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Using Computer Adaptive Assessment Tool to Evaluate the Use of High Cost Lipid Lowering Drug in Government Employee Medical Insurance in Thailand

การใช้เครื่องมือประเมินผลด้วยระบบคอมพิวเตอร์แบบประยุกต์ในการประเมินการใช้ยาลดระดับไขมันมูลค่าสูงในสวัสดิการรักษาพยาบาลข้าราชการในประเทศไทย

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The objective of this study was to develop computer adaptive assessment tool (CAAT) to evaluate the use of high cost drugs (HCDs) in Civil Servant Medical Benefit Scheme (CSMBS), the medical insurance for government employee in Thailand. A high cost lipid lowering agent, atorvastatin was selected for the evaluation. CAAT was validated by comparing the results with the conventional method using individual medical records. Spending on atorvastatin and rational utilization in the four regional hospitals were also presented. Drug use algorithm was developed as the evaluation guidelines in the process of CAAT development. Retrospective review of CSMBS outpatients initiating atorvastatin during November 2006 and April 2007 was conducted using the data from electronic dispensing, laboratory, and ICD-10 database. To validate CAAT, the results from CAAT were compared with the results from conventional drug use evaluation using same randomly selecting 148 CSMBS patients. Sensitivity, specificity, and accuracy of CAAT were analyzed. CAAT was also used to evaluate spending and rational utilization of atorvastatin in 584 patients from four regional hospitals. The validation of CAAT on atorvastatin based on pattern analysis showed that its sensitivity, specificity, and accuracy were 81.3, 100.0, and 98 percent respectively. Results from using CAAT showed that only 76 (13.0 percent) of 584 patients were rational use and only 448,500 Thai baht (15.0 percent) of 2,990,000 baht of the expenditure were rational spending. CAAT could be appropriate for monitoring HCD use in the limited health care resource countries. Policy to improve the HCD's prescribing pattern should be developed. Acceptability of using CAAT for the evaluation of HCD use among health care providers and third party payers will enhance the rational use of high cost drug use.

Keywords: High cost drug, drug use evaluation, atorvastatin, computer assessment tool

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ยุภาพรรณ มันกระโทก, วิทยา กุลสมบูรณ์, ยุพดี สิริสินสุข. การใช้เครื่องมือประเมินผลด้วยระบบคอมพิวเตอร์แบบประยุกต์ในการประเมินการใช้ยาลดระดับไขมันมูลค่าสูงในสวัสดิการรักษาพยาบาลข้าราชการในประเทศไทย. วารสารเภสัชกรรมโรงพยาบาล 2553; 20(2):111-23.

การพัฒนาเครื่องมือประเมินผลด้วยระบบคอมพิวเตอร์แบบประยุกต์มีวัตถุประสงค์เพื่อใช้ในการประเมินผลการใช้ยามูลค่าสูงในระบบสวัสดิการรักษาพยาบาลข้าราชการ โดยยาที่ใช้ในการประเมินผล คือ ยาอะทอร์วาสตาติน ซึ่งเป็นยาลดระดับไขมันในเลือดที่มีมูลค่าสูง การตรวจสอบความใช้ได้ของเครื่องมือทำโดยเปรียบเทียบผลที่ได้จากการวิเคราะห์ด้วยเครื่องมือดังกล่าวกับผลการประเมินการใช้ยาด้วยวิธีดั้งเดิมที่ได้จากบันทึกเวชระเบียนผู้ป่วยแต่ละราย รวมถึงการประเมินค่าใช้จ่ายสำหรับยาอะทอร์วาสตาตินและความเหมาะสมในการใช้ ขั้นตอนการประเมินการใช้ยาได้ถูกพัฒนาขึ้นเพื่อใช้เป็นแนวทางในการประเมินการใช้ยาโดยใช้เครื่องมือ ทำการศึกษาย้อนหลังในกลุ่มผู้ป่วยนอกในระบบสวัสดิการรักษาพยาบาลข้าราชการที่เริ่มใช้ยาอะทอร์วาสตาตินในระหว่างเดือนพฤศจิกายน พ.ศ. 2549 ถึงเดือนเมษายน พ.ศ. 2550 โดยใช้ข้อมูลจากฐานข้อมูลอิเลคทรอนิคส์ด้านการใช้ยา การตรวจทางห้องปฏิบัติการและการวินิจฉัยโรค การตรวจสอบความใช้ได้ของเครื่องมือ ทำโดยเปรียบเทียบผลที่ได้จากการวิเคราะห์ด้วยเครื่องมือดังกล่าวกับผลการประเมินการใช้ยาด้วยวิธีดั้งเดิมจากกลุ่มตัวอย่างเดียวกันที่ได้จากการสุ่มจำนวน 148 ราย โดยวิเคราะห์ค่าความไว ความจำเพาะ และความถูกต้องของเครื่องมือ การประเมินค่าใช้จ่าย และความสมเหตุผลในการใช้ยาอะทอร์วาสตาติน ประเมินจากผู้ป่วยจำนวน 584 ราย จากโรงพยาบาลศูนย์ 4 แห่ง ผลการตรวจสอบความใช้ได้ของเครื่องมือในการใช้ประเมินแบบแผนการใช้ยาอะทอร์วาสตาติน พบว่ามีค่าความไว ความจำเพาะ และความถูกต้องร้อยละ 81.3, 100, และ 98.0 ตามลำดับ ผลจากการนำเครื่องมือไปใช้ในการประเมินการใช้ยาอะทอร์วาสตาติน พบว่า มีการใช้ยาอย่างสมเหตุผลในผู้ป่วยเพียง 76 ราย (ร้อยละ 13) จากผู้ป่วย 584 ราย และมีค่าใช้จ่ายที่สมเหตุผลเพียง 448,500 บาท (ร้อยละ 15) จากค่าใช้จ่าย 2,990,000 บาท เครื่องมือนี้มีความเหมาะสมที่จะนำไปใช้ในการติดตามการใช้ยามูลค่าสูงในประเทศที่มีความจำกัดในเรื่องทรัพยากรด้านสุขภาพ การประเมินการยอมรับในการนำเครื่องมือไปใช้ในการประเมินผลในกลุ่มผู้ให้บริการและกลุ่มผู้รับผิดชอบการจ่ายค่าบริการด้านสุขภาพ จะเป็นการกระตุ้นให้เกิดการใช้ยามูลค่าสูงอย่างสมเหตุผล

คำสำคัญ: ยามูลค่าสูง การประเมินการใช้ยา อะทอร์วาสตาติน เครื่องมือประเมินผลด้วยคอมพิวเตอร์

Introduction

The rapid growth of pharmaceutical expenditure is one of several problems in health care resource management in countries around the world.[1] High cost drug (HCD) use is one of the most important factors affecting the increase of pharmaceutical expenditure. HCDs have been mainly used in patients who were enrolled in fee for service (FFS) payment and the uses of HCDs in the FFS environment are more likely to be irrational.[2-4]

In Thailand, top-ten sales among pharmaceutical products in 2005 were HCDs.[5] Eight of these drug items; atorvastatin, clopidogrel,

meropenem, human erythropoietin, gabapentin, clavulonate+amoxicillin, imipenem+cilastin, and sulbactam+cefoperazone were classified in the group of subclass 4 in the National Essential Drug List (NEDL) 2004.[6] They are required to prescribed by the specialists and are also required to conduct the drug use evaluation (DUE).

Atorvastatin, which is one of the HCD in subclass 4 in NEDL, was the highest sold among the top-ten sales in 2005 and 2006. It was mainly distributed through the hospital channel. Moreover, top ten HCD use in one regional hospital was accounted for 18-20 percent of overall pharmaceutical expenditure per year.[7] Similar to other studies, this study reported the differences of HCD use among health insurance schemes.

At present, Thailand has three main health insurance schemes including Social Security Health Insurance Scheme (SSS), National Health Security Scheme (NHSS), and Civil Servant Medical Benefit Scheme (CSMBS). NHSS is the main health insurance program covering 47 million beneficiaries which is three-fourth of population. NHSS is funded by the government based on capitation system. Similarly, SSS is also a capitation based system but the budget came from tripartite including employer, employee, and the government. On the contrary, the CSMBS is based upon FFS system, it has substantially use of drug expenditure and the highest use of the drug expense among the three health insurance schemes.

The study in one regional hospital also showed that 64 percent of top ten high cost drug expenditure was in CSMBS.[7] The rate per 1000 patients in aging group in CSMBS of atorvastatin was the highest which was 20.8 while the second was clopidogrel which was 6.47. In contrast, the rate of atorvastatin and clopidogrel use in NHSS was only 0.05 and 1.45 per 1000 patients respectively. It was evident that HCDs were prescribed inappropriately in health care settings.[8,9] Overuse was commonly found in CSMBS outpatients for chronic diseases treatments, such as using atorvastatin as a first line drug instead of generic simvastatin.

Drug use evaluation is one of the important measures to monitor and control drug use.[10] DUE was firstly introduced in Thailand in 1991 by the Ministry of Public Health (MOPH). Most of the DUE studies were qualitative studies describing drug use in hospitals. These conventional DUE studies commonly used patient records as the data sources to monitor the use of studied drugs. It consumed a lot of times and health care resources. In developed countries, electronic database was used and it was very useful for drug use monitoring.[11]

Thailand has no unique national electronic database system for monitoring the use of drugs. Hospitals have different computer programs for recoding the data in health care

services such as dispensing program, laboratory program, diagnosis program, etc. These several computer programs are hardly linked together to support the DUE in the hospitals. Therefore, both the time and resource consuming in conventional DUE and difficult to manage the electronic database have led to the situation of DUE in Thailand not well established. However, several studies concerning the drug use review using computerized databases have been implemented in the pilot scale.[7,12,13] The array of DUE included drug spending, quantity of drug use, and number of patients who were prescribed studied drug.

Since atorvastatin is account for the highest pharmaceutical spending and there was the report of its overuse, initiating the tool for monitoring the rational use of atorvastatin would provide the evidence for improving the use. Therefore, the purposes of this study were to develop the computer adaptive assessment tool (CAAT) for monitoring the use of atorvastain in CSMBS, to validate the use of CAAT comparing with conventional drug use evaluation and to evaluate the use of atorvastatin in CSMBS concerning pharmaceutical spending and rational utilization

Methods

CAAT Development. The process of CAAT development for drug use evaluation included the establishment of CAAT algorithm and the management of drug data.

1. CAAT Algorithm Establishment. Establishment of CAAT algorithm was aimed to provide appropriate clinical guidelines for reviewing the drug use using computerized databases and should get the results comparable to the conventional method using individual patient records. In order to establish CATT algorithm, there were five steps including 1) developing CAAT guidelines, 2) selecting key variables, 3) setting cut point of key variables, 4) setting time frame, and 5) setting the step for drug use evaluation according to the CAAT guidelines.

To evaluate the rational use of atorvastatin, CAAT algorithm of pattern-based and criteria-based evaluation were created. Comptroller's General Department (CGD) guidelines was reviewed and used for CAAT guidelines development. Key variables in the guidelines which were available in the electronic database were selected to be used for the evaluation. The cut-off level of each variable, for instance LDL-cholesterol, was set according to the established guidelines. Data before initiating atorvastatin in each patient are important to be used for determining whether the decision to use atorvastatin is rational based on the established guidelines. The time frame of one year was required for retrospective data collection.

1.1 CAAT Algorithm for Pattern-Based Evaluation. The pattern-based evaluation was set up to be used as the standard to

determine if the pattern of use follows the established guidelines. Data before initiating the use of atorvastatin (A) were explored including drug data for simvastatin use (S) and laboratory data for LDL-cholesterol check (LDL). According to the evaluation, 4 patterns of atorvastatin use were classified as in the followings:

The first pattern, *"SLA"* pattern, patients had used simvastatin followed by the step of LDL-cholesterol checking before initiating the use of atorvastatin.

The second pattern, *"SA"* pattern, patients had used simvastatin before initiating the use of atorvastatin without the step of LDL-cholesterol checking.

The third pattern, *"LA"* pattern, patients had checked LDL-cholesterol before initiating the use of atorvastatin. The patients had not used simvastatin before LDL-cholesterol checking.

The fourth pattern, *"A"* pattern, patients initiated the use of atorvastatin without simvastatin use and LDL-cholesterol checking prior to atorvastatin use.

A patient who had SLA pattern was classified as having the rational use pattern. A patient who did not follow SLA pattern including any patient who had SA, LA, or A pattern was classified as irrational use. Algorithm for pattern-based evaluation of atorvastatin use was demonstrated in Figure 1.

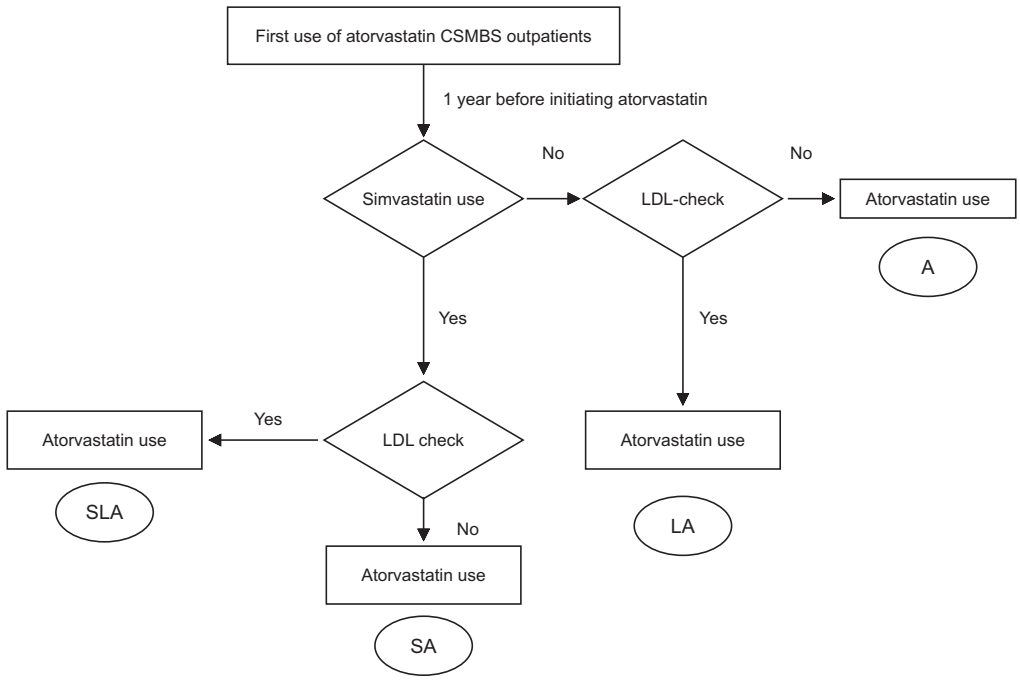

Figure 1. Algorithm for pattern-based evaluation of atorvastatin use

1.2 CAAT Algorithm for Criteria-Based Evaluation. Since the rational use of atorvastatin was not be limited only to the pattern-based which was *"SLA"* pattern, in addition to the *"SLA"* pattern, the rational use of atorvastatin had to be determined by criteria -based evaluation. Therefore, patients who initiated the use of atorvastatin by following the SLA pattern were also evaluated by criteria basis.

The first criterion for the evaluation was the histories of coronary heart disease (CHD) or CHD risk equivalence diagnosis of the patients. For a patient who had CHD or CHD risk equivalence, atorvastatin could be used for secondary prevention. For a patient who did not have CHD or CHD risk equivalence, atorvastatin could be used for primary prevention. The second criterion was the duration and the dose of simvastatin use. The last criterion was the LDL-cholesterol level before the initiating of atorvastatin use. All of these data were evaluated based upon the following conditions. First condition was for primary prevention, atorvastatin could be used if the patient received simvastatin continuously with the maximum dose of 40 mg at least three consecutive months, but the LDL-cholesterol level was still greater than 130 mg/dL. Second condition was for secondary prevention, atorvastatin could be used if the patients received simvastatin continuously with the maximum dose of 40 mg at least 3 months, but the LDL-cholesterol level was still greater than 100 mg/dL. Therefore, the patient who initiated atorvastatin followed the criteria-based was classified as having the rational use of atorvastatin.

The algorithm of criteria-based evaluation of atorvastatin use was demonstrated in Figure 2.

2. **Data Management**. In the process of data management, the key variables were selected for the purpose of rational use evaluation based on CAAT guidelines. Data from electronic dispensing, laboratory, and ICD-10 databases were used for data preparation. Data management consisted of data extraction, data linkage or data relation, and data completeness. Data extraction was employed to obtain all input variables related to the CAAT guidelines from the electronic databases. Data linkage wasemployed to make all of the databases be able to be merged for the purpose of the evaluation. The primary key variable was needed for linking the database. Finally, data completeness was employed for covering as much as data of key variables for those which could not be obtained from the direct variable. Proxy variables related to those key variables were used as a surrogated for the evaluation.

Validating CAAT. Since the current standard method in performing DUE in Thailand is the conventional DUE, thus, we assumed that the current approach could give the results

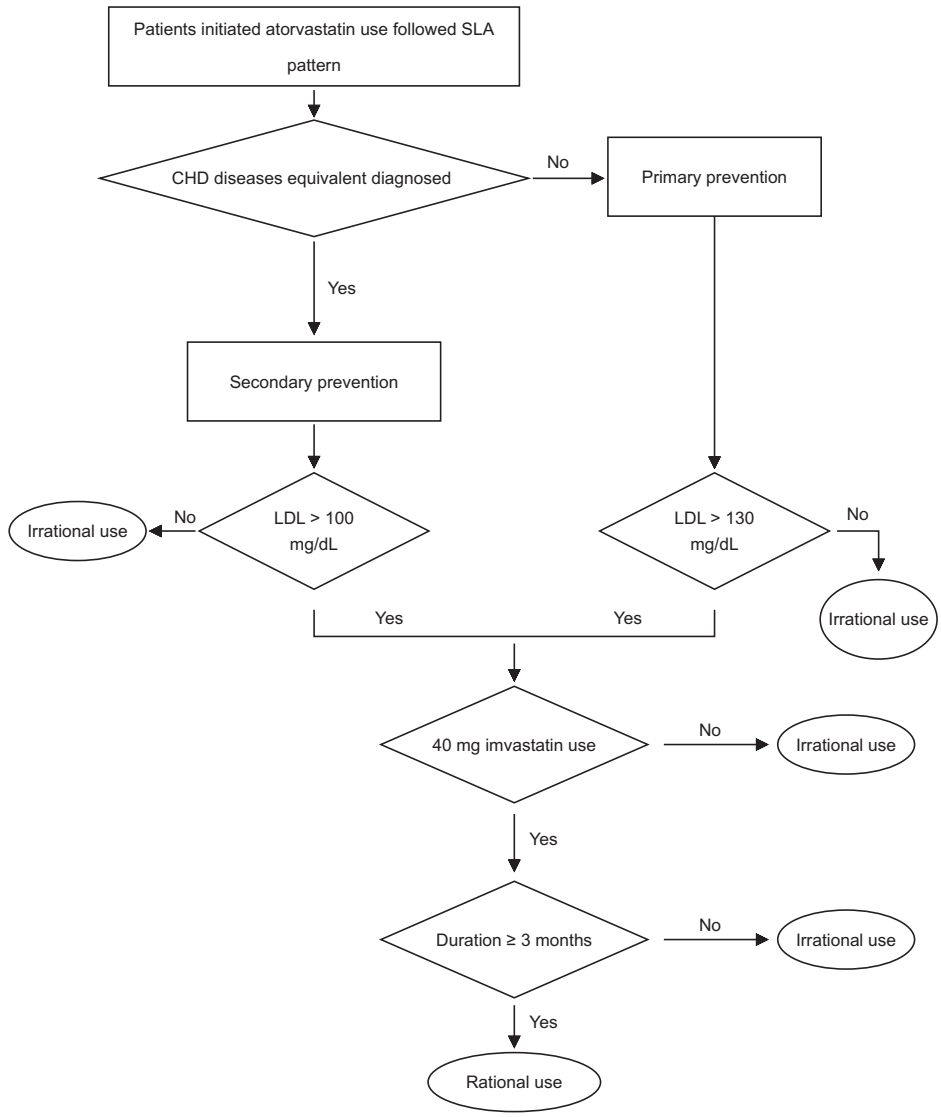

Figure 2. Algorithm of criteria-based evaluation of atorvastatin use

that could be used as the reference. Therefore, we compared the results from CAAT evaluation to the conventional DUE. For the purpose of the validation, sensitivity, specificity, and accuracy of CAAT compared with conventional DUE were analyzed.

The conventional retrospective DUE of 148 new CSMBS outpatients from one regional hospital who received atorvastatin during November 2006-April 2007 were explored based on CGD guidelines for using as the standard for the CAAT validation. For conventional DUE, the DUE forms were used for collecting the data from medical record of the same patient who was evaluated by CAAT.

Evaluating of the Use of Atorvastatin in Four Regional Hospitals. To evaluate the useof atorvastatin, retrospective study was

sconducted in the four selected regional hospitals during November 2006 to April 2007. These four hospitals were selected based on the availability of databases for the evaluation. They are located in the Central, in the North, and the rest are in the North-Eastern part. From total 584 CSMBS outpatients, 307, 175, 56, and 46 cases from Hospital 1 to Hospital 4 (Hosp 1- 4) respectively. CAAT was used to evaluate the use of atorvastatin based on the pattern analysis in two aspects: rational utilization and their expenditures. Excess of irrational atorvastatin use was also analyzed. Atorvastatin expenditure, was calculated based on each hospital's sale price. To evaluate the excess expenditure resulted from irrational use of atorvastatin, the criteria-based evaluation of the use of atorvastatin was employed.

According to the recommended guidelines for statin prescribing in the prevention of cardiovascular disease (University College London Hospitals NHS Foundation[C5], 2006), 40 mg of simvastatin should be used before the initiating of the use of atorvastatin. Four tablets of simvastatin 10 mg were used to substitute 1 tablet of atorvastatin among the patients who were in the patterns of LA, SA, and A which their uses were irrational. Maximum sale price of simvastatin 10 mg per tablet was 1.50 baht. Therefore, the expense of four tablets of simvastatin for one tablet atorvastatin substitution was 6 baht. Excess expenditure of irrational use of atorvastatin was the total expense of irrational use of atorvastatin minus the total expense of simvastatin that could be substituted for the irrational use of atorvastatin.

Results

Results of the validation of CAAT using conventional DUE method as the standard based on pattern analysis were similar to the conventional DUE method. The sensitivity, specificity[C6], and accuracy of CAAT were 81.3, 100.0, and 98.0 percen respectively.

Evaluating the use of atorvastatin in 584 CSMBS outpatients in the four regional hospitals based on pattern analysis, results showed that only 76 patients (13.0 percent) had the use followed the SLA pattern which was considered the rational use. The other 508 patients (87.0 percent) including 259 (44.3 percent), 172 (29.5 percent), and 77 patients (13.2 percent) were followed LA, A, and SA patterns respectively as shown in Table 1.

The overall expenditure of atorvastatin use in 584 patients during 6 months was 2,990,000 Thai baht. The expense for rational utilization in the patients who initiating atorvastatin followed SLA pattern was 448,500 baht (15.0 percent). The expense for irrational utilization was 2,225,600 baht (85 percent) as shown in Table 2.

Using the price of simvastatin to substitute the price of irrational use of atorvastatin, the total expense of the simvastatin was 304,100 baht. Excess spending of irrational use of atorvastatin was 2,237,500 baht as shown in Table 3.

Table 1. Evaluation of pattern of the first use of atorvastatin in CSMBS outpatientsin four hospitals

Hospitals	Number of Patients (%) by Pattern of the First Use of Atorvastatin				
	SLA	LA	SA	A	Total
Hosp 1	31 (10.1)	136 (44.3)	43 (14.0)	97 (31.6)	307 (100.0)
Hosp 2	29 (16.6)	80 (45.7)	20 (11.4)	46 (26.3)	175 (100.0)
Hosp 3	10 (17.9)	28 (50.0)	8 (14.3)	10 (17.9)	56 (100.1)
Hosp 4	6 (13.0)	15 (32.6)	6 (13.0)	19 (41.3)	46 (99.9)
Four hospitals	**76 (13.0)**	**259 (44.3)**	**77 (13.2)**	**172 (29.5)**	**584 (100.0)**

Note: SLA = a patient used simvastatin, checked LDL-cholesterol, then initiated the use of atorvastatin; SA = a patient used simvastatin, then initiated the use of atorvastatin without checking LDL-cholesterol; LA = a patient checked LDL-cholesterol before initiating the use of atorvastatin without using simvastatin before LDL-cholesterol checking; A = a patient initiated the use of atorvastatin without using simvastatin or checking LDL-cholesterol prior to atorvastatin use.

Table 2. Evaluation of expenditure of the use of atorvastatin in CSMBS outpatients in four regional hospitals

Hospitals	Expenditure of the Use of Atorvastatin: x1000 baht (% of Total) by Pattern of the First Use of Atorvastatin				
	SLA	LA	SA	A	Total
Hosp 1	169.9 (11.1)	663.6 (43.2)	269.8 (17.5)	433.7 (28.2)	1,537.0 (100.0)
Hosp 2	166.1 (18.5)	416.0 (46.4)	130.1 (14.5)	184.8 (20.6)	897.0 (100.0)
Hosp 3	85.5 (24.9)	167.1 (48.7)	37.1 (10.8)	53.4 (15.6)	343.1 (100.0)
Hosp 4	27.0 (12.7)	66.1 (31.0)	27.2 (12.8)	92.6 (43.5)	212.9 (100.0)
Four hospitals	**448.5 (15.0)**	**1,312.8(43.9)**	**464.2 (15.5)**	**764.5 (25.6)**	**2,990.0 (100.0)**

Note: SLA = a patient used simvastatin, checked LDL-cholesterol, then initiated the use of atorvastatin; SA = a patient used simvastatin, then initiated the use of atorvastatin without checking LDL-cholesterol; LA = a patient checked LDL-cholesterol before initiating the use of atorvastatin without using simvastatin before LDL-cholesterol checking; A = a patient initiated the use ofatorvastatin without using simvastatinor checking LDL-cholesterol prior to atorvastatin use.

Table 3. Simvastatin expenditure to substitute irrational use of atorvastatin expenditure and excess expenditure of irrational atorvastatin use based on pattern analysis

Hospitals	Simvastatin Expenditure to Substitute Irrational Use of AtorvastatinExcess (x1000 baht)	Expenditure of Irrational Use of Atorvastatin (x1000 baht)
Hosp 1	182.9	1,184.2
Hosp 2	71.3	659.6
Hosp 3	25.2	232.5
Hosp 4	24.8	161.1
Four hospitals	**304.1**	**2,237.5**

Discussion

To our knowledge, drug use evaluation using CAAT has been rarely conducted in the country that has no unique national databases. The significance of this validated CAAT is described as follows:

Firstly, to validate CAAT by comparing the results with the results evaluated by conventional DUE method case by case is suitable. This method of validation was applied from the acceptable method of accuracy checking of data extracted from electronic database in developed countries. Data of approximate 40 random samples extracted from database were compared with the original data of the same samples.[14]

Secondly, the accuracy of the results of drug use evaluation using data from electronic databases when comparing with the data in medical record was based on the availability and completeness of the variables and also requiring the data of key variables has to be recorded in the electronic databases. The more completeness of data in the databases, the higher accuracy of the evaluation there are. This study showed 98 percent of accuracy of the results evaluated by CAAT compared with the results evaluated by conventional evaluation method. To confirm the high accuracy of the results, verification of data extracted from the database was done by checking the data retrieved from electronic database against the data in patient records case by case. This method was confirmed by the previous study that the accuracy of each replicated extract data for DUE is verified monthly by manually comparing a sample (approximately 40 records) of the prescription data against the original data.[14] It was found that most of necessary data in patient records were the same as in electronic databases. Therefore, the present of the results were highly accurate.

However, drug use evaluation resulted from CAAT were 2 percent different from the results evaluated by conventional DUE method. It was mainly affected from different laboratories checked date as shown in the databases and in the patient records when comparing the set of data from database to the data from patient records. Findings showed that number of patients who had laboratory checked date in the patients records were more than number of patients who had laboratory checked in laboratory databases. It was possible that the patients really had laboratory checked date as same as laboratory checked date documented in laboratory databases, but they visited hospitals to see doctor on the day after laboratory checked date. Thus, the laboratory result would be recorded in the patient records on the visiting date instead of the real laboratory checked date. Another reason that may cause the difference of the laboratory checked date was a patient might had laboratory checked outside the hospital. Thus, laboratory results should be recorded only in patient record. These differences might have main effect on the patterns or steps before initiating

atorvastatin use. Because the difference of laboratory checked date had effect on the accuracy, the researchers must concern the acceptable difference of the laboratory checked date when laboratory checked date was included in the drug use evaluation guidelines.

Thirdly, evaluation of the use of atorvastatin by CAAT could be applied to evaluate the rational use of the other HCDs efficiently in developing countries, because some developing countries have been introduced the computer system to the medical process in their health system either for medication database development or for the medication reimbursement purposes. In Thailand, most of the hospitals did not have unique database in the hospital database. In general, evaluating of rational drug use has been conducted manually. Only some items of high cost or more specific drugs have been evaluated because the conventional method consumes much more time and human resources.

CAAT was developed to improve the implementation of DUE for monitoring the use of HCDs by using data from different electronic database. Its accuracy of 98 percent, when compared with the conventional DUE method, was quite high. When using CAAT to evaluate the rational use of atorvastatin among the outpatients of the four regional hospitals, it consumed time and human resources much less than manually. According to the results, CAAT will be useful for the policy makers in national or hospital level as well as third party payer to monitor the rational use of drugs. This approach could be applied to other classes of drug that have high expenditure. There are many drugs that should have rigorous monitoring for appropriate use (e.g. cloidogrel, anticancer agents, certain anti-diabetic drugs, anti-hypertensive agents, NSAIDs, etc.). For each drug, individual standard algorithm should be developed by the experts in each field for more acceptability. There were limitations of the evaluation based on the coding system of drugs, laboratory, and patient characteristics. To make the CAAT system to be used conveniently, the national coding system of drugs, laboratory, and patient characteristics should be established.

This study was specific to atorvastatin only, however, our results from the four hospitals showed only 15 percent had appropriate use of the drug. This led to significant financial burden for the government from these hospitals at the amount of 2,237,500 baht. At the national level, the number should be significantly higher. Thus, if the algorithm and theevaluation using CAAT are implemented based on national policy, considerable saving from drug use can be achieved.

Interestingly, despite comparable therapeutic outcomes between atorvastatin and simvastatin,[15,16] prescribing patterns among health care professionals preferred the use of atorvastatin. Thus, to fulfill our goal in cost reduction while maintaining desirable therapeutic outcomes in the patients, before imple-

menting this algorithm to other health care settings, clarification of the program objectives and therapeutic efficacy of these cholesterol-lowering agents to all responsible health care professionals is essential.

There are many generic simvastatin tablets in Thailand and several studies of bio-equivalence and efficacy of generic simvastatin tablets among Thai people were reported.[17,18] At present, generic atorvastatin is not available. The factor related to the availability of generic products plays a pivotal role in the difference of the price of the two agents. This may lead to our observed results in extremely high difference in the drug expenditure. However, when a generic atorvastatin formulation becomes commercially accessible in Thailand, the price of the drug will be reduced. Thus, this may affect the measured financial burden in other hospitals which may adopt this algorithm into their use in the future.

Conclusion

In conclusion, our newly introduced computerized algorithm in atorvastatin DUE is comparable to the conventional DUE approach. Using our CAAT approach, it was found that only 15 percent of atorvastatin use in the four regional hospitals was rational. If the rational use of drug was successfully implemented, all of the four hospitals would save around 2.2 million baht in six months. Successful implementation of the algorithm and CAAT evaluation could reduce drug expenditure in hospital settings resulting in the substantial drug cost saving in CSMBS scheme in Thailand.

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