Investigation into the causes of indwelling urethral catheter implementation and its effects on clinical outcomes and health care resources among dementia patients with pneumonia

A retrospective cohort study

Toshiki Maeda, MD, MPH*, Akira Babazono, MD, MS, PhD, Takumi Nishi, PhD, Midori Yasui, MPH, Yumi Harano, MD

Abstract

There is a possibility that unnecessary treatments and low-quality medical care, such as inappropriate indwelling urethral catheter use, are being provided to older Japanese individuals.

The aim of this study was to investigate contextual effects relating to indwelling urethral catheters in older people with dementia and to clarify the effects of indwelling urethral catheter use on patients’ mortality, length of stay (LOS), and health care spending. This retrospective cohort study involved 4501 male and female Japanese participants. Those who were aged 75 or older with dementia and had a primary diagnosis of acute lower respiratory disease with antibiotics administered during hospitalization were eligible for inclusion. Patient mortality, LOS, and total charge during hospitalization were the main study outcomes. This study showed that indwelling urethral catheter use was significantly associated with higher mortality, longer LOS, and higher total charge for hospitalization. The pattern of indwelling urethral catheter use was clustered by care facility level. Physician density was significantly associated with indwelling urethral catheter use; the relationship was not linear but U-shaped, such that the approximate median had the lowest rate of urethral catheter use and this increased gradually toward both lower and higher physician densities. Our study found considerable variation in indwelling urethral catheter use between care facilities in older people with dementia. Additionally, indwelling urethral catheter use was related to poor outcomes. Based on these findings, we consider there to be an urgent need for constructing a framework to measure, report on, and promote the improvement of care quality for older individuals in Japan.

Abbreviations: CAUTI = catheter-associated urethral tract infection, DPC = diagnosis procedure combination, ICC = intraclass correlation coefficient, ICD-10 = International Disease Classification 10th revision, LOS = length of stay, MOR = median odds ratio, PS = propensity scores, RA = regression analysis, STM = secondary tier of medical care, TC = total charge.

Keywords: care quality, claim data, health policy, indwelling urethral catheter, older people

1. Introduction

The Japanese population has been aging at a remarkably increasing rate. As of 2015, people aged 65 years or older comprised 33.84 million or 26.7% of the total population, which were the highest numbers ever recorded.[3] Dementia is one of the most serious problems in an aging society.[2] The Japanese government estimated that the number of individuals with dementia aged 65 years or older was 4.62 million, which is equivalent to a prevalence of 1 in 7 people in this age group.[3] Therefore, measures targeting dementia are of the utmost importance. The core symptoms of dementia are cognitive impairment, behavioral, and psychological symptoms.

People with dementia are likely to have functional urethral incontinence[4] resulting from cognitive impairment; this type of frequent incontinence[5] diminishes the patient’s daily quality of life. As urethral incontinence may be a burden for daily care,[6,7] use of an indwelling urethral catheter in hospitalized dementia patients may mitigate care burden. However, urethral catheter use in these patients violates the indications of indwelling urethral catheters, which are as follows: the patient has acute urinary retention or bladder outlet obstruction; there is a need for accurate measurements of urethral output in critically ill patients; perioperative use for selected surgical procedures; to assist in healing of open sacral or perineal wounds in incontinent patients; the patient requires prolonged immobilization (e.g., potentially unstable thoracic or lumbar spine, or multiple traumatic injuries); or to improve comfort for end-of-life care if needed.[8] Additionally, indwelling urethral catheters are associated with catheter-associated urethral tract infection (CAUTI),[8,9] immobility,[10] pressure ulcer,[11] mortality,[9,12,13]...
longer hospital stay,[9] and higher care costs.[9,14] Therefore, unnecessary use of urethral catheters could be unethical. Nevertheless, there have been few investigations into indwelling urethral catheter use in older people with dementia in Japan. It has been reported that indwelling urethral catheter use varies by region[15,16] or care facility,[15,16] although this has never been thoroughly studied in Japan.

Using an insurance claims database, we aimed to investigate contextual effects relating to indwelling urethral catheters in older people with dementia who presented with pneumonia and were admitted to care facilities. Patients with pneumonia were studied as this is a common disease affecting older people, and its incidence has been increasing with the increasing aging population.[17] Indeed, pneumonia has ranked third – ahead of cerebrovascular accident – among the causes of mortality in Japan since 2011.[17]

First, we assessed regional- and care facility-level variation after controlling for patient-level factors. If care providers adhered to the indications of urethral catheter use listed above, variation should be minimal after controlling for individual clinical factors. Conversely, clustered variations irrespective of patient factors indicate contextual effects. Second, we clarified the effects of indwelling catheter use on patients’ mortality, length of stay (LOS), and health care spending. We ultimately aimed to clarify issues of Japanese health care quality and suggest policy implications for health care issues in older Japanese people.

2. Materials and methods

2.1. Study subjects, materials, and design

This study was a retrospective cohort analysis that closely followed the internationally recognized Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[18] It used claims data submitted to the Fukuoka Late Elders’ Health Insurance from fiscal year 2010 to fiscal year 2013. In Japan, those aged ≥75 years, or those aged 65 to 74 years with a specific disability, are eligible for Late Elders’ Health Insurance. Those aged 65 to 74 years were assumed to have specific intractable disease; therefore, we only included those ≥75 years or older as study subjects. We initially identified 4791 patients whose primary diagnosis was acute lower respiratory disease, had been administered antibiotics during hospitalization, and were diagnosed as having dementia before or on the same day as admission using the International Disease Classification 10th revision (ICD-10). The ICD codes of “acute lower respiratory disease” and “dementia” are J100, J110, J69 and from J12 to J22, and F00, F01, F02, and F03, respectively. We defined those with procedure code 140013810 after admission as those that underwent placement of an indwelling urethral catheter. Those diagnosed with urinary retention (ICD-10: R33) on the same day as admission were excluded from the study (N = 37) as this is a definitive indication. Given that the claims data did not reflect withdrawal of the urethral catheter, we could not calculate the duration of urethral catheter placement. As many facilities in Japan routinely change urethral catheters once a month,[19,21] we excluded those with procedure code 140013810 (implementation of indwelling urethral catheter) and 140013980 (replacement of indwelling urethral catheter) within 1 month of each other (N = 82) because we could not rule those out as semipermanent indwelling urethral catheters. We also excluded who had an operation or procedure during hospitalization (N = 66). We then excluded missing data and obvious imputation error (N = 200). Finally, we identified 4501 patients as study subjects. Inclusion and exclusion details are shown in Fig. 1.

This study was approved by the Institutional Review Board of Kyushu University (Clinical Bioethics Committee of the Graduate School of Healthcare Sciences, Kyushu University).

2.2. Definition of variables

We measured the demographic variables, income state, and year of admission. Additionally, as the claims database used did not include clinical data, we used type of pneumonia, comorbidity, tube feeding, type of claims data, and characteristics of health care facilities to adjust for patient condition. At the patient level, they were categorized by age into 75 to 84 years, 85 to 89 years, and ≥90 years. We defined those having ICD-10 code J69 as having aspiration pneumonia. Urological past history and comorbidities were categorized as either diagnosed before or on the same day of admission. “Urinary retention (ICD-10: R33)” and “neurogenic bladder (ICD-10: N31)” were designated as urological past history, unless the urinary retention occurred on the same day as an indwelling urethral catheter placement. Comorbidities were classified according to the Charlson comorbidity index.[22] We defined those with procedure codes 114005210, 140051210, 140023210, 140023350, 150170550, and 15017610 as those undergoing tube feeding. Income status was determined by use of a meal charge copayment during hospitalization because meal charges are set according to income.[23] Income was classified as lower, middle, and higher. However, we combined middle and higher into a middle-to-higher group because the number in the higher income group was small. The types of claims data were either diagnosis procedure combination (DPC) or not. The DPC is a Japanese case-mix classification and adopted by almost all acute care hospitals.[24]

At the level of the care facility, we assessed the number of beds, ownership, and physician density. The number of beds was classified into <200, 200 to 399, and ≥400 because the Medical Care Law stipulates that at least 200 beds for a regional support hospital and at least 400 beds for an advanced treatment hospital are needed.

![Figure 1. Diagram of subject identification and inclusion and exclusion criteria details.](image-url)
Physician density was defined as the number of full-time physicians per bed. Because optimal physician density was not known, we classified physician density into 10 quantiles according to prior research.\textsuperscript{[23]} We classified ownership into private or public. At the regional level, we identified the secondary tier of medical care (STM) in which the facility was located. STM is the unit of secondary care governed by a prefecture, according to Japan Medical Service Law. Each prefecture must set its own STMs; Fukuoka Prefecture has 13 STMs.\textsuperscript{[23]}

### 2.3. Definition of outcomes

We set mortality, LOS, and total charge (TC) as outcome measures. Mortality was defined as all-cause death during hospitalization. LOS was defined as duration from admission to discharge or death. The TC (US\$1 = ¥100) billed during hospitalization was used as a proxy for cost. Under the Japanese health insurance scheme, hospital charges are determined by a standardized fee-for-service payment system known as the nationally uniform fee table. The TC included physician fees, instrument costs, laboratory or imaging test costs, and administration fees.\textsuperscript{[26]} In this study, the cost of indwelling urethral catheter was charged as a procedural and instrumental cost. We did not include CAUTI as an outcome variable, despite the fact that the relationship between urethral catheter use and CAUTI has been well established.\textsuperscript{[8,9]} because we could not detect the exact duration of indwelling because of data limitations. However, as subjects were administered antibiotics for pneumonia, the rate of urinary tract infection occurrence during hospitalization was extremely low: 0 cases in the indwelling urethral catheter group and 144 in the no indwelling urethral catheter group.

### 2.4. Statistical analyses

First, we performed Kruskal–Wallis test for continuous variables and Pearson Chi-square for categorical variables. We employed 3-level multilevel models with random intercept, setting patient factors as level 1, care facility factors as level 2, and regional factors as level 3 to detect contextual effects. We created a null model with care facilities as level 2 and STMs as level 3. Next, we created model 1, inputting patient-level factors, with \( P < 0.2 \) in bivariate analyses to the null model. We created model 2 adding care facility-level variables including number of beds, physician densities, and ownership in model 1 to detect contextual effects for urethral catheter use. We used an intraclass correlation coefficient (ICC) for similarity within groups and the median odds ratio (MOR) for variance between groups.\textsuperscript{[27]}

Subsequently, we analyzed the effects of urethral catheter use on mortality, LOS, and TC. We performed common logarithmic transformations for LOS and TC because these were right-skewed. First, we performed bivariate analyses to detect the association between urethral catheter use and outcomes. We performed regression analyses (RAs) with mortality, logLOS, and logTC as dependent variables and all variables listed in Table 1 as independent variables (RA model). We employed a logistic regression model for mortality and a linear regression model for logLOS and logTC in RA models. Then we performed a nonparsimonious logistic RA inputting all variables listed in Table 1 and dummy variables of STMs to obtain propensity scores (PS). Each patient in the indwelling urethral catheter group was matched with a unique control from the no indwelling urethral catheter group according to PS (PS match model). From the matched cohort, we employed multilevel logistic regression with mortality as a dependent variable and sex and age group as independent variables with random intercept of care facility level. Similarly, a multilevel linear regression model was used with logLOS or logTC as dependent variables and sex and age group as independent variables with random intercept of care facility level. We set caliper width as 0.02.\textsuperscript{[28]}

Last, we employed independent variables, including sex, age group, and PS, stratified by 5 quantiles\textsuperscript{[29]} with random intercept setting care facility as level 2 (PS stratification model). We also performed a multilevel logistic RA for mortality and multilevel linear RAs with logLOS and logTC as dependent variables. All reported \( P \)-values were 2-tailed, and the level of significance was set at \( P < 0.05 \). We used Stata statistical software, Release 14 (StataCorp, College Station, TX) for statistical analyses.

### 2.5. Sensitivity analysis

We employed a generalized linear model with clustering care facilities, changing STMs to dummy variables because regional variables were almost 0 for sensitivity analysis of model 2. With regard to outcome, we again analyzed TC and LOS, excluding mortality, as mortality can affect TC\textsuperscript{[29,30]} or LOS,\textsuperscript{[31]} and some urethral catheters were indwelling for palliation.

### 3. Results

#### 3.1. Descriptive analysis

The results of the descriptive analysis are shown in Table 1. The number of those with indwelling urethral catheter was 712 (15.8\%) among 4501 study subjects. There was no significant association between sex and urethral catheter use. As for age, there was no significant relationship with urethral catheter use. With regard to types of pneumonia, those with aspiration pneumonia had a significantly higher rate of indwelling urethral catheter use. Neurogenic bladder was significantly associated with indwelling urethral catheter use, although urinary retention was not. As for other comorbidities, cerebrovascular accident, pulmonary disease, and diabetes mellitus were associated with urethral catheter use. Those with tube feeding had a significantly higher prevalence of indwelling urethral catheter use.

Claims made by DPC had a significantly higher rate of indwelling urethral catheter use than claims made by non-DPC. Facilities having 200 to 399 beds had more instances of indwelling urethral catheter use and there was a significant difference in distribution. There was no association between ownership and urethral catheter use. There was a significant relationship between physician densities and indwelling urethral catheter use, with the lowest rate of indwelling urethral catheter use in the 6th quantile and a trend toward gradually increased rates toward both lower and higher quantiles.

#### 3.2. Results of the analyses for the variance of urethral catheterization

The results of multilevel analyses to detect contextual effects are shown in Table 2. In the null model, there was almost no variation at the STM level. However, there was variation at the care facility level, with an ICC of 0.15 and an MOR of 2.08.

In model 1, which controlled for patient factors, the variation at the care facility level was barely decreased and the changes of ICC and MOR were also minimal. In model 2, which added care
| Table 1 | Descriptive analysis of subjects by indwelling urethral catheter use. |
|---------|---------------------------------------------------|
|         | Indwelling urethral catheter | Nonindwelling urethral catheter | P       |
| Patient level |                     |                                  |         |
| Sex      |                     |                                  |         |
| Male     | 288 (40.4)          | 1643 (43.4)                      | 0.150   |
| Female   | 424 (59.6)          | 2146 (56.6)                      |         |
| Age median | 87 (8.0)            | 86 (7.0)                         | 0.160   |
| Age category |                 |                                  |         |
| <85      | 244 (34.3)          | 1399 (36.9)                      |         |
| 85 ≤ <90 | 238 (33.4)          | 1283 (33.9)                      | 0.211   |
| 90 ≤     | 230 (32.3)          | 1107 (29.2)                      |         |
| Type of pneumonia |               |                                  |         |
| Aspiration | 301 (42.3)          | 1270 (33.5)                      | <0.001  |
| Urological past History |         |                                  |         |
| Neurogenic bladder | 67 (9.4)           | 219 (5.8)                        | <0.001  |
| Urinary retention | 36 (5.1)           | 207 (5.5)                        | 0.659   |
| Comorbidities |                |                                  |         |
| Acute myocardial infarction | 19 (2.7)          | 79 (2.1)                         | 0.328   |
| Cerebrovascular disease | 208 (29.2)        | 1336 (35.3)                      | 0.002   |
| Congestive heart failure | 256 (36.0)        | 1231 (32.5)                      | 0.071   |
| Collagen disease | 10 (1.4)           | 71 (1.9)                         | 0.387   |
| Hemiplegia | 6 (0.8)             | 17 (0.4)                         | 0.176   |
| Peptic ulcer | 61 (8.6)           | 366 (9.7)                        | 0.362   |
| Peripheral vascular disease | 21 (2.9)          | 72 (1.9)                         | 0.071   |
| Pulmonary disease | 159 (22.3)        | 999 (26.4)                       | 0.024   |
| Renal disease | 36 (5.1)           | 202 (5.3)                        | 0.763   |
| Diabetes | No complication | 57 (8.0)                        | 214 (5.6) | 0.013   |
|         | With complications | 17 (2.4)                        | 59 (1.6)  |
|         | Liver disease | 16 (2.2)                        | 92 (2.4)  | 0.340   |
|         | Mild liver disease | 3 (0.4)                         | 6 (0.2)   |
|         | Moderate to severe liver disease | 69 (9.7) | 373 (9.8) | 0.942   |
|         | Malignancy | 5 (0.7)                         | 31 (0.8)  |
| Clinical status |                   |                                  |         |
| Tube feeding | 156 (21.9)         | 693 (18.3)                       | 0.023   |
| Economic status |                |                                  |         |
| Lower | 210 (29.5)          | 1123 (29.6)                      | 0.938   |
| Middle to higher | 502 (70.5)        | 2666 (70.4)                      |         |
| Type of claim | Non-DPC | 334 (46.9)          | 2013 (53.1) | 0.002   |
|         | DPC | 378 (53.1)          | 1776 (46.9)                      |         |
| Fiscal year | ~2010 | 170 (23.9)          | 780 (20.6)                       | 0.060   |
|         | 2011 | 198 (27.8)          | 992 (26.2)                       |         |
|         | 2012 | 163 (22.9)          | 1016 (26.8)                      |         |
|         | 2013 | 181 (25.4)          | 1001 (26.4)                      |         |
| Care facility level |                   |                                  |         |
| Number of beds | ~200 | 334 (46.9)          | 1034 (51.0)                      | <0.001  |
|         | 200–399 | 262 (36.8)         | 1039 (27.4)                      |         |
|         | 400–   | 116 (16.3)          | 816 (21.5)                       |         |
| Ownership | Private | 598 (84.0)          | 3259 (86.0)                      | 0.157   |
|         | Public | 114 (16.0)          | 530 (14.0)                       |         |
| Physician density | 1st | 80 (11.2)           | 371 (9.8)                        | <0.001  |
|         | 2nd | 69 (9.7)            | 304 (10.4)                       |         |
|         | 3rd | 99 (13.9)           | 338 (8.9)                        |         |
|         | 4th | 66 (9.3)            | 386 (10.2)                       |         |
|         | 5th | 54 (7.6)            | 397 (10.5)                       |         |
|         | 6th | 43 (6.0)            | 409 (10.8)                       |         |
|         | 7th | 67 (9.4)            | 492 (13.0)                       |         |
|         | 8th | 63 (8.8)            | 279 (7.4)                        |         |
|         | 9th | 75 (10.5)           | 372 (9.8)                        |         |

(continued)
facility factors to model 1, ICC and MOR were decreased (0.13 and 1.93, respectively), although there was variation at the care facility level. Number of beds and ownership were not significantly associated with urethral catheter use. Physician density was significantly associated with indwelling urethral catheter use, and each quantile, except for the 5th, 7th, and 8th, had significantly higher rates of indwelling urethral catheter use compared with the 6th quantile (Fig. 2).

3.3. Results of the assessment of the relationship of urethral catheterization with mortality and care resource use

The number of deaths among all 4501 subjects was 370 (8.2%). There was a significant difference between the number of deaths in the urethral catheter group (112 (15.7%)) and that in the nonurethral catheter group (258 [6.8%]). The indwelling urethral catheter group had significantly longer LOS and higher TC (Table 1). Indwelling urethral catheter was a significant risk factor for mortality, increasing the risk by between 130% and 200% according to all models shown in Table 3 (bivariate analysis: 2.55 [2.01–3.24] P<0.001; RA model: 3.13 [2.40–4.08] P<0.001; PS match model: 2.30 [1.59–3.33] P<0.001; and PS stratification model: 3.04 [2.31–3.99] P<0.001). Similarly, the results derived from all models revealed that indwelling urethral catheter use added significantly extra cost (bivariate analysis: 0.13 [0.10–0.16] P<0.001, RA model: 0.12 [0.10–0.15] P<0.001, PS match model: 0.12 [0.09–0.15] P<0.001, and PS stratification model: 0.13 [0.10–0.15] P<0.001). Those with indwelling urethral catheters had significantly longer LOS, except for those in the PS match model, where they tended to have longer LOS although this did not reach statistical significance (bivariate analysis: 0.08 [0.05–0.11] P<0.001, RA model: 0.07 [0.04–0.10] P<0.001, PS match model: 0.04 [0.00–0.08] P=0.067, and PS stratification model: 0.06 [0.03–0.09] P<0.001).

3.4. Results of sensitivity analyses

The results of the generalized linear model with clustering care facilities were similar to those of model 2 (Supplemental Digital Content 1, http://links.lww.com/MD/B36). The results of all the models, except for mortality, showed significant relationships between indwelling urethral catheter use and longer LOS and higher TC (logLOS: bivariate analysis: 0.09 [0.06–0.12] P<0.001, RA model: 0.08 [0.05–0.11] P<0.001, PS match model: 0.06 [0.02–0.10] P=0.007, PS stratification model 0.08 [0.05–0.11] P<0.001, logTC: bivariate analysis: 0.15 [0.12–0.17] P<0.001, RA model: 0.14 [0.11–0.16] P<0.001, PS match model: 0.16 [0.12–0.19] P<0.001, and PS stratification model: 0.14 [0.11–0.17] P<0.001) (Supplemental Digital Content 2, http://links.lww.com/MD/B36).

4. Discussion

4.1. Statement of principal findings

This study showed that indwelling urethral catheter use was significantly associated with higher mortality, longer LOS, and higher TC. The pattern of indwelling urethral catheter use was clustered by care facility level; nevertheless indwelling urethral catheter use was related to worse outcomes and care resource waste, as stated above. Regarding the characteristics of care facilities, number of beds and ownership were not significant determinants for indwelling urethral catheter use. Although physician density was significantly associated with indwelling urethral catheter use, the relationship was not linear but U-shaped, such that the approximate median had the lowest rate of urethral catheter use and this increased gradually toward both lower and higher physician densities.

4.2. Strengths and weaknesses of the study

The strength of this study was its comprehensive coverage; because almost all procedures were claimed, indwelling urethral catheter use was included in claims data. Additionally, the number of subjects belonging to Fukuoka Late Elders’ Health Insurance was approximately 600,000 people,[32] which was enough to obtain robust findings. Unavailability of reporting of the severities of pneumonia, activity of daily lives and clinical data including laboratory tests were limitations of the study. Furthermore, we could not find out the duration of indwelling urethral catheter placement because urethral catheter withdrawal was not claimed.

4.3. Important differences in results

It has been reported that those with indwelling urethral catheters had significantly higher mortality, longer LOS, and higher TC because urethral catheter use was closely related to CAUTI.[9,14] However, our study revealed that indwelling urethral catheter use in older patients with dementia was related to higher mortality, longer LOS, and higher TC despite the rare occurrence of urinary tract infection. Certainly, the claims database used did not include clinical information; therefore, we could not rule out whether patients with indwelling urethral catheter were already in a worse condition although we fully adjusted for patient condition using the available variables (comorbidities, type and characteristics of pneumonia, characteristics of healthcare facilities, and analytic tools, such as propensity score matching). However, the trend toward longer LOS and higher TC was clearly seen even when mortality was excluded. It has been suggested that low-quality care, represented by unnecessary indwelling urethral catheter use, could lead to poorer outcomes as well as wastage of health care resources including longer LOS and higher TC. Although

Table 1 (continued).

| Outcome | Indwelling urethral catheter | Nonindwelling urethral catheter | P |
|---------|-----------------------------|---------------------------------|---|
| 10th %  | 96                          | 13.5                            | 351 | 9.3 | <0.001 |
| Mortality |                             |                                 |     |     |     |
| Length of stay | IQR | 22                          | 23.0 | 19    | 20.0 | <0.001 |
| Total charge | IQR | 5624.5                      | 3632.5 | 4226 | 3742 | <0.001 |

GPC= diagnosis procedure combination.
### Table 2

Results of multilevel analyses to investigate contextual effects of indwelling urethral catheter use.

| Patients level | Bivariate | Multivariate | Bivariate | Multivariate | Bivariate | Multivariate |
|----------------|-----------|--------------|-----------|--------------|-----------|--------------|
| Sex            |           |              |           |              |           |              |
| Male           |           |              |           |              |           |              |
| Female         |           |              |           |              |           |              |
| Age category   |           |              |           |              |           |              |
| <85            |           |              |           |              |           |              |
| 85–90          |           |              |           |              |           |              |
| 90+            |           |              |           |              |           |              |
| Type of pneumonia |       |              |           |              |           |              |
| No aspiration  |           |              |           |              |           |              |
| Aspiration     |           |              |           |              |           |              |
| Neurological past history | |              |           |              |           |              |
| No aspiration  |           |              |           |              |           |              |
| Aspiration     |           |              |           |              |           |              |
| Comorbidities  |           |              |           |              |           |              |
| Cerebrovascular disease | |              |           |              |           |              |
| Congestive heart failure | |              |           |              |           |              |
| Hemiplegia     |           |              |           |              |           |              |
| Peripheral vascular disease | |              |           |              |           |              |
| Pulmonary disease |       |              |           |              |           |              |
| Diabetes       |           |              |           |              |           |              |
| Nondiabetes    |           |              |           |              |           |              |
| With complications |     |              |           |              |           |              |
| Clinical status |           |              |           |              |           |              |
| Tube feeding   |           |              |           |              |           |              |
| Type of claim   |           |              |           |              |           |              |
| Non-DPC        |           |              |           |              |           |              |
| DPC            |           |              |           |              |           |              |
| Fiscal year    |           |              |           |              |           |              |
| ≤2010          |           |              |           |              |           |              |
| 2011           |           |              |           |              |           |              |
| 2012           |           |              |           |              |           |              |
| 2013           |           |              |           |              |           |              |
| Care facility level |       |              |           |              |           |              |
| Number of bed  |           |              |           |              |           |              |
| ≤200           |           |              |           |              |           |              |
| 200–399        |           |              |           |              |           |              |
| 400+           |           |              |           |              |           |              |
| Ownership      |           |              |           |              |           |              |
| Private        |           |              |           |              |           |              |

| OR  | 95%CI | P     | OR  | 95%CI | P     | OR  | 95%CI | P     |
|-----|-------|-------|-----|-------|-------|-----|-------|-------|
| 1.13 | 0.96  | 1.33  | 0.150 |       |       | 1.10 | 0.92  | 1.32  | 0.292 |
| 1.06 | 0.88  | 1.29  | 0.533 |       |       | 1.07 | 0.87  | 1.32  | 0.532 |
| 1.19 | 0.98  | 1.45  | 0.081 |       |       | 1.25 | 1.00  | 1.55  | 0.046 |
| 1.45 | 1.23  | 1.71  | <0.001|       |       | 1.46 | 1.18  | 1.79  | 0.000 |
| 1.69 | 1.27  | 2.25  | <0.001|       |       | 2.03 | 1.46  | 2.82  | <0.001|
| 0.76 | 0.64  | 0.90  | 0.002 |       |       | 0.78 | 0.65  | 0.95  | 0.014 |
| 1.17 | 0.99  | 1.38  | 0.071 |       |       | 1.27 | 1.05  | 1.53  | 0.014 |
| 1.89 | 0.74  | 4.80  | 0.183 |       |       | 2.08 | 0.76  | 5.69  | 0.154 |
| 1.57 | 0.96  | 2.57  | 0.073 |       |       | 1.66 | 0.97  | 2.84  | 0.065 |
| 0.90 | 0.66  | 0.97  | 0.024 |       |       | 0.79 | 0.64  | 0.97  | 0.026 |
| 1.47 | 1.08  | 1.99  | 0.013 |       |       | 1.33 | 0.95  | 1.87  | 0.099 |
| 1.59 | 0.92  | 2.74  | 0.097 |       |       | 1.60 | 0.89  | 2.90  | 0.119 |
| 1.09 | 0.87  | 1.37  | 0.435 |       |       | 1.08 | 0.87  | 1.36  | 0.478 |
| 1.28 | 1.09  | 1.51  | 0.002 |       |       | 1.12 | 0.84  | 1.49  | 0.426 |
| 0.89 | 0.70  | 1.13  | 0.346 |       |       | 0.90 | 0.71  | 1.15  | 0.396 |
| 0.73 | 0.56  | 0.94  | 0.013 |       |       | 0.74 | 0.57  | 0.95  | 0.019 |
| 0.78 | 0.60  | 1.00  | 0.050 |       |       | 0.79 | 0.61  | 1.01  | 0.064 |
| 1.17 | 0.79  | 1.73  | 0.429 |       |       | 0.74 | 0.44  | 1.26  | 0.273 |
### Bivariate

|          | OR   | 95% CI    | P    |
|----------|------|-----------|------|
| Public   | 1.17 | 0.94 1.46 | 0.157|
| Physician density |
| 1st     | 2.05 | 1.38 3.05 | <0.001|
| 2nd     | 1.67 | 1.11 2.50 | 0.014|
| 3rd     | 2.79 | 1.89 4.10 | <0.001|
| 4th     | 1.63 | 1.08 2.45 | 0.020|
| 5th     | 1.29 | 0.85 1.98 | 0.234|
| 6th     | Reference | Reference | Reference |
| 7th     | 1.30 | 0.86 1.94 | 0.210|
| 8th     | 2.15 | 1.42 3.20 | <0.001|
| 9th     | 1.92 | 1.29 2.86 | 0.001|
| 10th    | 2.00 | 1.77 3.83 | <0.001|

### Multivariate

#### Null

|          | AOR   | 95% CI    | P    |
|----------|-------|-----------|------|
| Public   | 1.31  | 0.86 2.01 | 0.213|
| Physician density |
| 1st     | 2.46  | 1.25 4.82 | 0.009|
| 2nd     | 2.38  | 1.17 4.82 | 0.016|
| 3rd     | 2.71  | 1.32 5.55 | 0.006|
| 4th     | 2.28  | 1.14 4.55 | 0.020|
| 5th     | 1.59  | 0.79 3.19 | 0.195|
| 6th     | Reference | Reference | Reference |
| 7th     | 1.58  | 0.78 3.18 | 0.202|
| 8th     | 2.03  | 0.94 4.37 | 0.070|
| 9th     | 2.23  | 1.07 4.64 | 0.031|
| 10th    | 2.67  | 1.31 5.45 | 0.007|

#### Model 1

|          | AOR   | 95% CI    | P    |
|----------|-------|-----------|------|
| Public   | 0.16  | 0.13 0.18 | <0.001|
| Physician density |
| 1st     | <0.001 | <0.001 | <0.001|
| 2nd     | 0.59  | 0.39 0.87 | 0.087|
| 3rd     | <0.001 | <0.001 | <0.001|
| 4th     | 0.15  | 0.11 0.21 | 0.015|
| 5th     | 1.00  | 1.00 1.00 | 1.000|
| 6th     | 2.08  | 1.82 2.44 | 2.070|

#### Model 2

|          | AOR   | 95% CI    | P    |
|----------|-------|-----------|------|
| Public   | 1.93  | 1.70 2.28 | 2.070|
| Physician density |
| 1st     | 2.46  | 1.25 4.82 | 0.009|
| 2nd     | 2.38  | 1.17 4.82 | 0.016|
| 3rd     | 2.71  | 1.32 5.55 | 0.006|
| 4th     | 2.28  | 1.14 4.55 | 0.020|
| 5th     | 1.59  | 0.79 3.19 | 0.195|
| 6th     | Reference | Reference | Reference |
| 7th     | 1.58  | 0.78 3.18 | 0.202|
| 8th     | 2.03  | 0.94 4.37 | 0.070|
| 9th     | 2.23  | 1.07 4.64 | 0.031|
| 10th    | 2.67  | 1.31 5.45 | 0.007|

AOR = adjusted odds ratio, CI = confidence interval, DPC = diagnosis procedure combination, ICC = intraclass correlation coefficient, MOR = median odds ratio.
Physicians, PS stratification, culture, and education of care facilities \[13,36\] could contribute to higher rates of indwelling urethral catheter use even in affluent care resource facilities. Although there were conflicting reports as to whether more physicians could achieve higher care quality,\[4,12-41\] our findings indicate that higher physician density alone did not achieve higher care quality, which was consistent with prior research.\[38,41\] As our study results could not elucidate the specific cause of the relationships between higher physician density and higher rates of indwelling urethral catheter use, further research into this is needed.

### 4.4. Implications for policymakers

Our study found variation in indwelling urethral catheter use between care facilities. There have been few studies investigating the care quality for older people in Japan; some have reported inappropriate urethral catheter use,\[8,33,42\] suggesting that greater attention should be paid to care quality in aging societies. Governments should encourage more vigorous ongoing research using electronic administrative data, including insurance claims data, for assessing care quality. It has been reported that the rate of indwelling urethral catheter use tended to decrease once government-mandated nursing home quality measures were implemented in the United States,\[8\] although there was no similar activity in Japan. There is an urgent need to construct a framework to measure, report on, and promote the improvement of care quality for older people.

### Acknowledgments

The authors thank Fukuoka Late Elders’ Health Insurance for the provision of valuable data.

### References

1. Statistics of elderly. Available at: http://www.stat.go.jp/data/topics/top0900.htm. [Accessed February 16, 2016].
2. Okamura H, Ishii S, Ishii T, et al. Prevalence of dementia in Japan: a systematic review. Dement Geriatr Cogn Disord 2013;36:11–8.
3. The report of measure for elderly with dematia. Available at: http://www.mhlw.go.jp/file/05-Shingikai-12601000-Seisakutoukatsukan-Sanjikan_shitsu_Shakaishohoutantou/0000065682.pdf. [Accessed February 16, 2016].
4. Yap P, Tan D. Urinary incontinence in dementia – a practical approach. Aust Fam Physician 2006;35:237–41.
5. Campbell AJ, Reinken J, McCosh L. Incontinence in the elderly: prevalence and prognosis. Age Ageing 1985;14:63–70. Available at: http://www.ncbi.nlm.nih.gov/pubmed/4003185. [Accessed February 16, 2016].
[6] Lim PP, Sahadevan S, Choo GK, et al. Burden of caregiving in mild to moderate dementia: an Asian experience. Int Psychogeriatr 1999;11:411–20.

[7] Hope T, Keene J, Gedling K, et al. Predictors of institutionalization for people with dementia living at home with a carer. Int J Geriatr Psychiatry 1998;13:682–90.

[8] Gould CV, Unscheid CA, Agarwal RK, et al. Guideline for prevention of catheter-associated urinary tract infections 2009. http://www.cdc.gov/hicpac/pdf/CAUTI/CAUTIguideline2009FINAL.pdf 2009:1-67. doi:10.1086/651091.

[9] Saint S. Clinical and economic consequences of nosocomial catheter-related bacteriuria. Am J Infect Control 2000;28:68–75.

[10] Meddings J, Rogers MAM, Krein SL, et al. Reducing unnecessary urinary catheter use and other strategies to prevent catheter-associated urinary tract infection: an integrative review. BJM Qual Saf 2014;23:277–89.

[11] Sorbye LW, Finne-Soveri H, Ljunggren G, et al. Indwelling catheter use in home care: elderly, aged 65+, in 11 different countries in Europe. Age Ageing 2005;34:377–81.

[12] Platt R, Folk BF, Murdock B, et al. Mortality associated with nosocomial urinary-tract infection. N Engl J Med 1982;307:637–42.

[13] Wald H, Epstein A, Kramer A. Extended use of indwelling urinary catheters in postoperative hip fracture patients. Med Care 2005;43:1009–17.

[14] Tambahy PA, Knasinski V, Maki DG. The direct costs of nosocomial catheter-associated urinary tract infection in the era of managed care. Infect Control Hosp Epidemiol 2002;23:27–31.

[15] Greene MT, Fakhiri MG, Fowler KE, et al. Regional variation in urinary catheter use and catheter-associated urinary tract infection: results from a national collaborative. Infect Control Hosp Epidemiol 2014;35(Suppl 3):S99–106.

[16] McNulty C, Bowen J, Howell-Jones R, et al. Exploring reasons for variation in urinary catheterisation prevalence in care homes: a qualitative study. Age Ageing 2008;37:706–10.

[17] Minister of Health, Labour and Welfare. Journal of health and welfare statistics 2014/2015. J. Heal. Welf. Stat. abor Welf. Stat. Assoc. 2014.

[18] von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;4:296.

[19] Management manual for urinary catheter. Ogaki prefectural Hosp. Japanese.

[20] Management of urinary catheter. Manual Infect. Control Hokkaido Univ. [http://www2.huhp.hokudai.ac.jp/~ict-w/kansen/3.02_nyoudouyyuticatheter.p df] (in Japanese) 2006. Last access: January 26 2016

[21] Keisuke sunagawa; The Japanese Association for Infectious Diseases. Seminar for Hospital infection control http://www.kansensho.or.jp/suseninzaiyousyu/pdf/qa_all.pdf (in Japanese) 2006. Last access: February 6 2016

[22] Sundararajan V, Henderson T, Perry C, et al. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. J Clin Epidemiol 2004;57:1288–94.

[23] Maeda T, Babazono A, Nishi T, et al. Investigation of the existence of supplier-induced demand in use of gastrostomy among older adults. Medicine (Baltimore) 2016;95:e2519.

[24] Fushimi K, Hashimoto H, Imanaka Y, et al. Functional mapping of hospitals by diagnosis-dominant case-mix analysis. BMC Health Serv Res 2007;7:50.

[25] Teno JM, Mitchell SL, Gozalo PL, et al. Hospital characteristics associated with feeding tube placement in nursing home residents with advanced cognitive impairment. JAMA 2010;303:544–50.

[26] Kwabara K, Imanaka Y, Matsuda S, et al. Impact of age and procedure on resource use for patients with ischemic heart disease. Health Policy 2008;85:196–206.

[27] Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J Epidemiol Community Health 2006;60:290–7.

[28] 2011ustin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. 46:399–424.

[29] Seshamani M, Gray AM. A longitudinal study of the effects of age and time to death on hospital costs. J Health Econ 2004;23:217–35.

[30] Hogan C, Lunney J, Gabel J, et al. Medicare beneficiaries’ costs of care in the last year of life. Heal Aff 2001;20:188–95.

[31] Williams TA, Ho KM, Dobg GJ, et al. Effect of length of stay in intensive care unit on hospital and long-term mortality of critically ill adult patients, Br J Anaesth 2010;104:839–44.

[32] Insurance F late elderly. Medical expenditure of Fukuoka late-elderly insurance. http://www.fukuoka-kouji.co.jp/img/medical_expenses_h25_5.pdf (in Japanese) 2014:1-164. doi:10.1086/649293. Last access January 28

[33] Georgiou A, Potter J, Brocklehurst JC, et al. Measuring the quality of urinary continence care in long-term care facilities: an analysis of outcome indicators. Age Ageing 2001;30:63–6.

[34] Grytten J, Sørensen R. Practice variation and physician-specific effects. J Health Econ 2003;22:403–18.

[35] Nattinger AB, Gottlieb MS, Veum J, et al. Geographic variation in the use of breast-conserving treatment for breast cancer. N Engl J Med 1992;326:1102–7.

[36] Medical Practice Variation: Background Paper. Aust. Commision Safty Qual. Heal. Care (7th Edition): Routledge (London). Available at: http://www.amazon.ca/The-Economics-Health-Care-Edition/dp/0132773694. [Accessed July 15, 2015].

[37] Sherman Folland, Allen C. Goodman MS. The Economics of Health and Health Care? Health Aff 1986;5:63

[38] Cooper RA. States with more physicians have better-quality health care. Health Aff 2009;28:

[39] Perrin JM, Valvona J. Does increased physician supply affect quality of care? Health Aff 1986;5:63–72.

[40] The physician workforce. Available at: http://www.dartmouthatlas.org/keyissues/issue.aspx?con=2940. [Accessed February 20, 2016].

[41] Krakauer H, Jacoby I, Millman M, et al. Physician impact on hospital admission and on mortality rates in the Medicare population. Health Serv Res 1996;31:191–211.

[42] Knoll BM, Wright D, Ellingson L, et al. Reduction of inappropriate urinary catheter use at a veterans affairs hospital through a multifaceted quality improvement project. Clin Infect Dis 2011;52:1283–90.