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Healthcare resource utilization and clinical outcomes associated with acute care and inpatient rehabilitation of stroke patients in Japan

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Abstract

Objective: To investigate healthcare resource utilization and changes in functional status in stroke patients during hospitalization in an acute hospital and a rehabilitation hospital.
Design: Retrospective cohort study.
Setting: One acute and one rehabilitation hospital in Japan.
Participants: Patients who were admitted to the acute hospital due to stroke onset and then transferred to the rehabilitation hospital ($n = 263$, 56% male, age 70 ± 12 years).
Main outcome measures: Hospitalization costs and functional independence measure (FIM) were evaluated according to stroke subtype and severity of disability at discharge from the acute hospital.
Results: Median (IQR) costs at the acute hospital were dependent on the length of stay (LOS) and implementation of neurosurgery, which resulted in higher costs in subarachnoid hemorrhage [$52 413 ($49 166–$72 606) *vs* $14 129 ($11 169–$19 459) in cerebral infarction; and *vs* $15 035 ($10 920–$21 864) in intracerebral hemorrhage]. The costs at the rehabilitation hospital were dependent on LOS, and higher in patients with moderate disability than in those with mild disability [$30 026 ($18 419–$39 911) *vs* $18 052 ($10 631–$24 384)], while those with severe disability spent $25 476 ($13 340–$43 032). Patients with moderate disability gained the most benefits during hospitalization in the rehabilitation hospital, with a median (IQR) total FIM gain of 16 (5–24) points, compared with a modest improvement in patients with mild (6, 2–14) or severe disability (0, 0–5).
Conclusions: The costs for in-hospital stroke care were substantial and the improvement in functional status varied by severity of disability. Our findings would be valuable to organize efficient post-acute stroke care.

Key words: stroke, hospital care, rehabilitation/long-term care, healthcare costs

Introduction

Stroke is one of the leading causes of mortality worldwide, and the burden of stroke is great and increasing in terms of disability-adjusted life-years lost [1, 2]. The projected number of stroke patients will remain at >2.8 million until 2030 in Japan despite a decrease in total population [3]. The economic burden of cerebrovascular disease is also considerable: the direct medical cost was $17 billion in Japan [4].

Stroke care consists of acute, rehabilitation and long-term care provided in various settings, including inpatient, outpatient, community-based and informal care, and often in combination. Approximately 40% of stroke survivors are left with functional impairment [5], and rehabilitation is key to facilitating patients' independence after stroke and to helping them cope with their disabilities. A number of management strategies for stroke patients have been introduced and evaluated from health outcomes and economic perspectives [6–8]. An appropriate selection of a rehabilitation setting meeting the needs of the individual patients is essential for delivering cost-effective rehabilitation services [7–11]. Stroke severity is the most powerful predictor of ability to participate in and benefit from stroke rehabilitation, and can be a major determinant of patient disposition after acute care [9].

At present, in Japan, after stroke patients undergo acute care including neurosurgery, rehabilitation is generally initiated early in acute hospitals. Then, some patients are transferred to rehabilitation hospitals to receive further rehabilitation over several months. In this study, we aimed to investigate healthcare resource utilization and changes in functional status during consecutive inpatient stroke care including acute care and inpatient rehabilitation.

Methods

Study design and setting

This retrospective cohort study used data derived from medical records and inpatient claims from an acute hospital (Kurashiki Central Hospital, Okayama, Japan) and a rehabilitation hospital (Kurashiki Rehabilitation Hospital, Okayama, Japan). The acute hospital serves ~800 000 citizens with over 1000 inpatient beds and a stroke care unit, and the rehabilitation hospital is one of the major dispositions from the acute hospital. The research protocol was approved by the ethical review boards at Kyoto University and both hospitals.

Patients

All stroke patients who were admitted to the acute hospital between April 2008 and August 2012 were screened, and patients who received further inpatient rehabilitation in the rehabilitation hospital were selected for the study. Patients were followed up from admission to the acute hospital until the end of planned inpatient rehabilitation in the rehabilitation hospital or censoring due to death or loss to follow-up, e.g. transferring to other hospitals. Patients undergoing rehabilitation needing repeat admission and discharge between the two hospitals for stroke-related interventions, recurrences of stroke (including transient ischemic attacks), gastrostomy or pneumonia before completion of the predefined rehabilitation plans were continuously followed up. Patients were counted twice if they were admitted to the acute hospital with another stroke onset after stroke care for the previous stroke event had been completed. Patients requiring treatment for cancer during the follow-up period and patients developing stroke during a stay in the acute hospital for other medical reasons were excluded.

Main measurements

Primary diagnosis of stroke subtype (cerebral infarction, CI; intracerebral hemorrhage, ICH and subarachnoid hemorrhage, SAH) was determined for each patient. Demographics of patients, including age, sex, lifestyle variables, comorbidities, scores for the Japan Coma Scale (JCS), a measure of disturbed consciousness commonly used in Japan [12], at admission to the acute hospital, and modified Rankin Scale (mRS) at discharge from the acute hospital were collected. Neurosurgical procedures undergone and the total time spent in rehabilitation were examined. Outcome measures included length of stay (LOS), functional independence measure (FIM) and hospitalization costs. The FIM scores on the dates closest to admission and discharge were collected in the rehabilitation hospital, but for some patients ending their follow-up in the acute hospital, the FIM scores at discharge from the acute hospital were alternatively used for the analysis.

The mRS is a global scale for measuring the degree of independence, with scores from 0 (no symptoms) to 5 (severe disability) and 6 (death) [13]. We classified patients into three severity levels based on the scores of mRS: mild (mRS 1 and 2), moderate (mRS 3 and 4) and severe disabilities (mRS 5). The FIM employs 13 motor and 5 cognitive items, with scores from 1 (total assistance) to 7 (complete independence) [14], and is the most widely accepted functional assessment measure used in the rehabilitation community [15]. We evaluated patients' premorbid independence based on the FIM scores for eating, toileting and walking, and patients with scores of 6 or 7 in all three items were considered independent.

Cost analyses were performed from the payer perspective based on inpatient claims. The acute hospital used a diagnosis procedure combination/per-diem payment system, and costs for surgery, including neurosurgery and other surgical procedures, and rehabilitation were separately calculated. The rehabilitation hospital used a fee-for-services system, and we identified costs for rehabilitation separately. Costs in Japanese yen were converted to US dollars based on the average of purchasing power parities between 2008 and 2012 ($1 = ¥111) [16]. Inflation during the study period was not considered.

Analysis

Characteristics of the study cohort were described. Resource utilization and clinical outcomes were compared by stroke subtype (CI, ICH and SAH) or severity based on the mRS (mild, moderate and severe). Stratified analyses according to age (<65 and ≥65 years) were performed in patients with CI and ICH and in patients with mild and moderate disabilities. No stratified analysis was conducted in patients with SAH or severe disability due to the small sample sizes. For three-group comparisons, continuous variables were compared by the analysis of variance or the Kruskal–Wallis test, and categorical variables were compared by the chi-square test. We then performed Tukey's test, or Wilcoxon rank-sum test or chi-square test with Bonferroni correction to identify the differences between groups. For stratified analyses by age group, Wilcoxon rank-sum test or chi-square test was used. Correlations among costs and LOS were evaluated using Spearman's rank order correlation. All analyses were performed with IBM SPSS Statistics Version 22 (Armonk, NY, USA). A $P < 0.05$ (or $P < 0.017$ after Bonferroni correction) was considered statistically significant.

Results

Patient characteristics

During the study period, there were 3135 admissions due to stroke events to the acute hospital. Among these admissions, except for

7 missing data on their dispositions, 1363 (43%) discharged home and 243 (8%) died. The remaining 1522 (49%) were transferred to other hospitals or care facilities.

The study cohort included 263 patients who underwent treatment in the acute hospital, followed by admission to the rehabilitation hospital (Table 1). Mean age was 70 years (SD 12 years) and 146 (56%) were male. The stroke subtypes of the patients were CI in 166 patients (63%), ICH in 70 patients (27%) and SAH in 27 patients (10%). One-third of the patients had previous stroke events before the current hospitalization. The most frequently reported comorbidity was hypertension (71%), followed by diabetes (23%) and dyslipidemia (19%). Most patients (89%) were independent in daily life before the current stroke onset. Consciousness levels based on the JCS at admission to the acute hospital were alert in 49 patients (19%), disoriented but awake in 148 patients (56%), arousable with stimulation in 46 patients (17%) and unarousable in 20 patients (8%). Two-thirds of the patients discharged home, and two patients (0.8%) died during the follow-up period.

Outcomes by stroke subtype

The total costs and LOS for CI, ICH and SAH were $36 449 and 110 days, $47 812 and 139 days, and $80 719 and 145 days, respectively (Table 2). The cost at the acute hospital was the highest for SAH patients ($52 413 in 53 days), due to these patients having the highest rate of neurosurgery and the longest LOS. The costs and LOS at the acute hospital were comparable between CI ($14 129 in 29 days) and ICH patients ($15 035 in 31 days). Positive correlations were observed between costs and LOS for all stroke subtypes during hospitalization at the acute hospital (CI: $r = 0.89$, ICH: $r = 0.80$, SAH: $r = 0.75$, all $P < 0.001$). The costs and LOS for CI, ICH and SAH at the rehabilitation hospital were $22 571 in 84 days, $29 757 in 107 days, and $25 887 in 98 days, respectively. Strongly positive correlations were observed between costs and LOS for all stroke subtypes (all $r > 0.9$, all $P < 0.001$). The total FIM scores increased from 84 to 102 in CI, 74 to 102 in ICH and 80 to 96 in SAH during hospitalization at the rehabilitation hospital.

Table 1 Characteristics of the overall study cohort ($N = 263$)

Characteristics	*n* (%)/mean ± SD
Age (years)	70 ± 12
Sex (male)	146 (56)
Stroke subtype	
CI	166 (63)
ICH	70 (27)
SAH	27 (10)
Smoking status	
Never smoker	160 (61)
Past smoker	39 (15)
Current smoker	63 (24)
Missing	1 (0)
Alcohol consumption	
Non-drinker/occasional drinker	178 (68)
Drinker	79 (30)
Missing	6 (2)
Previous stroke	85 (32)
Comorbidities	
Hypertension	186 (71)
Diabetes mellitus	60 (23)
Dyslipidemia	49 (19)
Dementia	27 (10)
Atrial fibrillation	22 (8)
Independence before stroke onset	
Independent	235 (89)
Dependent	21 (8)
Missing	7 (3)
Number of family members living together	
0	31 (12)
1	91 (35)
≥2	141 (54)
Living situation	
Own house	229 (87)
Tenant	29 (11)
Others	2 (1)
Missing	3 (1)

Outcomes by severity of disability

The scores of mRS at discharge from the acute hospital were 1 in 20 patients (8%), 2 in 54 patients (21%), 3 in 63 patients (24%), 4 in 103 patients (39%) and 5 in 22 patients (8%), with 1 patient's data missing. The total costs and LOS for patients with mild, moderate and severe disabilities were $32 402 in 95 days, $49 135 in 139 days and $52 932 in 155 days, respectively (Table 3). Patients with severe disability had the longest LOS and highest cost in the acute hospital ($25 271 in 47 days), while these were comparable between patients with mild ($13 547 in 29 days) and moderate disabilities ($15 925 in 31 days). In the rehabilitation hospital, patients with moderate disability consumed more costs and spent longer time in rehabilitation than patients with mild disability ($30 026 *vs* $18 052, $P < 0.001$; and 171 h *vs* 102 h, $P < 0.001$), but there were no significant differences between patients with moderate and severe disabilities ($30 026 *vs* $25 476; and 171 h *vs* 121 h). Strong correlations were observed between costs and LOS in the acute or rehabilitation hospitals for all levels of severity (acute hospital: all $r > 0.8$, all $P < 0.001$, and rehabilitation hospital: all $r > 0.9$, all $P < 0.001$). The total FIM gain was higher in patients with moderate disability (16 points gain) than in those with mild (6 points gain) or severe disability (0 points gain). On the per day basis, the rehabilitation time and the costs for patients with mild, moderate and severe disabilities were 1.5 h and $269, 1.6 h and $278, and 1.3 h and $250, respectively, at the rehabilitation hospital.

Analyses by age group

Some age differences were observed in costs and functional status. In ICH patients, patients aged ≥65 years had higher total cost ($50 420 *vs* $40 064 for patients <65 years, $P = 0.039$) and longer LOS (144 *vs* 128 days, $P = 0.017$) (Supplementary Table S1). In both stroke subtypes, patients aged ≥65 years had a lower total FIM at admission (CI 79 *vs* 113, $P < 0.001$; and ICH 58 *vs* 92, $P < 0.001$) and at discharge (CI 94 *vs* 120, $P < 0.001$; and ICH 82 *vs* 114, $P < 0.001$). In patients with mild disability, patients aged ≥65 years had a longer LOS in total (105 *vs* 87 days, $P = 0.028$) and in the rehabilitation hospital (74 *vs* 63 days, $P = 0.042$), and higher costs in the rehabilitation hospital ($20 134 *vs* $15 863, $P = 0.048$) (Supplementary Table S2). In patients with either mild or moderate disability, patients aged ≥65 years had a lower total FIM at admission (mild 101 *vs* 119, $P < 0.001$; and moderate 73 *vs* 82, $P = 0.015$) and at discharge (mild 114 *vs* 122, $P < 0.001$; and moderate 86 *vs* 103, $P = 0.002$).

Discussion

In this study, we characterized stroke patients who underwent inpatient rehabilitation after discharge from an acute hospital from

Table 2 Healthcare resource utilization and functional status by stroke subtype

	CI (n = 166)	ICH (n = 70)	SAH (n = 27)	P values
Age (years)	73 ± 12	65 ± 12	65 ± 14	<0.001
Sex (male)	101 (61)	36 (51)	9 (33)	0.021
Independent before stroke onset[a]	145 (90)	64 (96)	26 (96)	0.213
mRS at discharge from acute HP[b]	3 (2–4)	4 (3–4)	3 (2–4)	0.011
Home disposition	115 (69)	41 (59)	18 (67)	0.283
Neurosurgery	12 (7)	16 (23)	26 (96)	<0.001
Rehabilitation time (h)				
Total	155 (104–253)	210 (139–285)	189 (115–267)	0.025
Acute HP	32 (22–43)	32 (24–43)	43 (36–55)	0.001
Rehabilitation HP	119 (70–215)	171 (102–248)	144 (58–240)	0.029
LOS (days)				
Total	110 (83–165)	139 (99–181)	145 (114–202)	0.005
Acute HP	29 (21–38)	31 (24–37)	53 (44–74)	<0.001
Rehabilitation HP	84 (51–130)	107 (75–148)	98 (47–146)	0.058
Costs (USD)				
Total	36 449 (27 885–55 087)	47 812 (34 569–59 930)	80 719 (65 922–107 748)	<0.001
Acute HP	14 129 (11 169–19 459)	15 035 (10 920–21 864)	52 413 (49 166–72 606)	<0.001
Surgery	0 (0–0)	0 (0–855)	19 906 (15 646–23 219)	<0.001
Rehabilitation	2389 (1615–3245)	2 445 (1 743–3 064)	2 938 (2 534–4 100)	0.004
Other	11 602 (9207–16 155)	12 319 (8 820–14 543)	30 955 (26 802–38 499)	<0.001
Rehabilitation HP	22 571 (13 527–35 790)	29 757 (18 548–40 750)	25 887 (11 617–41 218)	0.053
Rehabilitation	7918 (4 668–14 058)	11 116 (6 706–16 334)	9359 (3795–16 058)	0.036
Other	14 218 (8 762–22 916)	18 573 (11 888–25 916)	15 693 (7827–24 474)	0.091
FIM at rehabilitation HP admission				
Total	84 (50–111)	74 (36–101)	80 (43–101)	0.093
Motor	59 (30–79)	51 (20–74)	61 (26–76)	0.238
Cognitive	27 (19–33)	23 (14–30)	19 (13–25)	<0.001
FIM at rehabilitation HP discharge				
Total	102 (72–119)	102 (66–116)	96 (80–105)	0.478
Motor[b]	75 (48–86)	74 (48–85)	75 (61–83)	0.965
Cognitive[b]	29 (20–34)	27 (17–32)	24 (16–29)	0.011
FIM gain				
Total	10 (2–18)	12 (5–29)	11 (0–27)	0.092
Motor[b]	10 (1–17)	10 (3–24)	10 (0–23)	0.263
Cognitive[b]	0 (0–2)	2 (0–4)	2 (0–4)	<0.001

HP, hospital; USD, United States Dollars. Number of patients (%) or median (IQR) is shown, except for age (mean ± SD). FIM gain values were calculated by subtracting the first FIM score from the last FIM score for each patient.

[a] n = 256 (7 missing values).

[b] n = 262 (1 missing value).

two aspects: healthcare resource utilization and changes in functional status. Hospitalization costs per patient based on real-world data were substantial, and highly depended on LOS. Costs at the acute hospital were also dependent on whether or not the patient underwent neurosurgery, which would explain the higher costs in SAH patients. The cost differences for acute care by stroke subtype were also observed in previous studies. Higher costs in SAH patients were in line with findings from studies in the US, despite LOS being shorter in those studies [17, 18]. Our results showed similar costs in the acute hospital in CI and ICH patients although a study conducted from 2000 to 2001 in Japan showed higher costs in ICH patients than CI patients for acute care [19]. This discrepancy may be partly explained by differences in the characteristics of the study cohorts: thus, our cohort included patients who required subsequent inpatient rehabilitation and did not include those directly discharged home from the acute hospital.

Based on our results, patients with moderate disability showed the greatest improvements in FIM scores during subsequent inpatient rehabilitation, while those with mild or severe disability had only modest increases in FIM. Taking into account the substantial costs of stroke care for patients with mild and severe disabilities in our study cohort, we might have to consider efficient care settings suitable for these patients. The limited improvements in patients with mild disability could be attributed to the ceiling effects [9]. In Canada, inpatient rehabilitation for patients with mild disability is not recommended, with outpatient or community-based rehabilitation considered to be more cost-effective for this population [10, 20]. For patients with severe disability, further discussion is needed to select or establish rehabilitation settings based on comprehensive considerations from not only clinical and economic but ethical aspects [21].

Potential candidates of inpatient rehabilitation can be determined based on severity, but actually, the severity of patients who underwent inpatient rehabilitation has been shown to vary among facilities both within a country and across countries [22–24]. A range of factors might affect the decision, including individual patient factors, cultural expectations, levels of family support, living conditions, healthcare delivery system for acute and rehabilitative care, availability of rehabilitation services (inpatient or alternative) and health insurance [11, 20, 25–28]. These variations among

Table 3 Healthcare resource utilization and functional status by severity at discharge from the acute hospital

	Mild [mRS 1 or 2] ($n = 74$)	Moderate [mRS 3 or 4] ($n = 166$)	Severe [mRS 5] ($n = 22$)	*P* values
Age (years)	67 ± 12	71 ± 12	73 ± 15	0.026
Sex (male)	50 (68)	84 (51)	11 (50)	0.044
Independent before stroke onset[a]	66 (90)	151 (94)	17 (81)	0.117
Stroke subtype				
CI	51 (69)	104 (63)	10 (45)	0.220
ICH	14 (19)	47 (28)	9 (41)	
SAH	9 (12)	15 (9)	3 (14)	
Home disposition	70 (95)	101 (61)	2 (9)	<0.001
Neurosurgery	12 (16)	33 (20)	9 (41)	0.039
Rehabilitation time (h)				
Total	131 (87–183)	207 (128–290)	149 (88–257)	<0.001
Acute HP	31 (23–42)	35 (24–46)	36 (20–45)	0.219
Rehabilitation HP	102 (56–141)	171 (101–246)	121 (46–222)	<0.001
LOS (days)				
Total	95 (73–122)	139 (100–179)	155 (95–200)	<0.001
Acute HP	29 (21–35)	31 (22–41)	47 (30–72)	0.001
Rehabilitation HP	67 (44–90)	108 (73–141)	109 (48–150)	<0.001
Costs (USD)				
Total	32 402 (24 938–47 972)	49 135 (34 223–66 124)	52 932 (35 577–69 717)	<0.001
Acute HP	13 547 (10 648–17 140)	15 925 (11 304–23 022)	25 271 (15 763–40 164)	0.001
Surgery	0 (0–0)	0 (0–11)	661 (0–8 679)	0.014
Rehabilitation	2404 (1647–3 086)	2 582 (1 770–3 391)	2 670 (1 455–3 126)	0.292
Other	10 789 (8583–14 110)	13 087 (9 458–18 035)	20 870 (14 001–29 748)	<0.001
Rehabilitation HP	18 052 (10 631–24 384)	30 026 (18 419–39 911)	25 476 (13 340–43 032)	<0.001
Rehabilitation	6655 (3 788–9462)	11 137 (6 923–16 232)	7963 (3000–14 836)	<0.001
Other	11 239 (7663–15 369)	18 573 (11 678–24 649)	15 023 (8222–25 057)	<0.001
FIM at rehabilitation HP admission				
Total	111 (96–119)	74 (47–93)	19 (18–27)	<0.001
Motor	81 (69–86)	51 (27–63)	13 (13–14)	<0.001
Cognitive	32 (27–35)	23 (16–30)	5 (5–11)	<0.001
FIM at rehabilitation HP discharge				
Total	118 (112–124)	93 (72–112)	18 (18–29)	<0.001
Motor	87 (81–90)	68 (49–82)	13 (13–18)	<0.001
Cognitive	33 (28–35)	26 (17–32)	5 (5–15)	<0.001
FIM gain				
Total	6 (2–14)	16 (5–24)	0 (0–5)	<0.001
Motor	5 (1–12)	15 (5–22)	0 (0–5)	<0.001
Cognitive	0 (0–2)	1 (0–3)	0 (0–0)	0.042

HP, hospital; USD, United States Dollars. Number of patients (%) or median (IQR) is shown, except for age (mean ± SD). FIM gain values were calculated by subtracting the first FIM score from the last FIM score for each patient.

[a]$n = 255$ (7 missing values).

countries and hospitals may also limit generalizability of the findings from a setting where the study was conducted to other settings with different healthcare systems.

One of the major limitations of this study would be attributed to the investigation of a single combination of acute and rehabilitation hospitals. The selection of the rehabilitation hospital after discharge from the acute hospital was performed irrespective of the characteristics of patients, including stroke subtype, age, sex or degrees of disability at discharge. The outcomes such as LOS and FIM in this study were similar with those in a previous nationwide survey in Japan [29]. However, the applicability of our findings to different stroke care settings should be carefully considered, since variations of stroke care and costs by regions or type of hospitals have been reported [30, 31]. Next, due to the retrospective nature of this study, our analyses depended on the accuracy and completeness of the raw data. Claims data were compiled for reimbursement purposes, and the cost information was likely validated. We also examined medical records carefully for this study, which allowed us to perform in-depth evaluation of clinical outcomes, including severity based on the FIM scores [32, 33]. Finally, our results might be affected by confounders such as patients' comorbidities, caregivers' situations and patients' care preferences, although we presented the results stratified by some major factors, including severity and age [9]. Further studies, including a larger population from various healthcare settings, are required to establish better management strategies for stroke patients.

In conclusion, this study showed considerable healthcare resource utilization for inpatient stroke care in the context of Japanese healthcare system. Our data highlight the different degrees of improvement in functional status and hospitalization costs among severity levels. The findings from our study suggest potentially substantial room to improve cost-effectiveness in management of post-acute stroke care, and our results will greatly aid clinical professionals and policymakers in establishing optimal rehabilitation settings and ensuring appropriate healthcare resource allocation in the face of the rapid growth of the elderly population.

Supplementary material

Supplementary data are available at *International Journal for Quality in Health Care* online.

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