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Penetration factors and introduction possibility for image diagnostic equipment

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Visualize the spread of medical equipment

Abstract

Background

This study investigated and analyzed the relationship between medical resources and economic conditions of OECD member countries and extracted factors for introducing imaging diagnostic equipment in each country. We also investigated the possibility of introducing diagnostic imaging equipment.

Methods

A principal component analysis was conducted from medical environment indices and economic situation indices; the results were visualized on a graph with the extracted two principal components as axes, and the target nations were categorized according to the possibility of introducing diagnostic imaging equipment. Next, with the number of CTs and MRIs as response variables, we visualized the probability results on a graph by conducting a multiple regression analysis with the indices as explanatory variables and extracting the most influential factors on the number of diagnostic imaging equipment introduced.

Results

We classified 29 countries into four groups according to medical environment and economic situation indices. By extracting from the four groups a group with a high possibility for introducing medical equipment then conducting a multiple regression analysis with CT and MRI unit counts as objective variables and other medical environment and economic situation indices as explanatory variables, it became clear that the factor with the greatest influence on CT and MRI unit counts is the number of hospital beds.

Conclusion

As topics of future studies, we would like to clarify the factors behind as well as the probability for the introduction of medical equipment in each nation by researching high-growth medical equipment markets.

Introduction

The global market for medical equipment has maintained a growth rate of about 8% due to an expanding demand for medical treatment in developing nations as well as aging trends in developed nations. Fig. 1 shows a forecast for the medical equipment global market. Market scale was some $194.9 billion in 2007, and this was forecasted to grow to about $434.4 billion by 2017 [1].

According to a survey by Rohaya et al., developing nations stand to gain an extremely large latent benefit from the introduction of medical equipment, particularly of diagnostic imaging equipment, and there will be an increase in demand for this equipment in Southeast Asia and Eastern Europe [3]. Some of the triggers behind the introduction of diagnostic imaging equipment in developing nations–aside from PACS (picture archiving and communication systems) promotion, government support, and the expansion of healthcare consumerism and medical tourism–are increases in population and life expectancy, aging, and inadequate medical infrastructure and services.

These can be thought of as not just factors behind growth in the medical device markets in developing nations but also in developed countries. Particularly in terms of preparing medical infrastructure and responding to medical tourism, increases in demand are forecasted for large-size medical equipment in the diagnostic imaging fields of CT (computed tomography) and MRI (magnetic resonance imaging).

Prior studies have investigated the spread of these large-size medical equipment including CTs and MRIs in nations such as Japan, China, and Iran [4-6]. In addition, according to Raymond et al., while there are international comparisons of the spread and use of these equipment in Asian nations, this study states that there is a gap between the number of CTs and MRIs per million people [7]. Concerning factors behind the introduction of these large machines, Eun-Hwan et al. report that the spread of CTs and MRIs is influenced by the high cost of treatment per person and the piecework method of repayment to hospitals [8]. In an analysis of the factors behind the spread of MRIs in South Korea, Myung-Il et al. report that the average taxable income, number of physicians per person, and share of the population aged 65 or over in an area have positive effects on the popularization of MRI, while the number of existing MRIs in the region has a negative effect [9]. Medical expenses per person and payment methods differ among countries. Tuvia et al. analyze the differences in medical resources such as the number of doctors and hospital beds in the United States from geographical trends, but at present no study has been conducted concerning such matters as the differences in introduction of large-scale MRI equipment and CTs by country or nations with a high probability of introducing such machines, nor have there been studies attempting to visualize such data [10].

Looking at the current market size for medical equipment on a global basis, about 80% of the market is occupied by developed nations, but there are expectations for market growth in developing nations. Such expansion is important for further development of the medical device field as well as improvement of the global medical level.

Based on this, it is possible that the medical equipment industry, which will grow and develop further in the future, will be well-received overseas. This study investigated and analyzed the relationship between medical resources and economic conditions of OECD member countries and extracted factors for introducing imaging diagnostic equipment in each country. We also investigated the possibility for introducing image diagnostic equipment and tried to visualize the results.

2. Methodology

2.1 Target Nations

Among the publicly available medical device market data of the world, the largest database is the OECD database. Therefore, we used the OECD database in this study. Target nations were the 29 nations for which data was obtained among the 34 OECD member countries. Below is a list of target nations in descending order by 2016 medical device market projection [11]. In the past investigation–since the report is made by comparison after 5 years–we used the 2011 data in this research as well.

2.2 Research Indices

Research indices were categorized into medical environment and economic situation indices as shown below [12–13].

2.3 Analytical Methodology

A principal component analysis was conducted from medical environment indices and economic situation indices; the results were visualized on a graph with the extracted two principal components as axes. The target nations were categorized by the possibility of introducing diagnostic imaging equipment. Next, with the number of CTs and MRIs as response variables, we visualized the probability results on a graph by conducting a multiple regression analysis with other medical environment indices and economic situation indices as explanatory variables, along with extracting the most influential factors on the number of diagnostic imaging equipment introduced. In this research, we used the statistical software JMP Pro (version 12.2.0) for the statistical analysis.

3. Results

3.1 Principal Component Analysis Results

Principal component analysis results are shown in Table 3.

All primary principal component coefficients from Table 3 are positive and greatly influence the medical environment indices of MRI and CT counts and all economic situation indices. This primary principal component was therefore defined as “maturity of economic situation and medical environment.” For secondary principal components, economic situation index coefficients were negative, and those for the medical environment market were positive. From these results, we defined secondary principal components as “medical device market growth potential” so that the higher the number of MRIs, CTs, and hospital beds in a country, the lower future market growth could be interpreted. From Fig. 2, we can interpret that the higher we go along the vertical axis, the higher the possibility of growth in the medical equipment market, and the lower we go along the axis, the lower the possibility. As for the horizontal axis, we can interpret that the maturity of the economic situation and medical environment increases as one moves to the right and decreases as one moves to the opposite direction.

Based on the principal component analysis, Table 4 shows the results classified into four groups. In addition, Table 5 shows a comparison of the average values of groups in each item.

Comparing the B Group (high economic situation and medical environment maturity and low potential for medical device market growth) with the A Group (high level of economic situation and medical environment maturity as well as growth potential for the medical device market), while the medical environment is substantial with a high unit count of MRIs and CTs, GDP and medical device market forecasts are lower for Group B than for Group A. This point is thought to be a factor behind the low medical device market growth potential.

Compared to the A Group, the C Group (low economic situation and medical environment maturity and high potential for medical device market growth) is inferior in all economic situations and medical environment indices. This is the same even compared to the B Group.

Compared to the D Group, the A Group (both economic situation and medical environment maturity as well as potential for medical device market growth are high) is superior in terms of the number of physicians and hospital beds, but all other items are lower. Compared to the B Group, the D Group is inferior in all items. Compared to the C Group, the D Group is superior in all medical environment indices but lower in all economic situation indices.

While the C Group is classified as having high medical device market growth potential, to determine the reason behind this, we will consider the difference between the B Group and C

Group. Results of the principal component analysis show that the B Group has high economic situation and medical environment maturity and low medical device market growth potential while the C Group has low economic situation and medical environment maturity and high medical device market growth potential. Comparing only the average values for each item, however, the C Group is lower than the B Group in every item.

3.2 Multiple Regression Analysis Results

The results of a multiple regression analysis with CT and MRI unit counts as response variables and other medical environment indices and economic situation indices as dependent variables are shown below.

The results of the multiple regression analysis clarified that the most influential factor behind CT and MRI unit counts is the number of hospital beds. Since increasing the number of beds will raise the CT and MRI unit count, from these results, it is thought that the lower the number of hospital beds in a country and the more they are forecasted to increase in the future, the higher the possibility of introducing this equipment. Table 7 shows in ascending order the countries with few hospital beds in Groups A and C, which the principal component analysis forecasts as having a high possibility of introducing these machines.

4. Discussion

4.1 Principal Component Analysis Results

Fig. 3 below shows the trends of GDP growth rates [13]. Comparing GDP growth rates over the past three years, A, C, and D Groups have rates over 2% while B Group falls below 2%. Due to these analyses, since B Group is classified as having high economic situation and medical environment maturity and low medical device market growth potential in the principal component analysis results compared to the other groups, it is thought that economic growth has slowed.

The above results forecast that the countries with a high probability of introducing medical equipment are the A and C Groups.

4.2 Multiple Regression Analysis

Eun-Hwan et al. report that medical expenses per population and flexible payment methods are affecting the spread of CT and MRI. However, this report did not incorporate the number of beds as a variable of multiple regression analysis. Therefore, we think that the results differed from this research. Lazaro et al. report that healthcare expenditure is involved in the spread of CT, MRI, and radiotherapy devices. However, this study did not incorporate the bed number as a variable [14]. From these results, this study suggested that in countries with a high possibility of introducing CT and MRI in OECD countries, bed number–rather than medical expenses–may have influence.

Fig. 4 shows trends from 2009 to 2013 in the number of hospital beds in the top six countries in Table 7. While we can see that England, Ireland, and Canada show downward trends, Chile and Mexico have stayed put, and Turkey is on the rise.

Now we will look at the United States, which has the largest medical equipment market. There are relatively low numbers of hospital beds and physicians per person in this country (23rd place for the number of hospital beds and 22nd for the number of physicians out of 29 countries). In addition, while the number of beds has been on a downward trend in recent years as shown in Fig. 5, GDP and medical device market forecasts are far above other countries, and the future possibility for introducing medical equipment is sufficiently high.

Based on the results and observations of the multiple regression analysis, there is a high possibility for introduction of these machines in the United States, which has the highest growth potential for the medical device market; Mexico and Chile, where the market will expand because the number of hospital beds per person is low; and Turkey, where the number of beds is low but has increased in recent years and the introduction of CTs and MRIs will make progress in the near future. Fig. 6 shows the above results. The vertical axis shows the economic situation and medical environment maturity, and the horizontal axis shows the number of hospital beds per person. The size of the bubble chart represents the growth potential of the medical equipment market, and the possibility of introduction increases moving toward the lower left of the figure.

4.3 Issues in this Study

The below five points and issues should be considered in this study.

(1) Investigation of Non-OECD Countries

This study focused its analysis on OECD countries due to the circumstances of data collection. Considering economic growth, however, reporting on the possibility of introducing medical

equipment in China, ASEAN nations, Middle Eastern nations, and African nations would provide useful information as indicators to prepare medical infrastructure in these countries.

In 2013, the medical device market in China stood at US$16 billion, the fourth largest after the United States, Japan, and Germany. It will become the second largest in the world by 2019 at US$38 billion [15]. Medical system reform is underway in China, and the Chinese are proceeding with preparing systems for medical equipment. One should also pay attention to moves to produce medical equipment domestically, as about 70% of this market in China consists of foreign-branded products. To strengthen the competitiveness of its medical equipment industry, China is therefore promoting development of local diagnostic imaging equipment and other industries, which will increase the rate of introduction of medical equipment within China as well as the amount of exports to other countries. The global expansion of the medical device market will therefore continue. As a future study topic, it will be necessary to collect and analyze data from these countries.

(2) The Medical System in each Country

From the results of the principal component analysis and multiple regression analysis, investigation and analysis of regulations on introducing medical equipment was conducted on only the four nations where the probability of such is high. However, more detailed analysis is needed based on consideration of the examination process up to the introduction of pharmaceutical affairs laws and medical equipment.

(3) Researching the Spread of Medical Tourism

When introducing large-scale equipment such as CTs and MRIs, it is necessary to research the global spread of medical tourism. This is a growing industry, and Asia, America, Africa, and Eastern Europe offer medical services to one million medical tourists each year [16]. Of these nations, medical tourism is actively conducted in India, Singapore, Malaysia, Mexico, China, Brazil, Turkey, South Korea, Thailand, Taiwan, and other countries, with a particularly rapid increase in India [17]. In addition, there are reports that the spread of this kind of tourism in Egypt is activating the MRI market [15]. Interviews by Tilman et al. of 49,980 patients reported that 40% of these medical tourists considered having the world's most advanced technologies as a factor in medical consultation [18]. Since the medical tourism market is rapidly growing worldwide, updates to introduce the latest medical equipment or medical institutions participating in medical tourism introducing new equipment are easy to forecast. Since the future spread of medical tourism will be significantly influenced by the introduction of the newest CT and MRI equipment, it is necessary to research the current status of medical tourism worldwide. In order to describe the relevance between this research result and medical tourism, it is necessary to adopt the

number of medical tourists in each country as independent variables and the profit obtained by medical tourism for analysis. Therefore, we think that it is necessary to investigate such contents.

4.4 Limitation

We think that it may not be possible to fully describe the factors affecting the introduction of expensive diagnostic imaging equipment with only the variables used in this study, as we understand that other factors such as economics, politics, medical system, medical technology, etc. are complicated. It is very difficult to explain to what degree the complexity affects the spread of expensive medical equipment such as CT and MRI. We think it is necessary to investigate not only the published OECD data but also more detailed data.

5 Conclusion

This study investigated the economic environment and economic situations of OECD member nations to survey and analyze the possibility for introducing diagnostic imaging equipment. As a result of conducting a principal component analysis on 29 countries, it was possible to classify those nations into four main groups by medical environment and economic situation indices. Further, as a result of extracting a group with a high possibility of introducing medical equipment from the four groups and conducting a multiple regression analysis with CT and MRI unit counts as objective variables and other medical environment and economic situation indices as explanatory variables, it became clear that the factor with the greatest influence on CT and MRI unit counts is the number of hospital beds. Based on the results of the principal component analysis and multiple regression analysis, consideration of the order of highest probability of introducing medical equipment suggests that such probability is high in the United States, Mexico, Chile, and Turkey. As topics of future studies, we would like to clarify the factors behind as well as the probability of the introduction of medical equipment in each nation by researching non-OECD member nations, which have high growth medical device markets, and analyzing the possibility for introducing medical equipment based on research of the spread of medical tourism.

We think that the results of this research can be utilized for further development of the medical device industry and improvement of medical standards worldwide. In this study, we anticipated that the numbers of CTs and MRIs will increase due to an increase in the number of hospital beds. However, in some countries shown in this research, there is a possibility that the numbers of CTs and MRIs are not sufficiently developed. We think that it means potential demand. These results comprise the basic data for further dissemination of diagnostic imaging equipment for many countries and enterprises.

List of abbreviations

CT: Computed Tomography

MRI: Magnetic Resonance Imaging

PACS: Picture Archiving and Communication System

OECD: Organization for Economic Co-operation and Development

GDP: Gross Domestic Product

Figure legends

Fig.1 Prospects for the medical device world market

Forecast for the medical equipment global market. Market scale was some $194.9 billion in 2007, and this is forecast to grow to about $434.4 billion in 2017.

Fig.2 Principal Component Analysis Results

Maturity of Economic Situation and Medical Environment increases as one moves to the right and decreases the more one moves to the opposite direction.

Fig.3 Changes in the GDP growth rate of each group

Comparing GDP growth rates, over the past three years, A, C and D Groups have rates over 2% while B Group falls below 2%.

Fig.4 Changes in the number of beds(top 6 countries, 2009～2013)

Trends from 2009 to 2013 in the number of hospital beds in the top six countries

Fig.5 Changes in the beds per capita in the United States

The number of beds has been on a downward trend in recent years

Fig.6 Potential for growth in CT and MRI market

This figure shows the analysis resultThe vertical axis shows economic situation and medical environment maturity and the horizontal axis shows the number of hospital beds per person. The size of the bubble chart represents the growth potential of the medical equipment market, and the possibility of introduction increases moving toward the lower left of the figure.

Declarations

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Availability of data and materials
Additional data may be obtained by contacting the corresponding author, Dr. Katsuhiko Ogasawara.

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Competing interests
The authors declare that they have no competing interests.

Ethics approval and consent to participate
Not applicable

Author's contributions
Suzuki and Isomi managed the data, conducted statistical analysis, and drafted the manuscript. Suzuki interpreted all findings and drafted the manuscript. Tsuji, Tani, Tanikawa and Yamasina contributed to the study design and critically reviewed the manuscript. Ogasawara supervised the study design and the manuscript. All authors approved the final manuscript and agreed to be accountable for all aspects of the work.

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Reference

[1] Ministry of Economy, Trade and Industry in Japan
http://www.med-device.jp/pdf/state/event/20140303/1_meti.pdf.
(accessed: October 11,2016)
[2] Ministry of Health in Japan, Labor and Welfare
http://www.mhlw.go.jp/topics/yakuji/2013/nenpo/
(accessed: October 11,2016)
[3] Rohaya MONHD-NOR, Medical Imaging Trends and Implementation: Issues and Challenges for Developing Countries, Journal of Health Informatics in Developing Countries; 2010.
[4] Daisuke Shinjo, Toshiharu Aramaki, Geographic distribution of healthcare resources, healthcare service provision, and patient flow in Japan: A cross sectional study, Social Science & Medicine.Vol75;2012
[5] Da He, Hao Yu and Yingyao Chen, Equity in the distribution of CT and MRI in China: a panel analysis, International Journal for Equity in Health; 2013: p12-39.
[6] Mohammad Palesh, Sten Fredrikson, Hamidreza Jamshidi, Pia Maria Jonson, Goran Tomson, Diffusion of magnetic resonance imaging in Iran, International Journal of Technology Assessment in Health Care,23-2, 2007: p278-285.
[7] Raymond C. W. Hutubessy, Piya Hanvoravongchai, Tessa Tan-Torres Edejer, Diffusion and utilization of magnetic resonance imaging in Asia, International Journal of Technology Assessment in Health Care, 18-3, 2002: p690-704.
[8] Eun-Hwan Oh, Yuichi Imanaka, Edward Evans, Determinants of the diffusion of computed tomography and magnetic resonance imaging, International Journal of Technology Assessment in Health Care, 21:1 ,2005; p73-80.
[9] Myung-ll Hahmm Eun-Cheol Park, Sun-Hee Lee et al. Pattern and factors leading to the diffusion of magnetic resonance imaging in Korean, International Journal of Technology Assessment in Health Care, 23:2, 2007; p292-298.
[10] Tuvia Horev, Irena Pesis-Katz, Dana B. Mukamel, Trends in geographic disparities in allocation of health care resources in the US. Health Policy 2004;68: p.223-32.
[11] Masahiro Sakurauchi , Sekai no Iryoukiki Shijyou (Medical Equipment Market of the world), Tokyo: JETRO.2013.
[12] OECD Health Statics 2015. http://www.oecd.org/els/health-systems/health-data.htm.
(accessed: October 11,2016)
[13] OECD DATA web page. https://data.oecd.org/gdp/gross-domestic-product-gdp.htm.
(accessed: October 11,2016)
[14] Lazaro, Pablo, and Kathryn Fitch. "The distribution of “big ticket” medical technologies in

OECD countries." International Journal of Technology Assessment in Health Care 11.3 (1995): 552-570.
[15] Mizuho Bank. Mizuho Sangyou Chousa 2015 No.1. – 2015 Nendo no Nihon Sangyou Doukou(Mizuho Industrial Research – Industrial Trend of Japan in 2015). http://www.mizuhobank.co.jp/corporate/bizinfo/industry/sangyou/pdf/1049_12.pdf.
(accessed: October 11,2016)
[16] Medical tourism market report 2915 edition. http://globenewswire.com/news-release/2015/10/21/778186/10153404/en/Medical-Tourism-Market-Report-2015-Edition-Latest-Industry-Shares-Size-Trends-Growth-Survey-Insights-Outlook-ResearchMoz.html.
(accessed: October 11,2016)
[17] World medical tourism market-opportunities and forecasts,2014-2020 https://www.alliedmarketresearch.com/medical-tourism-market.
(accessed: October 11,2016)
[18] The Mckinsey Quarterly: mapping the market for medical travel. http://www.heal-wheel-india.com/white-pappers/McKinsey-Report-Medical-Travel.pdf
(accessed: December 27, 2016)

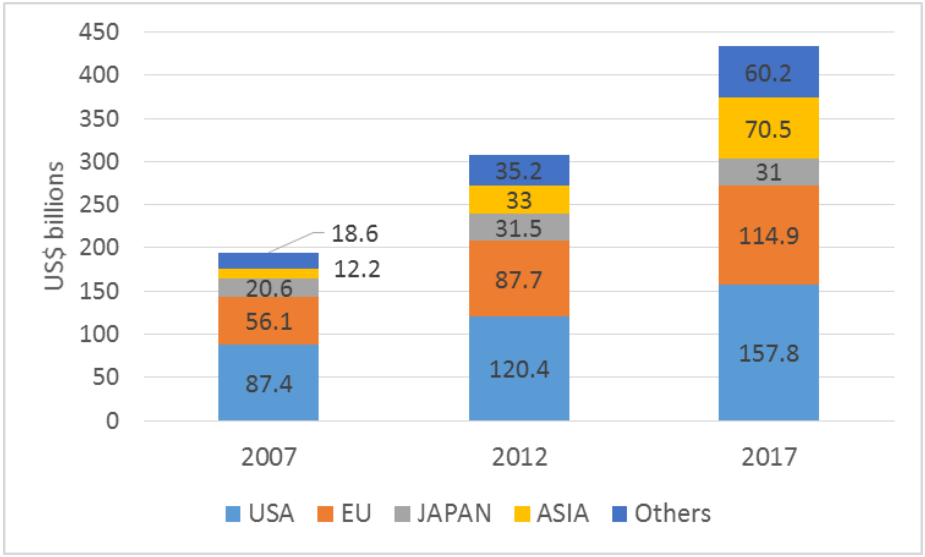


Fig.1 Prospects for the medical device world market

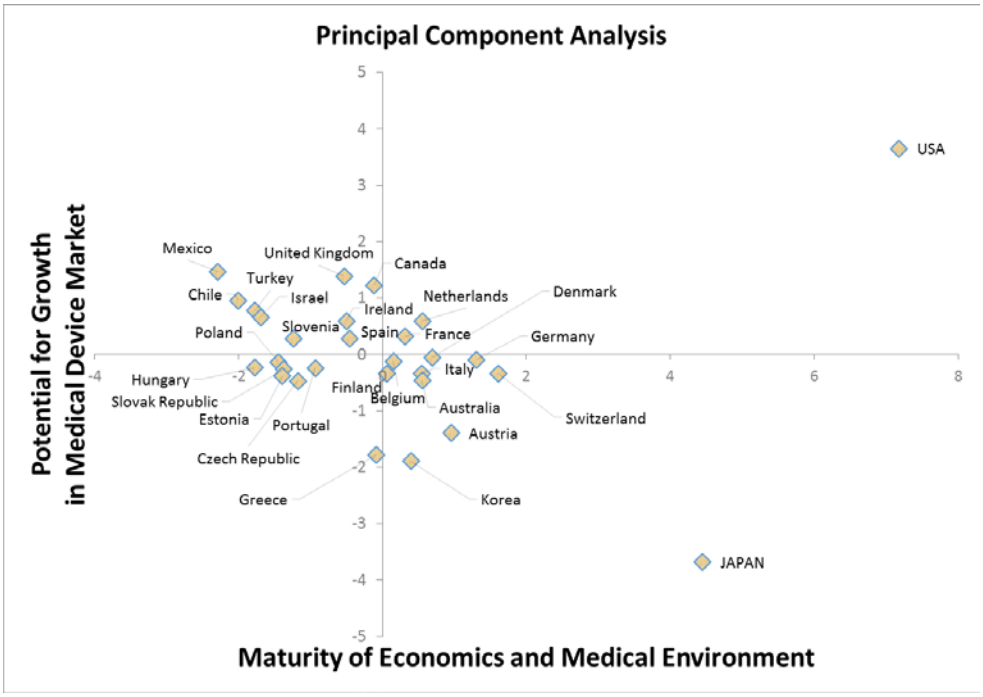


Fig.2 Principal Component Analysis Results

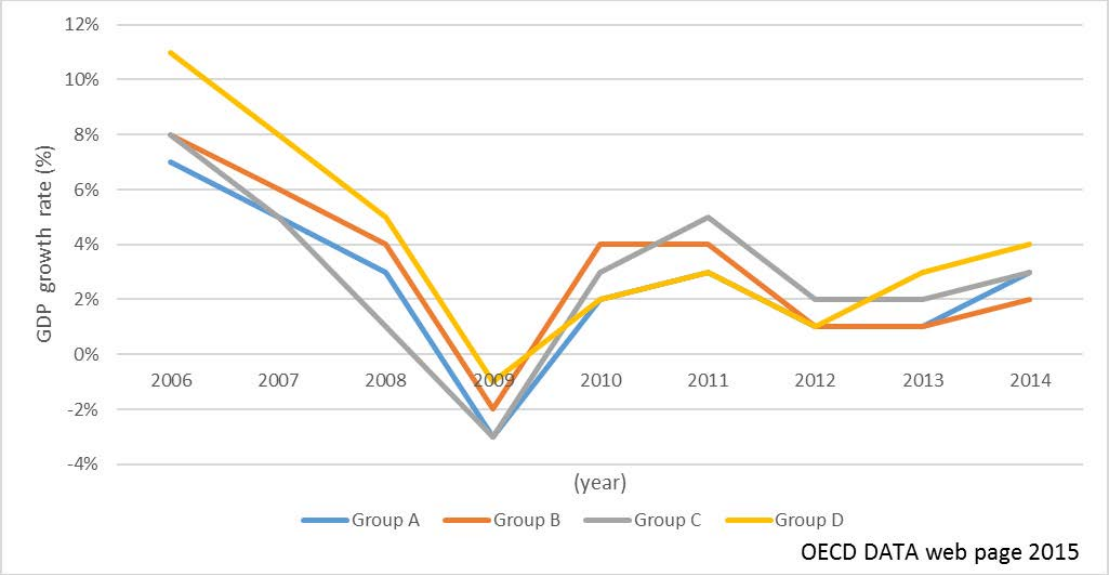


Fig.3 Changes in the GDP growth rate of each group

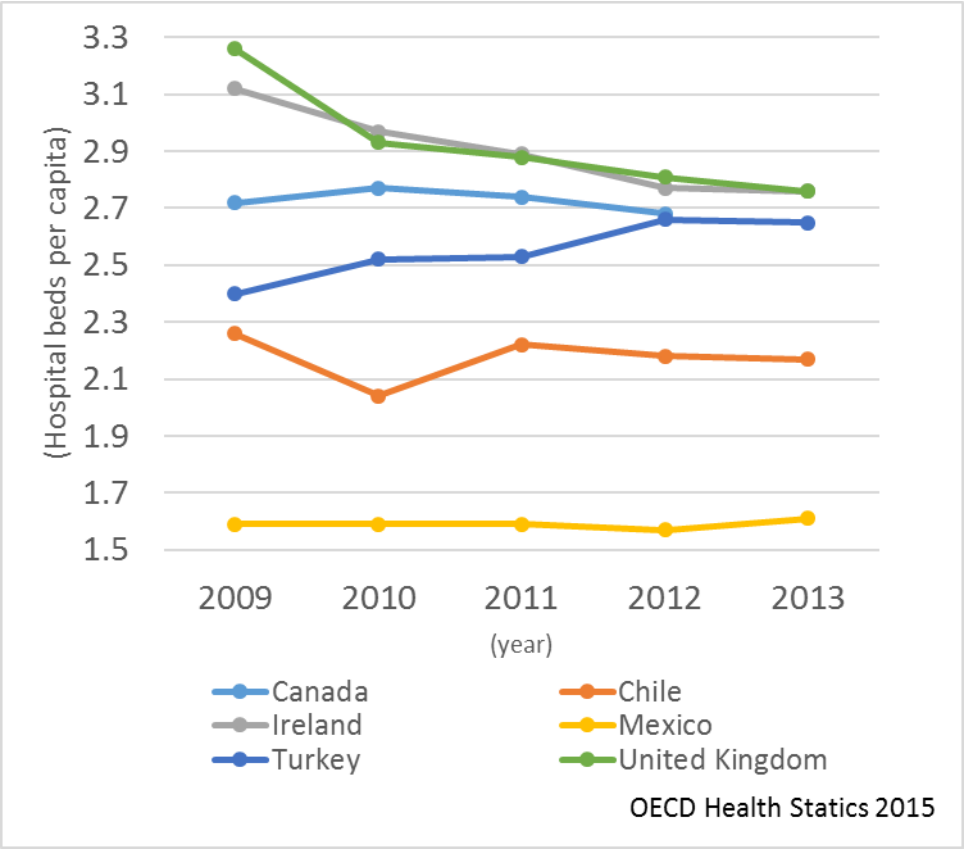


Fig.4 Changes in the number of beds(top 6 countries, 2009～2013)

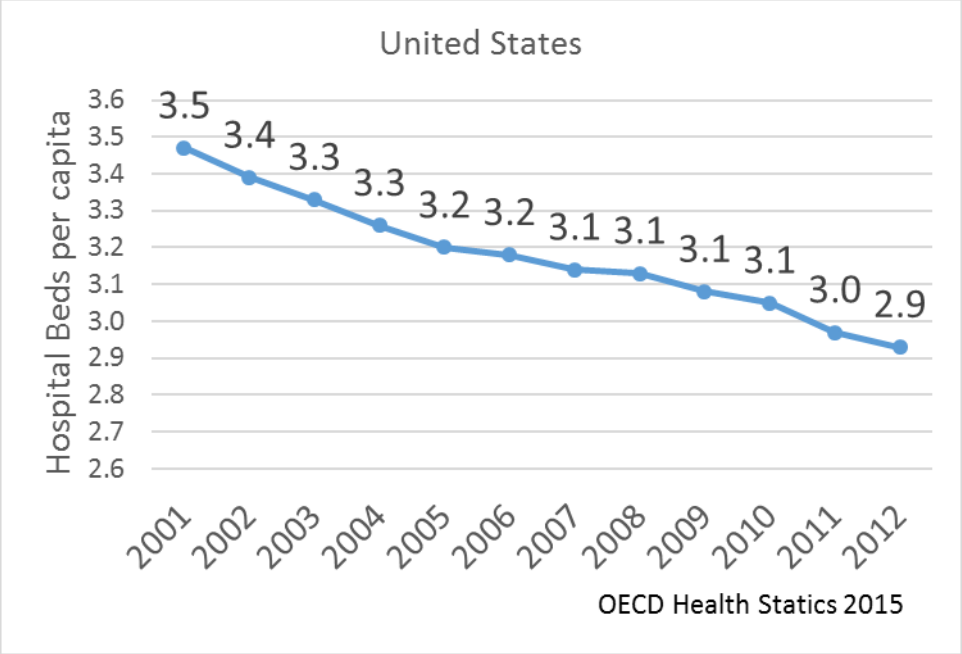


Fig.5 Changes in the beds per capita in the United States

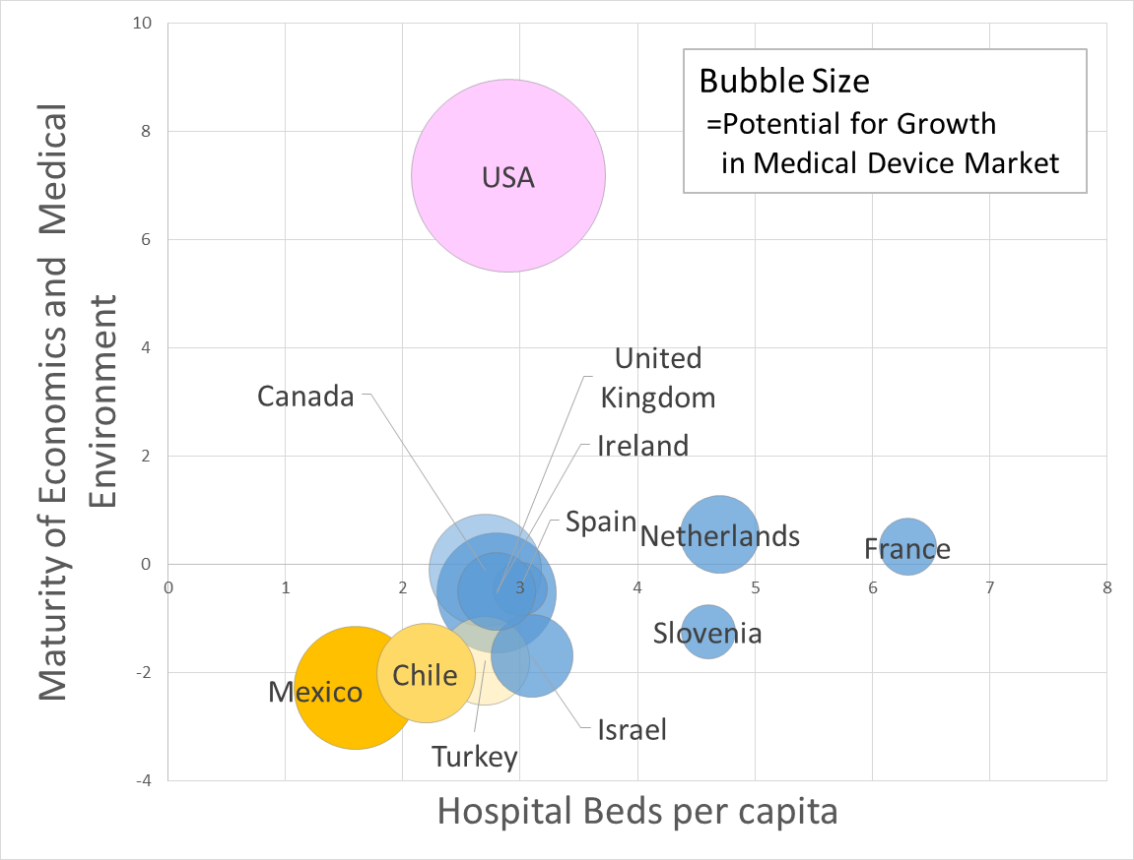


Fig.6 Potential for growth in CT and MRI market

Table 1 Scale of the medical equipment market

OECD member Countries	Global market for medical equipment			GDP (USb$)
	2011 (USm$)	2016 (USm$)	Average growth rate (2011-2016)	
United States	105761.5	133961.5	4.8%	16,663,160
Japan	32256.7	33505.1	0.8%	4,612,630
Germany	19547.1	22900.8	3.2%	3,553,607
United Kingdom	9163.5	10827.1	3.4%	2,483,660
France	8838.7	10178.4	2.9%	2,478,250
Italy	8221.7	8987.9	1.8%	2,109,334
Korea	4878.7	7863.3	10.0%	1,661,723
Canada	6453.1	7616.7	4.4%	1,512,972
Australia	2476.4	6125	13.1%	1,040,376
Switzerland	4661.7	5109.9	1.9%	460,259
Spain	4520.4	4961.7	1.9%	1,516,434
Mexico	3489.2	4321	4.4%	1,999,821
Poland	1999.1	3001.1	8.5%	909,269
Austria	2476.4	2899.4	3.2%	382,599
Turkey	1959.9	2798.7	7.4%	1,409,344
Netherlands	2316.4	2618.7	2.5%	785,388
Denmark	1736.3	1945.7	2.3%	245,834
Belgium	1529.8	1801.5	3.3%	461,908
Czech Republic	1454.3	1797.9	4.3%	304,418
Hungary	823.8	1107.3	6.1%	232,559
Finland	959.7	1102.7	2.8%	217,651
Israel	912.6	1096.8	3.7%	263,535
Portugal	887	983	2.1%	289,157
Greece	962.8	918.7	-0.9%	279,862
Slovak Republic	497	781.8	9.5%	143,908
Chile	495.4	651.3	5.6%	386,099
Ireland	618.6	575.8	-1.4%	215,632
Slovenia	328.6	410.1	4.5%	59,058
Estonia	117.6	138.7	3.4%	34,537

Table 2 Research indices

Medical environment indices	(1) number of physicians (per 1,000 people) (2) number of MRIs (per 1 million people) (3) number of CTs (per 1 million people) (4) number of hospital beds (per 1 million people)
Economic situation indices	(1) GDP (million USD) (2) medical outlays per person compared to GDP (USD) (3) medical expenses (borne by government) (USD) (4) medical device market projections (million USD)

Table 3 Principal component analysis coefficients

	Research indices	1st main component	2nd main component
Medical environment indices	The number of doctors (per thousand people)	0.03198	-0.26163
	Number of MRI (per million people)	0.42346	-0.31344
	Number of CT (per million people)	0.35874	-0.44558
	Number of beds (per million people)	0.16040	-0.59565
Economic situation indices	GDP（a million US$）	0.41027	0.34994
	Medical expenses per person	0.42937	0.20948
	Medical expenses per person (governments)	0.36537	0.06240
	Medical equipment market prospects（a million US$）	0.42316	0.33125

Table 4 The results of grouping by principal component analysis

Group	Maturity of Economics and Medical Environment	Potential for Growth in Medical Device Market	Country
Group A	High	High	United States, Netherlands, France
Group B	High	Low	Belgium, Denmark, Italy, Germany, Finland, Austria, Korea, Japan, Australia, Switzerland
Group C	Low	High	Mexico, United Kingdom, Canada, Chile, Turkey, Israel, Ireland, Slovenia, Spain
Group D	Low	Low	Hungary, Estonia, Czech Republic, Poland, Slovak Republic, Portugal, Greece

Table 5 Comparison of the average values of groups

Research indices		Group A (Average)	Group B (Average)	Group C (Average)	Group D (Average)
Medical environment indices	The number of doctors	3.1	3.4	2.6	3.8
	Number of MRI	18.8	20.9	8.3	9.8
	Number of CT	23.2	39.3	12.3	19.6
	Number of beds	4.6	6.7	2.8	5.6
Economic situation indices	GDP	6,642,266	1,474,592	1,094,062	313,387
	Medical expenses per person	5,989	4,088	2,520	1,960
	Medical expenses per person (governments)	3,980	3,042	1,745	1,403
	Medical equipment market prospects	48,920	9,224	3,696	1,247
1st main component	Maturity of Economics and Medical Environment	High	High	Low	Low
2nd main component	Potential for Growth in Medical Device Market	High	Low	High	Low

Table 6 The results of a multiple regression analysis with CT and MRI

	Number of CT		Number of MRI	
	Adjusted R^2 =0.28		Adjusted R^2 =0.55	
Variable	Coefficients	p-Value	Coefficients	p-Value
The number of doctors	1.043	0.772	46.473	0.38
Number of beds	3.426	0.014	406.578	0.015
GDP	-4.55E-06	0.593	5.7E-02	0.975
Medical expenses per person	-2.0.E-03	0.804	0.002	0.996
Medical expenses per person (governments)	5.0.E-03	0.68	2.362	0.842
Medical equipment market prospects	9.0.E-04	0.472	9.106	0.695

Table 7 Ranking of countries with fewer beds per capita

	Country	Number of beds per person	Group
1	Mexico	1.6	C
2	Chile	2.2	C
3	Canada	2.7	C
4	Turkey	2.7	C
5	The United Kingdom	2.8	C
6	Ireland	2.8	C
7	The United States	2.9	A
8	Spain	3	C
9	Israel	3.1	C
10	Slovenia	4.6	C
11	Netherlands	4.7	A
12	France	6.3	A