Barthel ADL Index ≥20	1.00	Referent	NA	1.00	Referent	NA	1.00	Referent	NA
Barthel ADL Index <20	1.71	(1.01,2.87)	0.045	1.72	(1.20,2.47)	0.003	2.11	(1.56,2.86)	<0.001
mRS 0 to 3	1.00	Referent	NA	1.00	Referent	NA	1.00	Referent	NA
mRS 4	1.61	(0.83,0.31)	0.158	1.69	(1.11,2.58)	0.014	1.91	(1.37,2.67)	<0.001
mRS 5	6.41	(3.49,11.77)	<0.001	4.65	(3.12,6.94)	<0.001	4.68	(3.38,6.49)	<0.001
After Hours	1.00	(0.73,1.36)	0.996	0.97	(0.76,1.24)	0.791	0.85	(0.69,1.06)	0.142
Weekends/Public Holidays	1.58	(1.06,2.35)	0.025	1.15	(0.82,1.62)	0.419	0.91	(0.67,1.24)	0.552

JCS, Japan Coma Scale; ADL, activities of daily living; mRS, modified Rankin Scale

Presenter Name

Sungchul Park

Presenter Affiliation

Kyoto University

Presenter E-mail Address

sungchul.p@fx8.ecs.kyoto-u.ac.jp

Presenter Phone Number

+81-80-4230-9155

Co-Author Names and Affiliations

Jason Lee, Kyoto University; Naoto Ukawa, Kyoto University; Hiroshi Ikai, Kyoto University; Yuichi Imanaka, Kyoto University

Discussant Name

John A. Romley

Discussant Affiliation

University of Southern California

Discussant E-mail Address

romley@healthpolicy.usc.edu

Discussant Phone Number

(213) 821-7965

Abstract Title

The Association between Quality of Care and Hospital Spending in Patients with Acute Myocardial Infarction: Evidence from Japan

Abstract [Copy and paste abstract into text box below (up to 500 words)] (424/500)

Background: The association between healthcare spending and quality of care has important implications for policy-makers to improve both the long-term sustainability of healthcare financing and quality of care simultaneously, but the relationship has received little attention at the hospital level.

Objective: To estimate the association between hospital spending and quality of care in acute myocardial infarction (AMI) patients in Japan

Methods: We utilized administrative data from patients admitted to 180 hospitals in Japan for AMI from 2008 to 2011. Multilevel logistic regression models were developed based on patients clustered within hospitals, with independent variables inclusive of patient-level risk factors such as age, gender, co-morbidities and infarct location; hospital characteristics such as teaching status, hospital ownership, hospital bed size, AMI case volume, and the number of physicians as well as nurses. To compare the quality of care among hospitals, hospitals were classified according to mean hospital spending, which was divided into four categories: bottom 10%, 11-50%, 51-89%, and top 10% of hospital spending. ANOVA with Bonferroni correction for multiple comparisons was conducted to test differences in process as well as outcome indicators among the categories of hospital spending. Also, Jonckheere-Terpstra tests were conducted to analyze trends in these indicators across the categories.

Study Outcomes: Quality of care for AMI was assessed using process as well as outcome measures: 30-day in-hospital risk-adjusted mortality rates, all-cause readmission rates; and the percentage of patients prescribed aspirin, ß-blockers, and angiotensin-converting enzyme (ACE) inhibitor during hospitalization.

Results: After adjustment for patient and hospital characteristics, the mortality rate decreased from 7.67% for the hospitals in the bottom 10% to 4.20% for those in the top 10% ($P<0.01$: test for trend). On the other hand, no statistical significance was found in the readmission rates after adjusting for patient and hospital characteristics across the categories of hospital spending ($P=0.161$: test for trend). Hospitals with higher spending were more likely to be associated with better quality of care in process indicators, and the trends across the categories of hospital spending were found to be statistically significant: the use of aspirin (60.44% in bottom 10% versus 90.32% in top 10%, $P<0.001$), β-blockers (22.40% in bottom 10% versus 45.34% in top 10%, $P<0.001$), and ACE inhibitor (47.08% in bottom 10% versus 75.26% in top 10%, $P<0.001$). Except for readmission, differences in both the mortality and process measures between hospital in bottom 10% and others were statistically significant ($P<0.05$ in β-blockers, and $P<0.001$ in the morality and other process measures).

Conclusion: Higher-spending hospitals were significantly associated with better quality of care among Japanese patients admitted for AMI.

The Association between Quality of Care and Hospital Spending in Acute Myocardial Infarction : Evidence from Japan

Sungchul Park, Jason Lee, Hiroshi Ikai,
Tetsuya Otsubo, Naoto Ukawa, Yuichi Imanaka

Department of Healthcare Economics and Quality Management,
School of Public Health, Graduate School of Medicine, Kyoto University

Background

- An increasing trend of acute myocardial infarction (AMI) incidence in the Japanese population[1]
- Health care spending for AMI can be expected to rise in Japan
  - The number of elderly people admitted for AMI treatment is expected to rise as age is a significant risk factor in Japan[2,3]
- Increasing pressure of both hospitals and governments to lower health care spending
- However, reducing health care costs without emphasizing quality of care may result in underused resources and treatment, thus compromising the quality of care among patients.
- Therefore, simply reducing health care utilization may not necessarily be the solution.[4]

[1]Ministry of Health, Labour and Welfare, Japan.
[2]Hayashida, et al. 2007. [3]Turin, et al. 2010. [4]Bodenheimer, et al. 2005.

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Background

- Evidence for the relationship between health care spending and quality of care are primarily from US reports

- **Literature Review**

WHAT IS KNOWN	• Mixed results regarding the association between health care spending and quality of care – *No association, or inconsistent association across specific disease*[1-4] – Positive association[5-8]
WHAT IS UNKNOWN	• Partial evaluation of quality of care using either mortality, process measures, hospital ranking, or a combination thereof • The impact of hospital structure on quality of care and health care spending • The association between hospital spending and quality of care in some countries with insurance or reimbursement systems *different from US*

[1]Chen, et al. 2010. [2]Yasaitis, et al. 2009. [3]Jha, et al. 2009. [4]Kaestner, et al. 2010. [5]Romley, et al. 2011. [6]Barnato, et al. 2010. [7]Stukel, et al. 2012. [8]Ong, et al. 2009.

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Objectives

- **The aim of our study**

Objectives	To assess whether higher health care (hospital) spending is associated with better quality of care for patients admitted for AMI in Japan
WHAT THIS STUDY ADDS	• Process and outcome measures as indicators for overall quality of care for AMI patients • Hospital characteristics that are associated with quality of care and health care spending • Investigation of the association between hospital spending and quality of care in Japan with different reimbursement system compared to the United States

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Methods: Data & Sample Selection

- **Data Sources**
  - Data from hospitals affiliated with the Quality Indicator/Improvement Project (QIP), Kyoto University
- **Subjects**
  - 26,604 patients admitted with a primary diagnosis of AMI (ICD I21) from 180 hospitals enrolled in QIP during the period of April 2008 to March 2011
- **Exclusion Criteria**
  - Patients who were admitted in hospital for durations longer than 90 days
  - Hospitals having case volume of less than 20 over three years
  - Missing data

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Methods: Quality of Care Indicators

Outcome Indicators[1]	Process Indicators[2]
▪ 30-day risk-adjusted in-hospital mortality	▪ Utilization of Aspirin ▪ Utilization of ß-blockers ▪ Utilization of angiotensin-converting enzyme [ACE] inhibitors

[1]Acute myocardial infarction (AMI): hospital 30-day, all cause, risk-standardized mortality rate (RSMR) following AMI hospitalization. Agency for Health care Research and Quality (AHRQ).
[2]Specification Manual for National Hospital Quality Measures. Joint Commission on Accreditation of Healthcare Organizations.

Methods: Covariates

Patient Characteristics	Hospital Characteristics
• Age • Sex • Major co-morbidity risk factors[1-2] - Shock - Pneumonia - Cancer - Chronic renal failure - Infarct location • Minor co-morbidity risk factors - Co-morbidity group 1 (Cerebrovascular disease / Diabetes / Liver disease / Pericarditis or endocarditis) - Co-morbidity group 2 (Acute renal failure / Cardiac dysrhythmia / Congestive heart failure / Pulmonary edema	• Teaching status • Hospital ownership • Hospital AMI case volume over the 3-year study period • Physician-to-bed ratio • Nurse-to-bed-ratio • Hospital size (bed numbers)

[1]Hayashida, et al. 2007. [2]Tu, et al. 2001.

Methods: Hospital Spending

- **Health care Spending during hospitalization**
  - Sum of all fees for hospitalization (e.g., basic and special inpatient care, including initial examination, imaging, pharmacy, injections, treatment, invasive procedure, guidance, and home care)
- **Calculation of Relative hospital spending index**[1,2]

$$\frac{\text{observed mean hospital spending of care per case for patients}}{\text{its expected value of care per case for the same categories of patients}}$$

  - The predicted hospital spending of care per case was calculated by *regression analysis on the patients' demographic characteristics* such as age, sex, co-morbidities and infarction location

[1]Chen, et al. 2010. [2]Jha, et al. 2009.

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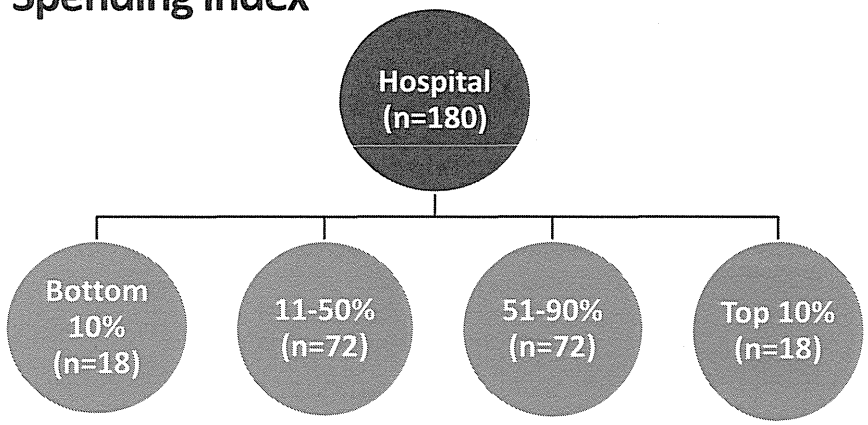
Methods: Hospital Categorization into Quartiles based on Relative Hospital Spending Index



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Methods: Statistical Analysis

- Test for a relationship between patient and hospital characteristics
  - **Chis-square test** for categorical variables
  - **Analysis of variance** for continuous variables

1. **Multilevel regression model for hospital spending**
   - Adjusting for patient-level factors (age, sex, co-morbidities, and infarction location)

2. **Multilevel logistic regression model for mortality**
   - Adjusting for patient and hospital characteristics (major teaching status, hospital ownership, hospital bed size numbers, AMI case volume, and physician-to-bed ratio, and nurse-to-bed ratio)

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Methods: Statistical Analysis

3. **Multilevel logistic regression analysis for mortality**
   - To investigate the impact of type of invasive procedure on mortality rates within the various hospital spending categories
   - Independent Variables

Independent Variables

- The variables from the previous logistic regression model
- Additional variables to indicate the type of AMI invasive procedure performed on each patient

   - AMI treatment procedures were classified into four categories

Invasive Procedures

- No invasive procedures
- Coronary artery bypass graft (CABG)
- Percutaneous coronary intervention (PCI)
- Both PCI and CABG

   - **Patients in the 11-50%** spending group who did not receive an invasive procedure alternatively were used as the **referent category**

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Methods: Statistical Analysis

- **Jonckheere-Terpstra test**
  - To analyze trends in process and outcome indicators across hospital spending categories [3]
- **Analysis of variance for multiple comparison**
  - To test differences in process and outcome indicators among hospital spending categories
- *P*-values
  - less than 0.05 were considered statistically significant
- Statistical package
  - Stata 11.2 (Stata Corp., College Station, TX)
  - IBM SPSS 19.0 (SPSS Inc., Chicago, IL).

[1]Hayashida, et al, 2007. [2]Silber, et al. 2010. [3]Bewick, et al. 2004.

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Results: Patient Characteristics According to Hospital Spending

	Hospital spending category				
Variable	Bottom 10 %	11-50%	51-90%	Top 10%	Test for Trend
Number of patients (n)	817	9,380	13,173	3,234	
Age (years)	72.79	69.89	69.68	68.97	<0.001
Women (%)	32.58	27.97	27.85	27.03	0.003
Co-morbidities (%)					
Shock	5.39	7.71	8.09	12.69	0.096
Pneumonia	2.88	1.75	2.06	1.71	<0.001
Cancer	3.01	2.33	2.05	1.84	0.181
Chronic renal failure	4.89	3.66	4.21	3.24	0.042
Co-morbidity group 1‡	15.79	11.65	13.34	13.91	0.007
Co-morbidity group 2§	38.47	32.91	38.17	37.79	<0.001
Infarct Location					<0.001
Anterior	30.45	33.13	35.73	34.39	
Inferior	29.95	26.72	28.75	29.28	
Subendocardial	1.75	1.25	0.50	1.03	
Other/unspecified	37.84	38.89	35.02	35.30	

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Results: Hospital Characteristics According to Hospital Spending

	Hospital spending category				
Variable	Bottom 10 %	11-50%	51-90%	Top 10%	Test for Trend
Number of hospitals (n)	18	72	72	18	
Observed 30-day in-hospital mortality (%)	27.96	10.76	8.10	6.51	<0.001
Length of stay (mean)	14.52	14.74	17.32	18.24	<0.001
Hospitals with ICU/CCU (%)	22.22	31.94	45.83	72.22	0.012
Number of beds (n)	267.67	386.76	419.82	448.50	0.008
Major teaching facility (%)	66.11	80.56	91.67	83.33	0.037
Hospital ownership (%)					0.089
Municipal	7.52	23.28	28.20	31.34	
Public	39.47	25.87	31.99	53.45	
Private	53.01	50.84	39.82	15.22	
AMI case volume (mean)	44.33	132.96	180.93	178.17	<0.001
Physician-to-bed ratio (mean)	0.14	0.19	0.20	0.22	<0.001
Nurse-to-bed ratio (mean)	0.69	0.82	0.80	0.83	0.075

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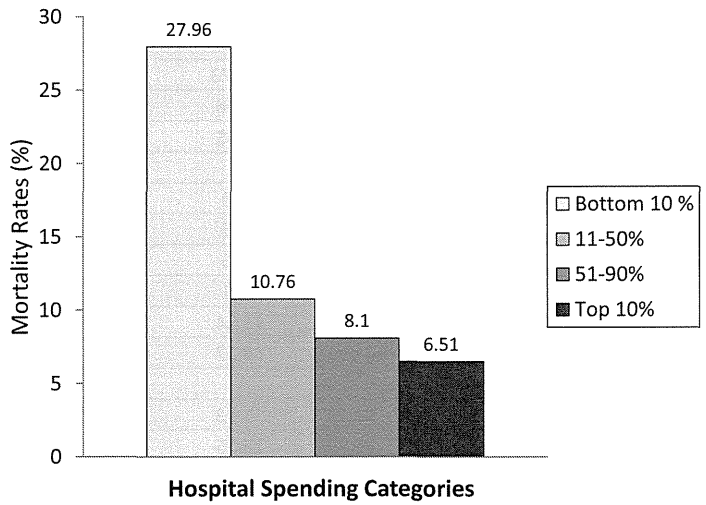
Results: Observed 30-day In-hospital Mortality Rates by Hospital Spending Category



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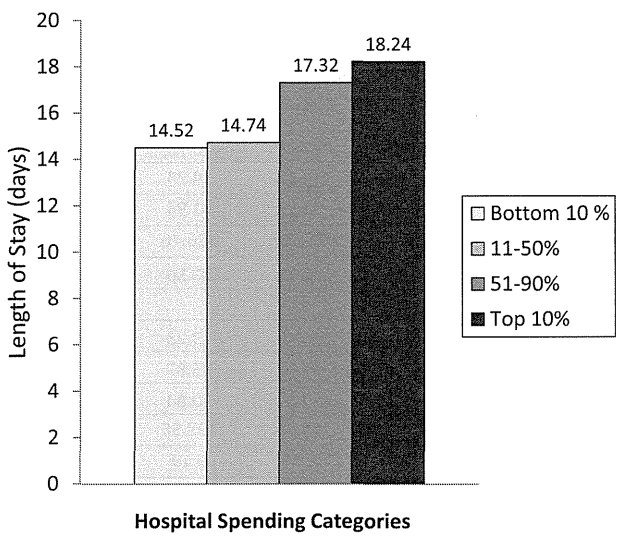
Results: Length of Stay by Hospital Spending Category



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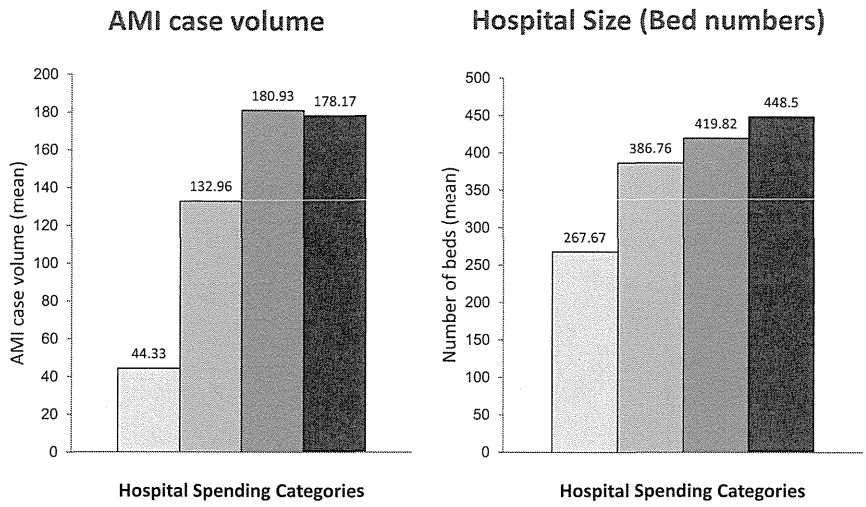
Results: Hospital Characteristics According to Hospital Spending



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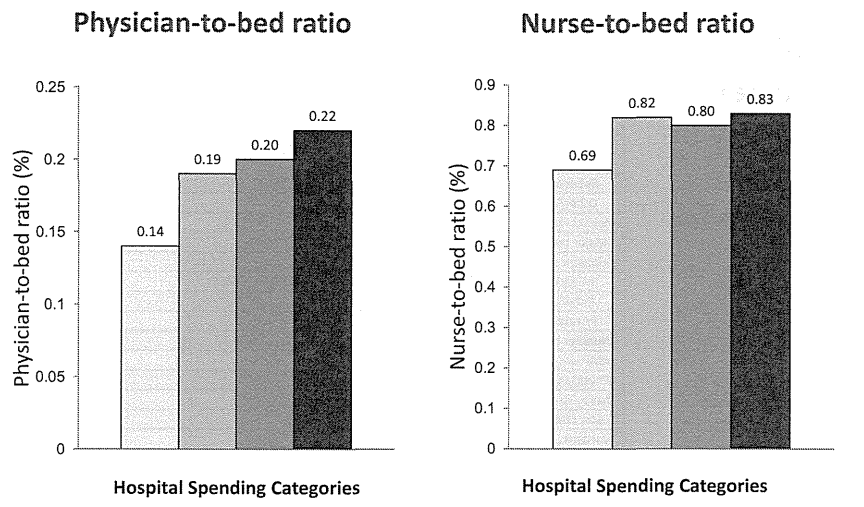
Results: Hospital Characteristics According to Hospital Spending



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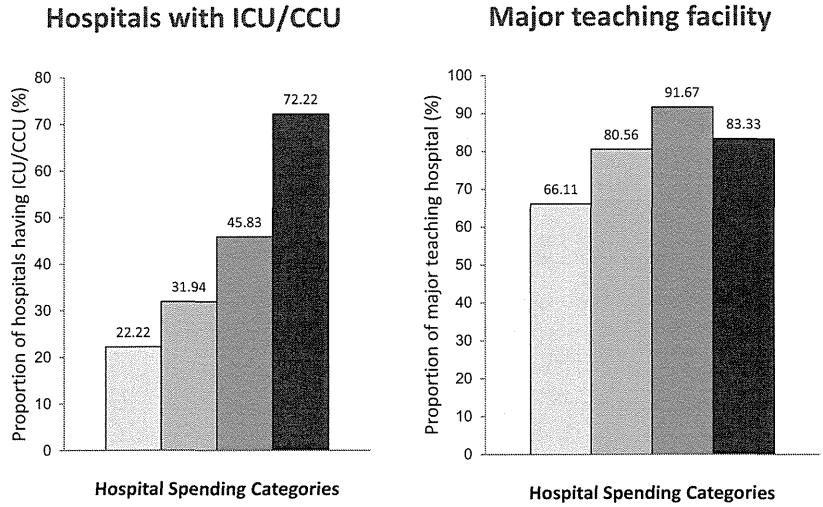
Results: Hospital Characteristics According to Hospital Spending



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Results: Effects of Patient, and Hospital Characteristics on 30-Day In-Hospital Mortality for AMI

	30-day In-hospital Mortality	
Variables	Odds Ratio	95% CI
Patient variables		
Age	1.06***	(1.06-1.07)
Women	1.21***	(1.10-1.33)
Co-morbidities		
Shock	3.60***	(3.16-4.09)
Pneumonia	1.51**	(1.17-1.94)
Chronic renal failure	1.56***	(1.28-1.90)
Cancer	1.03	(0.78-1.36)
Co-morbidity group 1†	0.97	(0.84-1.11)
Co-morbidity group 2‡	1.56***	(1.42-1.72)
Infarct Location		
Anterior	1.00 [reference]	
Inferior	0.59***	(0.51-0.68)
Subendocardial	0.41*	(0.20-0.87)
Other/unspecified	3.15***	(2.82-3.53)
Hospital variables		
Major teaching facility	0.93	(0.64-1.34)
Hospital ownership		
Municipal	1.00 [reference]	
Publicly owned	1.33	(0.99-1.80)
Privately owned	1.09	(0.78-1.50)
Number of beds	1.00	(1.00-1.00)
AMI case volume	1.00	(1.00-1.00)
Physician-to-bed ratio	0.06*	(0.01-0.59)
Nurse-to-bed ratio	1.96	(0.88-4.36)
Cluster effect		
$Variance_{Hospital}$	0.44	(0.34-0.60)
$MOR_{Hospital}$	1.90	(1.74-2.09)
$ICC_{Hospital}$	0.12	
Goodness-of-test		
c statistic	0.82	

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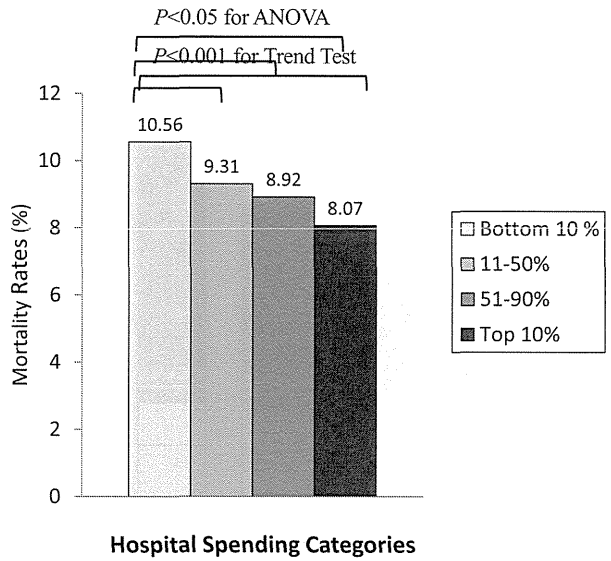
Results: 30-day Risk-adjusted In-hospital Mortality Rates



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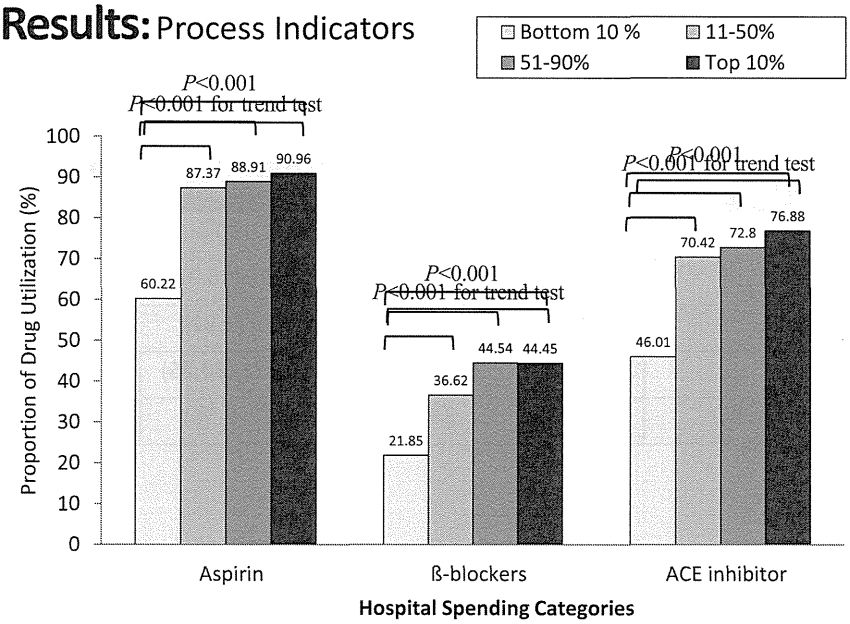
Results: Process Indicators



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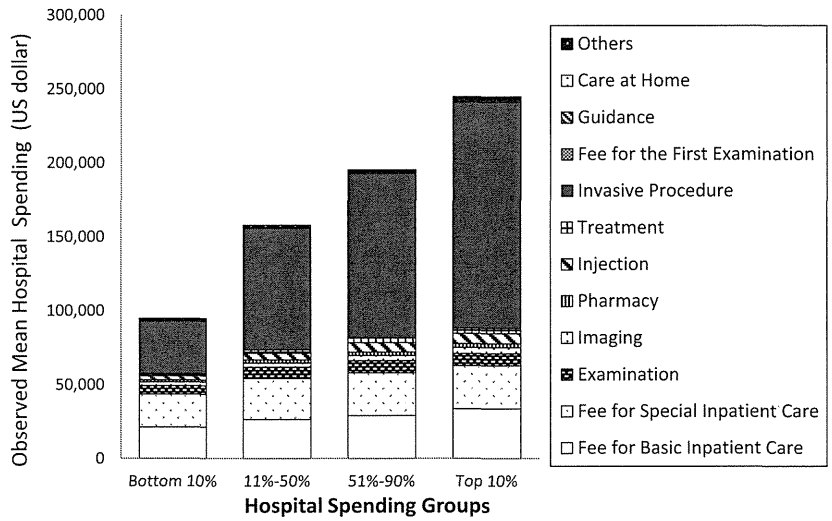
Results: Observed Spending Details of the Hospital Spending Categories



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Results: Effect of Invasive procedure on 30-day Mortality across Hospital Spending Categories

No. Patients (%)	Hospital spending category			
	Bottom 10 %	11-50%	51-90%	Top 10%
None	454 (55.57)	2,246 (23.94)	2,236 (16.97)	470 (14.53)
CABG	0 (0.00)	127 (1.35)	239 (1.81)	72 (2.23)
PCI	363(44.43)	6,973 (74.34)	10,571 (80.25)	2,659 (82.22)
CABG and PCI	0 (0.00)	34 (0.36)	127 (0.96)	33 (1.02)

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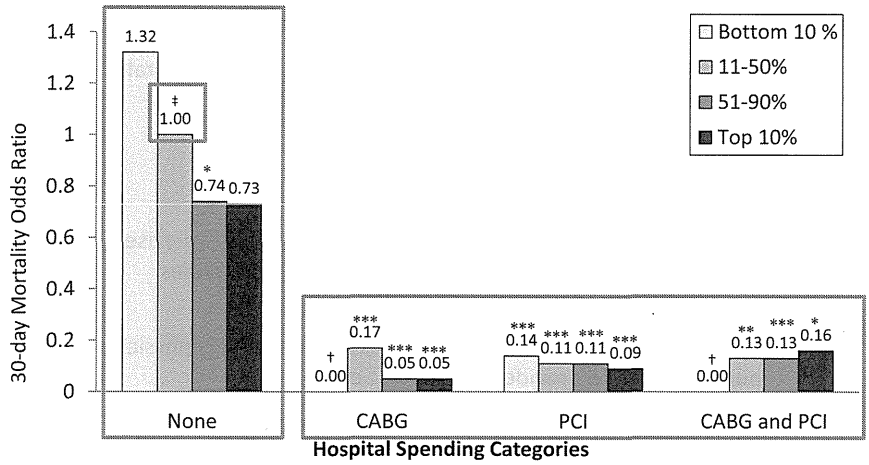
Results: Effect of Invasive procedure on 30-day Mortality across Hospital Spending Categories



*p<.05, **p<.01, ***p<.001.
†No case was observed in the categories
‡Referent category

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Discussion

- **The results show a positive relationship between hospital spending and quality of care** for both process and outcome measures in Japan
- **Invasive procedure (CABG and PCI in our study)**
  - A significant factor that contributes to increased health care spending, and was shown to be associated with reduced mortality
  - It is unclear whether the higher cost associated with AMI treatment is beneficial in terms of cost-effectiveness.
- **Hospital structure correlated with the relationship between hospital spending and quality of care**
  - According to our multilevel logistic regression, it was shown that the proportion of physician to the hospital bed numbers were significantly associated with decreased mortality.

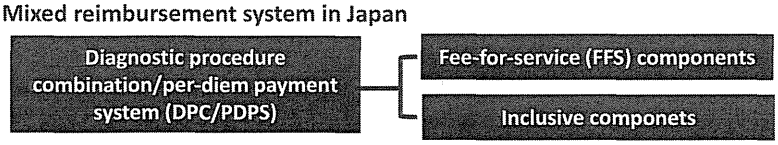
Discussion

- **Relationships between outcomes and hospital characteristics**
  - AMI case volume, [1-4] teaching status,[4-7] physician and hospital volume,[8] and availability of cardiac facilities[4]
- **Lower-spending hospitals**
  - are **likely to have less health care resources** such as expertise, manpower (presence of specialists), medical equipment, and facilities (catheterization laboratories and CCUs).
  - are **less likely to have an organized team** that includes physicians and nurses trained to provide AMI-specific care.
  - are **less likely to perform invasive procedures** such as PCI and CABG

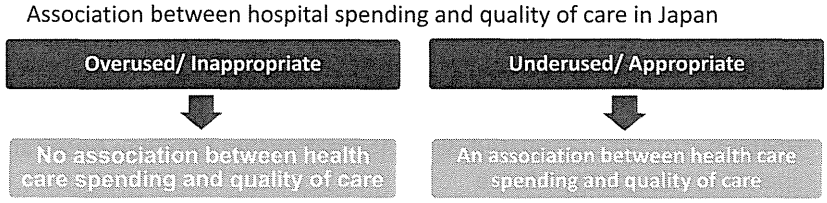
[1]Canto, et al. 2000. [2]Halm, et al. 2002. [3]Thiemann, et al. 1999. [4]Bradley, et al. 2010. [5]Polanczyk, et al. 2002. [6]Allison, et al. 2000. [7]Ayanian, et al. 2002. [8]Vakili, et al. 2001. [9]Fuchs, et al. 2011.

Discussion: Evidence from Japan

- **Nationally-uniform fee schedule** under a **universal health care insurance plan**
- **Mixed reimbursement system in Japan**



- Association between hospital spending and quality of care in Japan



- **Therefore, intensive care (or invasive procedures) partly under the FFS reimbursement system in Japan is unlikely to indicate overuse/inappropriate treatment.**

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Limitations

- Selection bias as hospitals are voluntarily enrolled in the QIP project
- Unadjusted in other aspects of health, which may be harder to measure[1]
- Referral bias whereby a patient at low risk for AMI may have been attracted to physicians or hospitals because of their reputation
- Sample may include patients admitted initially to one hospital for AMI and transferred to another

[1]Zuckerman et al. 2010.

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Conclusions

- **Hospitals with lower spending were associated with worse quality of care for AMI patients.**
- **Hospital structure influenced both health care spending and quality of care, resulting in variation in health care utilization.**
- It is necessary to consider hospital spending and quality of care when establishing clinical and payment policies.
- Our findings may help policy makers become aware of the relationship between hospital spending and quality of care when designing affordable health care reforms.

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Thank you

Sungchul Park (park.sungchul.53n@st.kyoto-u.ac.jp)
Correspondence to Professor **Yuichi Imanaka** (imanaka-y@umin.net)
Department of Healthcare Economics and Quality Management
Graduate School of Medicine, Kyoto University

急性心筋梗塞における病院医療費と医療の質との関係

Sungchul Park、Jason Lee、猪飼 宏、
大坪 徹也、宇川 直人、今中 雄一

京都大学 大学院医学研究科 医療経済学分野

背景

- 日本では高齢化により、年齢がリスク要因である急性心筋梗塞にかかる患者が増えていくと予測される[1]
- 急性心筋梗塞患者が増えることで、急性心筋梗塞にかかる医療費も増えると考えられる[2,3]
- 増大する医療費が国の財政を圧迫しているため、医療費削減が必要である
- しかし、医療の質を考慮しないまま、単純に医療費を下げると、医療資源の利用が過小になり、医療の質を低下させる恐れがある
- 増大する医療費の解決案として、単純に医療費削減するのは正しくない[4]
- したがって、医療費と医療の質にどのような関係があるかを調べる必要がある

[1]Ministry of Health, Labour and Welfare, Japan.
[2]Hayashida, et al. 2007. [3]Turin, et al. 2010. [4]Bodenheimer, et al. 2005.