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THE BENEFITS AND COSTS OF NEWER DRUGS: EVIDENCE FROM THE 1996 MEDICAL EXPENDITURE PANEL SURVEY

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ABSTRACT

The nation's spending for prescription drugs has grown dramatically in recent years. Previous studies have shown that the replacement of older drugs by newer, more expensive, drugs is the single most important reason for this increase, but they did not measure how much of the difference between new and old drug prices reflects changes in quality as better, newer drugs replace older, less effective medications.

In this paper we analyzed prescribed medicine event-level data (linked to person- and condition-level data) from the 1996 Medical Expenditure Panel Survey (MEPS) to provide evidence about the effect of drug age on mortality, morbidity, and total medical expenditure, controlling for a number of characteristics of the individual and the event. (Previous researchers have hypothesized that differences in treatment patterns across individuals and areas may occur because of physicians' uncertainty and ignorance over the best medical practice.) The MEPS data enable us to control for many important attributes of the individual, condition, and prescription that influence outcomes and non-drug expenditures and that may be correlated with drug age. These include sex, age, education, race, income, insurance status, who paid for the drug, the condition for which the drug was prescribed, how long the person has had the condition, and the number of medical conditions reported by the person. Indeed, the fact that many individuals in the sample have both multiple medical conditions and multiple prescriptions means that we can control for *all* individual characteristics—both observed and unobserved—by including "individual effects".

The results provide strong support for the hypothesis that the replacement of older by newer drugs results in reductions in mortality, morbidity, and total medical expenditure. Although the mortality rate in this sample is quite low—making it difficult to detect any effect of drug age on mortality—we found that people consuming new drugs were significantly less likely to die by the end of the survey than people consuming older drugs. As to morbidity, we found that people consuming new drugs were significantly less likely to experience work-loss days than people consuming old drugs, although the estimated effect was not very large.

The estimates indicate that reductions in drug age tend to reduce all types of non-drug medical expenditure, although the reduction in inpatient expenditure is by far the largest. The total estimated reduction in non-drug expenditure from reducing the age of the drug is almost four times as large as the increase in drug expenditure, so reducing the age of the drug results in a substantial net reduction in the total cost of treating the condition. It is sometimes suggested that, because generic drugs tend to be less expensive than branded drugs, allowing people to use only generic drugs might be an effective means of reducing health expenditure. However generic drugs tend to be much older than branded drugs, and our estimates indicate that denying people access to branded drugs would increase total treatment costs, not reduce them, and would lead to worse outcomes.

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Introduction

The nation's spending for prescription drugs has grown dramatically in recent years (see Figure 1). Even when controlling for general inflation, there has been a dramatic increase in drug spending, especially since the mid-1980s.

A recent study by the Barents Group for the National Institute for Health Care Management (1999) attempted to measure the relative importance of different factors in the growth of drug spending. In general, the study split inflation into two categories: "utilization" effects and "price" effects. Each of these effects were further split between older drugs (drugs that entered the market before 1992) and new drugs (drugs that entered the market in 1992 or later).

As Table 1 indicates, the study reported that increased utilization accounted for about one third of spending growth.[1] If price levels and the mix of prices had not changed between 1993 and 1998, 36 percent of the total spending growth would still have occurred as a result of the increased number of prescriptions. Increased utilization of newer drugs contributed almost twice as much as utilization of older drugs to this increase.

The study found that about two thirds of spending growth from 1993 to 1998 was attributable to price. Of this portion, 22 percentage points were attributable to pure price increases for older drugs. Another 42 percentage points reflected the fact that newer drugs cost more than older drugs: the study estimated that the average 1998 price for drugs introduced in 1992 or later was $71.49 per prescription, compared to $30.47 for previously existing drugs. This difference reflects higher initial introduction prices as well as price increases after introduction.

Thus the Barents study found that the replacement of older drugs by newer, more expensive, drugs was the single most important reason for rapidly increasing drug expenditure. But as noted in *Report to the President: Prescription Drug Coverage, Spending, Utilization, and Prices* (Department of Health & Human Services, April 2000),

the Barents study "did not attempt to measure how much of this difference [between new and old drug prices] reflects changes in quality as better, newer drugs replace older, less effective medications."

This paper seeks to fill that gap, i.e. to provide evidence about differences in quality between new and old drugs (prescribed for given conditions). We hypothesize that, in general, new drugs within a class or for a given diagnosis are of higher quality than old drugs, and that this increase may have a number of impacts, including reduced mortality, reduced morbidity, and reduced expenditure on other medical services, such as inpatient stays and emergency room visits

The hypothesis that drug quality is inversely related to drug age is consistent with "quality ladder" models of innovation. Grossman and Helpman (1991, p. 84) describe the key features of these models[2]:

> Technological progress stems from costly investments undertaken by profit-seeking agents. Entrepreneurs…attempt to develop superior versions of [goods that they see on the market]. When successful in the research lab, an innovator creates a new "state of the art" that captures market share at the expense of a previous generation product. Growth will be sustained if commercial R&D remains an economically viable activity so that the average quality of industrial products continues to rise…Innovative goods are better than older products simply because they provide more "product services" in relation to their cost of production.

If the quality of new drugs is higher than that of old drugs, the "quality-adjusted price" of new drugs may be lower than that of old drugs, even though the unadjusted price is higher. Cutler et al (1996) found that the average cost of treating heart-attack patients increased from $11,175 in 1984 to $14,772 in 1991. Most of this increase was due to a shift from older treatment regimens (medical management and catheterization) to

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[1] Part of this increase is due to the aging of the population: as Figure 2 shows, pharmaceutical consumption is strongly positively related to age, and the share of the population over the age of 65 increased from 8.1% in 1950 to 12.7% in 1997.

newer, more expensive regimens (angioplasty and bypass surgery). While mean treatment cost increased at an average annual rate of 4.5%, life expectancy following a heart attack increased by 8 months—from 62 to 70 months—during this period. Cutler et al showed that if the shift to newer treatment regimens were entirely responsible for the increase in life expectancy, and the value of a life-year is $25,000, then the shift actually *reduced* the "cost-of-living index"—a far more meaningful measure of inflation than the change in average treatment price—by 1.1% per year.

In this paper, we will analyze prescribed medicine event-level data (linked to person- and condition-level data) from the 1996 Medical Expenditure Panel Survey (MEPS) to provide evidence about the effect of drug age—the number of years since the drug's active ingredient was first approved by the FDA--on mortality, morbidity, and total medical expenditure, controlling for a number of characteristics of the individual and the event.

Methodology

To assess the effect that the age of the drug prescribed for a given condition has on mortality, morbidity, and total medical expenditures incurred to treat the condition, ideally one would like to randomly assign drugs of different ages to patients with that condition, and observe their outcomes and expenditures. Unfortunately, I was unable to conduct a large-scale experiment in which drugs of different ages were randomly assigned to people. Nevertheless, given the nature of the data-generating process and of the data available, I believe that a properly-specified model will enable me to make valid inferences about the effects of drug age.

To evaluate the effect of drug quality, or age, on medical expenditure and outcomes, there must be a significant amount of exogenous, random variation in prescribing behavior. The health economics literature suggests that, in general, medical *practice variation* is pervasive and sizeable. If 10 doctors saw a patient with given set of symptoms, conditions, and characteristics, it is highly unlikely that they would prescribe the same medications for him. Although practice variation may be undesirable from a

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[2] See also Aghion and Howitt (1990), Klette and Griliches (1997), and Segerstrom et al (1990).

medical perspective, it is advantageous econometrically, since it facilitates identification of the effect of drug choice on the variables of interest.[3]

It would surely be a mistake, however, to think that all or perhaps even most of the variation in drugs prescribed for a given condition is random, i.e. uncorrelated with attributes of the individual and/or his condition that may influence outcomes and non-drug medical expenditures. If determinants of outcomes and non-drug expenditure are correlated with the age of the drug prescribed and we fail to control for them, we will obtain biased estimates of the effect of drug age on outcomes and expenditures. For example, if more-educated people tend to receive newer drugs and (for unrelated reasons) also tend to have fewer hospital stays, if we don't control for education we will overestimate the effect of drug age on hospital stays.

While omission of some variables (like education) is likely to result in overstatement of the effect of drug age on hospital stays, the omission of others seems likely to result in understatement of this effect. Suppose that, among people with a given medical condition, the most severely ill are both more likely to receive the newest, most expensive, drugs and more likely to be hospitalized. Failure to control for (untreated) severity of illness—which is difficult to do, in practice—would then bias the drug-age coefficient towards zero. The net effect of plausible omitted-variables biases appears to be ambiguous, *a priori*.

Fortunately, the MEPS data enable us to control for many important attributes of the individual, condition, and prescription that influence outcomes and non-drug expenditures and that may be correlated with drug age. These include sex, age, education, race, income, insurance status (whether the person is covered by private insurance, Medicare, and Medicaid), who paid for the drug, the condition for which the drug was prescribed, how long the person has had the condition, and the number of medical conditions reported by the person. The first approach we will use to determine

[3] Significant geographical variation in treatment patterns was first documented by Wennberg and his colleagues (1982), who studied New England hospital markets. Other investigators have corroborated this finding in many other settings. For example, McPherson et al (1982) documented substantial variation in the use of common surgical procedures in New England, England, and Norway. As Folland et al (2001, p. 216) observe, "differences in treatment patterns across small areas may occur because of physicians' uncertainty and ignorance over the best medical practice."

the *ceteris paribus* effect of drug age on outcomes and expenditure will be to include, in a very nonrestrictive fashion, all of these factors as covariates in models of the form:

$$Y_{ij} = \beta \ln(AGE\_DRUG_{ij}) + \eta f(INCOME_j) + \mu MALE_j + \Sigma_h \theta_h CONDITION_{ijh} + \Sigma_y \psi_y COND\_DUR_{ijy} + \Sigma_k \lambda_k RACE_{jk} + \Sigma_m \phi_m INSURANCE_{im} + \Sigma_n \pi_n AGE_{in} + \Sigma_p \gamma_p EDU_{ip} + \varepsilon_{ij} \quad (1)$$

where:

Y_{ij} = one of the following variables associated with the i^{th} prescription consumed by person j

- Mortality: whether person j died by the end of the survey period
- Morbidity indicators: whether person j missed work or school days or spent days in bed due to the condition for which prescription i was consumed
- The number of, and expenditure on, non-drug medical events, by type, associated with the condition (inpatient hospital stays, emergency-room visits, office-based visits, outpatient department visits, dental visits, home health visits, other medical expenditure events)

AGE_DRUG_i = the number of years prior to 1996 that the active ingredient in prescription i consumed by person j was first approved by the FDA

$INCOME_j$ = the income of the person consuming the prescription

$MALE_j$ = 1 if the person consuming the prescription is male, otherwise zero

$CONDITION_{ijh}$ = 1 if the i^{th} prescription consumed by person j is prescribed for condition (ICD9 3-digit diagnosis) h (h = 1, 2,…, 496), otherwise zero

$COND\_DUR_{ijy}$ = 1 if the condition for which the i^{th} prescription consumed by person j began y years ago, otherwise zero

$RACE_{jk}$ = 1 if the person consuming the prescription is of race k (k = 1, 2,…,6), otherwise zero

$INSURANCE_{jm}$ = 1 if the person consuming the prescription has health insurance status (e.g. private insurance, Medicare, Medicaid, no insurance) m, otherwise zero

AGE_{jn} = 1 if the person consuming the prescription is n years old (n = 0, 1, 2,…,99), otherwise zero

EDU_{jp} = 1 if the person consuming the prescription has p years of schooling (p = 0, 1, 2,…,18), otherwise zero

ε_{ij} = the disturbance.

While eq. (1) appears to control for many potentially relevant determinants of Y that may be correlated with AGE_DRUG, the fact that many individuals in the sample have both multiple medical conditions[4] and multiple prescriptions means that we can control for *all* individual characteristics—both observed and unobserved—by pursuing a second approach. This involves estimating a model that includes "individual effects" (η_j's):

$$Y_{ij} = \eta_j + \beta \ln(AGE\_DRUG_{ij}) + \Sigma_h \theta_h CONDITION_{ijh} + \Sigma_y \lambda_y COND\_DUR_{ijy} + \Sigma_n \pi_n + \varepsilon_i \quad (2)$$

[4] Almost 2/3 of the people in the sample have 2 or more conditions. Almost 95% of the conditions are experienced by people who have more than one condition. Figure 3 shows the distribution of people in the MEPS sample, by number of reported medical conditions.

Estimates of the parameter of interest (β) from eq. (2) are based entirely on the *within-individual* correlation between Y and AGE_DRUG, not on the between-individual correlation.[5] Suppose a person has two conditions, asthma and hypertension, and is taking medications for both. He may have above-average numbers of hospital stays for both conditions, compared to other individuals with the same conditions. And he may be taking older-than-average drugs for both conditions. But due to the presence of individual effects in eq. (2), this would not make β positive. For β to be positive, it would have to be the case that the condition for which the age of the person's medications were *more* above average (relative to both individual and condition means) was the same as the condition for which his hospital stays were more above average.

MEPS data

We will estimate equations (1) and (2) using data from the 1996 Medical Expenditure Panel Survey (MEPS), a nationally representative survey of health care use, expenditures, sources of payment, and insurance coverage for the U.S. civilian noninstitutionalized population. MEPS is co-sponsored by the Agency for Health Care Research and Quality and the National Center for Health Statistics. This survey is designed to yield comprehensive data that estimate the level and distribution of health care use and expenditures, monitor the dynamics of the health care delivery and insurance systems, and assess health care policy implications.[6]

The MEPS Household Component collects extremely detailed data from 22,061 people on use and expenditures for office and hospital-based care, home health care, dental services, vision aids, and prescribed medicines. MEPS contains three kinds of data, i.e. data at three different levels of aggregation: the person level, the condition level (77 thousand conditions), and the event level. A person may have several conditions (e.g., hypertension, diabetes, and glaucoma); a given condition may be associated with a

[5] The η_j's capture all attributes of the individual that do not vary across prescriptions and conditions, including sex, age, education, race, income, insurance status, and the number of medical conditions reported by the person.

number of events. Figure 4 indicates the linkages between events, conditions, and persons. Table 2 shows the number of events, by type, and their associated average expenditures.

As indicated by eqs. (1) and (2), the unit of observation in our analysis is a prescribed-medicine event. The MEPS Prescribed Medicine Event file contains 171,587 observations. The file reveals the amount paid for the prescription, by source of payment, and the National Drug Code, from which we determined (by linking to other pharmaceutical databases) the year in which the active ingredient was first approved by the FDA. Figure 5 depicts the frequency distribution of MEPS prescriptions, by the date the active ingredient was first approved by the FDA. About ¼ of prescriptions consumed were for drugs approved before 1950; more than half of the drugs consumed in 1996 were approved before 1980. Table 3 shows the drug classes with the largest number of prescriptions in 1996.

Over 90% of the prescriptions are linked to exactly one medical condition.[7] The 1996 Medical Conditions file contains summary information about these medical conditions, including:

- When the condition began
- Whether the person with the condition *died* by the end of the survey period
- Whether the person *missed any work days* due to the condition
- Whether the person *missed any school days* due to the condition
- Whether the person *spent any days in bed* due to the condition
- The number of *home health events* associated with the condition
- The number of *dental events* associated with the condition
- The number of *hospital events* associated with the condition
- The number of *outpatient events* associated with the condition
- The number of *office-based events* associated with the condition
- The number of *emergency room events* associated with the condition

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[6] For further information about the Medical Expenditure Panel Survey, see the web site: http://www.meps.ahrq.gov/.

The Medical Conditions file does not report the amount of *expenditure* associated with each of these event types. However expenditure (and charges) associated with each condition, by event type, can be computed from the records contained in the respective medical event files.[8] For example, one can compute total hospital expenditure associated with individual x's hypertension. In addition to calculating expenditure, by event type, we calculated total non-drug expenditure, i.e. the sum of expenditures on the six event types listed above.

Empirical Results

Estimates of the parameter β from equations (1) and (2) are presented in Table 4. We discuss first the estimates of β from eq. (1), which controls for observed individual attributes such as age and education but excludes individual effects. The first dependent variable we consider is the amount paid for the prescription. The coefficient on ln(DRUG_AGE), β, is negative and highly significant, confirming the finding of previous studies (e.g. National Institute for Health Care Management Research and Educational Foundation (1999)) that new drugs are more expensive than old drugs prescribed for the same condition. A unit decrease of ln(DRUG_AGE)—which would occur, for example, if a 15 year-old drug were replaced by a 5.5 year-old drug—would increase the cost of the prescription by about $18.

The second dependent variable we consider is a mortality indicator: a dummy variable equal to 1 if the person had died by the end of round 3 of the survey, and otherwise equal to zero. The mortality rate in this sample is quite low—only 0.28% (65) of the 23,230 persons died by the end of round 3. This would seem to make it very difficult to detect any effect of drug age on mortality. But recall that the unit of observation in our analysis is a prescription, not a person, and the fraction of observations in which mortality occurs is higher than 0.28%. People with more prescriptions and more

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[7] 5.3% are linked to more than one condition; 4.4% are not linked to any condition.
[8] The CLNK file contains the variables needed to link records in the MEPS 1996 event files to records in the MEPS 1996 condition file.

conditions have a higher probability of death. The fraction of *conditions* in which mortality occurs is almost twice as high—0.48% (371 out of 76,602).

The estimates indicate that *people consuming new drugs were significantly less likely to die by the end of round 3 than people consuming older drugs*, controlling for all of the covariates included in eq. (1). A unit decrease of ln(DRUG_AGE) is estimated to have decreased the probability of dying by 0.10 percentage points.

This finding is quite consistent with more aggregate (disease-level) evidence I presented in an earlier paper (Lichtenberg (2000)). There I analyzed the relationship *across diseases* between the long-term reduction in life-years lost before age 75 and the relative utilization of new pharmaceutical products. I found a highly significant positive relationship across diseases between the new drug share and mortality reduction in all three periods I analyzed. Over 45 percent of the variation across diseases in the 1970-91 reduction in mortality was explained by the new drug share. Each new drug approved during the period 1970-91 was estimated to have saved 11,200 life-years in 1991.

Next we consider morbidity indicators. The fractions of conditions associated with any work-loss-, school-loss-, and bed-days, were as follows:

Work-loss days	14.7 %
School-loss days	9.0 %
Bed days	14.0 %

The coefficient on ln(DRUG_AGE) is insignificant in the school-loss days equation and only marginally significant in the bed-days equation. But the estimates of the work-loss days equation indicate that *people consuming new drugs were significantly less likely to experience work-loss days than people consuming old drugs*. This effect is highly statistically significant, but does not seem very large. A unit decrease in ln(DRUG_AGE)**,** which would increase the cost of the prescription by $18, would reduce the probability of any work-loss days by 0.0040. If the increase in prescription cost were to be justified solely on the basis of reduced work-loss days, the average cost of work-loss episodes would have to exceed $4500 (=$18/.0040). However we have already found evidence of one other benefit of newer drugs—reduced mortality—and we have yet to consider another potential benefit: reduced expenditures on other medical inputs.

We now present estimates of the effect of drug age on utilization of and expenditure on various non-drug medical events, by type. The first event type we consider is hospital stays, the single most costly type, accounting for almost 42% of total medical expenditure. The coefficient on ln(DRUG_AGE) in the equation explaining the number of hospital stays associated with the condition is positive and highly significant (t=3.68), indicating that *people consuming new drugs had significantly fewer hospital stays than people consuming old drugs*. A unit decrease in ln(DRUG_AGE) would reduce the expected number of hospital stays by .0059: replacing 1000 old prescriptions with 1000 new prescriptions—which would increase drug costs by $18,000--would reduce the number of hospital stays by 5.9. Since average expenditure on a hospital stay is $7588, one might expect a reduction in hospital expenditure of $44,469 (=5.9 * $7588). However the regression of a person's actual hospital expenditures associated with a condition indicates an even larger reduction in hospital expenditure from the use of newer drugs: the implied hospital cost reduction is $55,824. Use of newer drugs is evidently associated with less expensive (shorter), as well as fewer, hospital stays.

As before, this finding is quite consistent with more aggregate (disease-level) evidence I presented in an earlier paper (Lichtenberg (1996)). In that paper I examined the effect of changes in the quantity and type of pharmaceuticals prescribed by physicians on rates of hospitalization, surgical procedure, mortality, and related variables. The unit of analysis was a (ICD9 2-digit) disease or diagnosis, which we argued is analogous to a

product (or industry) in industrial organization economics. We controlled for the presence of "fixed (diagnosis) effects" by analyzing *growth rates* of the variables, using a database on diagnosis-level inputs and outcomes at two points in time (1980 and 1991 or 1992). Our principal findings were: (1) The number of hospital stays, bed-days, and surgical procedures declined most rapidly for those diagnoses with the greatest increase in the total number of drugs prescribed and the greatest change in the distribution of drugs. The estimates imply that an increase of 100 prescriptions is associated with 1.48 fewer hospital admissions, 16.3 fewer hospital days, and 3.36 fewer inpatient surgical procedures. (2) Greater quantity and novelty of pharmaceuticals had a negative impact on average length of stay in hospitals, as well as on the number of hospital stays. (3) A $1 increase in pharmaceutical expenditure is associated with a $3.65 reduction in hospital care expenditure (ignoring any indirect cost of hospitalization).

The estimates indicate that reductions in drug age tend to reduce *all* types of non-drug medical expenditure, although as the following table indicates, the reduction in inpatient expenditure is by far the largest.

Event type	**Estimated expenditure reduction from unit decrease in ln(DRUG_AGE)**	**% of total expenditure reduction**
Inpatient events	$55.82	78.5%
Outpatient department events	$9.05	12.7%
Office-based events	$3.11	4.4%
Emergency room events	$2.63	3.7%
Dental events	$0.47	0.7%
Total	$71.09	100.0%

The total estimated reduction in non-drug expenditure from a unit decrease in ln(DRUG_AGE) is $71.09. This reduction in non-drug expenditure is much greater than the increase in prescription cost ($18.00), so *reducing the age of the drug results in a substantial net reduction in the total cost of treating the condition*.

The estimates in the second column of Table , which are based on models that include individual effects, are quite similar, broadly speaking, to the estimates in the first

column, which are based on models without individual effects.[9] They also suggest that people consuming new drugs were significantly less likely to experience work-loss days than people consuming old drugs, although the estimated effect is about 30% smaller. The estimated effect of ln(DRUG_AGE) on total non-drug expenditure to treat the condition is almost identical--$72.22—but the distribution of cost reduction by event type is somewhat different. When individual effects are included, the reduction in inpatient expenditure accounts for an even higher proportion (89%) of the total reduction in non-drug expenditures.

To summarize, estimates of both eq. (1), which controls for many observed characteristics of the person, condition, and prescription, and eq, (2), which controls for all individual attributes (both observed and unobserved), indicate that people taking newer drugs are likely to have significantly lower medical expenditures and have fewer work-loss days than people taking older drugs for the same condition. The first equation also indicates that mortality is lower among people taking newer drugs.

It is sometimes suggested that, because generic drugs tend to be less expensive than branded drugs, allowing people to use only generic drugs might be an effective means of reducing health expenditure. As the following table shows, generic drugs tend to be much older than branded drugs.

	% of prescriptions	**mean age (in years) in 1996**
Branded drugs	60.0%	23
Generic drugs	40.0%	38
All drugs	100.0%	29

Suppose that, instead of consuming the actual mix of 60% branded and 40% generic drugs, people had to consume only generic drugs. This would increase the mean age of drugs consumed by 31%, from 29 years to 38 years. Our estimates indicate that *denying*

[9] Unlike the morbidity and expenditure variables, the mortality variable does not exhibit any within-individual variation—the *cause* of death is not indicated—so we are unable to estimate the mortality equation with individual effects.

people access to branded drugs would increase total treatment costs, not reduce them, and would lead to worse outcomes.

Conclusions

The nation's spending for prescription drugs has grown dramatically in recent years. Previous studies have shown that the replacement of older drugs by newer, more expensive, drugs is the single most important reason for this increase, but they did not attempt to measure how much of the difference between new and old drug prices reflects changes in quality as better, newer drugs replace older, less effective medications.

In this paper, we analyzed prescribed medicine event-level data (linked to person- and condition-level data) from the 1996 Medical Expenditure Panel Survey (MEPS) to provide evidence about the effect of drug age on mortality, morbidity, and total medical expenditure, controlling for a number of characteristics of the individual and the event. (Previous researchers have hypothesized that differences in treatment patterns across individuals and areas may occur because of physicians' uncertainty and ignorance over the best medical practice.) The MEPS data enable us to control for many important attributes of the individual, condition, and prescription that influence outcomes and non-drug expenditures and that may be correlated with drug age. These include sex, age, education, race, income, insurance status, who paid for the drug, the condition for which the drug was prescribed, how long the person has had the condition, and the number of medical conditions reported by the person. Indeed, the fact that many individuals in the sample have both multiple medical conditions and multiple prescriptions means that we can control for *all* individual characteristics—both observed and unobserved—by including "individual effects".

The results provide strong support for the hypothesis that the replacement of older by newer drugs results in reductions in mortality, morbidity, and total medical expenditure. Although the mortality rate in this sample is quite low—making it difficult to detect any effect of drug age on mortality—we found that people consuming new drugs were significantly less likely to die by the end of the survey than people consuming older drugs. As to morbidity, we found that people consuming new drugs were

significantly less likely to experience work-loss days than people consuming old drugs, although the estimated effect was not very large.

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Figure 1
Real per capita Rx expenditure (1998 $)

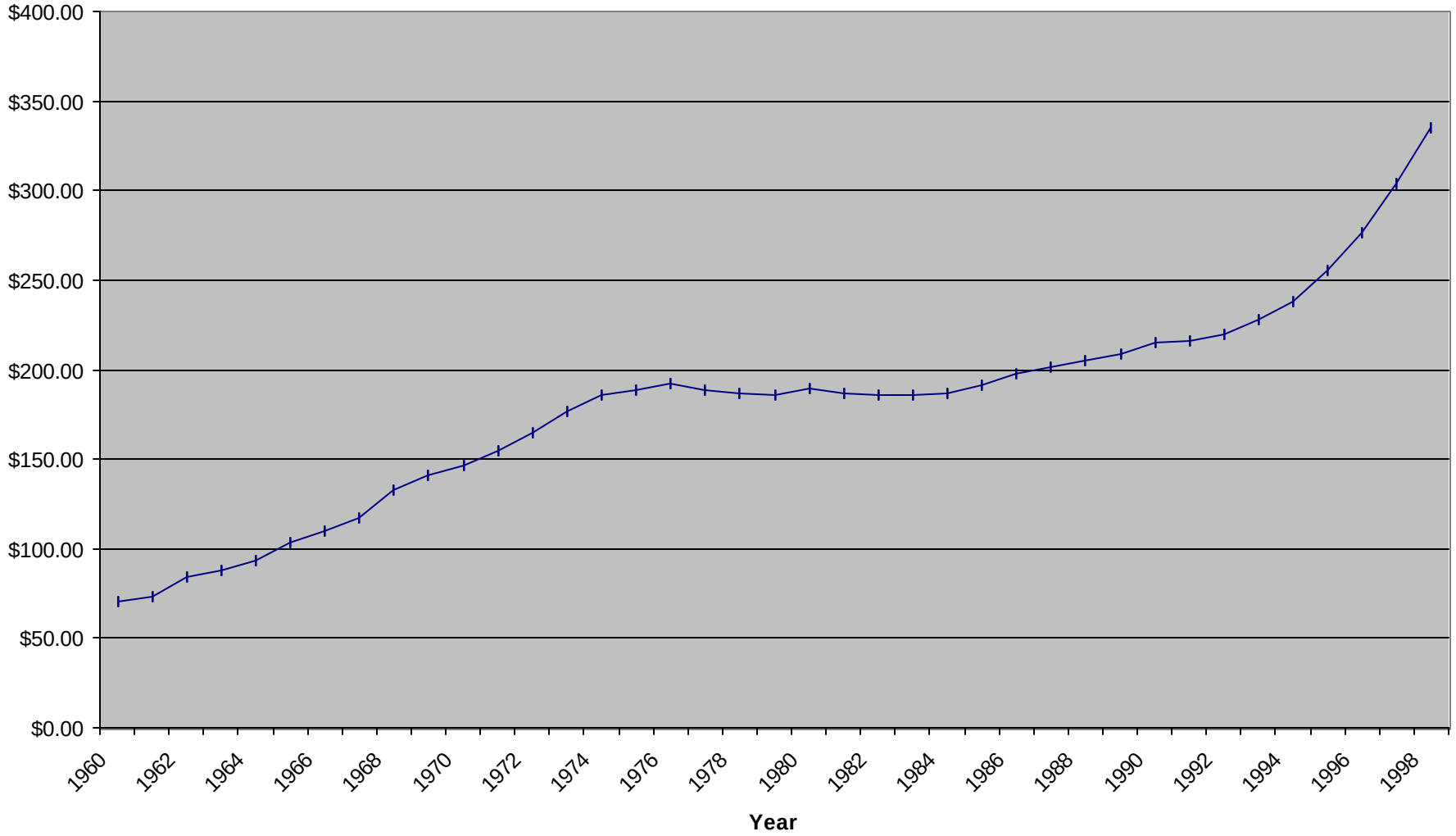

Figure 2
Mean Rx expenditure relative to Rx expenditure of 25-34 year-old, 1977 and 1996

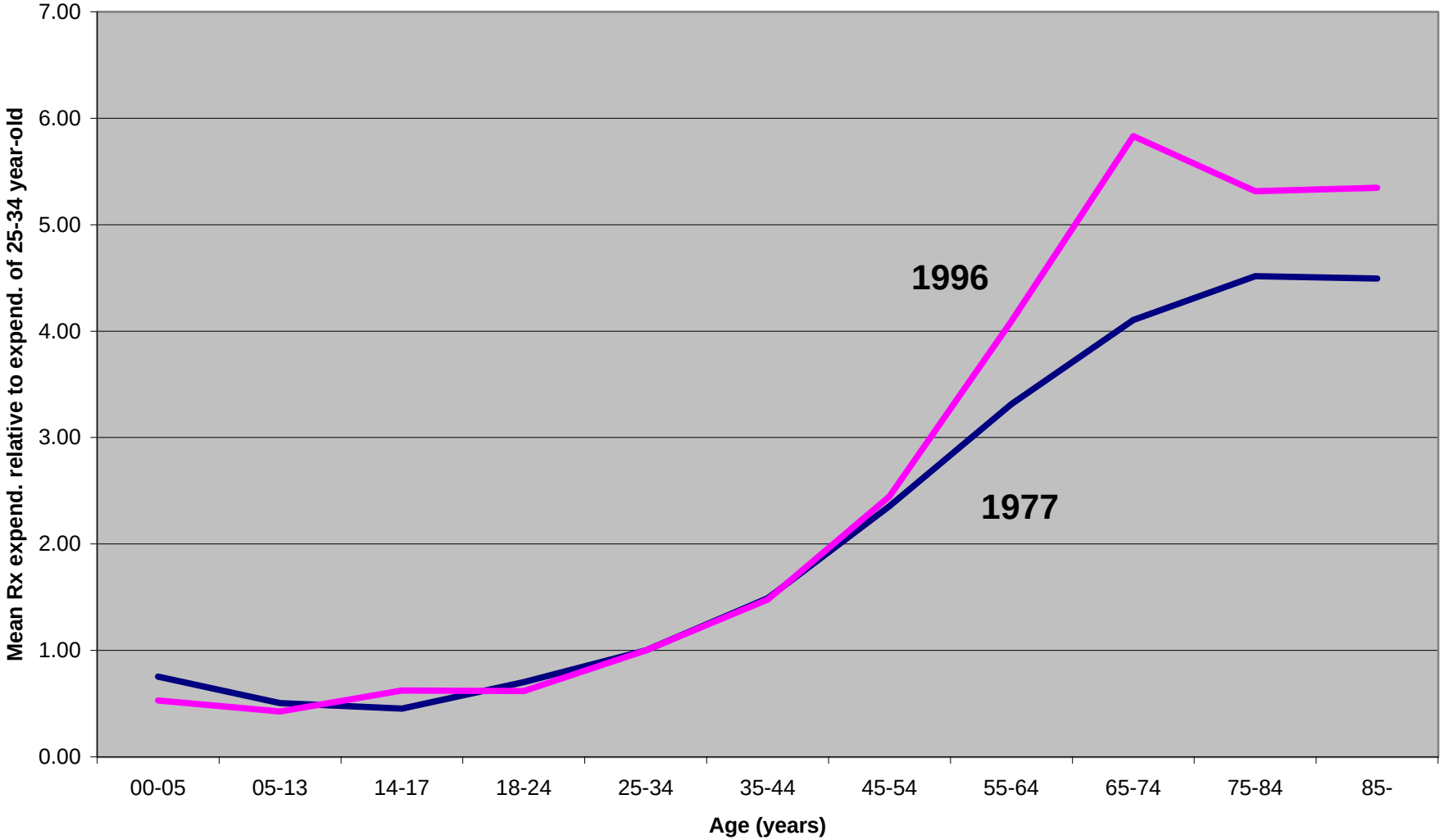

Table 1

Percentage Contribution of Changes in Price and Utilization to 1993-98 Increase in Prescription Drug Spending

	Percent of rise in drug spending attributable to prices (at introduction and subsequent increases)	Percent of rise in drug spending attributable to utilization	Total
New drugs (1992 or later)	42%	23%	65%
Older drugs	22%	13%	35%
Total	64%	36%	100%

Source: National Institute for Health Care Management Research and Educational Foundation, *Factors Affecting the Growth of Prescription Drug Expenditures,* Washington, 1999.

Report to the President: Prescription Drug Coverage, Spending, Utilization, and Prices
Department of Health & Human Services, April 2000
http://aspe.hhs.gov/health/reports/drugstudy/index.htm

Figure 3
Distribution of people in MEPS sample, by number of reported medical conditions

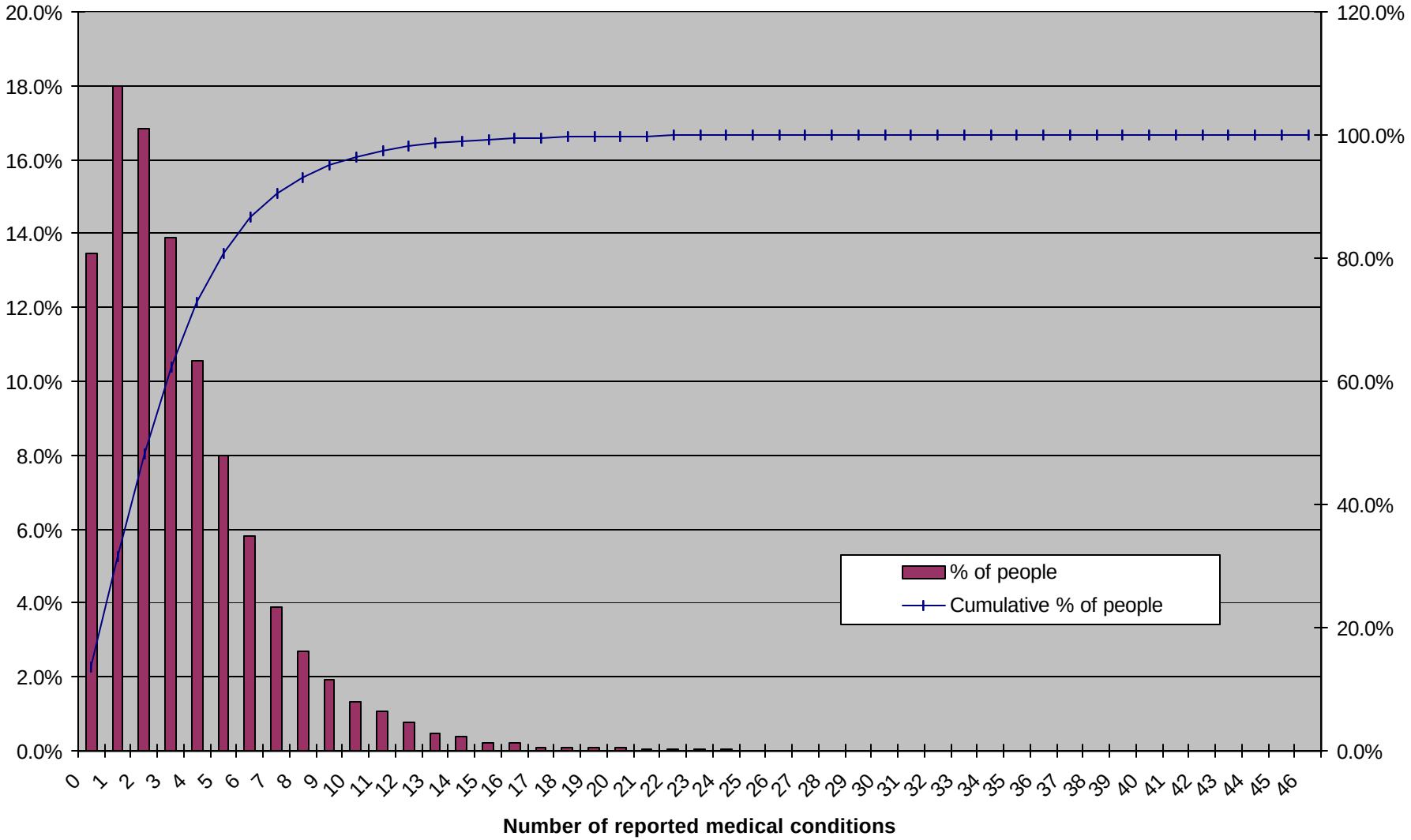

Figure 4

Persons, conditions, and events in MEPS

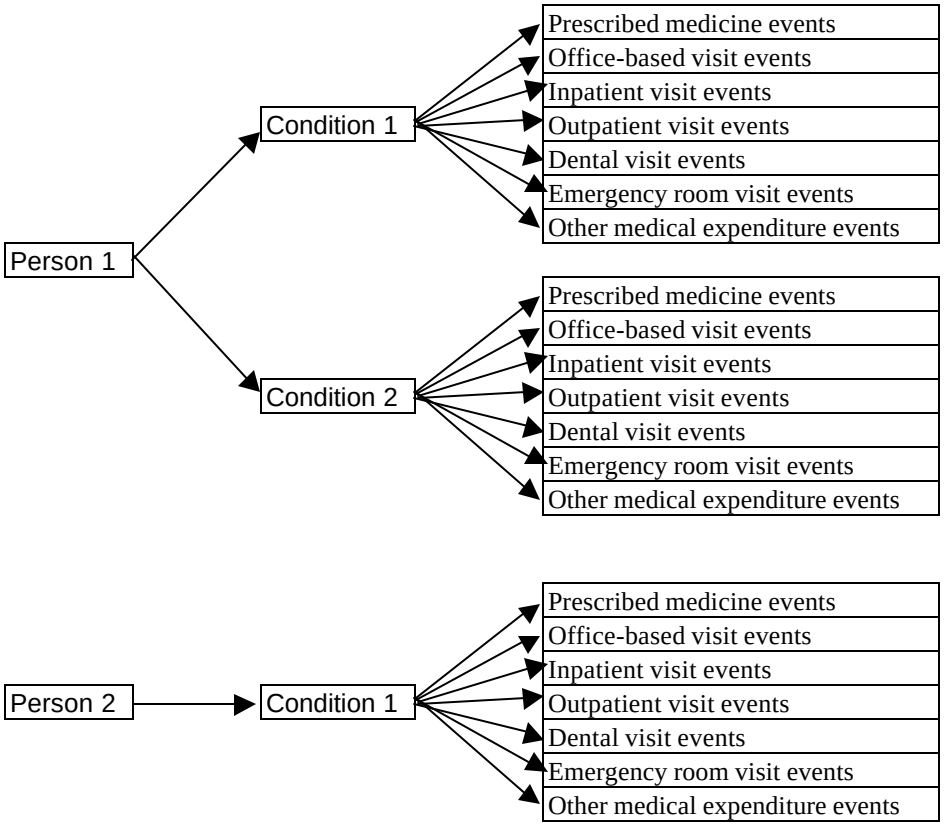

Table 2

Frequency of and expenditure on MEPS events

Event type	**No. of events**	**Avge. Expenditure**	**Total expenditure**	**% of total expenditure**
Inpatient visit events	2,207	$7,587.60	$16,745,833	41.5%
Office-based visit events	100,320	$81.45	$8,170,815	20.2%
Prescribed medicine events	171,587	$32.77	$5,623,511	13.9%
Outpatient visit events	9,957	$412.55	$4,107,802	10.2%
Dental visit events	22,165	$142.92	$3,167,747	7.8%
Emergency room visit events	3,899	$345.34	$1,346,490	3.3%
Other medical expenditure events	6,402	$189.70	$1,214,484	3.0%
All	316,537		$40,376,682	100.0%

Figure 5
Frequency distribution of MEPS prescriptions,
by date active ingredient was approved by the FDA

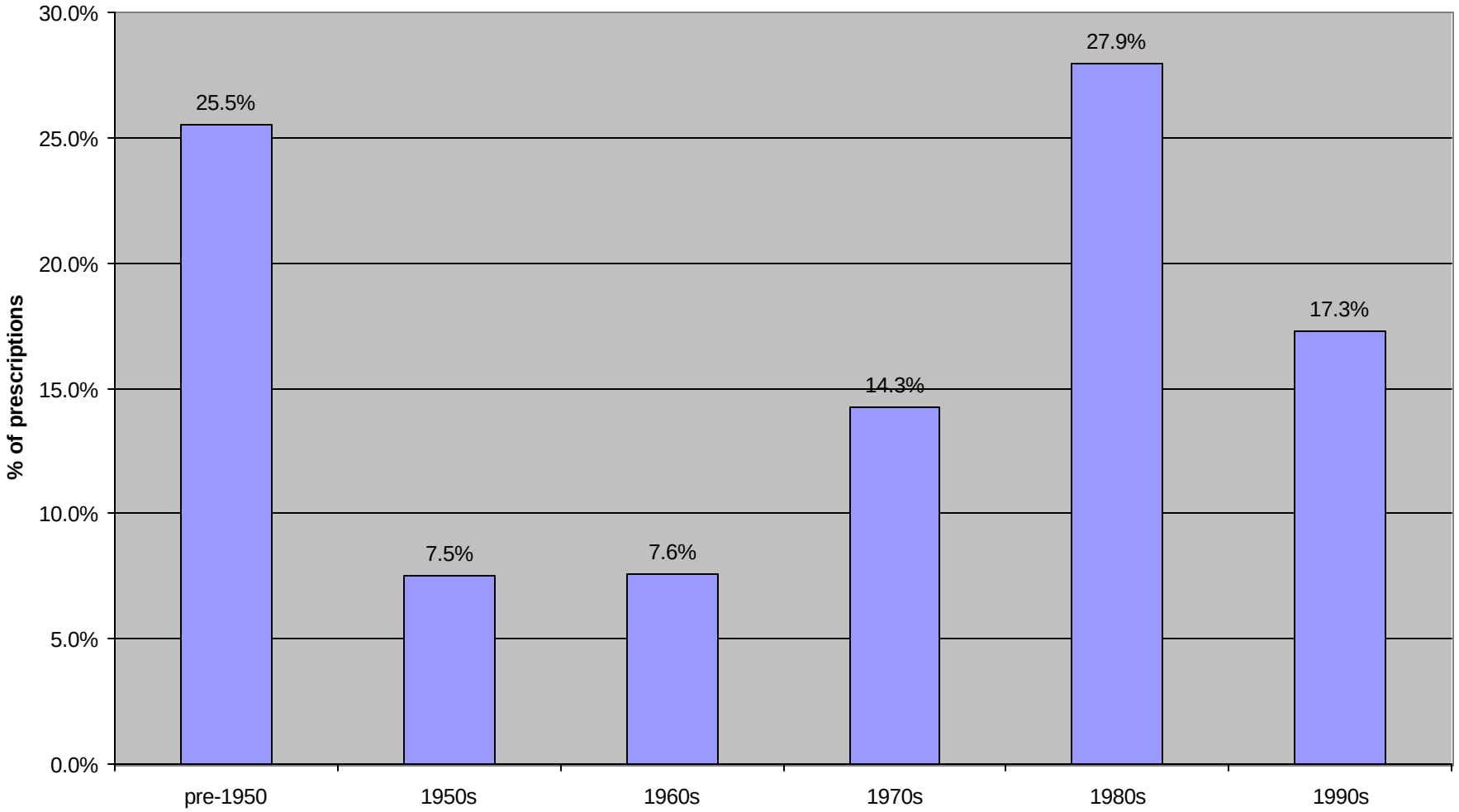

Table 3

Drug classes with the largest number of prescriptions in 1996

Millions of Rx's	% of Rx's	Drug class
83.0	5.1%	calcium channel blocking agents
77.7	4.8%	upper respiratory combinations
73.8	4.6%	nonsteroidal anti-inflammatory agents
66.4	4.1%	aminopenicillins
63.2	3.9%	narcotic analgesic combinations
60.6	3.7%	angiotensin converting enzyme inhibitors
52.5	3.2%	estrogens
41.2	2.5%	thyroid drugs
41.1	2.5%	SSRI antidepressants
39.7	2.4%	beta-adrenergic blocking agents
37.6	2.3%	macrolides
35.1	2.2%	H2 antagonists
34.1	2.1%	sulfonylureas
32.9	2.0%	adrenal cortical steroids
31.8	2.0%	loop diuretics
31.1	1.9%	HMG-CoA reductase inhibitors
30.5	1.9%	minerals and electrolytes
29.9	1.8%	insulin
29.6	1.8%	topical anti-infectives
24.8	1.5%	topical steroids
24.4	1.5%	antihistamines
22.8	1.4%	antianginal agents
21.6	1.3%	inotropic agents
20.1	1.2%	second generation cephalosporins
19.8	1.2%	respiratory inhalant products
19.1	1.2%	natural penicillins
18.6	1.1%	benzodiazepines
18.1	1.1%	nasal steroids
16.3	1.0%	miscellaneous antipsychotic agents
16.3	1.0%	progestins

Note: Only those drug classes accounting for at least 1% of total prescriptions are shown

Table 4

Estimates of b (the coefficient on ln(DRUG_AGE)) from eqs. (1) and (2)
(t-statistics in parentheses)

Dependent variable	Eq. (1)	Eq. (2)
Amount paid for prescription (total paid by all sources)	-17.99	-18.09
	(97.74)	(107.71)
Mortality		
Mortality dummy	0.0010	
(=1 if person died by the end of round 3)	(2.76)	
Morbidity		
MISSED WORK DAYS dummy	0.0040	0.0028
(=1 if person missed any work days due to the condition)	(3.32)	(3.25)
MISSED SCHOOL DAYS dummy	0.0001	-0.0005
(=1 if person missed any school days due to the condition)	(0.21)	(1.28)
BED DAYS dummy	0.0023	0.0019
(=1 if person spent any days in bed due to the condition)	(1.55)	(1.60)
Non-drug events		
Number of hospital stays associated with condition	0.0059	0.0043
	(8.04)	(6.34)
Hospital expenditure associated with condition	55.82	63.95
	(3.69)	(3.81)
Number of outpatient dept. visits associated with condition	0.0034	0.0001
	(5.46)	(0.19)
Outpatient dept. expenditure associated with condition	9.05	4.91
	(9.66)	(5.42)
Number of office visits associated with condition	-0.0054	-0.0031
	(1.97)	(1.18)
Office visit expenditure associated with condition	3.11	1.78
	(4.72)	(2.97)
Number of emergency room visits associated with condition	0.0073	0.0028
	(11.58)	(5.08)
Emergency room expenditure associated with condition	2.63	1.21
	(5.90)	(3.02)
Number of dental visits associated with condition	0.0034	0.0028
	(5.53)	(5.04)
Dental expenditure associated with condition	0.4730	0.3727
	(1.44)	(1.40)
Total non-drug expenditure associated with condition	71.09	72.22
	(4.69)	(4.29)