# ORIGINAL ARTICLE

# Overprescribing of lipid lowering agents

## M A Smith, E D Cox, J M Bartell

...............................................................................................................

See end of article for authors' affiliations
......................

Correspondence to:
Dr M A Smith, Associate Professor, Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, 505 WARF Bldg, 610 Walnut St, Madison, WI 53726-2397, USA; maureensmith@wisc.edu

Accepted for publication 2 April 2006
......................

**Background:** Undertreatment of hyperlipidemia has received considerable attention. However, little is known about trends in overprescribing of lipid lowering agents. We examined these trends and their associations with physician, practice, and organisational factors.

**Methods:** 2034 physicians were surveyed twice: baseline (1996–7) and follow up (1998–9). On each occasion they were asked: "For what percentage of 50 year old men without other cardiac risk factors would you recommend an oral agent for total cholesterol of 240, LDL 150, and HDL 50 after 6 months on a low cholesterol diet?" During the survey period the National Cholesterol Education Program guidelines did not recommend prescribing for these patients. Binomial and multinomial logistic regressions assessed baseline overprescribing and longitudinal changes in overprescribing, accounting for complex sampling.

**Results:** 39% of physicians recommended prescribing at baseline (round 1), increasing at follow up (round 2) to 51% (p<0.001). Physicians who were more likely to overprescribe at baseline were less likely to be board certified (odds ratio (OR) 0.49, 95% confidence interval (CI) 0.38 to 0.63; p<0.001), were in solo or two-physician practices (OR 1.88, 95% CI 1.46 to 2.41; p<0.001), had more revenue from Medicare (OR 1.10, 95% CI 1.03 to 1.17; p=0.004) or Medicaid (OR 1.09, 95% CI 1.01 to 1.18; p=0.03), or were family physicians (OR 1.87, 95% CI 1.35 to 2.58; p<0.001). Physicians with large increases in overprescribing were more likely than those with small increases in overprescribing to be international medical graduates (OR 2.09, 95% CI 1.20 to 3.64; p=0.011) and to spend more hours in patient care (OR 1.14, 95% CI 1.03 to 1.26; p=0.016).

**Conclusions:** Overprescribing of lipid lowering agents is commonplace and increased. At baseline and longitudinally, overprescribing was primarily associated with physician and practice characteristics and not with organisational factors.

To address the widespread problem of undertreatment of hyperlipidemia, much attention has focused on increasing prescribing of lipid lowering agents.[1] However, cost effectiveness analysis has shown that appropriate treatment for the entire US population is not financially feasible.[2] The National Cholesterol Education Program (NCEP) guidelines[3] recommend lipid lowering agents for 36 million US residents,[4] and proposed updates to these guidelines further increase the number of individuals requiring treatment.[5] Statins, the most commonly prescribed anti-hyperlipidemic agents, currently cost approximately $14.7 billion annually in the US;[6] this cost would increase further if updates to the NCEP guidelines are implemented. As the cost implications of the new Medicare prescription drug bill are debated,[7] the impact of guidelines on actual clinical practice become increasingly relevant. Additionally, drug treatments for hyperlipidemia are associated with significant adverse events, another costly consequence of unnecessary prescribing.[8–10]

No nationally representative studies have examined the prevalence of, or factors associated with, overprescribing of lipid lowering agents.[11] In the face of constrained resources, strategies to reduce overprescribing are critical to raise the number of persons treated appropriately. Such strategies should rely on clear understanding of factors influencing overprescribing. These factors may include physician characteristics, practice characteristics, and organisational efforts to shape physician behaviour such as guidelines, formularies and profiling, as well as pharmaceutical company advertising to physicians or consumers.[12–15] However, the extent and direction of influence of these factors on overprescribing of lipid lowering agents is unclear.

We have examined the overprescribing of lipid lowering agents using longitudinal vignette responses from the Community Tracking Study (CTS) physician survey during a 2 year period in which the NCEP guidelines remained unchanged. We hypothesize that overprescribing is shaped by physician and practice characteristics as well as organisational incentives. Understanding how these factors influence physicians' prescribing of lipid lowering agents has implications for targeting interventions to improve prescribing.

## METHODS

### Data and sampling

Data included rounds 1 (baseline, 1996–7) and 2 (follow up, 1998–9) of the CTS, a nationally representative survey of direct patient care physicians who provide at least 20 hours of patient care weekly and designed to assess how delivery of health care is changing.[16] The sample was randomly selected in proportion to the population of 60 randomly selected communities chosen after stratification to ensure diversity. This sample was supplemented with a small randomly selected national sample of physicians (n = 2306) to permit precise national estimates.

The sampling frame was taken from American Medical Association and American Osteopathic Association master files. Primary care physicians were oversampled to allow precise analysis of their practice of medicine.[16] As the CTS seeks to be nationally representative of direct patient care delivery, residents, fellows, federal physicians, graduates of foreign medical schools with temporary US licenses, physicians not office-based or hospital-based (such as teachers, researchers, and administrators), and certain specialists (such as radiologists, anesthesiologists and pathologists) were not surveyed.[17] From 17 704 physicians surveyed, 7092 were sampled longitudinally. The population of interest for this analysis was the 1218 internists and 816 family physicians who responded to the vignette both times. Although endocrinologists and cardiologists might initiate

pharmacotherapy for hyperlipidemia, they were not included in our analysis due to the small numbers surveyed in each specialty. Response rates were 64.5% and 60.9% for rounds 1 and 2, respectively. Additional information on the CTS survey can be found elsewhere.[16]

The study was approved by the University of Wisconsin Medical School's institutional review board.

## Variables

The dependent variable "baseline overprescribing of oral lipid lowering agents" was physician response during round 1 to the vignette:

*"What about treating an elevated cholesterol with oral agents for a 50 year old man who has no other cardiac risk factors except elevated cholesterol? After 6 months on a low cholesterol diet, his total cholesterol is 240 and his LDL is 150. His HDL cholesterol is 50, giving a ratio of total cholesterol to HDL cholesterol of 4.8. For what percentage of such patients would you recommend oral agents at this point?"*

Because NCEP guidelines concurrent with the surveys (NCEP II) would not recommend that the vignette patient should receive lipid lowering agents,[18] the physician responses were dichotomised to reflect overprescribing with 0 = no oral agent recommended (response to the vignette 0%)

and 1 = recommended oral agent (response to the vignette 1–100%). However, although guidelines for the management of hyperlipidemia did not change during the study period, scientific literature during this period began to suggest that stricter control of LDL might be warranted. Due to concerns about the stringency of this cutpoint—that is, physicians may be adopting new scientific knowledge about the benefits of stricter LDL control not yet incorporated in guidelines or may have patients similar to the vignette patient for whom lipid lowering agents could be appropriate based on factors not included in the vignette—we conducted sensitivity analyses by redefining the two categories using cutpoints of 5% and 10% instead of 0%. Conclusions were unchanged so we present results using the 0% cutpoint corresponding to the NCEP guidelines.

To examine factors that explained longitudinal increases in overprescribing, we used the subset of the sample who increased prescribing between baseline (round 1, 1996–7) and follow up (round 2, 1998–9). Longitudinal increases in overprescribing were categorised by tertiles into "small" (1–25%), "moderate" (26–50%), and "large" (51–100%) absolute increases.

We identified explanatory variables representing physician characteristics and practice characteristics. Physician

**Table 1** Physician characteristics by round of the Community Tracking Study (n = 2034)*

| Characteristic | Baseline (1996–7) | | Follow up (1998–9) | |
|---|---|---|---|---|
| | Mean or % | SE | Mean or % | SE |
| Physician characteristics | | | | |
|   Family physician (%) | 41.8 | 0.04 | 41.8 | 0.04 |
|   Internal medicine physician (%) | 58.2 | 0.04 | 58.2 | 0.04 |
|   Board certification (%) | 81.6 | 0.02 | 83.0 | 0.01 |
|   Osteopathic physician (%) | 11.0 | 0.01 | 11.0 | 0.01 |
|   International medical graduate (%) | 21.4 | 0.02 | 21.4 | 0.02 |
|   Female (%) | 19.8 | 0.01 | 19.8 | 0.01 |
|   Career satisfaction† | 4.0 | 0.06 | 3.8 | 0.03 |
|   Year of residency completion | 1981 | 0.30 | 1981 | 0.29 |
|   Hours of patient care per week | 45.2 | 0.75 | 44.6 | 0.78 |
| Practice characteristics | | | | |
|   Solo/two-physician practice (%) | 36.3 | 0.02 | 36.3 | 0.02 |
|   Metropolitan area (%) | 81.9 | 0.13 | 81.9 | 0.13 |
|   Percent revenue from Medicaid | 12.6 | 0.87 | 12.1 | 0.80 |
|   Percent revenue from Medicare | 35.6 | 0.84 | 36.2 | 1.04 |
| Financial factors | | | | |
|   Physician can make clinical decisions in the best interest of patients without reducing his/her income‡ | 4.0 | 0.06 | 3.9 | 0.07 |
| Educational factors | | | | |
|   Effect of guidelines on physician's practice of medicine§ | 2.3 | 0.04 | 2.4 | 0.03 |
|   Effect of use of computer for treatment/guidelines on physician's practice of medicine§ | 1.7 | 0.03 | 1.9 | 0.04 |
|   Effect of patient satisfaction surveys on physician's practice of medicine§ | 2.7 | 0.03 | 2.7 | 0.03 |
|   Effect of profiling on physician's practice of medicine§ | 2.0 | 0.05 | 2.0 | 0.05 |
|   Effect of use of computer to obtain or record clinical data (medical records and lab results)§ | 2.4 | 0.06 | 2.5 | 0.06 |
|   Effect of reminders about preventive services on physician's practice of medicine§ | 2.2 | 0.08 | 2.3 | 0.03 |
| **Policies and procedures** | | | | |
|   Physician has freedom to make decisions based on patient needs‡ | 4.2 | 0.06 | 4.1 | 0.06 |
|   Physician has the ability to maintain continuing patient relationships‡ | 3.9 | 0.08 | 3.8 | 0.06 |
|   Physician has the ability to obtain high quality specialist referrals¶ | 5.1 | 0.03 | 5.1 | 0.04 |
|   Physician has the ability to obtain high quality ancillary services such as physical therapy, nutrition, or home care¶ | 4.9 | 0.05 | 4.8 | 0.04 |
|   Physician has adequate time to spend with office patients† | 3.5 | 0.03 | 3.3 | 0.04 |
|   2 year change in complexity of patients cared for without specialist referral** | 3.4 | 0.02 | 3.3 | 0.03 |
|   2 year change in number of referrals to specialists** | 3.0 | 0.03 | 3.1 | 0.02 |
|   2 year change in complexity of patients expected to care for without specialist referral** | 3.2 | 0.02 | 3.2 | 0.02 |
|   Sufficient communication with specialists to ensure quality care† | 4.3 | 0.04 | 4.2 | 0.03 |
|   Percentage of patients for whom oral lipid lowering agent was recommended | 38.9 | 1.06 | 50.5 | 0.98 |

*Values represent means unless otherwise specified.
†Mean values with very dissatisfied = 1, very satisfied = 5.
‡Mean values with strongly disagree = 1, strongly agree = 5.
§Mean values with no effect = 0, very large effect = 5.
¶Mean values with never = 1, always = 6.
**Mean values with decreased a lot = 1, increased a lot = 5.

**Table 2** Adjusted odds ratios (OR) and 95% confidence intervals (CI) for variables associated with overprescribing of lipid lowering agents at baseline* (n = 2034)

| | OR† | 95% CI |
|---|---|---|
| **Physician characteristics** | | |
| Family physician | **1.87** | **1.35 to 2.58** |
| Board certification | **0.49** | **0.38 to 0.63** |
| Osteopathic physician | 1.14 | 0.86 to 1.50 |
| International medical graduate | 0.76 | 0.54 to 1.06 |
| Career satisfaction‡ | 1.05 | 0.95 to 1.16 |
| Year of residency completion | 0.99 | 0.98 to 1.00 |
| Hours of patient care per week (per 10 hour increment) | 1.06 | 0.95 to 1.19 |
| **Practice characteristics** | | |
| Solo/two-physician practice | **1.88** | **1.46 to 2.41** |
| Percentage revenue from Medicaid (per 10% increment) | **1.09** | **1.01 to 1.18** |
| Percentage revenue from Medicare (per 10% increment) | **1.10** | **1.03 to 1.17** |
| **Educational factors** | | |
| Effect of guidelines on physician's practice of medicine§ | 0.90 | 0.80 to 1.01 |
| Effect of use of computer for treatment/guidelines on physician's practice of medicine§ | 1.02 | 0.94 to 1.10 |
| Effect of use of computer to obtain or record clinical data (medical records and laboratory results)§ | 0.97 | 0.89 to 1.05 |
| **Policies and procedures** | | |
| Physician has freedom to make decisions based on patient needs¶ | 0.92 | 0.83 to 1.02 |
| Physician has the ability to maintain continuing patient relationships¶ | 1.02 | 0.94 to 1.10 |
| 2 year change in complexity of patients expected to care for without specialist referral** | 0.88 | 0.77 to 1.01 |
| Sufficient communication with specialists to ensure quality care¶ | 1.18 | 0.92 to 1.51 |

*Adjusted for sex, metropolitan area, physician can make clinical decisions in the best interest of patients without reducing his/her income, effect of patient satisfaction surveys on physician's practice of medicine, effect of profiling on physician's practice of medicine, effect of reminders about preventive services on physician's practice of medicine, physician has the ability to obtain high quality specialist referrals, physician has the ability to obtain high quality ancillary services such as physical therapy, nutrition, or home care, physician has adequate time to spend with office patients, 2 year change in complexity of patients cared for without specialist referral, 2 year change in number of referrals to specialists.
†For continuous explanatory variables, OR represents the odds of overprescribing for a one unit increase in the explanatory variable. For explanatory variables that reference the presence or absence of a characteristic, OR represents the the odds of overprescribing when the characteristic is present.
‡Mean values with very dissatisfied = 1, very satisfied = 5.
§Mean values with no effect = 0, very large effect = 5.
¶Mean values with strongly disagree = 1, strongly agree = 5.
**Mean values with decreased a lot = 1, increased a lot = 5.

characteristics included specialty (family practice or internal medicine), sex, type of physician (DO/MD), career satisfaction (1 = very dissatisfied to 5 = very satisfied), board certification (yes/no), international medical school graduate status (yes/no), year of residency completion, and hours spent in patient care during the previous week (in 10 hour increments). Practice characteristics included practice type (solo/two physician versus other), metropolitan area (yes/no), as well as percentage practice revenue from Medicaid (in 10% increments) and from Medicare (in 10% increments).

Our model also included organisational factors that potentially influence prescribing through educational and selection efforts (for example, managed care organisations may select providers with certain characteristics), policies and procedures, and financial incentives.[19] Organisational efforts to educate/select physicians were represented by six items assessing the physician's perception of the effect of (1) guidelines, (2) reminders about preventive services, (3) use of computer to obtain or record clinical data (medical records and laboratory results), (4) use of computer for treatment information or guidelines, (5) patient satisfaction surveys, and (6) profiling on their practice, all of which were reported as 0 = no effect to 5 = very large effect. Organisational policies and procedures were represented by the physicians' perceptions of nine factors. These included change in the previous 2 years in the number of referrals to specialists and in the complexity of the patients that they cared for or were expected to care for without specialist referral (all as

**Table 3** Categories of change in percentage prescribing of lipid lowering agents between survey rounds 1 (baseline) and 2 (follow up) (n = 2034)

| | N | Round 1 (baseline) Mean (SE) | Round 2 (follow up) Mean (SE) | Change Mean (SE) |
|---|---|---|---|---|
| **Appropriate prescribing** | | | | |
| Perfect (vignette responses in both rounds of 0% prescribing for the patient described, consistent with NCEP guidelines) | 360 | 0.0 (0.00) | 0.0 (0.00) | 0.0 (0.00) |
| **Overprescribing** | | | | |
| Increasing (round 2 prescribing higher than round 1, indicating change not consistent with NCEP guidelines) | 927 | 25.3 (0.87) | 70.5 (1.10) | 45.1 (1.02) |
| Stable (vignette responses in both rounds are the same but non-zero, indicating no change consistent with NCEP guidelines) | 276 | 82.2 (2.00) | 82.2 (2.00) | 0.0 (0.00) |
| Decreasing (round 2 prescribing less than round 1, indicating change consistent with NCEP guidelines) | 471 | 68.0 (1.59) | 27.2 (1.90) | −40.8 (1.82) |

1 = decreased a lot to 5 = increased a lot). Other policy and procedure items included having freedom to make clinical decisions that meet patients' needs, having sufficient communication with specialists to ensure quality care, having adequate time to spend with patients, having the ability to maintain continuing relationships with patients over time (all as 1 = disagree strongly to 5 = agree strongly), and having the ability to obtain high quality ancillary services or to obtain referrals to high quality specialists (both as 1 = never to 6 = always). Financial incentives were represented by the physician's perceived ability to make clinical decisions without reducing personal income (1 = disagree strongly to 5 = agree strongly).

## Statistical methods

Binomial and multinomial logistic regressions were used to analyse baseline overprescribing and longitudinal changes in prescribing behaviour, accounting for the complex sample design of the survey by using the "svy" commands in Stata 8.0 and applying recommended statistical techniques for longitudinal data.[20] Our analyses also incorporated non-response adjustments into survey weights and were therefore

less likely to be affected by non-response bias. Other researchers have shown that there was little difference between CTS responders and non-responders.[21] All analyses were performed on the total sample and used the subpopulation option to examine our population of interest (1218 internists and 816 family physicians surveyed longitudinally), ensuring correct calculation of standard errors. All explanatory variables were modeled as either ordinal or continuous unless otherwise specified. To guard against possible confounding, all variables were retained in statistical models but presented in tables only if significant at p<0.20 in either the baseline or longitudinal model.[22]

## RESULTS

### Respondent characteristics

Baseline (round 1) and follow up (round 2) characteristics of respondents are shown in table 1, accounting for survey design factors to produce nationally representative estimates. In general, respondents were predominantly men and were board certified graduates of US medical schools who perceived the impact of many organisational strategies designed to influence their behaviour. The percentage of

**Table 4** Odds ratios (OR) and 95% confidence intervals (CI) for variables associated with moderate or large increases in overprescribing compared with small increases*(n = 927)

|  | Moderate increase in overprescribing | | Large increase in overprescribing | |
|---|---|---|---|---|
|  | OR† | 95% CI | OR† | 95% CI |
| **Physician characteristics** | | | | |
| Family physician | 1.10 | 0.65 to 1.87 | 1.35 | 0.79 to 2.30 |
| Board certification | 0.80 | 0.49 to 1.30 | 0.85 | 0.58 to 1.25 |
| Osteopathic physician | 1.55 | 0.88 to 2.72 | 1.42 | 0.72 to 2.78 |
| International medical graduate | **1.70** | **1.07 to 2.71** | **2.09** | **1.20 to 3.64** |
| Career satisfaction‡ | 0.99 | 0.81 to 1.20 | 0.86 | 0.70 to 1.06 |
| Year of residency completion | 0.98 | 0.96 to 1.00 | 1.00 | 0.97 to 1.02 |
| Hours of patient care per week (per 10 hour increment) | **1.14** | **1.03 to 1.27** | **1.14** | **1.03 to 1.26** |
| **Practice characteristics** | | | | |
| Solo/two-physician practice | 1.15 | 0.82 to 1.62 | 0.72 | 0.44 to 1.18 |
| Percentage revenue from Medicaid (per 10% increment) | 0.94 | 0.79 to 1.12 | 0.98 | 0.86 to 1.11 |
| Percentage revenue from Medicare (per 10% increment) | **0.90** | **0.84 to 0.97** | 0.95 | 0.86 to 1.04 |
| **Educational factors** | | | | |
| Effect of guidelines on physician's practice of medicine§ | 0.96 | 0.76 to 1.20 | 1.02 | 0.87 to 1.19 |
| Effect of use of computer for treatment/guidelines on physician's practice of medicine§ | 0.87 | 0.75 to 1.00 | 1.03 | 0.90 to 1.18 |
| Effect of use of computer to obtain or record clinical data (medical records and laboratory results)§ | 1.08 | 0.97 to 1.21 | 1.07 | 0.94 to 1.23 |
| **Policies and procedures** | | | | |
| Physician has freedom to make decisions based on patient needs¶ | 1.01 | 0.80 to 1.27 | 0.97 | 0.73 to 1.30 |
| Physician has ability to maintain continuing patient relationships¶ | 1.01 | 0.84 to 1.22 | 0.91 | 0.81 to 1.03 |
| 2 year change in complexity of patients expected to care for without specialist referral** | 0.88 | 0.59 to 1.33 | 0.86 | 0.61 to 1.21 |
| Sufficient communication with specialists to ensure quality care¶ | 1.10 | 0.91 to 1.33 | 1.21 | 0.96 to 1.52 |

*Adjusted for sex, metropolitan area, physician can make clinical decisions in the best interest of patients without reducing his/her income, effect of patient satisfaction surveys on physician's practice of medicine, effect of profiling on physician's practice of medicine, effect of reminders about preventive services on physician's practice of medicine, physician has the ability to obtain high quality specialist referrals, physician has the ability to obtain high quality ancillary services such as physical therapy, nutrition, or home care, physician has adequate time to spend with office patients, 2 year change in complexity of patients cared for without specialist referral, 2 year change in number of referrals to specialists.
†For continuous explanatory variables, OR represents the odds of either moderate or large increases in overprescribing for a one unit increase in the explanatory variable compared with a small increase. For explanatory variables that reference the presence or absence of a characteristic, OR represents the odds of either moderate or large increases in overprescribing when the characteristic is present.
‡Mean values with very dissatisfied = 1, very satisfied = 5.
§Mean values with no effect = 0, very large effect = 5.
¶Mean values with strongly disagree = 1, strongly agree = 5.
**Mean values with decreased a lot = 1, increased a lot = 5.

vignette patients for whom respondents would recommend an oral lipid lowering agent increased from 38.9% at baseline to 50.5% at follow up (p<0.001).

### Factors associated with baseline overprescribing

At baseline a greater likelihood of overprescribing oral lipid lowering agents was significantly associated with being a family physician (p<0.001), in a solo or two-physician practice (p<0.001), and having more Medicaid (p = 0.03) or Medicare (p = 0.004) revenue (table 2). Board certification was associated with less likelihood of overprescribing (p<0.001).

### Changes in prescribing over time

Of the 2034 physicians surveyed longitudinally, approximately one fifth were consistently appropriate with respect to the NCEP guidelines (did not recommend oral lipid lowering agents for vignette patient in baseline or follow up survey; table 3). Of the remaining four fifths of physicians who recommended prescribing inappropriately in at least one survey round, more than half increased overprescribing from baseline, while one fifth had stable but non-zero overprescribing and slightly more than one quarter reduced their overprescribing.

### Factors associated with increasing overprescribing

To identify factors that might explain the 12% absolute increase in overprescribing, we focused on the 927 physicians who increased prescribing from baseline. Compared with physicians with small increases in overprescribing, those with moderate or large increases were more likely to be international medical graduates (p = 0.027 and p = 0.011, respectively) and to spend more hours in direct patient care (p = 0.012 and p = 0.016, respectively) (table 4). Physicians with moderate increases in overprescribing had less practice revenue from Medicare than those with small increases (p = 0.01).

## DISCUSSION

Our results suggest that overprescribing of lipid lowering agents may be significant in magnitude and increasing. At baseline, overprescribing of lipid lowering medications was primarily associated with physician and practice characteristics such as board certification, specialty, and practice setting. Longitudinal increases in overprescribing were also primarily related to physician and practice characteristics. Organisational incentives had little association with overprescribing, consistent with literature suggesting that most managed care strategies to influence physician prescribing have limited effectiveness.[23]

Our results are consistent with research demonstrating that guidelines may not be applied in clinical practice.[12 13 24–26] Despite substantial efforts to promote NCEP guidelines and to intensively fund physician education efforts, only 59% of internists in an American College of Physicians survey were familiar with NCEP guidelines.[24] Further, in a study about family physicians' awareness of hyperlipidemia consensus statements, less than 20% of respondents knew the exact values recommended in the statements.[25] Although interventions to change physician prescribing[27] and improve guideline adherence[12 13] have been studied extensively, few studies have examined factors associated with increasing overprescribing when guidelines are implemented in actual practice. Recognition of factors associated with increased overprescribing after guideline publication may inform future guideline implementations and interventions to decrease overprescribing.

No non-interventional studies have examined physician and practice characteristics associated with longitudinal increases in overprescribing. However, a randomised trial of an educational intervention suggested that prescribing changes were independent of physician characteristics, including age, board certification, specialty, rural versus urban practice, intensity of previous target drug use, and size of Medicaid practice.[28] This contrasts with our results that international medical graduates and physicians with more hours in direct patient care had larger increases in overprescribing. This may illustrate the distinction between randomised trials of interventions that target specific improvements in physician behaviour and changes in actual clinical practice after guideline publication. Many factors may affect these "real world" behaviour changes, but the relationship between overprescribing and more hours in direct patient care may be partially due to lack of agreement with guidelines. In a survey of internists who were members of the American College of Physicians, physicians seeing patients more than 20 hours per week were more likely to feel that guidelines challenged physician autonomy and were too rigid for actual use with individual patients than those with less clinical time.[24] Alternatively, this finding may represent the struggles that busy clinicians face in becoming aware of or familiar with guidelines. Lastly, international medical graduates may receive perplexing messages about hyperlipidemia management as guidelines and units of measure for lipid levels vary nationally. However, a previous study showed that, although national guidelines varied, the NCEP guidelines would treat more patients than several other international guidelines.[29] Thus, this would not explain the association between international medical graduates and increasing overprescribing. In addition, the definition of oral agent was left to the respondent. If international medical graduates were more likely to recommend dietary supplements, this might explain the association between overprescribing and international medical graduate status.

In contrast to studies of change over time, previous literature has suggested that a number of physician and practice characteristics are associated with baseline inappropriate prescribing. These physician characteristics include older age,[30 31] male sex,[30] family/general practitioner compared with other specialties,[30 32] lacking specialty certification,[31] and practice outside an urban area.[30 32] These findings are consistent with our results that physicians who were not board certified, were in solo or two-physician practices, or were family physicians were more likely to prescribe inappropriately. In addition, physicians who had more practice revenue from either Medicare or Medicaid were more likely to prescribe inappropriately at baseline, perhaps reflecting awareness of their patients' reduced financial barriers to prescription drug use.

As in all observational studies, unmeasured factors may contribute to or explain the relationships observed. While CTS data on physician, practice, and organisational characteristics do allow adjustment for many potential confounders, the impact of prescription drug insurance or formularies could not be assessed. It is conceivable that responses to the vignette may not reflect actual practice, although previous literature has shown that vignettes accurately reflect practice behaviour.[33] Overprescribing of lipid lowering agents was examined with a single clinical vignette, so the study results may not be generalisable to practice overall. In addition, the 2 year interval between surveys may not be sufficient to create a detectable impact of some organisational incentives.

Although the guidelines were unchanged during the study period, publications about the benefits of stricter LDL control[34 35] may have led some physicians to prescribe beyond guideline recommendations. Also, while the vignette states the patient has "no other cardiac risk factors", physicians may have believed there were some patients similar to the vignette patient for whom treatment could be indicated

based on factors not explicitly stated in the vignette. To address these possibilities, we performed a sensitivity analysis with less stringent cutpoints for appropriate prescribing. The less stringent cutpoints allowed physicians who prescribed for 5–10% of such patients to be considered as appropriate prescribers. Analyses based on these less stringent cutpoints did not alter the conclusions of the study.

The marked increase in overprescribing of lipid lowering agents may result from a number of factors directed to either patients or physicians. These include direct to consumer advertising (DTCA) or physician directed advertising by pharmaceutical companies, both of which have been shown to increase physician prescribing.[15] DTCA is a particularly likely cause as guidance by the Food and Drug Administration in 1997 (between the two rounds of the CTS) facilitated DTCA. Both hyperlipidemia diagnoses and the number of lipid lowering agent prescriptions are positively associated with DTCA expenditures for lipid lowering agents.[14] Marketing strategies directed towards physicians have also been shown to affect prescribing,[36] despite the fact that many of the promotional statements in advertisements for lipid lowering drugs are not supported by the cited reference.[37] Additionally, efforts to raise awareness of cardiovascular health[38] and the use of cholesterol screening as a marker for quality of care[39 40] could contribute to our findings. Although these factors cannot be assessed with our data, they could be considered in future research on overprescribing of lipid lowering agents.

This work shows the magnitude and trend of overprescribing of lipid lowering agents during a period of stability in the NCEP guidelines while also examining factors associated with this overprescribing. Recognition of overprescribing of lipid lowering agents is critical in the context of concerns about their safety.[8–10] Furthermore, previous work has shown our inability as a nation to fund lipid lowering agents for all patients who meet treatment criteria.[2] The findings of our study indicate that we are even less well situated to meet the treatment needs of our patients. This is particularly relevant given recent policy changes surrounding prescription drug coverage,[7] and NCEP guideline updates focused on tightening lipid level goals and thus increasing the number of people for whom such drugs are recommended.[3 5]

This work also suggests that interventions to curb overprescribing should consider the role of physician and practice characteristics in shaping physician behaviour. Because data on whether a physician prescribes inappropriately are rarely available, identifying these physicians through their common characteristics may promote effective targeting of quality improvement efforts. Furthermore, the characteristics of these physicians suggest that education (lack of board certification or international medical graduates), lack of time for educational pursuits (in solo or two-physician practices), and financial incentives (those with more practice revenue from Medicare or Medicaid) are potential root causes for overprescribing of lipid lowering agents.

## ACKNOWLEDGEMENTS

. . . . . . . . . . . . . . . . . . .

## Authors' affiliations

**M A Smith,** Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA
**E D Cox,** Department of Population Health Sciences and the Center for Women's Health Research, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA
**J M Bartell,** Group Health Cooperative of South Central Wisconsin, Madison, WI, USA

## REFERENCES

1 **Hoerger TJ**, Bala MV, Bray JW, et al. Treatment patterns and distribution of low-density lipoprotein cholesterol levels in treatment-eligible United States adults. Am J Cardiol 1998;**82**:61–5.
2 **Jacobson TA**, Schein JR, Williamson A, et al. Maximizing the cost-effectiveness of lipid-lowering therapy. Arch Intern Med 1998;**158**:1977–89.
3 **National Cholesterol Education Program**. Detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III), Publication No 02-5215. Bethesda, MD: National Institutes of Health, 2002.
4 **Fedder DO**, Koro CE, L'Italien GJ. New National Cholesterol Education Program III guidelines for primary prevention lipid-lowering drug therapy: projected impact on the size, sex, and age distribution of the treatment-eligible population. Circulation 2002;**105**:152–6.
5 **Grundy SM**, Cleeman JI, Merz CN, et al. Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. Circulation 2004;**110**:227–39.
6 **IMS Health**. Leading 20 therapeutic classes by US sales, Available at http://www.imshealth.com/ims/portal/front/articleC/0,2777,6599_49695983_54699443,00.html (accessed 3 September 2004).
7 **Meyer BM**, Cantwell KM. The Medicare Prescription Drug, Improvement, and Modernization Act of 2003: implications for health-system pharmacy. Am J Health Syst Pharm 2004;**61**:1042–51.
8 **Layne RD**, Sehbai AS, Stark LJ. Rhabdomyolysis and renal failure associated with gemfibrozil monotherapy. Ann Pharmacother 2004;**38**:232–4.
9 **Omar MA**, Wilson JP, Cox TS. Rhabdomyolysis and HMG-CoA reductase inhibitors. Ann Pharmacother 2001;**35**:1096–107.
10 **Thompson PD**, Clarkson P, Karas RH. Statin-associated myopathy. JAMA 2003;**289**:1681–90.
11 **Dubois RW**, Alexander CM, Wade S, et al. Growth in use of lipid-lowering therapies: are we targeting the right patients? Am J Manag Care 2002;**8**:862–7.
12 **Grol R**. Successes and failures in the implementation of evidence-based guidelines for clinical practice. Med Care 2001;**39**:S46–54.
13 **Grimshaw JM**, Shirran L, Thomas R, et al. Changing provider behavior: an overview of systematic reviews of interventions. Med Care 2001;**39**:S2–45.
14 **Zachry WM**, Shepherd MD, Hinich MJ, et al. Relationship between direct-to-consumer advertising and physician diagnosing and prescribing. Am J Health Syst Pharm 2002;**59**:42–9.
15 **Watkins C**, Harvey I, Carthy P, et al. Attitudes and behaviour of general practitioners and their prescribing costs: a national cross sectional survey. Qual Saf Health Care 2003;**12**:29–34.
16 **Kemper P**, Blumenthal D, Corrigan JM, et al. The design of the Community Tracking Study: a longitudinal study of health system change and its effects on people. Inquiry 1996;**33**:195–206.
17 **Keil L**, Chattopadhyay M, Potter F, et al. Community Tracking Study Physician Survey: Survey Methodology Report (Round 1, Release 1), Report No 9, Technical Publication. Washington, DC: Center for Studying Health System Change, 1998.
18 **National Cholesterol Education Program**. Summary of the second report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II). JAMA 1993;**269**:3015–23.
19 **Flynn KE**, Smith MA, Davis MK. From physician to consumer: the effectiveness of strategies to manage health care utilization. Med Care Res Rev 2002;**59**:455–81.
20 **Anon**. Community Tracking Study Physician Survey Public Use File: User's Guide, Round 2, Release 1, Report No 25. Washington, DC: Center for Studying Health System Change, 2001.
21 **Reschovsky J**, Reed M, Blumenthal D, et al. Physicians' assessments of their ability to provide high-quality care in a changing health care system. Med Care 2001;**39**:254–69.
22 **Maldonado G**, Greenland S. Simulation study of confounder-selection strategies. Am J Epidemiol 1993;**138**:923–36.
23 **Carroll NV**. How effectively do managed care organizations influence prescribing and dispensing decisions? Am J Manag Care 2002;**8**:1041–54.
24 **Tunis SR**, Hayward RS, Wilson MC, et al. Internists' attitudes about clinical practice guidelines. Ann Intern Med 1994;**120**:956–63.
25 **Troein M**, Rastam L, Selander S. Dissemination and implementation of guidelines for lipid lowering. Fam Pract 1991;**8**:223–8.
26 **Underwood P**, Beck P. Secondary prevention following myocardial infarction: evidence from an audit in South Wales that the National Service Framework for coronary heart disease does not address all the issues. Qual Saf Health Care 2002;**11**:230–2.
27 **Soumerai SB**, McLaughlin TJ, Avorn J. Improving drug prescribing in primary care: a critical analysis of the experimental literature. Milbank Q 1989;**67**:268–317.
28 **Soumerai SB**, Avorn J. Predictors of physician prescribing change in an educational experiment to improve medication use. Med Care 1987;**25**:210–21.

29 **Unwin N**, Thomson R, O'Byrne AM, *et al.* Implications of applying widely accepted cholesterol screening and management guidelines to a British adult population: cross sectional study of cardiovascular disease and risk factors. *BMJ* 1998;**317**:1125–30.

30 **Dhalla IA**, Anderson GM, Mamdani MM, *et al.* Inappropriate prescribing before and after nursing home admission. *J Am Geriatr Soc* 2002;**50**:995–1000.

31 **Anderson GM**, Beers MH, Kerluke K. Auditing prescription practice using explicit criteria and computerized drug benefit claims data. *J Eval Clin Pract* 1997;**3**:283–94.

32 **Ray WA**, Federspiel CF, Schaffner W. Prescribing of chloramphenicol in ambulatory practice. An epidemiologic study among Tennessee Medicaid recipients. *Ann Intern Med* 1976;**84**:266–70.

33 **Peabody JW**, Luck J, Glassman P, *et al.* Comparison of vignettes, standardized patients, and chart abstraction: a prospective validation study of 3 methods for measuring quality. *JAMA* 2000;**283**:1715–22.

34 **Shepherd J**, Cobbe SM, Ford I, *et al.* Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. West of Scotland Coronary Prevention Study Group. *N Engl J Med* 1995;**333**:1301–7.

35 **Downs JR**, Clearfield M, Weis S, *et al.* Primary prevention of acute coronary events with lovastatin in men and women with average cholesterol levels: results of AFCAPS/TexCAPS. Air Force/Texas Coronary Atherosclerosis Prevention Study. *JAMA* 1998;**279**:1615–22.

36 **Wazana A**. Physicians and the pharmaceutical industry: is a gift ever just a gift? *JAMA* 2000;**283**:373–80.

37 **Villanueva P**, Peiro S, Librero J, *et al.* Accuracy of pharmaceutical advertisements in medical journals. *Lancet* 2003;**361**:27–32.

38 **Grundy SM**, Balady GJ, Criqui MH, *et al.* Guide to primary prevention of cardiovascular diseases. A statement for healthcare professionals from the Task Force on Risk Reduction. American Heart Association Science Advisory and Coordinating Committee. *Circulation* 1997;**95**:2329–31.

39 **NCQA National Committee for Quality Assurance**. *Annual Member Health Care Survey Manual, Version 1.0*. Washington, DC: National Committee for Quality Assurance, 1995.

40 **NCQA National Committee for Quality Assurance**. *Health Plan Employer Data and Information Set (HEDIS) 3.0*. Washington, DC: National Committee for Quality Assurance, 1997.