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The Effects of Medication Supply on Hospitalizations and Health-Care Costs in Patients with Chronic Heart Failure

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A B S T R A C T

Objectives: Use of angiotensin-converting enzyme inhibitors or angiotensin receptor blockers results in decreased morbidity among patients with chronic heart failure (CHF). Undersupply of medication could result in inadequate control of CHF, whereas oversupply of medication could increase health-care costs and risks of toxicities. This study aimed to determine the effects of medication supplies on health-care costs and hospitalizations in patients with CHF receiving angiotensin-converting enzyme inhibitors or angiotensin receptor blockers. **Methods:** We retrospectively examined the electronic database in a hospital in Thailand. Patients who were diagnosed with CHF and who received angiotensin-converting enzyme inhibitors or angiotensin receptor blockers in the year 2003 were included. Medication supplies were assessed by using the medication possession ratio (MPR). The Cox proportional hazard model was used to determine the association of medication supply (appropriate supply: MPR 0.8–1.2, oversupply: MPR $>$ 1.2, undersupply: MPR $<$ 0.8) with CHF-related and all-cause hospitalizations. Health-care costs were compared by using multiple linear regressions. All analyses were adjusted for propensity score and other variables. **Results:** A total of 393 patients were included. Their mean age was 66 years, with 56% being females. Fifty-seven percent of the patients received an inappropriate –supply of medication. Undersupply of medication likely increased the risks of CHF-related hospitalization with an adjusted hazard ratio of 1.66 (95% confidence interval [CI] 0.80–3.46). The adjusted hazard ratio of undersupply and oversupply of medication for all-cause hospitalization was 1.13 (95% CI 0.74–1.73) and 3.19 (95%CI 0.66–15.47), respectively. The total health-care costs in the undersupply and oversupply groups were significantly greater than that in the appropriate-supply group: $49 (95% CI 32–66) and $103 (95% CI 32–173), respectively. **Conclusions:** Inappropriate medication supplies could increase the risks of CHF-related and all-cause hospitalizations. Both undersupply and oversupply of medication had significantly higher health-care costs.

Keywords: chronic heart failure, hospitalization and health-care costs, medication supply.

Introduction

Chronic heart failure (CHF) is a cardiovascular disease that severely affects patients' quality of life and incurs a substantial economic burden on the health-care system [1]. The incidence and prevalence of CHF continue to increase. The prevalence of CHF in the Western world has been estimated as 1% to 2% [2], while it is 0.4% in Thailand [3]. About 5 million people in the United States have heart failure, and more than 550,000 new patients are diagnosed yearly [4], resulting in 15 million medical visits and 6.5 million hospital-days each year [5]. The total cost associated with CHF in the United States was estimated to be $39.2 billion in the year 2010 [6].

The American College of Cardiology (ACC)/American Heart Association (AHA) clinical practice guidelines of 2009 recommended angiotensin-converting enzymes (ACEIs) and angiotensin receptor blockers (ARBs) as one of the first-line pharmacotherapy required for all patients with CHF without contraindications [7]. To achieve optimal therapeutic benefits from medications, the right drug should be prescribed and the right quantity needs to be supplied. Inappropriate medication supply could lead to inadequate control of CHF. A number of research studies have demonstrated that both types of inappropriate medication supply can result in an increased risk of hospitalization and death and increased health-care cost [8,9]. Oversupply of medications may have negative effects because it can lead to overuse of medications in both the recipients of the prescription and people surrounding them [8]. Even if patients do not consume or share excess medications, oversupply still causes inefficient use of health-care resources. The problem caused by undersupply has a different nature from that caused by oversupply. Insufficient provision of medications causes a noncompliance problem, possibly leading to inadequate control of CHF. In the United

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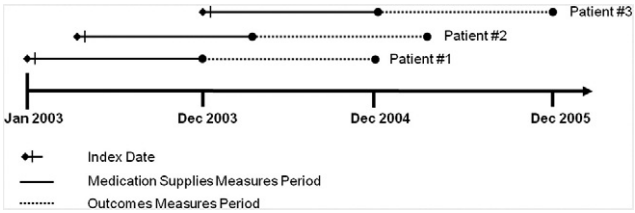

Fig. 1 – Index date, medication supplies measures period, and outcomes measures period.

States, the prevalence of undersupply and oversupply in patients with CHF was 8% and 37%, respectively. Overall drug costs in the undersupply group were 25% higher, while these were 18% higher in the oversupply group, compared with those in the appropriate-supply supply [9]. Because the health-care system in the United States is very unique, the findings from these studies [8,9] may not be directly applicable to countries in the Asia-Pacific region. Therefore, this study aimed to examine the effects of medication supplies on health-care costs and hospitalizations in patients with CHF receiving ACEIs or ARBs in the Thai health-care system.

Methods

Sources of data

A retrospective cohort study was conducted at a university-affiliated hospital in Thailand. The study protocol was approved by the Ethics Committee of the hospital. Electronic hospital databases including inpatient and outpatient databases, pharmacy databases, and charge databases were used in this study. Inpatient and outpatient databases contained information on age, sex, health insurance, date of birth, and diagnostic codes (*International Statistical Classification of Diseases, 10th Revision* [ICD-10]). Pharmacy databases contained drug name, regimen, and amount of medication per prescription. In addition, charge databases contained drug, laboratory, medical service, and other service charges.

Patients and study period

By using the electronic hospital database, we retrospectively identified patients diagnosed with the ICD-10 code of I-50.0 who received either ACEIs or ARBs from January to December 2003. Each patient's index date was determined by the first prescription date. To ensure that patients had continuity of care at this hospital, only those patients who received at least two prescriptions of ACEIs or ARBs within the first 6 months were included. In addition, they must have been at least 18 years old. All included patients were tracked from the index date for 2 years or until December 31, 2005. To ensure that the outcomes of this study came after the exposure of interest, medication supplies were measured within a year after the index date, while the outcomes were measured in the following year (Fig. 1).

Assessment of medication supplies

Medication supplies were determined by using the pharmacy database. The magnitude of medication supplies was measured by using the medication possession ratio (MPR) [10,11]. This method determines the extent of medication possession during the period of 1 year following the index prescription date. It is calculated by dividing the number of days supply for a patient over total days in the medication supplies measures period. In our study, we used 365 days as the number of days of the medication supplies measures period. We modified the means to calculate the MPR by incorporating the changes in treatment regimen and addition to the lag time among the prescription. Therefore, the modified method was likely to provide an estimated MPR that reflected the actual supply better than the traditional MPR [12].

Patients were classified as having an appropriate-medication supply (MPR 0.8–1.2), undersupply (MPR < 0.8), or oversupply (MPR > 1.2). We chose 0.8 as the threshold of undersupply because studies have suggested that the therapeutic responses to chronic treatments were preserved when patients took at least 80% of the prescribed medications [13,14]. We chose 1.2 as the threshold for oversupply because a number of studies supported the 20% buffer of medication supplies as the acceptable level [8,15].

Outcome measures

Outcomes of interest in this study were CHF-related hospitalization, all-cause hospitalization, and health-care costs. CHF-related hospitalization was defined as hospitalized patients coded in ICD-10 as I-50.0, while all-cause hospitalization was defined as any hospitalizations occurring during the outcome measuring period. The annual health-care costs were calculated by using only direct medical costs because this study was undertaken by using the hospital perspective. The total costs in our study included drug, laboratory, medical service, and other service costs. The health-care costs were calculated on the basis of the conversion of charge to cost by using the ratio of cost to charge (0.58 for 2003, 0.57 for 2004, and 0.72 for 2005) [16].

Statistical analyses

Descriptive statistics were used to describe baseline characteristics of included patients. Moreover, baseline characteristics were compared by using the chi-square test and the analysis of variance. Kaplan-Meier survival estimates and the Cox proportional hazard model were undertaken to examine the association between medication supplies and time to CHF-related and all-cause hospitalizations. To determine the association between medication supplies and health-care costs, a multivariate linear regression was used with log-link transformation adjusted with the Duan smearing factor [17]. To minimize potential differences between the three groups of medication supplies (undersupply, ap-

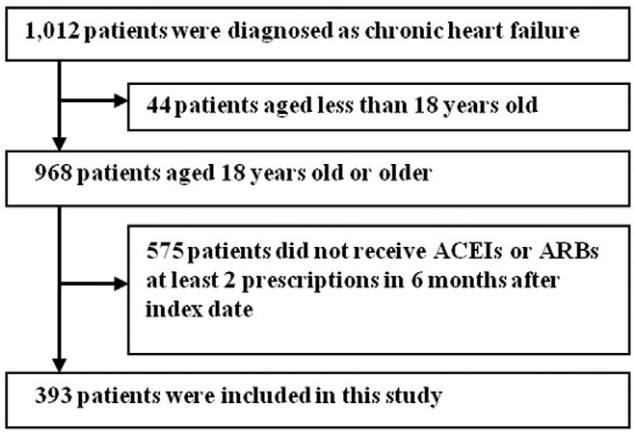

Fig. 2 – A flow of patient selection.