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Analyzing the Clinical Outcomes of a Rapid Mass Conversion From Rosuvastatin to Atorvastatin in a VA Medical Center Outpatient Setting

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Abstract

Background: Medication conversions occur frequently within the Veterans Health Administration. This manual process involves several pharmacists over an extended period of time. Macros can automate the process of converting a list of patients from one medication to a therapeutic alternative. **Objectives:** To develop a macro that would convert active rosuvastatin prescriptions to atorvastatin and to create an electronic dashboard to evaluate clinical outcomes. **Methods:** A conversion protocol was approved by the Pharmacy & Therapeutics Committee. A macro was developed using Microsoft Visual Basic. Outpatients with active prescriptions for rosuvastatin were reviewed and excluded if they had a documented allergy to atorvastatin or a significant drug-drug interaction. An electronic dashboard was created to compare safety and efficacy endpoints pre- and postconversion. Primary endpoints included low-density lipoprotein (LDL), creatine phosphokinase (CPK), aspartate transaminase (AST), alanine transaminase (ALT), and alkaline phosphatase. Secondary endpoints evaluated cardiovascular events, including the incidences of myocardial infarction, stroke, and stent placement. **Results:** The macro was used to convert 1520 patients from rosuvastatin to atorvastatin over a period of 20 hours saving $5760 in pharmacist labor. There were no significant changes in LDL, AST, ALT, or secondary endpoints ($P > .05$). There was a significant increase in alkaline phosphatase ($P = .0035$). **Conclusions:** A rapid mass medication conversion from rosuvastatin to atorvastatin saved time and money and resulted in no clinically significant changes in safety or efficacy endpoints. Macros and clinical dashboards can be applied to any Veterans Health Administration facility.

Keywords

cost-effectiveness, drug monitoring, dyslipidemia, electronic information, formulary, informatics, medication safety, P&T committee, pharmacoeconomics, therapeutic monitoring

Introduction

Drug shortages, discontinuations, and price changes are recurring problems facing most hospitals today.[1,2] Due to the need for quick drug transitions stemming from these problems, new techniques were pioneered at the Indianapolis VA Medical Center using existing pharmacy systems to automate the conversion from one prescription to a different prescription using predetermined criteria and dose equivalency algorithms. This technique was the result of a formulary change from rosuvastatin to atorvastatin. Historically, manually converting a prescription from one medication to a different medication took anywhere from 4 to 6 minutes per prescription. A conversion of 2000 prescriptions took approximately 133 to 200 total hours to complete. If the conversion was delayed, the patient still could request a refill for the higher priced item prior to the prescription being converted. In other words, the longer the duration to convert the medications, the more expensive it is to the facility in terms of drug costs.

The Veterans Health Administration uses a hospital information system named VistA, or Veterans Health Information Systems and Technology Architecture. The pharmacy department uses the terminal emulation program, Reflections by Attachmate, to interface with VistA and is used for all pharmacy purposes including medication order entry, verification, checking, and reporting. Reflections allows a user to create macros, a set of instructions that can

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quickly emulate a user to send keyboard commands to the screen and navigate quickly around VistA and perform calculations based on any number of variables or input. To build a macro in Reflections, the user must have a working knowledge of Microsoft Visual Basic and possess the skills to analyze, research, and synthesize the macro based on the steps required to complete a given task, such as taking a user to a specific prompt, running a report, or performing automated decisions and calculations based on different patient variables.

The thesis "Increased Efficiency: Formulary Drug Conversion Automation Using Visual Basic-Based Macros with Attachmate Reflection in the Pharmacy Setting" showed the steps to manually convert a patient without the aid of macro automation from one pharmaceutical item to another takes approximately 148.1 hours for 2222 prescriptions.[3] This requires a high focus on details including old prescription dosing, new prescription dosing, patient's doctor, patient's clinic, calculating correct day supply, calculating correct dispense quantities, calculating remaining refills, previous dispense date if applicable, and calculating a new dispense date. Unfortunately, there is significant room for error. It is estimated that medication errors make up 20% of all medical errors.[4] When this procedure is repeated several thousand times, the risk of making a medication error increases significantly.[5] It is realistic to estimate different pharmacists may be able to complete a single patient's prescription conversion more quickly (less than 4 minutes) or require more time (greater than 6 minutes) depending on the pharmacist's skill with converting medications, experience using Reflections, comprehension speed, and calculation speed. Macros decrease this time to approximately 10 to 15 seconds per prescription per patient.[3]

While the time and drug cost savings are easily quantified, the organization also needs to understand the longitudinal effects of such conversions. Data dashboards have the capability to take complex, micro data from multiple sources and consolidate it into simpler charts and graphs that may assist in making decisions from a higher level perspective. Stephen Few defines dashboard as a "visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance."[6] Such a dashboard would provide data that can be visually analyzed over time to spot potential population trends for quality assurance.

The Indianapolis VA Medical Center has a clinical data warehouse (CDW) containing patient information uploaded from VistA. The CDW contains information dating back to 1995 with new patient information uploaded daily, making it an ideal information source for the data dashboard to provide a global view of the effects of the statin conversion. This research is intended to evaluate the time and cost savings of using a macro for mass conversion of rosuvastatin to atorvastatin. The secondary objective is to use a data dashboard to evaluate the clinical effects of the rapid mass drug conversion.

Methods

The conversion method was developed as a Microsoft Visual Basic–based macro imported into the pharmacy terminal emulator system, Attachmate Reflections, which connects to the Department of Veterans Affairs electronic health record, VistA. The macro automates the keyboard strokes typically done by a pharmacist in the prescription verification process to read the current prescription and retrieve the necessary information from the prescription including drug name, drug dose, dosing frequency/schedule, original order date, refill fill dates (if applicable), remaining refills, future fill date (if applicable), day supply, quantity, ordering provider, and provider clinic. The macro then discontinues the current prescription, creates an order for the new prescription, populates the necessary fields with the applicable information from the previous prescription, and performs predetermined calculations to ensure that the new prescription is therapeutically equivalent, as shown in Figure 1, to the previous prescription as approved per Pharmacy and Therapeutics Committee. The macro then saves the new prescription to the patient's electronic health record so the patient may have the new prescription filled when needed. Figure 1 depicts the algorithms and decision processes used by the macro when verifying the prescriptions under the direction of the operating pharmacist to address extraneous events such as odd quantities, day supply, or fill history that the macro is unable to account for.

In June 2013, a report of all patients receiving rosuvastatin was generated to use as a list for converting the patients from rosuvastatin to atorvastatin. There was a total of 2091 patients which were then checked against exclusion criteria of a documented allergy to atorvastatin or if the patient was on a medication that has a significant drug interaction with atorvastatin. The significant drug interaction list contained boceprevir, clarithromycin, colchicine, cyclosporine, darunavir, fenofibrate, fosamprenavir, gemfibrozil, itraconazole, lopinavir, nelfinavir, niacin, rifampin, ritonavir, saquinavir, telaprevir, and tipranevir.

The data were separated into 2 groups to evaluate the effectiveness and validity of using a data dashboard as a visual resource. The first group is the "PRE" group and the second the "POST" group. The date range for the PRE group was June 1, 2012, to July 31, 2013, and POST group September 1, 2013, to August 30, 2014. The laboratory markers included for statin treatment evaluation were LDL (low-density lipoprotein), CPK (creatine phosphokinase), ALT (alanine transaminase [SGPT]), AST (aspartate transaminase [SGOT]), and alkaline phosphatase. If there are substantial changes in these laboratory markers after changing a patient's

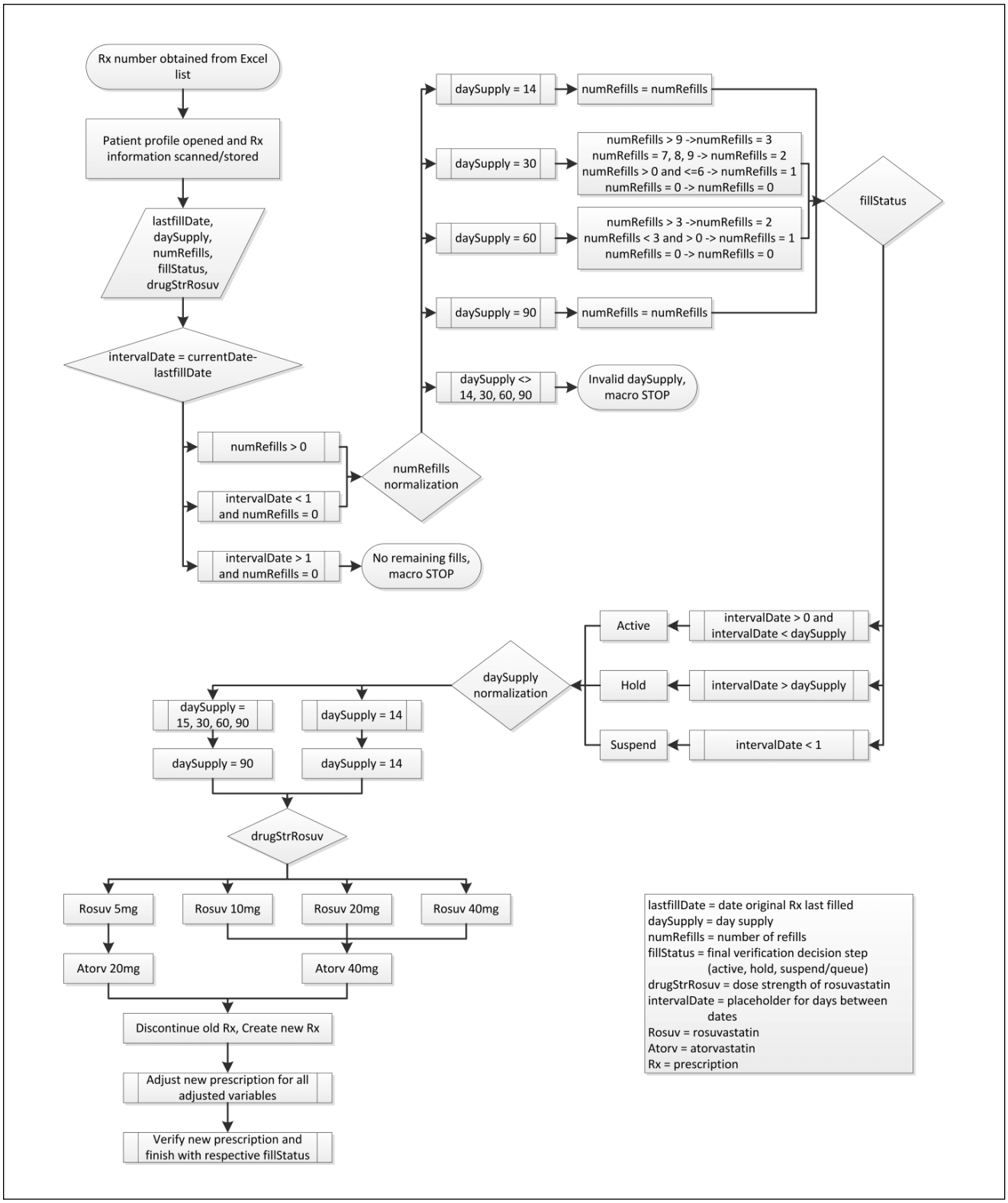

Figure 1. Atorvastatin conversion macro logic workflow and rules.

statin therapy, then the statin medication may be discontinued.[7] The dashboard also monitored the incidence of myocardial infarction diagnosis documented with ICD-9-CM 410.xx (International Classification of Diseases), stroke

Table 1. Laboratory Mean Value Comparisons (N = 1520).

Lab Value	PRE Mean	POST Mean	Mean Difference	*P*
LDL	90.92 mg/dL	95.88 mg/dL	4.96 mg/dL	.2887
ALT (SGPT)	43.92 IU/L	43.66 IU/L	0.26 IU/L	.8479
AST (SGOT)	23.28 IU/L	25.07 IU/L	1.78 IU/L	.1399
CPK	169.1 IU/L	286.02 IU/L	116.92 IU/L	.3660
Alkaline phosphatase	103.3 IU/L	124.68 IU/L	21.38 IU/L	.0035*

Abbreviations: LDL, low-density lipoprotein; ALT, alanine transaminase; AST, aspartate transaminase; CPK, creatine phosphokinase.
*Significance at $P < .05$.

Table 2. Monitored Unique Patient ICD Events (N = 1520).

Cardiovascular Event	PRE	POST	Difference	*P*
Myocardial infarction	26	15	11	.084
Stent placement	104	97	7	.609
Stroke	29	30	1	.895

Abbreviation: ICD = International Classification of Diseases.
*Significance at $P < .05$.

diagnosis documented with ICD-9-CM 434.xx, and stent placement diagnosis documented with ICD-9-CM V45.82.

Prescription information and patient laboratory data were obtained via CDW extraction and identifying protected patient information was removed. Paired *t* tests and descriptive statistics using SAS 9.0 were performed on the data to evaluate if visual and statistical analyses of trends from the conversion were comparable over the course of 1 year. Report Builder 3.0 was used to develop real-time charts of the data. The patient list meeting inclusion criteria was hard-coded into the report to prevent inadvertent inclusion of patients who were not converted using the macro. The report allowed the user to enter a start date, end date, and the drug for review. Atorvastatin was always selected in the report for the purposes of this research. This project was deemed quality improvement, and therefore was exempt from institutional review board review.

Results

A total of 1520 patients were converted from rosuvastatin to atorvastatin using a macro over a duration of 20 regular work hours. Use of the macro resulted in a labor cost savings of approximately $4727.60 to $7675.80 based on average salary data reported by the Bureau of Labor Statistics.[8] Of the patients converted, there were a total of 25 029 laboratory results in both the PRE and POST groups and 652 new ICD diagnosis events.

Mean LDL increased from preconversion to postconversion by 4.96 mg/dL ($P = .2887$). Mean AST and ALT did not change by more than 2 IU/L ($P = .1399, .8479$). The mean CPK increased by 116.92 IU/L ($P = .3660$). Mean alkaline phosphatase increased by 21.38 IU/L ($P = .0035$). Based on the data, there were no statistical or clinically significant differences between the PRE and POST data sets except in the case of alkaline phosphatase. Paired *t* tests were run on LDL, ALT (SGPT), AST (SGOT), alkaline phosphatase, and CPK data sets. All results of the paired *t* tests were statistically insignificant with a *P* value >.05, except alkaline phosphatase at .0035 (Table 1).

LDL, a proxy indicator of statin efficacy, was analyzed to determine if there were clinically significant differences between the PRE and POST LDL means as a group. The PRE mean LDL value of 90.92 mg/dL is not clinically significant when compared to the POST mean of 95.88 mg/dL.

The diagnosis events of myocardial infarction (410.xx; $P = .084$), stent placement (V45.82; $P = .609$), and stroke (434.xx; $P = .895$) were counted in both the pre- and postconversion groups. There was an overall decrease in all monitored diagnosis events in the POST group compared to the PRE group except stroke (Table 2).

Chi-square tests of independence were run on the ICD events between the pre- and postconversion groups. The data were normalized to include patients who experienced an event compared to those who did not. After normalization, in the preconversion group, a total of 159 patients (10.5%) experienced an event that met the ICD-9-CM criteria. Of the postconversion group, 142 patients (9.3%) experienced a cardiovascular event ($P = .302$).

Discussion

Macros are a potential solution to the problem of expediting and automating formulary conversions while maximizing safety. Macros can consider a multitude of variables and the programming software is already incorporated into the VA system. Implementing formulary conversion automation with macros is a logical and efficient solution that prevents medication errors, saves time, and saves money. This same group of prescriptions converted without a macro would theoretically take 130 to 191 hours longer than without a macro, or cost an extra $7559.50 to $11106.65 in employee wages at $58.15 per hour.[8] This does not include the additional medication cost savings that is realized by shortening

the duration time of conversion to the more cost-effective medication. A macro that can automate calculations and generate consistent, accurate, and correct results serves as an appropriate method to minimize errors while controlling health care costs.

An added benefit of using macros is that these are transferrable to other VA facilities. All VA Medical Centers use Attachmate Reflections for processing medication orders. Using the same software allows for modifications and developments to be shared among facilities. This macro for rosuvastatin to atorvastatin was shared with several other facilities, each receiving the benefits of its medication conversion efficiency resulting in widespread cost savings.

Macros are an extremely effective method of completing a large amount of work over a short duration of time. The use of macros in other areas should also be investigated as its use is only limited by the programmer's abilities. Macros continue to be used for mass conversions at the Indianapolis VA Medical Center and are now expanding into other areas of pharmacy, such as automated progress note writing for Veteran prescription refill calls to the regional pharmacy call center.

On review of the outcomes dashboard, it was noted there were several spikes in the data that warranted further monitoring. There was an increase in both AST and ALT in August 2013. When theorizing for the rationale, it was decided it may be a transient increase due to the conversion from rosuvastatin to atorvastatin. This theory was supported due to these increases tapering off.

CPK was initially suspected to be statistically significantly different between PRE and POST group means, like alkaline phosphatase, but was not identified as such. Due to the nonspecificity of CPK, the spikes in CPK could not be positively attributed to the statin mass conversion since there were periods of this lab being within normal limits at regular intervals. While the alkaline phosphatase was shown to be statistically significantly different between the PRE and POST groups, these differences were not clinically significant as the increase was isolated to a small period with subsequent values within normal limits.

Additional parameters that were monitored were counts of new diagnosis events of myocardial infarct, stent placement, and stroke. Atorvastatin in moderate to high-intensity statin therapy is recommended in patients at risk for cardiovascular complications.[8] When comparing the PRE group to the POST group, all documented new diagnosis events decreased with minor exception to stroke which differed by 1, indicating the mass conversion did not place patients at a higher risk of cardiovascular complications.

A limitation of using the developed data dashboard was the inability to drill in for patient-specific data. This was most hindering when theorizing for the spikes in both CPK in April 2014 and alkaline phosphatase in February 2014. The reasons for these increases were unable to be explained using solely the data dashboard. The spikes do not follow an observable pattern and were unable be attributed to a specific population event, such as another mass conversion. Another limitation was that the duration the preconversion group had been on rosuvastatin prior to conversion to atorvastatin was not measured. If a patient in the preconversion group had just started a statin prior to conversion, there was the possibility the patient could experience reduced cardiovascular complications and skew the results in favor of atorvastatin therapy. A final limitation in this quality assurance study was determining if patients had been taken off atorvastatin therapy due to treatment failure. When the study parameters were decided, it was determined there would be continual monitoring of the same group of patients from 1 year prior to conversion to 1 year post conversion, regardless if atorvastatin treatment was discontinued for a patient. This limitation presents the possibility that some laboratory values do not reflect continued atorvastatin usage. In addition, laboratory results may be confounded if the patient was noncompliant with his or her statin therapy as medication compliance was not monitored.

Using a data dashboard to visually analyze the effects of medication mass conversions has the potential to be useful for longitudinal tracking when monitoring patients from a higher level where time is sensitive and desired analysis effort minimal. Using this higher level view, a facility can monitor trends either in benefit, or to the detriment, of a patient population to evaluate if the mass conversion was both safe and effective. The data dashboard was developed to be dynamic to allow the addition of different patients outside the scope of this project once completed for quality assurance of other statin medications.

Macros and data dashboards are uniquely useful as they complement each other. Macros can process a large amount of information rapidly and data dashboards are able to analyze large amounts of information rapidly. Using these technologies together provides the ability for a system to automate mass conversions with an instantaneous global view of the results. Further exploration of these technologies should be done to discover even more novel ways to process and analyze data in the pharmacy and health system settings.

Conclusion

Utilizing a macro to convert patients from rosuvastatin to atorvastatin resulted in time and cost savings. Using a data dashboard is an acceptable method for long term, up-to-date, and real-time evaluation of mass conversion clinical outcomes.

Authors' Note

The contents do not represent the views of the US Department of Veterans Affairs or the US government.

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