

VERIFICATION OF THE DIFFERENCE BETWEEN ASPIRATION PNEUMONIA AND OTHER FORMS OF PNEUMONIA

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ABSTRACT. *The Diagnosis Procedure Combination (DPC)/Per Diem Payment System (PDPS), or DPC/PDPS, is a system that is used to calculate the bundled payment for emergency hospitalization in Japan. Pneumonia is the third leading cause of death in Japan and is covered by the DPC/PDPS. When the DPC/PDPS was revised in 2012, pneumonia was classified into aspiration pneumonia and pneumonia, acute bronchitis, and acute bronchiolitis (the latter 3 are collectively referred to here as “other forms of pneumonia”). The current study examined how the DPC/PDPS changed as a result of this revised classification of pneumonia. Results indicated that aspiration pneumonia is more prevalent among the elderly than other forms of pneumonia are and that patients with aspiration pneumonia are hospitalized for a longer period. Fees for individual medical services provided during a patient’s hospitalization were divided by the bundled cost of hospitalization (the per diem fee according to the DPC/PDPS plus fees for individual medical services) to yield the ratio of the fee-for-service (FFS) cost to the bundled cost. Both before and after revision of the DPC/PDPS, aspiration pneumonia was more prevalent when the ratio of the FFS cost to the bundled cost was 1 or less. After revision of the DPC/PDPS, aspiration pneumonia was more prevalent and other forms of pneumonia were less prevalent when the ratio of the FFS cost to the bundled cost was 1 or less. Decision tree analysis was performed. Before revision of the DPC/PDPS, the root node of the tree was the duration of hospitalization (days). After the node representing the mean duration of hospitalization (days), the tree branched into aspiration pneumonia and other forms of pneumonia. After revision of the DPC/PDPS, the root node of the tree was whether pneumonia was aspiration pneumonia or not. There was no branching beyond aspiration pneumonia. The decision branch representing pneumonia that was non-aspiration pneumonia (i.e., some other form of pneumonia) led to an event node, the duration of hospitalization (days). The event node led to event branches but no further nodes.*

Keywords: Aspiration pneumonia, Other forms of pneumonia, DPC/PDPS, The ratio of the fee-for-service (FFS) cost to the bundled cost, Decision tree method

1. Introduction. Fees for medical services are calculated to pay for medical services when healthcare is covered by insurance. These fees represent the total revenue that a medical facility earns from the provision of medical care. In Japan, healthcare is covered by National Health Insurance, and fees are calculated based on a list of medical fees (to be precise, fees are assessed as points). Since the system of medical fees was instituted in Japan, the cost of individual medical services (i.e., fees for specific medical services) was set and these fees were tallied to determine the cost of medical care. However, such a system can lead to unnecessary tests and treatments. In order to correct that problem and to curb rising medical costs as a result of the aging of Japan’s population, the Diagnosis Procedure Combination (DPC)/Per Diem Payment System (PDPS), or DPC/PDPS, was instituted in 2003. In 2012, the DPC/PDPS covered expenses for about 53.1% of all general wards in hospitals.

The DPC/PDPS calculates the bundled cost of emergency hospitalization; payment of a certain amount is determined based on the category of illness and the duration of hospitalization. Under the DPC/PDPS, hospitalization is divided into different periods. Period 1 hospitalization is the period from initial admission when the most intensive care is required until several days later. Period 2 hospitalization is the period of subsequent hospitalization (fees for this period are the average for each condition/illness). Period 3 hospitalization is the period of even further hospitalization. If hospitalization is further prolonged, fees are assessed for individual medical services as usual. The DPC/PDPS is reviewed every 2 years. Fees are set based on outcomes prior to the previous year, so if the ratio of the fee-for-service (FFS) cost to the bundled cost is close to 1 then the system is functioned as intended.

One item of the DPC/PDPS that was revised in 2012 was pneumonia, which was classified into aspiration pneumonia and other forms of pneumonia. Expenses for treatment of aspiration pneumonia now differ from those for treatment of other forms of pneumonia. If Period 1 hospitalization is prolonged, its cost increases. Overall, aspiration pneumonia involves a longer period of hospitalization than that for other forms of pneumonia. In the past, payment differed depending on whether additional conditions/illnesses were present or not. However, payment is no longer related to whether additional conditions/illnesses are present or not (Table 1, Figure 1).

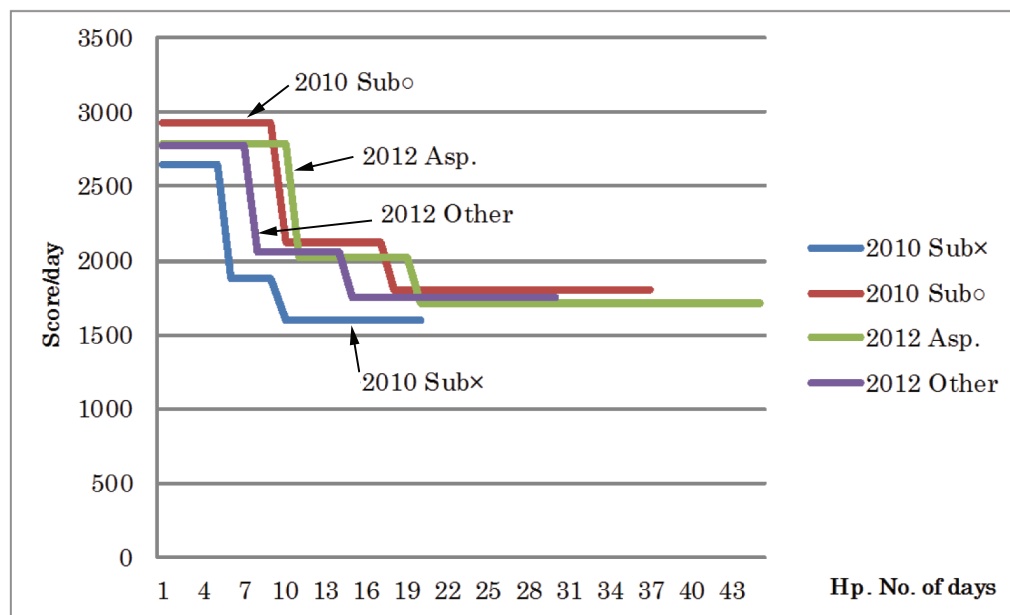


FIGURE 1. Change in the score and the duration of hospitalization (days)

The current study classified pneumonia into aspiration pneumonia and other forms of pneumonia and it varied conditions to determine their effect on the DPC/PDPS. The resulting findings could verify whether revision of the DPC/PDPS was meaningful and thus help to explore future avenues for the DPC/PDPS to take.

One aim of this study was to ascertain differences between aspiration pneumonia and other forms of pneumonia and to distinguish between the two types of pneumonia under different conditions in order to determine how those conditions affected the DPC/PDPS.

A second aim of this study was to compare aspiration pneumonia and other forms of pneumonia in terms of the duration of hospitalization (days), patient age, and the ratio of the FFS cost to the bundled cost. A decision tree analysis was then used to determine whether the distinction between pneumonia and other forms of pneumonia was evident in the ratio of the FFS cost to the bundled cost [1-4].

TABLE 1. Duration of hospitalization and score/day

Year: 2010

| DPC classification No. | Hospitalization period | | | Hospitalization period under A days | | Hospitalization period under B days | | Hospitalization period under C days | |
|------------------------|------------------------|----|-----|-------------------------------------|-----------|-------------------------------------|-----------|-------------------------------------|------------|
| | A | B | C | Hospitalization period I | Score/day | Hospitalization period II | Score/day | Hospitalization Period III | Score/day |
| | 040080xx99x00x | 5 | 9 | 20 | 1-5 days | 2,652 | 6-9 days | 1,873 | 10-20 days |
| 040080xx99x01x | 9 | 17 | 37 | 1-9 days | 2,933 | 10-17 days | 2,120 | 18-37 days | 1,802 |
| 040080xx99x1xx | 8 | 20 | 51 | 1-8 days | 3,811 | 9-20 days | 2,983 | 21-51 days | 2,536 |
| 040080xx97x0xx | 10 | 36 | 83 | 1-16 days | 2,740 | 17-36 days | 2,097 | 37-83 days | 1,782 |
| 040080xx97x1xx | 26 | 51 | 111 | 1-26 days | 3,954 | 27-51 days | 2,902 | 52-111 days | 2,467 |

Year: 2012 (Adult only)

| DPC classification No. | Hospitalization period | | | Hospitalization period under A days | | Hospitalization period under B days | | Hospitalization period under C days | |
|------------------------|-----------------------------|----|-----|-------------------------------------|-----------|-------------------------------------|-----------|-------------------------------------|-----------|
| | A | B | C | Hospitalization period I | Score/day | Hospitalization period II | Score/day | Hospitalization Period III | Score/day |
| | Aspiration pneumonia | | | | | | | | |
| 040081xx99x0xx | 10 | 19 | 45 | 1-10 days | 2,790 | 11-19 days | 2,021 | 20-45 days | 1,718 |
| 040081xx99x1xx | 9 | 22 | 56 | 1-9 days | 3,365 | 10-22 days | 2,623 | 23-56 days | 2,229 |
| 040081xx97x0xx | 23 | 45 | 99 | 1-23 days | 2,579 | 24-45 days | 1,892 | 46-99 days | 1,608 |
| 040081xx97x1xx | 30 | 59 | 134 | 1-30 days | 3,370 | 31-59 days | 2,476 | 60-134 days | 2,104 |
| Other pneumonia | | | | | | | | | |
| 040080x099x0xx | 7 | 14 | 30 | 1-7 days | 2,780 | 8-14 days | 2,054 | 15-30 days | 1,746 |
| 040080x099x1xx | 10 | 22 | 56 | 1-10 days | 3,662 | 11-22 days | 2,786 | 23-56 days | 2,368 |
| 040080x097x0xx | 17 | 38 | 91 | 1-17 days | 2,765 | 18-38 days | 2,113 | 39-91 days | 1,796 |
| 040080x097x1xx | 28 | 59 | 136 | 1-28 days | 3,766 | 29-59 days | 2,832 | 60-136 days | 2,407 |

2. Methods.

2.1. Data studied. Data were obtained from 5 hospitals. The periods studied were from July 2010 to discharge in March 2012 (before revision of the DPC/PDPS) and from April 2012 to July 2013 (after revision of the DPC/PDPS). Data were obtained on patients with aspiration pneumonia or other forms of pneumonia. In these patients, aspiration pneumonia or some other form of pneumonia required the greatest allocation of medical resources during the periods studied, i.e., aspiration pneumonia or some other form of pneumonia was listed on billing. Ninety-nine percent of the patients with aspiration pneumonia were adults (age 15 or over). Fifty-two point seven percent of the patients with other forms of pneumonia were children (under the age of 15) while 47.3% were adults. A previous study by the current authors [4] found that forms of care differ for children and adults, so the current study only analyzed adults (Table 1). Before revision of the DPC/PDPS, there were 631 cases of aspiration pneumonia and 1,715 cases of other forms of pneumonia. After revision of the DPC/PDPS, there were 242 cases of aspiration pneumonia and 437 cases of other forms of pneumonia. In total, 3,025 cases were analyzed.

2.2. Methods of analysis.

1) Differences between aspiration pneumonia and other forms of pneumonia were determined by comparing the duration of hospitalization (days), patient age, and the ratio of the FFS cost to the bundled cost before and after classification of pneumonia into 2 types.

The existence or lack of significant differences in the duration of hospitalization (days) and patient age was determined with a Mann-Whitney U test with a p value of 0.05 or less considered significant. The existence or lack of significant differences in the ratio of the FFS cost to the bundled cost for aspiration pneumonia and other forms of pneumonia was determined before and after classification of pneumonia into 2 types. Differences were determined with Pearson's χ^2 test with a p value of 0.05 or less considered significant.

2) A decision tree [5] was used to examine whether determinants of the ratio of the FFS cost to the bundled cost had an effect before and after classification of pneumonia into 2 types. The ratio of the FFS cost to the bundled cost served as a dependent variable. Whether aspiration was present or not, the duration of hospitalization (days), the age upon admission, sex, whether hospitalization was emergent or not, the reason for admission, and a code identifying the reason for admission served as independent variables. These variables represented factors that potentially affected the ratio of the FFS cost to the bundled cost, and these variables were analyzed before and after revision of the DPC/PDPS.

The statistical analysis software Statistical Package for Social Science (SPSS) Ver.22 (IBM) was used for analysis.

3. Results.

1) Duration of hospitalization (days): The median duration of hospitalization (days) was 18 days for aspiration pneumonia and 12 days for other forms of pneumonia (Table 2). $p < 0.05$, and significant differences in the duration of hospitalization (days) were noted (Table 2).

TABLE 2. Length of stay

| | Number | Average | Max. | Median | Min. |
|--------------------------|--------|---------|------|--------|------|
| Aspiration pneumonia | 873 | 23 | 290 | 18 | 2 |
| Other forms of pneumonia | 2152 | 15 | 123 | 12 | 1 |

TABLE 3. Age

| | Number | Average | Max. | Median | Min. |
|--------------------------|--------|---------|------|--------|------|
| Aspiration pneumonia | 873 | 82 | 104 | 84 | 15 |
| Other forms of pneumonia | 2152 | 74 | 106 | 78 | 15 |

2) Patient age: The median patient age was 84 years for aspiration pneumonia and 78 years for other forms of pneumonia (Table 3). $p < 0.05$, and significant differences in patient age were noted (Table 3).

3) The ratio of the FFS cost to the bundled cost: Before classification of pneumonia into 2 types, the ratio of the FFS cost to the bundled cost was 1 or less in 28.50% of the cases of aspiration pneumonia and greater than 1 in 71.50%. The ratio of the FFS cost to the bundled cost was 1 or less in 20.0% of the cases of other forms of pneumonia and greater than 1 in 80.0%. $p < 0.05$, and significant differences in the proportion of cases of aspiration pneumonia and other forms of pneumonia were noted (Table 4). After classification of pneumonia into 2 types, the ratio of the FFS cost to the bundled cost was 1 or less in 28.90% of the cases of aspiration pneumonia and greater than 1 in 71.10%, so cases where the ratio of the FFS cost to the bundled cost was 1 or less increased 0.40%. The ratio of the FFS cost to the bundled cost was 1 or less in 18.80% of the cases of other forms of pneumonia and greater than 1 in 81.20%, so cases where the ratio of the FFS cost to the bundled cost was 1 or less decreased 0.20%. In that instance, $p < 0.05$, and significant differences in the proportion of cases of aspiration pneumonia and other forms of pneumonia were noted (Table 4).

TABLE 4. The ratio of the fee-for-service (FFS) cost to the bundled cost

| | | Before revision | | After revision | |
|---|----------|----------------------|--------------------------|----------------------|--------------------------|
| | | Aspiration pneumonia | Other forms of pneumonia | Aspiration pneumonia | Other forms of pneumonia |
| The ratio of the fee-for-service (FFS) cost to the bundled cost | $1 <$ | 28.50% | 20.00% | 28.90% | 18.80% |
| | $1 \geq$ | 71.50% | 80.00% | 71.10% | 81.20% |

4) Determination with a decision tree analysis

Before revision of the DPC/PDPS, the root node of the decision tree was the duration of hospitalization (days) (Figure 2). The duration of hospitalization (days) branched into 4 nodes: hospitalization for fewer than 5 days, hospitalization for 6 to 12 days, hospitalization for 13 to 22 days, and hospitalization for longer than 23 days. There were fewer cases where the ratio of the FFS cost to the bundled cost was 1 or less with a briefer hospitalization. In other words, a greater portion of expenses was borne by the medical facility.

The event node representing hospitalization for 13 to 22 days led to a further node representing whether aspiration was present or not. The ratio of the FFS cost to the bundled cost was 1 or less in 32.6% of the cases of aspiration pneumonia and greater than 1 in 67.4%. In contrast, the ratio of the FFS cost to the bundled cost was 1 or less in 24.1% of the cases of other forms of pneumonia and greater than 1 in 75.9%.

After revision of the DPC/PDPS, the root node of the decision tree was whether aspiration was present or not (Figure 3). There was no branching beyond aspiration pneumonia. Other forms of pneumonia led to an event node representing the duration of hospitalization (days). In 94.0% of the cases of brief hospitalization (i.e., for fewer than 6 days), the ratio of the FFS cost to the bundled cost was greater than 1. Forty-eight point six

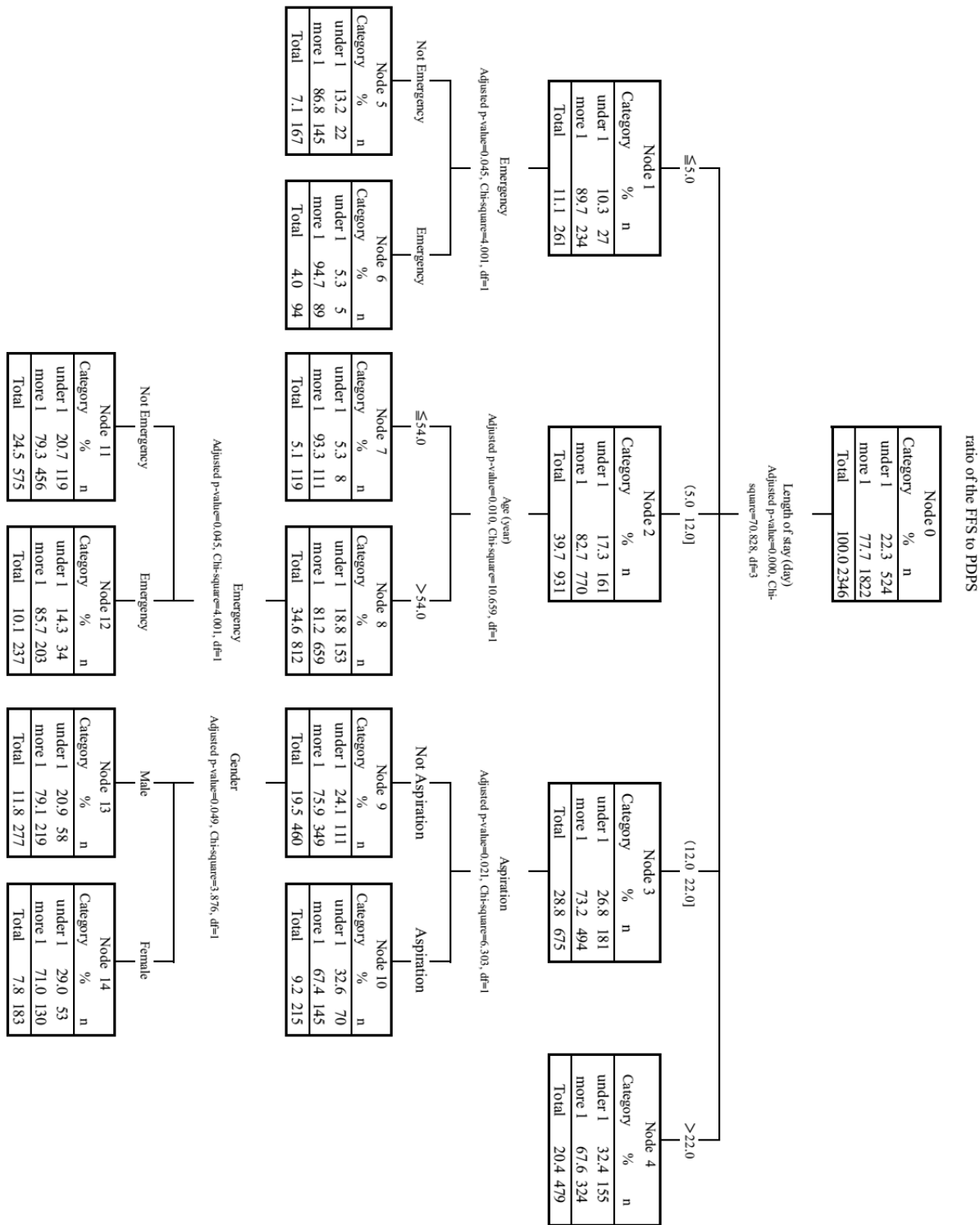


FIGURE 2. The ratio of the fee-for-service (FFS) to PDPS before revision

percent of all of the patients were hospitalized for 7 to 26 days. The ratio of the FFS cost to the bundled cost was 1 or less in 17.9% of the cases of hospitalization for 7 to 26 days and greater than 1 in 82.1%. The ratio of the FFS cost to the bundled cost was 1 or less in 35.1% of the cases of hospitalization for longer than 27 days and greater than 1 in 64.9%. Like before revision of the DPC/PDPS, there were fewer cases where the ratio of the FFS cost to the bundled cost was 1 or less with a briefer hospitalization.

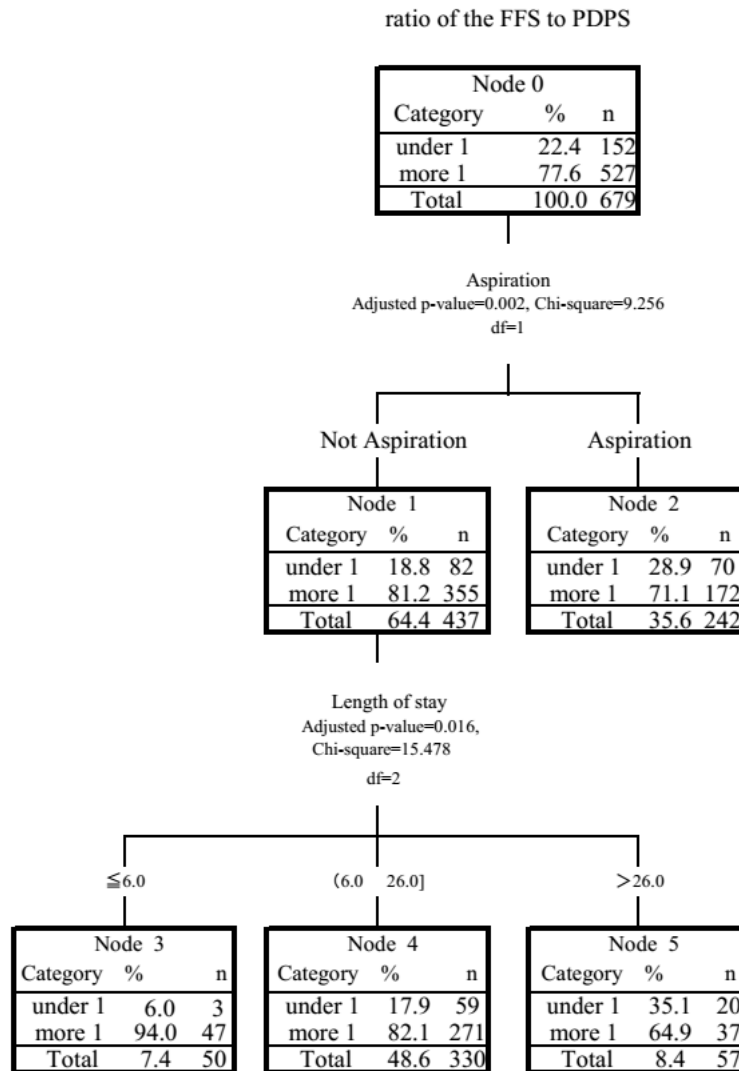


FIGURE 3. The ratio of the fee-for-service (FFS) to PDPS after revision

4. **Discussion.** Aspiration pneumonia and other forms of pneumonia differ primarily in the mechanisms that lead to their development. When physiological changes accompany age or a patient has an underlying condition in the form of a cerebrovascular disorder or a nervous system disorder, neurotransmitters decrease, causing aspiration pneumonia as a result of a diminished swallowing reflex or coughing. Elderly patients tend to be hospitalized for longer periods. Immediately after onset of a condition/illness, a patient receives intensive treatment; if the patient is hospitalized for a longer period, treatment moderates. Thus, aspiration pneumonia and other forms of pneumonia differ in terms of the age of the patient, the duration of hospitalization (days), and the ratio of the FFS cost to the bundled cost. In a sense, these differences are expected. By inference, the evidence of significant differences between the 2 types of pneumonia means that assessing the same costs for the 2 types would be unreasonable. Thus, fees have been set by distinguishing between the 2 types.

Correcting the period of hospitalization and the set fee for treatment of aspiration pneumonia did not result in branching in the decision tree after revision of the DPC/PDPS. However, other forms of pneumonia were an event node that led to branching depending on the duration of hospitalization (days), which was to be expected. Moreover, there were fewer cases where the ratio of the FFS cost to the bundled cost was less than 1 with a briefer hospitalization, and cases where the ratio of the FFS cost to the bundled cost was

less than 1 and cases where it was greater than 1 tended to be in the same proportion both before and after revision of the DPC/PDPS.

In light of these findings, the distinction between aspiration pneumonia and other forms of pneumonia that was made in 2012 has led to treatment of aspiration pneumonia in a more rational manner. However, there is still room for improvement with regard to the treatment of other forms of pneumonia.

5. Conclusion. Revision of the DPC/PDPS in 2012 distinguished aspiration pneumonia from other forms of pneumonia. Based on the data studied, this distinction has advanced the system for payment of medical expenses. This distinction proved effective for aspiration pneumonia, but other forms of pneumonia still need to be studied further. After revision of the DPC/PDPS, the proportion of cases where the ratio of the FFS cost to the bundled cost was less than 1 and cases where it was greater than 1 was about 3:7 for aspiration pneumonia, and this proportion was 2:8 for other forms of pneumonia. This fact indicates that the system for payment of medical expenses has yet to properly reflect the realities of treatment.

During revision of the DPC/PDPS in 2014, payment for treatment of aspiration pneumonia differed depending on whether additional conditions/illnesses were present or not. If additional conditions/illnesses are present, the cost during the set periods of hospitalization (Period 1, Period 2, and Period 3) is about double that when additional conditions/illnesses are absent. The set periods of hospitalization for treatment of other forms of pneumonia have changed little, but greater fees (points) are assessed for each period. In light of the revision of the DPC/PDPS in 2016, the authors would like to continue looking at the evolution of the system for payment of expenses for treatment of pneumonia in conjunction with changes in treatments.

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