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Optimal Supply and the Efficient Use of Hospital Bed Resources in Korea

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Section 1. Necessity and Purpose of the Research

1. Necessity of the Research

Various health care policies that were implemented to resolve imbalance in health care resources brought our nation a quantitative and qualitative expansion in the supply of health care resources. However, there still is controversy regarding the imbalance of health care resources among different regions, and the health care issues, such as the increasing and diversifying illnesses such as chronic diseases, are not properly handled. In the future, reasonable and efficient allocation of health care resources and the issue of fair distribution should be considered important, and improving the supply system of the health care resources to meet the needs of the era and to seek the efficient use of resources would be an important task (Oh et al., 2009). In particular, the efficient use of hospital bed resources is an important factor of health care policies. Because a large investment is involved in developing and supplying the health care resources, such as hospital bed allocation and health care facilities, it is advisable that supply is made to equal the demand. Insufficient supply will cause the problem of not satisfying the citizens' demand for health care, while excessive supply will result in wasting the nation's resources. Furthermore, if the excessive supply occurs for health care resources, such as hospital beds and facilities, medical expenses to be paid by the citizens will increase due to an induced demand beyond the problem of wasting resources.

Despite such importance, our nation still experiences many problems in terms of the supply and demand of hospital beds from the quantitative, distributive, and managerial aspect. In particular, management of the nation's overall hospital bed supply by type along with the regional hospital bed supply is emerging as the most important task given the related issues, such as the excessive supply of acute care beds due to an expansion of hospital beds by large hospitals in the capital area and the increase in the long-term care hospital beds due to the adoption of a long-term care insurance system. At this point, a review of South Korea's supply-demand policy for hospital beds is required, and simultaneously preparing an overall strategy corresponding to the new health care demand and an overall plan to manage the regional supply and demand are necessary. In addition, in the case of long-term care beds in the future, a policy-based review is necessary to evaluate expanding various intermediate facilities, such as nursing homes and hospice facilities for terminal patients in addition to the long-term care hospitals, depending on the various demands for long-term care.

2. Purpose of the Research

We sought to determine a supply-demand, use, and management plan for hospital bed resources, which meets the society's needs by correcting the numerical, distributive, and qualitative imbalance of the hospital beds. This plan should be applicable to our nation so that all citizens can afford correct care from the correct provider and so that the overall health care system can achieve improved efficiency, reduced medical costs, and improved patient health.

First, we developed indices for the status of the imbalance in supply-demand of the hospital beds by region and analyzed the level of imbalance and its causes. Second, a proper level of hospital beds for our nation was estimated on the basis of the data and reference of Organization for Economic and Cooperative Development (OECD) countries. Third, based on the recent policies on hospital bed resources of other countries, we sought implications that can be applied to our nation's policy for hospital bed supply and demand and its management. Fourth, by suggesting a policy alternative that can correct the imbalance in the supply and demand of the hospital bed resources, we attempted to suggest a plan that would make the supply system of health care efficient and improve the management system of the health care resources.

Section 2. Research Method and Content

1. Research Frame

Theoretical Considerations and review on preceding studies	□ Expectations on changes in health care environments and supply and demand of hospital bed resources. □ Review on theoretical models for analysis on causes of hospital bed resources imbalance. □ Review on hospital bed resources supply and demand estimation models. □ Review on management of major national hospital bed resources.
Analysis on supply and demand of hospital bed resources and its impact	□ Analysis on the current status of hospital bed resources and its changes. □ Analysis on the imbalance of the bed resources distribution and its causes. □ Analysis on the impacts of the bed resources supply. □ Expectations on supply and demand of the bed resources.
Review on foreign countries' cases	□ Review on supply and demand management of hospital bed resources in foreign cases and its implications.
Policy suggestion	□ A plan for optimal supply and demand of hospital bed resources. □ A plan for efficient utilization of the bed resources.

2. Research Method

This study incorporated various research methods, such as literature reference, analysis of the existing data, and the policy advisory council meetings.

A. Literature Review

By considering existing domestic and overseas studies of hospital bed resources, an overall research frame has been established through a method that quantifies the imbalance in hospital bed resources and sets forth a supply-demand model. By reviewing the hospital bed supply-demand policies in selected countries, we sought implications for an efficient way to use hospital bed resources and an efficient management system.

B. Analysis of the Existing Data and Investigation of the Real Conditions

To analyze the actual conditions of the hospital bed resources and the trend of their changes, as well as the imbalance and its causes, data from Korea Statistics (2014), Health Insurance Review & Assessment Service's data on the status of nursing homes, and the National Health Insurance Service's data on the patients' use of medical care (2013) were analyzed and a model was estimated. In addition, we attempted to forecast an optimal supply and demand of our nation's hospital bed resources by using the reference on hospital bed resources, socioeconomic data, and health care data of OECD countries.

C. Statistical Modeling and Estimation

To estimate the level of equity in the distribution of hospital bed resources, we utilized the regression analysis and Gini index using the regional group data by city and by district (Si, Gun, and Gu). Multinomial logic model and the ordinary least square (OLS) method were applied in the analysis for the cause of a regional imbalance of hospital bed resources. Curve estimation and the ARIMA model were applied to estimate the supply and demand of the high-price medical equipment. The panel analysis was applied to predict the optimal supply and demand of our nation's hospital bed resources.

D. Organizing Consultative Groups on Research and Policy Advisory Council Meetings

Regarding the points that must be considered in a research seeking an optimal supply and demand level and an efficient use of the hospital bed resources, but are not completely covered by the above methods, a consultative group on research was formed by academia, medical specialty societies, government, and health care organizations so that a review from the perspective of health care experts may be incorporated. Their opinions were surveyed through individual in-depth interviews, consultative meetings, and workshops.

2 Theoretical Considerations

2 Theoretical Considerations

This chapter discusses the need for government intervention in health care due to the field's distinct characteristics, proper extent of the intervention and its policy, and the rules for the allocation plan of health care resources. Lastly, establishment of a theoretical frame of this research is attempted through a consideration of preceding studies of hospital bed resources.

Section 1. Health Care and Government

1. Need for Government Intervention in Health Care

Human desires are unlimited, while the resources that can satisfy such desires are limited. In particular, in the case of a health care sector, because it requires highly skilled human resources and expensive equipments and facilities, the decision on how to allocate such health care resources efficiently and fairly is important for health care policies.

Ways to approach this problem can be categorized into two types: a method where the government directly intervenes and a market competition policy (Kim et al., 1989). Among these two approaches, health care has taken government intervention for granted, due to its genuine characteristics, such as the existence of externalities, incomplete knowledge, and uncertainty. This is because the government enforces political, economic, and legal intervention to raise efficiency and equity. Given such factors, the goal of government intervention is to offset market failures, inequity in health and health care use, an excessive spending for medical bills, inefficiency, and an unbalanced distribution and inefficient allocation of the resources. Details about the government's role can be described as follows.

First, in general, market failure occurs and causes inefficiency when the conditions for a purely competitive market have not been satisfied, which leads to government intervention. Health care is one of the representative areas where market failure occurs due to its characteristics, such as the failure of market competition resulting from not satisfying the conditions for a pure market competition, public good, externality, and information failure. Due to these characteristics of a health care market, the government inevitably intervenes in regulation and promotion policies, instead of leaving the production, consumption, and distribution to the competition governed by the market theory (Kwon, 2004).

Second, one of the goals of health care is to improve equity. Because the subject of a policy is the human being's life in health care, the matter of equity has been an even more important interest of the public policy and currently is recognized as a fundamental right. Thus, equity is a very important standard of evaluation in health care. Equity can be defined from the perspective of the interclass difference and distribution of health care and health-related indices set forth by the related socioeconomic variables.

In particular, the core variable that determines a citizen's health is inequity (Kqwachi & Kennedy, 1999; Wilkinson, 1997; Wilkinson & Picket, 2006). Inequity harms the health of not only the poor class but also the overall citizens. The more the nation pursues equity, the happier the citizens will be. Therefore, government must consider a policy means to improve the inequity in health and use of medical care. Equity in the use of medical care can be improved by faithfully providing insurance benefits or through financial support that waives the expenses to be paid by the poor people or directly provides medical care for them.

Third is the emergence of health as a human right. Living a healthy life is a human being's universal wish and has been recognized as a universal right that should be enjoyed by anyone. Health became not an individual problem but a problem for all of us. Thus, health care provided by the nation, emerging as one of the fundamental rights necessary for survival instead of an endowment made to a beneficiary, has established itself as an active right that can be requested actively from the nation as well as a passive right to ask the nation not to intervene with a healthy life. Today, it is beyond discussion that the nation should take responsibility in maintaining and improving citizens' health, and the concept is progressing to one of guaranteeing the "citizens' health" beyond a simple "institutional guarantee" of health care (Oh, 2005).

2. Proper Level of Government Intervention and the Policy

Due to the characteristics of health care, government intervention is inevitable. Notwithstanding such characteristics, the fact that government intervention also creates much inefficiency cannot be overlooked. Some examples are the inefficient management and operation caused by the lack of an owner; reacting to consumer needs less sensitively, which leads to low consumer satisfaction because the business does not face as severe competition as in the private sector; careless management due to a more stable employment and bureaucratization; and difficulty in evaluating the achievement of the public sector whose objective is to pursue the welfare of the patients, unlike the private sector that pursues profits.

Inefficiency caused by government intervention is considered government failure or nonmarket failure. Excessive government intervention causes government failure while shrinking the private sector. In addition, because enforcing government policy necessarily creates beneficiaries and victims, there is a limit in maximizing the overall benefit to the society. Nonetheless, a proper policy that embraces efficiency and equity must be adopted, because the key point of establishing a health care policy is to vitalize market economy by curing the market failure and to decide the proper level of the government's role that can allocate resources efficiently. Appropriate level of government intervention that can maximize the efficient allocation of usable resources cannot avoid being affected by the society's normative values. The equity and efficiency can be the reference frame for establishing health care policies (Oh et al., 2005).

To measure the proper level of hospital bed resources in the public health care sector and to evaluate the current status of our nation compared to the proper level, the concept of the proper level of public health care sector hospital beds must be defined more strictly. That is, the optimal standard with regards to hospital bed resources in the public health care sector must be evaluated according to a socially agreed upon standard. Academically, the most widely accepted methods for estimating the optimal value involves two processes.

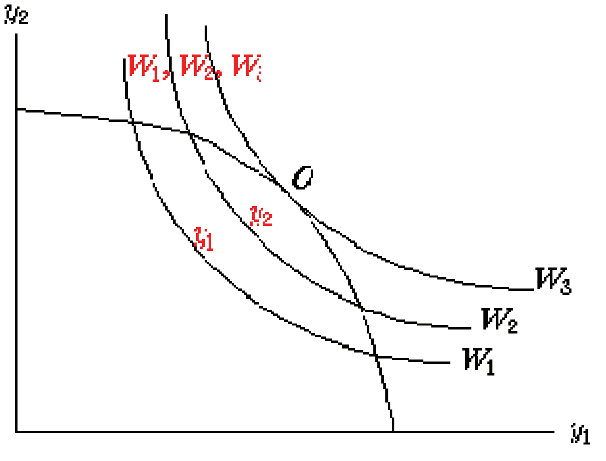
First, we must estimate the production possibility curve, which indicates the maximum output values that can be produced with a given limited resources or means of policies. Second, determining the points on the estimated production possibility curve that maximize the socially agreed upon social welfare function becomes the standard for evaluating the optimal standard. For example, let us introduce an economy where *n* different outputs $y_1, y_2, \ldots, y_n$ are being produced, and each output requires *m* different inputs, $x_1, x_2, \ldots, xm$.

$$
\begin{aligned}
y_1 &= f_1(x_{11}, x_{21}, \ldots, x_{m1}), \\
y_2 &= f_2(x_{12}, x_{22}, \ldots, x_{m2}), \\
&\cdots \\
y_n &= f_m(x_{1n}, x_{2n}, \ldots, x_{mn}), \\
\sum_{j=1}^{n} x_{ij} &= x_i, \ \ i = 1, 2, \ldots, m.
\end{aligned}
$$

On the other hand, assuming that the socially agreed upon social welfare function can be defined as $W = W(y1, y2\ldots, yn)$, finding the combination of outputs that maximizes the social welfare function becomes the standard that determines the optimal output level.

$$
\begin{aligned}
&\max \ \ W(y_1, y_2, \ldots, y_n) \\
y_1 &= f_1(x_{11}, x_{21}, \ldots, x_{m1}), \\
y_2 &= f_2(x_{12}, x_{22}, \ldots, x_{m2}), \\
&\cdots \\
y_n &= f_m(x_{1n}, x_{2n}, \ldots, x_{mn}), \\
\sum_{j=1}^{n} x_{ij} &= x_i, \ \ i = 1, 2, \ldots, m.
\end{aligned}
$$

If there are only two types of outputs, the production possibility curve can be drawn as below, and the optimal points that maximize social welfare function can be evaluated as the crossing points between the production possibility curve and the indifference curve.



The Figure above shows a graph with a combination of different levels of social welfare, while each curve provides the same level of social welfare. To reach the highest level of social welfare, the output can be considered the values corresponding to the point O (Lee, 1998). However, in reality, estimating this type of production possibility curve and finding the optimal production levels based on a proper social welfare function are difficult. In addition, realistically, because estimating a proper social welfare function can likely be highly arbitrary, there is difficulty in applying this method to the real economic policy (Oh et al., 2005).

In this study, to estimate the proper level of hospital bed resources in the public health care sector, a model for proper supply of hospital beds will be established for each of the three categories including all OECD countries, countries with a government-based health care supply system, and countries with a private-based health care supply system. That is, based on the average relationship that appears in the OECD countries, estimates for the proper level of hospital bed resources will be compared against the actual values of South Korea to determine the appropriateness. In other words, the basis of the proper level refers to the public hospital bed ratio based on the average relationship between the variables observed as determinants of the public health care sector in OECD countries (or countries with a government-based or private-based health care systems), which will be applied for the rest of discussion.

Section 2. Preceding Studies on Hospital Bed Resources

There have been 4 types of prior studies on hospital bed resources in Korea. The first type focuses on the quantitative aspect of hospital beds, and derives a policy alternative by analyzing the current management status and medical care use behavior. The second type, by considering the distribution of hospital bed resources, focuses on the concentration around the capital area and supply and demand in the suburban area. The third type of study evaluates optimal supply and improvement in the management of special forms of hospital beds, such as emergency hospital and long-term care beds. The fourth type focuses on a specific policy alternative and analyzes reasons why previous hospital bed-related policies failed, and seeks how to adopt the alternative policy. Most of the domestic research is of the first type.

The first type of research, which focuses on the quantitative aspect of hospital beds, analyzes the relationship between the number of hospital beds, management status, and medical care use rates. Growth in the continuous supply of hospital beds has exceeded the rate of increase in the number of days that people stay in the hospital, resulting in a surplus supply. Meanwhile, there are structural issues, including the imbalance in hospital beds by type and by region, and problems with the size of hospital beds by hospital. Moreover, the general low use rate of hospital beds, tendency for the average length of stay to decline, and the inappropriate use of emergency hospital beds have been undesirable factors when considering the efficient use of hospital bed resources (Lee, 2003). These problems have been continuously in controversy and point out that there are situations, such as the inefficient use of hospital bed resources, distortion in health care delivery system, worsening business of less competitive hospitals or increasing number of bankrupt hospitals, overall imbalance in supply and demand, absence of monitoring systems, and the absence of policies, in which hospital bed resources management policies can be realized and intervention can improve the quality level (Park et al., 2011). With regards to these issues, it is necessary to establish the types of hospital beds by health care institutions to reestablish the function of health care facilities. Also necessary are setting up and continuously operating a monitoring system, setting up a health care facility management plan to ensure a management means for health care facilities, improving the approval procedure for building new health care facilities, review of adopting contractual care facilities, improving fee regulations to enhance the quality and applicability of health care facilities, modifying operation standards for health care facilities (modify health care delivery system), and developing the supply structure of medical services (Park, 2005). Given that many hospital beds already have been supplied, instead of a policy that simply restricts hospital bed supply, an effort to improve the efficiency of hospital bed operation, such as preparing the standards of facility and human resources by hospital bed type, or a graded fee system related to the quality (facility or human resource, etc.) of the medical care are necessary. Hong (2012) has suggested that a policy is necessary that induces health care providers to voluntarily change their practice style or behavior, by preparing a hospital bed monitoring system that continuously announces information, such as the length of stay and hospital bed use rates by area and by type, and reports the result to the health care facilities. On the other hand, there are studies analyzing the relationship between the number of beds, health care supply, and use of health care. Countries with a high hospital bed ratio have a long length of stay per event, and countries with a high ratio of health care human resources, such as doctors, pharmacists, and nurses show a high frequency of hospitalizations but a short length of stay per event. Among various human resources, nurses are most highly related to the amount of use of hospital beds. Thus, hospitalization behavior is highly influenced by the status of the nation's health care human resources, and the length of stay is largely affected by the condition of hospital beds (Jung, 1995).

The second type of study focuses on the concentration around the capital area with regards to the distribution of hospital bed resources. Supply oriented around the capital city has brought a quantitative growth. However, most are acute care beds that do not accommodate the needs for long-term care service. Even if the number of beds per person is high, competition for more hospital beds in large hospitals in the city has continued to increase, and the related policy that is unable to manage this situation properly has been indicated. According to the preceding studies, along with an enhanced policy to increase the effectiveness of the nationwide hospital bed supply plan, legislation is necessary to resolve the problem of excessive hospital bed supply in the capital area, which has reached a serious level. The studies also suggest that the thoughtless increase of beds in the metropolitan area hospitals should be limited to establish a proper allocation of health care resources among different regions of the country and to set up a stable health care delivery system. In addition, these preceding research studies claim that development of a policy regarding the function and roles of each type of health care facility, and reasonable establishment of function and roles by the type of health care facility are necessary (Lee, 2005; Choi, 2010). As for the estimation of mid- and long-term demand for hospital beds by region and the resulting needs for a specific policy alternative for the efficient use of hospital bed resources, regional imbalance has decreased significantly when the movement was measured based on the living zone as opposed to the administrative district of residence. Furthermore, considering that there is a difference in the form and cause of the movement based on the movement's level and standard, the preceding studies argue that establishing the standard and the process of understanding the cause and depth of the movement should be considered as important when evaluating the resource retention status of each region (Yoon, 2007)

Meanwhile, the studies related to the supply and demand of hospital beds in the suburban area indicate that, although the Article 29 of the Framework Act on Health Care states that health care resources must be distributed evenly among different regions to achieve a balance in the supply and demand of health care, there is a problem in the existing measurement method as there were insufficient research mechanisms to fairly measure the regional hospital bed resources of the nation. When measuring the regional distribution of hospital beds, results may differ depending on the measurement instrument; thus, instead of measuring only the region's average number of beds per population or the coefficient of variation, hospital bed distribution aspects can be compared reasonably. The index for hospital bed distribution must be suggested by simultaneously considering Gini index and the Lorenz curve, which can offer statistical values (Ahn, Park, and Kim, 2011). According to Lee (2005), optimal supply and demand has been suggested as an important means to resolve the financial crisis of the national health insurance, as the excessive supply of hospital beds has been pointed out as one of the causes of this crisis. However, Lee basically approaches the plan for hospital bed supply and demand only from the perspective of stabilizing the financial conditions of the national health insurance. In addition, comparing the hospital bed supply and demand plan by the local health care plan in the Local Public Health Act, the study pursues the same objective of rationalizing the local hospital bed supply and demand, but there is a problem of redundancy in the recording methods and frequency. Therefore, it is argued that by combining supply and demand plans for health care resources that now are defined separately in the Local Public Health Act and the Special Act for National Health Insurance Financial Stability, comprehensive rule should be specified in the Medical Care Act that most inclusively defines the rules related to health care resources.

Third, when considering research related to the imbalance in supply and demand by the type of hospital beds and a plan for optimal supply, because the supply of long-term care beds did not meet its demand in 2001, it was suggested that the over-supplied acute care beds should be converted. The numbers of necessary beds for long-term care facilities in 2001 were over 10,000 for long-term care hospitals, approximately 7000 for highly specialized nursing homes, and approximately 193,500 for specialized nursing homes, but the supply of long-term care beds was markedly inadequate. Thus, it was suggested that, as a plan for supplying long-term care beds, the supply and operation status of the long-term care beds, regional demand for long-term care facilities, and the supply status of the acute care beds should be presented. As there is an over-supply of more than 70,000 beds at facilities of the level of a hospital or above, it also was suggested that these beds be used as long-term care beds for the time being (Lee, 2001). It is necessary to review converting the current acute care beds to long-term care beds, which means building long-term care hospitals or wards, or inducing them to convert to highly specialized long-term care facilities. Regarding the functions of the small to mid-size hospitals, they can be promoted as regular hospitals and nursing home-type hospitals in the case of agricultural and fishing villages. Small to mid-size cities can promote specialized hospitals in addition to these two types of hospitals, while big cities can consider promoting specialized hospitals and nursing home-type hospitals. As for the current status of the hospitals beds in the nursing homes, the number of beds is increasing continuously instead of the acute care beds converting to nursing home beds. If this phenomenon continues, the possibility for an increased competition for more long-term care patients and lower pricing cannot be disregarded. If nursing homes maintain the trend of rapid increase, ignoring the supply and demand status, competition among nursing homes will become more severe, while bringing in more long-term care patients will become more difficult, deteriorating the meaning of pursing the hospital bed transformation project to ameliorate the business status of the small to mid-size hospitals. In addition, despite the fact that private nursing homes have expanded owing to the long-term care beds expansion project supported by the government, and a sufficient supply to accommodate the senior citizens' demand has been secured, there is a problem with the quality of service provided by nursing homes because of the price competition caused by a sudden increase in nursing homes in the absence of related regulations for nursing services, while the fees for nursing home beds implemented as of January 2007 have not been settled. This also is partly due to the failure of the hospital bed transformation project and unseparated functions of medical clinics, hospitals, and general hospitals. As a policy alternative, it is necessary to make the legal basis related to building long-term care beds and the standards for human resources more specific and to lower the fees for long-term care hospitals. In addition, it is necessary to convert some non-benefit items to benefit items by conducting actual inspections and investigations on the nonbenefits items and to set up the standards for medical care provided by the long-term care hospitals. Furthermore, providing patients with information on the treatment cost by the care hospitals will naturally induce competition, lowering the medical cost, and improving the quality of care.

Lastly, the fourth type of research analyzes why existing policies related to hospital bed resources failed and suggests the prospects of individual policies, such as limiting the total number of hospital beds, along with the methods to adopt the policies. Existing policies related to hospital bed resources were formed without securing sufficient time and material resources. Inadequate administrative management and support during the policy formation and announcement, and the absence of the instruction for the exact steps or procedures to be followed have been problems. Furthermore, proper handling, such as analyzing why the subject group's smooth adoption did not happen in consideration of the external conditions, was not implemented. Due to the repeatedly changing focus on policy issues and a decreased interest when new issues emerged, the relevant policy was not implemented at times (Do et al., 2002). This research suggests that a hospital bed resources policy should establish a plan to secure sufficient time and material resources, and properly prepare a related administrative support as a resolution to secure the efficiency of the policy limiting the hospital bed resources. On the other hand, one study attempts to resolve the issue of excessive hospital bed resources through a specific policy alternative called the policy of limiting the total number of hospital beds. Lee (2012) points out that, although the number of hospital beds in Korea is relatively high within OECD, a simply regulation-oriented local policy of limiting the total number of hospital beds is expected to have a reverse effect, from the perspective of medical care consumers who consider that improved quality of the nation's medical care is because of market competition among health care providers. Ultimately, a premise is necessary to institutionalize the policy of limiting the total number of hospital beds. That is, the number of hospital beds because of considering the health care facilities characteristics and the categorical characteristics should be distributed flexibly. In addition, hospital bed supply and demand must be adjustable based on the regional characteristics, while there is a need for a clear procedure and standard for deciding the amount of supply of local hospital beds. The policy of limiting the total number of hospital beds should be considered along with the policy of limiting the total local medical treatment as a parallel alternative (Lee, 2013). In adopting the policy of limiting the total number of hospital beds, a policy that is based simply on the total number of beds should be avoided. Clarification on the effect and limit of adopting the policy as well as avoiding the expansion of conflict-inducing controversy also are necessary. Lee also suggests securing the central government's capability to adjust supply and demand of hospital beds, strengthening standards for building new hospitals, and changing the current policy advisory council to a deliberative council to ensure the effectiveness of the hospital bed supply and demand plan. Furthermore, Jwa (2005) suggests implementing system to manage hospital bed resources. Because the existing hospital bed resources-related references have a problem in accuracy and miss a periodic, constant monitoring system, there is a need for determining the number, types, and the use status of hospital beds and implementing a monitoring system to systematically manage hospital bed resources. Consequently, pivotal points in system implementation are the creation of reliable data or material and the nation's efficient management of these materials. From this perspective, in the case of health care providers, the National Health Insurance Service, and the Health Insurance Review & Assessment Service, there is a drawback that the government cannot directly control. That is, it is considered as optimal that the community health centers in Si, Gun, and Gu, as the most basic units of administrative districts for managing the nation's health care facilities, take charge of gathering information. Also, efforts are put into minimizing the redundancies in the related jobs when designing the system. Preparing a web-based system that anyone can connect to from anywhere, anytime, and allowing researchers and regular citizens to use the system by providing real-time search results of basic statistical analysis are the characteristics of this management system. Lastly, the researcher suggests that a periodic real inspection must be done to increase the accuracy and reliability of the materials.

3 Research Methods

3 Research Methods

Section 1. Research Data

This study used data on hospital beds, health care use, and demographic and socioeconomic factors. Data on hospital beds and health care use were drawn from the Yearbook of Health and Welfare Statistics and internal data from the Health Insurance Review and Assessment Service. Data from Statistics Korea were used to obtain regional demographic and socio-economic information. This study examines the imbalance in hospital bed resources in municipality units; namely, Si (city), Gun (county), and Gu (district). In some areas, these administrative units differ slightly from the geographic areas in which individuals conduct their daily activities, leaving room for future debate. However, most of the administrative units are closely related to the geographic areas of daily activities, and government statistics and data are generally maintained in local administrative units. When the administrative units and areas of daily activities are significantly different, regional characteristics should be considered in the policy-development phase. Finally, to estimate the optimal number of hospital beds in Korea, health data from the OECD covering 33 years (1980–2013) were used. This dataset had a considerable number of missing variables across years and countries, significantly reducing the actual observations available for quantitative analysis. Furthermore, as the number of observations used in regression analysis is determined by the intersection of valid observations for all variables, adding a variable to an analysis reduces the usable observations, and reduces the reliability of estimates in a panel analysis. Therefore, estimations[1] were made for any missing OECD data to minimize the number of countries omitted from the analysis.

Section 2. Research Variables and Estimation Models

The optimal supply model for hospital beds in Korea was based on the need for medical care. This approach was used because an analysis of regional imbalance must be equity-based; basing an approach on the need for medical care rather than the demand for medical care is therefore valid. The model for determining regional imbalance in hospital beds in Korea analyzed the relationship between medical care need and hospital beds, using variables recognized as basic medical care need factors, including population size, age, and gender.

1) Estimates for missing data were calculated using specific methods: first, regression analysis was used when at least one data point was missing for a variable for a country in a cross-sectional data set; second, exponential smoothing was used when the data points for the last year in two time series variables for a country were missing; and third, linear interpolation was used when one of two observations for a time series variable was missing.

Gender was included as in general, women have higher medical care need than men. At present, the numbers representing the demand and supply of hospital beds in Korea are based on the inadequate use and supply of hospital beds, making it difficult to make precise estimation of demand and optimal supply. Therefore, optimal hospital bed resources in Korea were determined and future hospital bed supply estimated on the basis of comparisons with developed countries (relative ratios and averages), using data from OCED member countries.

1. Current Imbalance and Root Cause Analysis

A. Regional Imbalance (Equity) in Hospital Beds: Variables

The degree of regional imbalance in hospital beds was estimated using two methods. The first method, Gini Index estimation, indicates the overall imbalance in major hospital bed resources. The variables used in this method were the hospital bed numbers and population size in each region. The second method involved estimating an equity-based imbalance index for each region, using selected medical equipment by region and factors indicating basic medical care need in each region as variables. The regional variables describing basic medical care need included population size, ratio of females, proportions of children aged 0-4 and seniors aged 65-plus, and the health index (indicating the health state of residents).

〈Table 3-1〉 Model for Estimating Regional Imbalance in Hospital Bed Resources

	All hospital beds	Total number of general beds	All general beds (excluding tertiary hospital beds)	Nursing care beds
Population	x	x	x	x
Female ratio	x	x	x	x
Ratio of children aged 0-4	x	x	x	x
Ratio of seniors aged 65-plus	x	x	x	x
Health index	x	x	x	x
Estimation method	OLS	OLS	OLS	OLS

B. Variables used in the Root Cause Analysis of Regional Imbalance (Equity) in Hospital Bed Resources

The dependent variables used in the root cause analysis models of regional imbalance were the hospital bed imbalance index and hospital bed supply for each region. Hospital bed imbalance indices were categorized as follows: oversupplied region (imbalance index of +0.10 or higher), optimal supply region (imbalance index of −0.09 to +0.09), and supply shortage region (imbalance index of −0.10 or lower). These categories considered the distribution of imbalance indices for regions where estimations were based on equity. The categories were used as dependent variables in multinomial logistic regression, which involves designating a reference category and comparing other variables against this reference category. In other words, the odds that an outcome of a dependent variable belongs to another category in relation to the reference category are calculated (Maddala, 1983). The hospital bed supply variable was used to find the cause of regional imbalance in hospital beds through the analysis of hospital bed supply based on ordinary least squares (OLS). Explanatory variables used in both models included demographic variables, socioeconomic variables, and level of health. There are many other variables that may affect the distribution of hospital beds. However, demographic and socioeconomic variables associated with medical care demand, medical care need, and income may be crucial factors in determining the cause of imbalance (Ruhe, 1976; Cooper, 1975). In the first model (the multinomial logit model categorizing regional imbalance indices), the variables shown in Table 3-2 were selected; variables selected for the second model (the hospital bed demand and supply model) are shown in Table 3-3.

In the multinomial logit model, demographic variables associated with medical care demand and need were particularly important. Reinhardt (1975) noted that demographic variables were important as medical and health care supply (e.g., medical workforce) is generally concentrated in regions with a large effective demand; regions with a large absolute population size (POP) and high population density (DEN) may have high medical care demand or need. In addition, as demographic structure influences medical care demand, independent variables included the proportions of children aged 0–4 (AGE4R) and seniors aged 65-plus (AGE65R), considered the age distribution and ratio of females (FEMR), and incorporated the difference in medical care demand between men and women in each region. In addition, the model included birth rate (BRTR) and death rate (DTHR) as variables associated with health state that affect medical care demand and need, as well as the amount of health care use, length of hospital stay, and medical expenses, which can be used as proxy health state variables. The income level is an important economic variable because it directly impacts medical care use. However, as there were no available data to estimate the income level for local administrative units (e.g., city, county, and district), the local tax burden per capita (TAXO) and insurance premium (INCO) were selected as proxy variables for objective income indicators. Local taxes are primarily determined by property and farmland taxes and do not include income tax, making it difficult to represent regional income levels. Therefore, the model included the insurance premium, because this is determined by the income level. The fiscal self-reliance ratio (FIN) and proportion of beneficiaries of national basic livelihood support (POR) were also included as regional economic level indicators. The presence of tertiary hospitals (HOSP3) and general hospitals (HOSPGEN) were included as regional medical environment variables, along with the supply of drinking water (WATR) and population growth rate (2008-2012) (POPVARR) as regional environment and environmental change variables.

The hospital bed supply model used the same variables as described above for the multinomial logit model. The only difference was that the dependent variable in the second model was the number of hospital beds rather than the hospital bed imbalance indices used in the first model. The relevance index (RI) refers to the ratio of the local residents' use of local medical facilities in all medical facility use; a higher relevance index suggests that local medical facilities are high in quantity or quality. The commitment index (CI) refers to the ratio of local residents' medical care use in the total regional medical care use; a lower commitment index indicates a high level of use by residents from other regions, suggesting that local medical resources are high in quantity or quality.

High correlations were found in the independent variables included in the hospital bed imbalance model, including intercorrelations in the proportions of children aged 1–4 years and seniors aged 65-plus, death rate, and birth rate (representing demographic and aging characteristics); a correlation between supply of drinking water and population density (representing urbanization); and intercorrelations for local tax burden, proportion of beneficiaries of basic livelihood support, insurance premium per household, and fiscal self-reliance (representing the regional economic condition). In addition, there was a high correlation between the number of days visiting or staying in western or eastern medical facilities and the subjective health level ratio. The two variables that represented medical care delivery (the RI and the CI) were also correlated. The problem of multicollinearity occurs when correlated variables are simultaneously included in an estimation equation; therefore, factor analysis[2)] was performed. The factors included in the final model were urbanization level, economic level, objective health level, subjective health level, affinity of health care use, and concentration of health care use.

〈Table 3-2〉 Root Cause Analysis Model of Regional Imbalance in Hospital Bed Resources

Variables	All hospital beds (general beds +specialized beds)	General bed I	General bed II (excluding tertiary hospital beds)	Nursing care beds
Number of outpatient visits	x	X	x	x
Length of stay	x	X	x	x
Medical care expenses	x	X	x	x
Population	x	X	x	x
Female ratio	x	X	x	x
Age (percentage, %)				
0-4 ≥65	x x	X X	x x	x x
Crude birth rate	x	X	x	x
Crude death rate	x	X	x	x

2) Principal component analysis was used as the factor analysis method because the first principal component was a linear combination that accounted for most variance in the sample. The second principal component was a linear combination that accounted for most variance unrelated to the first principal component. The most commonly used orthogonal rotation method, Varimax, was used.

Variables	All hospital beds (general beds +specialized beds)	General bed I	General bed II (excluding tertiary hospital beds)	Nursing care beds
Population density (people/km2)	x	X	x	x
Local tax burden per capita	x	X	x	x
Monthly income per capita (insurance premium)	x	X	x	x
Fiscal self-reliance ratio (%)	x	X	x	x
Beneficiaries of national basic livelihood support (%)	x	X	x	x
Supply rate of drinking water (%)	x	X	x	x
Population growth rate (%)	x	X	x	x
Number of hospital beds per 1,000 people	x	X	x	x
Number of physicians per 1,000 people	x	X	x	x
Presence of tertiary hospitals	x	X	x	x
Presence of general hospitals	x	X	x	x
Relevance index (RI)	x	X	x	x
Commitment index (CI)	x	X	x	x
Estimation method	Multinomial Logit Model			

〈Table 3-3〉 Root Cause Analysis Model of Regional Imbalance in Hospital Bed Supply (OLS method)

Variables	All hospital beds (general beds +specialized beds)	General bed Ⅰ	General bed Ⅱ (excluding tertiary hospital beds)	Nursing care beds
Number of outpatient visits	x	X	x	x
Length of stay	x	X	x	x
Medical care expenses	x	X	x	x
Population	x	X	x	x
Female ratio	x	X	x	x
Age (percentage, %)				
0-4	x	X	x	x
≥65	x	X	x	x
Crude birth rate	x	X	x	x
Crude death rate	x	x	x	x
Population density (people/km2)	x	x	x	x
Local tax burden per capita	x	x	x	x
Monthly income per capita (insurance premium)	x	x	x	x
Fiscal self-reliance ratio (%)	x	x	x	x
Beneficiaries of national basic livelihood support (%)	x	x	x	x
Supply rate of drinking water (%)	x	x	x	x
Population growth rate (%)	x	x	x	x
Number of hospital beds per 1,000 people	x	x	x	x

Variables	All hospital beds (general beds +specialized beds)	General bed Ⅰ	General bed Ⅱ (excluding tertiary hospital beds)	Nursing care beds
Number of physicians per 1,000 people	x	x	x	x
Presence of tertiary hospitals	x	x	x	x
Presence of general hospitals	x	x	x	x
Relevance index (RI)	x	x	x	x
Commitment index (CI)	x	x	x	x
Estimation method	Ordinary Least Squares			

Note: 1) Hospital beds were calculated with per 1,000 people and the variable of health care use was with per capita.

C. Models and Research Variables for Estimating the Optimal Supply of Hospital Beds

Four models of hospital bed supply were used in this study: all hospital beds, acute care beds, long-term care beds, and public hospital beds. The dependent variables for these models were the ratio of the total number of hospital beds, number of acute care beds, number of long-term care beds, and public hospital beds respectively. Hospital bed supply is a medical resource determined by medical care demand. In this context, the model for the analysis of determinants of hospital bed resources can be explained within the medical care demand model.

A commonly used medical care demand model is the

Andersen behavioral model, which explains medical care use behaviors according to demographic and socioeconomic characteristics and diseases (Andersen, 1978). However, this model has limitations in that it has low explanatory power, and the difference in health care use is difficult to be explained by variables other than the disease (Mechanic, 1979). To address these problems, Andersen's model was modified to add medical care delivery system characteristics and patient characteristics (Dutton, 1986). In addition, for balanced health care use, the characteristics of care providers and medical care demand were considered (Ciocco, 1952).

The analyses of hospital bed supply models discussed in this study were based on Dutton's (1986) model, in addition to the results of previous studies. The basic factors used in hospital bed supply models include health care factors, demographic and socioeconomic factors, and medical care delivery and system factors. Medical expenses per capita and the public health care expense ratio were used as health care factors associated with the direct demand for hospital bed supply. Per capita income (GDP), proportion of seniors aged 65-plus, death rate, proportion of those with a secondary education and above, and female economic activity rate were used to represent demographic and socioeconomic characteristics. The number of doctors per 1,000 people was included as a care delivery factor that affects hospital bed resources. Medical expenses per capita, GDP per capita, and number of doctors per 1,000 people were transformed to natural log, and the number of doctors per 1,000 people was squared as the increase pattern may change as the number increases. The reduced form equation with which hospital bed supply was estimated is as follows:

$$Pbbed_{j,t} = X_{j,t}\beta_1 + Z_{j,t}\beta_2 + P_{j,t}\beta_3 + \epsilon_{j,t}$$
(note: $\epsilon_{j,t} = \mu_j + \lambda_t + \nu_{jt}$)

Here, j: Country

t: Year in time series (t = 1980, ⋯, 2013)

$Pbbed_{j,t}$: Proportion of public hospital beds

$Ttbed_{j,t}$: Total number of hospital beds

$Acbed_{j,t}$: Number of acute care beds

$Lcbed_{j,t}$: Number of long-term care beds

$X_{j,t}$: Vector of health care-related explanatory variables (health level, medical expenses) including a constant term

$Z_{j,t}$: Vector of demographic and socioeconomic variables (GDP, proportion of older adults)

$P_{j,t}$: Vector related to care delivery and system (number of doctors per 1,000 people, care delivery system type)

$\beta_1, \beta_2, \beta_3$: Vectors of respective coefficients to estimate

μ_j: Unobserved effect of individual country characteristics

λ_t: Unobserved time series effect

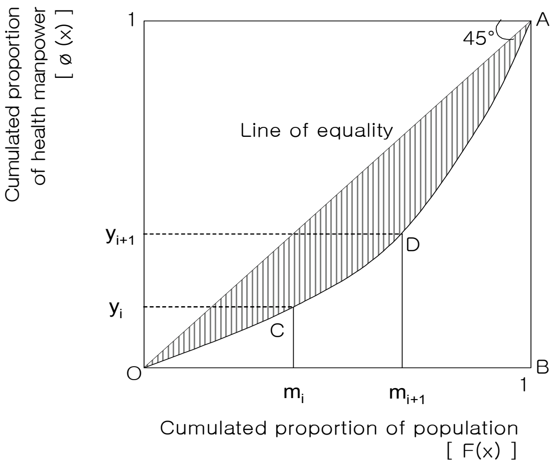
$\nu_{j,t}$: Stochastic disturbances (remainder term of stochastic distribution), that is, the error term that has the independent and homogeneous distribution with the mean of 0 and variance of $\sigma2$ for all countries (j) and time (t).

Section 3. Quantitative Model Estimation Methods

1. Estimation Methods for Regional Imbalance in Hospital Bed Resources

Regional imbalance or equity in hospital beds can be estimated by various methods. This study first investigated how regional imbalance in hospital beds changed between 2008 and 2012 using the Gini index, which is commonly used in estimating inequality in income distribution. Second, the regional degree of imbalance was estimated (from the standpoint of equity) after controlling for basic regional health care demand (including population size, gender, age, and health state) using the OLS method. The Gini index estimation method Gini indexcan provide a good indicator for a comparison of the change patterns in imbalance, because it represents hospital bed resources and population distributions for the entire country and provides a visual representation of regional imbalance with a Lorenz curve. Calculation of the Gini index is based on a Lorenz curve. To briefly describe the Gini index estimation method using hospital beds, Figure 3-1 shows the cumulative proportion of health care personnel by hospital beds on the horizontal axis, the cumulative proportion of population on the vertical axis, and the 45° line as an auxiliary line. To express these in equations, when $F(x)$ denotes the proportion of the population of regions with x or fewer hospital beds in the total population, and $\phi(x)$ denotes the proportion of the sum of the hospital beds in regions with a total number of hospital beds of x or fewer, they are expressed as $F(x)=\int_0^x f(t)dt$ and $\phi(x)=\frac{1}{\mu}\int_0^x tf(t)dt$ respectively, where μ is the mean and is expressed as $\mu=\int_0^\infty xf(x)dx$. In Figure 3-1, the 45° line represents the ideally balanced distribution, the perpendicular line (OBA) represents the most imbalance, and the curve (OA) represents the realistic distribution. Here the area between the line of perfect equality and the Lorenz curve (the hatched area), is called the concentration area; the ratio between this area and the area △OAB, that is, the estimate of the degree of imbalance, is the Gini index (Oh et al., 2009).

[Figure 3-1]Concentration Area



The hatched area representing imbalance is △OAB minus △OCAB. When the cumulative proportion of the population of a region is $m_i(_{i=0,1,\ldots M})$, the cumulative proportion of the population of the region in the next strata is m_{i+1}, and the cumulative proportions of hospital beds are y_i, y_{i+1}, respectively. CD becomes closer to a straight line as M approaches infinity(∞). The Gini index can be calculated as follows:

GI = (△OAB − △OCAB)/△OAB

$$= \left\{ \frac{1}{2} - \sum_{i=1}^{M} (y_i + y_{i+1})(m_{i+1} - m_i)/2 \right\} \times 2$$

$$= 1 - \sum_{i=1}^{M} (y_i + y_{i+1})(m_{i+1} - m_i)$$

The Gini index can range from 0 to1, with 0 indicating an ideal distribution, and 1 indicating complete imbalance; a larger Gini index value indicates more regional imbalance. The shape of the Lorenz curve is useful to determine the distribution, as it varies with the Gini index value, and can vary even when the values are identical (Oh et al., 2009).

The second estimation method was based on regression analysis. The Gini index can be used to indicate the overall hospital bed imbalance in Korea, but is limited in that it cannot provide information about which regions have a shortage or surplus of hospital beds. The Gini index is therefore a useful indicator for international comparison, but has limitations in informing specific, regional-based hospital bed supply policies. The regression analysis method complements this limitation and provides regional estimates of the hospital beds needed. This method assigns relative evaluative values to varying situations of hospital bed imbalance, and is suitable for approaches based on regional balance in supply or on the correspondence between demand and supply. The former approach is also an important basic step toward assigning the final target value based on the correspondence between demand and supply. Therefore, the indicator of imbalance in this study was estimated using an approach based on regional imbalance in the supply of hospital beds (Oh et al., 2009).

The regression model explaining the relationship between hospital beds and basic medical care demand variables can be established as follows:

$$[S_{ij} = k_i * POP_j + \alpha_i * SEXR_j + \beta_i * AGER_j + \gamma_i * HEALTH + \varepsilon_{ij}]$$

Here, $\widehat{S_{ij}}$, the predicted value of S_{ij}, denotes the standard number of hospital beds for a region that has a population size, POP, gender ratio, $SEXR$, age composition (proportions of children aged 1-4 years and seniors aged 65-plus), $AGER.$, and health level (the amount of medical care used as a proxy variable for health level), $HEALTH_j$; the regression coefficients k_i, α_i, β_i, and γ_i are estimated accordingly. Based on the standard number of hospital beds estimated using the equation, the difference in the actual capacity of hospital beds in that region is obtained. The imbalance index for each type of hospital bed is expressed as the following equation (Oh et al., 2009).

$$L_{ij} = \frac{S_{ij} - \widehat{S_{ij}}}{\widehat{S_{ij}}}$$

(note: $\widehat{S_{ij}} = k_i * POP_j + \alpha_i * SEXR_j + \beta_i * AGER_j + \gamma_i * HEALTH_j$)

L_i: Imbalance index of hospital beds for type i, in region j

S_{ij}: Number of hospital beds for type i, in region j

$\widehat{S_{ij}}$: Estimate of the standard number of hospital beds for type i, in region j

The value of the imbalance index is positive if the actual number of hospital beds in that region is above the standard number of hospital beds for the population size, and negative if the actual number is below the standard number. If the region has no hospital beds, the index is −1.0. The imbalance index for each type of hospital bed resources estimated by the procedure described above effectively represents the shortage of each type of hospital bed. The indicator of imbalance demonstrates that regions can be classified by differences in and relationships between imbalance situations, and the relative characteristics of different regional imbalance situations can be clarified by establishing the standard hospital bed resources for a specific population size as the reference for relative evaluation of imbalance situations, and then estimating the imbalance index for each region. A comprehensive picture of the relative positions of regions in terms of regional imbalance in hospital bed resources can be gained by categorizing regions based on the view that they are complete medical environments that include social and economic factors (Oh et al., 2009).

2. Methods for Estimating the Causes of Regional Imbalance and Supply and Demand in Hospital Bed Resources

Estimating the cause of regional imbalance in hospital bed resources can be conducted in two ways. The analysis can be performed by categorizing the regional imbalance indices (estimated using the model on regional imbalance in hospital bed resources) into three types. In general, when the dependent variable is binary, estimation methods such as linear probability model, logit model, and probit model are used, and the probit model is used when the error term has a normal distribution. However, when the dependent variable has two or more categories, the logit or probit models cannot be used and the multinomial logit model is used. In this study, as the dependent variable was types of imbalance in hospital bed resources, the probability that the dependent variable belongs to specific economic activity state j [P(Y=j)] can be defined as follows (Oh et al, 2009):

$$P(Y=j) = \frac{e^{\sum \beta_k x_k}}{1+\sum_{j=1}^{J-1} e^{\sum_{k=1}^{K} \beta_k x_k}} \quad \cdots\cdots (3\text{-}1)$$

In addition, the probability of an observation to belong to the reference category, J, is defined as (Liao, 1994):

$$P(Y=J) = \frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=1}^{K} \beta_k x_k}} \quad \cdots\cdots (3\text{-}2)$$

Accordingly, the probability of belonging to the category j, in relation to category J, can be expressed as follows because the denominators of the Eq. (3-1) and (3-2) are identical.

$$P(Y=j)/P(Y=J)=e\sum\beta_{jk}x_k \quad \cdots\cdots (3\text{-}3)$$

Taking the log to both sides of the equation results in:

$$\log[P(Y=j)/P(Y=J)]=\sum\beta_{jk}x_k \quad \cdots\cdots (3\text{-}4)$$

As a result, the multinomial logit model provides β in Equation 3-4 as a regression coefficient. When the analysis is performed with statistical software, the result is similar to the result of a regression analysis, with β in the result the same as β in Equation 3-4. As β is the ratio of two categories, the number of β coefficients varies depending on the number of categories. For example, when a dependent variable has three categories, two β coefficients are generated, and when a dependent variable has four categories, six β coefficients are generated. In this study, the dependent variable had three categories and the reference category was optimal supply, meaning two β coefficients were generated: one for supply shortage/optimal supply, and the other for oversupply/optimal supply. With these β coefficients, the probability that a value of the dependent variable belongs to each category can be obtained. The probability can be calculated as follows (Oh et al., 2009):

$$P(Y=1)=\frac{e^{\sum\beta_k x_k}}{1+\sum_{j=1}^{J-1} e^{\sum_{k=1}^{K}\beta_k x_k}} \quad \cdots\cdots (3\text{-}5)$$

$$P(Y=2) = \frac{e^{\sum \beta_k x_k}}{1+\sum_{j=1}^{J-1} e^{\sum_{k=1}^{K} \beta_k x_k}} \quad \cdots\cdots (3\text{-}6)$$

$$P(Y=0) = \frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=1}^{K} \beta_k x_k}} \quad \cdots\cdots (3\text{-}7)$$

In the second method, data for OECD member countries was used to estimate the optimal supply of hospital beds. When using data that combines cross-sectional and time series data (as in the OECD data on individual countries by year), the error term of the established model is likely to include disturbances in the cross-sectional data, disturbances in time series data, and combined disturbances of the two data types. In other words, when OLS estimation is performed on the combined data, the error term is expected to have heteroskedasticity and autocorrelation. Therefore, use of combined data requires panel analysis. Panel data have a temporal element of specific periods added to certain cross-sectional data components (Maddala, 1992). The structure of a panel analysis model is expressed as follows:

$$y_{it} = \alpha_i + \mathbf{z}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \text{ for } i = 1,\Lambda, N,\ t = 1,\Lambda, T,$$

$$z_{it} : 1 \times k \text{ vectors, } \beta : k \times 1 \text{ vectors.}$$

Panel analysis models are largely divided into fixed effects models and random effects models.

○ Fixed Effects Model

The fixed effects model estimates coefficients using combined data on the assumption that the units of time series and cross-section have different intercepts. Therefore, α_i, which denotes the intercept (shown below), is fixed even if the unit of time or cross section considered in the model changes. In addition, if there is no dependence between the explanatory variable, $Z_{i,t}$, and the constant term, α_i, the estimates are the same as those obtained from introducing a dummy variable into an ordinary regression equation. Therefore, when the assumption between $Z_{i,t}$ and α_i is met, regression coefficients estimated with the fixed effects model are the most efficient estimators. The fixed effects model can be expressed as follows:

$$\mathbf{y}_i = \mathbf{i}\alpha_i + \mathbf{Z}_t\boldsymbol{\beta} + \boldsymbol{\varepsilon}_{i\cdot},$$

$\mathbf{y}_i : T \times 1$ vector, $\mathbf{i} : T \times 1$ vector, $\mathbf{Z}_t : T \times k$ matrix, $\boldsymbol{\varepsilon}_{i\cdot}\left(= \frac{1}{T}\sum_{t=1}^{T}\varepsilon_{it}\right) : T \times 1$ vector,

$$\mathbf{y} = \mathbf{D}\boldsymbol{\alpha} + \mathbf{Z}\boldsymbol{\beta} + \boldsymbol{\varepsilon},$$

$$\mathbf{y} = \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \mathrm{M} \\ \mathbf{y}_n \end{bmatrix}, \quad \underset{(nT\times n)}{\mathbf{D}} = \begin{bmatrix} \mathbf{i} & 0 & \Lambda & 0 \\ 0 & \mathbf{i} & \Lambda & 0 \\ & & \mathrm{M} & \\ 0 & 0 & \Lambda & \mathbf{i} \end{bmatrix}, \quad \underset{(n\times 1)}{\boldsymbol{\alpha}} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \mathrm{M} \\ \alpha_n \end{bmatrix}, \quad \underset{(nT\times k)}{\mathbf{Z}} = \begin{bmatrix} \mathbf{Z}_1 \\ \mathbf{Z}_2 \\ \mathrm{M} \\ \mathbf{Z}_n \end{bmatrix}, \quad \underset{(nT\times 1)}{\boldsymbol{\varepsilon}} = \begin{bmatrix} \boldsymbol{\varepsilon}_1 \\ \boldsymbol{\varepsilon}_2 \\ \mathrm{M} \\ \boldsymbol{\varepsilon}_n \end{bmatrix},$$

n : Number of countries.

The estimates obtained from the fixed effects model are the most efficient when the model assumptions are met. Therefore, whether the intercept changes according to the unit of cross-section or time series needs to be tested. The fixed effect model can be tested using the F-statistic as shown below.

$$F \equiv \frac{n-1}{n \cdot T - n - k} \frac{ESS_p - ESS_u}{ESS_u} \sim f_{(n-1, n \cdot T - n - k)},$$

Where, ESS_p : ESS estimated with the fixed effects model,

ESS_u : ESS estimated with an ordinary regression model.

ESS : Error sum of squares.

○ Random Effects Model

The random effects model estimates regression coefficients on the assumption that the constant term, α_i, varies across regions and is a random variable with a normal distribution. This model attempts to find the cause of variation in intercepts according to the units of time and cross-section, using the distribution of the error term. The random effect model assumes that the error term consists of three independent factors: the units of time and cross-section, and the combination of these two factors. The random effects model is expressed as follows:

$$y_{it} = \alpha + \mathbf{Z}_{it}\boldsymbol{\beta} + \varepsilon_{it},$$

$$\varepsilon_{it} = \mu_i + v_t + \omega_{it}$$

Where, $\mu_i \sim N(0, \sigma_\mu^2)$: Error factor for cross-section unit,

$v_t \sim N(0,\sigma_v^2)$: Error factor for time series unit,

$w_{it} \sim N(0,\sigma_w^2)$: Combined error factor.

As it is assumed that the error factors are not correlated with one another, and each of the error factors is absent of serial correlation, the following equations are established for the error term.

$$E[\mu_i \mu_j] = 0, \quad (i \neq j), \quad E[v_t v_s] = 0, \quad (t \neq s),$$

$$E[w_{it} w_{is}] = E[w_{it} w_{jt}] = E[w_{it} w_{js}] = 0,$$

$$\boxed{E[\mu_i v_t] = E[\mu_i w_{it}] = E[v_t w_{it}] = 0}.$$

As a result, the combined error term, $\varepsilon_{i,t}$, has the following homoskedasticity.

$$Var(\varepsilon_{it}) = \sigma^2 = \sigma_u^2 + \sigma_v^2 + \sigma_w^2.$$

However, the error term for cross section units in a given time point, and the error term for two different time points in a given cross section unit, are correlated.

$$\frac{Cov(\varepsilon_{it}, \varepsilon_{jt})}{\sqrt{Var(\varepsilon_{it})}\sqrt{Var(\varepsilon_{jt})}} = \frac{\sigma_v^2}{\sigma_u^2 + \sigma_v^2 + \sigma_w^2} = \frac{\sigma_v^2}{\sigma^2},$$

$$\frac{Cov(\varepsilon_{it},\varepsilon_{is})}{\sqrt{Var(\varepsilon_{it})}\sqrt{Var(\varepsilon_{is})}}=\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2+\sigma_w^2}=\frac{\sigma_u^2}{\sigma^2}$$

Overall, the random effects model has a problem of serial correlation, a rather unique form of basic assumption for OLS. Therefore, to obtain the efficient estimator, the model must be estimated using the generalized least squares method (GLS).

○ Model Selection

Differences between the fixed and random effects models result in choosing between them to best explain the data. The fixed effects model can show variation in intercepts using a dummy variable; however, it cannot determine what causes the variation, and loses degrees of freedom due to the dummy variable. The random effects model provides the most efficient estimates when the assumptions of the model are met; however, its assumption that individual effects are uncorrelated with other explanatory variables is generally unjustifiable. If a correlation exists between error factors or a serial correlation exists within an error factor, the model yields inconsistent estimators that do not approximate parameters even in with a larger sample size.

To test orthogonality among random effects and explanatory variables, Hausman (1978) proposed the specification error test. This is a commonly used method for testing the hypothesis that a model is free of specification errors (Maddala, 1992). The basic concept of the test is that with the null hypothesis that correlation is absent, both fixed and random effects models provide consistent estimators, but the fixed effects model is inefficient. When the alternative hypothesis is true, the fixed effects model provides a consistent estimator but the random effects model does not. If the null hypothesis is true, the difference between the two estimators is not great, whereas if the alternative hypothesis is true, the difference is great. Therefore, the specification error test is based on the difference between the two estimators.

H_0: Random effects, H_A: Fixed effects,

$$V(\hat{\boldsymbol{\beta}}_{CV} - \hat{\boldsymbol{\beta}}_{GLS}) = V(\hat{\boldsymbol{\beta}}_{CV}) - V(\hat{\boldsymbol{\beta}}_{GLS}) \equiv \boldsymbol{\Sigma}.$$

Here, as Σ cannot be calculated, the Σ obtained from variance-covariance matrices of the regression coefficients estimated from the fixed and random effects models are used.

$$W \equiv [\hat{\boldsymbol{\beta}}_{CV} - \hat{\boldsymbol{\beta}}_{GLS}]'\hat{\boldsymbol{\Sigma}}^{-1}[\hat{\boldsymbol{\beta}}_{CV} - \hat{\boldsymbol{\beta}}_{GLS}] \stackrel{\cdot}{\sim} \chi^2_{(K-1)}.$$

4 Distribution of Major Hospital Bed Resources

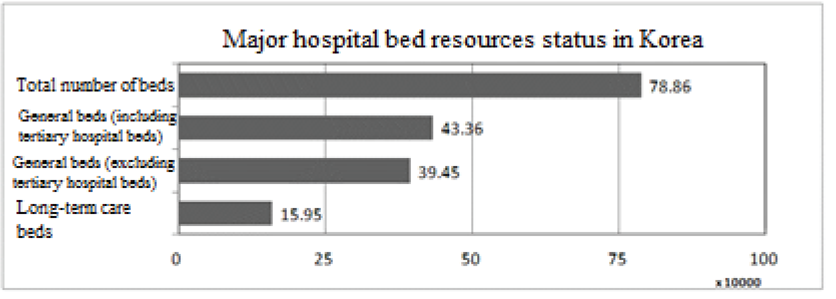
4 Distribution of Major Hospital Bed Resources

Before analyzing regional imbalance in major hospital resources and the causes of this imbalance, this chapter examines the extent of regional imbalance in the hospital bed resources using descriptive methods (tables and figures), and discusses how the types of hospital bed resources have changed by comparing 2008 and 2012.

Section 1. Hospital Bed Resources by Region

The capacity of selected types of hospital beds was high in a number of the regions where many health care facilities were located, including Seoul, Gyeonggi, and other large cities. There were 788,618 hospital beds in total, including general and specialized beds, 433,580 general beds, 394,480 general beds excluding tertiary hospital beds, and 159,545 long-term care beds.

[Figure 4-1] Hospital Bed Resources in Korea



In terms of regional bed distribution, Gyeonggi had the highest number of total hospital beds (145,782), followed by Seoul (113,772), and Busan (72,857). Gyeonggi also had the highest number of general beds (80,810), followed by Seoul (68,754). Gyeongnam had third-highest number of general beds (37,023), but had significantly fewer beds than Gyeonggi and Seoul. Gyeonggi had the highest number of general beds excluding tertiary hospital beds (76,819), followed by Seoul (51,067), and Gyeongnam (36,189). Gyeonggi had 30,496 long-term beds available and Busan had 21,946, followed by Gyeongnam (14,371) and Seoul (14,371).

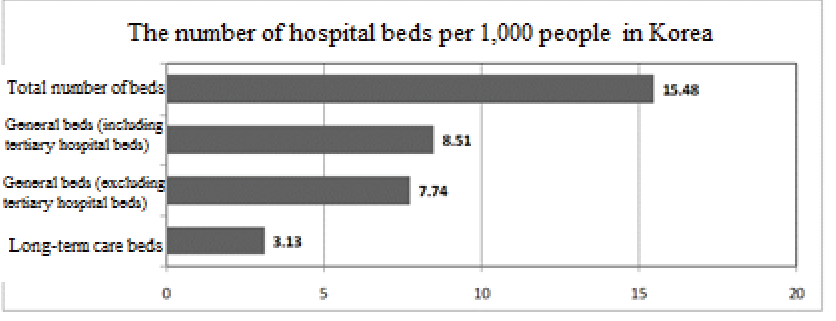
〈Table 4-1〉 Hospital Bed Resources by Region

Region	All hospital beds		General beds (including tertiary beds)		General beds (excluding tertiary beds)		Nursing care beds	
	Beds	%	Beds	%	Beds	%	Beds	%
Seoul	113,772	14.4	68,754	15.9	51,067	12.9	12,628	7.9
Busan	72,857	9.2	36,515	8.4	32,875	8.3	21,946	13.8
Incheon	37,846	4.8	21,748	5.0	19,664	5.0	6,577	4.1
Daegu	41,846	5.3	24,663	5.7	21,463	5.4	7,095	4.4
Gwangju	35,241	4.5	21,814	5.0	20,354	5.2	6,111	3.8
Daejeon	28,542	3.6	14,525	3.4	13,463	3.4	6,641	4.2
Ulsan	16,810	2.1	8,983	2.1	8,983	2.3	3,970	2.5
Gyeonggi	145,782	18.5	80,810	18.6	76,819	19.5	30,496	19.1
Gangwon	24,300	3.1	15,258	3.5	14,155	3.6	2,593	1.6
Chungbuk	26,448	3.4	14,030	3.2	13,437	3.4	4,752	3.0
Chungnam	34,056	4.3	15,989	3.7	14,818	3.8	8,762	5.5
Jeonbuk	44,213	5.6	21,093	4.9	19,475	4.9	11,617	7.3
Jeonnam	46,931	6.0	24,712	5.7	24,055	6.1	9,260	5.8
Gyeong buk	48,023	6.1	24,117	5.6	24,117	6.1	12,201	7.6
Gyeong nam	65,382	8.3	37,023	8.5	36,189	9.2	14,371	9.0
Jeju	6,569	0.8	3,546	0.8	3,546	0.9	525	0.3
Total	788,618	100	433,580	100	394,480	100	159,545	100

Section 2. Per Capita Distribution of Hospital Beds by Region

The total number of hospital beds per 1,000 people including general and specialized beds was 15.48; the number of general beds was 8.51, the number of general beds excluding tertiary hospital beds was 7.74, and there were 3.13 long-term care beds.

[Figure 4-2] Hospital Bed Resources per 1,000 People in Korea



By region, the number of hospital beds per 1,000 people was highest in Jeonnam (24.58) and lowest in Seoul (11.16). Gwangju had the highest number of general beds (14.85), whereas Jeju had the lowest (6.07). Gwangju also had the highest number of general beds excluding tertiary hospital beds at 13.85 per 1,000 people, whereas Seoul had the lowest number (5.01). Busan and Jeonbuk both had the most long-term care beds per 1,000 people (6.20), and Jeju had the least long-term beds available (0.90).

〈Table 4-2〉 Hospital Bed Resources per 1,000 People by Region

Region	All beds	General beds	General beds (excluding tertiary beds)	Nursing care beds
Seoul	11.16	6.74	5.01	1.24
Busan	20.59	10.32	9.29	6.20
Incheon	13.31	7.65	6.91	2.31
Daegu	16.70	9.84	8.57	2.83
Gwangju	23.99	14.85	13.85	4.16
Daejeon	18.72	9.53	8.83	4.36
Ulsan	14.65	7.83	7.83	3.46
Gyeonggi	12.05	6.68	6.35	2.52
Gangwon	15.79	9.92	9.20	1.69
Chungbuk	16.89	8.96	8.58	3.04
Chungnam	15.90	7.46	6.92	4.09
Jeonbuk	23.60	11.26	10.40	6.20
Jeonnam	24.58	12.94	12.60	4.85
Gyeongbuk	17.80	8.94	8.94	4.52
Gyeongnam	19.70	11.15	10.90	4.33
Jeju	11.25	6.07	6.07	0.90
Total	15.48	8.51	7.74	3.13

Section 3. Change over Time in Hospital Bed Resources by Region

There was a change over time between 2008 and 2012 in hospital bed resources by region. The greatest change was the increased number of long-term care beds. In terms of regional variation in change in bed capacity over time, Gwangju had the most change in the total number of hospital beds including general and specialized beds, with a 33.3% increase from 17.99

beds per 1,000 people in 2008 to 23.99 beds in 2012, followed by Busan and Jeonbuk with 31.7% and 25.5% increases respectively. Gwangju also had the largest change in the number of general beds, with a 26.0% increase from 11.78 beds per 1,000 people in 2008 to 14.85 in 2012, followed by Jeonbuk with a 16.4% increase, and Daegu with a 12.5% increase. However, Gyeongnam showed a 0.5% decrease from 11.21 beds per 1,000 people in 2008 to 11.15 in 2012. Gwangju showed the greatest change in the number of general beds excluding tertiary hospital beds, increasing by 28.9% from 10.75 beds per 1,000 people in 2008 to 13.85 in 2012, followed by Jeonbuk with an 18.7% increase, and Daegu with a 15.0% increase. In contrast, Gyeonggi showed a 2.5% decrease from 6.52 beds per 1,000 people in 2008 to 6.35 in 2012. Gwangju and Busan showed markedly higher increases in the number of long-term care beds than other regions, with an increase of 166.9% in Gwangju (from 1.56 to 4.16 beds per 1,000 people) and 129.6% in Busan (from 2.70 to 6.20 beds per 1,000 people), followed by Gyeonggi with a 123.8% increase from 1.13 to 2.52 beds per 1,000 people.

〈Table 4-3〉 Change over Time in Hospital Bed Resources for 10 Regions

(Unit: person)

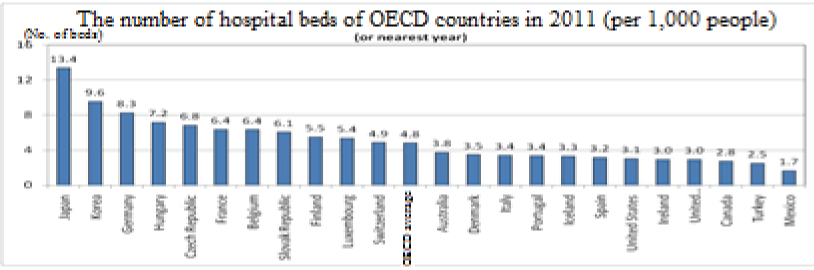
Region	Year	All beds	General beds (including tertiary beds)	General beds (excluding tertiary beds)	Nursing care beds
Seoul	2008	10.04	6.39	4.63	0.62
	2012	11.16	6.74	5.01	1.24
	Growth rate	11.1	5.5	8.1	99.5
Busan	2008	15.63	9.21	8.23	2.70
	2012	20.59	10.32	9.29	6.20
	Growth rate	31.7	12.0	12.9	129.6
Incheon	2008	11.54	7.24	6.52	1.07
	2012	13.31	7.65	6.91	2.31
	Growth rate	15.4	5.7	6.0	115.2
Daegu	2008	13.94	8.75	7.45	1.60
	2012	16.70	9.84	8.57	2.83
	Growth rate	19.8	12.5	15.0	77.3
Gwangju	2009	17.99	11.78	10.75	1.56
	2012	23.99	14.85	13.85	4.16
	Growth rate	33.3	26.0	28.9	166.9
Daejeon	2008	16.06	9.03	7.81	2.43
	2012	18.72	9.53	8.83	4.36
	Growth rate	16.5	5.6	13.1	79.6
Ulsan	2008	12.62	7.43	7.43	1.92
	2012	14.65	7.83	7.83	3.46
	Growth rate	16.1	5.4	5.4	80.4
Gyeonggi	2008	10.47	6.60	6.52	1.13
	2012	12.05	6.68	6.35	2.52
	Growth rate	15.2	1.2	-2.5	123.8
Gangwon	2008	14.57	9.71	8.92	1.06
	2012	15.79	9.92	9.20	1.69
	Growth rate	8.4	2.1	3.1	59.7
Chungbuk	2008	14.89	8.47	8.14	1.46
	2012	16.89	8.96	8.58	3.04
	Growth rate	13.5	5.8	5.4	107.9
Chungnam	2008	14.05	7.35	6.64	2.09
	2012	15.90	7.46	6.92	4.09
	Growth rate	13.2	1.6	4.1	96.0
Jeonbuk	2008	18.81	9.67	8.75	3.34
	2012	23.60	11.26	10.40	6.20
	Growth rate	25.5	16.4	18.7	85.7
Jeonnam	2008	20.31	11.86	11.86	2.17
	2012	24.58	12.94	12.60	4.85
	Growth rate	21.0	9.1	6.2	123.7
Gyeongbuk	2008	15.35	8.89	8.89	2.30
	2012	17.80	8.94	8.94	4.52
	Growth rate	15.9	0.5	0.5	96.3

Region	Year	All beds	General beds (including tertiary beds)	General beds (excluding tertiary beds)	Nursing care beds
Gyeongnam	2008	17.90	11.21	10.95	2.44
	2012	19.70	11.15	10.90	4.33
	Growth rate	10.0	-0.5	-0.4	77.6
Jeju	2008	10.82	5.97	5.97	0.78
	2012	11.25	6.07	6.07	0.90
	Growth rate	4.0	1.7	1.7	15.4

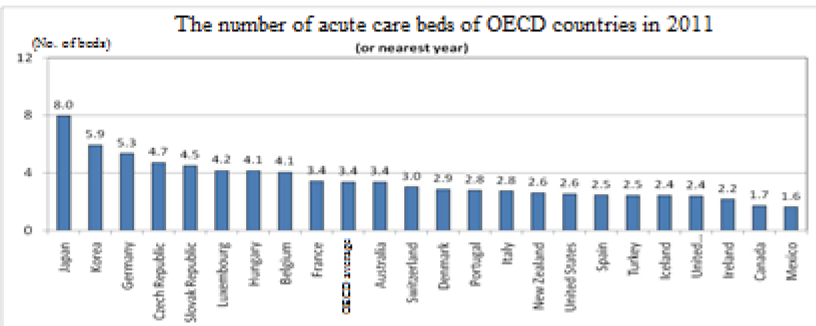
Section 4. International Comparisons of Hospital Bed Resources

The comparison between hospital bed resources in Korea in 2012 and that of other OECD member countries showed that the total number of hospital beds in Korea (9.6 beds per 1,000 people) was the second highest, following Japan, and this number was approximately twice the OECD average. Korea had 5.9 acute care beds per 1,000 people, about 1.7 times the OECD average (3.4 beds). Korea also had 0.9 psychiatric beds per 1,000 people, about 1.3 times the OECD average. The OECD average number of long-term care beds was 0.7 beds; Korea with 2.7 beds had the highest number of long-term beds per 1,000 people, over four times higher than the average.

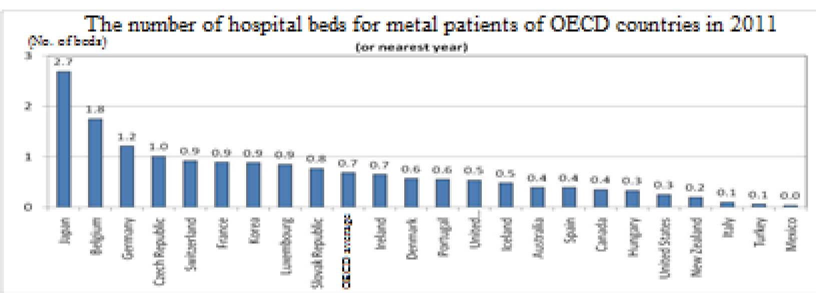
[Figure 4-3] Total Number of Hospital Beds in OECD Countries



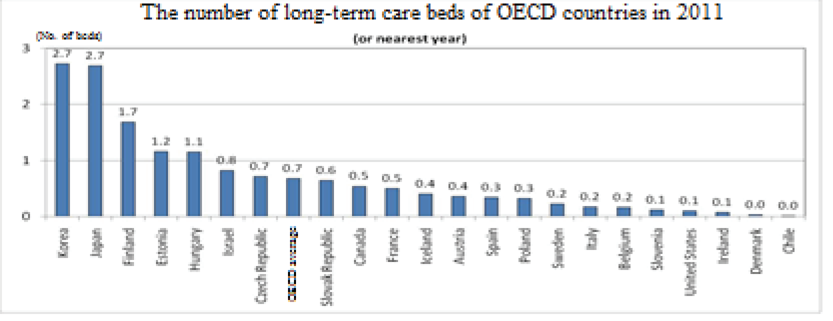
[Figure 4-4] Number of Acute Care Beds in OECD Countries



[Figure 4-5] Number of Psychiatric Beds in OECD Countries



[Figure 4-6] Number of Long-term Care Beds in OECD Countries



5

Analysis of Regional Imbalance in Major Hospital Bed Resources

5 Analysis of Regional Imbalance in Major Hospital Bed Resources

The previous chapter compared the regional imbalance in hospital bed resources in Korea and compared hospital bed resources among OECD countries. This chapter gauges the level of imbalance in hospital bed resources in Korea using statistical estimation. First, changes in the regional imbalance levels over time will be examined by determining the level of imbalance in hospital bed resources for individual regions in 2008 and 2012 and calculating the Gini index for each type of hospital bed resource. The regional imbalance levels were quantified by estimating the regional imbalance index using linear regression analysis.

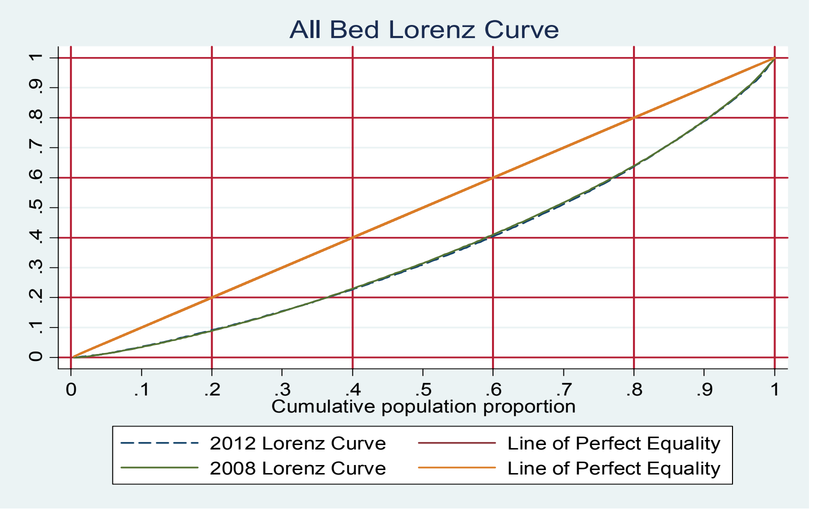
Section 1. Analysis of Imbalance Using the Gini Index

Table 5-1 shows the regional imbalance index of hospital bed resources in Korea estimated using the Gini index. Gini index changes over time were examined for all beds (including general and specialized beds), all general beds, general beds excluding tertiary hospital beds, and long-term care beds using 2008 and 2012 data. Changes in the Gini indices showed that imbalance levels for all beds (general + specialized) increased by 1.44%, from 0.26910 in 2008 to 0.27298 in 2012. The imbalance level for all general beds showed no significant change from 0.31594 in 2008 to 0.31312 in 2012. However, the imbalance level for general beds decreased by 2% if the tertiary hospital beds were excluded. An 8% decrease was also found in the imbalance level for long-term care beds, from 0.53102 in 2008 to 0.48652 in 2012.

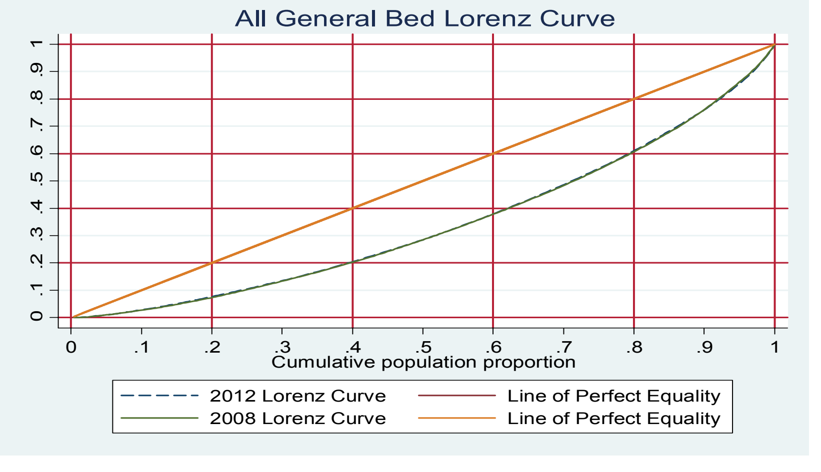
〈Table 5-1〉 Gini Index Comparisons for Hospital Bed Resources between 2008 and 2012 (in Si-Gun-Gu Units)

Year	All beds (general +specialized beds)	General beds	General beds (excluding tertiary hospitals)	Nursing care beds
2012 (A)	0.27298	0.31312	0.30486	0.48652
2008 (C)	0.26910	0.31594	0.31106	0.53102
Rate of change (%) '08 -'12	1.44	-0.89	-1.99	-8.38

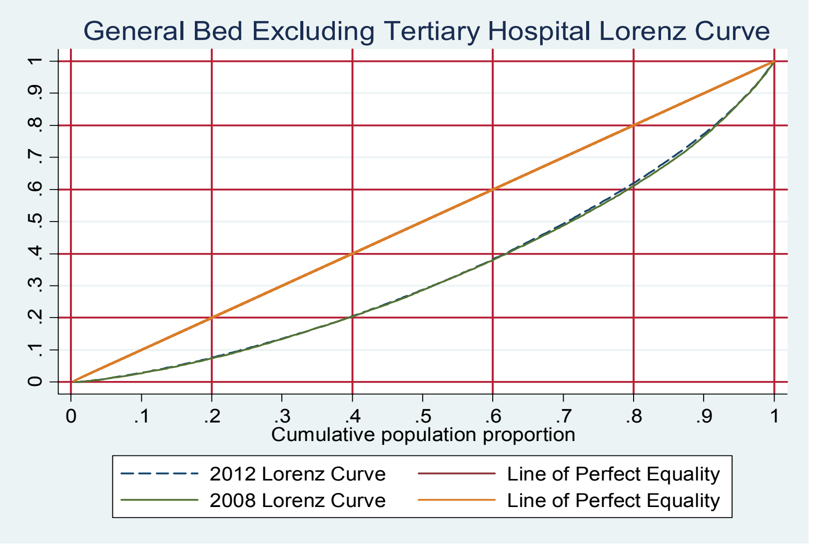
[Figure 5-1] Regional Imbalance Levels for All Beds (General + Specialized Beds)



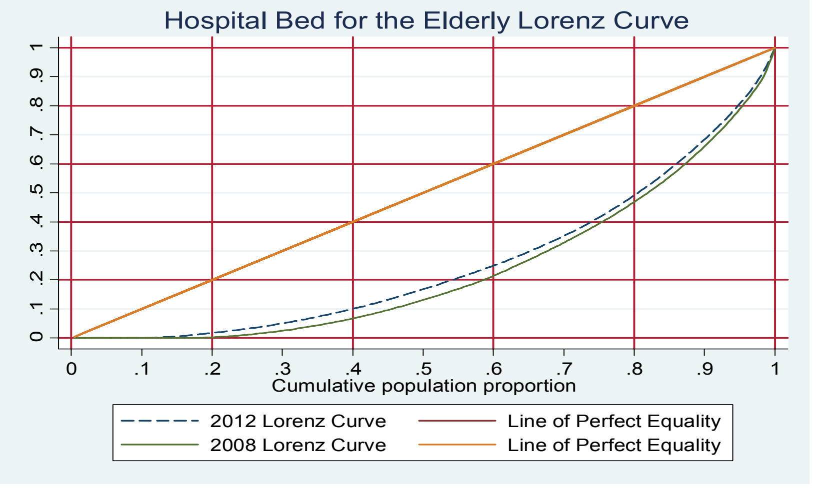
[Figure 5-2] Regional Imbalance Levels for General Beds



[Figure 5-3] Regional Imbalance Levels for General Beds (Excluding Tertiary Hospital Beds)



[Figure 5-4] Regional Imbalance Levels for Long-term Care Beds



Section 2. Analysis of Imbalance Levels by Region using Regression Analysis

1. Descriptive Analysis

In 2012, there were 17.0 total hospital beds per 1,000 people in Korea; Gwangju had the highest number (28.2 beds), followed by Jeonnam (24.9 beds). Jeju had the lowest number (10.1 beds). There were 8.9 general beds per 1,000 people, with Gwangju having the highest number (17.6 beds), and Jeju having the lowest number (5.0 beds). There were 8.2 general beds excluding tertiary hospital beds per 1,000 people in Korea; again, Gwangju had the highest number (14.9 beds), followed by Jeonnam (12.0 beds), with Jeju having the lowest number (5.0 beds). In addition, there were 3.6 long-term care beds per 1,000 people. Of the 16 regions, Busan had the most (6.3 beds), and Jeju the least long-term beds (0.9 beds).

2. Estimation of Regional Imbalance Levels in Hospital Bed Resources

Table 5-3 shows the results of the equity-based model for estimating hospital bed resources. This model included variables representing basic medical care demand (population size, gender, age, and health state) to assess the levels of regional imbalance in hospital bed resources. In this model, the dependent variables (all beds, general beds, general beds excluding tertiary hospital beds, and long-term care beds) were log-transformed as they slightly violated the assumption of a normal distribution. Proxy variables (number of western medicine outpatient visits, number of eastern medicine outpatient visits, hospital length of stay of western medicine inpatients, and hospital length of stay of eastern medicine inpatients), showed the problem of multicollinearity; therefore, a health index was estimated using factor analysis and used in the model. Overall, statistically significant positive relationships were found in all models between hospital bed resources and the demographic variables of population size, female ratio, proportion of children aged 0–4 years, and health index. This means that hospital bed resources were higher when the population size was larger, there was a higher ration of females, a larger proportion of children aged 0–4 years, and the health state was poorer. The proportion of seniors aged 65-plus was negatively related to hospital bed resources. This result might be explained by regions with larger older adult populations usually being rural areas or fishing villages with fewer hospitals.

〈Table 5-2〉 Equity-based Model Estimations of Selected Types of Hospital Bed resources (248 Si, Gun, and Gu)

	All beds		All general beds		General beds (excluding tertiary beds)		Nursing care beds	
	B	Stan. error	B	Stan. error	B	Stan. error	B	Stan. error
Constant	4.088**	1.764	3.596	2.316	2.592	2.322	3.304	3.534
Population	.000***	.000	.000***	.000	.000***	.000	.000***	.000
Female ratio	.016	.037	.010	.049	.039	.048	.022	.074
Ratio of children aged 0-4	.131***	.046	.146**	.061	.172***	.062	.119	.081
Ratio of seniors aged 65-plus	-.022**	.009	-.031**	.012	-.030**	.012	-.019	.017
F objective health index	.644***	.047	.678***	.062	.466***	.049	.340***	.067
F value	171.904***		123.294***		122.703***		28.824***	

Note: *, **, ***: mean that they are significant with the significance levels of 10%, 5%, and 1%.

Estimations of the imbalance between demand and supply of hospital beds at Si (city), Gun (county), and Gu (district) levels were conducted by categorizing them as having an oversupply or a supply shortage for all beds (general + specialized), all general beds, general beds (excluding tertiary hospital beds), and long-term care beds. The oversupply category was divided into three levels: high-level of oversupply (30% or higher), mid-level oversupply (20-29%), and low-level oversupply (10-19%). First, for all beds, a high-level of oversupply was found in 63 regions including Uiseong-Gun, Pocheon, and Goheung-Gun; mid-level oversupply was found in 16 regions including Jinhae, Cheongwon-Gun, and Busan Suyeong-Gu; and a low-level of oversupply was found in 25 regions including Seongnam Sujeong-Gu, Goyang Ilsan Dong-Gu, and Cheongdo-Gun. Second, for general beds, a high-level of oversupply was found in 68 regions including Jeongseon-Gun, Goheung-Gun, and Eumseong-Gun; a mid-level of oversupply was found in 21 regions including Yeosu, Yeongam-Gun, and Pohang Nam-Gu; and a low-level of oversupply was found in 19 regions including Gwangyang, Busan Buk-Gu, and Danyang-Gun. Third, for general beds excluding tertiary hospital beds, a high-level of oversupply was found in 86 regions including Goheung-Gun, Eumseong-Gun, and Jeongseon-Gun; a mid-level of oversupply was found in 20 regions including Gwangju Seo-Gu, Dongdaemun-Gu, and Pohang Buk-Gu; and a low-level of oversupply was found in 19 regions including Busan Yeonje-Gu, Bucheon Ojeong-Gu, and Ansan Sangnok-Gu. Fourth, for long-term care beds, a high-level of oversupply was found in 94 regions including Busan Geumjeong-Gu, Busan Saha-Gu, and Pohang Buk-Gu; a mid-level of oversupply was found in seven regions including Paju, Goyang Deokyang-Gu, and Namwon; and a low-level of oversupply was found in 11 regions including Mungyeong, Incheon Namdong-Gu, and Yeongcheon.

The supply shortage category was also divided into three levels: high-, mid-, and low-level shortages. First, for all beds, a high-level shortage was found in 35 regions including Goseong-Gu, Jung-Gu, and Gwacheon; a mid-level shortage was found in 19 regions including Hanam, Gumi, and Daegu Suseong-Gu; and a low-level shortage was found in 14 regions including Sunchang-Gun, Goryeong-Gun, and Changwon. Second, for all general beds, a high-level shortage was found in 46 regions including Goseong-Gun, Gwacheon, and Ulleung-Gun; a mid-level shortage was found in 13 regions including Goyang Ilsanseo-gu, Gunpo, and Namhae-Gun; and a low-level shortage was found in 10 regions including Buan-Gun, Jincheon-Gun, and Gwangju Nam-Gu. Third, for general beds excluding tertiary hospital beds, a high-level shortage was found in 57 regions including Goseong-Gun, Gwancheon, and Daegu Jung-Gu; a mid-level shortage was found in 12 regions including Seongnam Bundang-Gu, Namyangju, and Anyang Dongan-Gu; and a low-level shortage was found in 13 regions including Jeju, Gochang-Gun, Daejeon Seo-Gu. Finally, for long-term care beds, a high-level shortage was found in 99 regions including Yanggu-Gun, Yangyang-Gun, and Jeongseon-Gun; a mid-level shortage was found in 12 regions including Busan Seo-Gu, Gwangmyeong, and Boseong-Gun; and a low-level shortage was found in eight regions including Yesan-Gun, Incheon Jung-Gu, and Tongyeong. For general beds (excluding tertiary hospital beds) and long-term care beds, both high-level oversupply and high-level supply shortage were found in a number of regions, indicating a significant imbalance between supply and demand based on a close examination of regions at city, county, and district levels.

〈Table 5-3〉 Regions with Imbalance in Supply of All Hospital Beds by Region

Supply surplus and shortage		All hospital beds (general beds + special beds)
Surplus	≥30%	Uiseong-Gun, Pocheon, Goheung-Gun, Eumseong-Gun, Jeongsun-Gun, Milyang, Busan Sasang-Gu, Wanju-Gun, Gimcheon, Gapyoeng-Gun, Yangju, Changnyeong-Gun, Bucheon Sosa-Gu, Haenam-Gun, Gangreung, Uiwang, Chungju, Hongcheon-Gun, Yeoju-Gun, Ulsan Ulju-Gun, Gyeongju, Gyeongsan, Yangpyeong-Gun, Jeongeup, Daegu Seo-Gu, Anseong, Hampyeong-Gun, Busan Saha-Gu, Sacheon, Yeongcheon, Yongin Cheoin-Gu, Gongju, Gimje, Dongducheon, Ulsan Jung-Gu, Geumsan-Gun, Nonsan, Busan Geumjeong-Gu, Daegu Dalseong-Gun, Buyeo-Gun, Seongju-Gun, Pohang Buk-Gu, Chilgok-Gun, Andong, Hadong-Gun, Jangseong-Gun, Yeosu, Yeosan-Gun, Sangju, Masan, Naju, Yeongwol-Gun, Suncheon, Yeongju, Bucheon Ojeong-Gu, Yangsan, Hongseong-Gun, Busan Buk-Gu, Donghae, Ansan Sangrok-Gu, Jecheon, Incheon Ganghwa-Gun, Daecheon Daedeok-Gu
	20 - 29%	Jinhae, Cheongwon-Gun, Busan Suyeoung-Gu, Muan-Gun, Gunsan, Geumcheon-Gu, Shinan-Gun, Mungyeong, Icheon, Asan, Daejeon Yuseong-Gu, Gwangmyeong, Goesan-Gun, Busan Nam-Gu, Dobong-Gu, Haman-Gun
	10 - 19%	Seongnam Sujeong-Gu, Goyang Ilsan Dong-Gu, Cheongdo-Gun, Busan Dongrae-Gu, Gochang-Gun, Taebaek, Yecheon-Gun, Tongyeong, Busan Gijang-Gun, Uijeongbu, Dangjin-Gun, Boeun-Gun, Yongin Giheung-Gu, Daegu Dong-Gu, Pohang Nam-Gu, Busan Gangseo-Gu, Busan Yeongdo-Gu, Damyang-Gun, Namwon, Cheongsong-Gun, Taean-Gun, Incheon Gyeongyang-Gu, Siheung, Yeoncheon-Gun, Gangbuk-Gu
Shortage	≥30%	Goseong-Gun, Jung-Gu, Gwacheon, Hwacheon, Yeongyang-Gun, Jeungpyeong-Gun, Busan Jung-Gu, Sancheong-Gun, Ulreung-Gun, Yangyang-Gun, Inje-Gun, Gyeongryong, Mapo-Gu, Pyeongchang-Gun, Incheon Ongjin-Gun, Gangwon Goseong-Gun, Muju-gun, Jindo-Gun, Jangsu-Gun, Daejeon Seo-Gu, Imsil-Gun, Busan Dong-Gu, Jeju, Gangseo-Gu, Gwanak-Gu, Daegu Dalseo-Gu, Hwaseong, Gangdong-Gu, Suwon Paldal-Gu, Hamyang-Gun, Seogwipo, Yanggu-Gun, Yeonggwang-Gun, Hoengseoung-Gun, Namyangju
	20 - 29%	Hanam, Gumi, Daegu Suseong-Gu, Gwangmyeong, Uljin-Gun, Ulsan Buk-Gu, Eunpyong-Gu, Buan-Gun, Mokpo, Gunwi-Gun, Gwangju Gwangsan-Gu, Gwangju Seo-Gu, Cheongju Sangdang-Gu, Jinan-Gun, Yongin Suji-Gu, Ulsan Nam-Gu, Incheon Bupyong-Gu, Gwangju Nam-Gu, Ulsan Dong-Gu
	10 - 19%	Sunchang-Gun, Goryeong-Gun, Changwon, Geochang-Gun, Suwon

Supply surplus and shortage		All hospital beds (general beds + special beds)
		Jangan-Gu, Samcheok, Seongnam Jungwon-Gu, Yeongdeok-Gun, Namhae-Gun, Gwangju, Sokcho, Cheongyang-Gun, Incheon Dong-Gu, Jincheon-Gun

Note: exclude the regions where specialized general nursing care hospitals (tertiary hospitals) are in analyzing by regions.

〈Table 5-4〉 Regions with Imbalance in Supply of All General Beds by Region

Supply surplus and shortage		Total general beds
Surplus	≥30%	Jeongsun-Gun, Goheung-Gun, Gapyeong-Gun, Hampyeong-Gun, Gimcheon, Pocheon, Changnyeong-Gun, Uiseong-Gun, Haenam-Gun, Gangreung, Milyang, Hadong-Gun, Uiwang, Busan Sasang-Gu, Cheongsong-Gun, Yangju, Yeongcheon, Chilgok, Hapcheon-Gun, Yeongwol-Gun, Hongcheon-Gun, Sacheon, Incheon Ganghwa-Gun, Ulsan Ulju-Gun, Taebaek, Gimje, Daegu Dalseong-Gun, Donghae, Wanju-Gun, Chungju, Sangju, Suncheon, Yeongju, Cheongwon-Gun, Andong, Daegu Seo-Gu, Buyeo-Gun, Yesan-Gun, Bucheon Sosa-Gu, Yeoju-Gun, Uijeongbu, Yangsan, Gyeongju, Ulsan Jung-Gu, Damyang-Gun, Cheongdo-Gun, Yongin Cheoin-Gu, Busan Gangseo-Gu, Masan, Icheon, Mungyeong, Daejeon Daedeok-Gu, Jeongeup, Boseong-Gun, Gyeongsan, Naju, Yeongdeok-Gun, Busan Saha-Gu, Goyang Ilsan Dong-Gu, Haman-Gun, Tongyeong, Busan Nam-Gu, Gongju, Jecheon, Jinhae, Seongnam Sujeong-Gu, Guri
	20 - 29%	Yeosu, Yeongam-Gun, Pohang Nam-Gu, Gangbuk-Gu, Nonsan, Asan, Jangheung-Gun, Dobong-Gu, Gangjin-Gun, Bucheon Ojeong-Gu, Namwon, Muan-Gun, Incheon Dong-Gu, Boryeong, Busan Gijang-Gun, Busan Geumjeong-Gu, Geumcheon-Gu, Gunsan, Goesan-Gun, Daegu Dong-Gu, Suwon Gwansun-Gu
	10 - 19%	Gwangmyeong, Busan Buk-Gu, Danyang-Gun, Ansan Sangrok-Gu, Busan Dongrae-Gu, Yongin Giheung-Gu, Sokcho, Gimpo, Busan Suyeong-Gu, Jungryang-Gu, Yecheon-Gun, Goyang Deokyang-Gu, Dangjin-Gun, Yeoncheon-Gun, Uiryeong-Gun, Yangpyeong-Gun, Anseong, Incheon Seo-Gu, Daegu Buk-Gu
Shortage	≥30%	Goseong-Gun, Gwacheon, Ulreung-Gun, Jung-Gu, Sancheong-Gun, Gangwon Goseong-Gun, Gurye-Gun, Jangsu-Gun, Pyeongchang-Gun, Busan Jung-Gu, Musu-Gun, Hwacheon-Gun, Jeungpyeong-Gun, Sunchang-Gun, Mapo-Gu, Inje-Gun, Yangyang-Gun, Seogwipo, Gyeryong, Busan Dong-Gu, Jindo-Gun, Yeongyang-Gun, Hwaseong, Imsil-Gun, Daejeon Seo-Gu, Gwanak-Gu, Gangseo-Gu, Okcheon-Gun, Hamyang-Gun, Jeju, Gangdong-Gu, Goryeong-Gun, Seongju-Gun, Namyangju, Taean-Gun, Yeongdong-Gun, Daegu Dalseo-Gu, Suwon Paldal-Gu, Daejeon Dong-Gu, Gumi, Daegu Suseong-Gu, Gwangmyeong, Ulsan Nam-Gu, Uljin-Gun, Cheongyang-Gun, Bonghwa-Gun
	20 - 29%	Goyang Ilsan Seo-Gu, Gunpo, Namhae-Gun, Changwon, Gwangju Seo-Gu, Eunpyeong-Gu, Ulsan Dong-Gu, Ulsan Buk-Gu,

Supply surplus and shortage		Total general beds
		Gokseong-Gun, Mokpo, Wando-Gun, Gochang-Gun, Jeonju Wansan-Gu
	10 - 19%	Buan-Gun, Jincheon-Gun, Gwangju Nam-Gu, Incheon Bupyeong-Gu, Gimhae, Hoeseong-Gun, Yongin Suji-Gu, Busan Yeonje-Gu, Suwon Jangan-Gu, Cheongju Sangdang-Gu

Note: exclude the regions where specialized general nursing care hospitals (tertiary hospitals) are in analyzing by regions.

〈Table 5-5〉 Regions with Imbalance in Supply of General Beds (Excluding Tertiary Hospital Beds) by Region

Supply surplus and shortage		General beds (excluding tertiary hospital beds)
Surplus	≥30%	Goheung-Gun, Eumseong-Gun, Changnyeong-Gun, Gapyeong-Gun, Gimcheon, Busan Sasang-Gu, Gimje, Haenam, Hampyeong, Yeongcheon, Gangreung, Pocheon, Milyang, Uiseong-Gun, Sacheon, Hadong-Gun, Andong, Naju, Hapcheon-Gun, Masan, Suncheon, Daegu Seo-Gu, Cheongsong-Gun, Chuncheon, Incheon Ganghwa-Gun, Chilgok-Gun, Ulsan Ulju-Gun, Uiwang, Hongcheon-Gun, Damyang-Gun, Chungju, Yangsan, Taebaek, Buyeo-Gun, Yangju, Donghae, Gyeongju, Yeongwol-Gun, Uijeongbu, Yeongju, Wanju-Gun, Cheongdo-Gun, Daegu Dalseong-Gun, Sangju, Busan Saha-Gu, Jeongeup, Goyang Ilsan Dong-Gu, Jecheon, Nonsan, Mungyeong, Busan Dongrae-Gu, Busan Geumjeong-Gu, Gongju, Ulsan Jung-Gu, Wonju, Daejeon Daedeok-Gu, Yeosu, Yesan-Gun, Namwon, Gyeongsan, Yeoju-Gun, Gwangju Buk-Gu, Busan Nam-Gu, Boseong-Gun, Boryeong, Bucheon Sosa-Gu, Jinju, Gunsan, Guri, Busan Suyeong-Gu, Tongyeong, Gangbuk-Gu, Daejeon Dong-Gu, Yongin Cheoin-Gu, Icheon, Pohang Nam-Gu, Yeongdeok-Gun, Daegu Buk-Gu, Cheongwon-Gun, Yeonggwang-Gun, Jungryang-Gu, Busan Buk-Gu, Dobong-Gu, Seongnam Sujeong-Gu, Geumcheon-Gu
	20 - 29%	Gwangju Seo-Gu, Dongdaemun-Gu, Pohang Buk-Gu, Jinhae, Yeongam-Gun, Incheon Dong-Gu, Sokcho, Goyang Deokyang-Gu, Gwangju Nam-Gu, Jangheumg-Gun, Haman-Gun, Incheon Nam-Gu, Pyeongtaek, Busan Haeundae-Gu, Hwasun-Gun, Asan, Mokpo, Incheon Gyeyang-Gu, Seocheon-Gun, Busan Yeongdo-Gu
	10 - 19%	Busan Yeonje-Gu, Bucheon Ojeong-Gu, Ansan Sangrok-Gu, Jeonju Wansan-Gu, Gwangjin-Gu, Cheongju Sangdang-Gu, Siheung, Gimpo, Busan Gijang-Gun, Incheon Seo-Gu, Boeun-Gun, Muan-Gun, Jangseong-Gun, Anseong, Daejeon Jung-Gu, Yongin Giheung-Gu, Buan-Gun, Suwon Gwonsun-Gu, Hongseong-Gun
Shortage	≥30%	Goseong-Gun, Gwacheon, Daejeon Jung-Gu, Ulreung-Gun, Gangwon Goseong-Gun, Sancheong-Gun, Jangsu-Gun, Pyeongchang-Gun, Jongro-Gu, Hwacheon-Gun, Gurye-Gun, Muju-Gun, Songpa-Gun, Jeungpyeong-Gun, Yangyang-Gun, Busan Seo-Gu, Inje-Gun, Gangnam-Gu, Sunchang-Gun, Gyeryong, Suwon Yeongtong-Gu, Mapo-Gu, Yeongyang-Gun, Seocho-Gu, Yongsan-Gu, Jung-Gu,

Supply surplus and shortage		General beds (excluding tertiary hospital beds)
		Guro-Gu, Jindo-Gun, Busan Jung-Gu, Nowon-Gu, Hamyang-Gun, Seogwipo, Seongbuk-Gu, Hwaseong, Cheonan, Gwangju Dong-Gu, Goryeong-Gun, Seodaemun-Gu, Bonghwa-Gun, Seongju-Gun, Imsil-Gun, Yangcheon-Gu, Ulsan Buk-Gu, Gwanak-Gu, Taean-Gun, Incheon Namdong-Gu, Okcheon-Gun, Cheongyang-Gun, Gangseo-Gu, Uljin-Gun, Incheon Ongjin-Gun, Wando-Gun, Donggak-Gu, Yeongdong-Gun, Seongdong-Gu, Gwangmyeong, Gokseong-Gun
	20 - 29%	Seongnam Bundang-Gu, Namyangju, Anyang Dongan-Gu, Gunpo, Yongin Suji-Gu, Namhae-Gun, Gumi, Cheongju Heungdeok-Gu, Busan Jin-Gu, Yanggu-Gun, Gunwi-Gun, Jincheon-Gun
	10 - 19%	Jeju, Gochang-Gun, Daejeon Seo-Gu, Daejeon Dong-Gu, Hoengseong-Gun, Cheorwon-Gun, Hanam, Goyang Ilsan Seo-Gu, Daegu Suseong-Gu, Gangdong-Gu, Daegu Dalseo-Gu, Gwangju, Busan Dong-Gu

Note: include the regions where specialized general nursing care hospitals (tertiary hospitals) are in analyzing by regions.

〈Table 5-6〉 Regions with Imbalance in Supply of Long-term Care Beds by Region

Supply surplus and shortage		Nursing care beds
Surplus	≥30%	Busan Geumjeong-Gu, Busan Saha-Gu, Pohang Buk-Gu, Gyeongju, Naju, Dongducheon, Anseong, Busan Sasang-Gu, Gongju, Wanju-Gun, Gyeongsan, Masan, Nonsan, Jeongeup, Uiseong-Gun, Busan Suyeong-Gu, Yeoju-Gun, Jangseong-Gun, Busan Dongrae-Gu, Milyang, Hongseong-Gun, Daegu Seo-Gu, Hwasun-Gun, Jeonju Wansan-Gu, Andong, Busan Haeundae-Gu, Gimhae, Busan Yeonje-Gu, Gimje, Bucheon Sosa-Gu, Gurye-Gun, Okcheon-Gun, Daejeon Yuseong-Gu, Busan Buk-Gu, Ansan Sangrok-Gu, Geumsan-Gun, Yangpyeong-Gun, Yangsan, Buyeo-Gun, Yongin Giheung-Gu, Daejeon Jung-Gu, Ansan Danwon-Gu, Daejeon Dong-Gu, Sunchang-Gun, Gochang-Gun, Ulsan Jung-Gu, Incheon Gyeyang-Gu, Yeongdong-Gun, Busan Dong-Gu, Yeosu, Jecheon, Daegu Nam-Gu, Changnyeong-Gun, Pocheon, Ulsan Ulju-Gun, Seongju-Gun, Yangju, Chungju, Gunpo, Gwangju Gwangsan-Gu, Siheung, Busan Jin-Gu, Seocheon-Gun, Iksan, Gwangju Nam-Gu, Goyang Ilsan Seo-Gu, Jinhae, Gunsan, Ulsan Nam-Gu, Dobong-Gu, Jinju, Goyang Ilsan Dong-Gu, Sacheon, Boeun-Gun, Gimcheon, Yongin Cheoin-Gu, Taean-Gun, Jeonju Deokjin-Gu, Seongbuk-Gu, Bucheon Ojeong-Gu, Busan Gijang-Gun, Busan Nam-Gu, Incheon Nam-Gu, Mokpo, Daegu Buk-Gu, Uiwang, Namyangju, Chuncheon, Daegu Dong-Gu, Changwon, Yeongju, Incheon Seo-Gu, Hongcheon-Gun, Suncheon
	20 - 29%	Paju, Goyang Deokyang-Gu, Namwon, Geumcheon-Gu, Daegu Dalseong-Gun, Bucheon Wonmi-Gu, Yeongdeungpo-Gu
	10 - 19%	Mungyeong, Incheon Namdong-Gu, Yeongcheon, Busan Yeongdo-Gu, Gwangju Buk-Gu, Cheongdo-Gun, Damyang-Gun, Goesan-Gun, Suwon Paldal-Gu, Guro-Gu, Daegu Suseong-Gu

Supply surplus and shortage		Nursing care beds
Shortage	≥30%	Yanggu-Gun, Yangyang-Gun, Jeongsun-Gun, Taebaek, Hwacheon-Gun, Hoengseong-Gun, Gwacheon, Sancheong-Gun, Hadong-Gun, Hamyang-Gun, Hapcheon-Gun, Gunwi-Gun, Yeongyang-Gun, Cheongsong-Gun, Yongsan-Gu, Jongro-Gu, Incheon Dong-Gu, Incheon Ongjin-Gu, Gangjin-Gun, Wando-Gun, Jangheumg-Gun, Hampyeong-Gun, Jangsu-Gun, Jinan-Gun, Gyeryong, Jeungpyeong-Gun, Jung-Gu, Daegu Jung-Gu, Hanam, Mapo-Gu, Gangnam-Gu, Guri, Gwangjin-Gu, Seocho-Gu, Cheongju Sangdang-Gu, Anyang Dongan-Gu, Yeonggwang-Gun, Sokcho, Seongnam Jungwon-Gu, Jindo-Gun, Dangjin-Gun, Goseong-Gun, Yangcheon-Gu, Donggak-Gu, Muan-Gun, Eumseong-Gun, Samcheok, Jeju, Gwangyang, Seosan, Inje-Gun, Ulreung-Gun, Shinan-Gun, Seogwipo, Imsil-Gun, Seodaemun-Gu, Yeongdeok-Gun, Busan Gangseo-Gu, Geochang-Gun, Pyeongchang-Gun, Muju-Gun, Boryeong, Nowon-Gu, Gwangju, Cheongwon-Gun, Seongdong-Gu, Gwangju Dong-Gu, Suwon Yeongtong-Gu, Geoje, Goheung-Gun, Danyang-Gun, Gwanak-Gu, Pyeongtaek, Ulsan Buk-Gu, Namhae-Gun, Yongin Suji-Gu, Gangreung, Gumi, Songpa-Gu, Gangwon Goseong-Gun, Yeongwol-Gun, Haenam-Gun, Cheongyang-Gun, Gwangju Seo-Gu, Uijeongbu, Suwon Jangan-Gu, Gangbuk-Gu, Yeongam-Gun, Chilgok-Gun, Bonghwa-Gun, Daegu Dalseo-Gu, Jungryang-Gu, Dongdaemun-Gu, Incheon Bupyeong-Gu, Suwon Gwonsun-Gu, Uiryeong-Gun, Uljin-Gun, Pohang Nam-Gu, Donghae
	20 - 29%	Busan Seo-Gu, Gwangmyeong, Boseong-Gun, Wonju, Cheorwon-Gun, Sangju, Seongnam Bundang-Gu, Icheon, Jincheon-Gun, Ulsan Dong-Gu, Yeoncheon-Gun, Eunpyeong-Gu
	10 - 19%	Yesan-Gun, Incheon Jung-Gu, Tongyeong, Yecheon-Gun, Hwaseong, Incheon Ganghwa-Gun, Haman-Gun, Gangseo-Gu

Note: include the regions where specialized general nursing care hospitals (tertiary hospitals) are in analyzing by regions

3. Policy Implications

Various regional factors must be considered when implementing policies on hospital bed supply and demand in regions with an imbalance between the demand and supply of hospital beds, including the population size, geographic size, transportation, affinity of medical care use (the ratio of local residents' use of local medical facilities against all facilities), and area of major activities. The analysis of the imbalance between the demand and supply of hospital beds found that oversupply and supply shortages existed in both urban and rural areas. An improvement in this imbalance requires a policy focused on increasing the supply for areas with shortages while decreasing the supply in oversupplied areas. These policies should also consider the characteristics of individual regions. In other words, policies intended to adjust the supply of hospital beds to an appropriate level should closely examine the region's status, including demographic and socioeconomic characteristics, health care delivery system, areas of major activities, and transportation. In urban areas, a shortage of hospital beds may not cause significant problems as medical care can be easily accessed in adjacent areas; however, in rural areas, these shortages can cause significant problems as it takes time and money to access medical care in adjacent areas. For areas with a shortage of hospital beds, the problem of failing to meet the residents' needs for medical care should be resolved by examining the status of the supply of health care resources as well as regional demographic and socioeconomic characteristics. In addition, if a region with an oversupply of hospital beds is also an area of major activities for residents of an adjacent area that has a shortage of hospital beds, the oversupply should be examined more closely. Developing appropriate regional policies for optimal supply of hospital bed resources should therefore consider the primary areas of major activities, transportation conditions, and status of health care personnel of adjacent regions along with the hospital bed imbalance index.

6

Root Cause Analysis of Regional Imbalance in Major Hospital Bed Resources

6 Root Cause Analysis of Regional Imbalance in Major Hospital Bed Resources

In the previous chapter, the overall imbalance levels and changes in these levels were examined using Gini indices. The imbalance level of major hospital bed resources for individual city, county, and district units were determined by calculating imbalance indices based on regression analysis. This chapter uses two approaches to analyze the causes of imbalance. In the first approach, the analysis of the cause of imbalance involved categorizing the imbalance indices of hospital bed resources (estimated in the previous chapter) into oversupply, supply shortage, and optimal supply categories, and estimating multinomial logit models using the categorized imbalance index as a dependent variable. In the second approach, the causes of demand-supply imbalance in major hospital bed resources were investigated on the basis of the demand-supply model of major hospital bed resources.

Section 1. Descriptive Analysis

The regional medical care use in Korea is as follows. The national average of outpatient visits to western medical facilities per capita was 14.6 visits per year. Regionally, this was the highest in Daegu (19.4 visits), followed by Jeonbuk (17.3 visits), and Gwangju (17.0 visits). Gangwon had the lowest number of outpatient visits to western medical facilities per capita at 11.6 visits. In terms of inpatient care use, Gwangju had the longest length of stay at western facilities per capita (5.6 days), followed by Busan (5.1 days), and Daegu (4.9 days). Again, Gangwon had the shortest length of stay at western medical facilities per capita. Seoul and Jeju also showed relatively short stays at western medical facilities per capita.

The socioeconomic characteristics showed that, nationally, there was little difference in the gender ratio (female ratio of 49.9%). Children aged under 5 and seniors aged 65-plus accounted for 4.2% and 15.8% of the total population, respectively. For individual regions, with the exception of the Seoul Capital Area and other metropolitan areas, most areas showed a population of older adults 4–6 times higher than the child population. The Seoul Capital Area and other metropolitan areas (e.g., Gyeonggi and Jeju) showed a somewhat smaller gap between the older adult and child populations, with the population of older adults being less than three times larger than that of children. In addition, the crude birth and death rates showed similar national averages (0.9 and 0.7, respectively). However, Gwangju, Ulsan, and Gyeonggi were regions with high crude birth rates, whereas Jeolla-do and Gyeongsang-do had high crude death rates. The local tax burden was about 930,000 Won per capita, overall fiscal self-reliance was 30.2%, and around 3.2% were beneficiaries of basic livelihood support. Regions with the highest proportions of beneficiaries of basic livelihood support were Jeonnam (5.0%) and Jeonbuk (5.3%), with the lowest being Ulsan (1.3%) and Gyeonggi (1.6%). The average population growth rate was −2.2, indicating little overall change in population size. In terms of regional changes for recent five years, the populations of Incheon and Gyeonggi increased by 6.5% and 6.4%, respectively, indicating relatively large growth in those regions.

Section 2. Root Cause Analysis of Imbalance in Hospital Bed resources

In the root cause analysis of the imbalance in hospital bed resources, regions with comprehensive long-term care facilities were excluded from the models for all beds and for general beds (including tertiary hospital beds). These regions were excluded because comprehensive long-term care facilities are used by residents of the extended medical service area for that location or other extended service areas, as well as the residents of the region in which they are located. High correlations were found among the independent variables included in the hospital bed imbalance model, including intercorrelations among the proportions of children under 5 and seniors aged

65-plus, death rate, and birth rate (representing demographic and aging characteristics), a correlation between the supply rate of drinking water and population density (representing urbanization), and intercorrelations among local tax burden, proportion of beneficiaries of basic livelihood support, insurance premium per household, and fiscal self-reliance (representing regional economic condition). In addition, the correlation between the number of days of visiting or staying in western or eastern medical facilities and the ratio of subjective health level was high. Moreover, there was a high correlation between the two variables representing medical care delivery characteristics (the relevance index or ratio of local residents' use of local medical facilities to their use of all medical facilities and the commitment index or ratio of local residents' use of medical facilities in a region to the total use of medical facilities in that region). Multicollinearity occurs when there are high correlations among many variables that are simultaneously included in an estimation equation; therefore, factor analysis[3] was performed to resolve this problem.

3) For the factor analysis, principal component analysis was used because the first principal component was a linear combination that accounted for most variance in the sample, and the second principal component was the linear combination that accounted for the most variance unrelated to the first principal component. Varimax, the most commonly used orthogonal rotation method, was used.

1. Root Cause Analysis of Imbalance in Hospital Bed resources Using Multinomial Logit Models

The analysis of the cause of imbalance was conducted by categorizing the imbalance indices (estimated in the previous chapter) for all beds (general + specialized), general beds, general beds excluding tertiary hospital beds, and long-term care beds as follows: oversupply (imbalance index of 0.10 or higher); supply shortage (imbalance index of −0.09 or lower); and optimal supply (imbalance index of −0.10 through 0.09). Then, multinomial logit models were estimated using the categorized imbalance index as a dependent variable. The multinomial logit model results varied by the type of hospital beds, whether tertiary hospital beds were excluded, and whether regions with tertiary hospitals were excluded from analysis. When regions with tertiary hospitals were excluded, although the statistical significance of the models for all beds (general + specialized) and general beds were low, important factors that explained the differences between supply shortage and optimal supply regions were statistically significant. In particular, objective and subjective health level factors, and affinity and concentration of health care use factors were statistically significant at 1% and 5% significance levels. Hospital bed supply was more likely to be insufficient when the residents' objective health levels (estimated by factor analysis using medical care use and subjective health index) were poorer. However, when the proportion of local residents who perceived they were healthy was higher, a shortage of hospital beds was more likely. In addition, when the affinity of health care use, which represents the ratio of local residents' use of local medical facilities against all facilities, was higher, the shortage of hospital bed supply was more likely to be higher. However, the concentration of health care use (commitment index), representing the ratio of use by local residents in relation to all use of local medical facilities, was negatively correlated with a hospital bed supply shortage. This suggests an association between high concentration and lower shortage. However, there were few variables that differentiated between the regions with oversupply and supply shortage.

When all regions were included, the model on general beds excluding comprehensive long-term care facilities (tertiary beds) and the model on long-term care beds were statistically significant at a 5% significance level. In the model for general beds excluding tertiary beds, the comparison between supply shortage and optimal supply regions showed similar results to that for all general beds. Factors that determined optimal supply and supply shortage of hospital beds were objective health level factors, subjective health level factors, the affinity of health care use, and the concentration of health care use, all of which were statistically significant at 1% or 5% significance levels. In the model for general beds excluding tertiary beds, the comparison of oversupply and optimal supply regions showed that population growth rate, urbanization, and affinity and concentration of health care use were statistically significant. An oversupply of hospital beds was less likely to occur when population growth rate and urbanization were higher, and affinity of health care use was higher. In the long-term care beds model, affinity of health care use showed a significant positive relationship, and population growth, aging, and concentration of health care use showed a significant negative relationship. Specifically, a shortage of long-term care beds was less likely when population growth and the aging index were higher, and the ratio of use by local residents in relation to all users was higher. No variables or factors were statistically significant in classifying oversupply and optimal supply of long-term care beds.

〈Table 6-1〉 Results of the Multinomial Logit Model for Types of Imbalance in Hospital Bed Supply (I)

3 categories of the imbalance of bed resources		All beds (general beds + specialized beds)			General beds I		
		B	Wald	p	B	Wald	p
Supply shortage	Constant	23.433	3.607	.058	-21.091	12.193	.084
	Female ratio	-.460	3.484	.062	.439	.245	.074
	Population growth rate for 5 years	.008	.051	.821	-.008	.034	.812
	F population aging level	-.302	.353	.553	-.481	.500	.336
	F urbanization level	.442	1.271	.260	.036	.403	.929
	F economic level	-.245	.287	.592	-.134	.452	.766
	F objective health level	1.441	5.516	.019	.752	.595	.206
	F subjective health level	.021	.007	.934	.159	.273	.560
	F affinity of health care use	.710	1.617	.203	.277	.562	.621
	F concentration of health care use	-1.016	7.161	.007	-.770	.377	.041
Oversupply	Constant	39.080	9.701	.002	-18.297	11.930	.125
	Female ratio	-.763	9.234	.002	.394	.240	.101
	Population growth rate for 5 years	.012	.112	.738	-.030	.034	.365
	F population aging level	.949	3.514	.061	.064	.483	.895
	F urbanization level	-.356	.877	.349	-.575	.390	.140
	F economic level	-.165	.135	.714	-.251	.443	.571
	F objective health level	-.727	1.506	.220	-.991	.583	.089
	F subjective health level	-.610	5.522	.019	-.451	.268	.093
	F affinity of health care use	-1.658	9.329	.002	-1.455	.543	.007
	F concentration of health care use	.801	4.642	.031	.462	.362	.202
Chi-Square		407.706			432.810		
p		.439			.155		

a. The reference category is optimal.

〈Table 6-2〉 Results of the Multinomial Logit Model for Types of Imbalance in Hospital Bed Supply (II)

3 categories of the imbalance of bed resources		General beds II (excluding tertiary hospital beds)			Nursing care beds		
		B	Wald	p	B	Wald	p
Supply shortage/optimal supply	Constant	-17.162	2.412	.120	-16.185	.839	.360
	Female ratio	.358	2.590	.108	.371	1.083	.298
	Population growth rate for 5 years	-.010	.100	.752	-.103	5.573	.018
	F population aging level	-.191	.179	.672	-.700	1.072	.301
	F urbanization level	.142	.175	.675	-.331	.483	.487
	F economic level	-.015	.002	.968	.287	.306	.580
	F objective health level	.570	1.567	.211	.672	1.458	.227
	F subjective health level	.030	.016	.899	.227	.411	.521
	F affinity of health care use	.436	.882	.348	1.273	3.861	.049
	F concentration of health care use	-.898	7.471	.006	-1.367	8.544	.003
Oversupply/optimal supply	Constant	-12.063	1.194	.274	-5.442	.095	.757
	Female ratio	.268	1.451	.228	.152	.183	.669
	Population growth rate for 5 years	-.056	2.762	.097	-.028	.555	.456
	F population aging level	-.184	.173	.677	.187	.079	.779
	F urbanization level	-.307	.847	.357	-.152	.105	.746
	F economic level	-.359	.938	.333	-.124	.058	.810
	F objective health level	-.230	.265	.607	-.039	.005	.944
	F subjective health level	-.243	1.212	.271	.366	1.132	.287
	F affinity of health care use	-.476	1.158	.282	.069	.012	.913
	F concentration of health care use	.427	1.956	.162	.139	.095	.758
Chi-Square		505.701			512.621		
p		.167			.119		

2. Root Cause Analysis of Imbalance in Hospital Bed resources Using OLS Models

All OLS models for all beds, general beds, general beds excluding tertiary beds, and long-term care beds were statistically significant at a 1% significance level. In addition, the R-square, which indicates the explanatory power of a model, was 24.2% for all beds, 15.5% for general beds, 20.8% for general beds excluding tertiary beds, and 30.1% for long-term care beds. The OLS models that used the imbalance index as a continuous variable, and the multinomial logit models which used the imbalance index as a categorical variable showed similar results.

Variables or factors that were statistically significant were nearly identical in the models for all beds, general beds, and general beds excluding tertiary beds, when regions with tertiary hospitals were excluded from analysis. The variables or factors that showed a statistically significant positive relationship were the level of population aging and concentration of health care use factors, whereas those that showed a statistically significant negative relationship were urbanization level, objective health level (significant only in the general beds model), and affinity of health care use factors. An oversupply of hospital beds was more likely to occur when aging level and concentration, urbanization level, subjective health level, and affinity of health care use were higher, and objective health level was lower. In the model for long-term care beds, the level of population aging, and affinity and concentration of health care use were statistically significant.

〈Table 6-3〉 Results of Models Estimating Imbalance in Hospital Bed Resources Using the OLS Method

Supply	All beds (general beds + specialized beds)			General beds I			General beds II (excluding tertiary hospital beds)			Nursing care beds		
	B	Stan. error	p	B	Stan. error	p	B	Stan. error	p	B	Stan. error	p
Constant	2.417	1.429	.092	1.920	2.346	.414	3.241	2.229	.147	4.037	3.056	.188
Female ratio	-.046	.029	.109	-.034	.047	.467	-.060	.045	.179	-.078	.061	.207
Population growth rate for 5 years	-.002	.005	.656	-.012	.007	.122	-.013	.007	.088	.014	.010	.173
F population aging level	.231	.061	.000	.214	.100	.033	.173	.093	.064	.224	.128	.082
F urbanization level	-.141	.047	.003	-.228	.078	.004	-.173	.069	.014	-.039	.095	.684
F economic level	.051	.054	.347	.051	.089	.571	-.025	.076	.740	-.183	.104	.079
F objective health level	-.352	.063	.000	-.411	.104	.000	-.258	.079	.001	-.286	.108	.009
F subjective health level	-.076	.031	.015	-.120	.051	.019	-.081	.045	.077	.007	.062	.907
F affinity of health care use	-.354	.062	.000	-.425	.101	.000	-.295	.090	.001	-.495	.123	.000
F concentration of health care use	.299	.041	.000	.293	.067	.000	.354	.056	.000	.567	.077	.000
F	8.601			4.568			6.821			7.767		
p	.000			.000			.000			.000		
R2	.277			.169			.205			.227		

Section 3. Analysis of Supply Model of Hospital Bed resources

Regarding hospital bed supply models, the supply models for all beds (general + specialized), general beds, general beds excluding tertiary hospital beds, and long-term care beds were estimated. For the supply models on all beds and general beds, regions with tertiary hospitals were excluded from the analyses.

In addition, the models estimating hospital bed supply were conducted by classifying the models including affinity and concentration of health care use factors and those excluding these two factors. First, for the models excluding affinity and concentration of health care use, the results for the all beds supply model, the general bed supply model, and the general bed excluding tertiary beds supply model showed little difference. The variables or factors that showed a positive influence on hospital bed supply were female ratio, economic level, and objective health level, whereas those that showed a negative influence on hospital bed supply were population growth rate and population aging level. Hospital bed supply was higher in regions with a higher female ratio or economic level, and a lower objective health level, whereas hospital bed supply was lower in regions with higher population growth or aging level. In the long-term care bed supply model, only the female ratio, population aging level, and objective health level were statistically significant.

Second, the estimation results of the models including affinity and concentration of health care use factors showed that most model effects were explained by local residents' health care use patterns and health care use by residents of other regions. The affinity of health care use factor, or the proportion of use of local facilities in the total use by local residents, showed a negative relationship, suggesting that hospital bed supply is likely to be insufficient as the proportion of local residents' use of local facilities increases. On the other hand, the concentration of health care use factor, or the proportion of use by local residents of the total use of local medical facilities, showed a positive relationship.

〈Table 6-4〉 Results of the Estimation of Hospital Bed Supply Model (I)

Supply	All beds (general beds + specialized beds)			General beds I			General beds II (excluding tertiary hospital beds)			Nursing care beds		
	B	Stan. error	p	B	Stan. error	p	B	Stan. error	p	B	Stan. error	p
Constant	42.721	17.140	.013	19.316	13.520	.155	16.044	13.000	.218	15.917	10.368	.126
Female ratio	-.513	.344	.138	-.210	.271	.440	-.155	.261	.552	-.249	.208	.233
Population growth rate for 5 years	.031	.054	.567	-.045	.043	.297	-.043	.043	.320	.068	.034	.046
F population aging level	.378	.730	.605	-.675	.576	.242	-.683	.544	.211	.875	.434	.045
F urbanization level	-2.482	.569	.000	-1.533	.448	.001	-1.381	.405	.001	-.486	.323	.134
F economic level	-2.624	.653	.000	-1.123	.515	.030	-1.356	.441	.002	-1.303	.351	.000
F objective health level	4.312	.760	.000	2.283	.600	.000	1.563	.460	.001	-.077	.367	.834
F subjective health level	.672	.371	.072	.229	.293	.436	.232	.264	.381	.199	.211	.346
F affinity of health care use	-4.048	.739	.000	-2.171	.583	.000	-1.465	.522	.005	-1.784	.416	.000
F concentration of health care use	2.629	.493	.000	1.151	.388	.003	1.485	.329	.000	1.578	.262	.000
F	50.795			19.992			20.350			13.245		
p	.000			.000			.000			.000		
R2	.694			.471			.435			.334		
adjusted R2	.680			.448			.414			.309		

Section 4. Analysis of Hospital Bed Demand Models

For the analysis of hospital bed demand, a model using the length of stay to represent inpatient care use was established separately for an estimation including regions with tertiary hospitals and an estimation excluding those regions. First, the goodness-of-fit index for the length of stay model including regions with tertiary hospitals was statistically significant at a 1% significance level, and the explanatory power of the model was high (79.8%). The goodness-of-fit index for the model excluding regions with tertiary hospitals was also statistically significant at a 1% significance level, with an explanatory power of 78.6%. The two models were not significantly different in terms of model fit or explanatory power. The two models also showed little difference in the effects of independent variables. The variables that influenced length of stay were the numbers of general beds and long-term care beds per 1,000 people, female ratio, urbanization, subjective health, and affinity and concentration of health care use factors. Of these, the variables that showed a positive relationship with length of stay (hospital bed demand) were the numbers of general beds and long-term care beds per 1,000 people, female ratio, and concentration of health care use, whereas urbanization, subjective health, and affinity of health care use showed a negative relationship.

〈Table 6-5〉 Results of Estimation of Hospital Bed Demand Models

Supply	Length of stay I			Length of stay II		
	B	Stan. error	p	B	Stan. error	p
(Constant)	2.160	4.068	.596	2.529	4.211	.549
General beds per 1,000 people	1.009	.161	.000	.910	.159	.000
Nursing care beds per 1,000 people	.755	.092	.000	.837	.100	.000
Female ratio	-.031	.081	.701	-.038	.085	.657
Population growth rate for 5 years	-.003	.012	.802	-.003	.012	.822
F population aging level	-.274	.154	.076	-.329	.163	.045
F urbanization level	-.409	.113	.000	-.436	.123	.001
F economic level	-.376	.136	.006	-.304	.157	.055
F objective health level	1.014	.126	.000	1.018	.162	.000
F subjective health level	.010	.072	.893	-.007	.079	.931
F affinity of health care use	-.651	.165	.000	-.549	.187	.004
F concentration of health care use	.089	.110	.422	.102	.125	.413
F	106.825			73.073		
p	.000			.000		
adjusted R2	.840			.808		

Note: Length of stay I: including local areas where tertiary hospitals are / length of stay II: excluding local areas where tertiary hospitals are.

Section 5. Policy Implications

The results of the root cause analysis of regional imbalance in hospital bed resources for general beds (excluding tertiary hospital beds) showed that major factors determining supply shortage and oversupply were regional population growth and urbanization level, health level, local residents' health care use behavior, and health care use by residents of other regions. Regions with a shortage of hospital beds were primarily those with high health care use by local residents, high subjective health level, high use of local medical facilities, and high use of medical facilities by residents from other regions. Therefore, for regions with a hospital bed shortage, policies to improve this shortage should be based on an analysis of the optimality of health care use, including the hospital bed use rate for respective regions. Regions with a hospital bed oversupply were likely to be regions with low population growth and urbanization level, low health care use by local residents, and low health care use by residents from other regions. Therefore, in regions with hospital bed oversupply, oversupply policies should be established after examining local residents' health care use behavior.

These findings suggest a necessary precaution in policy-making, that is, regional policies on imbalance in major hospital bed resources must not be based on a one-size-fits-all approach. As regions with hospital bed shortages can differ in terms of local situations depending on areas of major activities, measures to reduce the gaps in major hospital bed resources that fit individual regions must be devised. This requires close examination of specific regional situations based on the results of this study.

7

Estimation of Optimal Supply of Hospital Beds

7 Estimation of Optimal Supply of Hospital Beds

The previous chapters examined overall imbalance and change in imbalance in major hospital bed resources, using the Gini index, and conducted analysis on imbalance in key hospital bed resources in each Si, Gun, and Gu counties as well as root cause analysis of the imbalance in key hospital bed resources by estimating the imbalance index using regression analysis. In this chapter, the optimal levels of hospital bed resources in Korea are estimated from perspectives of medical resources, national health expenditure, and health level on the basis of the averages on the variables observed as determinants of hospital bed supply, using OECD country data.

As health care is of strong public interest, the problem of shortage in supply develops in certain medical services that are avoided by private medical institutions, such as maternity care, rare disease treatment, emergency medicine, and prevention and treatment of infectious diseases, because they do not generate profit if they are left to the market only. This is a problem caused by market failure, which occurs when health care is left to the private sector or market only. This is why the role of government and public health care is important (Oh, 2013).

The outbreak of Middle East respiratory syndrome (MERS) in

Korea, which began in June and ended in August 2015, inflicted significant socioeconomic damage and its aftermath, such as dampening of domestic economic activity and decreased foreign tourism. In particular, during the MERS outbreak, as the numbers of patients with MERS and suspected patients increased, the public became particularly concerned that no medical facilities may be available to provide proper care, in case they and their families became infected. The MERS outbreak has ended; however, it was predicted that the prevalence of infectious diseases would increase due to emerging new infectious diseases resulting from changes in health care environments and the introduction of foreign-born infections. The problem under the current health care delivery system in Korea is not unlike if a second or third MERS outbreak was to occur. Treatment or management of infectious diseases, such as MERS, is one of the most important roles of public health because it is the area that the private sector avoids due to low profitability, and public health is in charge due to reasons such as negative externality, namely, the negative influence on others' health. However, the public health system in Korea is too weak to perform the role, and it constitutes less than 10% of the entire health care system in terms of numbers of hospital beds or facilities. This is the lowest level among OECD countries.

Therefore, for the public health system to perform its role and function fully, an efficient and reasonable care delivery system first must be established so that health care is performed in the public interest. Such a care delivery system can be achieved when public and private sectors work together to develop the system considering the nature of health care. In particular, public health must be able to perform its role properly enough to be able to check the private sector at a reasonable level, in complementary and cooperative relationship between the public and private sectors (Oh, 2013). In this regard, this study will estimate the optimal level of hospital bed resources and public hospital beds in the public health sector, to advance toward establishing a reasonable and efficient care delivery system.

Section 1. Descriptive Analysis

Table 1 shows the change over time in key variables by the type of health care delivery systems from 1980 to 2012. Over the 32-year period, the average life expectancy increased 1.11-fold from 72.5 years in 1980 to 80.37 years in 2012. When examined by the health care delivery system, the life expectance in countries with a private-based health care system increased 1.11-fold from 72.45 years in 1980 to 80.25 years in 2012, while the life expectancy in countries with a state-led health care system also increased 1.11-fold from 72.61 years in 1980 to 80.58 years in 2012. The life expectancy in countries with a state-led health care system was slightly higher than that in the countries with a private-based health care system; however, the increase rate showed no significant difference.

National health expenditure per capita increased 6.32-fold from 554.01 dollars in 1980 to 3503.23 dollars in 2012, which is 4.57 times higher than the increase in gross domestic product (GDP) per capita, indicating a rapid growth in health expenditure. When examined by the type of health care delivery system, national health expenditure per capita in the countries with a private-based health care system increased 6.24-fold from 582.38 dollars in 1980 to 3634.27 dollars in 2012, while those in the countries with a state-led health care system increased 6.47-fold from 504.35 dollars in 1980 to 3263.01 in 2012. Although the increase rate in health expenditure per capita did not show a significant difference, the difference between health care delivery systems in health expenditure per capita was significant, where countries with private-based health care system showed significantly higher national health expenditure per capita.

〈Table 7-1〉 Change Over Time in Key Variables by Health care Delivery system (1980-1912)

Government supply system	Year	Medical expenses per capita	GDP per capita	No. of beds per 1,000 people	Secondary education or more	Aged population ratio	Death rate	Life expentancy	Percent of public health expenditures
Private-based supply system	1980(A)	582.38	8589.83	9.20	56.182	11.264	9.645	72.45	72.894
	1990	1167.26	15494.67	7.92	63.715	11.848	9.264	74.62	73.329
	2000	1940.62	24043.42	6.51	75.958	13.348	8.742	76.98	70.977
	2010	3386.85	35342.47	5.57	82.690	14.991	8.377	79.68	71.231
	2012(B)	3634.27	38009.38	5.50	83.455	15.542	8.559	80.25	71.154
	(B/A)	6.24	4.42	0.60	1.49	1.38	0.89	1.11	0.98
Government-based supply system	1980(A)	504.35	7110.44	7.01	40.678	11.629	9.501	72.61	73.735
	1990	1003.52	13913.21	5.88	52.153	12.690	9.428	75.04	74.447
	2000	1784.69	22308.78	4.19	62.409	13.924	8.950	77.41	72.494
	2010	3078.76	32752.05	3.54	71.359	15.208	8.409	80.06	74.387
	2012(B)	3263.01	34840.45	3.43	72.863	15.914	8.502	80.58	74.639
	(B/A)	6.47	4.90	0.49	1.79	1.37	0.89	1.11	1.01
Total	1980(A)	554.01	8067.70	8.40	50.710	11.393	9.594	72.50	73.191
	1990	1107.72	14936.51	7.18	59.634	12.145	9.322	74.77	73.724
	2000	1885.58	23431.19	5.66	71.176	13.551	8.816	77.13	71.513
	2010	3278.11	34428.20	4.85	78.691	15.068	8.388	79.82	72.345
	2012(B)	3503.23	36890.93	4.77	79.717	15.673	8.539	80.37	72.384
	(B/A)	6.32	4.57	0.57	1.57	1.38	0.89	1.11	0.99

Section 2. Analysis on Determinants of Hospital Bed Supply

Table 2 shows the results of panel analyses with hospital bed supply as an independent variable on all OECD countries from 1980 to 2012. Estimation results are provided of the two factor-fixed effects model and the two factor-random effects model, on the independent variable; however, the results of the two-factor-random effects model was used in the analysis of this study because it was estimated to be more suitable for analysis on all OECD countries according to the Lagrange Multiplier test statistic and Hausman test results.

The analysis results on the model on all hospital bed supply showed that the total supply per 1000 people was higher when the national hospital expenditure per capita, GDP per capita, women's economic activity rate, proportion of people with at least secondary education, proportion of the elderly aged 65-plus, life expectancy, and the number of physicians per 1000 people were higher. However, the signs of the squared term for the number of physicians per 1000 people and GDP per capita were negative. This means that although the hospital bed supply increases as the number of physicians increases, the increase rate is lower when the number of physicians and GDP are higher. For instance, the total bed supply shows a strong positive relationship with GDP, where the supply increases by 1.08677% for every 1% increase in GDP per capita. The national health expenditure also showed a strong positive relationship with hospital bed supply, where the bed supply increased by 0.47476% for every 1% increase in the national health expenditure. The supply model for acute care beds showed results similar to those of the supply model for all beds, except that women's economic activity rate and proportion of seniors aged 65-plus showed negative relationships with acute care bed supply, in contrast to their positive relationships with all hospital bed supply. The supply model for long-term care beds also showed a similar pattern of results. However, long-term care bed supply was estimated to increase as the proportion of the elderly aged 65-plus increases, and to decrease as the death rate increases.

〈Table 7-2〉 Determinants of the Number of Hospital Beds in OECD Countries

Explanatory variables	Dependable variables					
	No. of general beds		No. of acute care beds		Long-term care beds	
	2 REM[1)]	2 FEM[2)]	2 REM[1)]	2 FEM[2)]	2 REM[1)]	2 FEM[2)]
Ln (medical expenses per capita)	.23944*** (0.04246)	.47476*** (0.04655)	.16435*** (0.04826)	.42209*** (0.05404)	.73504*** (0.22992)	0.29987 (0.18711)
Ln (GDP per capita)	2.02693*** (0.26041)	1.14790*** (0.27403)	1.47109*** (0.2887)	.63679** (0.30602)	6.93359*** (1.69034)	6.29080*** (1.3174)
Women's economic activity rate	0.00239 (0.00276)	.01311*** (0.00297)	-.02349*** (0.00296)	-.01027*** (0.00331)	.14157*** (0.01502)	.08552*** (0.01303)
Percentage of people having at least secondary education	0.00135 (0.00108)	0.00161 (0.00112)	0.00073 (0.00114)	0.00083 (0.00122)	.02097*** (0.00638)	0.00691 (0.00507)
Ratio of seniors aged 65-plus	.03754*** (0.01056)	.05051*** (0.01083)	-.03521*** (0.01163)	-.03016** (0.01201)	.14121*** (0.05285)	.18699*** (0.04828)
Death rate	-0.01523 (0.0206)	-0.01691 (0.02174)	.10816*** (0.02206)	.13357*** (0.02401)	-0.15297 (0.12388)	-.35246*** (0.0965)
Life expentancy	-0.01969 (0.01325)	.02783* (0.01426)	.05406*** (0.01523)	.12878*** (0.01686)	-0.09317 (0.08606)	-.20589*** (0.06368)
Public health expenditure per capita	.01561*** (0.00121)	.00823*** (0.00136)	.01598*** (0.00136)	.00838*** (0.00158)	-.01507* (0.00777)	0.00798 (0.00672)
Ln (No. of physicians per 1,000 people)	.38647*** (0.05863)	.38295*** (0.05918)	.39261*** (0.06416)	.37920*** (0.06555)	4.06836*** (1.12347)	3.38087*** (0.99187)
(Ln No. of physicians per 1,000 people)2	-.28207*** (0.0322)	-.21017*** (0.03314)	-.15269*** (0.03475)	-0.04288 (0.03625)	-2.10302*** (0.52777)	-1.89422*** (0.46973)
(LnGDP)2	-.11649*** (0.01441)	-.06113*** (0.01533)	-.08922*** (0.01617)	-.03675** (0.0173)	-.42306*** (0.09923)	-.37254*** (0.0763)
Constant	-8.92618*** (1.52662)	-11.0971*** (1.57988)	-10.6951*** (1.77398)	-15.5662*** (1.86124)	-34.5827*** (10.15977)	-18.0796** (8.16465)
R2	0.496	0.883	0.424	0.794	0.313	0.671
Hausman test	173.66***		176.88***		114.45***	

Note: 1) Two factor random effect model
2) Two factor fixed effect model
*, **, *** mean that they are significant with the significance levels of 10%, 5%, and 1%.
Values in the parentheses refer to t values.
Refer to Table 1 for the names of variables.

Table 3 shows the estimation results of the public hospital bed supply model that includes versus excludes the type of health care delivery system. Regarding the examination of the model fit of fixed versus random effects models for the models with versus those without the type of health care delivery system, the fixed effects model was more suitable, according to the Lagrange multiplier test statistic and Hausman test results. Therefore, hospital bed supply models will be explained, and appropriate capacity will be estimated, using the two-factor fixed effects model.

First, regarding the estimation results of the supply model for public hospital beds excluding the type of health care delivery system, the variables that have a positive influence on the proportion of public hospital beds were GDP per capita and women's economic activity rate. On the other hand, variables that have a negative influence were national health expenditure per capita, proportion of the elderly aged 65-plus, death rate, life expectancy, public health expenditure per capita, and number of physicians per 1000 people. However, although the supply decreases as the number of physicians increases, the decrease rate is lower when the number of physicians is higher. In addition, although the public hospital bed supply increases as GDP increases, the increase rate is lower when GDP is higher. The estimation results of the supply model for public hospital beds including the type of health care delivery system showed a pattern of results similar to those of the model excluding the type of health care delivery system; however, the effect size of each variable was significantly lower in the inclusion model. In general, the proportion of public hospital beds was 28.2% higher in countries with a state-led health care system than in the countries with the private-based health care system.

〈Table 7-3〉 Determinants of the Proportion of Public Hospital Beds in OECD Countries

Explanatory variables	Dependable variables			
	Percentage of public hospital beds (I)		Percentage of public hospital beds (II)	
	2 REM[1)]	2 FEM[2)]	2 REM[1)]	2 FEM[2)]
Ln (medical expenses per capita)	-15.5949*** (3.74999)	-19.8734*** (4.07601)	0.93194 (2.81469)	-1.14469 (3.14244)
Ln (GDP per capita)	89.4299*** (34.14464)	151.105*** (37.19557)	-23.7913 (25.0889)	3.05282 (28.13462)
Women's economic activity rate	1.26208*** (0.18156)	.70377*** (0.19915)	1.00188*** (0.13123)	.76958*** (0.14162)
Percentage of people having at least secondary education	-.11484* (0.06904)	-0.04832 (0.07426)	.21933*** (0.05269)	.21429*** (0.05547)
Ratio of seniors aged 65-plus	-0.85134 (0.73127)	-0.27366 (0.79111)	-1.40639*** (0.53025)	-0.87434 (0.56368)
Death rate	-0.90715 (1.44391)	-5.67573*** (1.66435)	0.76056 (1.06945)	-1.96822 (1.20731)
Life expentancy	-1.51455* (0.91583)	-5.81776*** (1.07261)	-1.70709** (0.66679)	-3.64563*** (0.77537)
Public health expenditure per capita	-.34780*** (0.07946)	-0.12193 (0.101)	0.01332 (0.06121)	0.0401 (0.07256)
Ln (No. of physicians per 1,000 people)	-38.2366*** (3.88866)	-48.3121*** (4.08891)	-42.6862*** (2.78687)	-47.2677*** (2.90724)
(Ln No. of physicians per 1,000 people)2	15.3256*** (2.20844)	12.5460*** (2.26268)	11.9082*** (1.58464)	9.94558*** (1.61719)
(LnGDP)2	-3.49010** (1.63126)	-7.41149*** (1.83146)	1.28602 (1.19239)	-0.32377 (1.38087)
Government-based/private-based supply system	-	-	30.9004*** (1.61953)	28.2265*** (1.83396)
Constant	-222.979 (166.4665)	-38.1486 (172.7968)	272.295** (121.5893)	361.486*** (125.5407)
R2	0.496	0.843	0.613	0.925
Hausman Test	123.54***		97.12***	

Note: 1) Two factor random effect model
2) Two factor fixed effect model
*, **, *** mean that they are significant with the significance levels of 10%, 5%, and 1%.
Values in the parentheses refer to t values.
Refer to Table 1 for the names of variables.

Section 3. Estimation of Optimal level of Hospital Bed Supply

This section will evaluate if the current level of hospital bed supply is appropriate on the basis of the estimation results of hospital bed supply models thus far. As noted earlier, the concept of "optimal" is based on the application of average levels of OECD countries to Korea and cannot be interpreted as "best possible." It merely indicates the criteria for evaluating the supply level of hospital beds in Korea as compared with other OECD countries. Table 7-4 shows a comparison between the estimates on the basis of each model and actual values. Overall, the current supply levels of hospital beds in Korea, such as all beds, acute care beds, and long-term care beds, were estimated to be very high. However, the proportion of public hospital beds in Korea was very low as compared with other OECD countries. Regarding the number of all beds, the optimal level of hospital bed supply on the basis of the patterns observed among OECD countries is 4.02 to 7.48 beds per 1000 people; however, the actual hospital bed supply level in 2012 was 10.0 beds per 1000 people, showing 1.3 to 2.4 times the estimates for the optimal level. Similarly, the estimate for optimal level for acute care bed supply was 2.78 to 5.12 beds per 1000 beds; however, the actual level of acute care bed supply in 2012 was 6.0 beds per 1000 people, showing 1.27 to 2.17 times the estimate for optimal level. However, in the case of long-term care beds, oversupply is more serious. The optimal level was estimated to be 0.38 to 0.70 bed per 1000 people; however, the actual long-term care bed supply level was 2.92 beds per 1000 people, showing an oversupply of 4 to 7 times the optimal level. On the other hand, in the case of public hospital beds, estimates for the optimal proportion of public hospital beds on the basis of the patterns observed in OECD countries was 57.11% to 71.81% when the model did not include the type of health care delivery system. The estimates changed greatly when the model included the type of the health care delivery system. On the basis of the data on countries with a private-based health care delivery system, the optimal proportion of public hospital beds was estimated to be 53.61% to 55.15%. However, the actual proportion of public hospital beds in Korea was 12%, which was only 17% to 22% of the optimal level.

To summarize the results described above, the supply levels of acute care and long-term care beds in Korea showed a serious oversupply as compared with other OECD countries. However, it can be concluded that the proportion of public hospital beds showed a markedly low level as compared with other OECD countries.

〈Table 7-4〉 Estimates and Actual Values of Optimal Levels of Hospital Beds in Korea

Classification		Actual values in Korea (2012)	Optimal number of hospital beds	
			Optimal size[1)]	Optimal size[2)]
Total number of hospital beds (per 1,000 people)		10.00	7.48	4.02
Number of acute hospital beds (per 1,000 people)		6.00	5.12	2.76
Number of long-term care beds (per 1,000 people aged 65-plus)		2.92	0.38	0.70
Ratio of public hospital beds (%)[3)]	Scenario I	12.00	57.11	71.81
	Scenario II	12.00	53.61	55.15
	Scenario III	12.00	81.84	86.05

Note: 1) Estimated with the two factor fixed effect model.
2) Estimated with the two factor fixed effect model.
3) Scenario I in the ratio of public hospital beds was a result with all OECD countries; Scenario II was estimated with countries with private-based health care delivery system; Scenario III was estimated with the countries with government-based health care delivery system.

Section 4. Policy Implications

This section evaluated whether the current level of hospital bed supply is optimal, using the estimation equations for appropriate hospital bed level model estimated in the previous chapter. As noted earlier, the concept of "optimal" is based on the application of average levels of OECD countries to Korea, and cannot be interpreted as "best possible." It merely indicates the criteria for evaluating the supply level of hospital beds in Korea as compared with other OECD countries. Although the supply level of hospital beds in Korea, such as all beds, acute care beds, and long-term care beds, was estimated to be very high as compared with OECD countries, the proportion of public hospital beds was evaluated as very low as compared with the countries. The level of all bed supply was 1.3- to 2.4-fold oversupply of the optimal level, and the supply of acute care beds was 1.27–2.17 times the optimal level. The supply of long-term care beds showed a more serious oversupply of 4 to 7 times the optimal level. In contrast, the proportion of public hospital beds was merely 17% to 22% of the optimal level. Therefore, it is clear that there is a serious oversupply level of acute and long-term care beds as compared with the other OECD countries. On the other hand, the proportion of public hospital beds is markedly low as compared with other OECD countries, even when it is considered that the concept of public health in Korea is changing from ownership to function.

The problem of hospital bed supply in Korea is that acute and long-term care beds show an oversupply, whereas the public hospital bed capacity is too low. This problem is considered the result of policy failure and absence; i.e., failing to have an effective policy on hospital beds in place. Therefore, policies in the future should be directed toward reducing the supply of acute and long-term care beds on the basis of regional distributions and expanding the supply of public hospital beds on the basis of the public health care demands.

Regarding policy measures for the optimal supply of hospital beds by type, health insurance and medical resource policies must be considered proactively. In particular, regarding the health insurance policy measures to improve the regional and overall imbalance in hospital bed resources, fee or payment systems must be considered, such as the differential copay system, fee schedules for individual regions, improved payment systems for medical expenses, and restriction to the length of stay (fee deduction system). In addition, regarding medical resources policies that have a direct impact on hospital bed supply, the policy to limit the total number of hospital beds, and the measures to strengthen barriers against new suppliers' entry into supply chain must be examined. Moreover, the measures to increase public hospital beds include the government's direct purchase of private hospital beds in regions with oversupply by estimating the level of the public hospital bed supply that can ensure changing roles and function of public health care to be performed.

8

Policies on Hospital Bed Supply Management in Korea

8 Policies on Hospital Bed Supply Management in Korea

In the previous chapter, the optimal level of hospital bed resources in Korea was estimated by applying the average levels of OECD countries to Korea. This chapter discusses hospital bed supply policies in the United States and Japan in addition to Korea, to find implications for policy making to reduce the problems of overall and regional imbalance in hospital bed resources in Korea.

Section 1. Korea

Korea's policies on hospital bed resources management can largely be divided into three periods: before 1977, from 1977 to the mid-1990s, and after the mid-1990s. In the period before 1977, although all health care resources were in absolute shortage, effective demand was not large due to low GDP, and resolving economic barriers to health care use due to the lack of physicians in rural areas, and expensive services was the greatest challenge. Despite the enactment of the Medical Insurance Act in 1963, its mandatory enforcement was deferred, and the policy on expansion of medical resources that the Ministry of Health and Social Affairs has implemented several times had not been successful due to budget shortfalls and failing to acquire foreign loans, among other reasons. In the second period, from 1977 to mid-1990s, the problem of hospital bed shortage emerged because of rapid growth in demand due to full implementation of the health insurance system in 1977. Private companies built hospitals in rural areas by establishing charitable foundations, under special executive order on expansion of hospital bed resources in medically disadvantaged areas, and starting from the early 1980s, full-pledged expansion of hospital resources was attempted as shown below, by bringing in foreign loans and policy loans, focusing on the support for new construction and expansion of private medical facilities.

〈Table 8-1〉 Efforts for Expansion of Hospital Bed Resources in Korea

Period	Financial resources	Target project and content
1978 - 1984	Foreign loans (OECF, KFW) Domestic funds	Establishment of 67 private hospitals in underserved medical care areas; 6,580 hospital beds
1986 - 1988	Rural Development Fund	Establishment of 26 private hospitals in underserved medical care areas; 2,076 hospital beds
1991 - 1995	National Welfare Fund	10,000 hospital beds
Since 2004	Special Account for Financial Investment and Loan	Increase in hospital beds and improvement in old facilities; 15,938 hospital beds

On the other hand, in the areas that private medical institutions were reluctant to participate in or in the case of specialized beds, public medical facilities were expanded, including changing public health center in 17 counties to hospital-scale public health centers (health care centers), and over

13,000 specialized beds were added to public hospitals, such as national and public psychiatric hospitals, public psychiatric nursing homes, and national tuberculosis hospitals. In addition, there were research and policy efforts to counter the worsening regional imbalance in the distribution of hospital bed resources, which included the announcement of regions where new or additional hospital beds are banned, restricted, or recommended, by enacting the Regulation on Medical Facility Permit Restriction by Region created in January 1985, on the basis of the results of National Health care Network Establishment Study conducted in 1982 and 1984, and implementing the medical care delivery system that divided the nation into eight large medical service areas and 138 mid-sized medical service areas, along with implementation of national health insurance system, on the basis of the results of the Second National Health care Network Establishment Study conducted in 1987. In the third period after the mid-1990s, the Study on National Supply and Optimal Allocation of Hospital Beds conducted in 1997 and the Hospital Supply Optimization Study conducted in 1998 pointed out the problems of oversupply of acute care beds, shortage of long-term care beds, and regional imbalance in distribution of hospital bed resources. When establishing “The 21st Century Health care Development Master Plan” in 1998, the government announced its commitment to changing its policy on hospital bed resources toward control of acute care beds and expanding long-term care beds, and began funding the expansion of long-term care beds. The government implemented expansion of geriatric hospitals as part of the financing project for building fee-based facilities for the elderly, and provided financial support using special accounting for financial investment and loans, in the cases of transformation of acute care beds, beginning from 2002. In addition, in January 2002, the government enacted "The Special Act for National Health Insurance Financial Stability," specifying the obligations of the central government and local governments with regards to supply and management of hospital beds.

Korea's policies on hospital bed resource management have been focused primarily on supply management. The policy on private medical facilities construction and expansion funding using foreign loans and policy loans has made some contribution to expansion of insufficient acute care beds; however, the policies for maintaining balance in hospital bed resources have not been successful. The policies introduced in the 1980s to prevent worsening of regional concentration of hospital bed resources were either abolished or no longer enforced in the early 100s,[4] which includes The Regulation on Medical Facility Permit Restriction by Region, which was no longer enforced due to the abolition of the Regulation on Annual Cap on

4) The deregulation measure implemented in June 1990 led to the record growth in hospital beds in the 1990s.

Hospital Bed Capacity in Large Medical Service Areas in June 1990, then abolished as the provisions on the regulation was removed from the Medical Law in 2000. The system on mandatory preapproval by Minister of Health and Welfare on hospital bed capacity expansion also was gradually deregulated as the preapproval system for hospital beds, and the preapproval system for hospital beds in general hospitals excluding university hospitals were abolished in June 1990 and April 1993, respectively. In addition, the University Hospital Construction and Expansion Standards, which allowed permits for only the cities and provinces university hospitals are located was deregulated in June 1990, and abolished in April 1994. The medical service area system, which was introduced along with implementation of the national health insurance, was abolished in 1998 as part of deregulation plan. The policy on hospital bed resource management presently being implemented also has some problems. Although the government changed the direction of the policy on hospital bed resource management toward control/reduction of acute care beds and expansion of long-term care beds, legal mechanisms or policy measures to realize the policy have not been placed. To be more specific, first, the ways to control the increase of acute care beds are lacking. Although construction and expansion of hospitals and general hospitals require a permit, in reality, the system is implemented just like a reporting system,[5] and in particular, there are no measures to control the increase in the number of beds in clinics, which are growing sharply lately, as opening a clinic is subject to reporting only, and restrictions on the hospital beds operated in clinics are very weak as compared with those in hospitals. Moreover, as local governments (public health centers) are in charge of construction reporting and permit of all medical facilities, due to a series of deregulation and devolution, there is no practical means for the central government to intervene.

Second, optimal supply and equitable allocations of acute and long-term care beds require timely identification of change in demand and supply; however, monitoring of them is not in place. Various health care planning is merely perfunctory as legal definition on different types of hospital beds required for determination of supply is not clear,[6] the information on official numbers of hospital beds that actually are being used, in addition to the number of hospitals submitted in the course of

5) As facilities apply for a permit specified on medical law after completing all procedures specified in building codes, as long as the requirements and facility standards are met, it is impossible not to issue the permit, and medical law does not have a provision to use as a basis for refusing to issue a permit on the ground of oversupply of hospital beds.

6) At present, the official data on acute and long-term care bed numbers are not being collected as legal definitions on them are lacking, and their numbers are currently based on estimations by researchers. Even the estimation criteria vary slightly among researchers. In addition, definitions on pseudo hospital beds (e.g., bassinets, incubators, and observation beds for newborns), and specialized beds (e.g., beds in ICU, isolettes for immunosuppressed patients and infectious disease patients, and radiation therapy beds with shields) are also lacking.

reporting and permit processes, is not being collected,[7] and the information on demand and use of hospital beds is not provided.

Finally, the policy that allows intervention with qualitative level of hospital beds is lacking. As public attention to quality of medical services grows, social demands for quality and amenity of hospital beds are also growing. Despite the reports on large variation in quality between urban and rural areas, by the size of hospital, and among individual medical facilities, medical law provides standards on minimal requirements for facility, and the policy for improvement of other types of quality presently is absent.

Section 2. Policy Implications

Policies on hospital bed supply management must facilitate expansion of hospital bed supply in the period of supply shortage, while facilitating control or reduction of hospital bed supply in the period of oversupply. In this regard, the policies on expansion of hospital beds in all three countries of the United States, Japan, and Korea can be considered successful. The hospital bed expansion policies in the three countries were

7) Many facilities gradually expand the number of hospital beds after submitting a target number of hospital beds at the time of permit application for facility, or expand or reduce hospital bed numbers temporarily without a permit for change, describing the complex procedure as the reason.

performed using financial incentives, such as deregulation or grants to disadvantaged areas, as part of social reconstruction in the context of weak social infrastructure, implemented intensively in the period before change in disease structures, as in now, and had background of surge in health care demand coupled with expansion of medical security. In other words, hospital bed expansion policies can be seen as having an inseparable tie with expansion of medical security.

Unlike the hospital bed expansion policy, the hospital bed control policy in Korea was unsuccessful because there were few actual means to control the number of hospital beds, even though many laws had a provision for management of hospital bed resources at a general level. On the other hand, in the United States, the Certificate of Need (CON) program, on the basis of an independent law enacted by the Congress in 1974, which absorbed and integrated all existing scattered local laws on health care planning, was created, and the implementation system for local-level health care planning on the basis of the CON program was established. In other words, this program was designed for allocation rather than regulation of health care resources, and state governments implemented health care planning at local level to receive financial support from the federal government, which worked as incentive for state governments. Japan also made the first amendment of the medical law in 1985, the basic law on medical facilities, for regional management of hospital bed resources, and implemented on-going quantitative and qualitative management of hospital bed resources through a series of amendments of medical law.

The regulation policies, such as the hospital bed control policy at the local health care administration level in Korea, have no group to benefit from the policies at least in a short term, and are likely to be very vulnerable politically. Therefore, for the central government of Korea to encourage local governments to effectively implement the policies, certain incentives and counter-incentives in the intergovernmental relations are required. This actually is observed in two aspects related to CON program in the United States. One of them is that as in the original purpose of the 1974 law, in the intergovernmental relations, the federal government provides state governments with incentives using local-level health planning as a medium. The other aspect is to establish an incentive structure that encourages state governments to voluntarily implement health care planning. For instance, many states that closed the CON program are conducting their own reviews on new facilities for nursing homes. State governments do this because they pay part of the Medicaid budget and they try to reduce the burden. However, in Korea, in the current context of no existing incentives or counterincentives for local governments to control hospital bed numbers, the hospital bed control policy of the central government is likely to result in only the administrative and political burden on local governments. The comparison between the three countries in implementation of policies on coordination of functions and adjustment in structure of hospital bed capacity is as follows. Overall policy implementation has failed in Korea, whereas it was relatively smooth in Japan. On the other hand, in the United States, the policy on hospital bed resources planning no longer exists at the level of federal government, and only the CON program is operating at the local government level to prevent too much overlap among care delivery. In particular, the United States is addressing the issues on composition and function of provided hospital bed resources in a way completely different from Korea or Japan. The difference is attributed to the context of the overall United States health care regulation policies, which places emphasis on evaluation of process and outcome of medical services. The regulatory features of the federal government on United States health care sectors include Professional Review Organizations (PROs), practice guideline, and outcome research (Hafez, 1997). This may reflect the experience of failed health care planning using government policies in the United States. After the failure in health care resource planning in the private-based health care delivery and health insurance, regulatory policies primarily focused on the process and outcome, and quality and cost of medical services presently are implemented.

In Korea, to ensure the effectiveness of the policies on hospital bed resource control and functional transformation that are in major discussion, the problems uncovered during the policy implementation process to date must be addressed. The key issues among them are as follows. First, sufficient time and physical resources for policy implementation must be secured. In addition, the approach must now take the perspective of long-term health care resource planning, which considers national-level total quantities and regional-level distributions and compositions comprehensively, instead of targeting short-term control of increase in the number of hospital beds or transformation of long-term care beds. In addition, policy measures as incentives to increase compliance of target groups must be prepared. Without this consideration on cost, policy implementation is highly likely to fail. Second, policies must be made on the basis of the current reality and characteristics of the central government and local health care administration, and in the long term, roles of health care administration at each level must redefined.

9

Future Directions and Challenges in Hospital Bed Supply Policy

9 Future Directions and Challenges in Hospital Bed Supply Policy

Section 1. Outlook on Health Care Environment

Considering demographic and socioeconomic factors in Korea, health care needs are expected to grow significantly in the future. One demographic change of great significance can be aging—the increase in the proportion of the elderly in the total population. The elderly population aged 65 and older (as of 2010) is 11.0% in Korea; however, due to extended life expectancy and reduced birthrates, Korea is expected to become an "aged society" in 2018 and a super-aged society in 2026, with the proportion of the elderly at 14.3% and 20.8%, respectively. Another aspect worth noting is the change in disease structure. The disease structure in Korean society is changing rapidly from acute and communicable diseases to chronic and non-communicable diseases due to aging and changing dietary habits. This change in disease structure is expected to increase health care demand significantly. In addition, improved economic status and living standards are also expected to increase the need for high-quality medical services as well as medical care demand. To respond to the change in health care environment and provide high-quality medical services in a more reliable and efficient manner, it is first and foremost necessary to predict future changes in the health care environment and social changes in the future, and establish an optimal supply plan for health care resources and a sound medical care delivery system for efficient use of resources.

Section 2. Policy Directions

The first policy direction required for optimal supply of hospital resources relates to the establishment of an efficient medical care delivery system. The primary purpose of health care resources is to provide consumers with medical services without disruption, and limited health care resources must be available and used efficiently; therefore, building an efficient health care system is a key element of the national health care system. As one of the main components of the health care delivery system, optimal supply of hospital resources can ultimately be achieved through the establishment of an efficient medical care delivery system,[8] and accordingly, the policy must push

8) Building an effective health care delivery system is the core of a health care system, in that it is an important means to improved medical access, high-quality medical care delivery, efficient use of medical resources, and maintenance of optimal national health expenditure. The WHO defines a reasonable medical care delivery system as the state of reasonably established regionalization of medical services, and presents designation of medical service areas, provision of necessary medical resources, and coordination among medical institutions as requirements of reasonable

forward in the right direction.

The second policy direction relates to finding effective regulatory and incentive measures for improvement in imbalanced hospital bed supply. To improve the problem of overall and regional imbalance in hospital bed supply, the Basic Law on Health, Medical Law, and the Regulation on Establishment and Adjustment of Hospital Bed Supply Plan stipulate that a local health care supply data and plan of hospital bed resources be set up. In addition, Article 33, paragraph 4 of the Medical Law stipulates that general hospitals, hospitals, dental hospitals, Eastern medicine hospitals, or long-term care hospitals must acquire permits from municipal or provincial governments in accordance with the ordinances of the Ministry of Health and Welfare; the Medical Law Enforcement Rules, Article 23 stipulates that an application should be submitted to the local government to acquire the permit for hospital-level medical facilities. However, these laws and system have not been very effective in improving the imbalance in hospital bed supply and accomplishing optimal supply. This is thought to result from the lack of effective regulatory measures to curb the oversupply of hospital bed resources and an overemphasis on the supply imbalance in the approach to the issue of optimal supply. Therefore, effective regulatory and incentive measures to improve the imbalance need to be established.

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regionalization. WHO (2008). Primary Health care - now more than ever.

Finally, an ongoing monitoring system for determining demand and supply in local medical services needs to be set up, and principles and methods for long-term reasonable resource allocation need be developed.

Section 3. Policy Challenges

The problem of supply of hospital beds is a challenge that must be resolved as it pertains not only to equity in medical accessibility but also to optimum use of medical resources. To improve the imbalance in hospital bed supply, first, the functions of facilities and hospital beds must be clarified.[9] One measure that can be taken to resolve the supply imbalance is to change the medical facility classification scheme, based on the number of hospital beds, to a function-based one, and to overhaul facility and personnel operation standards, based on the new scheme. In future, the supply of long-term care beds also needs to be optimized to meet the demand in various intermediate

9) The primary classification scheme for medical facilities must be changed from the classification based on the number of beds (general hospital-hospital-clinic) to the classification based on the functions of beds. Japan removed the classification between general hospitals and other hospitals through the 1998 medical law amendment, and instead, reclassified hospitals into "specialized function hospitals, regional medical support hospitals, and (ordinary) hospitals." Taiwan classified medical facilities into hospitals and clinics; then again, classified hospitals into medical centers, regional hospitals, and district hospitals; and the classification between general hospitals and hospitals are specified in the enforcement rules on facility standards, as in Japan.

care facilities, such as nursing homes, and hospice facilities for terminally ill patients, in addition to long-term care hospitals, in7 accordance with various long-term care demands.[10)]

Second, a national hospital bed allocation plan or a national health care resources allocation plan needs to be established, and effective policy measures to implement them need to be

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10) The problem with hospital bed supply in Korea is one of both oversupply in total quantity and imbalance in the supply of different types of hospital beds. This problem can be removed by establishing the functions and roles of medical facilities. In other words, hospitals need to be reorganized such that clinics focus on outpatient care of mild and chronic diseases, hospitals seek disease-specific specialization primarily for inpatients, and mega hospitals are focused on severe diseases and research. To that end, the chronic disease management system should be established for intensive management of chronic diseases in the elderly and children by clinics, and hospitals should be categorized into specialized, open, and specialty hospitals using the specialized hospital system allowed by the medical law; in addition, the regional base for hospitals should be designated and fostered. Also, mega hospitals need to shift their focus to severe diseases and research, and endeavor to become global in nature as well as meet domestic needs. As a policy measure, economic incentives are used, including incentives for facilities providing class-appropriate services. The same incentive scheme applies to patients' use of facilities. In other words, for medical facilities providing services consistent with their class, patients who use services from appropriate facilities are rewarded. The insurance system also proposes to bring about a gradual improvement to help medical facilities by providing class-specific standard services—namely, outpatient services by clinics, inpatient services by hospitals, and treatment of severe diseases and specialized care and research by mega hospitals. Specifically, reimbursement to hospitals need to be adjusted toward the increase in outpatient fees and the decrease in inpatient fees for clinics; the decrease in outpatient fees and the increase in inpatient fees for hospitals; and patient co-pay amounts needed for adjustment toward a decrease for outpatient services in clinics, an increase for outpatient services and a decrease for services treating serious diseases in hospitals. Moreover, it is proposed that the class-specific fee schedules also be diversified, depending on the functional correspondence of facilities. Various fee schemes, including the uniform fee schedule, across different types of facilities need to be redesigned to incentivize functional correspondence in medical care delivery.

put in place.[11] The central government needs to predict the demand and supply of hospital beds by function, and establish a national hospital bed allocation plan or national health care resources allocation plan, which is to include the regions to limit, defer, and allow new supply for each bed type, at the national level. In addition, local governments need to create hospital bed allocation plans by facility size, bed type, and small area unit, considering characteristics of medical care demand and supply, based on the plan by the central government, and regularly evaluate and renew these plans. In particular, the supply plan for hospital bed resources must take an integrative approach to optimal supply and allocation, and efficient use of all medical resources, including facilities, personnel, and equipment. In addition, to determine whether to permit hospital beds under the hospital bed supply plan, the review on the need for construction and expansion of hospitals must be conducted using a committee such as the State Hospital Review and Planning Council in the United States. The screening by the committee on the need for hospital bed capacity expansion

11) In Japan, the medical law stipulates that local governments are obligated to create a “health care plan” for the overhaul of health care delivery systems, and in Taiwan, the medical law also stipulates that the central government is obligated to create a health care network plan on the division of medical service districts and specification of a “classified health care system” for a balanced development of medical resources and reasonable distribution of medical facilities and personnel. In Korea, the stipulation on the establishment of a hospital bed resource supply plan also exists in laws such as the medical law and the basic law on health, but has been ineffective due to a lack of effective measures.

needs to administer the hospital bed supply plan—which is currently just draining administrative resources—with effective regulatory power, and revive the hospital permit system—currently reduced to a procedural step—into a system with a true regulatory function.

Third, financial measures to improve the imbalance in hospital bed supply need to be established. The government's funding for balancing the hospital bed supply, which are secured and executed by individual project, such as functional transformation of small hospitals, and support for geriatric hospitals construction, needs to be integrated into the "hospital bed supply imbalance control fund." Funding needs to be provided for facility improvement at capital cost or functional transformation necessary for the expansion of hospital bed capacity in regions with shortage. Through an integrated operation, for regions with an oversupply of acute care beds, funding for functional transformation of the beds can be provided as a priority, and for regions that require significant reduction of hospital beds, providing financial incentives for voluntary reduction can be considered. Sources of the fund can include reserve funds for health insurance as well as special accounts for financing and agriculture, and the general account budget.[12)]

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12) In Taiwan, one of the intended uses of the reserve fund for national health insurance is stipulated as the funding for control of hospital bed resources. This is because balanced allocation of appropriate number of hospital beds helps in a reliable execution of health insurance finance.

10 Conclusions

10 Conclusions

This study aimed to determine the optimal supply of hospital bed resources and measures to resolve regional imbalances using the analysis on the imbalance level of distribution of hospital bed resources and its causes, estimation of optimal level, and reviews on policies of other countries. A macroscopic measure for improving the imbalance is to establish a monitoring system for optimal supply. Regional imbalances as well as oversupply of hospital beds in total quantity are becoming problematic issues in Korea. To reduce the gaps among regions using a shared policy for reasonable supply of hospital bed resources, first, the precise determination of total quantity of hospital beds is required. The determination of local health care demand should not be a one-time operation, and an ongoing monitoring system must be in place. The second strategy is to find a measure for the optimal allocation of hospital bed resources among the various regions. Demand estimation for optimal allocation among regions must be based on various factors, such as physical and mental health, public health, and proportions of the disabled and the elderly, and in order to establish an allocation policy, an assessment of existing hospital bed resources must be conducted. It is important to create reasonable allocation principles and a formula that matches the Korean situation, based on the determination of demand and supply status; the government must have specific implementation strategies and goals to reduce regional gaps by establishing policy goals, such as minimum standards or national standards.

Regulatory polies such as limiting the total number of hospital beds at the local health care level—currently discussed in Korea—are bound to be ineffective in implementation because no one benefits from the policy, at least over the short term. Therefore, to facilitate local governments to implement the policies, certain incentives and counter-incentives are necessary between the central and local governments, as in the CON program in the United States, which provides incentives for implementation.

One precaution must be taken while introducing the policy of limiting the total number of hospital beds in individual regions to improve imbalance—it must not be implemented uniformly across the regions with a supply imbalance. In other words, the data on imbalance levels in different regions obtained from the study must not be interpreted in a uniform fashion when implementing the policy. As regions with shortage in hospital bed supply may have different situations, depending on areas of major activities, measures to close the regional gaps that are appropriate for individual regions must be employed, which requires a close examination of the specific circumstances of the individual regions. Examination of hospital bed resources from a policy standpoint for regions of supply imbalance must be conducted by considering microscopic characteristics, including demographic and socioeconomic characteristics of individual regions, as well as the supply level of medical resources of individual regions, including hospital beds.

Optimal supply and improvement of regional imbalances in hospital bed resources in the future must be preceded by increasing long-term efficiency of the health care delivery system. The most important consideration in the health care delivery system is the allocation method of health care resources—that is, the issue of the extent of government intervention versus leaving allocation to market economy, which requires a careful approach as it is fundamental and an ideological challenge; however, as a more specific challenge, an efficient medical care delivery system that represents regionalization, phase-based approach, and the division of functions needs to be established in the near future.

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