hpm 보건행정학회지 2017;27(4):359–365 | ISSN 1225-4266
Health Policy and Management Vol.27 No.4, 359-365
https://doi.org/10.4332/KJHPA.2017.27.4.359

ORIGINAL ARTICLE

Computed Tomography Spending and Utilization for Inpatients with Cerebral Infarction in South Korea

Su Kyung Choi[1,2,*], Kyu-Tae Han[3,4,*], Sun Jung Kim[5], Tae Yong Sohn[6], Byungyool Jeon[7], Eun-Cheol Park[7]

[1]Department of Health Policy and Management, Yonsei University Graduate School of Public Health; [2]Review and Assessment Department, Daegu Branch, Health Insurance Review and Assessment; [3]Department of Public Health, Yonsei University Graduate School; [4]Institute of Health Services Research, Yonsei University College of Medicine, Seoul; [5]Department of Health Administration, Namseoul University, Cheonan; [6]Department of Health Services Administration, Yuhan University, Bucheon; [7]Department of Preventive Medicine, Yonsei University College of Medicine, Seoul, Korea

Background: Computed tomography (CT) is one of the most efficient diagnostic methods for stroke patients. The number of CT scanners in South Korea, however, is higher than in other countries, and may cause the overuse of this tool in healthcare. We aim to study the relationship between using CT and various patient and hospital characteristics among patients with cerebral infarction.
Methods: We analyzed nationwide health insurance claims data for patients due to cerebral infarction during the second half of 2013 for up to 3 months. We performed multilevel analysis, including both inpatient and hospital-level variables, to determine how factors affect CT spending and utilization.
Results: The data used in our study consisted of 17,046 hospitalizations at 583 hospitals. Inpatients who visited more than one hospital had higher CT utilization numbers and cost (number: ≥ 3 hospitals: β, 2.27; $p < 0.05$; 2 hospitals: β, 0.70; $p < 0.05$; cost: ≥ 3 hospitals: β, 251,108; $p < 0.05$; 2 hospitals: β, 77,299; $p < 0.05$). People who visited a general hospital had higher numbers and cost of CT utilization than people who visited a smaller hospital.
Conclusion: Increased sharing of records and improved continuity of care between hospitals are needed to help curb the overuse of CT.

Keywords: Computed tomography; Cerebral infarction; Health expenditures; Continuity of patient care

INTRODUCTION

Stroke is the major cause of death worldwide and causes a serious burden on both the patients and society [1]. Health care professionals have studied the prevention, management, and treatment for stroke to efficiently manage the care of stroke patients. As a result of such efforts, some alternatives for managing stroke have been developed. Among them, early detection is considered a major alternative for managing stroke patients. Diagnoses of stroke are made via radiological techniques, such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography [2]. CT can quickly provide essential information for a diagnosis of stroke; therefore, diagnostic methods using CT have been commonly used in many healthcare disciplines [3].

For that reason, in January 1996, the South Korean government included the use of CT in coverage of National Health Insurance Service (NHIS). Thus, many hospitals in South Korea rapidly introduced CT for efficient diagnoses and to increase profits [4]. By the results of such changes, new problems were emerged such as overuse of CT. In the Organization for Economic Cooperation and Development (OECD) report, the number of CT scanners in South Korea is higher than in other OECD countries (South Ko-

Correspondence to: Eun-Cheol Park
Department of Preventive Medicine, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
Tel: +82-2-2228-1862, Fax: +82-2-392-7734, E-mail: ecpark@yuhs.ac
*These authors contributed equally to this work.
Received: September 12, 2017 / **Revised:** November 13, 2017 / **Accepted after revision:** November 13, 2017

rea: 37.7 per million people, average for other OECD countries: 23.9 per million people) [5]. Of course, the introduction of many superior medical devices potentially improves the quality of care and patient satisfaction. On the other hand, increasing the supply of CT scanners may also increase the number of unintended outcome [6,7]. In the healthcare market, there are many inequities between providers and consumers, which could result in unintended outcome due to the overuse of CT. Many previous studies about health care expenditures have been performed in the past, but few studies related to the utilization of CT have been conducted in South Korea. Therefore, it is worth investigating how factors affect CT utilization in hospitals. We aim to study the relationship between CT utilization for cerebral infarction among stroke patients as reflected by patient and hospital characteristics.

METHODS

1. Study population

The data used in our study were NHIS claim data for 2013. Among these data, we only included in our study inpatients who had not used CT or MRI during the first half of 2013, and who first visited a hospital for CT or MRI due to a cerebral infarction (international classification of diseases, 10th revision: I63) between June 2013 and October 2013. To conduct a follow-up study for more than 3 months, inpatients who first visited the hospital after October 2013 were excluded. These data consisted of 21,190 hospitalizations at 877 hospitals. To analyze CT utilization, we excluded duplicate cases and hospitals that had fewer than 10 CT cases. The data used in the final analysis consisted of 17,046 hospitalizations at 583 hospitals.

2. Variables

The outcome variables in our study were number/cost of CT use for each inpatient due to cerebral infarction. The cost of CT utilization was included in the total cost associated with CT scanning. Number or cost of CT utilization was calculated as the sum of values per each hospitalization event for 3 months from the first hospitalization using the following equations:

Number of CT use = Σ number of scans per stroke inpatient for 3 months

Cost of CT use = Σ cost of scan per stroke inpatient for 3 months

To analyze the factors related to CT utilization, we adjusted for both inpatient- and hospital-level variables. Inpatient-level variables consisted of sex, age, type of insurance coverage, expanded benefit coverage, type of healthcare, number of visited medical institutions, and types of visited medical institutions. Types of insurance were categorized into Medicaid and national health insurance (NHI) beneficiaries. Medicaid beneficiaries included government-covered healthcare utilization by people who could not maintain their lives. NHI beneficiaries were the remaining inpatients. Expanded benefit coverage was defined as that which reduced the coinsurance rate and was applied to people with diseases that are difficult to treat, such as cancer, cerebrovascular disease, cardiovascular disease, and rare disease, as determined by the government. The number of visited medical institutions was defined as the total number of all hospitals visited by each cerebral infarction patient for a CT or MRI scan within the study period. Types of visited medical institutions were categorized as upscale general hospital, general hospital, and hospital. If a patient visited more than one hospital, the types of visited hospitals were defined as the highest-level institution among the total hospitalization for each patient.

Hospital-level variables included type of ownership, number of beds, number of doctors, number of radiology technologists, number of CT scanners, number of MRI scanners, and the CT depreciation period. The number of beds was based on 300 beds. The number of doctors/radiology technologists was defined as the number per 100 beds in hospitals, based on 10 or 3, respectively. The number of CT and MRI scanners was categorized as one, two, or more than three per hospital. CT depreciation period was defined as the amount of time from the date of purchase and categorized as less than 5 years, 6–10 years, 11–15 years, and more than 16 years.

3. Statistical analysis

We first examined the general characteristics of both inpatient- and hospital-level variables by analyzing the distributions and averages of each variable. Next, we performed an analysis of variance to examine the differences in the number/cost of CT use by each independent variable. Also, a multilevel model considering both inpatient- and hospital-level variables was analyzed to investigate the relationship between the number and cost of CT use. Finally, we performed a subgroup analysis in accordance with the number and type of visited medical institution. All analyses were performed using SAS software ver. 9.2 (SAS Institute Inc., Cary, NC,

USA). A *p*-value less than 0.05 was considered statistically significant. Statistically significant results were indicated by bold type in tables or using asterisks in Figures.

RESULTS

Tables 1, 2 show the distribution or average value for each independent variable. The data used in our study consisted of 17,046 hospitalizations at 583 hospitals. Table 1 presents the distribution of inpatient-level variables. Males (55.3%) were more numerous than females (44.7%) in our dataset. NHI beneficiaries (90.0%) were more numerous than Medicaid beneficiaries (10.0%). The number of inpatients that used expanded benefit coverage (6.7%) was fewer than inpatients who did not (93.3%). The number and type of visited medical institution were greater than one at a primarily general hospital. The average number of CT uses was 1.4, and the average cost was 174,545 Korean won (KRW) (average foreign exchange rate in 2013: 1 US dollar = 1,095.04 KRW). Table 2 shows the distribution of hospital-level variables. In our dataset, a smaller hospital was more frequent than other types of medical institutions (upscale general hospital, 7.4%; general hospital, 45.3%; hospital, 47.3%). Private hospitals (88.3%) were more numerous than public hospitals (11.7%). The number of CT or MRI scanners was more numerous than one per hospital. The CT depreciation period was less than 10 years in our dataset.

Table 3 presents the difference in the average value for the number or cost of CT use for each variable. In the number of CT uses, inpatients that had expanded benefit coverage used CT more frequently than did inpatients without such coverage. Inpatients who visited the hospital more than three times used CT more frequently than inpatients who visited the hospital fewer than two times. Inpatients who visited an upscale general hospital used CT more frequently than inpatients who visited other types of hospitals. For hospital-level variables, public hospitals were more frequently used than private hospitals, and hospitals with a greater number of

Table 1. General characteristics of the study population

Characteristic	Value
Sex	
Male	9,432 (55.3)
Female	7,614 (44.7)
Age (yr)	
≤ 49	1,248 (7.3)
50–59	2,760 (16.2)
60–69	3,644 (21.4)
70–79	5,938 (34.8)
≥ 80	3,456 (20.3)
Type of insurance coverage	
Medicaid	1,700 (10.0)
National health insurance	15,346 (90.0)
Expanded benefit coverage	
Application	1,140 (6.7)
Nonapplication	15,906 (93.3)
Type of healthcare	
Outpatient + inpatient care	1,817 (10.7)
Inpatient care	15,229 (89.3)
No. of medical institutions visited	
≥ 3	144 (0.8)
2	1,917 (11.2)
1	14,985 (87.9)
Type of medical institution visited	
Upscale general hospital	5,927 (34.8)
General hospital	9,165 (53.8)
Hospital	1,954 (11.5)
Average no. of CT scans	1.4 ± 1.6
Average cost of CT utilization (Korean won)	174,545 ± 207,084
Total	17,046 (100.0)

Values are presented as number (%) or mean ± standard deviation.
CT, computed tomography.

Table 2. General characteristics of hospitals in our dataset

Characteristic	No. (%)
Type of medical institution	
Upscale general hospital	43 (7.4)
General hospital	264 (45.3)
Hospital	276 (47.3)
Type of ownership	
Private	515 (88.3)
Public	68 (11.7)
No. of beds	
> 301	173 (29.7)
< 300	410 (70.3)
No. of doctors (per 100 beds)	
> 10	255 (43.7)
< 9	328 (56.3)
No. of radiology technologist (per 100 beds)	
> 3	334 (57.3)
< 2	249 (42.7)
No. of CT scanners	
≥ 3	78 (13.4)
2	66 (11.3)
1	439 (75.3)
No. of magnetic resonance imaging scanners	
≥ 3	30 (5.1)
2	86 (14.8)
1	344 (59.0)
0	123 (21.1)
CT depreciation period (yr)	
≤ 5	214 (36.7)
6–10	283 (48.5)
11–15	65 (11.1)
≥16	21 (3.6)
Total	583 (100.0)

Values are presented as number (%) or mean ± standard deviation.
CT, computed tomography.

Table 3. The average and standard deviation for CT use by patient- and hospital-level variables

Variable	No. of CT scans	Cost of using CT
Patient-level		
Sex		
Male	1.42±1.64	177,801±209,774
Female	1.42±1.62	170,512±203,645
Age (yr)		
≤49	1.42±1.68	**188,711±223,509**
50–59	1.36±1.72	**169,182±212,450**
60–69	1.39±1.68	**171,866±211,291**
70–79	1.44±1.65	**177,109±209,928**
≥80	1.46±1.47	**172,133±185,930**
Type of insurance coverage		
Medicaid	1.46±1.49	**160,306±177,423**
National health insurance	1.41±1.65	**176,123±210,058**
Expanded benefit coverage		
Application	**3.73±3.22**	**455,170±382,874**
Nonapplication	**1.25±1.31**	**154,433±171,496**
Type of healthcare		
Outpatient + inpatient care	**2.18±2.07**	**269,613±252,600**
Inpatient care	**1.33±1.55**	**163,202±197,951**
No. of medical institution visited		
≥3	**4.01±3.03**	**484,503±344,477**
2	**2.23±2.02**	**276,275±250,447**
1	**1.29±1.50**	**158,553±192,682**
Type of medical institution visited		
Upscale general hospital	**1.68±1.83**	**225,490±238,293**
General hospital	**1.36±1.56**	**158,538±190,313**
Hospital	**0.90±1.08**	**95,098±128,958**
Hospital-level		
Types of ownership		
Private	**1.35±1.56**	**170,881±202,324**
Public	**1.74±1.91**	**191,306±226,875**
No. of beds (beds)		
>301	**1.54±1.73**	**194,152±219,111**
<300	**1.04±1.24**	**115,047±150,432**
No. of doctors (per 100 beds)		
>10	**1.51±1.70**	**189,400±217,167**
<9	**1.03±1.22**	**110,933±139,938**
No. of radiology technologists (per 100 beds)		
>3	**1.48±1.69**	**185,605±214,333**
<2	**1.09±1.29**	**120,775±156,707**
No. of CT scanners		
≥3	**1.65±1.81**	**214,244±233,354**
2	**1.26±1.47**	**152,961±180,251**
1	**1.10±1.29**	**118,162±150,301**
No. of magnetic resonance imaging scanners	**1.61±1.89**	**212,926±236,843**
≥3	**1.58±1.74**	**200,047±224,139**
2	**1.08±1.27**	**120,450±150,998**
1	**1.52±1.15**	**145,080±128,421**
0		
CT depreciation period (yr)	**1.47±1.66**	**178,461±211,389**
≤5	**1.40±1.63**	**175,319±206,340**
6–10	**1.08±1.39**	**103,411±154,004**
11–15	0.97±0.60	94,784±68,429
≥16		
Total	1.42±1.63	174,545±207,084

Values are presented as number (%) or mean±standard deviation. Bold type indicate a statistically significant difference between variables ($p<0.05$).
CT, computed tomography.

Table 4. Results of a multilevel analysis considering both patient- and hospital-level variables

Variable	No. of CT scans	Cost of using CT
Patient-level		
Sex		
Male	-0.03	752
Female	Ref	Ref
Age (yr)		
≤49	**-0.22**	**-16,294**
50–59	**-0.19**	**-22,359**
60–69	**-0.21**	**-25,096**
70–79	**-0.11**	**-9,976**
≥80	Ref	Ref
Type of insurance coverage		
Medicaid	**0.12**	4,308
National health insurance	Ref	Ref
Expanded benefit coverage		
Application	**2.25**	**263,941**
Nonapplication	Ref	Ref
Type of healthcare		
Outpatient + inpatient care	0.08	10,388
Inpatient care	Ref	Ref
No. of medical institution visited		
≥3	**2.27**	**251,108**
2	**0.70**	**77,299**
1	Ref	Ref
Type of medical institution visited		
Upscale general hospital	0.08	8,091
General hospital	**0.23**	**21,526**
Hospital	Ref	Ref
Hospital-level		
Type of ownership		
Private	**-0.18**	**26,997**
Public	Ref	Ref
No. of beds		
>301	0.12	16,212
<300	Ref	Ref
No. of doctors (per 100 beds)		
>10	0.11	9,889
<9	Ref	Ref
No. of radiology technologists (per 100 beds)		
>3	0.01	2,469
<2	Ref	Ref
No. of CT scanners		
≥3	0.21	**43,365**
2	-0.04	7,403
1	Ref	Ref
No. of magnetic resonance imaging scanners		
≥3	**-0.71**	-35,609
2	**-0.63**	**-40,631**
1	**-0.67**	**-53,115**
0	Ref	Ref
CT depreciation period (yr)		
≤5	0.25	32,491
6–10	0.21	24,680
11–15	0.26	21,605
≥16	Ref	Ref
Total		

Values are presented as β. Bold type indicate a statistically significant difference between variables ($p<0.05$).
CT, computed tomography; Ref, reference.

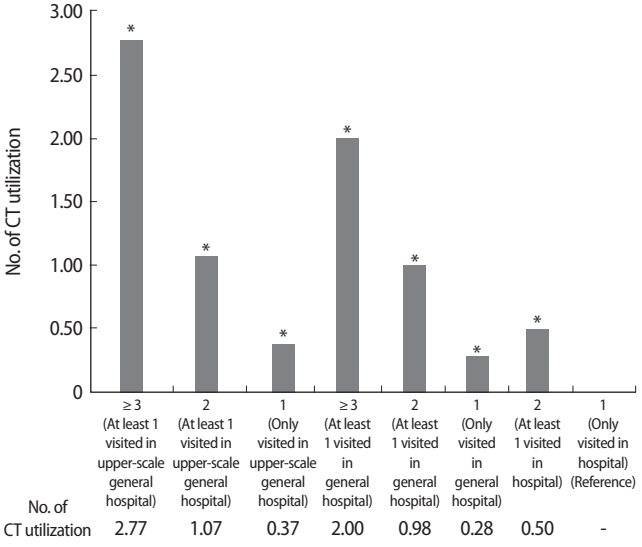

Figure 1. Difference in the number of CT scans by the number and type of medical institutions visited. CT, computed tomography. *Statistically significant difference in the number of CT scans compared to only one time visited hospital.

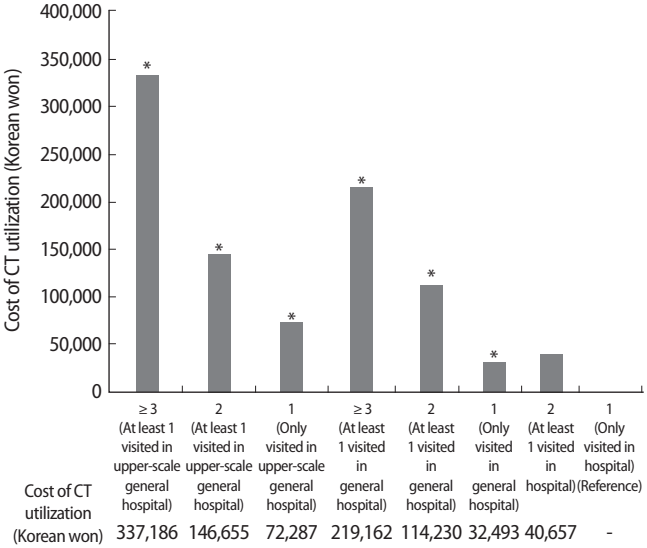

Figure 2. Difference in the cost of CT utilization by the number and type of medical institutions visited. CT, computed tomography. *Statistically significant difference in the cost of CT utilization compared to only one time visited hospital.

beds, doctors, radiology technologists, and CT and MRI scanners utilized CT more frequently than other hospitals. Inpatients who had expanded benefit coverage had greater costs associated with CT use than inpatients who did not have such coverage. Inpatients who visited medical institutions more often had greater costs associated with CT use than inpatients who infrequently visited medical institutions. For hospital-level variables, public hospitals had higher CT utilization costs than private hospitals. The number of beds, doctors, radiology technologists, and CT and MRI scanners had higher costs associated with CT use.

Table 4 shows the results of a multilevel analysis considering both inpatient- and hospital-level variables. Inpatients with Medicaid coverage had higher numbers of CT utilization than NHI beneficiaries (Medicaid: β, 0.12; $p < 0.05$). Inpatients who used expanded benefit coverage had higher numbers and cost for CT utilization (number of CT utilization: β, 2.25; $p < 0.05$; cost of CT utilization: β, 263,941; $p < 0.05$). Inpatients who visited more than one hospital within the study period had higher numbers/cost for CT utilization. People who visited a general hospital had higher numbers and cost for CT utilization than people who visited a smaller hospital.

For hospital-level variables, private hospitals had lower numbers of CT utilization than public hospitals, but a higher cost (number of CT utilization: private: β, -0.18; $p < 0.05$; cost of CT utilization: private: β, 26,997; $p < 0.05$). Additionally, hospitals with more than three CT scanners had a higher cost for CT utilization than hospitals with one scanner. Hospitals with more MRI scanners had lower number and cost for CT utilization than hospitals that did not have an MRI scanner.

We also performed a subgroup analysis by the number and type of the visited medical institution. Figures 1 and 2 show the results of the subgroup analysis. The results of the subgroup analysis showed that both a higher number of and upscale type of visited medical institution had higher numbers of CT use. Similar results were seen with the cost of CT utilization.

DISCUSSION

Through the development of numerous medical techniques and devices aimed to provide better quality of care to patients, people are able to receive improved health care and treatment outcomes for serious diseases. Among the developed tools, CT has substantially contributed to the treatment of serious conditions such as cerebrovascular disease [8]. Since 1996, the South Korean government began to include CT in the NHIS coverage. Afterwards, many hospitals introduced CT to increase profits by attracting patients [6,9-11]. This resulted in an excess supply of CT scanners in South Korea compared to other countries [5]. While this supply helps provide better care, it has caused some unintended outcomes [6], demonstrating the need to review the policy for CT coverage.

An investigation of how factors affect CT utilization is needed prior to reconsideration; therefore, we analyzed the relationship between CT utilization and inpatient- and hospital-level variables.

The results of our study show that inpatients who more frequently visited a greater number of medical institutions or who visited upscale medical institutions had higher CT use. These results may be caused by a disruption in the continuity of care (COC) [12,13]. COC for patients would positively affect healthcare outcomes and prevent excessive health care expenditures [14]. However, the current situation regarding CT utilization in South Korea does not effectively contribute to COC for patients. Patients want better quality of care and improved accessibility of health care, especially for serious diseases. Thus, patients often visit several different hospitals. In such cases, better communication and sharing of medical records between hospitals are needed to prevent unnecessary healthcare expenditures, such as repetitive CT scans. For those reasons, healthcare professionals and hospital managers must consider alternatives for activating such sharing between hospitals to reduce and prevent excessive healthcare expenditures [15,16] for both medical records and COC. Our findings also suggest that inpatients who used Medicaid or expanded benefit coverage had higher CT use. These results may be due to the relatively lower coinsurance rates compared to those for the general population; thus, these patients may have a better access to CT. Additionally, physicians might feel more comfortable utilizing CT when the patients have better insurance. For hospital-level variables, hospitals with more MRI scanners had lower value for CT use, possibly because MRI was used as an alternative or complementary method to CT [17]. Such situations could also be used to control and properly manage healthcare expenditures.

Our study has several strengths and some limitations. First, we used NHIS claim data, which consisted of information about patients' visits to the hospitals. Next, our study considered the number of CT scanners, as well as their cost. In South Korea, the number of CT scanners is high compared with other countries, which may have resulted in higher utilization than expected. Because few studies have examined CT utilization using claim data in South Korea, our findings offer an important perspective on the health policy. Furthermore, we performed a multilevel analysis considering both inpatient- and hospital-level variables.

Because we only considered cerebral infarction patients in our study, and excluded hospitals with fewer than 10 cases of CT scanning for cerebral infarction, our findings are difficult to extrapolate to the general South Korean population. The data used in our study did not include details about inpatients, such as their socioeconomic status; additionally, our dataset did not include inpatients at other types of medical institutions. For further reconsideration of CT policy, studies using more detailed variables are needed. In addition, our follow-up period was only for 3 months during the second half of 2013. For that reason, our findings do not reflect the overall situation for patients. Finally, the decision to use CT was generally made by physicians, but our data did not include information from these healthcare providers.

Despite some limitations, our findings suggest that patients who visited a greater number of hospitals, especially upscale types of medical institutions, had higher numbers of using CT scans. These data may be helpful in the reconsideration of the current CT health policy and may help healthcare professionals and hospital managers decide whether to consider activating COC to help reduce excessive healthcare expenditures. Further detailed studies are needed to help investigate these issues.

Inpatients who visited a greater number of hospitals, especially larger hospitals, had higher CT utilization. Increased sharing of records and improved COC between hospitals are needed to help curb the overuse of this aspect of healthcare.

REFERENCES

1. World Health Organization. The top 10 causes of death. Geneva: World Health Organization; 2014.
2. Jolles PR, Chapman PR, Alavi A. PET, CT, and MRI in the evaluation of neuropsychiatric disorders: current applications. J Nucl Med 1989;30(10):1589-1606.
3. Knauth M, von Kummer R, Jansen O, Hahnel S, Dorfler A, Sartor K. Potential of CT angiography in acute ischemic stroke. AJNR Am J Neuroradiol 1997;18(6):1001-1010.
4. Kung PT, Tsai WC, Yaung CL, Liao KP. Determinants of computed tomography and magnetic resonance imaging utilization in Taiwan. Int J Technol Assess Health Care 2005;21(1):81-88.
5. Organization for Economic Cooperation and Development, World Health Organization. Health at a glance: Asia/Pacific 2014. Paris: Organization for Economic Cooperation and Development Publishing; 2014.
6. Oh EH, Imanaka Y, Evans E. Determinants of the diffusion of computed tomography and magnetic resonance imaging. Int J Technol Assess Health Care 2005;21(1):73-80.
7. Broder J, Fordham LA, Warshauer DM. Increasing utilization of computed tomography in the pediatric emergency department, 2000-2006. Emerg Radiol 2007;14(4):227-232. DOI: https://doi.org/10.1007/s10140-007-0618-9.
8. Larson EB, Omenn GS, Loop JW. Computed tomography in patients with cerebrovascular disease: impact of a new technology on patient care. AJR Am J Roentgenol 1978;131(1):35-40. DOI: https://doi.org/10.2214/ajr.131.1.35.

9. Sistrom CL, McKay NL. Costs, charges, and revenues for hospital diagnostic imaging procedures: differences by modality and hospital characteristics. J Am Coll Radiol 2005;2(6):511-519. DOI: https://doi.org/10.1016/j.jacr.2004.09.013.
10. Horwitz JR, Nichols A. Hospital ownership and medical services: market mix, spillover effects, and nonprofit objectives. J Health Econ 2009;28(5):924-937. DOI: https://doi.org/10.1016/j.jhealeco.2009.06.008.
11. Devers KJ, Brewster LR, Casalino LP. Changes in hospital competitive strategy: a new medical arms race? Health Serv Res 2003;38(1 Pt 2):447-469. DOI: https://doi.org/10.1111/1475-6773.00124.
12. Saultz JW, Lochner J. Interpersonal continuity of care and care outcomes: a critical review. Ann Fam Med 2005;3(2):159-166. DOI: https://doi.org/10.1370/afm.285.
13. Van Servellen G, Fongwa M, Mockus D'Errico E. Continuity of care and quality care outcomes for people experiencing chronic conditions: a literature review. Nurs Health Sci 2006;8(3):185-195. DOI: https://doi.org/10.1111/j.1442-2018.2006.00278.x.
14. Binstock MA, Wolde-Tsadik G. Alternative prenatal care: impact of reduced visit frequency, focused visits and continuity of care. J Reprod Med 1995;40(7):507-512.
15. Cleverley WO, Harvey RK. Is there a link between hospital profit and quality? Healthc Financ Manage 1992;46(9):40,42,44-45.
16. Werner RM, Bradlow ET. Relationship between Medicare's hospital compare performance measures and mortality rates. JAMA 2006;296(22):2694-2702. DOI: https://doi.org/10.1001/jama.296.22.2694.
17. Lansberg MG, Albers GW, Beaulieu C, Marks MP. Comparison of diffusion-weighted MRI and CT in acute stroke. Neurology 2000;54(8):1557-1561. DOI: https://doi.org/10.1212/wnl.54.8.1557.