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Demand and Supply Outlook for Health Workforce in Korea

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Chapter

01

Basic Perspective

Chapter 1

Basic Perspective

▢ The ultimate goal of Korea's health care is to improve the health of Koreans. To achieve this goal, strategies are needed to improve the quality and efficiency of, and ensure equitable access to, health care services.

- Health care workforce is the most important element in achieving this goal and developing necessary strategies, and is also essential to ensuring people's rights to health. Yet a long-term approach to health care workforce development is needed as the process requires extensive investment.
- The volume and the quality of health care workers are an important determinant of health care supply. Hence, maintaining health care workforce at a proper level is essential.

▢ With the changing demographic, economic and social structures expected to generate diverse needs for health care services as well as deepen sophistication and segmentation of health care fields, health care workforce policies are becoming very important as they play a pivotal role in the supply of health care services, and health care workforce planning and policies must be used as a tool for more effective and efficient delivery of health care services.

- Health care workforce planning that reflects future changes

in society and health care requirements can serve as a guideline for well-planned supply of health professionals as well as for effective execution of health care policies.

- Health care workforce planning improves consumer satisfaction for health care services and prevents waste and inefficient supply of health care services through effective delivery of health services.
- Health professionals supplied under the health care workforce planning can be effectively managed, thereby contributing to the reduction in overall health care expenditures at the national level.

▢ As a result of the implementation of a number of health care workforce policies, such as the introduction of the public health doctor system and the establishment of new medical schools, to meet the rapidly growing demand for health care and to address the health care workforce imbalances arising from the universal coverage of health insurance plans, the health care workforce supply has increased.

- The increase in health care workers has been accompanied by some issues concerning the supply-and-demand imbalance, quality, and uneven distribution of health care workforce. Other concerns raised relate to the inappropriate response to the increasingly diversifying and growing number of health care issues, such as the growing number of chronic diseases.
- Rational and efficient allocation of health care workers and the equality in the distribution of health care workers must be further emphasized in future plans on health care

workforce. Health care workforce supply system also needs to be improved to facilitate effective health care workforce planning.

- ▢ This study makes supply and demand projections for doctors, oriental medicine doctors, dentists, nurses, pharmacists, and medical technicians, and based on the results, attempts to provide a long-term outlook and policy implications for health care workforce supply and demand for the years leading up to 2025.

Chapter

02

Analysis of Current State of Supply and Demand

Chapter 2

Analysis of Current State of Supply and Demand

1. Analysis of Current State of Supply

□ Medical school intake, the number of registered license holders, the number of available health professionals and the number of active health professions for different health professions are shown in Table 1.

〈Table 1〉 Current state of health care workforce supply

(Unit: Person, %)

Health Profession	Intake	License Holders (A)	Available Professionals (B)	Active Professionals (C)	(B/A)	(C/B)
Doctors	3,058	95,179	85,703	77,599	90.0	90.5
Oriental medicine doctors	750	17,844	15,814	13,768	88.6	87.1
Dentists	750	23,855	22,127	19,526	92.8	88.2
Nurses	14,201	238,174	222,822	141,759	93.6	63.6
Midwives	-	9,147	7,230	2,785	79.0	38.5
Pharmacists	1,700	59,925	52,635	29,874	87.8	56.8
Physical therapists	3,365	31,079	30,472	22,110	98.0	72.6
Clinical pathologists	2,547	40,197	38,670	22,672	96.2	58.6
Radiographers	2,475	25,485	24,678	19,215	96.8	77.9
Occupational therapists	1,940	2,842	2,809	2,147	98.8	76.4
Dental technicians	1,430	23,321	22,367	10,368	95.9	46.4

Health Profession	Intake	License Holders (A)	Available Professionals (B)	Active Professionals (C)	(B/A)	(C/B)
Dental hygienists	4,650	34,396	34,058	20,793	99.0	61.1
Medical records and health information technicians	4,549	12,545	12,419	7,076	99.0	57.0
EMT-Level I	1,238	6,845	6,797	4,953	99.3	72.9
EMT-Level II	910	6,240	6,193	5,763	99.2	93.1
Opticians	2,435	29,266	28,534	16,688	97.5	59.1
Total		656,340	613,328	408,358	93.4	66.6

Note: Available professionals = License holders registered-(Deaths+Emigrants)/Active professionals = Health fields + Welfare fields +Non-health medical fields

Note: (Number of provider training institutions) and intake are based on the year 2010/License holders registered, available professionals and active professionals are based on the December 2007 data. The number of active opticians is our assessment data supplemented by data from the opticians' association.

▢ In terms of available workforce rates among the doctor groups, comprising physicians, oriental medicine doctors and dentists, excluding deaths and emigrants, oriental medicine doctors showed a low rate of available providers at 88.6%, while physicians and dentists showed 90.0% and 92.8%, respectively. Available workforce rates in other professions were mostly over 90%, except midwives at 79.0% and pharmacists at 87.8%.

▢ In terms of active workforce rates among the available workforce of doctor groups comprising physicians, oriental medicine doctors and dentists engaged in clinical practice (medical treatment) and non-clinical practice (non-medical treatment), the highest rate was found from physicians at 90.%, followed by dentists at 88.2% and oriental medicine doctors at 87.1%. Among assistive personnel who are not

doctors, EMT-Level II workers showed the highest rate of active workforce at 93.1%, followed by radiographers, occupational therapists, EMT-Level I workers, and physical therapists in the 70% range. Nurses and dental hygienists were in the 60% range, while dental technicians and midwives were in the lowest range at 46.4% and 38.5%, respectively.

2. Analysis of Trends in Demand for Health Care

Table 2 shows trends in utilization of western medicine, dental, and oriental medicine services.

▢ Utilization of western medicine services per capita has steadily increased from 2003 through 2007. However, utilization growth rates slightly varied depending on the type of insurance and the type of health care used.

- In the case of the number of outpatient visits to doctors, use of health insurance and use of medical aid have both increased 10% over the past five years. Specifically, use of medical aid outpaced health insurance until 2006, but it rapidly declined from 14% in 2006 to 10% in 2007.
- In inpatient services, length of stay for health insurance patients and length of stay for medical aid patients have both substantially increased by 45% and 24%, respectively, with utilization by medical aid patients growing approximately 1.9 times faster than health insurance patients.

〈Table 2〉 Health care utilization growth per recipient of the health security system

Type of Care	Inpatient Outpatient	Type of Insurance	Year				
			2003	2004	2005	2006	2007
Western	Outpatient	Health Insurance	100	101	105	109	110
		Medical Aid	100	103	103	114	110
		Total	100	102	105	110	111
	Inpatient	Health Insurance	100	104	109	124	145
		Medical Aid	100	109	109	119	124
		Total	100	106	115	130	147
	Total	Health Insurance	100	102	105	110	113
		Medical Aid	100	105	105	116	115
		Total	100	102	106	112	115
Oriental	Outpatient	Health Insurance	100	109	118	127	131
		Medical Aid	100	107	109	119	113
		Total	100	109	118	127	131
	Inpatient	Health Insurance	100	96	100	101	141
		Medical Aid	100	116	145	166	196
		Total	100	99	110	116	155
	Total	Health Insurance	100	109	117	126	131
		Medical Aid	100	108	111	122	118
		Total	100	109	117	127	131
Dental	Outpatient	Health Insurance	100	101	102	102	103
		Medical Aid	100	104	102	113	115
		Total	100	101	102	103	103
	Inpatient	Health Insurance	100	92	87	90	94
		Medical Aid	100	88	69	78	78
		Total	100	92	86	90	94
	Total	Health Insurance	100	101	102	102	103
		Medical Aid	100	104	102	113	115
		Total	100	101	102	103	103

Note: Outpatient is utilization for visits and inpatient is utilization for length of stay. The index represents yearly trend in utilization on the assumption that the 2003 utilization is 100.
Source: Health Insurance Review & Assessment Service internal data.

□ Use of oriental medicine services has continued to increase between 2003 and 2007, but utilization in different types of

insurance and different types of care showed slightly different growth rates.

- In the case of the number of outpatient visits to oriental medicine doctors, use of health insurance has increased 31% and use of medical aid has risen 13% over the past five years, with the growth rate of visits by health insurance patients over 2.4 times bigger than that by medical aid patients.
- In inpatient services, use of health insurance has increased 41% over the past five years, but use of medical aid has grown more sharply by 96%, which is over 2.3 times bigger growth than health insurance.

▢ Use of dental care services has steadily increased between 2003 and 2007, but the growth rates were different between outpatients and inpatient.

- In outpatient visits to dentists, use of health insurance has increased at a low 3% over the past five years, but use of medical care has grown 15% during the same period, which suggests that visits to dental clinics by medical aid patients were about five times higher compared to health insurance users.
- In inpatient services, length of stay for both health insurance patients and medical aid patients has declined over the past five years. Specifically, length of stay declined from 2003 to 2005, but began to increase in both health insurance patients and medical aid patients after 2005.

Chapter

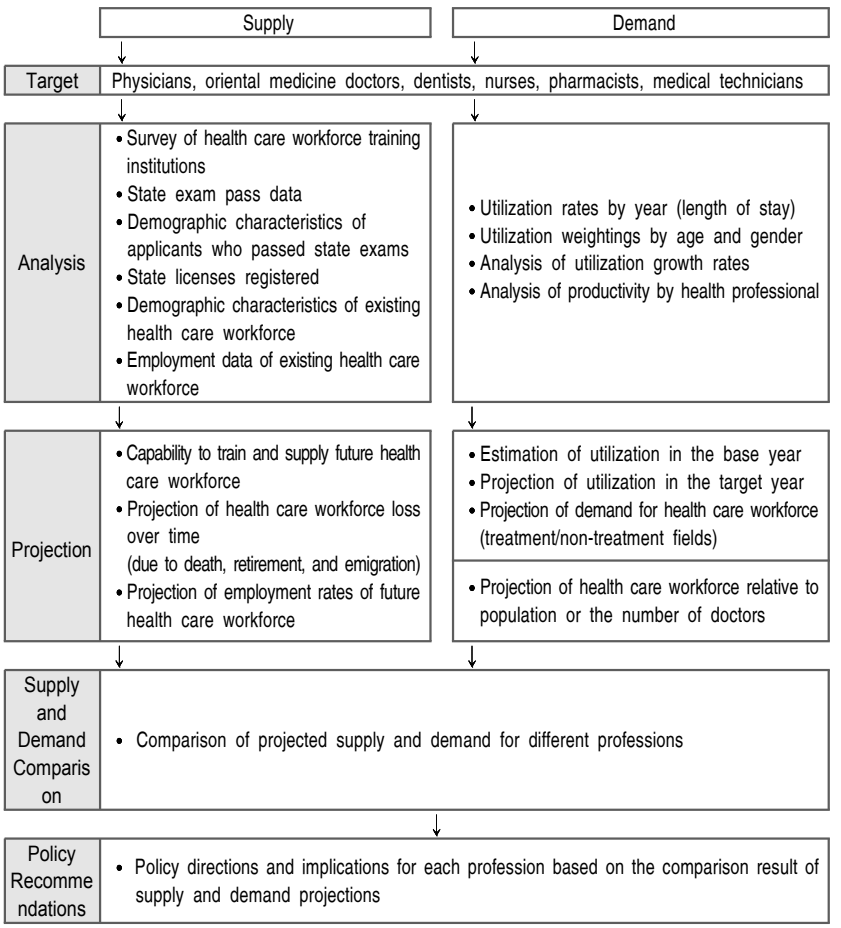
03

Supply and Demand Projection Methodology

Chapter 3

Supply and Demand Projection Methodology

[Figure 1] Framework for studying proper levels of health care workforce supply and demand



1. Supply Projection Methods

□ In the projection of health care workforce supply for each health care profession, the baseline projection method has been used as the projection type, and the in-and-out moves method and demographic method have been used as the projection methods. The supply projection model has been devised to reflect different circumstances specific to each profession, such as counting graduates from foreign education and the time data are obtained.

〔Figure 2〕 Health care workforce supply projection model

Step	Doctors
Workforce Increase	NS(n)=New(n-6(4))×g(n)×α×β • New(n-6(4)): Number of students admitted to domestic medical schools in the year n-6(4) • g(n): Graduation rate from domestic medical schools in the year n • α: Application rate of state exams • β: Pass rate of state exams
Workforce Decrease	L(n)=D(n)+EM(n)+R(n) • D(n) : Number of deaths in the year n • EM(n) : Number of emigrants in the year n • R(n) : Number of retirees
Available Workforce	S(n)=S(n-1)+NS(n)−L(n) • S(n): Number of surviving providers in the year n • S(n-1): Number of surviving domestic providers in the year n-1 • NS(n): Number of new providers in the year n • L(n): Number of lost providers in the year n
Active Workforce	WS(n)= S(n)× (CWR + UCWR) • WS(n): Number of active providers in the year n • CWR: Active provider rate in clinical practice • UCWR: Active provider rate in non-clinical practice

▢ To reflect the impact of foreign-educated physicians, dentists, oriental medicine doctors, pharmacists, and nurses whose number has been on the increase since 1990 on the workforce supply, we separately calculated application and pass rates of these personnel.

▢ We assumed that the number of freshmen has remained constant since 2010.

▢ Workforce loss consists of the number of deaths, emigrants and retirees. We applied the death rates by age obtained from the life table of the National Statistical Office to the estimation of the number of deaths. In estimating the number of retirees, we included health professionals who work past their retirement age in the active workforce group. In counting the number of emigrants, we used the average emigration rates over the past five years.

2. Demand Projection Methods

○ In the projection of demand, the health care demand method has been used as the primary method and the provider-to-population ratio or provider-to-doctor ratio has been used as the secondary method.

▢ Estimation of health care utilization in the base year (subdivided into health insurance, medical aid, outpatient and inpatient)

– Index adjusted for inpatient and outpatient care: Considering

the proportion of inpatient care relative to outpatient care, inpatient utilization has been multiplied by three to estimate outpatient utilization for physicians, dentists, and oriental medicine doctors. For nurses, inpatient utilization has been multiplied by 12 to estimate outpatient utilization.

- Health care utilization adjusted for programs other than health insurance: Total national health care utilization has been estimated by adjusting utilization of services not covered by the medical security system, such as full amounts of medical cost paid by patients, worker's compensation insurance, and auto insurance (estimation is made by analysing 2005 patient data)

▢ Projection of health care utilization in the target year

- Population-adjusted: Health care utilization weightings by gender and age have been estimated using the internal data of the Health Insurance Review & Assessment Service, and then the estimates have been applied to the target year's population.
- Reflection of trends in health care use: Historical utilization trends in health care have been applied to the base year's utilization. Concerning trend forecasts, we used the average annual growth rate in the ARIMA Model (Curve Estimation) that makes the most conservative trend projection.

▢ Projection of workforce requirements for each profession

- Total national health care utilization has been divided by patient's treated volume per year (patient's treated volume a day x number of days worked a year)

– Based on the one-day patient's treated volume projected, demand projections have been made using different levels of provider's productivity: 120%, 110%, 100%, 90%, and 80% of 2007 productivity, for 255 days worked and 265 days worked.

[Figure 3] Demand projection steps

Steps	Physicians/oriental medicine doctors/dentists/nurses/medical technicians
1. Estimation of base year's health care utilization	Per capita utilization in the base year =Total utilization in the base year/Total population • Adjusted for utilizations other than under health insurance • Application of inpatient/outpatient conversion factor • Population-adjusted (using utilization weightings by gender and age)
2. Projection of target year's health care utilization	Utilization in the target year =Utilization per person x Population adjusted for the target year • Reflection of utilization trend (excluding contributions made by the population aging) • Population-adjusted (using utilization weightings by gender and age)
3. Projection of demand for health professionals	Demand for health professionals = Utilization in the target year/Productivity • Productivity (Number of days worked/Number of patients seen per day, etc.) • Application of clinical and non-clinical ratios

Chapter

04

Supply and Demand Projection Results

Chapter 4

Supply and Demand Projection Results

1. Physician Supply and Demand Projections

〈Table 3〉 Analysis of supply and demand projection results for physicians, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	105,414	121,467	137,280	153,092	105,414	121,467	137,280	153,092
Available	92,135	103,751	114,371	122,947	92,135	103,751	114,371	122,947
Active (A)	85,216	95,959	105,782	113,714	85,216	95,959	105,782	113,714
Demand (B)								
Productivity Scenario 1	72,927	83,226	92,092	100,253	70,175	80,085	88,617	96,470
Productivity Scenario 2	79,557	90,792	100,464	109,367	76,555	87,365	96,673	105,240
Productivity Scenario 3	87,513	99,871	110,510	120,303	84,210	96,102	106,340	115,763
Productivity Scenario 4	97,236	110,967	122,789	133,670	93,567	106,780	118,155	128,626
Productivity Scenario 5	109,391	124,838	138,138	150,379	105,263	120,128	132,925	144,704
Difference (A-B)								
Productivity Scenario 1	12,288	12,734	13,690	13,461	15,040	15,874	17,165	17,244
Productivity Scenario 2	5,659	5,168	5,318	4,347	8,661	8,594	9,109	8,474
Productivity Scenario 3	-2,297	-3,911	-4,729	-6,590	1,005	-143	-558	-2,050
Productivity Scenario 4	-12,021	-15,008	-17,007	-19,957	-8,351	-10,821	-12,374	-14,912
Productivity Scenario 5	-24,175	-28,879	-32,356	-36,665	-20,047	-24,168	-27,143	-30,991

	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	105,414	121,467	137,280	153,092	105,414	121,467	137,280	153,092
Available	92,135	103,751	114,371	122,947	92,135	103,751	114,371	122,947
Active (A)	85,216	95,959	105,782	113,714	85,216	95,959	105,782	113,714
Demand (B)								
Productivity Scenario 1	75,439	90,829	107,389	125,213	72,592	87,402	103,337	120,488
Productivity Scenario 2	82,297	99,086	117,152	136,596	79,191	95,347	112,731	131,442
Productivity Scenario 3	90,527	108,995	128,867	150,256	87,111	104,882	124,004	144,586
Productivity Scenario 4	100,585	121,106	143,185	166,951	96,789	116,536	137,782	160,651
Productivity Scenario 5	113,158	136,244	161,083	187,820	108,888	131,103	155,005	180,733
Difference (A-B)								
Productivity Scenario 1	9,777	5,130	-1,607	-11,500	12,624	8,558	2,445	-6,775
Productivity Scenario 2	2,919	-3,127	-11,370	-22,883	6,024	612	-6,949	-17,728
Productivity Scenario 3	-5,311	-13,036	-23,085	-36,542	-1,895	-8,923	-18,222	-30,872
Productivity Scenario 4	-15,369	-25,146	-37,404	-53,238	-11,574	-20,576	-32,001	-46,938
Productivity Scenario 5	-27,943	-40,284	-55,302	-74,107	-23,672	-35,143	-49,223	-67,019

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

□ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students admitted to medical schools in the year n for new physicians entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-6(4) were presumed to graduate, although

the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of physicians was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 71 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 70 from the available workforce, excluding those aged 71 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ Assumptions related to demand projection

- First, target year's population was adjusted for age-specific weightings that reflect differences in health care utilization between different age groups. Data on the projected population were taken from the National Statistical Office, and health care utilization weightings are the figures we have re-analyzed using the 2007 internal data of the Health

Insurance Review & Assessment Service.

- Second, in terms of health care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.
- Third, physician productivity, or the number of patients seen per day, was estimated based on the 2007 productivity of 52.14 and based on the assumption that physicians work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[1].
- Fourth, in estimating workforce requirements, projection of outpatient service requirements based on inpatient service requirement requires the relative ratios of the effort and time inputs of health providers for inpatients and outpatients. In this study, we set the conversion factor for outpatient and inpatient services as 3 to 1 according to the legal standard.
- Fifth, inpatient services were estimated based on different types of hospital beds. Inpatients per physician are 10 for general beds, 40 for geriatric care beds, and 60 for psychiatric beds. Therefore, the projection is based on the number of inpatients per bed for inpatient services.

1) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

B. Results

- The result of this projection suggests that the direction and degree of supply of and demand for physicians varied depending on physician productivity and utilization growth scenarios. As far as health care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.
- Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 1,005-15,040 physicians and a shortage of 2,297-24,175 physicians in 2010, and from a surplus of 4,347-17,244 physicians and a shortage of 2,050-36,665 physicians by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of 1,005 physicians or a shortage of 2,297 physicians is likely in 2010 depending on the number of days worked. By 2025, a shortage of minimum 2,050 or maximum 6,590 physicians is likely.
- Changes in future physician productivity greatly influence the projected supply and demand of physicians. While accurate forecasting cannot be made due to the lack of basic research in physician productivity, the number of patients seen by a physician per day is projected to slightly increase compared

to 20 years ago, and future physician productivity is also forecast to slightly improve compared to it is today. If government policies on physician productivity remain unchanged in the future, the imbalance between supply and demand of physicians is not likely to be a big concern.

▢ Nevertheless, the growth in the economy and national income is expected to boost health care needs both in quantitative and qualitative terms. As such, if government policies are geared towards meeting these growing requirements, the number of patients per physician, or physician productivity, will fall, leading to more demand for physicians. Therefore, the physician supply and demand imbalance will be affected by the government policy on health care services.

2. Dentist Supply and Demand Projections

〈Table 4〉 Analysis of supply and demand projection results for dentists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	26,357	30,597	34,438	38,278	26,357	30,597	34,438	38,278
Available	23,719	26,986	29,603	31,356	23,719	26,986	29,603	31,356
Active (A)	21,148	24,061	26,394	27,958	21,148	24,061	26,394	27,958
Demand (B)								
Productivity Scenario 1	17,371	18,193	19,016	19,662	16,715	17,507	18,298	18,920
Productivity Scenario 2	18,950	19,847	20,745	21,449	18,235	19,098	19,962	20,640
Productivity Scenario 3	20,845	21,832	22,819	23,594	20,059	21,008	21,958	22,704
Productivity Scenario 4	23,161	24,258	25,355	26,216	22,287	23,342	24,398	25,227

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Productivity Scenario 5	26,056	27,290	28,524	29,493	25,073	26,260	27,448	28,380
Difference (A-B)								
Productivity Scenario 1	3,777	5,867	7,378	8,296	4,433	6,554	8,096	9,038
Productivity Scenario 2	2,198	4,214	5,650	6,508	2,913	4,962	6,432	7,318
Productivity Scenario 3	303	2,229	3,575	4,363	1,090	3,053	4,436	5,254
Productivity Scenario 4	-2,013	-197	1,040	1,742	-1,139	718	1,996	2,731
Productivity Scenario 5	-4,908	-3,229	-2,130	-1,535	-3,925	-2,199	-1,053	-422
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	26,357	30,597	34,438	38,278	26,357	30,597	34,438	38,278
Available	23,719	26,986	29,603	31,356	23,719	26,986	29,603	31,356
Active (A)	21,148	24,061	26,394	27,958	21,148	24,061	26,394	27,958
Demand (B)								
Productivity Scenario 1	17,364	18,149	18,908	19,459	16,709	17,464	18,194	18,725
Productivity Scenario 2	18,943	19,799	20,627	21,229	18,228	19,052	19,848	20,427
Productivity Scenario 3	20,837	21,779	22,689	23,351	20,051	20,957	21,833	22,470
Productivity Scenario 4	23,152	24,199	25,210	25,946	22,279	23,285	24,259	24,967
Productivity Scenario 5	26,046	27,223	28,362	29,189	25,063	26,196	27,291	28,088
Difference (A-B)								
Productivity Scenario 1	3,784	5,912	7,486	8,498	4,439	6,597	8,200	9,232
Productivity Scenario 2	2,205	4,262	5,768	6,729	2,920	5,009	6,546	7,530
Productivity Scenario 3	311	2,282	3,705	4,606	1,097	3,104	4,561	5,487
Productivity Scenario 4	-2,004	-138	1,184	2,012	-1,130	775	2,135	2,991
Productivity Scenario 5	-4,898	-3,163	-1,967	-1,232	-3,915	-2,135	-897	-130

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity (52.14); Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

□ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students admitted to dental schools in the year n for new

dentists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-6(4) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of dentists was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 66 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 65 from the available workforce, excluding those aged 66 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ Assumptions related to demand projection

- First, target year's population was adjusted for age-specific

weightings that reflect differences in health care utilization between different age groups. Data on the projected population were taken from the National Statistical Office, and dental care utilization weightings are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.

- Second, in terms of dental care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.
- Third, dentist productivity, or the number of patients seen per day, was estimated to be 16.40 using the 2007 dental care utilization and based on the assumption that dentists work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[2].
- Fourth, in estimating dental care workforce requirements, projection of outpatient service requirements based on inpatient service requirement requires the relative ratios of the effort and time inputs of health providers for inpatients and outpatients. In this study, we set the conversion factor for outpatient and inpatient services as 3 to 1 according to the legal standard.

2) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for dentists varied depending on dentist productivity and utilization growth scenarios. As far as dental care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

▢ Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 303-4,433 dentists and a shortage of 1,139-4,908 dentists in 2010, and from a surplus of 1,742-9,038 dentists and a shortage of 422-1,535 dentists by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of 303-1,090 dentists is projected in 2010 and a surplus of 4,363-5,254 dentists is likely by 2025 depending on the number of days worked.

▢ The growing economic levels and income are expected to boost dental care requirements both in quantitative and qualitative terms. As such, if government policies are set in a way that expands health insurance benefits to cover more dental services, such as dentures for senior citizens, as part of efforts to meet the growing needs for dental care, dental care services as well as demand for dentists will increase

over time. Therefore, the surplus of dentists is likely to be influenced by the government's dental care service policy.

3. Oriental Medicine Doctor Supply and Demand Projections

〈Table 5〉 Analysis of supply and demand projection results for oriental medicine doctors, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	20,324	24,277	28,226	32,176	20,324	24,277	28,226	32,176
Available	17,657	20,808	24,046	27,055	17,657	20,808	24,046	27,055
Active (A)	15,344	18,083	20,896	23,511	15,344	18,083	20,896	23,511
Demand (B)								
Productivity Scenario 1	13,516	16,041	18,240	20,251	13,006	15,436	17,552	19,487
Productivity Scenario 2	14,745	17,500	19,898	22,092	14,188	16,839	19,147	21,258
Productivity Scenario 3	16,219	19,250	21,888	24,301	15,607	18,523	21,062	23,384
Productivity Scenario 4	18,021	21,388	24,320	27,001	17,341	20,581	23,402	25,982
Productivity Scenario 5	20,274	24,062	27,360	30,377	19,509	23,154	26,327	29,230
Difference (A-B)								
Productivity Scenario 1	1,828	2,041	2,656	3,260	2,338	2,647	3,344	4,024
Productivity Scenario 2	599	583	998	1,419	1,156	1,243	1,749	2,252
Productivity Scenario 3	-875	-1,167	-992	-791	-263	-441	-166	127
Productivity Scenario 4	-2,677	-3,306	-3,424	-3,491	-1,997	-2,499	-2,506	-2,472
Productivity Scenario 5	-4,930	-5,979	-6,464	-6,866	-4,165	-5,071	-5,431	-5,720
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	20,324	24,277	28,226	32,176	20,324	24,277	28,226	32,176
Available	17,657	20,808	24,046	27,055	17,657	20,808	24,046	27,055
Active (A)	15,344	18,083	20,896	23,511	15,344	18,083	20,896	23,511

Demand (B)								
Productivity Scenario 1	13,793	17,095	20,577	24,114	13,273	16,450	19,801	23,204
Productivity Scenario 2	15,047	18,649	22,448	26,306	14,479	17,945	21,601	25,313
Productivity Scenario 3	16,552	20,514	24,693	28,937	15,927	19,740	23,761	27,845
Productivity Scenario 4	18,391	22,793	27,437	32,152	17,697	21,933	26,401	30,939
Productivity Scenario 5	20,689	25,643	30,866	36,171	19,909	24,675	29,701	34,806
Difference (A-B)								
Productivity Scenario 1	1,551	988	319	-603	2,071	1,633	1,095	307
Productivity Scenario 2	297	-567	-1,552	-2,795	865	137	-705	-1,803
Productivity Scenario 3	-1,208	-2,431	-3,797	-5,426	-583	-1,657	-2,865	-4,334
Productivity Scenario 4	-3,047	-4,711	-6,541	-8,641	-2,353	-3,851	-5,505	-7,428
Productivity Scenario 5	-5,346	-7,560	-9,970	-12,660	-4,565	-6,592	-8,805	-11,295

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

▢ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students admitted to oriental medicine schools in the year n for new oriental medicine doctors entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-6(4) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.
- Second, workforce loss is calculated as the sum of health

providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of oriental medicine doctors was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 71 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 70 from the available workforce, excluding those aged 71 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ Assumptions related to demand projection

- First, target year's population was adjusted for age-specific weightings that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and oriental medical care utilization weightings are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of health care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

- Third, oriental medicine doctor productivity, or the number of patients seen per day, was estimated to be 28.74 using the 2007 oriental medical care utilization and based on the assumption that oriental medicine doctors work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[3].
- Fourth, in estimating oriental medicine workforce requirements, projection of outpatient service requirements based on inpatient service requirement requires the relative ratios of the effort and time inputs of health providers for inpatients and outpatients. In this study, we set the conversion factor for outpatient and inpatient services as 3 to 1 according to the legal standard.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for oriental medicine doctors varied depending on productivity of oriental medicine doctors and utilization growth scenarios. As far as health care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation

3) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

- Under the "Demand Scenario 1," oriental medicine doctors projections varied under different productivity scenarios, ranging from a surplus of 599-2,338 oriental medicine doctors and a shortage of 263-4,930 oriental medicine doctors in 2010, and from a surplus of 127-4,024 oriental medicine doctors and a shortage of 791-6,866 oriental medicine doctors by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a shortage of 263-875 oriental medicine doctors is forecast in 2010 depending on the number of days worked. By 2025, the workforce is likely to be between a shortage of 791 oriental medicine doctors and a surplus of 127 oriental medicine doctors.
- Changes in future oriental medicine doctor's productivity greatly influence the projected supply and demand of oriental medicine workforce. As the number of patients seen by an oriental medicine doctor per day has been on the increase to date, productivity of oriental medicine doctors is expected to improve over time compared to today's productivity. If government policies on oriental medicine doctor's productivity remain unchanged, the imbalance between supply and demand of oriental medicine doctors is not likely to be a big concern.
- Nevertheless the growing economic levels and national income are expected to boost health care needs both in quantitative and qualitative terms. As such, if government policies are geared towards meeting these growing requirements, the number of

patients per oriental medicine doctor, or oriental medicine doctor's productivity, will fall, which in turn will lead to more demand for oriental medicine doctors. Therefore, the supply and demand imbalance of oriental medicine workforce will be affected by the government policy on health care services.

4. Nurse Supply and Demand Projections

〈Table 6〉 Analysis of supply and demand projection results for nurses, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	272,071	340,027	417,114	488,665	272,071	340,027	417,114	488,665
Available	242,386	293,716	352,127	391,479	242,386	293,716	352,127	391,479
Active (A)	155,194	188,059	225,458	250,655	155,194	188,059	225,458	250,655
Demand (B)								
Productivity Scenario 1	125,426	165,136	201,147	233,336	120,692	158,904	193,556	224,531
Productivity Scenario 2	136,828	180,148	219,433	254,549	131,665	173,350	211,152	244,943
Productivity Scenario 3	150,511	198,163	241,376	280,004	144,831	190,685	232,268	269,437
Productivity Scenario 4	167,234	220,181	268,196	311,115	160,923	211,872	258,075	299,375
Productivity Scenario 5	188,138	247,704	301,720	350,004	181,039	238,357	290,335	336,797
Difference (A-B)								
Productivity Scenario 1	29,768	22,923	24,312	17,319	34,502	29,155	31,902	26,124
Productivity Scenario 2	18,366	7,911	6,026	-3,894	23,529	14,709	14,306	5,712
Productivity Scenario 3	4,683	-10,104	-15,918	-29,349	10,363	-2,626	-6,809	-18,783
Productivity Scenario 4	-12,040	-32,122	-42,737	-60,460	-5,729	-23,813	-32,617	-48,720
Productivity Scenario 5	-32,944	-59,645	-76,262	-99,350	-25,845	-50,297	-64,876	-86,142

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	272,071	340,027	417,114	488,665	272,071	340,027	417,114	488,665
Available	242,386	293,716	352,127	391,479	242,386	293,716	352,127	391,479
Active (A)	155,194	188,059	225,458	250,655	155,194	188,059	225,458	250,655
Demand (B)								
Productivity Scenario 1	125,164	167,187	212,741	262,896	120,440	160,878	204,713	252,975
Productivity Scenario 2	136,542	182,386	232,081	286,795	131,390	175,503	223,323	275,973
Productivity Scenario 3	150,196	200,624	255,289	315,475	144,528	193,054	245,656	303,570
Productivity Scenario 4	166,885	222,916	283,655	350,528	160,587	214,504	272,951	337,300
Productivity Scenario 5	187,745	250,780	319,112	394,344	180,661	241,317	307,070	379,463
Difference (A-B)								
Productivity Scenario 1	30,030	20,872	12,717	-12,241	34,754	27,181	20,745	-2,320
Productivity Scenario 2	18,652	5,673	-6,623	-36,141	23,804	12,556	2,135	-25,318
Productivity Scenario 3	4,998	-12,565	-29,831	-64,820	10,665	-4,994	-20,197	-52,915
Productivity Scenario 4	-11,691	-34,857	-58,196	-99,873	-5,393	-26,445	-47,492	-86,645
Productivity Scenario 5	-32,551	-62,721	-93,653	-143,689	-25,467	-53,258	-81,611	-128,808

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

▢ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students admitted to nursing schools in the year n for new nurses entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams. In addition, we applied a 30% of nursing school intake as the rate of transfer students entering nursing schools for five years from 2010 to 2014.
- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of nursing workforce was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement

rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ Assumptions related to demand projection

- First, target year's population was adjusted for age-specific weightings that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and health care utilization weightings are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of health care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis. As requirements for nursing providers are different for different types of hospital bed (general clinics: 2.5 inpatients per nurse; care hospitals: 6 inpatients; oriental medicine clinics: 5 inpatients), we made adjustments to the estimated inpatient service utilization of nurses.
- Third, nurse productivity, or the number of outpatients cared by a nurse per day, was estimated to be 52.78[4)]

4) In estimating nurse productivity, we considered nursing requirements for different types of inpatient beds in the case of inpatient services.

using the 2007 health care utilization and based on the assumption that nurses work 265 days per year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[5].

- Fourth, in estimating nursing workforce requirements, projection of outpatient service requirements based on inpatient service requirement requires the relative ratios of the effort and time inputs of health providers for inpatients and outpatients. In this study, we set the conversion factor for outpatient and inpatient services as 12 to 1 according to the legal standard.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for nurses varied depending on nurse productivity and utilization growth scenarios. As far as nursing care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

5) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

- Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 4,683-34,502 nurses and a shortage of 5,729-32,944 nurses in 2010, and from a surplus of 5,712-26,124 nurses and a shortage of 18,783-99,350 nurses by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of 4,683-10,363 nurses is forecast in 2010, and a shortage of 18,783-29,349 nurses is likely by 2025, depending on the number of days worked.
- Based on the above supply and demand projections, a surplus or a shortage of nursing care workforce is forecast depending on the productivity scenario used. While different productivity scenarios result in different workforce requirements, the government's policy direction will eventually play the biggest role in which scenario must be chosen. In other words, whether productivity of nurses should be projected to be higher or lower than it is today depends on the government policy that must consider several factors such as financial resources of health insurance.
- Demand for nurses can substantially be influenced by the future changes in the health care environment and health care policies. Changes in the health care environment, such as the growing senior population and income, are likely to further increase nurse requirements. As demand for nurses is expected to grow, there must be policies aimed at increasing student intake as well as make full use of nurses not in active service. In order to make full use of available nurses not in active nursing, currently available nurses must first be

identified, and there must be a variety of measures designed to prevent attrition of nurses and promote employment of nurses not in active service by improving working conditions or providing new training programs for re-employment.

5. Pharmacist Supply and Demand Projections

〈Table 7〉 Analysis of supply and demand projection results for pharmacists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	63,922	68,279	76,771	85,293	63,922	68,279	76,771	85,293
Available	51,647	50,593	54,317	57,209	51,647	50,593	54,317	57,209
Active (A)	36,490	40,474	43,453	45,767	36,490	40,474	43,453	45,767
Demand (B)								
Productivity Scenario 1	34,674	37,973	41,223	44,385	33,566	36,741	39,868	42,911
Productivity Scenario 2	37,343	40,942	44,488	47,936	36,134	39,597	43,010	46,328
Productivity Scenario 3	40,545	44,504	48,405	52,198	39,216	43,025	46,779	50,429
Productivity Scenario 4	44,460	48,858	53,192	57,408	42,982	47,215	51,386	55,442
Productivity Scenario 5	37,547	41,169	44,738	48,208	36,331	39,816	43,250	46,590
Difference (A-B)								
Productivity Scenario 1	1,816	2,501	2,230	1,382	2,923	3,734	3,585	2,857
Productivity Scenario 2	-853	-467	-1,034	-2,169	355	877	444	-561
Productivity Scenario 3	-4,056	-4,030	-4,952	-6,431	-2,726	-2,551	-3,326	-4,662
Productivity Scenario 4	-7,970	-8,384	-9,739	-11,640	-6,493	-6,741	-7,933	-9,675
Productivity Scenario 5	-1,057	-695	-1,284	-2,441	159	658	203	-823

	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	63,922	68,279	76,771	85,293	63,922	68,279	76,771	85,293
Available	51,647	50,593	54,317	57,209	51,647	50,593	54,317	57,209
Active (A)	36,490	40,474	43,453	45,767	36,490	40,474	43,453	45,767
Demand (B)								
Productivity Scenario 1	35,047	38,874	43,069	47,499	33,925	37,608	41,644	45,907
Productivity Scenario 2	37,750	41,925	46,501	51,334	36,526	40,544	44,947	49,597
Productivity Scenario 3	40,993	45,586	50,619	55,936	39,647	44,066	48,910	54,025
Productivity Scenario 4	44,957	50,060	55,653	61,560	43,461	48,372	53,754	59,438
Productivity Scenario 5	37,957	42,159	46,764	51,627	36,725	40,768	45,200	49,880
Difference (A-B)								
Productivity Scenario 1	1,442	1,600	384	-1,732	2,564	2,866	1,809	-140
Productivity Scenario 2	-1,260	-1,451	-3,048	-5,567	-36	-69	-1,494	-3,830
Productivity Scenario 3	-4,504	-5,112	-7,166	-10,168	-3,157	-3,592	-5,457	-8,258
Productivity Scenario 4	-8,468	-9,586	-12,200	-15,793	-6,972	-7,898	-10,300	-13,670
Productivity Scenario 5	-1,467	-1,684	-3,311	-5,860	-236	-294	-1,747	-4,113

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: legal

A. Assumptions

▢ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students admitted to pharmacy schools in the year n for new pharmacists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake

in the year n-6 were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of pharmacists was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 71 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 70 from the available workforce, excluding those aged 71 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ Demand projection of pharmacists include pharmacists in pharmacies, pharmacists in hospitals, and non-clinical pharmacists. Demand projection for pharmacists in pharmacies is based on outpatient prescriptions; demand projection for pharmacists in hospitals is based on pharmacist requirement regulations for hospital dispensaries amended in February 2010; and

demand projection for non-clinical pharmacists is based on the ratio of clinical services to non-clinical services.

▢ Assumptions related to demand projection for pharmacists in pharmacies

- First, target year's population was adjusted for age-specific weightings that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and outpatient prescription weightings are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of utilization rates (outpatient prescriptions), data on outpatient utilization and inpatient utilization (outpatient prescriptions for inpatient services are minimal) per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.
- Third, pharmacist productivity, or the number prescriptions by a pharmacist per day, was estimated to be 68.62 using the 2007 outpatient prescription data and based on the assumption that pharmacists work 265 days per year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[6].

6) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for pharmacists varied depending on pharmacist productivity and utilization growth scenarios. As far as outpatient prescription growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the prescription growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

▢ Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 1,816-2,923 pharmacists and a shortage of 853-6,493 pharmacists in 2010, and from a surplus of 1,382-2,857 pharmacists and a shortage of 561-11,640 pharmacists by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a shortage of 2,726 to 4,056 pharmacists is forecast in 2010, and a shortage of 4,662 to 6,431 pharmacists is likely by 2025, depending on the number of days worked. The shortfall of pharmacists is likely to be experienced by hospitals, the pharmaceutical industry, research institutions and the public sector, not by pharmacies[7].

7) The number of pharmacists per 1,000 population is 0.65 in Korea, which is slightly lower than the OECD average of 0.76. On the other hand, the number of pharmacies per 100,000 population is higher than other countries at 43 (Korea Institute for Health and Social Affairs, 2009), which clearly shows that Korea's pharmacy workforce

▢ Future supply of pharmacists must take into consideration factors that increase demand, such as the expected increase in health care use caused by population aging, development of new drugs, and expansion of insurance coverage for drugs. In addition, other factors affecting pharmacist supply and demand, such as the pharmacy school system, sale of OTC drugs at places other than pharmacies, and government policy to increase investment in facilitation of pharmaceutical industrialization must also be considered in order to flexibly supply pharmacy resources.

is heavily concentrated in pharmacies. The shortfall of pharmacists is largely found in hospitals, the pharmaceutical industry, research institutions and the public sector.

6. Physical Therapist Supply and Demand Projections

〈Table 8〉 Analysis of supply and demand projection results for physical therapists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	39,516	56,212	73,995	91,779	39,516	56,212	73,995	91,779
Available	38,449	53,964	69,345	82,433	38,449	53,964	69,345	82,433
Active (A)	27,976	39,264	50,455	59,978	27,976	39,264	50,455	59,978
Demand (B)								
Productivity Scenario 1	25,239	36,791	46,627	55,153	24,286	35,403	44,867	53,072
Productivity Scenario 2	27,533	40,136	50,865	60,167	26,494	38,621	48,946	57,897
Productivity Scenario 3	30,287	44,149	55,952	66,184	29,144	42,483	53,840	63,686
Productivity Scenario 4	33,652	49,055	62,169	73,538	32,382	47,204	59,823	70,763
Productivity Scenario 5	37,858	55,187	69,940	82,730	36,430	53,104	67,301	79,608
Difference (A-B)								
Productivity Scenario 1	2,737	2,473	3,829	4,825	3,689	3,862	5,588	6,906
Productivity Scenario 2	442	-871	-410	-189	1,481	643	1,509	2,081
Productivity Scenario 3	-2,311	-4,885	-5,497	-6,206	-1,168	-3,219	-3,385	-3,708
Productivity Scenario 4	-5,676	-9,791	-11,714	-13,560	-4,406	-7,939	-9,368	-10,785
Productivity Scenario 5	-9,883	-15,922	-19,485	-22,752	-8,454	-13,840	-16,845	-19,630
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	39,516	56,212	73,995	91,779	39,516	56,212	73,995	91,779
Available	38,449	53,964	69,345	82,433	38,449	53,964	69,345	82,433
Active (A)	27,976	39,264	50,455	59,978	27,976	39,264	50,455	59,978
Demand (B)								
Productivity Scenario 1	24,077	33,628	44,245	56,120	23,168	32,359	42,575	54,003
Productivity Scenario 2	26,266	36,685	48,267	61,222	25,275	35,301	46,446	58,912
Productivity Scenario 3	28,892	40,354	53,094	67,345	27,802	38,831	51,090	64,803
Productivity Scenario 4	32,103	44,837	58,993	74,827	30,891	43,145	56,767	72,004

Productivity Scenario 5	36,116	50,442	66,368	84,181	34,753	48,539	63,863	81,004
Difference (A-B)								
Productivity Scenario 1	3,899	5,636	6,210	3,857	4,807	6,905	7,880	5,975
Productivity Scenario 2	1,710	2,579	2,188	-1,244	2,701	3,963	4,009	1,066
Productivity Scenario 3	-917	-1,089	-2,639	-7,367	173	433	-635	-4,825
Productivity Scenario 4	-4,127	-5,573	-8,538	-14,849	-2,916	-3,881	-6,312	-12,026
Productivity Scenario 5	-8,140	-11,178	-15,912	-24,203	-6,777	-9,274	-13,408	-21,026

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

□ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students admitted to physical therapy courses in the year n for new physical therapists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.
- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate

of physical therapists was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In projecting demand for physical therapists, demand in health care institutions was projected, and based on this, demand for physical therapists in non-health care institutions was projected using the ratio of physical therapists between non-health care institutions and health care institutions.

▢ Assumptions used in the projection of demand for physical therapists at health care institutions

- First, target year's population was adjusted for age-specific weightings of physical therapies that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of physical therapies are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of health care utilization rates (number of physical therapies received), data on outpatient utilization

and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

- Third, physical therapist productivity, or the number of physical therapies provided per day, was estimated to be 69.16 using the 2007 utilization data and based on the assumption that physical therapists work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[8].

B. Results

□ The result of this projection suggests that the direction and degree of supply of and demand for physical therapists varied depending on physical therapist productivity and utilization growth scenarios. As far as physical therapy growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

8) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

- ▢ Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 442-3,689 physical therapists and a shortage of 1,168-8,454 physical therapists in 2010, and from a surplus of 2,081-6,906 physical therapists and a shortage of 189-22,752 physical therapists by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a shortage of minimum 1,168 and maximum 2,311 physical therapists is projected in 2010, and a shortage of 3,708 to 6,206 physical therapists is likely by 2025, depending on the number of days worked.
- ▢ Demand for physical therapy workforce is expected to grow due to many changes taking place in the health care environment, such as the rapid increase in the senior population, environmental pollution resulting from industrialization, increases in chronic diseases, traffic accidents, and industrial accidents, as well as introduction of the long-term care insurance system. In particular, with Korea entering into aging society, there has been vigorous debate on the need to introduce the professional physical therapist system and the need to include long-term care rehabilitation services in covered services. Demand for physical therapy workforce is also likely to increase when community rehabilitation programs designed to help the disabled and the elderly who are mostly confined to home are properly in place.
- ▢ Yet the current physical therapy infrastructure in Korea is poor, and there must be policies that focus on building rehabilitation service infrastructure suitable for aging society, providing high-quality physical therapy services and

effectively making use of physical therapists.

7. Clinical Pathologist Supply and Demand Projections

〈Table 9〉 Analysis of supply and demand projection results for clinical pathologists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	46,225	58,948	72,398	85,864	46,225	58,948	72,398	85,864
Available	42,646	53,601	64,144	72,467	42,646	53,601	64,144	72,467
Active (A)	25,569	32,138	38,459	43,450	25,569	32,138	38,459	43,450
Demand (B)								
Productivity Scenario 1	23,401	30,152	35,180	39,117	22,518	29,014	33,853	37,641
Productivity Scenario 2	25,528	32,893	38,378	42,673	24,565	31,652	36,930	41,063
Productivity Scenario 3	28,081	36,183	42,216	46,941	27,021	34,817	40,623	45,169
Productivity Scenario 4	31,201	40,203	46,907	52,156	30,023	38,686	45,137	50,188
Productivity Scenario 5	35,101	45,228	52,770	58,676	33,776	43,522	50,779	56,462
Difference (A-B)								
Productivity Scenario 1	2,169	1,986	3,279	4,332	3,052	3,123	4,606	5,808
Productivity Scenario 2	42	-756	81	776	1,005	486	1,529	2,386
Productivity Scenario 3	-2,511	-4,045	-3,757	-3,491	-1,452	-2,679	-2,164	-1,720
Productivity Scenario 4	-5,631	-8,065	-8,448	-8,707	-4,454	-6,548	-6,678	-6,739
Productivity Scenario 5	-9,531	-13,091	-14,311	-15,226	-8,207	-11,384	-12,320	-13,012

	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	46,225	58,948	72,398	85,864	46,225	58,948	72,398	85,864
Available	42,646	53,601	64,144	72,467	42,646	53,601	64,144	72,467
Active (A)	25,569	32,138	38,459	43,450	25,569	32,138	38,459	43,450
Demand (B)								
Productivity Scenario 1	23,847	32,956	42,757	53,202	22,947	31,712	41,143	51,194
Productivity Scenario 2	26,015	35,952	46,644	58,039	25,033	34,595	44,884	55,848
Productivity Scenario 3	28,616	39,547	51,308	63,842	27,537	38,054	49,372	61,433
Productivity Scenario 4	31,796	43,941	57,009	70,936	30,596	42,283	54,858	68,259
Productivity Scenario 5	35,771	49,433	64,135	79,803	34,421	47,568	61,715	76,792
Difference (A-B)								
Productivity Scenario 1	1,722	-818	-4,298	-9,753	2,622	426	-2,684	-7,745
Productivity Scenario 2	-446	-3,814	-8,185	-14,589	536	-2,457	-6,425	-12,399
Productivity Scenario 3	-3,047	-7,409	-12,849	-20,393	-1,967	-5,917	-10,913	-17,984
Productivity Scenario 4	-6,227	-11,803	-18,550	-27,487	-5,027	-10,145	-16,399	-24,810
Productivity Scenario 5	-10,201	-17,296	-25,676	-36,354	-8,851	-15,430	-23,256	-33,342

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

▢ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students enrolled in clinical pathology in the year n for new clinical pathologists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students

in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of clinical pathologists was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 (those in active service are included in active workforce) were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In projecting demand for clinical pathologists, demand in health care institutions was projected, and based on this, demand for clinical pathologists in non-health care institutions was projected using the ratio of clinical pathologists between non-health care institutions and health care institutions.

▢ Assumptions used in the projection of demand for clinical pathologists at health care institutions

- First, target year's population was adjusted for age-specific weightings of laboratory testing services that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of laboratory testing services are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of utilization rates (laboratory testing services), data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.
- Third, clinical pathologist productivity, or the number of laboratory testing services of a pharmacist per day, was estimated to be 181.62 using the 2007 utilization data and based on the assumption that clinical pathologists work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[9].

9) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for clinical pathologists varied depending on clinical pathologist productivity and laboratory testing service growth scenarios. As far as laboratory testing service growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

▢ Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 42-3,052 clinical pathologists and a shortage of 1,452-9,531 clinical pathologists in 2010, and from a surplus of 776-5,808 clinical pathologists and a shortage of 1,720-15,226 clinical pathologists by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a shortage of minimum 1,452 and maximum 2,511 clinical pathologists is projected in 2010, and a shortage of 1,720 to 3,491 clinical pathologists is likely by 2025, depending on the number of days worked.

▢ Demand for clinical pathologists is expected to increase due to the growing health care utilization and development of new types of clinical laboratory test. Especially the growing interest in health is likely to increase demand for medical checkup services and early detection of diseases, which in

turn will boost demand for health examination centers as well as clinical pathologists. However, the increase in demand for clinical pathologist is not likely to be big, as the advances and automation of medical devices have been increasingly replacing many of the tasks traditionally performed by clinical pathologists in recent years, and small clinics are turning to specialized medical test agencies to conduct medical tests in order to save personnel expenses.

▢ Considering that an undersupply of clinical pathologies and increased demand are anticipated, policy makers must seek ways to increase supply of clinical pathology workforce to address the expected shortage and at the same time make use of available but not-employed workers - employment rate of clinical pathologists is just around 60%. Efforts need to focus on providing more job opportunities to the unemployed workforce, for instance through expansion of test room functions at health centers, an increase in enrollment and guarantee of status of clinical pathology workers, establishment of a permanent test system for outpatients, enhanced test functions in industrial accident fields and clinics, control of unlicensed test personnel, and expansion of workforce to foreign markets.

8. Radiographer Supply and Demand Projections

〈Table 10〉 Analysis of supply and demand projection results for radiographers, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	31,479	44,349	57,958	71,570	31,479	44,349	57,958	71,570
Available	29,728	40,948	51,807	61,010	29,728	40,948	51,807	61,010
Active (A)	23,464	32,320	40,891	48,155	23,464	32,320	40,891	48,155
Demand (B)								
Productivity Scenario 1	19,135	24,126	28,638	32,446	18,413	23,215	27,557	31,221
Productivity Scenario 2	20,875	26,319	31,241	35,395	20,087	25,326	30,062	34,060
Productivity Scenario 3	22,962	28,951	34,365	38,935	22,096	27,859	33,068	37,466
Productivity Scenario 4	25,514	32,168	38,184	43,261	24,551	30,954	36,743	41,629
Productivity Scenario 5	28,703	36,189	42,957	48,669	27,620	34,823	41,336	46,832
Difference (A-B)								
Productivity Scenario 1	4,329	8,195	12,253	15,710	5,051	9,105	13,334	16,934
Productivity Scenario 2	2,589	6,001	9,650	12,760	3,377	6,994	10,829	14,096
Productivity Scenario 3	502	3,369	6,526	9,221	1,368	4,462	7,823	10,690
Productivity Scenario 4	-2,049	153	2,707	4,894	-1,087	1,366	4,148	6,527
Productivity Scenario 5	-5,239	-3,868	-2,066	-513	-4,155	-2,503	-445	1,323
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	31,479	44,349	57,958	71,570	31,479	44,349	57,958	71,570
Available	29,728	40,948	51,807	61,010	29,728	40,948	51,807	61,010
Active (A)	23,464	32,320	40,891	48,155	23,464	32,320	40,891	48,155
Demand (B)								
Productivity Scenario 1	18,839	23,442	28,137	32,945	18,128	22,557	27,075	31,701

Productivity Scenario 2	20,551	25,573	30,695	35,940	19,776	24,608	29,536	34,583
Productivity Scenario 3	22,606	28,130	33,764	39,534	21,753	27,069	32,490	38,042
Productivity Scenario 4	25,118	31,256	37,516	43,926	24,170	30,076	36,100	42,269
Productivity Scenario 5	28,258	35,163	42,205	49,417	27,192	33,836	40,612	47,552
Difference (A-B)								
Productivity Scenario 1	4,626	8,879	12,754	15,211	5,337	9,763	13,816	16,454
Productivity Scenario 2	2,913	6,747	10,196	12,216	3,689	7,713	11,355	13,572
Productivity Scenario 3	858	4,190	7,127	8,622	1,711	5,252	8,401	10,114
Productivity Scenario 4	-1,654	1,065	3,375	4,229	-706	2,244	4,791	5,887
Productivity Scenario 5	-4,794	-2,842	-1,314	-1,261	-3,727	-1,515	279	603

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

▢ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students enrolled in radiology courses in the year n for new radiographers entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.
- Second, workforce loss is calculated as the sum of health

providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of radiographers was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year.

□ In projecting demand for radiographers, demand in health care institutions was projected, and based on this, demand for radiographers in non-health care institutions was projected using the ratio of radiographers between non-health care institutions and health care institutions.

□ Assumptions used in the projection of demand for radiographers at health care institutions

- First, target year's population was adjusted for age-specific weightings of the number of examinations that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of the number of examinations are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of health care utilization rates (number of examinations performed by radiographers), data on outpatient utilization and inpatient utilization per recipient

of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

- Third, radiographer productivity, or the number of examinations of a radiographer per day, was estimated to be 39.36 using the 2007 utilization data and based on the assumption that radiographers work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[10].

B. Results

□ The result of this projection suggests that the direction and degree of supply of and demand for radiographers varied depending on radiographer productivity and examination volume growth scenarios. As far as examination growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

10) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

- Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 502-5,051 radiographers and a shortage of 1,087-5,239 radiographers in 2010, and from a surplus of 1,323-16,934 radiographers and a shortage of 513 radiographers by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of minimum 502 and maximum 1,368 radiographers is projected in 2010, and a surplus of 1,368 to 10,690 radiographers is likely by 2025, depending on the number of days worked.
- As people are increasingly aware of health issues due to longer life expectancy arising from improved standards of living and medical advances, demand for health care services is naturally growing. Also, there have been growing needs for more accurate diagnosis of health conditions due to the growing incidence of various diseases including cancers as a result of environmental pollution and westernized diet. With the focus of health care moving from treatment to prevention, demand for health examinations is growing, hence more demand for radiographers is anticipated.
- On the other hand, despite further advancement and automation of medical equipment, each patient has different needs for radioactive examinations and considering that this medical field requires care by specialists, demand for radiographers is likely to continue to grow. As the work scope of radiographers is broad from simple examinations to special examinations, longer-term projections of demand for radiographers need to consider work volume and time required for each task of

radiographers. In planning future supply of radiology workforce, factors that increase demand for radiographers and other factors that affect the radiography workforce planning such as policy directions on the radiographer system must be sufficiently taken into consideration in order to flexibly supply radiology workforce in proper numbers.

9. Occupational Therapist Supply and Demand Projections

〈Table 11〉 Analysis of supply and demand projection results for occupational therapists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	5,574	12,860	20,933	29,009	5,574	12,860	20,933	29,009
Available	5,516	12,743	20,701	28,564	5,516	12,743	20,701	28,564
Active (A)	4,221	9,752	15,842	21,859	4,221	9,752	15,842	21,859
Demand (B)								
Productivity Scenario 1	4,392	12,236	19,147	23,229	4,226	11,774	18,424	22,352
Productivity Scenario 2	4,791	13,348	20,887	25,340	4,611	12,844	20,099	24,384
Productivity Scenario 3	5,270	14,683	22,976	27,874	5,072	14,129	22,109	26,822
Productivity Scenario 4	5,856	16,314	25,529	30,971	5,635	15,699	24,565	29,803
Productivity Scenario 5	6,588	18,354	28,720	34,843	6,340	17,661	27,636	33,528
Difference (A-B)								
Productivity Scenario 1	-171	-2,484	-3,305	-1,369	-5	-2,022	-2,582	-493
Productivity Scenario 2	-570	-3,596	-5,045	-3,481	-389	-3,093	-4,257	-2,525
Productivity Scenario 3	-1,049	-4,931	-7,134	-6,015	-850	-4,377	-6,267	-4,963
Productivity Scenario 4	-1,635	-6,563	-9,687	-9,112	-1,414	-5,947	-8,723	-7,943
Productivity Scenario 5	-2,367	-8,602	-12,878	-12,984	-2,118	-7,909	-11,794	-11,669

	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	5,574	12,860	20,933	29,009	5,574	12,860	20,933	29,009
Available	5,516	12,743	20,701	28,564	5,516	12,743	20,701	28,564
Active (A)	4,221	9,752	15,842	21,859	4,221	9,752	15,842	21,859
Demand (B)								
Productivity Scenario 1	2,606	4,240	6,039	8,050	2,508	4,080	5,811	7,746
Productivity Scenario 2	2,843	4,625	6,588	8,782	2,735	4,451	6,339	8,451
Productivity Scenario 3	3,127	5,088	7,246	9,660	3,009	4,896	6,973	9,296
Productivity Scenario 4	3,474	5,653	8,052	10,734	3,343	5,440	7,748	10,329
Productivity Scenario 5	3,909	6,360	9,058	12,075	3,761	6,120	8,716	11,620
Difference (A-B)								
Productivity Scenario 1	1,615	5,512	9,803	13,809	1,714	5,672	10,031	14,113
Productivity Scenario 2	1,379	5,127	9,254	13,077	1,486	5,301	9,503	13,408
Productivity Scenario 3	1,094	4,664	8,596	12,199	1,212	4,856	8,869	12,563
Productivity Scenario 4	747	4,099	7,790	11,125	878	4,312	8,094	11,531
Productivity Scenario 5	312	3,392	6,784	9,784	460	3,632	7,126	10,239

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

□ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students enrolled in occupational therapy programs in the year n for new occupational therapists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of

absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of occupational therapists was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

□ In projecting demand for occupational therapists, demand in health care institutions was projected, and based on this, demand for occupational therapists in non-health care institutions was projected using the ratio of occupational therapists between non-health care institutions and health care institutions.

□ Assumptions used in the projection of demand for occupational therapists at health care institutions

- First, target year's population was adjusted for age-specific

weightings of the number of occupational therapies that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of the number of occupational therapies are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.

- Second, in terms of health care utilization rates (number of occupational therapies), data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.
- Third, occupational therapist productivity, or the number of occupational therapies of a pharmacist per day, was estimated to be 22.61 using the 2007 utilization and based on the assumption that occupational therapists work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[11].

11) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for occupational therapists varied depending on productivity of occupational therapists and therapy growth scenarios. As far as occupational therapy growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

▢ Under the "Demand Scenario 1," a shortage of 5-2,367 occupational therapists is forecast in 2010, and by 2025 a shortage of 493-12,984 occupational therapists is anticipated under different productivity scenarios. Under the "Productivity Scenario 3," which is based on 2007 productivity, a shortage of minimum 850 and maximum 1,049 occupational therapists is projected in 2010, and by 2025 a shortage of 4,963 to 6,015 occupational therapists is likely, depending on the number of days worked.

▢ The growing senior population is expected to be accompanied by the growing number of patients with dementia and patients with degenerative diseases. This will result in increased demand for occupational therapists to prevent or improve deterioration in cognitive awareness and physical functions of senior citizens. The long-term care insurance and the need to look after senior

citizens who use senior facilities are also likely to increase demand for occupational therapists. Furthermore, as the demand for health workers for purposes of treating children with developmental disorders is increasing as part of national welfare policies, along with the growing awareness of rehabilitation services for accidents or diseases, the work scope of occupational therapists is expanding from rehabilitation medicine to psychiatry, welfare centers and local communities. Accordingly, demand for occupational therapists will grow.

- One of the reasons why supply of occupational therapists has been low compared to other medical technicians is that many health care institutions have avoided installation of occupational therapy rooms because reimbursement for health care services provided by occupational therapists is not properly covered by health insurance plans. Therefore, it seems desirable to develop health insurance fees for occupational therapy services so that the occupational therapy workers have more opportunities to pursue their careers.

10. Dental Hygienist Supply and Demand Projections

〈Table 12〉 Analysis of supply and demand projection results for dental hygienists, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	47,626	72,193	96,768	121,343	47,626	72,193	96,768	121,343
Available	47,578	71,927	96,202	120,843	47,578	71,927	96,202	120,843
Active (A)	29,054	43,923	58,747	73,794	29,054	43,923	58,747	73,794
Demand (B)								
Productivity Scenario 1	18,189	19,198	20,231	21,099	17,502	18,474	19,468	20,303
Productivity Scenario 2	19,842	20,944	22,070	23,017	19,093	20,153	21,237	22,148
Productivity Scenario 3	21,826	23,038	24,277	25,319	21,003	22,169	23,361	24,363
Productivity Scenario 4	24,252	25,598	26,975	28,132	23,336	24,632	25,957	27,070
Productivity Scenario 5	27,283	28,798	30,346	31,648	26,253	27,711	29,201	30,454
Difference (A-B)								
Productivity Scenario 1	10,865	24,724	38,516	52,695	11,551	25,449	39,279	53,491
Productivity Scenario 2	9,212	22,979	36,676	50,777	9,960	23,769	37,509	51,645
Productivity Scenario 3	7,227	20,884	34,469	48,475	8,051	21,754	35,386	49,430
Productivity Scenario 4	4,802	18,325	31,772	45,662	5,717	19,291	32,790	46,723
Productivity Scenario 5	1,771	15,125	28,400	42,145	2,800	16,212	29,545	43,339
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	47,626	72,193	96,768	121,343	47,626	72,193	96,768	121,343
Available	47,578	71,927	96,202	120,843	47,578	71,927	96,202	120,843
Active (A)	29,054	43,923	58,747	73,794	29,054	43,923	58,747	73,794
Demand (B)								
Productivity Scenario 1	18,180	19,138	20,080	20,809	17,494	18,416	19,322	20,024
Productivity Scenario 2	19,833	20,878	21,905	22,701	19,085	20,090	21,078	21,844
Productivity Scenario 3	21,816	22,965	24,095	24,971	20,993	22,099	23,186	24,029
Productivity Scenario 4	24,240	25,517	26,773	27,746	23,326	24,554	25,762	26,699

Productivity Scenario 5	27,270	28,707	30,119	31,214	26,241	27,624	28,983	30,036
Difference (A-B)								
Productivity Scenario 1	10,873	24,785	38,667	52,984	11,559	25,507	39,425	53,770
Productivity Scenario 2	9,221	23,045	36,842	51,093	9,969	23,833	37,668	51,949
Productivity Scenario 3	7,237	20,957	34,651	48,823	8,061	21,824	35,560	49,765
Productivity Scenario 4	4,813	18,405	31,974	46,048	5,728	19,368	32,984	47,095
Productivity Scenario 5	1,783	15,216	28,627	42,580	2,812	16,299	29,764	43,758

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

□ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students enrolled in dental hygiene programs in the year n for new dental hygienists entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.
- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of dental hygienists was obtained from the mortality rate

by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In projecting demand for dental hygienists, demand in health care institutions was projected, and based on this, demand for dental hygienists in non-health care institutions was projected using the ratio of dental hygienists between non-health care institutions and health care institutions.

▢ Assumptions used in the projection of demand for dental hygienists at health care institutions

- First, target year's population was adjusted for age-specific weightings of dental care utilization that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of dental care utilization are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of dental care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and 2007

were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

- Third, dental hygienist productivity was estimated to be 15.73 using the 2007 dental care utilization data and based on the assumption that dental hygienists work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[12].

B. Results

□ The result of this projection suggests that the direction and degree of supply of and demand for dental hygienists varied depending on dental hygienist productivity and dental care utilization growth scenarios. As far as dental care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

□ Under the "Demand Scenario 1," projections varied under different productivity scenarios, ranging from a surplus of 1,771-11,551 dental hygienists in 2010 and a further surplus

12) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

of 42,145-53,491 dental hygienists by 2025. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of minimum 7,227 and maximum 8,051 dental hygienists is projected in 2010, and a surplus of 48,475 to 49,430 dental hygienists is likely by 2025, depending on the number of days worked.

- ▢ Surpluses of dental hygienists are likely regardless of years forecasted. Yet as of 2009, as much as 27.5% of dental clinics were operating with only nursing assistants and not with dental hygienists, and the percent is even higher in Seoul at 28%. This suggests that there exists demand for additional dental hygienists at dental clinics.
- ▢ Analysis of accurate productivity of dental hygienists and the possibility of entry into the labor market by the dental hygiene workers not in active service appear to be needed for more accurate projections. To address the high turnover rate stemming from high tensions among dental hygiene workers due to the unclear division of roles, there is a need to clarify division of roles for the workforce and facilitate systems that recognize their professionalism and skills gained from longer years worked to reduce unnecessary waste of professional workers and training, while setting a vision for the profession .

11. Dental Technician Supply and Demand Projections

〈Table 13〉 Analysis of supply and demand projection results for dental technicians, 2010-2025

(Unit: Person)

	Demand Scenario 1 (Logit Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	27,721	35,277	42,834	50,392	27,721	35,277	42,834	50,392
Available	25,859	31,843	36,421	39,374	25,859	31,843	36,421	39,374
Active (A)	12,164	14,978	17,132	18,521	12,164	14,978	17,132	18,521
Demand (B)								
Productivity Scenario 1	9,101	9,607	10,123	10,558	8,758	9,244	9,741	10,159
Productivity Scenario 2	9,929	10,480	11,044	11,518	9,554	10,085	10,627	11,083
Productivity Scenario 3	10,922	11,528	12,148	12,669	10,510	11,093	11,690	12,191
Productivity Scenario 4	12,135	12,809	13,498	14,077	11,677	12,326	12,989	13,546
Productivity Scenario 5	13,652	14,410	15,185	15,837	13,137	13,866	14,612	15,239
Difference (A-B)								
Productivity Scenario 1	3,062	5,372	7,009	7,963	3,406	5,734	7,391	8,362
Productivity Scenario 2	2,235	4,498	6,088	7,003	2,610	4,894	6,505	7,438
Productivity Scenario 3	1,242	3,450	4,984	5,852	1,654	3,885	5,442	6,330
Productivity Scenario 4	29	2,169	3,634	4,444	486	2,653	4,144	4,975
Productivity Scenario 5	-1,488	568	1,947	2,684	-973	1,112	2,520	3,282
	Demand Scenario 2 (ARIMA Model)							
	255 Days Worked				265 Days Worked			
	2010	2015	2020	2025	2010	2015	2020	2025
Supply								
Licences Registered	27,721	35,277	42,834	50,392	27,721	35,277	42,834	50,392
Available	25,859	31,843	36,421	39,374	25,859	31,843	36,421	39,374
Active (A)	12,164	14,978	17,132	18,521	12,164	14,978	17,132	18,521
Demand (B)								
Productivity Scenario 1	9,097	9,576	10,048	10,413	8,754	9,215	9,668	10,020
Productivity Scenario 2	9,924	10,447	10,961	11,359	9,550	10,053	10,547	10,931
Productivity Scenario 3	10,917	11,492	12,057	12,495	10,505	11,058	11,602	12,024
Productivity Scenario 4	12,130	12,769	13,397	13,884	11,672	12,287	12,891	13,360

Productivity Scenario 5	13,646	14,365	15,071	15,619	13,131	13,823	14,503	15,030
Difference (A-B)								
Productivity Scenario 1	3,067	5,402	7,084	8,108	3,410	5,763	7,464	8,501
Productivity Scenario 2	2,239	4,531	6,171	7,161	2,614	4,926	6,585	7,590
Productivity Scenario 3	1,247	3,487	5,075	6,026	1,659	3,920	5,530	6,497
Productivity Scenario 4	34	2,210	3,735	4,637	492	2,692	4,241	5,161
Productivity Scenario 5	-1,482	614	2,061	2,902	-967	1,156	2,629	3,491

Note: Productivity Scenario - Scenario 1: 120% of 2007 productivity; Scenario 2: 110% of 2007 productivity; Scenario 3: 100% of 2007 productivity; Scenario 4: 90% of 2007 productivity; Scenario 5: 80% of 2007 productivity

A. Assumptions

▢ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students enrolled in dental technology programs in the year n for new dental technicians entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.
- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of dental technicians was obtained from the mortality rate

by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In projecting demand for dental technicians, demand in health care institutions was projected, and based on this, demand for dental technicians in non-health care institutions was projected using the ratio of dental technicians between non-health care institutions and health care institutions.

▢ Assumptions used in the projection of demand for dental technicians at health care institutions

- First, target year's population was adjusted for age-specific weightings of dental care utilization that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and weightings of dental care utilization are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.
- Second, in terms of dental care utilization rates, data on outpatient utilization and inpatient utilization per recipient of health insurance and medical aid between 2003 and

2007 were used to estimate per capita utilization in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

- Third, dental technician productivity, or dental care utilization per dental technician, was estimated to be 38.23 using the 2007 productivity and based on the assumption that dental technicians work for 265 days a year. In terms of the number of days worked, the most widely accepted 265 days and 255 days were used[13].

B. Results

▢ The result of this projection suggests that the direction and degree of supply of and demand for dental technicians varied depending on productivity of dental technicians and dental care utilization growth scenarios. As far as dental care utilization growth scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. In this regard, we will focus on explaining projection results under the "Demand Scenario 1" that employs the logit model.

▢ Under the "Demand Scenario 1," projections varied under

13) Number of days worked is about 265 days, excluding legal holidays, Sundays, Saturdays, and so on. Study by Park Hyeon-ae et al. (1990) also supports this figure, and Moon Hyeok-su (1994) also used 255 working days excluding days patients are not seen due to attendance to conferences, etc.

different productivity scenarios, ranging from a surplus of 29-3,406 dental technicians and a shortage of 973-1,488 dental technicians in 2010. By 2025, a surplus of 2,684-8,362 dental technicians is anticipated. Under the "Productivity Scenario 3," which is based on 2007 productivity, a surplus of minimum 1,242 and maximum 1,654 dental technicians is projected in 2010, and by 2025 a surplus of 5,852 to 6,330 dental technicians is likely, depending on the number of days worked.

- ▢ The growing economic levels and income are expected to boost dental care requirements both in quantitative and qualitative terms. As such, if government policies are set in a way that expands health insurance benefits to cover more dental services, such as dentures for senior citizens, as part of efforts to meet the growing needs for dental care, future dental care services are likely to grow. However, as the rapid increase in productivity brought about by the advent of CAD/CAM systems (computer-based mass production systems) in dental technology greatly influences the supply and demand of dental technology workers who have traditionally performed manual work, workforce policies need to be formulated based on the accurate estimates of workers.
- ▢ Factors that increase demand for dental care, such as increased income, and factors that decrease demand, such as improved productivity driven by the use of CAD/CAM, must be reflected in dental care service policies to ensure that proper levels of dental technology workers can be flexibly supplied.

12. Supply and Demand Projections for Medical Records and Health Information Technicians

〈Table 14〉 Analysis of supply and demand projection results for medical records and health information technicians, 2010-2025

(Unit: Person)

		Year			
		2010	2015	2020	2025
Supply					
Licenses Registered		19,223	32,000	44,819	57,638
Available (A)		18,948	31,495	43,779	54,753
Active (B)		10,827	17,997	25,016	31,286
Demand (C)					
Relative to Doctors	Scenario 1	7,800	9,392	11,104	12,947
	Scenario 2	7,541	8,605	9,522	10,366
Relative to Beds	Scenario 1	12,024	21,432	27,060	33,328
	Scenario 2	12,224	22,893	31,383	42,704
Difference (B-C)					
Relative to Doctors	Scenario 1	3,026	8,605	13,912	18,339
	Scenario 2	3,286	9,391	15,493	20,920
Relative to Beds	Scenario 1	-1,197	-3,436	-2,044	-2,042
	Scenario 2	-1,397	-4,896	-6,368	-11,418

Note: 1) Demand Scenario 1: Based on the logit model/ Demand Scenario 2: Based on the ARIMA model
2) Demand projections based on the number of beds are projections for inpatient beds, and demand projections for medical records and health information technicians working in non-health care institutions such as insurance firms are not included.

A. Assumptions

▢ Assumptions related to supply projection

– First, due to the lack of accurate data on the number of students enrolled in medical records administration courses

in the year n for new medical records and health information technicians entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3,2) were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of medical records and health information technicians was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In estimating demand for medical records and health information technicians, the ratio of medical records and health information technicians to the number of doctors and to the number of hospital beds was used. In the case of projections based on the number of hospital beds, data on inpatient beds at hospitals and clinics between 2001 and 2007 were used to project the number of beds in the target year with the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis. While the US Health Information Management System Society (HIMSS) provides recommended number of medical records and health information technicians per bed, it is quite different from Korean situations. In this study, we applied 40 beds per medical records and health information technician until 2019, 35 beds until 2024 and 30 beds from 2025.

B. Results

▢ Under the "ratio of medical records and health information technicians to the number of doctors" method, a surplus of 3,026-3,286 technicians is projected in 2010, and a further surplus of 18,339-20,920 technicians is anticipated by 2025. On the other hand, when the projection is made using the number of medical records and health information technicians relative to the number of hospital beds, a shortage of 1,197-1,397 technicians is forecast in 2010 and a shortage of 2,042-11,418 technicians is likely by 2025.

- Projection results varied depending on the projection method used. As the number of hospital beds plays a bigger role than the number of doctors in the projection of demand for medical records and health information technicians, we believe that projections made using the former method are more adequate. As far as hospital bed increase scenarios are concerned, we believe that the logit function that shows initial exponential growth, followed by a period in which growth slows is more adequate than the time series analysis ARIMA model that assumes a continuation of the growth trend of the past five years. Therefore, we believe that plausible medical record workforce policies should be based on the supply and demand projection results that are made using the number of beds estimated under the logit model and the number of beds per medical records and health information technician.
- Yet unlike the US health care market where demand for medical records and health information technicians is heavy, there are not sufficient laws or regulations pertaining to employment of medical records and health information technicians in Korea. Demand for medical record administration workers is expected to increase due to the growing demand for health services and the accelerating digitization of health care information. As such, laws and regulations aimed at stimulating employment of medical records administration workers by hospitals and clinics will be needed.

13. Emergency Medical Technician Supply and Demand Projections

〈Table 15〉 Analysis of supply and demand projection results for emergency medical technicians (EMT), 2010-2025

(Unit: Person)

		Year			
		2010	2015	2020	2025
Supply					
Licenses Registered		17,468	26,851	36,128	45,402
Available (A)		17,208	26,069	33,960	39,999
Active (B)		14,193	21,280	27,510	32,091
Demand (C)					
Relative to Doctors	Scenario 1	11,796	14,203	16,792	19,579
	Scenario 2	11,403	13,014	14,400	15,676
US Guideline	Scenario 1	29,700	35,166	39,887	42,862
	Scenario 2	27,519	30,506	33,444	35,773
Difference (B-C)					
Relative to Doctors	Scenario 1	2,397	7,078	10,718	12,512
	Scenario 2	2,790	8,267	13,110	16,415
US Guideline	Scenario 1	- 15,507	- 13,885	- 12,377	- 10,771
	Scenario 2	- 13,325	- 9,226	- 5,934	- 3,682

Note: Demand Scenario 1: Based on the logit model/ Demand Scenario 2: Based on the ARIMA model

A. Assumptions

▢ Emergency medical technicians (EMT) consist of EMT-Level I and EMT-Level II workforce. Assumptions pertaining to supply projections of EMT workforce are as follows:

– First, due to the lack of accurate data on the number of students enrolled in paramedic training programs in the year n for new EMTs entering the workforce, it was assumed

that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students enrolled in EMT-Level I and Level II programs were presumed to graduate, although the actual number may differ for various reasons that may occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of EMTs was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 56 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 55 from the available workforce, excluding those aged 56 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

□ In estimating demand for EMTs, we used the ratio of EMT personnel to the number of doctors and the US EMT workforce guideline. The US method uses the equation of calculating

the number of EMTs relative to GDP.

- In GDP projections of Korea and the United States, we applied the logit function in the Curve Estimation Regression Model and the ARIMA Model for time series analysis.

B. Results

- Under the "EMT-to-doctor ratio" method, a surplus of 2,397-2,790 EMTs is projected in 2010, and a further surplus of 12,512-16,415 EMTs is forecast by 2025. On the other hand, projections with the US method, or EMT workforce relative to GDP, showed a shortage of 13,325-15,507 EMTs in 2010 and a shortage of 3,682-10,771 EMTs by 2025.
- Projection results varied depending on the projection method used. When the EMT-to-doctor ratio is applied, projections are made based on the number of EMTs currently supplied, so there can be a problem of reflecting the currently distorted ratio of EMTs.
- Therefore, we believe that it is more appropriate to apply the criteria Korea needs to aim to follow, such as those employed in developed countries where the emergency care system is well established, rather than the ratio of EMTs used in Korea. However, it must be noted that roles and duties of EMTs may slightly differ between Korea and other developed countries. Considering this, future projections of demand for EMT workforce need to be made for different fields of paramedic activity, such as emergency care institutions and the number of ambulances.

14. Optician Supply and Demand Projections

〈Table 16〉 Analysis of supply and demand projection results for opticians, 2010-2025

(Unit: Person)

		Year			
		2010	2015	2020	2025
Supply					
Licenses Registered		3,546	2,103	1,461	60,831
Available (A)		31,504	38,525	45,882	52,033
Active (B)		8,619	2,768	7,116	30,752
Demand (C)					
Relative to Doctors	Scenario 1	18,537	22,318	26,387	30,767
	Scenario 2	7,919	0,450	22,629	24,634
Relative to Population		17,564	18,792	20,058	21,376
Difference (B-C)					
Relative to Doctors	Scenario 1	83	450	729	-15
	Scenario 2	700	2,318	4,488	6,118
Relative to Population		1,055	3,976	7,059	9,376

Note: Demand Scenario 1: Based on the logit model/ Demand Scenario 2: Based on the ARIMA model

A. Assumptions

▢ Assumptions related to supply projection

- First, due to the lack of accurate data on the number of students enrolled in opticianry programs in the year n for new opticians entering the workforce, it was assumed that students in entrance quota and outside quota would all be included in the intake. Also due to the lack of accurate data on the number of graduates, all students in the intake in the year n-4(3) were presumed to graduate, although the actual number may differ for various reasons that may

occur while at school, such as leave of absence from school, return to school, or expulsion from school. In the calculation of state exam applicants, it was assumed that graduates in the year n and those who failed to pass the exams in the year (n-1) all took the exams.

- Second, workforce loss is calculated as the sum of health providers leaving the workforce through mortality, retirement and emigration. In this study, the mortality rate of opticians was obtained from the mortality rate by age of the general population of the National Statistical Office. Among health providers aged 71 or older, those who were not in active service until 2007 were all considered as retirees and not captured in the workforce, and the percentage of those aged 70 from the available workforce, excluding those aged 71 or older, was used as the retirement rate until the target year. Emigrants were also excluded from the workforce until 2007, and the estimated average emigration rate over the past five years among those entering the workforce each year was used as the emigration rate until the target year.

▢ In estimating demand for opticians, we used the optician-to-doctor ratio and the optician-to-population ratio. In the application of the optician-to-population ratio, target year's population was adjusted for age-specific weightings that reflect differences in health care utilization between different age groups. Data on projected population were obtained from the National Statistical Office, and health care utilization weightings are the figures we have re-analyzed using the 2007 internal data of the Health Insurance Review & Assessment Service.

B. Results

- Under the "optician-to-doctor ratio" method, a surplus of 83-700 opticians is projected in 2010, and by 2025 the projected numbers varied from a shortage of 15 opticians to a surplus of 6,118 opticians. Also under the "optician-to-population ratio" method, a surplus of 1,055 is projected in 2010 and a surplus of 9,376 opticians is likely by 2025.
- Optician workforce planning requires consideration of the characteristics of demand for health care services in recent years as well as factors that affect supply of and demand for opticians to ensure that proper levels of workers can be flexibly supplied to the labor market.

Chapter

05

Policy Directions and Implications

Chapter 5

Policy Directions and Implications

1. Policy Directions

▢ Health care workforce is the most fundamental component of health care resources. The quantity and quality of a country's health care workforce are used as a yardstick for determining the country's health care level. Considering the fact that health care workforce supply and demand cannot be controlled in a short period of time, ill-formulated workforce supply and demand policies can cause inefficiency in a nation's health care system in the long run. Especially oversupply of health care workers generates demand for health care services, thereby increasing unnecessary use of health care services as well as medical expenses. For this reason, government intervention to a certain extent is needed and this is a global trend.

▢ The volume and quality of health care workforce are a major determinant of health care supply, so it is essential to maintain a proper level of health care workforce to ensure health rights of people. Growing awareness of health issues due to rising income and standards of living, population aging caused by longer life expectancy, and expansion of health insurance coverage all contribute to the continued increase in demand for health care services. Therefore, making appropriate health care services available to the public is essential for purposes

of promoting national welfare.

▢ Likewise, the growing economic and income levels are also expected to increase needs for health care services both in quantitative and qualitative terms. If government policies are geared toward meeting the growing health care needs, the number of patients per health provider per day, or provider productivity, will fall. This in turn will increase demand for health care workers. Therefore, it is advised that the government take into consideration insurance finances and people's ability to pay for health care services in its health care policies, because the imbalance between supply and demand of health care workers, including doctors, can be influenced to a certain extent by the government's policy directions for health care services.

2. Policy Implications

▢ Supply and demand projections for health care workforce estimate surpluses or shortages of health care workers typically based on the employed workers. If the unemployment is not all voluntary even in the health care professions where employment rates are low, it may be an indication that in reality the supply is not insufficient. Thus it is desirable to make projections of surpluses or shortages based on the understanding of the voluntary unemployment, and explore ways to make full use of available workers.

▢ For more accurate planning of health care workforce, health care workforce data must be collected and relevant information

systems must be in place.

- Planning and allocation of health care resources must be based on data. That is, improvements must be made in terms of the extent of data required, content and quality of data, and there must be foundations upon which data on health providers such as doctors for different types of health care institutions, hours worked, demographics (gender, age), and provider productivity can be collected.
- Data on deaths, emigration, leave of absence, transfer or retirement essential for projecting supply of health care workforce are either non-existent or insufficient, thus health care workforce reporting mechanisms must be enhanced.
- To secure basic data for planning health care workforce supply policies, relevant institutions need to build and constantly monitor databases on health care workers supplied, workers in active service, and health care utilization by patients. Demand for health care services and supply of resources must be re-analyzed in response of major policy changes.

▢ Supply and demand projections for health care workforce are made on the assumption that the current health care system remains unchanged and with a limited set of assumptions about demographic, economic and social changes. Thus there are many limitations for predicting future trends.

- Projection results in this study may be quite inconsistent with reality due to institutional changes expected in the future, such as the introduction of the DRG system, segregation of functions among health care institutions,

expansion of the special hospital system, stimulation of the attending system, stimulation of home care nursing, and expansion of public health care functions.

- Not only is it difficult to forecast the changes in the health care environment taking place in Korea and abroad, such as the opening of the health care market, low-fertility rates and aging society, changes in the health care delivery system and medical security system, and specialization of health care services, but it is also difficult to predict social and economic changes that affect demand for health care services. In this regard, there is a need to set up a health care workforce projection team to conduct comprehensive studies on a regular basis.

▢ Finally, as there is no intake for midwives, midwives are not included in the health care workforce development planning, nor in projections of this study. Yet the role of midwives is important in Korea that faces delivery room management and low-fertility issues. In this regard, several suggestions for adequate supply and demand of midwifery workforce are provided here.

- The regulations that define health care facilities with over 100 birth events on average per month as midwifery training institutions need to be revised to reflect the reduction in the number of deliveries per month due to low birth rates.
- There is a need to have nursing training organizations open up midwifery training courses to supply proper number of midwives to the market. In addition, midwifery associations or midwifery training organizations directly

involved in midwifery practice or midwifery qualifications need to develop standards for the practice of nurse-midwifery that define specific core competencies or scope of work required for midwives to perform basic tasks, while universities also need to provide midwifery education to produce high-quality midwifery workers.

- Monitoring and supervision mechanisms need be put in place to ensure that Article 38 of the Enforcement Regulations of the Medical Act, which defines quotas for midwifes (over a third of nurses allocated to ob/gyn departments of general hospitals, hospitals and clinics must be midwives), is well observed and midwifery workforce is sufficiently utilized.

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