented among those with higher morbidity and mortality rates, irrespective of their prescribing and practice habits. It is not clear why sicker patients would seek particular physicians, especially since the physicians had systematic differences in age, sex and billing behaviour. But, if this is the case, certain physicians had sicker patients, saw them more often and billed more per patient. Regional disparities between industrialized and rural areas may be another source of variability in the results. Pollution, socioeconomic differences and higher stress levels in certain regions may adversely affect patients' health, morbidity and mortality.

The second interpretation infers a causal link between certain physician and practice characteristics, prescribing behaviour and patient outcomes. It is not clear why sicker patients would seek young or male physicians, but it is possible that these physicians favour more aggressive investigations and treatments than older physicians and female colleagues. Given the relation between practice intensity and prescribing behaviour and the mounting evidence that overprescribing and inappropriate prescribing seriously affect morbidity and mortality rates among elderly patients, there may also be a causal relation between practice and prescribing behaviour and health outcomes.^{6,7,26} Although it is unreasonable to as-

Table 7: Characteristics of GPs by hip-fracture rate quartile

Characteristic	Quartile				χ^2 test		ANCOVA	
	First <i>n</i> = 92	Second <i>n</i> = 95	Third <i>n</i> = 88	Fourth <i>n</i> = 91	χ^2	<i>p</i>	F	<i>p</i>
Age,* yr	44.1 (43.5)	44.1 (41.2)	43.3 (42.9)	42.2 (46.0)			0.62	0.60
Male:female ratio	3.4 (71/21)	4.6 (78/17)	6.3 (76/12)	7.3 (80/11)	4.6	> 0.1		
Ratio of GPs qualified by CCFP to those not qualified by CCFP	0.2 (15/71)	0.5 (31/63)	0.4 (24/62)	0.3 (23/66)	5.8	> 0.1		
Ratio of GPs trained in Canada to those not trained in Canada	5.1 (71/14)	6.8 (82/12)	11.3 (79/7)	5.8 (76/13)	2.9	> 0.25		
No. of years in practice*	18.6 (18.1)	18.9 (16.1)	17.9 (17.6)	16.6 (20.3)			0.82	0.48
No. of patients in practice*	1 833 (1 877)	2 434 (2 624)	2 522 (2 582)	2 123 (1 829)			9.33	< 0.001
No. of practice days*	186.9 (188.5)	216.8 (224.2)	209.5 (211.6)	207.5 (196.3)			4.79	< 0.005
No. of visits per day*	22.3 (22.6)	26.0 (27.3)	25.3 (25.8)	25.1 (23.0)			2.38	0.07
No. of services per day*	32.2 (32.6)	36.1 (38.0)	38.7 (39.4)	37.3 (34.3)			1.50	0.21
No. of visits per year*	4 634 (4 711)	6 051 (6 401)	5 505 (5 646)	5 289 (4 721)			3.79	< 0.05
Amount billed per patient,* \$	68.1 (67.5)	67.1 (64.4)	65.8 (65.9)	71.2 (74.4)			0.73	0.53
Amount billed per year,* \$	120 086 (122 102)	160 529 (168 880)	155 944 (160 035)	147 885 (133 429)			6.61	< 0.001

*Adjusted (and observed) mean.

sume that all of the practices in our study were equal, it is also unlikely that differences in health outcomes can be explained solely by differences intrinsic to the patients of these practices. Our results most probably reflect a combination of patient and physician variables. It was impossible to measure the contribution of each variable to patient outcomes or measure the appropriateness of physician prescribing.

We recommend that physician characteristics and prescribing patterns be examined in relation to specific illnesses to determine their contribution to patient outcomes. Such a thorough analysis is the only way to quantify the respective influences of patient health status and physician behaviour on these important health outcomes. We also believe that regional disparities should be examined. It may be unfair to compare physicians without considering the location of their practice, but it is also improbable that all physicians who practice in a certain fashion aggregate in the same areas.

Our methodology of database linkage may help in the evaluation of physicians' performance and in the development of strategic interventions and practice guidelines. These data may help to identify physicians in need of remedial education. Of greatest concern, however, is the fact that in this fee-for-service system, the patients of the GPs who saw more patients daily, provided more services daily, billed more per patient and per year fared the worst: they spent more time in hospital and were more likely to die or have a hip fracture. The incentives in this fee-for-service system need to be reviewed.

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