

Development of Models for Regional Cardiac Surgery Centers

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Background: This study aimed to develop the models for regional cardiac surgery centers, which take regional characteristics into consideration, as a policy measure that could alleviate the concentration of cardiac surgery in the metropolitan area and enhance the accessibility for patients who reside in the regions. **Methods:** To develop the models and set standards for the necessary personnel and facilities for the initial management plan, we held workshops, debates, and conference meetings with various experts. **Results:** After partitioning the plan into two parts (the operational autonomy and the functional comprehensiveness), three models were developed: the 'independent regional cardiac surgery center' model, the 'satellite cardiac surgery center within hospitals' model, and the 'extended cardiac surgery department within hospitals' model. Proposals on personnel and facility management for each of the models were also presented. A regional cardiac surgery center model that could be applied to each treatment area was proposed, which was developed based on the anticipated demand for cardiac surgery. The independent model or the satellite model was proposed for Chungcheong, Jeolla, North Gyeongsang, and South Gyeongsang area, where more than 500 cardiac surgeries are performed annually. The extended model was proposed as most effective for the Gangwon and Jeju area, where more than 200 cardiac surgeries are performed annually. **Conclusion:** The operation of regional cardiac surgery centers with high caliber professionals and quality resources such as optimal equipment and facility size, should enhance regional healthcare accessibility and the quality of cardiac surgery in South Korea.

Key words: 1. Regional allocation of resources
2. Health services accessibility
3. Quality of health care
4. Thoracic surgery
5. Health facilities

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Introduction

Optimal healthcare facilities and human resource distribution strategies in health policy could enhance geographic accessibility for regional healthcare by properly allocating resources based on regional characteristics, minimizing duplication and waste of resources. If the supply system cannot respond appropriately to a region's health issue, the outcomes of patient health could diminish and the burden on patients and their families could increase [1]. Moreover, since it takes more than 10 years of education and training of medical personnel to develop medical resources and provide services, preparation via policy intervention is needed [2]. The regionalization model is one way to develop medical facilities and plan the education and training of personnel. The regionalization model takes population and geographical characteristics into consideration and prepares in phases a supply system that provides needed healthcare services in each region. The earlier regionalization model divided medical treatment into primary, secondary, and tertiary levels, and proposed that the 3rd medical treatment supply system was appropriate for a population size of 500,000 to 5,000,000 and a distance of 70 kilometers (or a 60-minute car ride) [1,2].

In South Korea, however, more than half of the population resides in Seoul and Gyeonggi regions, and healthcare resources are also concentrated in the metropolitan area. Therefore, when deciding on healthcare policies, countermeasures to prevent the concentration of healthcare usage in the metropolitan area are also discussed. Since patients are free to choose medical institutions and because regional healthcare services do not have systematic referral systems, concentration in the metropolitan area is predicted to increase for healthcare services such as cardiac surgery or cancer surgery, which requires a high degree of professionalism, medical personnel, and facilities. The following are percentages of patients who reside in non-metropolitan areas but used hospitals in the metropolitan area to undergo surgeries categorized as 3rd level medical treatment (including cardiac surgery): cardiac surgery (49.0%), brain surgery (22.5%), gastrectomy, which is mainly for cancer patients (35.2%), colorectal surgery (29.6%), and metrectomy (14.9%). Compared to other types of

surgery, patients were 1.4 to 3.3 times more likely to move from region to region for cardiac surgery region [3].

Analysis of the 2014 health insurance claims data showed that 87 medical institutions provided cardiac surgery in South Korea, and of those, 52 institutions (59.8%) were located in the metropolitan area and carried out 74.7% of the total number of cardiac surgeries. In particular, only 13 medical institutions performed more than 200 cases annually and of those, 10 were located in the metropolitan area [3]. Such regional imbalance of cardiac surgery-related resources hinders the geographic accessibility for patients in the region. For intensive healthcare services like cardiac surgery, which requires a high degree of resources, a dose-response relationship is shown between the quantity of treatment and the results of the treatment [4-7]. The regional imbalance of cardiac surgery-related resources could also affect the patient's accessibility to high quality healthcare.

Recently, the South Korean government has been designating and operating special public treatment centers per region for special treatment fields that need governmental support either because there is a lack of supply due to low profitability of the field, or because there is an imbalance of supply [8]. The examples include regional cancer centers, regional cardiovascular disease centers, regional respiratory disease centers, regional rheumatism and degenerative arthritis centers, children's hospitals, and emergency medical care centers. Special public treatment centers aim to improve the accessibility of health and medical services between regions and resolve the health level gap. Because the recently enacted legislation on the prevention and management of cardiovascular diseases includes provisions on the designation of cardiovascular disease centers and expenses needed for facilities, personnel, and equipment, the establishment of a comprehensive national plan for cardio-cerebrovascular diseases—not just cardiac surgeries—can be expected [9].

In addition, policy research was conducted on the establishment of regional cardiac surgery centers for the enhancement of cardiac surgery treatment in regions and the reduction of cardiac surgery concentration in the metropolitan area [3,10-12]. Results from surveys conducted on specialists and the general population showed that cardiac surgery patients

Table 1. Functions of regional cardiac surgery centers

Classification	General functions
Medical care function	
Core Medicare care key practice	Surgery Critical patient care
General medical care practice	In-patient treatment Out-patient treatment
Clinical support	Cardiology test Imaging test Diagnostic test
Management function	
Supply management	Management of goods and drugs Management of meal service
Education and in-service training	
Administrative management	Planning/budget/public relations Hospital administration/medical insurance General affairs/human resources, buying/procurement Management of facilities and environment, management of parking

were concentrated in large hospitals in Seoul, and to solve this issue, a plan to cultivate regional cardiac surgery centers was developed [12]. Establishing and operating regional cardiac surgery centers with good facilities, equipment, and high quality professionals should enable centers to carry out cardiac surgeries beyond a certain capacity, which in turn would enhance regional healthcare accessibility and the quality of cardiac surgery in South Korea.

This study aimed to develop models for regional cardiac surgery centers that take regional characteristics into consideration as one policy measure that could alleviate the concentration of cardiac surgery in the metropolitan area and enhance the treatment results for cardiac surgery patients who reside in regions. Moreover, it formulated standards on the necessary personnel and facilities needed for initial management plans.

Methods

This study is divided into two parts. The first is the development of models that incorporate the governance structure and functional capacity of regional cardiac surgery centers. The second is formulating plans on actual facilities and personnel for each of

the developed models. In order to develop the models, workshops and conference meetings were held with authors from various backgrounds such as welfare policy, the department of thoracic and cardiovascular surgery, the department of preventive medicine, and hospital management. Other experts provided counsel and moderated debates. Visits to cardiac surgery institutions also helped with the development.

Among hospitals that were founded relatively recently, the average values from the top 3 were applied to facility plans for each model. For plans on required personnel, it was assumed that 1 medical specialist would carry out 80 cardiac surgeries each year. The annual number of surgeries was determined based on the 2014 annual average (97.3 cases) of the top 10 national cardiac surgery institutions and the average of the top 20 institutions (69.9 cases) [3]. The number of medical specialists was calculated by assuming that 50% of doctors in the department of thoracic and cardiovascular surgery specialized in cardiac surgery. To plan the number of nurses, the nurse-per-bed standard that corresponds to grade 2 on the sliding scale of nursing management expenses for the intensive care unit and the general ward was applied.

In order to propose suitable models for each treatment region, suggestions were based on results from cardiac surgery demand projections. Population projection data from Statistics Korea and medical expenses data from the Health Insurance Review and Assessment Service were used for these predictions. Detailed results of demand projections can be found in the study by Lee et al. [13], which is included in the same issue of this journal.

Results

1) Development of the schematic model for regional cardiac surgery centers

The models for regional cardiac surgery centers was categorized into two parts: the autonomy of the main operating body and the degree of comprehensiveness of the functions. The autonomy of the main operating body was greatest when establishing an independent institution, and weakest when reinforcing the cardiac surgery function in the treatment functions of existing institutions. The compre-

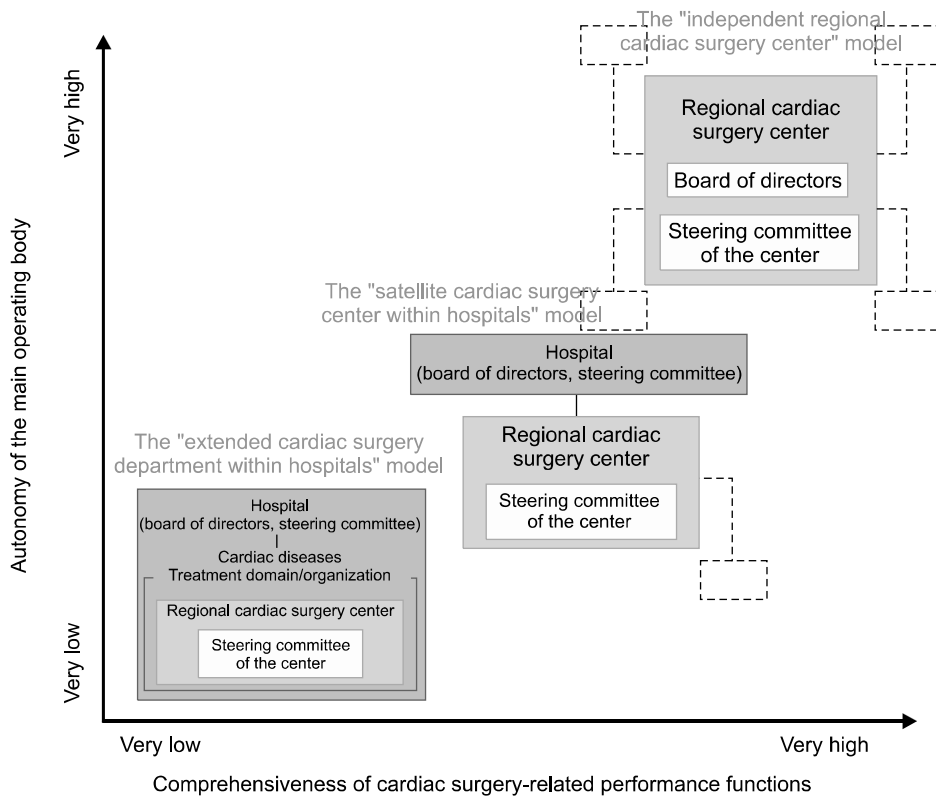


Fig. 1. Regional cardiac surgery centers models according to the scope of functions and operational autonomy.

comprehensiveness of cardiac surgery functions was classified as highest when all treatment and management functions for cardiac surgery were incorporated in the regional cardiac surgery center, and lowest when reinforcing cardiac surgery-related key treatment functions in existing institutions (e.g., surgery and treatment of critical patients). Table 1 summarizes the functions of a regional cardiac surgery center, which are divided into treatment functions and management functions. Treatment functions are further divided into key treatment functions and clinical support functions.

After classifying the management plans into two parts (the autonomy of the main operating body and the comprehensiveness of the functions), three models for regional cardiac surgery centers were developed, which are shown in Fig. 1: the 'independent regional cardiac surgery center' models, the 'satellite cardiac surgery center within hospitals' models, and the 'extended cardiac surgery department within hospitals' models. Establishing an independent regional cardiac surgery center is a model that allows the main operating body the most autonomy—the facility operates under a separate, independent management

system and includes all functions related to cardiac surgery, like surgery, anesthesia, treatment of critical patients, hospital admissions and outpatients, and diagnostic tests. The 'satellite cardiac surgery center within hospitals' models establish a new facility next to an existing hospital building, but the center shares medical equipment or anesthesia with the parent hospital and partially includes management functions. The 'extended cardiac surgery department within hospitals' models reinforce the key treatment functions (such as cardiac surgery), facilities, personnel, and equipment of an existing hospital to allow more cardiac surgeries to be performed than the present.

The 'independent regional cardiac surgery center' models take the region's existing supply system and characteristics into account. This model will have a high likelihood of success if there is a high demand for cardiac surgery within the region and preparations are sound for building a cooperation system between the main supply institutions. Compared to other models, this model more easily secures administrative autonomy. However, since the cardiac surgery treatment domain will be operated as a separate institution, the ability to build a cooperative

Table 2. Standards of personnel/facilities for each regional cardiac surgery center model

Classification	Independent regional cardiac surgery center model (presuming 500 cases/yr)	Satellite cardiac surgery center within hospitals model (presuming 500 cases/yr)	Extended cardiac surgery department within hospitals model (presuming 500 cases/yr)
Personnel			
Doctors	20	19	7.5
Department of thoracic and cardiovascular surgery	7	7	3
Department of pediatric cardiac surgery			
Department of vascular surgery			
Department of cardiovascular medicine	2	2	1
Department of pediatric cardiovascular medicine			
Department of anesthesia and pain medicine	2	2	1
Department of medical imaging	1	0.5	0.25
Department of laboratory medicine	1	0.5	0.25
Fellows	7	7	2
Nurses	39	38	16
Pharmaceutical/health service staff	10	5.5	1.75
Administrative staff	12	6	1.25
Facilities			
Site area	Approximately 520 pyeong ^{a)}	1,390 m ² (approximately 400 pyeong)	Approximately 140 pyeong
Total ground area for construction	Approximately 1,610 pyeong	Approximately 1,230 pyeong	Approximately 450 pyeong
Operating room	3 Rooms	3 Rooms	1 Room
Beds for intensive care unit	12 Beds	12 Beds	5 Beds
Beds for inpatient care	17 Beds	17 Beds	7 Beds

^{a)}Pyeong is a Korean unit to measure floor space. It equals 3.3068 m².

treatment system between surgical treatment and internal medicine treatment will be an important success factor.

The 'satellite cardiac surgery center within hospitals' model has an intermediate level of autonomy, but is a structure that could maintain a high level of comprehensiveness of different functions, depending on the method of management. This model is predicted to succeed in cases where there is a high demand for cardiac surgery within the region and when one medical institution has an unrivaled status for cardiac surgery in the region. If functions are appropriately divided between the existing medical institution and the regional cardiac surgery center, the center can partially utilize the infrastructure of the existing institution to increase efficiency and also secure autonomy for budgeting and human resources.

Lastly, the 'extended cardiac surgery department within hospitals' model has a relatively weak autonomy and a low level of comprehensiveness over various functions. This model is appropriate for regions where a large-scale investment in a facility is challenging because of low demand for cardiac surgery but where there is a need to enhance the level of treatment for cardiac diseases in the area. In cases where an existing medical institution possesses the capacity for cardiac disease treatment, like running a regional cardiac surgery center, the level of cardiac surgery in the region would improve with even a small-scale investment. However, securing the autonomy to run the regional cardiac surgery center seems relatively difficult in this model.

2) The capacity of operations and standards for personnel and facilities in the regional cardiac surgery center (plan)

In order to implement the facilities and models for cardiac surgery centers, the most integral feature is the capacity of cardiac surgeries that could be accommodated at the center. In order to efficiently utilize resources through scaling and enhance the quality of cardiac surgery care, the center must maintain a minimum capacity of cardiac surgeries annually. In this study, the capacity of cardiac surgeries is categorized into more than 200 cases per year and more than 500 cases per year. The reason the capacity is set for more than 200 cases per year is because it is the standard volume in which the relationship be-

tween the volume of treatment and the results of treatment appears significant and because it is the minimum capacity with which to operate an exclusive facility for cardiac surgeries (where 1 operation per day is possible) and also manage personnel with autonomy. The reason the capacity is set for more than 500 cases per year is because it is the minimum capacity with an economically valid standard and with it, the center could not only expect an enhancement in the quality of healthcare due to a definitive relationship between the volume of treatment and the results of treatment, but also operate a separate, autonomous facility [3].

Standards for personnel and facilities differ according to the capacity for surgeries and models of the regional cardiac surgery center, and results are presented in Table 2. The 'independent regional cardiac surgery center' model requires 20 doctors, 3 operating rooms, and 12 sickbeds in the intensive care unit. The 'satellite cardiac surgery center within hospitals' model requires 19 doctors, 3 operating rooms, and 12 sickbeds in the intensive care unit. The 'extended cardiac surgery department within hospitals' model was estimated to need 7.5 doctors, 1 operating room, and 5 sickbeds in the intensive care unit.

3) Application of the regional cardiac surgery center models to each treatment area

A qualitative approach is needed to determine the appropriate regional cardiac surgery center model for each region but at the same time, the different supply systems and circumstances of each area must be taken into account. In order to classify the regions, treatment areas for the regional cardiac surgery centers were categorized. This study used the Organization for Economic Cooperation and Development regional division that calculates the regional well-being index [14]. The categorization takes living zones and cultural characteristics into account. Each area has a population size that exceeds 5 million, except for Gangwon Province and Jeju Island.

The demand for cardiac surgery is the most important factor in determining the capacity and model of the regional cardiac surgery center. Based on the number of cardiac surgery-related patients and the 2040 population estimate, cardiac surgery demand for each region was projected (please refer to the

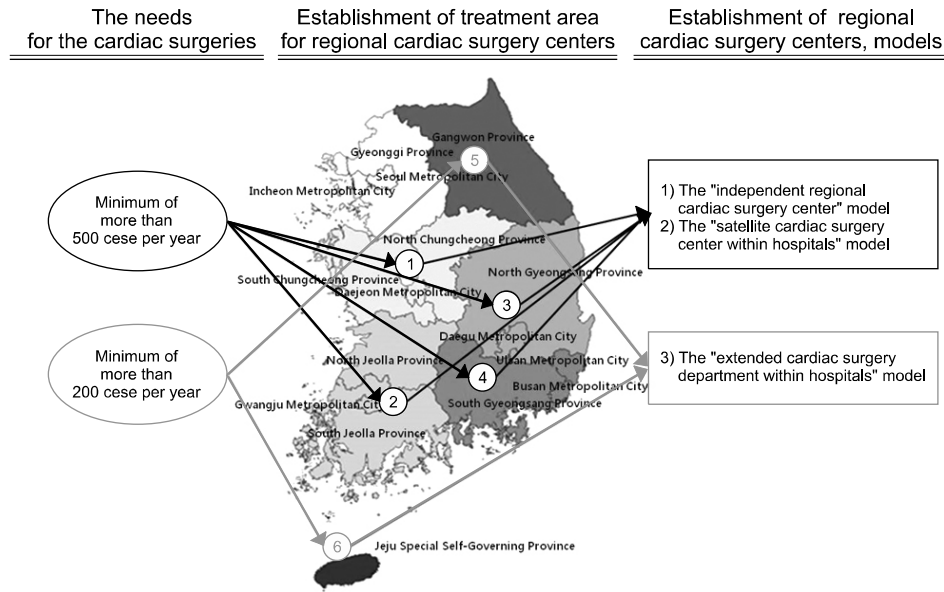


Fig. 2. The estimation of the needs for cardiac surgeries by regions and the application of the regional cardiac surgery center models.

study by Lee et al. [13], which is included in the same volume of this journal, for the method of demand projection). Regional cardiac surgery center models that could be applied to each region were proposed based on the 6 treatment areas (excluding the metropolitan area) and the projected cardiac surgery demand.

Regions with more than 500 cases of cardiac surgeries per year are the Chungcheong, Jeolla, North Gyeongsang, and South Gyeongsang areas while regions with more than 200 cases of cardiac surgeries per year are the Gangwon and Jeju areas. For treatment areas where there are more than 500 cases of cardiac surgeries, the ‘independent regional cardiac surgery center model’ or the ‘satellite cardiac surgery center within hospitals’ model could be established. For treatment areas where there are more than 200 cases of cardiac surgery per year, it is more efficient to establish the ‘extended cardiac surgery department within hospitals’ model than investing in a separate facility (Fig. 2).

Discussion

Cardiac surgery is a field in which there is a high concentration of patients in the metropolitan area because the surgery is mainly carried out in medical institutions located in the metropolitan area. Due to this, policies must be developed in order to enhance

the quality of healthcare and the geographical accessibility for patients residing in regions. In this study, plans to establish regional cardiac surgery centers in South Korea were proposed based on workshops and debates with authors and specialists and analyses of cases on facilities and personnel management.

Three models were developed after considering the minimum capacity of cardiac surgery needed to enhance treatment results of cardiac surgery, the autonomy of the main operating body, and the comprehensiveness of performance functions. Before the South Korean government designated and established regional cardiac surgery centers and special diseases centers, the government went through the process of researching various models and collecting different opinions. Quantitative and a qualitative analysis were also conducted in order to verify the political validity of the plans. The models developed in this study will need to go through a similar process in order to maximize receptiveness and efficiency.

This study has a few limitations. First, there is a possibility that the annual cardiac surgery demand per region, which is the basis of models for regional cardiac surgery centers and plans for personnel and facilities, might have been under-projected. When compared to the number of coronary artery bypasses performed per 1 million people in OECD countries, South Korea had the lowest level of all the member states and performed one-fifth of the number of car-

diac surgeries in Germany [15,16]. Moreover, South Korea's aging population and increase in chronic diseases are expected to cause the demand for cardiac surgery to grow in the future. The second limitation of this study is the failure to include regional receptiveness, which is an important factor in determining the actual success of the models. Lastly, while as many regional experts as possible participated in debates, there was a limit to the extent of representation for each region.

Additional discussions and research are needed in order to establish regional cardiac surgery centers and promote the stable management and continuous development of the centers. First, to designate regions for the establishment of regional cardiac surgery centers, the following must be taken into consideration: whether the region is willing to undergo the project, the preferences of the region, access to funding, the extent of project preparation, accessibility to the metropolitan area, and treatment environment. Because a massive amount of resources must be injected into the regional cardiac surgery center project, it will be difficult to procure investment into the large-scale project and maintain it if the strong will or preferences of the government, local government, and local residents are not reflected. In addition to securing resources for the establishment of regional cardiac surgery centers (e.g., finances, facilities, equipment, and professionals), regions that have collected the opinions of local residents on the project and prepared an agreement in advance could have an advantage. In particular, since forming a special team for heart treatment is required in order to maintain a certain capacity for surgery, medical institutions within the region must be willing to participate and build a cooperative network. Second, to establish and run regional cardiac surgery centers, detailed management plans must be set in order to define the specific functions of each model, design the governance structure for decision making, develop operation plans, and map out a treatment system that includes the entire treatment process, from surgery to cares after surgery and referring the patient. Third, for the regional cardiac surgery centers to be built and run in a stable manner from the outset, political support plans must accompany the project. Specific policies must be developed to attract patients within the region and plans to preserve profits

must be sought until the centers reach an expected surgery capacity.

In conclusion, the establishment and management of regional cardiac surgery centers supported by well-qualified professionals and advanced facilities and equipment, should enable centers to carry out the optimal number of cardiac surgeries in the regions, which will, in turn, enhance regional health-care accessibility and the quality of cardiac surgery in South Korea.

Conflict of interest

No potential conflicts of interest relevant to this article are reported.

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