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Underutilization of Hospital-based Cardiac Rehabilitation after Acute Myocardial Infarction in Korea

Sun-Hyung Kim,[1*] **Jun-soo Ro**,[2*] **Yoon Kim**,[3,4] **Ja-Ho Leigh**,[2] **and Won-Seok Kim**[1]

[1]Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seongnam, Korea
[2]Department of Rehabilitation Medicine, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea
[3]Department of Health Policy and Management, Seoul National University College of Medicine, Seoul, Korea
[4]Institute of Health Policy and Management, Medical Research Center, Seoul National University, Seoul, Korea

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Address for Correspondence:
Ja-Ho Leigh, MD
Department of Rehabilitation Medicine, Seoul National University Hospital, Seoul National University College of Medicine, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.
E-mail: jaho.leigh@gmail.com

Won-Seok Kim, MD, PhD
Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, 82 Gumi-ro 173-beon-gil, Bundang-gu, Seongnam 13620, Republic of Korea.
E-mail: wondol77@gmail.com

*Sun-Hyung Kim and Jun-soo Ro contributed equally to this work.

ORCID iDs
Sun-Hyung Kim
https://orcid.org/0000-0001-5845-5436
Jun-soo Ro
https://orcid.org/0000-0002-8156-5294

ABSTRACT

Background: Cardiac rehabilitation (CR) after acute myocardial infarction (AMI) is recommended as a mandatory intervention in several national clinical practice guidelines published in America, Europe, and Korea to reduce recurrence and mortality. However, underutilization of CR is an established worldwide issue. In Korea, the promotion of CR is expected due to coverage by National Health Insurance. Nevertheless, the national status of CR use has not been reported. This retrospective cohort study aimed to investigate the current status of CR use in patients with AMI using nationwide data from the National Health Insurance Service of Korea.

Methods: Patients with AMI admitted with the diagnosis of 'I21' code (from International Classification of Diseases, 10th revision, Clinical Modification) from July 1st, 2017 to June 30th, 2018 were included. CR use was defined as CR treatment or evaluation being performed during an outpatient follow-up period within 6 months after discharge. Participation rate and density were calculated nationally and by administrative division. Logistic regression analysis was performed to identify the influencing factors of CR participation.

Results: Nationally, 1.5% of AMI patients (960/64,982) underwent CR during outpatient treatment after discharge. CR density was approximately 10. Logistic regression analysis revealed that influencing factors included old age, female sex, rural residence, and low Charlson comorbidity index.

Conclusion: Hospital-based CR after AMI is underutilized despite its coverage by the National Health Insurance. More CR facilities have to be installed according to the needs of CR in various regions.

Keywords: Acute Myocardial Infarction; Cardiac Rehabilitation; Patient Participation Rates; Density; Barrier; Health Services Underutilization

INTRODUCTION

Ischemic heart disease (IHD) is one of the most burdensome chronic diseases in Korea.[1] With an improvement in survival after IHD,[2] more efforts are being channeled towards secondary

Yoon Kim
https://orcid.org/0000-0001-7257-1679
Ja-Ho Leigh
https://orcid.org/0000-0003-0465-6392
Won-Seok Kim
https://orcid.org/0000-0002-1199-5707

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Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

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prevention.[3] Cardiac rehabilitation (CR), an aspect of secondary prevention program, is highly recommended after IHD in national clinical practice guidelines,[4-6] (based on the evidence of CR) for improving clinical outcomes.[7-9] Nevertheless, CR participation rate after IHD has been low and shows disparities between countries[10] and individuals on account of various barriers.[11] According to a global report based on the responses of experts in CR from countries in 2017, and IHD burdens report from the Institute for Health Metrics and Evaluation, CR was available in only half of all countries, and the number of CR facilities for patients with IHD was insufficient in Korea.[12,13] The number of incident IHD cases per year per CR facility in Korea was 22, higher than the median value among countries worldwide (n = 21) and the mean of the Organization for Economic Cooperation and Development countries (n = 17).[12]

In Korea, CR was primarily introduced around the late 1990s. There has been expert- and government-led efforts to promote CR. Regional cardiocerebrovascular centers have been established since 2009, and a total of 14 centers are being operated to improve the quality of cardiovascular treatment, including CR. CR services after IHD have been reimbursed as medical treatment benefits since February 2017. Despite these efforts, the rate of CR participation remains low in the hospitals actively delivering CR (14%–35%).[11] Nationwide CR participation rates are expected to be lower, considering the insufficient number of CR facilities[12]; however, this has not been estimated in Korea. Understanding the current status of nationwide CR use may be an important first step to establish an effective strategy towards the promotion of CR in Korea.

Therefore, this study was designed to measure the nationwide hospital-based CR participation rate, the current numbers of hospitals delivering CR services among patients after acute myocardial infarction (AMI), and the insufficiency in the number of CR facilities in Korea compared to those of other high-income countries. The Korean National Health Insurance Service (NHIS) database from 2017 was used, because only claim codes starting from February 2017 could be identified. Similarly, the risk factors for CR nonparticipation after AMI were identified in hospitals considered as actively delivering CR.

METHODS

Data source

The NHIS, the only insurer operated by the Korean government, covers 97.0% of the Korean population.[14] The NHIS database contains eligibility information (income-based insurance contributions, demographic variables, date of death), healthcare utilization information (diagnosis, length of stay, treatment costs, services received), and healthcare provider information (types of institutions, human resources, equipment).[15] With permission to access the database, one can collect information about demographics, inpatient and outpatient medical service claim data, and disorders diagnosed per the International Classification of Diseases, 10th revision, Clinical Modification (ICD-10-CM) codes.

Operational definitions of AMI patients and CR participation

Patients were diagnosed with AMI if they were 1) aged between 40 and 80 years, and 2) hospitalized according to the ICD-10-CM based diagnosis of AMI (I21). In a previous study, this definition had a range between 71.4%–73.1% accuracy and fair-to-good reliability.[16] The index admission occurred between July 1, 2017 and June 30, 2018 (**Fig. 1**). This period was selected with consideration for National Health Insurance coverage of CR starting in February 2017.

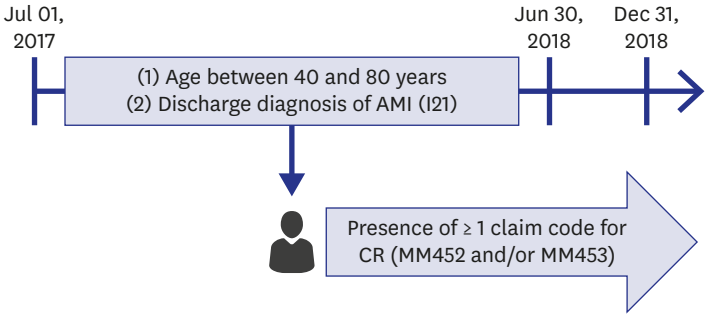

Fig. 1. Study flow.AMI, acute myocardial infarction.

The CR participation was defined as the presence of at least one outpatient-based claim code for 'MM452 (cardiac rehabilitation evaluation)' or 'MM453 (cardiac rehabilitation therapy)'. To avoid irrelevant claims, the claim code had to be presented within 6 months after the diagnosis of AMI until December 31st, 2018 (**Fig. 1**). During the analysis period, the medical costs of CR were fully insured by the NHIS.

Other variables

Age, sex, and the amount of health insurance premium were identified from the NHIS database. Age was categorized as follows: 40–60, 61–70, and 71–80. Based on the amount of health insurance premium per patient, the income status among all Korean citizens was estimated as quartile. All subjects were classified into urban and rural residents according to their place of registration, which was Si-Gun-Gu (administrative districts in Korea). Urban residents were defined as people living in 'Si' or 'Gu', whereas rural residents were those who live in 'Gun'.

The classification variable in the NHIS database was used in the identification of hospital types. The hospitals were classified into three divisions according to the Korean medical law as follows: tertiary hospital, general hospital, and hospital.

For the identification of underlying comorbidities of patients, Charlson comorbidity index (CCI) was obtained by reviewing ICD-10-CM diagnoses.[17] In this study, CCI was categorized as 0–4, 5–6, and ≥ 7.

Data analysis and outcomes

Based on the definition, as mentioned earlier, the number of AMI patients and CR participants were estimated. The crude CR participation rate was calculated using the formula below:

$$\text{CR participation rate (\%)} = \frac{\text{Number of CR participants}}{\text{Number of AMI patients}} \times 100$$

CR density, which was first suggested by Turk-Adawi et al.,[12] means the number of AMI cases per year per CR facility. Higher numbers represent less sufficient capacity of CR services.

$$\text{CR density} = \frac{\text{AMI incidence}}{\text{Number of CR facilities} \times \text{Median annual capacity per facility } (=250)}$$

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The numbers below the decimal point were rounded off. In addition, the number of CR facilities could be identified from the administrative data. Median annual capacity per facility was adapted from the report from Turk-Adawi et al.[12] It was estimated by surveying the average number of annual patients-per-center to CR experts in each country. In Korea, this number was 250. CR participation rate and density was calculated both nationally and by administrative division.

Statistical analysis

Baseline characteristics of the study participants according to CR participation were expressed as the number and percentage, and each variable was categorized. Values were compared using χ^2 tests. Logistic regression analyses were conducted to identify the influencing factors of CR only in hospitals with more than 10 CR participants per year, considering the volume threshold for the supply pattern of CR. The SAS software (version 7.1; SAS Institute, Cary, NC, USA) was used, and a 2-sided *P* value of < 0.05 was considered statistically significant.

Ethics statement

This study was approved by the Institutional Review Board (IRB) of Seoul National University Bundang Hospital, Korea (IRB No. X-1901/514-901), the need to obtain informed consent was waived due to the retrospective nature of the study. Data in the Korean NHIS were fully anonymized for analyses.

RESULTS

Baseline characteristics

During the index period, 64,982 patients were hospitalized following the clinical diagnosis of AMI in Korea, including 43,160 (66.4%) males and 21,822 (33.6%) females. **Table 1** shows the characteristics of the study population according to CR participation. Significant differences were observed between the participants and the nonparticipants following classification by age, sex, residential area, hospital type, and CCI. High ratios of older age, female, rural resident, hospital (non-tertiary, non-general), and low CCI were observed in the nonparticipant group.

CR participation rate and density

In the 64,982 study subjects, the national CR participation rate was 1.5% (960/64,982). There were 26 CR-providing facilities (15 tertiary hospitals and 11 general hospitals). In the calculation of the CR density, the number of study subjects was treated as annual AMI incidence. According to this parameter, the national CR density was approximately 10 AMI incidence/capacity/year, which means 10 times more CR facilities are needed to accommodate the incidence of AMI.

The CR use, according to the administrative divisions, is presented in **Table 2**. The CR participation rate widely varied across the nation, ranging from 0.0% to 6.4%. Similarly, variation was observed in CR density, with values ranging from 3 to 18.

Among 8,855 patients who were treated in hospitals with more than 10 participants per year, the participation rate increased to 9.5% (843/8,855).

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Table 1. Baseline characteristics of study participants

Characteristics	Total	CR participants	CR nonparticipants	*P* value
Number	64,982	960 (1.5)	64,022 (98.5)	
Age, yr				< 0.001[a]
40–60	25,508	513 (2.0)	24,995 (98.0)	
61–70	19,496	307 (1.6)	19,189 (98.4)	
71–80	19,978	140 (0.7)	19,838 (99.3)	
Sex				< 0.001[a]
Male	43,160	824 (1.9)	42,336 (98.1)	
Female	21,822	136 (0.6)	21,686 (99.4)	
Insurance premium				0.347
1st quantile	11,868	171 (1.4)	11,697 (98.6)	
2nd quantile	11,236	164 (1.5)	11,072 (98.5)	
3rd quantile	14,731	226 (1.5)	14,505 (98.5)	
4th quantile	21,237	353 (1.7)	20,884 (98.3)	
Medical aid recipients	5,008	35 (0.7)	4,973 (99.3)	
Urban/rural				< 0.001[a]
Urban resident	55,997	887 (1.6)	55,110 (98.4)	
Rural resident	8,981	73 (0.8)	8,908 (99.2)	
Hospital type				< 0.001[a]
Tertiary hospital	19,790	634 (3.2)	19,156 (96.8)	
General hospital	27,274	306 (1.1)	26,968 (98.9)	
Hospital	10,190	10 (0.1)	10,180 (99.9)	
CCI, preoperative				< 0.001[a]
0–4	7,843	9 (0.1)	7,834 (99.9)	
5–6	34,302	594 (1.7)	33,708 (98.3)	
≥ 7	23,797	357 (1.5)	23,440 (98.5)	

Data are presented as number (%).
CR = cardiac rehabilitation, CCI = Charlson comorbidity index.
[a]Significance below 0.05.

Table 2. Hospital-based CR utilization by administrative division

Administrative division	AMI incidence	No. of CR-providing facilities	CR capacity[a]	CR density[b]	CR participation rate, %
Seoul	14,015	7	1,750	8	1.3
Busan	5,672	2	500	11	2.3
Daegu	4,549	1	250	18	1.7
Incheon	2,845	1	250	11	2.1
Gwangju	2,561	1	250	10	1.1
Daejeon	1,627	1	250	7	0.9
Ulsan	1,522	0	0	-	0
Gyeongi-do	12,409	5	1,250	10	1.9
Gangwon-do	2,491	2	500	5	1.0
Chungcheongbuk-do	1,996	1	250	8	0.2
Chungcheongnam-do	2,598	0	0	-	0.1
Jeollabuk-do	2,637	1	250	11	4.8
Jeollanam-do	2,319	0	0	-	0.1
Gyeongsangbuk-do	2,936	1	250	12	0.3
Gyeongsangnam-do	4,004	2	500	8	0.4
Jeju-do	801	1	250	3	6.4
Total	64,982	26	6,500	10	1.5

AMI = acute myocardial infarction, CR = cardiac rehabilitation.
[a]CR capacity calculated as the median number of patients that each facility could serve per year (= 250) multiplied by the number of facilities; [b]CR density calculated as the AMI incidence divided by CR capacity.

Factors associated with CR participation

Factors associated with the CR participation are shown in **Table 3**. The younger age group demonstrated a higher odds ratio of CR participation than did the older age group. Male patients participated more in CR than female patients did. In addition, urban residents seemed to participate more in CR than rural residents. Patients with the lowest CCI ranging from 0–4

Table 3. Logistic regression analysis for CR participation

Variables	OR (95% CI)	*P* value
Age, yr		< 0.001[a,b]
40–60	2.804 (2.259–3.479)	
61–70	2.272 (1.811–2.849)	
71–80	Ref.	
Sex		
Male	2.026 (1.675–2.539)	< 0.001[a]
Female	Ref.	
Insurance premium		
1st quantile	0.853 (0.432–1.053)	0.953
2nd quantile	0.912 (0.691–1.145)	0.274
3rd quantile	0.987 (0.752–1.110)	0.315
4th quantile	Ref.	
Urban/rural		
Urban resident	1.382 (1.062–1.797)	0.016[a]
Rural resident	Ref.	
CCI		0.001[a,b]
0–4	0.073 (0.030–0.177)	
5–6	1.133 (0.976–1.316)	
≥ 7	Ref.	

CCI = Charlson comorbidity index, CI = confidence interval, CR = cardiac rehabilitation, OR = odds ratio.
[a]Significance below 0.05; [b]*P* for trend.

participated less in CR than those with CCI ≥ 7. No significant difference was observed in CR participation between the groups classified based on insurance premium quantile.

DISCUSSION

Despite the recommendations accentuating the role of CR in AMI patients,[4-6] only 1.5% of these patients participated in the CR program in Korea. There was geographical variance in participation, ranging from 0.0% to 6.4%. The relatively high AMI incidence obtained in this study compared to that of the Statistics Korea[18] and a range of 71.4%–73.1% accuracy of the operational definition for diagnosing AMI[16] could have resulted in the underestimation of the participation rate. Nevertheless, even considering these limitations, the participation rate of 1.5% was remarkably lower than that of Europe (30%–50%)[19] and the United States (10.3%–16.3%).[20] According to our calculation, the CR density in Korea was about 10. This means that approximately 234 more CR facilities should be established to cover the annual incidence of AMI.

In hospitals with > 10 CR participants, the CR participation rate was similarly insufficient (9.5%). This suggests that efforts are required to promote CR participation even in actively-operating CR facilities; the identification of CR barriers is important to plan effective promotion strategies. This study showed a markedly lower CR participation in patients with old age, female sex, and rural residence, in line with the results of previous studies.[21-23] The reasons for inadequate CR participation among these populations are multifactorial.[24,25] Proposed explanations for low participation in elderly patients include inadequate physician referral, comorbidity-associated mobility issues, and transportation issues.[26] Poor CR participation in females might be attributed to insufficient physician referral, more familial responsibilities, and less spare time to attend CR programs.[27] Self-reliant rural attitudes and low accessibility to medical facilities might have contributed to poor CR participation among rural residents.[28] To overcome these issues, strategies should be implemented,

including automated referral systems, improved awareness of CR, flexible therapy hours, and alternative CR delivery models such as home- and community-based CR.[24,29]

In this study, no difference was observed between the participants and the nonparticipants with regard to income status; this is different from previous studies that revealed higher income earning patients attend CR more in Europe[30] and the United States.[31] One possible explanation for the unobserved difference is the decreased economic burden of CR due to its coverage by the National Health Insurance in Korea. Another possible explanation is that high income earning patients are more likely to be economically active with insufficient time to participate[32]; this can offset the beneficial effects of high income on CR participation. Therefore, further study is required to clarify the effect of socioeconomic status on CR participation in Korea. Similarly, CCI was not a significant factor in previous studies investigating CR barriers.[23,33,34] However, the fewer comorbidities group (the group with the lowest CCI ranging between 0–4) participated least often in this study; this could be due to the less motivation and fewer needs of these patients, which could have resulted in nonparticipation in CR.[11,35] In addition, CCI is determined by the number of comorbid diseases, and this may not directly reflect the patient's physical or cardiac function, which are important factors for CR participation.[36] Therefore, a further study including variables such as cardiorespiratory fitness level or ejection fraction is needed.

In this study, only a limited number of potential barriers were retrospectively investigated. Nevertheless, various CR barriers have been reported in the literature[21,37,38] and they may differently affect CR participation depending on the particular clinical situation in each hospital or region. Therefore, efforts to identify CR barriers in each region and planning effective CR promotion strategies according to identified barriers are required.[39]

There are several limitations to this study. First, the diagnosis of AMI was operationally defined using medical claim records. In a previous study, this method has been known to have an accuracy ranging between 71.4%–73.1% and fair-to-good reliability.[16] Nevertheless, there are possibilities of false exclusion or inclusion. Second, national CR density was calculated using the median capacity of Korean hospital-based CR facility participating in a previous global survey.[12] Most of the hospitals used in the estimation of the CR capacity were tertiary or general hospitals that probably had larger CR capacity, and the CR density may have been underestimated. In addition, the distance from a CR facility to a patient's home is an important influencing factor for CR participation[27] that was not considered. For example, a CR facility with a large capacity could be situated extremely far from the patient's home; therefore, the required number of CR facilities based on CR density in this study could have been equally underestimated. Third, there could be mismatch between procedure, benefits, and claim record. Because the period of index admission in this study was the transition period of the change in benefits type for CR, there is a possibility of incomplete reimbursement for any reason. Therefore, follow-up research until the post-transitional period is important. Fourth, other known factors that affect participation in CR, including physician referral pattern, the ability to drive, and education level, were not evaluated.[21,23] Further comprehensive studies should be performed to evaluate CR barriers. Fifth, indication for CR was confined to AMI in this study. Current indications for CR are broader, including other cardiovascular diseases such as unstable angina, valvular heart disease, heart failure, and peripheral arterial diseases.[5,6,40,41] Therefore, the possibility of unrevealed demand for CR exists. Further studies, including these group of patients, are needed. Finally, this is the initial report of CR utilization (in the period of CR utilization) in Korea. Three more regional

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cardiocerebrovascular centers were installed in 2019, and more hospitals may provide CR at this time. Therefore, a follow-up study is required.

In conclusion, hospital-based CR participation rate after AMI was only 1.5% nationally, and the overall supply was insufficient in Korea, despite coverage by the National Health Insurance, compared to CR use in other high-income countries. To overcome these problems, more CR facilities and effective strategies to overcome CR barriers are required. Therefore, a follow-up study with a more comprehensive evaluation of barriers to CR is needed in the future.

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