Price Elasticity and Medication Use: Cost Sharing Across Multiple Clinical Conditions

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ABSTRACT

BACKGROUND: To address the impact that out-of-pocket prices may have on medication use, it is vital to understand how the demand for medications may be affected when patients are faced with changes in the price to acquire treatment and how price responsiveness differs across medication classes.

OBJECTIVE: To examine the impact of cost-sharing changes on the demand for 8 classes of prescription medications.

METHODS: This was a retrospective database analysis of 11,550,363 commercially insured enrollees within the 2005-2009 MarketScan Database. Patient cost sharing, expressed as a price index for each medication class, was the main explanatory variable to examine the price elasticity of demand. Negative binomial fixed effect models were estimated to examine medication fills. The elasticity estimates reflect how use changes over time as a function of changes in copayments.

RESULTS: Model estimates revealed that price elasticity of demand ranged from -0.015 to -0.157 within the 8 categories of medications ($P<0.01$ for 7 of 8 categories). The price elasticity of demand for smoking deterrents was largest (-0.157, $P<0.0001$), while demand for antiplatelet agents was not responsive to price ($P>0.05$).

CONCLUSIONS: The price elasticity of demand varied considerably by medication class, suggesting that the influence of cost sharing on medication use may be related to characteristics inherent to each medication class or underlying condition.

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What is already known about this subject

- Cost sharing for prescription medications has risen in the past decade, placing a larger share of the treatment cost on the enrollee.
- In some medication classes, increases in consumer cost sharing have been linked to lower levels of medication utilization.

What this study adds

- Price elasticity of demand varied considerably by medication class among 8 categories of prescription medications.
- Results suggest the need for plan designers and practitioners to be sensitive to changing levels of patient cost sharing when providing guidance on medication use.

Between 2000 and 2009, the average copayment for generic (tier 1), preferred brand (tier 2), and nonpreferred brand (tier 3) medications increased 25%, 80%, and 59%, respectively.[1] By 2010, the average drug copayment was $10 for a generic prescription, $29 for preferred brand medications, and $49 for nonpreferred brand medications.[2] Many studies have found that higher prescription drug cost-sharing amounts are associated with lower levels of medication utilization. For example, Goldman et al. (2004) found that doubling copayment amounts resulted in a 25%-45% decrease in the days of medication supplied, depending on the drug class.[3] Across multiple studies, the price elasticity of demand for medications (i.e., the percentage of change in the quantity demanded of a good in response to a 1% change in its price) has been observed to be inelastic and in a range from -0.032 to -0.60—every percentage increase in a medication's price would result in a 0.032%-0.60% decrease in the amount demanded (often fills per person or the number of days with medication on hand).[4-7] Moreover, without respect to medication class, price elasticity of demand for medications to treat chronic conditions was shown to be -0.23 in Medicare patients.[8] While such evidence primarily emphasizes the effects that differential cost sharing can have on medication use, it further serves to highlight differences between drug classes and conditions, suggesting that price responsiveness varies by medication class.

The variation in price responsiveness may be rooted in the basic determinants of demand for prescription drugs: a derived demand based on the individual's overall demand for health—the ultimate good being "purchased." We would expect to see changes in its demand due to several factors, including increases in its own price, as reflected in the level of cost sharing faced by the patient to purchase the medication, and the availability and price of close substitutes or complements.[9] In the latter case, if a medication class has less expensive over-the-counter (OTC) substitutes, then the price elasticity of prescription alternatives are likely to be higher than other classes without OTC alternatives, so that when faced with a price increase, the patient may substitute away from prescription medications. Similarly, if a high percentage of generic medications exist within the medication class, then patients may substitute away from brand-name alternatives.

However, when considering the role of medication in the production of health, we must consider the varied intention

inherent to different classes of medications and their related effects. While numerous medications may be given to resolve acute symptoms or disease, many are prescribed to manage ongoing symptoms or as preventive measures intended to reduce the impact of risk factors or symptoms known to be associated with particular conditions. In the case of prevention, the benefit understood by the patient and the physician may differ dramatically, impacting the resulting value placed on the medication by the patient, who is the consumer.[10] In determining this value and making a purchasing decision, the patient must then weigh the benefits and likelihood of obtaining better health in the future against the present cost of the medication; in essence, the patient is determining individual and immediate necessity for the prescribed treatment. Observations to date incorporating the perception of necessity have demonstrated that there is mixed evidence on price elasticities for medications considered to be essential and those that are "discretionary," with a few studies finding differences in the price responsiveness between essential and discretionary medications and others finding no clear pattern.[3,5,7] Additional evidence on price responsiveness across medication classes is warranted to better understand how patients behave when faced with differential cost sharing and how this pattern may differ by medication class.

The purpose of this study was to further investigate the relationship between cost sharing and medication utilization patterns across multiple conditions among commercially insured adults. Unlike most previous studies, we analyzed price effects for each medication class across an enrolled population of 11.5 million adults, estimating the collective effects of price changes on medication utilization within the entirety of enrollment. This approach adopted a payer view of the impact of changes in cost sharing, the net effect of which is a combination of behaviors: initiation, discontinuation, and adherence to a medication class. This is in contrast to a patient cohort approach, which focuses on discontinuation and adherence rates for those who have already chosen to initiate a medication class. Results of this study adds to the scant literature on differences in the price elasticity of demand for medications across 8 classes of pharmacotherapy for the treatment of a variety of conditions and will inform efforts to determine cost sharing levels for medication classes.

Methods

Data Source

This analysis was based on data from the 2005-2009 Truven Health MarketScan Commercial Claims and Encounters Research Database. This database contains health insurance claims for inpatient, outpatient, and outpatient prescription drug services of millions of employees of over 100 medium and large-sized firms in the United States. The data have been statistically de-identified and conform to the Health Insurance Portability and Accountability Act of 1996 (HIPAA); neither informed consent nor institutional review board (IRB) approval were necessary.

Study Population

Enrollees were eligible for inclusion in the study if they were between the ages of 18 and 64, were continuously enrolled for at least 7 continuous calendar quarters between January 1, 2006, and September 30, 2009, and had no evidence of pregnancy throughout the study period. Enrollees were included in any calendar quarter if they were enrolled throughout the quarter.

Prescription Fills

Medication categories of interest included smoking deterrents, nonsteroidal anti-inflammatory drugs or opioids (NSAIDs/opioids), proton pump inhibitors (PPIs), anticonvulsants, 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors (statins), bisphosphonates, thyroid hormone, and antiplatelet agents (see Appendix, available in online article). These medications were chosen because they are commonly used and because many are high-cost categories and are classes for which cost-related nonadherence has been identified.

The number of prescription fills for each medication was calculated per quarter throughout the study window based on paid claims for each patient. The number of fills per claim was based on the days supply field on the prescription drug claims: a claim with days supply of 30 or less was considered to be 1 fill, while claims with days supply greater than 30 were standardized to a 30-day fill. For example, if a patient had one 12-day fill for a specific drug during the quarter, that patient would have 1 prescription fill, whereas if a patient had one 90-day fill for a specific drug, that patient would have 3 prescription fills during the quarter.

Explanatory Variables

The main explanatory variable was patient cost sharing—for each medication class, this was measured using a cost-sharing index created for each employer/plan combination within the database.[11] The cost-sharing index was based on the average cost-sharing amount (i.e., copayment, coinsurance) per prescription (standardized to a 30-day supply) in an employer/plan for brand and generic drugs in each medication class. The price index is a market basket approach providing an aggregate measure of plan-level cost sharing weighted for utilization. The index aggregated the brand and generic copayments using weights developed from the overall proportion of utilization of brand and generic drugs within each medication class during the study time frame, with the weights for each class summing to 1. For example, the weights for statins were 0.55 for brand name and 0.45 for generic. Such aggregation of cost sharing into levels for each employer/plan combination reduces any

effects of potential selection bias related to actual, individual-level cost sharing and related choices.

Sociodemographic variables included age in years, gender, urban or rural residence (based on metropolitan statistical area), median household income (from the 2000 census files based on ZIP codes), and U.S. census region (Northeast, North Central, West, and South). The number of general practitioners and specialists per capita were also included (based on county of residence) from the Area Resource File. The relationship of the enrolled to the employee (self, spouse, or dependent) was indicated.

Two health status controls were also included. The Deyo Charlson Comorbidity Index (CCI) was calculated in the year prior to the index date—the date of first fill for each medication. This version of the CCI accounts for the effects of comorbid conditions in the analysis of claims data.[12] The number of psychiatric diagnostic groupings (PDG) were also measured during the pre-index period of this study. PDG measures the presence of psychiatric or substance dependent conditions. There are 12 possible PDGs, which are aggregated from ICD-9-CM (*International Classification of Diseases, Ninth Revision, Clinical Modification*) diagnosis codes.[13] Examples include alcohol and other substance use disorders, depression, bipolar disorder, post-traumatic stress disorders, and schizophrenia.

Analysis

As a descriptive analysis of each medication class, patient characteristics and quarterly utilization measures were calculated in the quarter of first fill for each medication.

For a multivariable analysis of price elasticity, we created a panel dataset with employer/plan as the cross sectional unit and calendar quarter as the unit of time. In each employer/plan combination, quarterly prescription fills and enrollee counts were summarized, and average characteristics within the plan (e.g., average age, percent female) were calculated. In these plans, cost-sharing levels were assessed across all plan members. The key variable of interest, cost sharing, was measured at the plan level, and we focused on the price responsiveness to these cost-sharing changes. Such an analysis approximates the payer view and includes nonusers of medications in the denominator. Although we did not formally examine cost sharing and initiation of use of a medication class, this per enrollee analysis included the impact of differential rates of initiation.

We estimated negative binomial fixed effect models with a fixed effect for each employer/plan combination to account for time invariant employer/plan-level characteristics. We also included quarterly time dummy variables to account for common time trends and exposure-adjusted for enrollment counts in the employer/plan.[14]

To estimate the impact of cost sharing on the demand for medications, we utilized a fixed effects panel data measuring changes in utilization as they related to changes in cost sharing in a given employer/plan from 1 year to the next. By estimating a unique intercept for each employer/plan, the fixed effect design accounted for any time-invariant employer/plan characteristics that were correlated with cost sharing and medication use. The model also accounted for time-variant characteristics that might affect cost sharing over time equally across all employer/plans by including a separate intercept for each quarter. Price responsiveness was measured by calculating the price elasticity: the percentage of change in the utilization measure (fills) with a 1% percentage of change in price.

TABLE 1 Sample Characteristics

Characteristic	Total Enrollment N = 11,550,464
Age in years, mean (SD)	42.03 (12.69)
Female gender, %	53.1
Census region, %	
Northeast	13.8
North Central	25.9
South	38.8
West	20.7
Urban, %	85.8
Employee relationship, %	
Employee	58.9
Spouse	30.2
Child/other	10.9
Plan type, %	
PPO	52.4
HMO	21.3
POS	14.2
Other	12.2
Income (000s), mean (SD)[a]	49.98 (18.08)
General practitioners per capita, mean (SD)	2.96 (1.36)
Specialists per capita, mean (SD)	9.40 (7.26)
Charlson Comorbidity Index, mean (SD)	0.21 (0.71)
Psychiatric diagnostic grouping, mean (SD)	0.14 (0.46)

[a]*Average median household income by ZIP code of residence.*

HMO = health maintenance organization; POS = point of service; PPO = preferred provider organization; SD = standard deviation.

Results

Demographics

Across the entire population, the mean age was approximately 42 years, and slightly more than half of the included enrollees were female. The majority of subjects were employees (versus spouse or child), and a larger proportion resided in the southern United States, reflecting the underlying composition of the convenience sample, and in an urban setting. Also, most subjects were insured under a preferred provider organization, and the average median income by ZIP code of residence was approximately $50,000 (Table 1).

The demographic characteristics of individuals utilizing each medication class varied: mean ages ranged from 45.5

TABLE 2 Medication Use and Costs by Class

Drug Class	Sample Population (n)	Fills Mean (SD)	Medication Cost[a] Mean (SD)	Price Index ($)	Generic Use (%)
Statins	1,123,236	2.64 (1.31)	204.14 (158.40)	12.11	45.5
Bisphosphonates	200,404	2.70 (1.30)	196.13 (106.39)	15.71	24.5
Thyroid hormone	438,603	2.96 (1.42)	31.29 (25.20)	6.92	48.4
Antiplatelet agents	116,799	2.70 (1.40)	330.83 (187.35)	16.43	15.6
NSAIDs/opioids	8,249,187	1.65 (1.32)	42.67 (227.05)	8.05	88.4
PPIs	994,424	2.23 (1.30)	267.72 (210.51)	15.30	36.7
Anticonvulsants	555,401	2.21 (1.66)	210.09 (336.77)	12.24	62.4
Smoking deterrents	200,522	1.68 (1.00)	172.81 (111.20)	23.48	4.7

[a]*Average spend by quarter.*

NSAID = nonsteroidal anti-inflammatory drug; PPI = proton pump inhibitor; SD = standard deviation.

to 55.7, and patients were mostly female in all but 2 classes (statins and antiplatelet agents). Average median household income was similar across all drug classes, ranging from $45,550 to $50,400. Aside from patients on antiplatelet agents, comorbidity indices were relatively similar (not shown).

Medication Use and Cost

Patient cost sharing (the price index) varied from $6.92 for thyroid hormones to $23.48 for antiplatelet agents. Average spending (quarterly) for medications in each class ranged considerably by drug class—those taking thyroid hormone reported an average expenditure of $31.29, while those on antiplatelet agents had an average expenditure of $330.38. Quarterly spending generally increased with increasing comorbidity indices, while higher levels of generic medication use were associated with lower cost sharing. The vast majority of fills for antiplatelet agents (84.4%) and nearly all fills for smoking deterrents (95.3%) were for branded medications; however, most fills for NSAIDs/opioids were for generic products (88.4%; Table 2). Between the first and last quarter of the study period for each medication class, the percentage of change in average cost sharing ranged from 1.1% (biphosphonates) to 70.9% (smoking deterrents) for generic medications and from 2.0% (NSAIDs/opioids) to 45.7% (smoking deterrents) for brand medications.

Elasticity of Demand

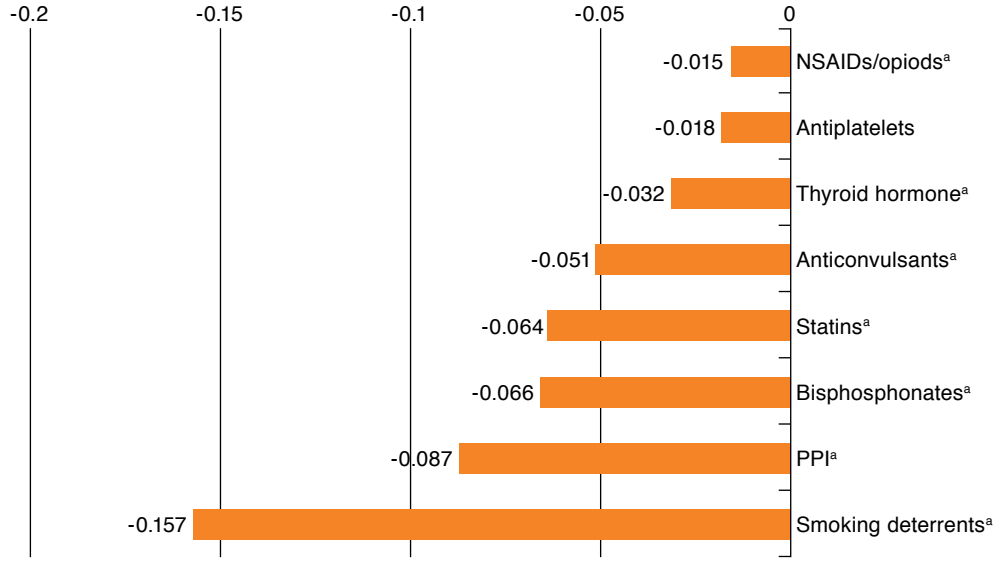
Estimated price elasticity of demand per enrollee is shown graphically in Figure 1. The effects on prescription drug fills at a per enrollee level ranged from -0.015 to -0.157 ($P < 0.01$ for 7 of the 8 medication classes). Smoking deterrents were observed to have the largest price responsiveness across all drug classes (-0.157, $P < 0.001$) followed by PPIs and bisphosphonates; NSAIDs/opioids were observed to be the least responsive to price across all medication classes (-0.015, $P < 0.05$). Demand for antiplatelet agents was not observed to be responsive to price ($P > 0.05$).

Discussion

Relatively few studies have investigated the effect of differential cost sharing on price elasticity of demand for a variety of classes of prescription medication. Our results suggest that changes in the demand for particular medications, as evidenced by subsequent fills, can be expected when patients face increases in their required cost sharing. While the magnitude of effects varied by medication class, statistically significant changes, with 1 exception, were seen for each of the included medication classes, suggesting that differential cost sharing has the potential to impact ongoing medication use regardless of therapeutic class.

Compared with 2 recent analyses examining the impact of cost sharing on the use of medications in several defined therapeutic classes indicated to treat chronic conditions, the values for price elasticity of demand in our study were noticeably smaller. Goldman et al. observed that across 8 therapeutic classes, the decrease in medication use due to a doubling in copayment (100% change in price) ranged from 25%-45%.[3] Moreover, they reported findings that are double our own, where a doubling in copayment was associated with an inelastic response for antiplatelets to a 15.7% decrease for smoking deterrents. Unlike Goldman et al., we controlled for unobserved employer/plan traits by including employer/plan fixed effects, so our elasticities reflect changes over time in employers as a function of how much they raised copayments without relying on differences between employers. Some variation in results may be due to the medication classes examined by each study, since only 4 classes were represented in both analyses; however, wide disparities in the use of medications were observed between classes included in both studies. Differences may also be due to the benefit structure examined by each study as the availability of medications for these conditions and the number of lower-priced generic substitutes would have changed considerably between the years of data used by each investigation, allowing for more patients to remain on their original therapies rather than making abrupt cost-related dis-

FIGURE 1 Price Elasticity of Demand by Drug Class



Note: Bars represent price elasticity of demand for each drug class.
[a]P < 0.01, otherwise P > 0.05.
NSAID = nonsteroidal anti-inflammatory drug; PPI = proton pump inhibitor.

continuations. Considering the years of data used by Goldman et al. (1997-2000) and our own study (2005-2009), significant differences in market structure would be expected; therefore, our study provides an updated snapshot of consumer reaction to cost-sharing changes in a more recent market that likely offered more generic and OTC options.

More recently, Landsman et al. (2005) published findings on medication price elasticity of demand across 8 therapeutic classes that similarly exceeded our own.[6] Partial explanation for these differences may be due to the limited overlap of studied medication classes between the 2 studies. However, disparities existed for estimates of the price elasticity of demand when considering the 2 classes (statins and NSAIDs/opioids) included in both investigations. Differences in results are also likely due to the methods employed by each study. Our investigation focused on longitudinal changes in cost sharing over time and the corresponding changes in utilization, including plans in each quarter that did and did not change cost-sharing amounts, allowing for a contemporaneous comparison. Comparatively, Landsman et al. examined 3 health plans with a defined benefit change in prescription drug tier structure, attributing the entire drop in demand after the price increase to the price increase.[6] Additionally, and similar to what was mentioned previously, our study examined changes in price elasticity from 2005 to 2009, providing an update on consumer behavior and a snapshot of a more recent market from the 1999-2001 data employed by Landsman et al.

The current findings may provide guidance on how patients are likely to alter their medication-taking behaviors when changes are made to the prices they face for particular classes of drugs. For medications with close OTC substitutes, we may have expected to see more dramatic differences in use—such as that observed with PPIs—as patients substitute away from more expensive prescription products. Such a phenomenon was seen in an earlier study where a doubling of copayments led to a 45% and 44% reduction in days supplied for NSAIDs and antihistamines, respectively.[3] However, this would fail to explain the relatively small change in NSAIDs/opioids we observed, a category of medications for which some therapeutic equivalent exists over the counter. For this class of drugs, this may be a reflection of the severity of the underlying disease or pain being addressed in our population, suggesting a level of treatment that cannot be adequately managed by OTC substitutes. In terms of benefit design, high value classes with the largest amount of price responsiveness are those that may cause the greatest concern. These classes may be the best candidates for payers to reduce cost-sharing amounts or to implement value-based approaches.

Limitations

Several limitations impacted the results of our study. The analysis was driven by the use of administrative claims data that is an indirect measure of medication use and may not

accurately reflect actual use patterns; however, since these data are generated based on health care claims, they do reflect actual purchasing patterns, which was the focus of this research. The database is also limited in how health status may be measured and accounted for, changes in which may lead to alterations in medication use. Additionally, since multiple medications may have been taken by those included, the resulting fill behavior may be the result of changes in the total cost burden faced by the patient rather than merely the consequence of change realized in each drug class. This may have affected some of the reported values for price elasticity of demand. However, the large sample size employed and range of medication classes included in this analysis are strengths of this study, contributions beyond what has been performed previously in this area of research. Also, this study was limited to only those individuals with commercial health coverage; therefore, results may not be generalizable to patients with other insurance or without coverage.

Conclusions

These results of this study suggest that variation in price elasticity of demand exists between classes of medication in response to changes in cost sharing. Considering these results, payers should be wary of the potential effects that changes in cost sharing may have on subsequent medication use, regardless of the role that each medication may play in the patient's treatment, since some deterrence is likely when cost sharing increases. Of particular note are high value drug classes where patients are highly responsive to price—consideration for the lowering of copayments in these classes should be made to avoid potential interruptions in therapy. Therefore, connecting the patient with the present and future value of therapy at the time of initiation and beyond should be encouraged to optimize treatment effectiveness.

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DISCLOSURES

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APPENDIX Medication Classes Used to Determine Study Categories

Study Category	Example Medications	Common Uses	Market
Proton pump inhibitors	Dexlansoprazole, Esomeprazole Magnesium, Lansoprazole, Lansoprazole/Naproxen, Omeprazole, Omeprazole/Sodium Bicarbonate, Pantoprazole Sodium, Rabeprazole Sodium	Gastroesophageal reflux disorder	Limited generic entry during study period; OTC substitutes in similar classes
Biphosphonates	Alendronate Sodium, Alendronate Sodium/Cholecalciferol, Ibandronate Sodium, Risedronate Sodium, Risedronate Sodium/Calcium Carbonate, Tiludronate Disodium, Etidronate Disodium, Pamidronate Disodium, Zoledronic Acid	Osteoporosis	Some generic substitutes made available during the study period; no in-class OTC options
Statins	Atorvastatin Calcium, Cerivastatin Sodium, Fluvastatin Sodium, Lovastatin, Lovastatin/Niacin, Pravastatin Sodium, Rosuvastatin Calcium, Simvastatin, Amlodipine Besylate/Atorvastatin Calcium, Ezetimibe/Simvastatin, Niacin/Lovastatin, Niacin/Simvastatin	Hyperlipidemia	No OTC substitutes; some generic medications available
Anticonvulsants	Carbamazepine, Clonazepam, Diazepam, Divalproex Sodium, Ethosuximide, Ethotoin, Felbamate, Gabapentin, Lacosamide, Lamotrigine, Levetiracetam, Mephenytoin, Methsuximide, Oxcarbazepine, Paramethadione, Phenacemide, Phenobarbital, Phenobarbital Sodium, Phenytoin, Pregabalin, Primidone, Rufinamide, Tiagabine HCl, Topiramate, Trimethadione, Valproate Sodium, Valproic Acid, Vigabatrin, Zonisamide	Anxiety disorders, insomnia, muscle relaxant, epilepsy, panic disorders	Numerous generic options available; no OTC substitutes
Thyroid hormone	Levothyroxine Sodium, Liothyronine Sodium, Liotrix	Hypothyroidism	Generic substitutes available but no OTC options
Antiplatelet agents	Dipyridamole, Cilostazol, Clopidogrel Bisulfate, Aspirin/Dipyridamole, Ticlopidine HCl	Acute coronary syndrome, peripheral artery disease, stroke	OTC medication available but limited generic substitutes available
NSAIDs/opioids	Alfentanil HCl, Buprenorphine HCl/Naloxone HCl, Butorphanol Tartrate, Celecoxib, Codeine[a], Diclofenac Sodium, Etodolac, Fenoprofen Calcium, Flurbiprofen, Ibuprofen[a], Indomethacin, Ketoprofen, Ketorolac Tromethamine, Meclofenamate Sodium, Mefenamic Acid, Levomethadyl Acetate HCl, Levorphanol Tartrate, Meloxicam, Meperidine HCl[a], Methadone HCl, Morhine Sulfate[a], Nalbuphine HCl, Nabumetone, Naproxen, Oxaprozin, Pentazocine HCl, Piroxicam, Rofecoxib, Sulindac, Tolmetin Sodium, Valdecoxib, Aspirin[a], Salsalate, Propoxyphene HCl[a], Tapentadol HCl, Acetaminophen (including combination products), Fentanyl Citrate[a], Hydrocodone[a], Hydromorphone[a], Oxycodone[a], Oxymorphone, Propoxyphene Napsylate, Tramadol HCl[a], Remifentanil HCl, Bromfenac Sodium	Pain, inflammation, arthritis	Numerous generic and OTC substitutes available
Smoking deterrents	Bupropion HCl, Nicotine, Nicotine Polacrilex, Varenicline, Varenicline Tartrate	Smoking cessation	OTC medications widely available but few generic substitutes

[a]*Including available combination products.*
HCl = hydrochloride; OTC = over the counter.