Impact of board-certificated physiatrists on rehabilitation outcomes in elderly patients after hip fracture: An observational study using the Japan Rehabilitation Database

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Aim: To clarify the impact on rehabilitation outcomes of board-certificated physiatrists (BCP) as the physicians with primary responsibility for elderly patients in convalescent rehabilitation wards after hip fracture.

Methods: The present retrospective observational study used 2005–2013 data from the Japan Rehabilitation Database. We identified in-hospital patients with hip fracture admitted to rehabilitation wards. After applying exclusion criteria, 824 patients were eligible. The primary outcome was functional independence measure instrument efficiency.

Results: BCP were responsible for the care of 46% of patients with hip fracture. Patients who were managed by a BCP had significantly higher mean functional independence measure efficiency than patients who were not, both before and after adjustment by inverse propensity-score weighting (0.37 vs 0.26; \( P = 0.04 \) and 0.39 vs 0.26; \( P < 0.01 \), respectively). Additionally, the mean length of stay was significantly shorter in patients who were managed by BCP than in those who were not, both before and after inverse propensity-score weighting (65 vs 71 days, \( P = 0.04 \) and 64 vs 69 days, \( P < 0.01 \), respectively).

Conclusions: Our data suggest that the participation of BCP is associated with good rehabilitation outcomes in patients with hip fracture at convalescent rehabilitation wards. Geriatr Gerontol Int 2015; ••: ••–••.

Keywords: activities of daily living, aged, hip fracture, physical rehabilitation, retrospective study.

Introduction

Hip fracture is the most common fracture among elderly persons. The aging of populations in developed countries has led to a worldwide increase in the number of patients with hip fractures. Hip fracture is associated with a reduced ability to carry out activities of daily living, and rehabilitation is an important aspect of care in these patients. In Japan, patients who need more in-hospital rehabilitation after the acute phase are moved to a convalescent rehabilitation ward.

Many countries have education and training programs, and board-certification processes for physiatrists (rehabilitation physicians). These physiatrists evaluate disability severity, plan exercise programs, arrange an environment appropriate for rehabilitation and set goals for each therapist. A board-certificated physiatrist (BCP) is a physiatrist certified by a governing board as having obtained specific skills and knowledge related to rehabilitation medicine. In general, such board certification improves the quality of clinical practices. A previous study of stroke patients showed that better rehabilitation outcomes were achieved by hospitals with higher rates of BCP participation than by those with lower BCP participation. However, the impact of BCP participation on post-acute rehabilitation outcomes in older patients with hip fracture remains unclear.

Using propensity-score analysis of data collected from the Japan Rehabilitation Database, this retrospective observational study aimed to determine the impact of BCP, as the physicians with primary responsibility for elderly patients with hip fracture in convalescent rehabilitation wards, on rehabilitation outcomes.
Materials and methods

The present study was approved by the institutional review board of the Japanese Association of Rehabilitation Medicine, which waived the requirement for informed patient consent because of the anonymous nature of the data.

Data source

The Japan Rehabilitation Database was developed with financial support from the Ministry of Health, Labor and Welfare of Japan. Detailed clinical data were collected for rehabilitation inpatients discharged from participating hospitals beginning in 2005. This database comprises only voluntary, non-random samples. The database includes unique identifiers for the following data on patients with hip fracture: age, sex, Functional Independence Measure (FIM) scores (ranging from 18 [totally dependent] to 126 [totally independent]), length of stay in a rehabilitation ward, days from injury onset, type of fracture and whether the physician responsible was a BCP. Rehabilitation staff collected baseline data at the time of admission. Variables not collected at admission were collected at discharge. These data were submitted to the Japan Association of Rehabilitation Database, which extracted the data and sent it to researchers. By 2013, 78 hospitals had contributed to the database, providing data for 29,339 patients. All personal data are coded and any personally identifiable information has been deleted.

Patient selection

The present study included data sourced from the Japan Rehabilitation Database on patients admitted to the convalescent rehabilitation wards of 34 participating rehabilitation hospitals with a diagnosis of hip fracture from January 2005 to December 2013. The exclusion criterion was a lack of data on BCP participation. Convalescent rehabilitation wards are the main providers of inpatient rehabilitation that are covered by Japan’s medical insurance system. Patients who require further assistance in activities of daily living after acute treatment are transferred to these rehabilitation wards. BCP and non-BCP are present in almost all rehabilitation wards in Japan.

Rehabilitation programs

Rehabilitation programs focused on gait and exercise related to activities of daily living. The typical gym exercise program comprised 40–80 min of physical therapy per day for 5–7 days per week. This program included muscle-strengthening exercises and walking. Additionally, patients were encouraged to stay out of bed during the day.

Board-certificated physiatrists

In this study, we defined the BCP group as patients for whom the physician responsible for care was a BCP. The non-BCP group was defined as patients who did not receive care primarily from a BCP.

Physical medicine and rehabilitation associations in some countries define the requirements for board certification to include residency training for 2–6 years, followed by successful completion of examination. The BCP requirements of the Japanese Association of Rehabilitation Medicine include a 3-year residency program that covers the entire field of rehabilitation medicine (i.e., brain injury, spinal cord injury, cerebral palsy, musculoskeletal diseases, neurological diseases and amputation) at Japanese Association of Rehabilitation Medicine-certified institutions. The residency program is followed by final written and oral examinations. BCP must renew their certification every 5 years in Japan.

Although the route to BCP training differs slightly among countries, BCP curricula and certification systems share many similarities across the world, many of which are consistent with those of the Japanese Board. BCP working in rehabilitation wards evaluate impairment, set rehabilitation goals and lead a rehabilitation team. Medical issues specific to rehabilitation include pain, neurogenic bowel and bladder, spasticity, and disease teaching. A BCP also manages other comorbidities to prevent medical complications.

Variables and outcomes

We extracted the following data from the database: age, sex, whether the physician responsible for care was a BCP, FIM score at admission and discharge, days from injury, type and laterality of fracture, whether surgery had been carried out, comorbidities (cerebrovascular disease, orthopedic disease and dementia), and number of family members. The FIM score, a basic indicator of disability severity, is popular in Japanese rehabilitation hospitals and familiar to almost all rehabilitation staff. The instrument consists of 18 items, each of which is assessed against a 7-point ordinal scale; the higher the score for an item, the more independently the patient is able to carry out the tasks required by that item. The FIM can be subdivided into a 13-item motor subscale (eating, grooming, bathing, upper-body dressing, lower-body dressing, personal hygiene, bladder management, bowel management, bed-to-chair transfer, toilet transfer, shower transfer, walk or wheelchair and stairs) and a five-item cognitive subscale (comprehension, expression, social interaction, problem solving and memory). The motor and cognitive subscale scores range from 13 to 91 (motor FIM) and from 5 to 35 (cognitive FIM), respectively. The Japanese national health insurance scheme uses the bedridden degree to
judge the level of long-term care. This indicates handicapped elderly patients’ level of independence in daily living activities, ranging from fully independent to completely bedridden as follows: independent (fully independent), J1 and J2 (independent with some disability), A1 and A2 (moving around indoors independently, but requiring some assistance when they go out), B1 and B2 (mostly bedridden) or C1 and C2 (completely bedridden). In the present study, we divided this range of independence into four variables: independent (independent, J1 or J2), homebound (A1 or A2), mostly bedridden (B1 or B2) or completely bedridden (C1 or C2).

The primary outcome was FIM efficiency, which was calculated as follows: (discharge FIM score – admission FIM score) / length of stay in days. The secondary outcomes were motor-FIM efficiency, cognitive-FIM efficiency and length of hospital stay in days. Motor-FIM efficiency was calculated as follows: (discharge motor FIM score – admission motor FIM score) / length of stay in days. Similarly, cognitive-FIM efficiency was calculated as follows: (discharge cognitive FIM score – admission cognitive FIM score) / length of stay in days.

Statistical analysis

We compared outcomes between the BCP and non-BCP groups. We carried out inverse probability weighting (IPW), which is part of a larger family of causal methods known as the marginal structural model. IPW is a propensity score-based method that uses weights based on the propensity score to create a synthetic sample in which the distribution of measured covariates is independent of treatment assignment. The propensity score is the probability of treatment assignment that is conditional on observed characteristics. In particular, the propensity score is a balancing score. After applying this score, the distribution of observed covariates will be similar between treated and untreated subjects. The use of IPW is similar to the use of survey sampling weights, which are used to weigh survey samples so that they are representative of specific populations. IPW attempts to simulate a randomized experimental situation in which both groups are comparable in observed prognostic factors.

Quasi-experimental design using a marginal structural model

A quasi-experimental design is created when the probability (propensity score) that a patient would have been treated is used to adjust the estimate of the treatment effect. Four steps are required to construct a marginal structural model by IPW using the propensity score: (i) estimation of the propensity score; (ii) weighting; (iii) balance checking; and (iv) estimation of impact.

We estimated the propensity score for the allocation of BCP with a non-parsimonious multivariable logistic regression model using the following predictor variables: age, sex, FIM at admission, motor FIM at admission, days from injury, type of fracture, presence of surgery, number of family members, year of admission, comorbidities (cerebrovascular disease, orthopedic disease and dementia) and premorbid bedridden degree. These baseline variables included confounding variables and those related to exposure and outcome. The c-statistic for goodness of fit was 0.76 in the propensity-score model. We treated within-hospital correction using generalized estimation equations, which are commonly used to analyze clustered data, while correcting for confounding by cluster.

The BCP group was weighted by the inverse of the propensity score, and the non-BCP group was weighted by the inverse of 1 minus the propensity score. Descriptive statistics for all patients, either with or without IPW adjustment, were carried out to check covariate balance and estimate influence. Student’s t-test and the $\chi^2$-test were used to compare the BCP and non-BCP groups.

Values are expressed as the mean ± standard deviation. We carried out all statistical analyses using IBM SPSS Statistics for Windows, version 22.0 (IBM, Armonk, NY, USA). The threshold for significance was a value of $P < 0.05$.

Results

We identified 838 patients with hip fracture treated at convalescent rehabilitation wards. A total of 14 patients with incomplete data regarding BCP involvement were excluded; thus, 824 patients were eligible for analysis. Table 1 shows the demographics for all patients in the BCP and non-BCP groups before and after IPW adjustment. Mean FIM efficiency was significantly greater in the BCP group than in the non-BCP group before ($P = 0.04$) and after ($P < 0.01$) IPW adjustment. Mean motor-FIM efficiency was significantly greater in the BCP group than in the non-BCP group before ($P < 0.01$) and after ($P < 0.01$) IPW adjustment. Mean cognitive-FIM efficiency was significantly greater in the BCP group than in the non-BCP group after ($P = 0.04$).
<table>
<thead>
<tr>
<th></th>
<th>Unadjusted data</th>
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<th>Data adjusted by IPW</th>
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<tbody>
<tr>
<td></td>
<td>Total ((n = 824))</td>
<td>BCP ((n = 379))</td>
<td>Non-BCP ((n = 445))</td>
<td>(P) value</td>
<td>BCP ((n = 379))</td>
</tr>
<tr>
<td>Mean age ± SD (years)</td>
<td>81.8 ± 30.7</td>
<td>81.5 ± 10.3</td>
<td>82.1 ± 9.5</td>
<td>0.38</td>
<td>81.6 ± 10.1</td>
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<tr>
<td>Female (%)</td>
<td>80.2</td>
<td>79.7</td>
<td>80.7</td>
<td>0.73</td>
<td>79.9</td>
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<tr>
<td>Fracture type (%)</td>
<td></td>
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<tr>
<td>Femoral neck (%)</td>
<td>86.2</td>
<td>81.0</td>
<td>90.6</td>
<td>&lt;0.01</td>
<td>83.7</td>
</tr>
<tr>
<td>Trochanteric (%)</td>
<td>13.8</td>
<td>19.0</td>
<td>9.4</td>
<td>16.3</td>
<td>14.2</td>
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<tr>
<td>Non-operative (%)</td>
<td>6.1</td>
<td>3.4</td>
<td>8.3</td>
<td>&lt;0.01</td>
<td>6.5</td>
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<tr>
<td>Comorbidities (%)</td>
<td></td>
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<tr>
<td>Cerebrovascular disease</td>
<td>16.6</td>
<td>16.9</td>
<td>16.4</td>
<td>0.85</td>
<td>17.4</td>
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<tr>
<td>Orthopedic disease</td>
<td>26.3</td>
<td>28.2</td>
<td>24.7</td>
<td>0.27</td>
<td>28.0</td>
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<tr>
<td>Dementia</td>
<td>40.2</td>
<td>40.4</td>
<td>40.0</td>
<td>0.94</td>
<td>35.9</td>
</tr>
<tr>
<td>Pre-injury bedridden degree (%)</td>
<td>46.1</td>
<td>44.3</td>
<td>47.6</td>
<td>0.45</td>
<td>43.7</td>
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<tr>
<td>Independent</td>
<td>26.0</td>
<td>26.4</td>
<td>25.6</td>
<td>0.45</td>
<td>27.7</td>
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<tr>
<td>Homebound</td>
<td>13.5</td>
<td>11.3</td>
<td>15.3</td>
<td>0.27</td>
<td>15.9</td>
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<tr>
<td>Mostly bedridden</td>
<td>3.8</td>
<td>5.3</td>
<td>2.5</td>
<td>0.3</td>
<td>3.3</td>
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<tr>
<td>Completely bedridden</td>
<td>10.7</td>
<td>12.7</td>
<td>9.0</td>
<td>0.94</td>
<td>9.4</td>
</tr>
<tr>
<td>Mean days from onset ± SD (days)</td>
<td>22.6 ± 18.4</td>
<td>24.2 ± 18.5</td>
<td>21.3 ± 18.3</td>
<td>0.03</td>
<td>21.6 ± 17.9</td>
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<tr>
<td>Mean admission FIM ± SD</td>
<td>73.0 ± 26.5</td>
<td>75.5 ± 26.1</td>
<td>70.9 ± 26.7</td>
<td>0.01</td>
<td>73.0 ± 27.4</td>
</tr>
<tr>
<td>Mean admission motor FIM ± SD</td>
<td>48.2 ± 48.2</td>
<td>50.2 ± 19.9</td>
<td>46.6 ± 20.6</td>
<td>0.01</td>
<td>48.3 ± 21.0</td>
</tr>
</tbody>
</table>

BCP, board-certificated physiatrist; FIM, Functional Independence Measure; IPW, inverse probability weighting; SD, standard deviation.
Table 2  Outcomes of the BCP and non-BCP groups

<table>
<thead>
<tr>
<th></th>
<th>BCP (n = 379)</th>
<th>Non-BCP (n = 445)</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Unadjusted data (n = 824)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIM efficiency ± SD</td>
<td>0.37 ± 0.75</td>
<td>0.26 ± 0.74</td>
<td>0.04</td>
</tr>
<tr>
<td>Motor FIM efficiency ± SD</td>
<td>0.34 ± 0.57</td>
<td>0.25 ± 0.67</td>
<td>0.04</td>
</tr>
<tr>
<td>Cognitive FIM efficiency ± SD</td>
<td>0.03 ± 0.23</td>
<td>0.01 ± 0.10</td>
<td>0.15</td>
</tr>
<tr>
<td>Mean length of stay ± SD (days)</td>
<td>64.9 ± 29.0</td>
<td>70.8 ± 31.9</td>
<td>0.01</td>
</tr>
<tr>
<td>Data adjusted by IPW (n = 824)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FIM efficiency ± SD</td>
<td>0.39 ± 0.69</td>
<td>0.26 ± 0.86</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Motor FIM efficiency ± SD</td>
<td>0.35 ± 0.54</td>
<td>0.25 ± 0.78</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cognitive FIM efficiency ± SD</td>
<td>0.03 ± 0.19</td>
<td>0.01 ± 0.10</td>
<td>0.04</td>
</tr>
<tr>
<td>Mean length of stay ± SD (days)</td>
<td>63.5 ± 29.2</td>
<td>68.7 ± 29.8</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

BCP, board-certificated physiatrist; FIM, Functional Independence Measure; IPW, inverse probability weighting; SD: standard deviation.

Discussion

In the present study, we used a large rehabilitation inpatient database to examine the impact of BCP on FIM efficiency. After IPW adjustment, BCP were significantly associated with increased FIM efficiency, and the length of stay was significantly shorter in the BCP group.

Clinical studies in other medical fields have identified the important role of BCP in facilitating appropriate and aggressive therapeutic interventions, which often lead to better functional recovery.20–22 In the field of rehabilitation medicine, one study showed that the presence of a BCP was an indicator of value for a rehabilitation hospital.5 However, that study might have had confounding by cluster. We assumed that allocation of BCP depended on the preferences of hospitals. These preferences caused a within-center correlation with the response variables. Such correlation or clustering occurs when outcomes within centers tend to be more similar to one another than to outcomes in other centers. In the present study, we adjusted for data clustering with generalized estimation equations.

In this study, the biggest limitation was selection bias. Allocation of BCP is affected by prior information on patient characteristics and hospital records. As a result, the characteristics of the BCP group systematically differed from those of the non-BCP group. Therefore, we needed to account for these systematic differences in characteristics between the two groups when estimating the influence of BCP care on outcomes. Historically, researchers have relied on the use of regression adjustment to account for differences in measured characteristics between two groups. However, analyzing causal effects in an observational study is generally difficult because of selection bias. Therefore, we adjusted for differences in the baseline characteristics of patients by using IPW to remove the selection bias and ensure comparability.23

Propensity-score analysis requires a large sample size to achieve statistically reliable results.23 In the present study, a large sample size was possible because we used the Japan Rehabilitation Database, which contains a large proportion of the hip fracture rehabilitation population. Additionally, a randomized controlled trial would have been difficult to carry out, because the practice of board certification is widespread. Therefore, a large-scale observational study using propensity-score analysis was a feasible alternative to a randomized controlled trial.

Although the specific mechanisms by which BCP were associated with good rehabilitation outcomes are not clear, several reasons can be speculated. BCP residency programs include the management of patients with complicated rehabilitation courses. Therefore, BCP might excel at managing clinical complications that adversely affect rehabilitation. BCP can keep patients in good physical condition, and increase the quality and quantity of rehabilitation. Additionally, BCP function as leaders of rehabilitation teams, and are familiar with the coordination of interdisciplinary rehabilitation teams.24 A good rehabilitation team enables patients to achieve their maximum potential. We speculate that BCP influence rehabilitation outcomes through comprehensive management of patients’ rehabilitative care and by building good interdisciplinary teamwork.

It has been reported that approximately 4000 BCP are currently required in Japan, but that there were approximately 2000 BCP in 2015.24 Furthermore, almost all BCP are employed in acute care hospital settings, with just 14% working at rehabilitation hospitals. Many countries do not have enough BCP or education and
training opportunities; therefore, investment in increasing these factors is required to improve the quality of rehabilitative management in Japan and elsewhere.

Several limitations of the present study should be acknowledged. First, the database that we used lacks detailed information, including the training backgrounds of BCP. Second, because we did not have detailed data on the individual practice styles of BCP, we were unable to determine the specific qualities and practices that achieved good recovery outcomes. Third, the Japan Rehabilitation Database consists only of voluntary samples, not random samples. As a result, application of these findings to all patients with hip fracture undergoing rehabilitation might be limited. Fourth, we did not receive enough information about the type of surgery.

In conclusion, primary responsibility for rehabilitative care by BCP is associated with improved functional recovery of elderly patients with hip fracture after rehabilitation. Increasing the number of BCP may improve the quality of rehabilitative management.

Acknowledgments

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Disclosure statement

No potential conflicts of interest were disclosed.

References