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Constructing a Real-Time Prescription Drug Monitoring System

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Objectives: The objective of this investigation was to demonstrate the possibility of the construction of a real-time prescription drug monitoring system (PDMOS) using data from the nationwide Drug Utilization Review (DUR) system in Korea. **Methods:** The DUR system collects information on drug prescriptions issued by healthcare practitioners and on drugs dispensed by pharmacies. PDMOS was constructed using this data. The screen of PDMOS is designed to exhibit the number of drug prescriptions, the number of prescriptions dispensed by pharmacies, and the dispensed prescription drug costs on a daily and weekly basis. Data was sourced from the DUR system between June 1, 2016 and July 18, 2016. The TOGA solution developed by the EYEQMC Co. Ltd. of Seoul, Korea was used to produce the screen shots. **Results:** Prescription numbers by medical facilities were more numerous than the number of prescriptions dispensed by pharmacies, as expected. The number of prescriptions per day was between 2 to 3 million. The prescriptions issued by primary care clinics were most numerous, at 75% of the total number of prescriptions. Daily prescription drug costs were found to be approximately US $50 million. The prescription drug costs were highest on Mondays and were reduced towards the end of the week. Prescriptions and dispensed prescriptions numbered approximately 1,200 and 1,000 million, respectively. **Conclusions:** The construction of a real-time PDMOS has been successful to provide daily and weekly information. There was a lag time of only one day at the national level in terms of information extraction, and scarcely any time was required to load the data. Therefore, this study highlights the potential of constructing a PDMOS to monitor the estimate the number of prescriptions and the resulting expenditures from prescriptions.

Keywords: Prescription Drugs, Drug Monitoring, Drug Costs, Drug Utilization, Drug Utilization Review

I. Introduction

The proportion of prescription drug costs in healthcare is very high. In the United States, the percent of national health expenditures for prescription drugs was 9.8% compared to that for hospital care, which was 32.1% in 2014 [1]. Prescription drug costs accounted for 22.6% of the national health insurance program in 2015, approaching that of hospital care, which accounted for 35.7% in Korea [2]. Therefore, it is very important to monitor the number of medical prescriptions and the overall cost, which represents a substantial proportion. The causes of abnormal increases can be identified by monitoring the number of prescriptions and the

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dispensed prescription drug costs. Increased dispensed prescription drug costs can be controlled with the construction of efficient monitoring systems or solutions. These schemes for medical drugs would reduce the ultimate supply cost in the medical sector.

Medical suppliers or small health insurance companies would find it overwhelming to monitor the number of medical prescriptions or the prescription drug costs, as they hardly have the healthcare information infrastructure and communications technologies (ICTs) to collect all information in real time. Large-scale insurance companies or health maintenance organizations may have some prescription drug monitoring schemes because they have well-equipped ICT infrastructure systems, although there little research has been conducted regarding the collection of real-time information to monitor the number of prescriptions and prescriptions dispensed by pharmacies or the prescription drug costs. In Korea, the Health Insurance Review and Assessment Service (HIRA) uses the "Healthcare Utilization Monitoring System" (HUMS) to monitor medical usage factors [3]. However, this system relies on health insurance claim data, implying that it is not a real-time system. Moreover, there is a lag time of 1 to 3 months. The main purposes of HUMS include investigations of rapid variations in the areas of healthcare utilization, treatments, and medical costs.

The HIRA of Korea involves a third-party administrator to review health insurance claims and to assess the healthcare services of providers under the National Health Insurance Program of Korea. The HIRA is the only independent organization that has been delegated by the government to carry out these functions. Since December of 2010, the HIRA had operated the nationwide Drug Utilization Review (DUR) system in order to induce the safe usage of medical products. The DUR system can be defined as a structured ongoing systematic review process to maintain the safe, appropriate, and effective use of drugs [4]. HIRA's DUR system identifies any possibility of contraindications in drug prescriptions by healthcare facilities and in prescriptions dispensed by pharmacies to inform those involved, such as doctors and patients, in real time. Therefore, DUR has data with which it can estimate the real-time number of drug prescriptions and the prescription drug costs.

The data in the DUR system can be utilized to establish a real-time prescription drug monitoring system (PDMOS). There is no detailed definition in previous research of a PDMOS, except for the research on prescription drug monitoring programs (PDMP) [5-8]. In the United States, 49 states along with Washington DC have written statutes about these programs [9]. A PDMP in the United States is defined collectively as a "state-run electronic database" to monitor abuse, overuse and misuse in relation to prescriptions and the dispending of medical products [7].

This investigation defines a PDMOS operationally as an electronic database and computer system for monitoring the number of drug prescriptions and the dispensed prescription drug costs. Overall, it is an electronic system which was established to provide information about the number of drug prescriptions and the prescribed drug costs from a variety of viewpoints of those involved in its use. Examples can be the real-time provision of the number of drug prescriptions or the dispensed prescription drug costs for different types of healthcare facilities.

The purpose of this investigation is to share HIRA's experience of a pilot study on PDMOS establishment for monitoring the real-time (daily or weekly) number of prescriptions and the prescription drug costs using the DUR system. In addition, the limitations of a PDMOS using the DUR system of Korea will be investigated. The international sharing of these cases will have the effect of knowledge expansion about how to use various healthcare ICTs [10-12]. The findings of this study will bring advantages such as a reduction of the direct and/or indirect investment costs associated with the development of the system.

II. Methods

1. Data Source

Data was sourced from the DUR system between June 1, 2016 and July 18, 2016 in order to investigate the feasibility of real-time PDMOS construction using the DUR system. If patients received healthcare from medical providers or were prescribed medications by pharmacies, their information would automatically be included in the data. The content of any prescription may have changed due to the possibility of a contraindication between different drug prescriptions through the DUR system, implying that two prescriptions per patient may have been issued by the same healthcare facility. This study did not exclude one of two prescriptions because this investigation focuses on the feasibility of system construction and not on the calculation of correct statistics. Therefore, the statistics in this investigation remains unverified.

2. Data Processing and Coding

Data transferred to the DUR system was stored in a database for the purpose of this investigation, and the data was sent to

a data warehouse (DW) for the production of daily or weekly monitoring screens. The information sent to the DUR system by the medical facilities includes prescriptions, prescribed medical product information, facility information, regional information and the prescription date. The information sent to the DUR system by the pharmacies includes prescriptions, prescribed medical product information, facility information, regional information and the prescription date. This information and the drug price master database of HIRA were merged to calculate the number of drug prescriptions, the number of prescriptions dispensed by pharmacies, and the prescription drug costs. All statistics could be produced on a

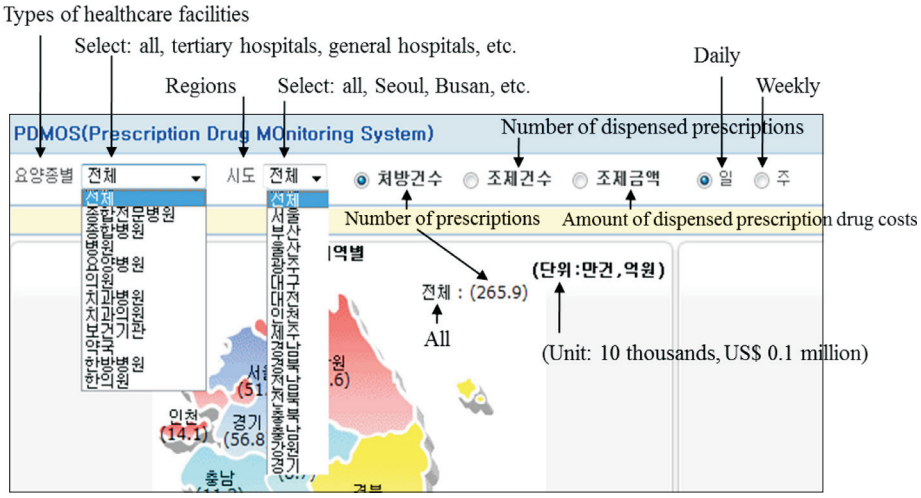

Figure 1. Drop-down search boxes of the front page of the Prescription Drug Monitoring System.

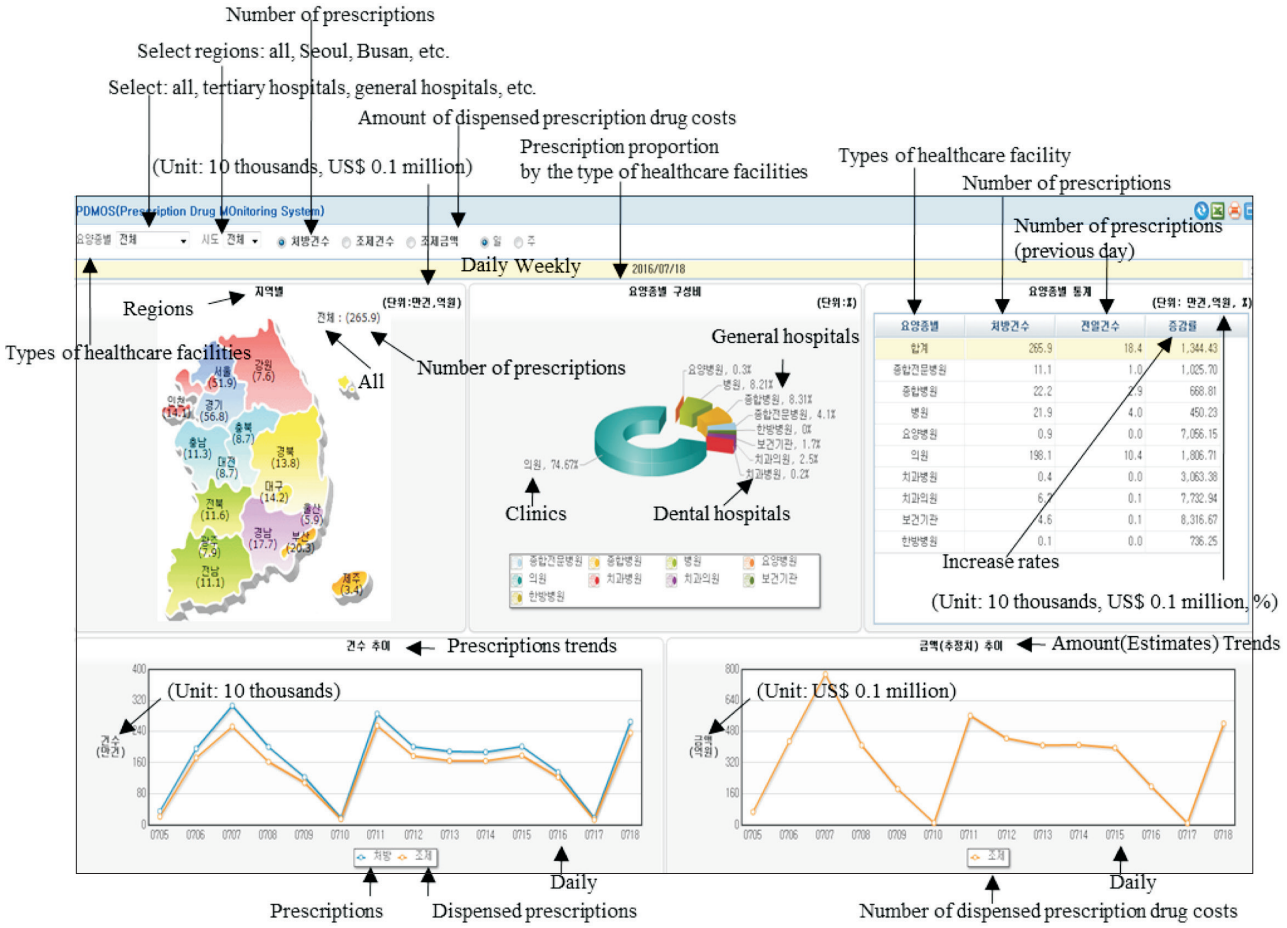

Figure 2. Number of drug prescriptions by type of facility, region, and prescription trends.

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daily and weekly basis with respect to statistical calculations. In addition, the statistics were produced according to the types of healthcare facilities and the geographical locations (Figure 1). The TOGA solution developed by the EYEQMC Co. Ltd. of Seoul, Korea, was used for the production of the PDMOS screens.

III. Results

1. Daily Number of Drug Prescriptions at Healthcare Facilities

Figure 2 shows the number of prescriptions by region, by the type of healthcare facility and related proportions, by the daily prescriptions, by the number of dispensing locations, and lastly by the daily prescription drug costs. It can be observed that the number of prescriptions exceeds the number of dispensing locations. The numbers of prescriptions and dispensing locations were highest on Mondays, and were reduced towards the weekends. The number of prescriptions was highest in primary care clinics. There were nearly 2,660,000 prescriptions recorded on July 18, 2016.

2. Daily Number of Drug Prescriptions Dispensed by Pharmacies

Figure 3 displays the number of dispensed prescriptions by region and mostly by pharmacies, the proportion of prescriptions for each type of healthcare facility, and the number of prescriptions according to the type of healthcare institution or facility. It can be observed that most dispensing occurs at pharmacies, and there were approximately 2,370,000 prescriptions dispensed on July 18. The number of prescriptions, the number of drugs dispensed and the prescription drug costs shown in the graphs at the bottom are identical to those in Figure 2. The number of prescriptions is higher than that of the dispensing locations, although the two show identical patterns.

3. Daily Costs of Prescription Drugs Dispensed by Pharmacies

Prescription drug costs were investigated according to dif-

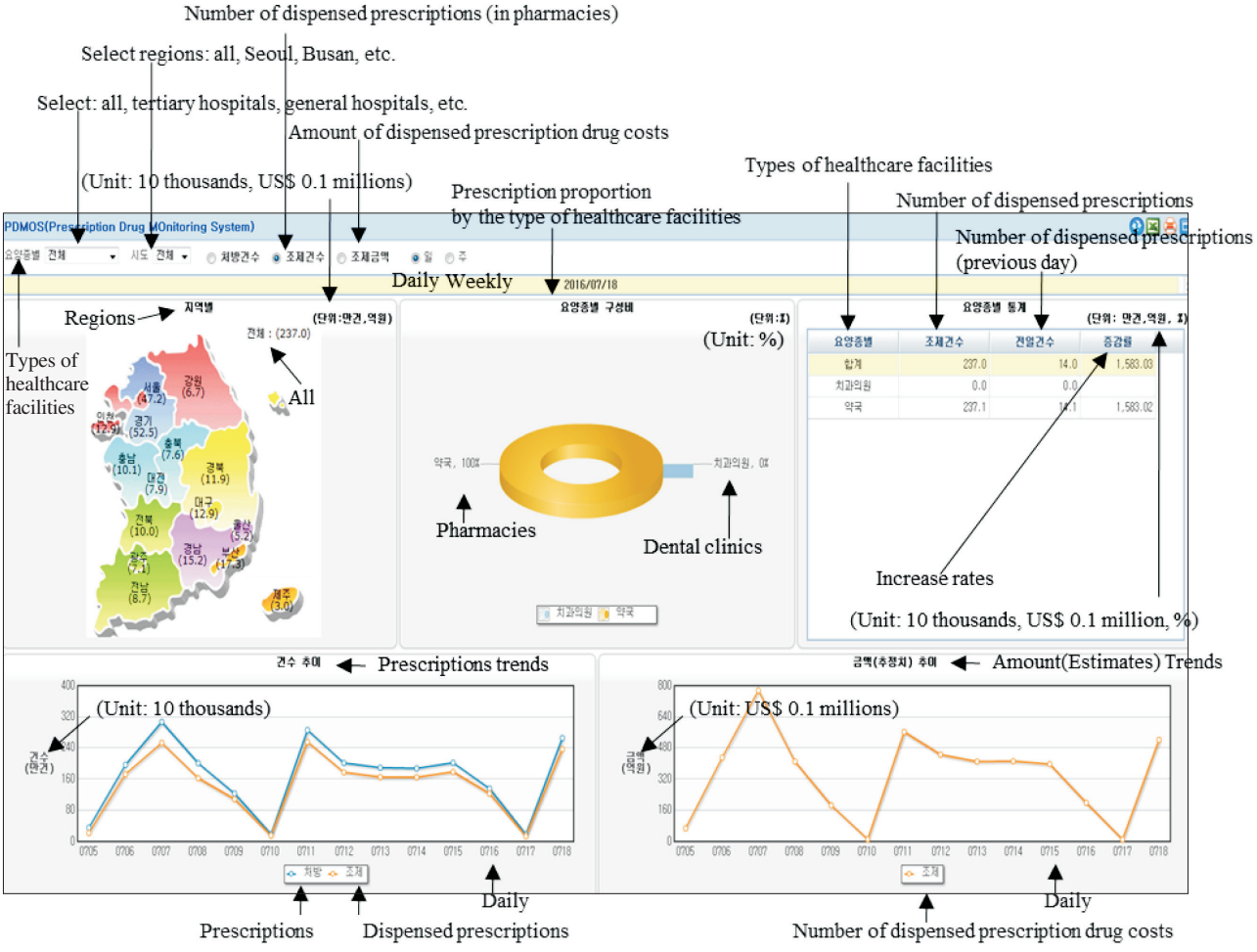

Figure 3. Number of drug prescriptions dispensed by pharmacies by type of facility, region, and prescription trends.

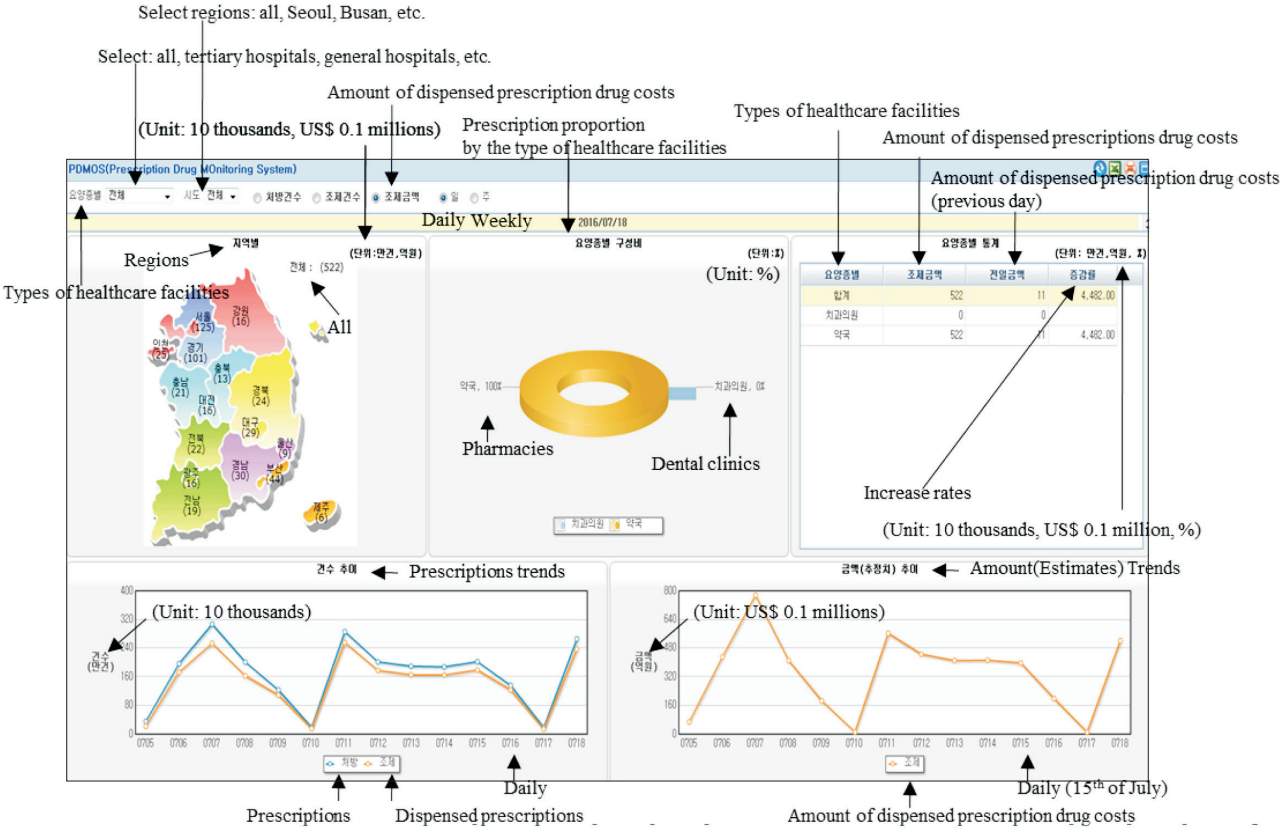

Figure 4. Daily costs of prescriptions dispensed by pharmacies and related trends.

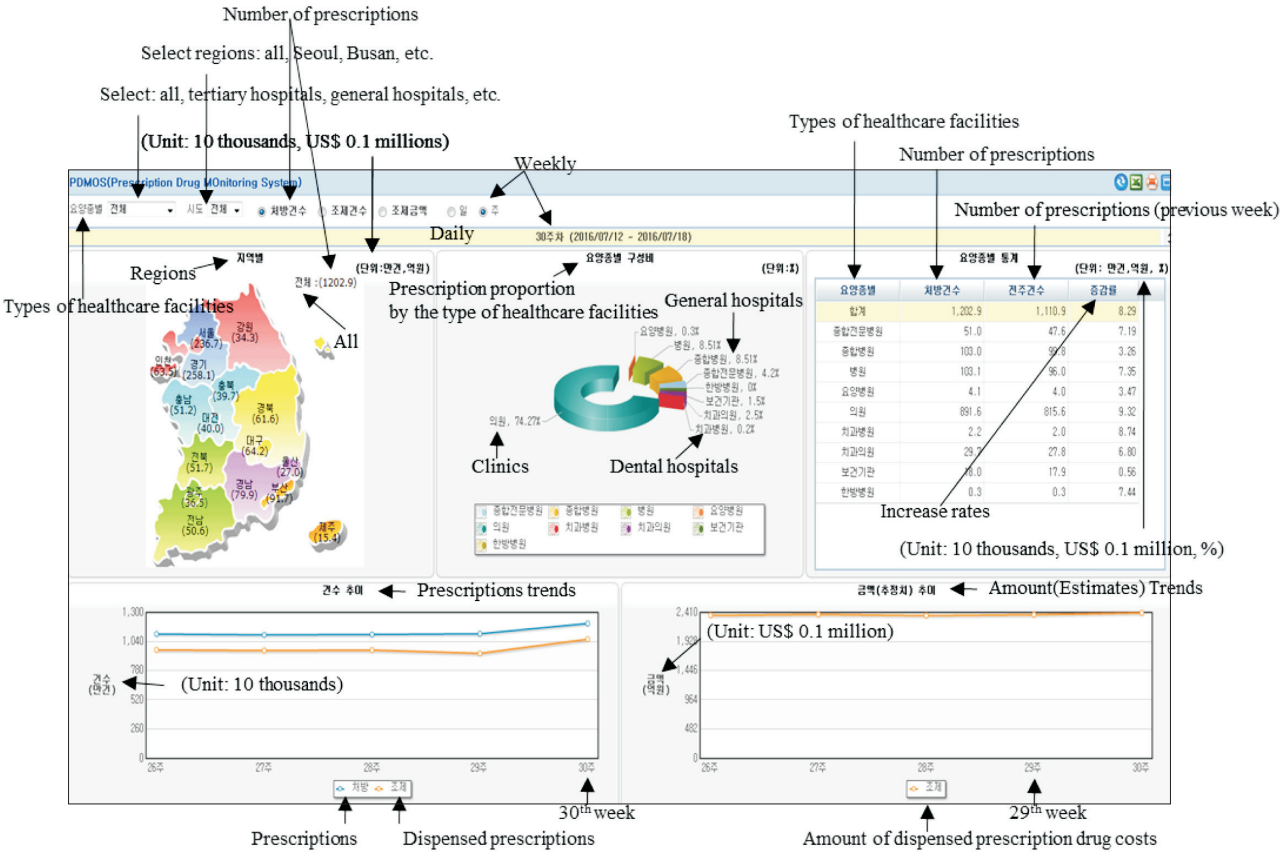

Figure 5. Weekly number of drug prescriptions and related trends.

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ferent regions and types of health care institutions (Figure 4) through the PDMOS. On July 18, 2016, the total prescription drug cost was US $52.2 million. The prescription drug cost stems mostly from pharmacies, and the costs were the highest on Mondays and negligible on weekends.

4. Weekly Number of Drug Prescriptions

Information on weekly prescriptions of the PDMOS is shown in Figure 5, including the number of prescriptions by region and the types of healthcare facilities and the proportion of prescriptions by each type of healthcare facility (Figure 5). On Week 30 (July 12, 2016 to July 18, 2016), the total number of prescriptions was approximately 12 million. Seventy-four percent all weekly prescriptions occurred at primary care clinics. On a weekly basis, the number of prescriptions exceeded that of dispensing locations.

5. Weekly Number of Drug Prescriptions Dispensed in Pharmacies

Figure 6 shows the number of dispensed prescriptions on a weekly basis for different regions, the proportion of the different types of healthcare facilities, and the different types of healthcare facilities. On Week 30 (July 12, 2016 to July 18, 2016), approximately 10 million prescriptions were dispensed at pharmacies, with very few dispensed by hospitals and dental clinics.

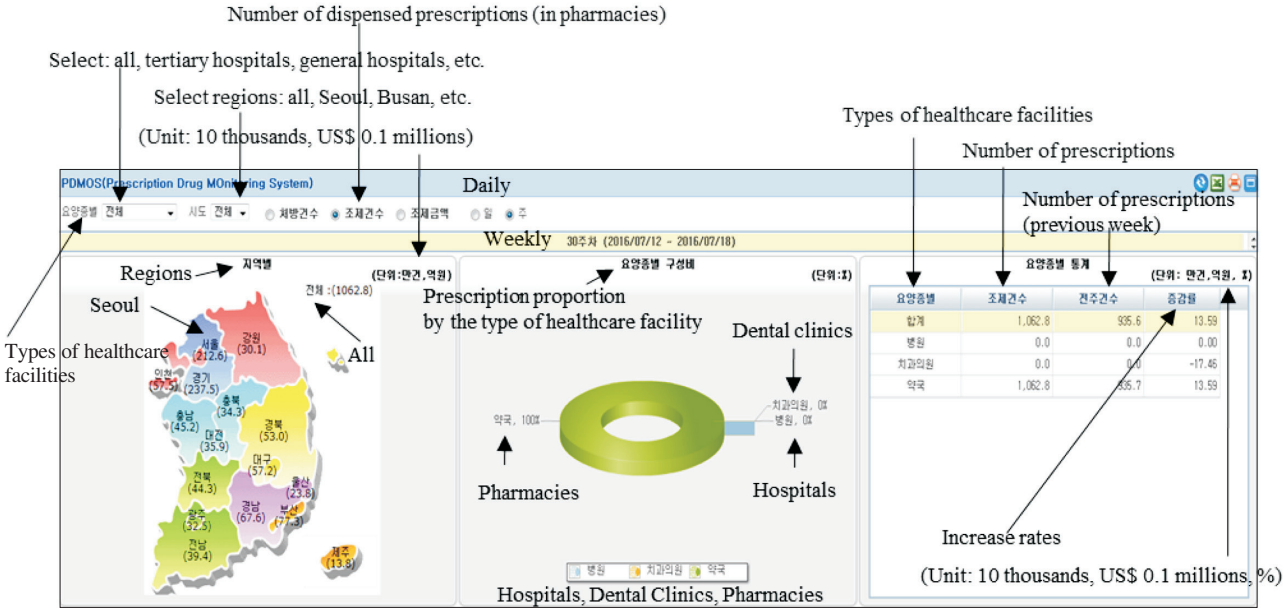

Figure 6. Weekly number of drug prescriptions dispensed by pharmacies according to the type of facility and region.

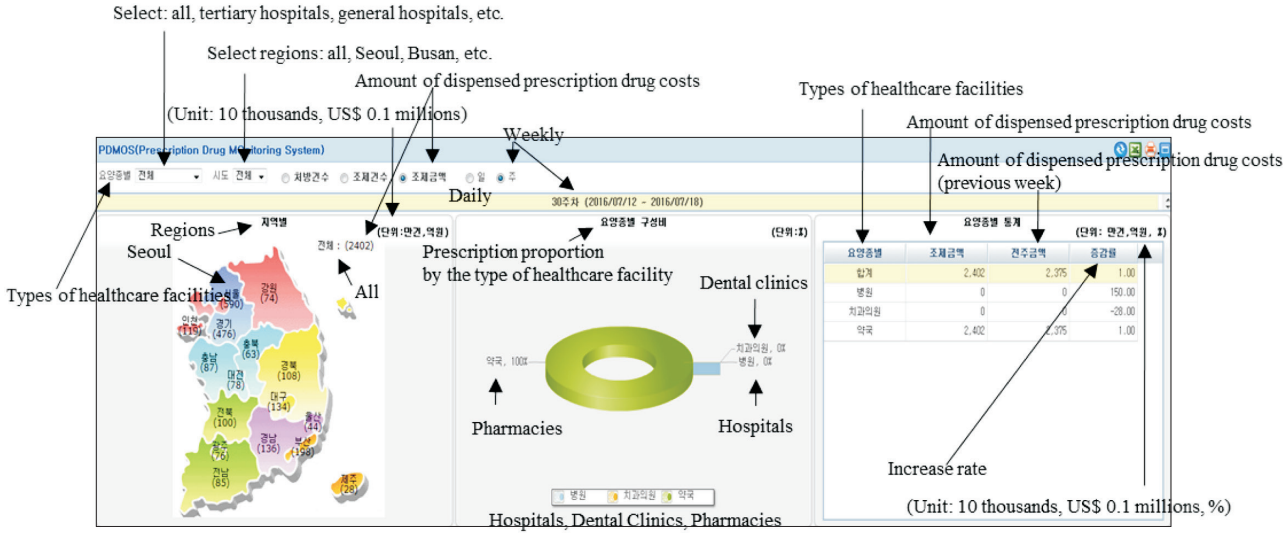

Figure 7. Weekly costs of prescription drugs dispensed by pharmacies.

6. Weekly Cost of Prescription Drugs Dispensed by Pharmacies

Figure 7 shows the prescription drug costs for different regions and the proportion of the different types of healthcare facilities. On Week 30 (July 12, 2016 to July 18, 2016), total prescription drug costs were approximately US $240 million. Approximately US $59 million was spent in Seoul, and most dispensing locations were pharmacies.

IV. Discussion

This investigation was done to examine the construction of a pilot PDMOS with information from the DUR system of Korea. The construction of the PDMOS resulted in a 1 day lag time, and it took 1 to 3 seconds to load the data. Therefore, a user can view information on drug prescriptions on the screen immediately. It can be concluded that it is possible to construct a real-time PDMOS construction using prescriptions from medical providers and dispensed drug prescriptions on the DUR system. This system provides daily or weekly information on the number of drug prescriptions, the number of prescriptions dispensed by pharmacies, and the prescription drug costs.

There was no national system to monitor daily or weekly numbers of drug prescriptions, numbers of prescriptions dispensed by pharmacies, and the prescription drug costs in Korea. In the case of the United States, each state operates a PDMP at various time intervals: real time (1 state), real time/24 hours (2 states), daily (20 states including DC), 72 hours (5 states), weekly (20 states), and others (2 states) [9].

A special feature of the PDMOS system is that it provides the number of drug prescriptions, the number of prescriptions dispensed by pharmacies, and the prescription drug costs on a daily or weekly basis. The daily provision of prescriptions and/or dispensing locations at the national level can be found in real time. The development of health and medical ICT infrastructure enables a variety of information to be monitored in real time. These data can be utilized in policies through a variety of routes. The detection of abnormal amounts of medical drugs being used, the stable provision of medical drugs, and statistics about medical drugs are the benefits of operating such a system. Healthcare ICTs have many potential and advantages to improve the quality of care and to reduce their healthcare costs [13-15].

The trial system developed in this investigation had the following limitations. The report had the aim of constructing a pilot system to monitor the real-time number of drug prescriptions, the number of prescriptions dispensed by pharmacies, and the prescription drug costs through the DUR system. Therefore, the statistics were not verified, implying that the numbers cannot be referenced formally. The statistics can be referenced after an accurate examination of the DUR system and statistical adjustment processes have taken place in the future. The prescription drug costs were calculated by multiplying the unit cost by the drug dispensed, meaning that the results are only estimates. For example, the cost was not assumed to be incurred by actually dispensing a drug but was calculated using a formula which accounted for the number of drugs dispensed in each prescription multiplied by its unit cost.

There are prescription drug costs in the PDMOS results. These could be over- or underestimates. Underestimates can be related to injected medicines prescribed by a hospital, whereas injected medicines are not dispensed by pharmacies. Therefore, this may led to reduce the final dispensed prescription drug costs as used in this investigation. On the other hand, a doctor could correct a prescription, and such correction information is logged onto the DUR system as two prescriptions. Therefore, a calculation without corrections can lead to overestimates. This investigation did not incorporate corrected prescription numbers into the calculations. There may also be other factors affecting the dispensed prescription drug costs. For this reason, a more in-depth investigation is required.

The PDMOS requires future refinements. It is necessary to monitor insurance coverage or prescriptions that are not covered by insurance. Moreover, it is not possible to observe past daily results; therefore, an icon on the dashboard enabling the selection of a specific date to monitor past daily records will be necessary.

To conclude, this report investigated the possibility of a real-time PDMOS system to monitor information on various prescription drugs using the DUR system. It was found to be possible to construct such a system to calculate statistics on a daily and weekly basis. Future improvements of system functions will lead to the production of a variety of real-time information to reduce the overall costs. It is hoped that the system will provide the opportunity to cooperate and advance in this field through the shared construction experience with international scholars of the PDMOS using the DUR system.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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