

Comparison of clinical characteristics and management of asthma by types of health care in South Korea

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Background: Data on the clinical characteristics of asthma patients including utilization of medical facilities, disease management, and healthcare costs by types of health care are insufficient.

Methods: We evaluated data on 729,343 asthma patients from the Health Insurance Review and Assessment Service (HIRA) database of Korea between July 2013 and June 2014.

Results: Most asthma patients were treated via primary care (81.7%), followed by tertiary (17.8%) and secondary (0.5%) care. Patients requiring secondary or tertiary care exhibited more comorbidities and exacerbations than those treated via primary care, and utilized more medical facilities (associated with higher medical costs). The prescription rate of leukotriene receptor antagonists (LTRAs) was relatively high for those receiving all types of health care, ranging from 62% to 78%. However, the prescription rate of inhalants containing corticosteroids was significantly lower in patients treated via primary care than those receiving secondary or tertiary care ($P < 0.001$). In addition, pulmonary function testing (PFT) was performed less often in patients treated via primary care than in those receiving secondary or tertiary care ($P < 0.001$).

Conclusions: Most patients with asthma were treated via primary care; however, those receiving secondary or tertiary care exhibited substantial utilization of medical facilities with high costs. Diagnostic measures and the prescription of inhalants containing corticosteroids in primary care require urgent attention.

Keywords: Asthma; management; health care

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Introduction

Asthma is a major health burden worldwide; its prevalence has increased continuously over the past decades and now affects over 10% of the global population (1-5). The economic and personal health burdens imposed by asthma are substantial in children and adolescents, particularly those in whom asthma is suboptimally controlled (6,7). The increasing prevalence of the disease and the associated socioeconomic burdens have drawn more attention to asthma control allowing patients to participate in regular activities without any restrictions (8-10). Although most patients can achieve and maintain control of the disease with appropriate treatment and upward titration of medication, significant numbers of patients have poorly controlled asthma (11-13).

Primary care is the key in the management of many chronic diseases (14). However, depending on health condition of patients, primary care patients may require referral to secondary or tertiary care (14,15). In terms of asthma, the guidelines recommend referral of patients with severe or poorly controlled asthma to specialists (1,16). However, the 2014 Royal College of Physicians' National Review of Asthma Deaths showed that more than half of all asthma patients who died were not under specialist care during the preceding 12 months (17). Consequently, the characteristics of asthma patients by types of health care warrant investigation; currently, such information is lacking.

In the present study, we investigated clinical characteristics, management and medical cost of asthma patients in primary, secondary and tertiary medical institutions using data from the Health Insurance Review and Assessment Service (HIRA) in Korea (18).

Methods

Data sources

Korea has a single, mandatory, government-established health insurance system, and HIRA is the agency responsible for evaluating all medical claim data. HIRA collects all medical records; almost all Korean citizens are supposedly covered by the system (18-21). We retrospectively reviewed and analyzed the data from the HIRA database between July 2013 and June 2014.

Study population

We included all patients ≥ 15 years of age with asthma (codes J45.x-J46.x of the International Classification of Diseases

10th revision) as the principal or secondary (within the fifth position) diagnosis, and who were prescribed asthma-related medication (inhaled, oral, or injected) on at least two outpatient visits, or on at least one outpatient visit along with systemic corticosteroids prescribed on admission (20). Asthma-related medications included inhaled corticosteroids (ICSs), leukotriene receptor antagonists (LTRAs), ICSs plus long-acting β_2 -agonists (LABAs), short-acting β_2 -agonists (SABAs), short-acting muscarinic antagonists (SAMAs), SABAs plus SAMAs, long-acting muscarinic antagonists (LAMAs), systemic bronchodilators, and xanthine derivatives (21). The study was approved by the Institutional Review Board of the Catholic University of Korea, Seoul St. Mary's Hospital (approval no. KC16RESI0560).

Definition of types of health care

Primary care (n=14,745) principally provides outpatient clinics. Secondary care (n=910) delivers to both outpatients and inpatients in hospitals with ≥ 30 but < 100 beds. Tertiary care (n=323) delivers in general hospitals with ≥ 100 beds and at least three specialists among the four medical fields of internal medicine, general surgery, pediatrics, or obstetrics, together with specialists in laboratory medicine (or pathology), anesthesia, and radiology. General hospitals with ≥ 300 beds also have specialists in psychology and dentistry (22). Of the tertiary hospitals evaluated (n=323), 43 were comprehensive general hospitals and 280 were general hospitals.

We did not evaluate other nursing hospitals or public healthcare centers, because only small numbers of asthma patients visited such centers (0.35% for nursing hospitals and 0.40% for public healthcare centers). It is relatively easy for patients to access secondary care and tertiary care in Korea. Asthma patients who usually received primary care and were visiting secondary or tertiary care centers twice or less during the study period, were defined as being treated via primary care. When patients visited secondary or tertiary care centers at least three times, they were defined as patients treated by secondary or tertiary care. In particular, those who visited tertiary care centers at least three times were considered to be receiving tertiary care. Severe asthma exacerbation requiring hospital admission was defined as an admission to a general ward (GW), an emergency room (ER), or an intensive care unit (ICU), with a diagnosis of asthma as the principal or first additional diagnosis. Medical costs included those associated with blood tests, imaging studies, pulmonary function testing (PFT), consultations,

and treatments. All costs are presented in US dollars; 1 dollar was equivalent to 1,070.80 Korean won on March 28 2018.

Statistical analyses

Data are presented as means and standard deviations for continuous variables and as numbers (with percentages) for categorical variables. Continuous variables were analyzed using one-way analysis of variance (ANOVA) and categorical data were compared using Pearson's χ^2 test or Fisher's exact test. If variables exhibited significant differences on one-way ANOVA, we performed further bivariate comparisons between pairs of groups using the Tukey test. All tests were two-sided and a P value <0.05 was considered to indicate statistical significance. All statistical analyses were performed using SAS software (ver. 9.4; SAS Institute, Cary, NC, USA).

Results

Patients

The baseline characteristics of 729,343 asthma patients are summarized in *Table 1*. Most (n=595,748, 81.7%) were treated via primary care, while 3,553 (0.5%) and 130,042 (17.8%) received secondary and tertiary care, respectively. The latter patients were more likely to be older and male compared with those receiving primary care (P<0.001 for age and P<0.001 for sex). In terms of spirometry, patients receiving primary care were significantly less likely to undergo PFT than patients receiving secondary or tertiary care (14.1% of primary vs. 54.2% of secondary vs. 52.9% of tertiary care patients, P<0.001). The prevalence rates of comorbidities such as allergic rhinitis, hypertension, diabetes mellitus, arthritis, ischemic heart disease, osteoporosis, congestive heart failure, depressive disorders, anemia, and pneumothorax were significantly higher in

Table 1 Baseline characteristics of study population

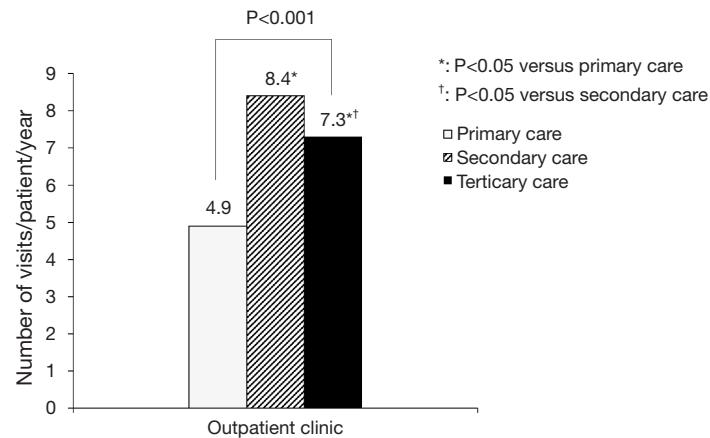
Characteristics	Primary care (n=595,748, 81.7%)	Secondary care (n=3,553, 0.5%)	Tertiary care (n=130,042, 17.8%)	P value
Age, yr	55.8±18.17	64.3±17.05*	63.4±16.35*†	<0.001
Male sex	228,541 (38.4)	1,707 (48.0)*	63,514 (48.8)*	<0.001
Performance of spirometry	84,266 (14.1)	1,924 (54.2)*	68,793 (52.9)*	<0.001
Comorbidity				
Allergic rhinitis	390,427 (65.5)	2,610 (73.5)*	89,503 (68.8)*†	<0.001
Hypertension	77,627 (13.0)	1,142 (32.1)*	32,480 (25.0)*†	<0.001
Diabetes mellitus	38,727 (6.5)	636 (17.9)*	16,992 (13.1)*†	<0.001
Arthritis	31,885 (5.4)	493 (13.9)*	15,227 (11.7)*†	<0.001
Ischemic heart disease	20,111 (3.4)	185 (5.2)*	4,096 (3.2)*†	<0.001
Osteoporosis	11,633 (2.0)	374 (10.5)*	9,184 (7.1)*†	<0.001
Congestive heart failure	11,115 (1.9)	172 (4.8)*	4,851 (3.7)*†	<0.001
Depressive disorder	8,961 (1.5)	365 (10.3)*	7,848 (6.0)*†	<0.001
Anemia	4,607 (0.8)	126 (3.6)*	2,970 (2.3)*†	<0.001
Pneumothorax	5,265 (0.9)	74 (2.1)*	2,073 (1.6)*†	<0.001
Insurance type				
Health insurance, \$	492,274.89 (93.8)	2,770.04 (88.5)*	100,090.75 (87.4)*†	<0.001
Medical aid, \$	32,613.22 (6.2)	360.35 (11.5)	14,477.32 (12.6)	

Data are expressed as mean ± standard deviation or number of patients with percentage. *, P<0.05 versus primary care; †, P<0.05 versus secondary care.

Table 2 Comparison of asthma medications ever used across the patients in primary, secondary and tertiary care

Medication	Primary care (%)	Secondary care (%)	Tertiary care (%)	P value
ICS/LABA	121,886 (20.5)	2,465 (69.4)*	84,124 (64.7)*†	<0.001
ICS	78,653 (13.2)	1,564 (44.0)*	30,325 (23.3)*†	<0.001
OCS	220,995 (37.1)	2,250 (63.3)*	60,068 (46.2)*†	<0.001
LABA	1,608 (0.3)	105 (3.0)*	2,871 (2.2)*†	0.003
LAMA	9,221 (1.6)	723 (20.4)*	23,061 (17.7)*†	<0.001
LTRA	370,580 (62.2)	2,773 (78.1)*	93,912 (72.2)*†	<0.001
SABA	140,356 (23.6)	2,539 (71.5)*	54,270 (41.7)*†	<0.001
Oral beta agonist	149,174 (25.0)	1,617 (45.5)*	33,542 (25.8)*†	<0.001

Data are expressed as mean \pm standard deviation or number of patients with percentage. *, $P < 0.05$ versus primary care; †, $P < 0.05$ versus secondary care. ICS, inhaled corticosteroids; LABA, long-acting β_2 agonist; OCS, oral corticosteroids; LAMA, long-acting muscarinic antagonist; LTRA, leukotriene antagonist; SABA, short-acting β_2 agonist.

**Figure 1** Annual number of outpatient visits per patient.

patients receiving secondary or tertiary care than primary care ($P < 0.001$ for all comorbidities). Secondary and tertiary care patients were more likely to receive (financial) medical aid than did primary care patients (11.5% secondary *vs.* 12.6% tertiary *vs.* 6.2% primary care patients, $P < 0.001$).

Comparison of asthma medications used in primary, secondary and tertiary care

ICSs, alone and combined with LABAs, oral corticosteroids, LAMAs, LTRAs, SABAs, and oral β -agonists were used significantly more often by those in secondary and tertiary than primary care. Of patients treated via primary care, LTRAs were used by 62.2% and ICSs/LABAs, ICSs, and oral corticosteroids by 20.5, 13.2, and 37.1%, respectively.

Of secondary and tertiary care patients, LTRAs were given to 78.1% and 72.2%, respectively (Table 2).

Comparison of outpatient visit, ER visit, and hospitalization among patients treated in primary, secondary and tertiary care

The mean number of annual outpatient visits was highest among patients receiving secondary care, followed by those receiving tertiary care and primary care (number of outpatient visits/patient/year, 8.4 ± 9.5 *vs.* 7.3 ± 6.9 *vs.* 4.9 ± 5.7 , respectively; $P < 0.001$; Figure 1). Acute asthma exacerbation was most common in patients receiving secondary care ($n = 1,570$, 44.2%), followed by those receiving tertiary ($n = 22,887$, 17.6%) and primary care ($n = 11,921$, 2%)

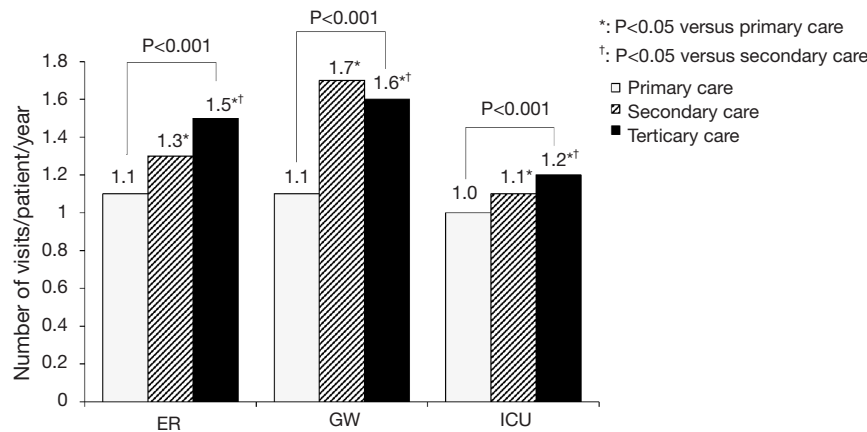


Figure 2 Annual number of visits per patient to emergency room, and annual number of admissions per patient to general ward and intensive care unit. The annual number of emergency room (ER) visits per patient was calculated for those who ever visited an ER and the annual number of admissions to general ward (GW) per patient was calculated for those who were ever admitted to GW. The annual number of admissions to intensive care unit (ICU) per patient was calculated for those who ever experienced ICU admission.

Table 3 Comparison of cost/patient/year in asthma patients across primary, secondary and tertiary care

Medical cost	Primary care	Secondary care	Tertiary care	P value
Cost/patient/year of outpatients, \$	98	308	240	<0.001
Cost/patient/year of inpatients, \$	2,432	3,593	3,347	<0.001
Total cost/patient/year of outpatients and inpatients, \$	298	2,355	1,534	<0.001

All costs are presented in US dollars; 1 dollar was equivalent to 1,070.80 Korean won on March 28 2018.

during the study period ($P<0.001$; primary *vs.* secondary *vs.* tertiary care).

Of patients who ever visited an ER or were admitted to a GW or an ICU, the mean numbers of annual visits per patient to the ER and the mean annual admission rates per patient to GWs or ICUs differed among patients receiving primary, secondary, and tertiary care ($P<0.001$ for ER visits, $P<0.001$ for admissions to GWs, and $P<0.001$ for admissions to ICUs; *Figure 2*).

Outpatient and inpatient medical expenses

As shown in *Table 3*, the total medical costs/patient/year of outpatients and inpatients were highest for those receiving secondary care, followed by those receiving tertiary and primary care ($P<0.001$ for outpatients and $P<0.001$ for inpatients). The total medical (outpatient and inpatient) costs/patient/year were the highest for patients receiving

secondary care, followed by those receiving tertiary and primary care (mean \$2,355 *vs.* \$1,534 *vs.* \$298; $P<0.001$).

Discussion

We used HIRA data on almost all Koreans to study the clinical characteristics, the medications, utilization of medical facilities, and medical costs of asthma patients receiving primary, secondary and tertiary care. Of 729,343 patients who required treatment for asthma, most (81.7%) received primary care, while 17.8% received tertiary care and 0.5% secondary care. Asthma patients treated in secondary or tertiary care centers were older and had higher rates of comorbid diseases than did those receiving primary care. LTRAs were commonly prescribed to all patients, but the prescription rate of ICS-containing inhalers was low in primary care. The patients treated in secondary or tertiary care used more medical facilities with frequent outpatient

visits, ER visits and hospital admissions than those receiving primary care. The total medical costs were over 8-fold higher for patients treated via secondary than primary care.

Although most asthma patients are managed via primary care, some with severe asthma and those who experience frequent acute exacerbations despite optimized medical therapy, should be considered for transfer to the specialists for evaluation of correctable risk factors (1,16). Accordingly, in the present study, patients receiving secondary or tertiary care utilized more medical facilities than those receiving primary care. Asthma patients treated in secondary or tertiary care centers exhibited more outpatient visits, and ER and hospital admissions (including ICU admissions) than those treated via primary care. Accordingly, the annual per-patient medical costs of secondary and tertiary care were significantly higher than those of primary care. Older age and a higher prevalence of comorbid diseases in asthma patients receiving secondary or tertiary care might have contributed to the increased medical costs.

The quality of asthma management in secondary care centers, estimated according to the use of ICS-containing inhalers and PFT performance, was similar to that of tertiary care. In addition, outpatient clinic visits and GW admissions were more common in patients receiving secondary than tertiary care. However, the proportion of patients persistently receiving secondary care was only 0.5%, much smaller than the proportion receiving tertiary care. Perhaps, this phenomenon is explained by the relatively easy access to tertiary care in Korea. Patients can directly visit tertiary care centers with only a referral note from the primary care physician. As secondary care is geographically more accessible than tertiary care, asthma patients with comorbid conditions may prefer to visit local secondary care centers. The tertiary hospitals of Korea include 43 comprehensive general hospitals with respiratory specialists and 280 general hospitals with or without such specialists. Thus, the clinical severity of asthma in tertiary hospitals with respiratory specialists might be diluted by less severe asthma patients treated in tertiary hospitals without respiratory specialists.

ICS-containing inhalers are the first-line therapy for long-term control of asthma (1). In the USA, the prescription rate of ICSs to asthma patients is 72.5% (23) and it is 43% in Europe (2). In the present study, the overall prescription rates of ICSs/LABAs and ICSs were 28.6% and 15.2%, respectively, reflecting low usage of ICS-containing inhalers by those in primary care (21% ICSs/LABAs and 13% ICSs). Given that LTRA is the most common

medication prescribed to primary care patients (62.2%), primary physicians may find it difficult to explain inhaler techniques. Also, because relatively higher proportions of patients with stable or asymptomatic asthma receive primary care, patient adherence to inhalers may be poor in the real world (24,25). However, a low ICS prescription rate can trigger poor asthma control (26). Continuous education emphasizing the useful role of ICS-containing inhalers in terms of asthma control is urgently needed by physicians and primary care patients.

The GINA guidelines (1) indicate that once asthma has been diagnosed, PFT should generally be recommended both at that time and 3–6 months after treatment initiation, as lung function is a useful indicator of disease severity and a predictor of the risk of acute exacerbation (27–30). However, PFT was performed on only 14% of primary care patients, which was lower than in Canada (23%) (31). PFT was performed on approximately 55% of secondary and tertiary care patients, similar to the rate associated with specialist care in Canada (55%) (31). This may be because PFT is not easily available in primary clinic compared to secondary or tertiary care. Also, approximately half of all patients did not undergo PFT when treated in secondary or tertiary care centers. Thus, lack of knowledge of physicians regarding the importance of PFT could be possible reason for the low PFT rate. Further studies are needed to investigate the poor adherence to guidelines regarding PFT.

The medical costs associated with asthma vary widely worldwide; the mean annual per-patient cost is \$1,900 in Europe and \$3,100 in the USA (32). In the Asia-Pacific region, the annual per-patient direct cost ranged from \$108 to \$1,010, being \$268 in Korea, thus similar to that of most other countries of the Asia-Pacific region (33). In our study using HIRA data, the total direct medical cost for patients in primary care was \$298/patient/year, and averaged \$528/patient/year for all patients (in primary, secondary, or tertiary care). The total medical costs differed by the nature of the care delivered, with a substantial economic burden being imposed by patients receiving secondary and tertiary care.

Our study had certain limitations. First, the patient adherence to inhalers could not be assessed because the HIRA database does not record such information. Second, the definition of patients belonged to each health care was arbitrarily based on the number of visits to clinics due to mixed visits among primary, secondary or tertiary care. This is explained by a unique feature of the Korean healthcare system, which allows patients to freely visit any specialist

once the primary care physician writes a referral note. Finally, the reasons for the low-level prescription of ICSs and performance of PFT by primary clinics remain unclear. Further studies are necessary to investigate obstacles to appropriate management. Despite these limitations, the large amount of nationwide data evaluated in the present study provided useful information on asthma management in daily practice in Korea and can aid in the development of improved asthma management.

Conclusions

Most patients with asthma were managed in primary care, but those receiving secondary or tertiary care utilized more medical facilities with higher medical costs. Given the low use of diagnostic measures and the low rate of prescription of inhalants containing corticosteroids to patients in primary care, we suggest that continuous education of both patients and physicians is required to improve the quality of asthma management.

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Footnote

Conflicts of Interest: Chin Kook Rhee has received consulting/lecture fees from MSD, AstraZeneca, Novartis, GSK, Takeda, Mundipharma, Sandoz, Boehringer-Ingelheim, and Teva-Handok. Hye Yun Park has received lecture fees from AstraZeneca, Novartis, and Boehringer-Ingelheim. The other authors have no conflicts of interest to declare.

Ethical Statement: The study was approved by the Institutional Review Board of the Catholic University of Korea, Seoul St. Mary's Hospital (approval no. KC16RESI0560).

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