A Model for Comparing Unnecessary Costs Associated with Various Prescription Fill-Quantity Policies: Illustration Using VA Data

OBJECTIVE: To describe a model for analyzing the unnecessary costs associated with outpatient prescription fill quantities and to apply the model to prescription data from the Veterans Administration's Chicago Health Care System (VACHCS) to examine costs under various scenarios.

DESIGN: The model developed here included the cost of drugs, quantity of drug wasted, and the cost to fill the prescription, and is used to determine and compare the total unnecessary costs (TUC) of different prescription fill quantities. The model was applied to the VACHCS outpatient prescription records for two formulary hydroxymethyl glutaryl coenzyme A (HMG-CoA) reductase-inhibitor drugs to determine TUC for 30- and 90-day fills. Sensitivity analysis was used to analyze changes in the TUC over a range of possible values for each variable in the model.

RESULTS: A total of 16,990 prescriptions met the study inclusion criteria, of which 21.4% were for a 30-day supply and 78.6% for a 90-day supply. For 30-day and 90-day prescriptions, the average prescription cost per day was $0.56 and $0.54, respectively; quantity wasted was 1.06 days and 5.33 days; and TUC per prescription were $5.62 and $3.17. Sensitivity analysis demonstrated that the 90-day policy maintained lower TUC for most scenarios with the exception of very high drug costs.

CONCLUSION: Prescription benefit managers will find this model informative for determining policies for prescription fill quantities.

KEYWORDS: Prescription switches, costs, waste, fill quantity

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Prescription medications account for an increasing portion of health care costs in the United States and are rising at a rate higher than any other category of health care expenditures. In 1980, outpatient prescription expenditures were $12.0 billion, accounting for 4.9% of the $247.3 billion in total health expenditures. In 1999, outpatient prescription expenditures were $99.6 billion, which represented 8.2% of the $1,210.7 billion in total health expenditures that year.1 If this growth rate continues, outpatient prescription expenditures will exceed 12% of total health care spending by 2008. The high cost of newly developed medications, increases in per capita utilization of drugs, and the aging of the population all suggest continued growth in pharmaceutical expenditures. With costs spiraling upward, those who pay for prescription benefits, including employers, government payors, insurance companies, and managed care organizations, have been eager to find more effective methods to reduce drug costs. One method used in the acute care setting is to reduce the cost of wasted medications. Because wastage may account for up to 25% of drug costs for some medications, improvements in this area can result in significant cost avoidance.2, 3 Medication wastage may also be a problem in the outpatient setting, but to our knowledge has not been studied. Because federal law prohibits the return of unused prescription medications, changes in a patient's prescription regimen can result in wasted medication.4 The amount of drug wasted depends on how frequently physicians make changes to patients' drug therapy and the quantity of drug patients have on hand when the changes are made. It is generally thought that dispensing smaller quantities, such as a 30-day supply, can reduce the quantity of medication wasted if a switch in drug therapy is made. However, the frequency and cost of medications wasted due to switches have not been adequately studied. Consequently, the relative costs associated with different fill-quantity policies are not known. Because prescription payors incur the total cost of the prescription regardless of whether the patient uses the entire quantity dispensed, it would be valuable to better understand the effect of fill quantity and medication wasted on total pharmacy costs. The purpose of this research project was to investigate the relative roles that fill quantity, dispensing costs, and wasted medication play in the total cost of outpatient prescriptions. The specific objectives of this project were to develop...
up a method for calculating and comparing the unnecessary costs associated with 30-day and 90-day fill quantities, and to test this model on outpatient prescription data for two commonly dispensed chronic medications.

**Methods**

Factors that influence total unnecessary costs (TUC) are the quantity of drug wasted, the cost of the drug wasted, and the dispensing costs associated with that prescription. A model was developed to determine and compare the total unnecessary costs associated with a 30-day or 90-day fill policy and applied to outpatient prescription data from the Veterans Administration’s Chicago Health Care System (VACHCS). The model builds upon total prescription costs (C_t):

\[ C_t = (C_n \times Q_n) + C_f \]

Where \( C_n \) is the cost of the drug per unit (i.e., per tablet or per day), \( Q_n \) is the quantity of drug dispensed, and \( C_f \) is the cost of dispensing the prescription.

It is important to consider the units of measure for the drug cost and quantity, which could be the number of days of therapy, number of dosages, or number of capsules/tablets. When applying the model, the units of measure of cost and quantity must be consistent. When the actual quantity of drug used by a patient (\( Q_u \)) is less than the quantity dispensed (\( Q_d \)), because a physician switches the prescription, then waste occurs, which is one form of unnecessary costs. The cost of drug wasted (\( C_{w} \)) is a function of the quantity wasted (where \( Q_w = Q_d - Q_u \)) and the unit cost of the drug (\( C_n \)). Hence, the cost of a drug that is wasted following a prescription switch that occurs before the patients next scheduled fill date can be described as follows:

\[ C_w = C_n \times Q_w \]

If everything else is equal, the quantity wasted will vary positively with the quantity dispensed.

Another factor in TUC is unnecessary dispensing costs. Dispensing costs are incurred with each prescription fill; therefore, more unnecessary dispensing costs occur with smaller fill quantities because these prescriptions must be filled more frequently over a given period of time. However, unnecessary dispensing costs also arise when a patient’s prescription is switched and a new prescription must be dispensed.

When comparisons of unnecessary costs are made between different fill quantities, it is imperative to evaluate the costs for a standardized period of time in order to equally compare the total costs. A standardized time period is incorporated into our model, which aggregates the costs of drug waste and dispensing to calculate TUC for two common fill quantities, 30 days and 90 days. It is usually easiest to standardize the time period to reflect the longest fill quantity being evaluated. For the base case used in our model, we standardized over a 90-day period. Because patients in our analysis received one unit of drug per day, the quantity of drug used (\( Q_u \)) is equal to the number of days of use, the quantity dispensed (\( Q_d \)) is equal to the days supply, and the unit drug costs (\( C_n \)) are equal to the daily cost of the drug. The total unnecessary costs in our model can be calculated with the equation below:

\[
\begin{align*}
TUC_{30} &= [(C_n \times Q_{w30}) + C_f] \times \frac{D_30}{Q_{30}} - C_f \\
TUC_{90} &= [(C_n \times Q_{w90}) + C_f] \times \frac{D_90}{Q_{90}} - C_f
\end{align*}
\]

Here the terms \( D_30 \) and \( D_90 \) standardize the total unnecessary costs for a standardized period of days (D), and the dispensing cost (\( C_f \)) is subtracted to reflect the fact that one necessary dispensing cost will be incurred for each set period of days (D). Each value used in the equation represents an average value calculated for an entire group of patients who received the prescriptions of interest during a given time period. To help in understanding these equations, we discuss two examples in Figure 1, below.

In most cases, determining the best fill-quantity policy will involve a tradeoff between the amount and cost of drugs wasted and the cost of the added dispensing when smaller quantities are dispensed more frequently. Hence, the cost of the drugs and the dispensing are both important factors.

**Data Analysis**

The model we developed was applied to outpatient prescription data from the VACHCS. The data set included all prescriptions filled for two specific hydroxyethyl glutaryl coenzyme A (HMG-CoA) reductase-inhibitor drugs used at the VACHCS (simvastatin 10 mg, 20 mg, 40 mg, or 80 mg; and lovastatin 10 mg or 20 mg) over a one-year period. The data set comprised new prescriptions and refills, and each prescription had the following data elements: prescription number, anonymous patient identification number, quantity dispensed, days supply, days of use, and cost of drug. The cost of drug wasted (\( C_{dw} \)) is

\[ C_{dw} = C_{rx} \times Q_{w} \]

where \( C_{rx} \) is the cost of the drug per unit of measure (i.e., per tablet or per day), \( Q_{w} \) is the quantity wasted, and \( Q_{d} \) is the quantity dispensed.

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When comparisons of unnecessary costs are made between different fill quantities, it is imperative to evaluate the costs for a standardized period of time in order to equally compare the total costs. A standardized time period is incorporated into our model, which aggregates the costs of drug waste and dispensing to calculate TUC for two common fill quantities, 30 days and 90 days. It is usually easiest to standardize the time period to reflect the longest fill quantity being evaluated. For the base case used in our model, we standardized over a 90-day period. Because patients in our analysis received one unit of drug per day, the quantity of drug used (\( Q_u \)) is equal to the number of days of use, the quantity dispensed (\( Q_d \)) is equal to the days supply, and the unit drug costs (\( C_n \)) are equal to the daily cost of the drug. The total unnecessary costs in our model can be calculated with the equation below:

\[
TUC_{30} = [(C_n \times Q_{w30}) + C_f] \times \frac{D_30}{Q_{30}} - C_f \\
TUC_{90} = [(C_n \times Q_{w90}) + C_f] \times \frac{D_90}{Q_{90}} - C_f
\]

Here the terms \( D_30 \) and \( D_90 \) standardize the total unnecessary costs for a standardized period of days (D), and the dispensing cost (\( C_f \)) is subtracted to reflect the fact that one necessary dispensing cost will be incurred for each set period of days (D). Each value used in the equation represents an average value calculated for an entire group of patients who received the prescriptions of interest during a given time period. To help in understanding these equations, we discuss two examples in Figure 1, below.

In most cases, determining the best fill-quantity policy will involve a tradeoff between the amount and cost of drugs wasted and the cost of the added dispensing when smaller quantities are dispensed more frequently. Hence, the cost of the drugs and the dispensing are both important factors.

**Example 1**

Assume that none of the patients have their prescriptions switched, so there is zero waste. The average quantity used for a 90-day prescription is 90 (\( Q_{w90}=90 \)) and the average quantity used for 30-day prescriptions is 30 (\( Q_{w30}=30 \)). In this case, the calculated total unnecessary cost for the 30-day prescriptions is equal to two times the cost of dispensing (\( C_f \)) and the total unnecessary cost for the 90-day prescription is zero. When there is no drug waste, a 30-day policy is always more costly because of extra dispenses.

**Example 2**

Assume that on average patients switch their prescriptions on day 15 after the prescription was filled. The quantity used is 15 for both the 30-day and 90-day supplies (\( Q_{w30}=Q_{w90}=15 \)). In this case, there are substantially higher unnecessary costs with the 90-day fill policy since 75 days are wasted with each 90-day prescription while only 15 days are wasted per 30-day prescription, and six dispensing costs are given per 90 days of therapy under either fill quantity.

**Note:** TUC is total unnecessary costs.
identifier, drug identification number, quantity dispensed, days supply, and date dispensed. The VACHCS outpatient pharmacy also provided acquisition costs for the drugs (Crx) and the cost of dispensing a prescription (Cf).

Prescriptions were eliminated if the quantity dispensed was not for either 30 or 90 days, or if there was not at least one refill dispensed. No other criteria, such as patient characteristics or patient history, were used to select prescriptions. Prescription records were grouped into those with a quantity dispensed of 30 days and those with 90 days. After the data were divided into 30-day and 90-day groups, switches were identified. A switch was defined as a patient changing from one drug to another drug, or from one strength of a particular drug to another strength of the same drug. Note that only simvastatin and lovastatin were included in the analysis; therefore, switches from those two drugs to any other drugs were not included. For the 30-day and 90-day groups, separate analyses of the prescription data were conducted to determine how frequently switching occurred and the number of days supply of medication wasted due to switching. For example, a patient could be included in both the 30-day and the 90-day groups, but switches between 30-day and 90-day prescriptions were not counted.

The mean quantity of drug wasted (Qw) in each of the two groups was calculated as the difference between the average quantity dispensed (Qd) and the average quantity used (Qu) for each group. The quantity used was equal to the quantity dispensed (measured in days, assuming a dosage of one tablet per day) if no switch occurred before their next scheduled fill date. If a switch occurred, the quantity used (Qu) was calculated as the difference between the date the first prescription was dispensed and the date the second, different prescription was dispensed.

Using the model, we first calculated the total unnecessary costs that corresponded to the data using a standardized period of 90 days (D=90). In constructing this base case, we incorporated the average quantity used and the average quantity wasted, and used the actual dispensing cost of $1.79 (Cf) and the average daily acquisition drug costs (Crx) provided by the VACHCS. One-way sensitivity analyses were conducted relative to the base case to examine differences in TUC under a variety of different scenarios. We varied drug costs, quantity wasted, and dispensing costs from 50% to 200%. In addition, average whole prices (AWP) for lovastatin and simvastatin were used in place of VACHCS costs. Finally, Medicaid dispensing fees (Illinois maximum and standard fees for 2000) were used as high-end values in the model to evaluate their effect on TUC.

### Results
A total of 24,470 prescriptions were received in the dataset. Of these, 16,990 met the entry criteria for the analysis, where 3,635 (21.4%) were for a 30-day supply and 13,355 (78.6%) were for a 90-day supply. The 30-day and the 90-day prescriptions had similar rates of switches; 14.96% of the 30-day prescriptions were changed and 14.3% of the 90-day prescriptions were changed before the next scheduled fill date.

For the base-case analysis using VACHCS data, the weighted average daily drug costs for lovastatin and simvastatin were $0.56 in the 30-day group and $0.54 in the 90-day group.

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**Table 1** Difference in Total Unnecessary Costs for Various Scenarios

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>90 Days</th>
<th>30 Days</th>
<th>90 Days</th>
<th>30 Days</th>
<th>Difference (Cost Savings with 90 Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>—</td>
<td>—</td>
<td>$3.17</td>
<td>$5.62</td>
<td>($2.45)</td>
</tr>
<tr>
<td>50% quantity wasted, days</td>
<td>2.66</td>
<td>0.53</td>
<td>$1.54</td>
<td>$4.58</td>
<td>($3.04)</td>
</tr>
<tr>
<td>200% quantity wasted, days</td>
<td>10.64</td>
<td>2.12</td>
<td>$6.77</td>
<td>$7.82</td>
<td>($1.05)</td>
</tr>
<tr>
<td>50% cost of drug per day</td>
<td>$0.27</td>
<td>$0.28</td>
<td>$1.64</td>
<td>$4.70</td>
<td>($3.06)</td>
</tr>
<tr>
<td>200% cost of drug per day</td>
<td>$1.08</td>
<td>$1.12</td>
<td>$6.23</td>
<td>$7.47</td>
<td>($1.24)</td>
</tr>
<tr>
<td>AWP drug costs (simvastatin/lovastatin)</td>
<td>$2.79</td>
<td>$2.80</td>
<td>$15.92</td>
<td>$13.01</td>
<td>$2.91</td>
</tr>
<tr>
<td>50% dispensing fee</td>
<td>$0.90</td>
<td>$0.90</td>
<td>$3.12</td>
<td>$3.74</td>
<td>($0.62)</td>
</tr>
<tr>
<td>200% dispensing fee</td>
<td>$3.58</td>
<td>$3.58</td>
<td>$3.28</td>
<td>$9.40</td>
<td>($6.12)</td>
</tr>
<tr>
<td>Medicaid dispensing fee</td>
<td>$3.45</td>
<td>$3.45</td>
<td>$3.28</td>
<td>$9.13</td>
<td>($5.85)</td>
</tr>
<tr>
<td>Medicaid dispensing fee, maximum</td>
<td>$15.70</td>
<td>$15.70</td>
<td>$4.05</td>
<td>$34.97</td>
<td>($30.92)</td>
</tr>
</tbody>
</table>
These costs were slightly different between the groups because there were slight differences in the mix of lovastatin and simvastatin used. We found that the average quantity wasted for the 30-day prescriptions was 1.06 days for each 30-day fill period compared to 5.33 days for the 90-day group. The average total unnecessary cost for the base-case scenario was $5.62 per prescription for the 30-day prescriptions (standardized for 90 days) and $3.17 for the 90-day prescription fills. Therefore, the average TUC for the 90-day prescriptions was $2.45 lower for each 90-day prescription dispensed than for the 30-day prescriptions.

Results of the sensitivity analyses for different scenarios are shown in Table 1, page 388. When the quantity of drug wasted was 50% lower and 200% higher than the base case, the TUC for the 90-day prescriptions was still lower than for 30-day prescriptions. Similarly, when the unit costs of the drugs (Crx) varied by 50% and 200%, the 90-day option remained less costly compared to the 30-day fill policy. Changing the dispensing costs (Cf) to 50% and 200% over the base case and using the Illinois Medicaid dispensing fees of $3.45 and $15.70, still resulted in the 90-day fill policy having a lower TUC than the 30-day policy. The only scenario in which the 30-day policy was found to have lower TUC was when the average wholesale price was used for the cost of drugs.

Discussion

This analysis found that while the incidence of switching was similar for the 90-day and the 30-day supplies, the quantity of medication wasted was higher with a 90-day supply. However, when the additional dispensing costs associated with the more frequent 30-day fills were included in the model, the 90-days supply was found to cost $2.45 less per prescription, on average, than the 30-days supply. The results of this analysis show that at low levels of drug waste, 90-day fill policies tend to have the lowest amount of unnecessary pharmacy costs. Moreover, in cases with low drug costs, 90-day fill policies will tend to result in lower costs. High dispensing costs make 30-day policies even less attractive in terms of unnecessary costs. It appears that total pharmacy costs for the VACHCS would be lower with a 90-day fill quantity because the system would save on dispensing costs and it also has relatively low drug costs that result in low costs of drug waste.

In evaluating the results of this analysis, five limitations should be considered. First, our methods did not take into consideration prescriptions that were discontinued after the initial fill (one-time fills). Because these prescriptions were excluded, the actual frequency of switching may be under-represented by the results. Second, we used only two drugs in our analysis. This again implies a negative bias in our measured rate of switches because switches to drugs or drug classes other than the two drugs examined were not counted. It is also important to note that different drugs and/or drug classes would be very likely to have different rates of switching and therefore would present different results in terms of which fill policy is less costly.

Third, because we could not measure how often patients finished their prescriptions before starting a new prescription in cases of switches within a particular drug, there may be a potential bias resulting in an overestimate of the quantity wasted. For example, patients switching from lovastatin 10 mg to lovastatin 20 mg prior to the refill date could continue to take two lovastatin 10 mg tablets for a few days before beginning the lovastatin 20 mg prescription. Similarly, patients could split tablets in cases of switches from stronger to weaker tablets. More detailed data on patient behavior during these types of switches would be necessary to evaluate this bias.

Fourth, selection bias in the 30-day and 90-day patient populations may exist. Patients prescribed a 90-day supply may have been less prone to switching than those receiving 30-day prescriptions. While there is currently no reliable method to predict when a medication switch will occur for a particular prescription, it is likely that more switches occur early in a course of therapy. Therefore, bias may occur in the frequency of switching. Physicians may intentionally prescribe for only 30 days before determining if the medication is appropriate for the patient, in an attempt to prevent waste, and then prescribe for 90 days once a patient has been stabilized on a medication. More detailed information would be required to evaluate this bias. However, it is possible that correcting for this bias would show lesser savings under the 90-day plan than that suggested by our estimates. In addition, physicians may use samples early in therapy prior to writing a prescription, which may reduce switches for both 30- and 90-day fills; however, this has not been studied and again more detailed data are required.

Fifth, our comparisons use a constant dispensing cost for the 30- and 90-day policies. It is unlikely that the cost of dispensing would change because of a policy change from a 30-day to a 90-day fill quantity because the change in labor costs is not significant. However, other costs (such as overhead) that are typically included in the cost of dispensing may need to be reallocated. Nevertheless, even with high dispensing costs, our sensitivity analysis indicated that the 90-day policy would remain optimal.

In addition to the stated limitations, the results of this data analysis may not be directly transferable to other settings where the prevalence of switching and the relevant costs are likely to be different. However, it is important to keep in mind that the value of this analysis is to illustrate the use of the model. The model is flexible and can be applied to different settings (including various managed care settings) to analyze prescription waste and total unnecessary costs across different fill policies. In addition, this type of model can be used to understand how total pharmacy costs change as the input variables (such as drug costs) change. Although we have not formally tested the validity of the model across different settings or with different
classes of drugs, it performs well in providing reasonable estimates of unnecessary costs and responds appropriately to changes in the variables. In addition, the sensitivity analysis is informative in predicting what the model will yield under various conditions. It is important to remember that this model is intended to be used to evaluate aggregate data over an extended time period (i.e., one year). The model adjusts for average time differences in fill quantities and incorporates mean values for each input variable. Therefore, it is a population-based model and is not directly applicable to assessing costs for individual cases.

We have described a model for calculating the total unnecessary costs associated with policies for various outpatient prescription fill quantities. The model can be used to compare unnecessary costs under various fill policies using prescription data. Furthermore, variables in the model can be adjusted to determine their impact on costs. Prescription benefit payors may find this model useful for evaluating costs and policies for prescription fill quantities.

References