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CLINICAL AND ADMINISTRATIVE OUTCOMES DURING PUBLICLY-FUNDED INPATIENT STROKE REHABILITATION BASED ON A CASE-MIX GROUP CLASSIFICATION MODEL

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Objectives: **To determine efficiency and efficacy of publicly-funded inpatient stroke rehabilitation based on a Case-Mix Group Classification Model, and to analyse the usefulness of this decisional aid in the refinement of rehabilitation services delivery needed to optimize accessibility to inpatient rehabilitation services for individuals with stroke in a publicly-funded healthcare system.**

Design: **Individuals with stroke ($n = 422$) who received inpatient rehabilitation through the Montreal Rehabilitation Hospital Network were included in this retrospective study. Clinical (total, motor and cognitive-Functional Independence Measure (FIM) scores, percentage of discharge to community) and administrative outcomes (onset to rehabilitation interval, length of inpatient rehabilitation stay, length of stay efficiency) were measured.**

Results: **Across Case-Mix Groups, mean onset to rehabilitation days varied between 16.2 (5.7) and 32.0 (19.4) days whereas the mean length of stay fluctuated between 27.5 (13) and 77.0 (27) days. Best total (41.6 (21.4)) and motor-FIM (38.9 (19.0)) gains were observed in most severely disabled cases (114) whereas the Case-Mix Group 103 presented the best cognitive-FIM gain (5.8 (4.0)). Optimal mean total, motor and cognitive-FIM efficiency rates, found in moderately disabled stroke patients, were 0.668 (0.434), 0.634 (0.377) and 0.15 (0.136), respectively. Majority of patients returned home following rehabilitation in all Case-Mix Groups (63.6% to 96.4%) except for groups 112 and 108.**

Conclusion: **Moderate to good length of stay efficiencies are observed among all Case-Mix Group following stroke rehabilitation. In fact, individuals with moderate disability present the best rate of recovery. Variations in length of stay efficiency suggest that the use of a Case-Mix Group Classification Model in stroke rehabilitation could represent an innovative approach, especially for program evaluation in publicly-funded and universal-access rehabilitation hospitals.**

Key words: stroke rehabilitation, outcomes, case-mix group, function, length of stay.

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INTRODUCTION

Over the past few years, there has been a marked increase in the annual rate of stroke in the Province of Quebec, as well as in Canada (1). In addition, this rate is expected to continue to rise given that the population at risk for cerebrovascular disease is rapidly increasing and the progress in clinical management of acute stroke has resulted in higher survival rates (1). The integrity of motor, sensory and cognitive functions is often affected in individuals following a stroke (2). Within the first few weeks after the neurological event, it is well recognized that stroke survivors benefit from intensive rehabilitation services (3). Traditionally, in order to assure optimal quality and intensity of rehabilitation services during their initial recovery period, most of these individuals have been referred to specialized inpatient rehabilitation facilities.

Despite an increasing demand for post-stroke rehabilitation, the limited funding available in the publicly-funded and universal-access healthcare system in the Province of Quebec forces the government to indirectly limit access to inpatient rehabilitation programs through different operational strategies (i.e. reduction in operational beds, reduction in human resources). As a result, access within clinically recommended time frames to organized inpatient stroke rehabilitation services provided by a multidisciplinary team is often jeopardized despite its outstanding benefits over alternative services (ambulatory hospital-based rehabilitation services or early supported discharge with home rehabilitation) (4).

To simultaneously assure that these subjects achieve adequate access to rehabilitation during the critical initial phase of recovery and that equitable funding is offered to rehabilitation facilities, healthcare professionals need to explore new alternatives offering greater accountability. To date, quality assurance programs for inpatient stroke rehabilitation units in the Province of Quebec primarily target an annual reduction of mean length of stay (LOS) to progressively control healthcare costs and possibly increase the number of patients served within a fiscal year. This practice may lead to inequities among

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rehabilitation providers since there are potential incentives to preferentially select individuals with least complex impairments and disabilities combined with most favorable social and physical environments in order to reach targeted objectives. Perniciously, individuals with most severe impairment and disability levels might be confronted with limited accessibility, or even illegibility, to neurological rehabilitation programs. In addition, rehabilitation facilities might meet annual objectives by applying a cost-shifting strategy that consists primarily of increasing referral rates to other rehabilitation providers (i.e. home healthcare providers). Therefore, the possibility of developing and implementing a case-mix group (CMG) classification system for inpatient stroke rehabilitation has sparked considerable interest.

Concerned about the reasonable cost-based payment system under which rehabilitation hospitals and rehabilitation units of hospitals were reimbursed for publicly-funded programs in the USA, Centers for Medicare and Medicaid Services (CMS) recently designed and implemented an inpatient rehabilitation facility-prospective payment system (IRF-PPS) (5) inspired by the Functional Independence Measure-Functional Related Group model (FIM-FRG) in the USA (6). This new system includes 21 distinct rehabilitation impairment categories (RIC), such as stroke (Table I), based on primary rehabilitation diagnosis. All RIC were further divided into distinct CMGs using a Classification and Regression Trees statistical methodology based on clinical characteristics known on admission to inpatient rehabilitation facility (motor-FIM, cognitive-FIM, age). Each CMG is further divided into tiers (tier 1 = most costly; tier 3 = least costly) recognizing clinically relevant co-morbidities and complications which have been shown to influence length of stay and treatment costs. Other factors (geographic variation in wages, percentage of low-income patients, and location in rural area) are weighted to calculate the reimbursement rate for a rehabilitation facility. Separate CMG are available for subjects who die or have a very short stay (3 days or fewer). Theoretically, expected resource needs will be determined and resource use homogeneity will be assured for each specific CMG (homogeneous groups) in all rehabilitation facilities servicing the USA. Applications of CMGs are frequently found in development of specific lengths of stay, payment models, outcome measures and benchmarking initiatives (7).

Table I. *Description of the Inpatient Rehabilitation Facility Case-Mix Group (IRF-CMG) classification system for individuals with stroke (5)*

IRF-CMG	FIM motor score* (12–84)	FIM cognitive score (5–35)	Age (years)
101	69–84	23–35	–
102	59–68	23–35	–
103	59–84	5–22	–
104	53–58	–	–
105	47–52	–	–
106	42–46	–	–
107	39–41	–	–
108	34–38	–	≥83
109	34–38	–	≤82
110	12–33	–	≥89
111	27–33	–	82–88
112	12–26	–	82–88
113	27–33	–	≤81
114	12–26	–	≤81

* Tub/shower transfer score not included (10).

It is clear that the publicly-funded and universal-access Quebec healthcare system fails to account for variability of impairment and disability levels of individuals treated in rehabilitation hospitals. As a result, inequitable distributions of limited human and financial resources are currently experienced among stroke rehabilitation providers. To date, there has been no study exploring potential benefits of adopting an inpatient rehabilitation evidence-based decision-making process, based on the recent CMG classification model developed in the USA, in a publicly-funded and universal-access healthcare system as seen in Canada. Therefore, the objectives of this study were to apply the CMG classification model developed in the USA to determine inpatient stroke rehabilitation efficiency and efficacy in an healthcare environment not guided by such stratifications and to assess the usefulness of this decisional aid to refine the delivery of rehabilitation services needed to optimize accessibility to inpatient rehabilitation services for individuals with stroke. Furthermore, the feasibility of implementing a disability-adjusted classification system for individuals with stroke who require inpatient rehabilitation will be discussed.

METHODS

Setting

The Montreal Rehabilitation Hospital Network (MRHN) is formed of 5 rehabilitation hospitals located within the City of Montreal. This rehabilitation network is funded by the Regional Health and Social Services Agency of the Quebec Ministry of Health and Social Services. Each rehabilitation facility currently offers a structured interdisciplinary inpatient neurological rehabilitation program. Out of 595 designated rehabilitation beds currently in operation within the MRHN, 99 beds are specifically allocated for neurological rehabilitation programs. A total of 749 subjects were admitted to the neurology program during 2002–03 fiscal year (April 1, 2002 to March 31, 2003). The majority of these subjects admitted to the neurology program were primarily diagnosed with stroke (534 individuals) whereas remaining subjects suffered from different diagnoses (Parkinson's disease, multiple sclerosis, Guillan-Barré syndrome, polyneuropathy, etc.).

Participants

Once approvals were obtained from Research and Ethics Committees, medical records were reviewed retrospectively for 534 subjects registered in the MRHN neurology program with a primary diagnosis of stroke based on clinical history, neurological evaluation or neuroimaging studies. Patients were excluded from the study if they presented with associated medical conditions influencing the course of rehabilitation (previous stroke, post-cardiac surgery, lower extremity amputation or recent hip fracture), had incomplete medical records (particularly incomplete Functional Independence Measure (FIM) at admission or discharge), were discharged to acute care facilities due to medical complications, died during rehabilitation or simply abandoned rehabilitation despite medical advice. Once atypical stroke rehabilitation patients were excluded, the final sample consisted of 422 patients discharged from the inpatient neurological rehabilitation program after a first stroke (79% of all cases) during 2002–03 fiscal year out of 534

cases initially selected. Nominative information was omitted whereas clinical and administrative data were stored anonymously to protect confidentiality.

Clinical evaluation

The FIM™ instrument (8) rating was used to assess the functional ability at admission (within 72 hours) and at discharge of all subjects included in this retrospective study. This instrument describes type and amount of human assistance required by a person with disability to perform basic activities of daily living. The FIM consists of 18 items organized under 6 categories of function: self-care activities, sphincter control, mobility, locomotion, communication and social integration. Each item is scored on a standardized ordinal scale from 1 (total assistance) to 7 (completely independent) for a maximum potential total score of 126. This measurement instrument also allows the calculation of a motor-FIM subscore derived from 13 items describing physical abilities (eating; grooming; bathing; upper body dressing; lower body dressing; toileting; bladder management; bowel management; bed, chair, wheelchair transfer; toilet transfer; tub/shower transfer; walk/wheelchair; and stairs) whereas the cognitive-FIM subscore highlights communication (comprehension and expression) and social cognition abilities (social cognition, problem solving and memory). Motor-FIM and cognitive-FIM subscores range from 13 to 91 and from 5 to 35, respectively. Summated total-FIM score as well as its motor and cognitive subscales have been documented to be valid and reliable measures (9). All facilities of the MRHN adhere to the credentialing and training system suggested by the Uniform Data System for Medical Rehabilitation (8).

Classification of subjects

All subjects selected were classified into 1 of 14 CMGs, specifically developed for individuals with a diagnosis of stroke, as described in HCFA regulations (5). The IRF-CMG classification system for individuals with stroke is summarized in Table I. These 14 groups are structured on the basis of motor-FIM scores obtained at admission for all subjects. Further, cognitive-FIM scores solely classified high functioning stroke survivors while age is uniquely considered among most severe ones. It is important to highlight that the tub/shower transfer score was removed from the motor score equation in the IRF-PPS classification system proposed by CMS since measured performance level were positively correlated with costs as opposed to most of the other items and that transfer-to-tub question does not measure an absolute level of function in its current wording (10). In fact, this score could fluctuate depending on architectural configuration of the environment and adaptive equipment available to patients. For this reason, motor dimension of the FIM ranges from 12 to 84 in this classification structure instead of the usual 13 to 91 points.

Outcomes

Clinical outcomes were measured primarily from FIM gains (total, motor and cognitive). Variations in functional status (total-FIM, motor-FIM and cognitive-FIM) between admission and discharge were estimated by using an absolute method of calculation that reflected the change in scores between the admission and discharge. Administrative indicators selected were onset-admission interval, LOS, LOS efficiency and percentage of patients returning to their prior living arrangement in the community. The onset-admission interval represents the number of days between the onset of the disability (stroke) and the admission to intensive functional inpatient rehabilitation. The LOS corresponds to the net number of days elapsed between admission and discharge from inpatient stroke rehabilitation. Individuals transferred to an acute care facility and readmitted to the MRHN within 30 days were considered to have had a single rehabilitation admission. The LOS efficiency reports the average change in FIM per day during rehabilitation hospital stay. This measure is often referred to as the average amount of FIM gain per day. Given normal distributions of the total, motor and cognitive-FIM gains measured at the MRHN, a quartile analysis was completed to classify LOS efficiency for total, motor and cognitive-FIM gains in 4 sub-groups: low (1st quartile), moderate (2nd quartile), good (3rd quartile) or excellent (4th quartile).

Table II. *Distribution and characteristics of individuals with stroke admitted at the Montreal Rehabilitation Hospital Network in 2002–2003 fiscal year based on the Inpatient Rehabilitation Facility Case-Mix Group (IRF-CMG) classification system and total sample*

		Gender (%)		
IRF-CMG	Individuals *n* (%)	Male *n* (%)	Female *n* (%)	Age (years) mean (SD)
Total	422 (100)	211 (50.0)	211 (50)	71.9 (10.5)
CMG-stroke				
101	110 (26.07)	58 (52.7)	52 (47.3)	70.8 (10.7)
102	71 (16.82)	35 (49.3)	36 (50.7)	74.4 (10.7)
103	24 (5.69)	12 (50)	12 (50)	71.9 (10.6)
104	48 (11.37)	28 (58.3)	20 (41.7)	74.3 (10.1)
105	38 (9)	17 (44.7)	21 (55.3)	72.4 (10.6)
106	21 (4.98)	10 (47.6)	11 (52.4)	70.7 (8.3)
107	22 (5.21)	11 (50)	11 (50)	72.0 (12.3)
108	1 (0.02)	0 (0)	1 (100)	84
109	18 (4.27)	8 (44.4)	10 (55.6)	64.7 (11.0)
110	–	–	–	–
111	5 (1.18)	3 (60)	2 (40)	85 (2.4)
112	5 (1.18)	3 (60)	2 (40)	85 (2.1)
113	36 (8.53)	14 (38.9)	22 (61.1)	69.2 (7.7)
114	23 (5.45)	12 (52.2)	11 (47.8)	67.8 (8.5)

Data analysis and statistics

Descriptive statistics were calculated for subject characteristics, clinical and administrative outcomes for all subjects (total sample) and every CMG (14 subgroups).

RESULTS

Distribution and characteristics of individuals with stroke involved in this retrospective study are presented in Table II. A total of 211 men and 211 women were included in this project, and the average age was 71.9 (10.5) years on admission. These 422 subjects were unevenly distributed among 14 different CMGs specifically designed for individuals with stroke. Almost half of these subjects (48.6%) were classified within the first 3 CMGs (101, 102 and 103) as they presented a motor-FIM score of 59 or over whereas only 16.4% of subjects obtained a motor-FIM score of 33 or less in the last 5 CMGs (110–114). Mean ages varied between 64.7 (11) (lowest) and 85 (2.1) (highest) years of age among all CMGs. Of importance, no patient was assigned to the CMG #110 and only 1 person formed the CMG #108 justifying its exclusion in final analysis.

Functional gains (total, motor and cognitive) made by subjects during inpatient stroke rehabilitation are presented in Table III. Generally, individuals with stroke made gains in all CMGs during inpatient rehabilitation although the absolute amount of gain varied within and across CMGs. Overall, subjects presented a mean total-FIM score of 86.1±21.7 on admission while this score was 107.7 (16.7) at discharge, representing an average gain of 21.6 (14.4). The highest total-FIM gain (41.6 (21.4)) originated from the CMG #114 while the CMG #101 displayed the lowest one (9.5 (5.6)). Overall mean motor-FIM scores for all subjects at admission and discharge were 58.8 (19.2) and 78.1

Table III. *Functional gain and percentage of subjects returning home following rehabilitation based on the Inpatient Rehabilitation Facility Case-Mix Group (IRF-CMG) classification system and total sample*

	FIM-Total			FIM-Motor			FIM-Cognitive			
	Admission	Discharge	Gain	Admission	Discharge	Gain	Admission	Discharge	Gain	
IRF-CMG	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	Returned home (%)
Total	86.1 (21.7)	107.7 (16.7)	21.6 (14.4)	58.8 (19.2)	78.1 (13.5)	19.2 (13.5)	27.2 (6.4)	29.6 (5.6)	2.4 (3.2)	83.4
CMG-Stroke										
101	110.2 (7.1)	119.4 (5.0)	9.3 (5.6)	80.6 (5.9)	87.9 (3.3)	7.3 (4.9)	29.6 (5.0)	31.6 (3.8)	2.0 (2.8)	96.4
102	97.5 (6.4)	115.6 (7.0)	18.2 (5.5)	67.4 (4.0)	83.6 (4.7)	16.2 (4.8)	30.1 (4.2)	32.1 (3.6)	2.0 (2.3)	91.5
103	92.0 (9.4)	107.5 (8.8)	15.5 (6.9)	75.0 (8.2)	84.6 (5.2)	9.6 (5.0)	17.0 (3.5)	22.9 (5.6)	5.8 (4.0)	83.3
104	87.0 (5.8)	108.7 (12.3)	21.8 (10.0)	58.7 (2.5)	78.8 (9.0)	20.1 (8.6)	28.2 (5.5)	29.9 (5.7)	1.7 (3.4)	91.7
105	81.4 (6.2)	110.5 (12.5)	29.1 (9.2)	52.1 (2.1)	79.2 (9.0)	27.1 (8.6)	29.3 (5.4)	31.3 (4.7)	2.0 (2.4)	94.7
106	74.0 (4.7)	102.2 (11.2)	28.2 (10.6)	46.1 (1.8)	71.9 (10.4)	25.8 (9.7)	27.9 (4.8)	30.3 (3.7)	2.4 (3.3)	85.7
107	66.6 (7.0)	94.8 (15.2)	28.1 (12.4)	41.9 (1.7)	67.6 (12.3)	25.7 (11.6)	24.8 (6.8)	27.2 (6.5)	2.4 (2.6)	63.6
108	66	98	32	38	66	28	28	32	4	0
109	64.3 (6.4)	97.1 (18.3)	32.8 (15.6)	37.7 (1.5)	68.7 (14.2)	31.0 (14.4)	26.6 (5.6)	28.4 (5.7)	1.8 (3.4)	66.7
110										–
111	58.6 (6.5)	87.6 (16.6)	26.6 (19.9)	32.6 (0.5)	60.6 (15.2)	25.6 (15.9)	26.0 (6.6)	27.0 (4.3)	1.0 (5.1)	80.0
112	43.8 (5.6)	58.6 (14.1)	14.8 (10.4)	24.4 (4.3)	38.0 (10.4)	13.6 (9.9)	19.4 (8.8)	20.6 (8.9)	1.2 (2.8)	20.0
113	55.6 (7.2)	91.5 (17.6)	35.9 (15.7)	32.2 (2.2)	64.1 (14.0)	31.8 (14.0)	23.4 (6.8)	27.5 (6.2)	4.1 (3.3)	69.4
114	45.6 (9.2)	87.2 (22.9)	41.6 (21.4)	23.0 (3.3)	61.9 (19.6)	38.9 (19.0)	22.6 (7.8)	25.3 (7.3)	2.7 (4.5)	73.9

(13.5), respectively. The highest motor-FIM gain (38.9 (19)) originated from the CMG #114 whereas the CMG #101 was the lowest one (7.3 (4.9)). Overall mean cognitive-FIM gain (2.4 (3.2)) for all patients resulted from the difference in score measured at admission (27.2 (6.4)) and discharge (29.6 (5.6)) from the admission. Finally, individuals in the CMG #103 reached the highest cognitive-FIM gain (absolute = 5.8 (4)).

Administrative results of this study are presented in Tables IV and V. On average, individuals with stroke were admitted to inpatient intensive functional rehabilitation more than 23.3 (17.9) days after the onset of the neurological event and were discharged, on average, 43.6 (23) days later (LOS) as presented in Table IV. Furthermore, 83.4% of these patients returned to their prior living arrangement following inpatient rehabilitation. The results of the quartile analysis used to classify LOS efficiency for total, motor and cognitive-FIM gains were 0.302, 0.251 and 0.000 (1st quartile), 0.508, 0.452 and 0.041 (2nd quartile), 0.703, 0.624 and 0.098 (3rd quartile), 2.400, 2.350 and 0.857 (4th quartile). Mean LOS efficiencies were considered as being good for total (0.536 (0.331)), motor (0.469 (0.305)) and cognitive-FIM (0.066 (0.106)) as presented in Table V, since mean values were superior to median ones (3rd quartile). It is important to highlight that excellent motor efficiency rates were obtained in CMG 104 and 105 whereas an excellent cognitive one was observed in CMG 103.

DISCUSSION

In an effort to maintain accessibility, continuity and universality of care and services for individuals with stroke in publicly-funded and universal access healthcare environments, new alternatives requiring little or no additional financing need to be explored. For this reason, the objectives of the study were to apply the CMG classification model developed in the USA to determine inpatient stroke rehabilitation efficiency and efficacy in a healthcare environment not guided by such stratifications, and to assess the usefulness of this decisional aid to refine the delivery of rehabilitation services needed to optimize accessibility to inpatient rehabilitation services for individuals with stroke. Furthermore, the feasibility of implementing a disability-adjusted classification system for individuals with stroke that require inpatient rehabilitation will be discussed.

Since a clear consensus does not exist on clinical characteristics defining the severity of disability following a stroke, individuals with severe stroke were identified as having a motor-FIM score of 33 points or less at admission (CMG = 110–114) and accounted for 16.3% of all individuals (69 subjects) admitted for stroke rehabilitation in 2002–03. Knowing that usually approximately one quarter of all stroke patients are severely disabled in the early recuperation phase (11), the lower ratio found (16.3%) might corroborate those admission policies and procedures, currently in place, that favor admissions of less severe cases. Despite controversies around the rehabilitation of severely disabled patients with stroke (12), 53.6% (37 subjects) and 58% (40 subjects) of those with severe

Table IV. *Summary of onset-admission intervals and lengths of stay based on the Inpatient Rehabilitation Facility Case-Mix Group (IRF-CMG) classification system and total sample*

IRF-CMG	Onset admission intervals (days) mean (SD)	Observed Rehabilitation LOS in Montreal (days) mean (SD)	Expected (Averaged) rehabilitation LOS in the USA (days) mean (SD)	Observed/ Expected LOS	Patients meeting the expected LOS (%)
Total	23.3 (17.9)	43.6 (23.0)	–	–	4.3
CMG-stroke					
101	19.5 (10.6)	27.5 (13.0)	10	2.75	7.2
102	17.0 (11.2)	33.9 (13.0)	12	2.82	0.0
103	30.9 (16.9)	42.7 (19.0)	14	3.05	4.2
104	25.0 (28.1)	36.4 (16.9)	17	2.14	10.4
105	21.3 (16.4)	48.5 (17.7)	17	2.85	0.0
106	32.0 (19.4)	52.7 (18.6)	18	2.93	4.7
107	24.1 (14.8)	56.0 (18.6)	21	2.67	4.5
108	4	55	27	2.03	0.0
109	29.9 (20.7)	65.6 (18.2)	24	2.73	0.0
110	–	–	29	–	–
111	16.2 (5.7)	62.0 (21.7)	29	2.14	0.0
112	28.4 (12.6)	48.0 (20.6)	40	1.20	20.0
113	31.2 (24.3)	67.9 (23.0)	27	2.52	2.8
114	27.2 (19.1)	77.0 (27.0)	37	2.08	0.0

LOS = length of stay.

stroke demonstrated good to excellent rehabilitation effectiveness as measured on total and motor-FIM, respectively. Furthermore, 68.1% of those subjects returned home following rehabilitation. Environmental factors (social, physical, cultural and political) become of particular importance for those patients who have considerable residual disabilities upon discharge (averaged total-FIM of 87.4 (20.2)) and wish to return to their prior living arrangements. Although these results further promote the effectiveness of rehabilitation programs for stroke survivors with severe motor, and often cognitive deficits, one must be prudent in interpreting these results as lower admission scores on the FIM (underscore) might represent a possible bias (13).

Table V. *Summary of length of stay efficiencies based on the Inpatient Rehabilitation Facility Case-Mix Group (IRF-CMG) classification system and total sample*

IRF-CMG	Length of stay efficiency* FIM-Total mean (SD)	FIM-Motor mean (SD)	FIM-Cognitive mean (SD)
Total	0.536 (0.331)	0.469 (0.305)	0.066 (0.106)
CMG-stroke			
101	0.392 (0.284)	0.305 (0.254)	0.087 (0.140)
102	0.604 (0.271)	0.538 (0.229)	0.066 (0.087)
103	0.399 (0.237)	0.249 (0.148)	0.150 (0.136)†
104	0.688 (0.434)	0.634 (0.377)†	0.055 (0.116)
105	0.667 (0.328)	0.625 (0.310)†	0.042 (0.050)
106	0.547 (0.237)	0.506 (0.186)	0.041 (0.094)
107	0.530 (0.240)	0.484 (0.216)	0.046 (0.052)
108	0.582	0.509	0.073
109	0.516 (0.235)	0.485 (0.216)	0.031 (0.054)
110	–	–	
111	0.485 (0.388)	0.459 (0.306)	0.026 (0.100)
112	0.308 (0.200)	0.285 (0.174)	0.023 (0.076)
113	0.602 (0.409)	0.540 (0.393)	0.062 (0.048)
114	0.589 (0.357)	0.546 (0.303)	0.043 (0.080)

*Length of stay efficiency calculation = Functional Independence Measure gain/length of stay. † Excellent length of stay efficiency.

In accordance with previous studies (14–15), it was once again demonstrated that moderately affected stroke survivors (CMG = 104 and 105) tend to benefit most from interdisciplinary inpatient rehabilitation. LOS efficiencies of 0.688 and 0.667 were calculated based on the total-FIM score for CMGs #104 and #105 whereas LOS efficiencies of 0.634 and 0.625 were estimated with the motor-FIM score for these 2 groups. It corresponded to the highest levels of efficiency obtained among all CMGs based on total and motor-FIM. Accordingly, admission to comprehensive inpatient stroke rehabilitation should be encouraged for patients with moderate disabilities since optimal gains are observed. These results might not be representative of long-term outcomes since preservation of gains made during inpatient rehabilitation over time remains unknown.

Over 25% of all individuals admitted to stroke rehabilitation (26.1% or 110 subjects) experienced minimum disability (CMG = 101) which demonstrates that the actual quality assurance program targeting mean inpatient rehabilitation LOS can easily be achieved since this indicator is not weighted according to impairment and disability levels experienced by subjects admitted to rehabilitation. On admission, these patients demonstrated the highest mean total (110.2 (7.1)) and motor (80.6 (5.9)) FIM scores. Limited FIM gain, due in part to the ceiling effect of this measurement tool, combined to the relatively long rehabilitation LOS are possible explanations of the low efficiency ratio calculated among these high functioning stroke survivors. This suggests that admission to inpatient stroke

rehabilitation is not a highly cost-effective approach for these individuals and further support the need for various models in stroke rehabilitation. Limited availability of alternative rehabilitation services, such as ambulatory hospital-based rehabilitation programs or early supported discharge with home rehabilitation, and the complexity of referral systems within the continuum of care also explain the disappointing efficiency measured in this specific group. In practice, admission to inpatient rehabilitation for these patients is often a consequence of social, cultural or political environmental difficulties despite a relatively high level of physical function. Additional efforts should be made to better serve patients with mild disability following stroke.

Of interest, the CMG #103 classifies individuals with stroke who present significant cognitive deficits with motor functions that are minimally affected by the neurological event. This specific CMG considers the possibility of bias resulting from limited cognitive-linguistic skills among the otherwise high functioning stroke survivors. The CMG #103 presented the most elevated LOS efficiency for the cognitive-FIM (0.15 (0.136)). A strong correlation exists between cognitive status and rehabilitation success, with better outcomes being achieved among cognitively intact patients with stroke aged over 60 (16). Interestingly, these stroke patients (CMG = 103) were admitted on average 30.9 (16.9) days after the onset of the stroke while survivors with similar motor deficit presenting better cognitive function (CMG = 101 and 102) were transferred to inpatient rehabilitation within 19.5 (10.6) and 17 (11.2) days after the onset of the neurological event. Moreover, patients with important cognitive deficits stayed 15.2 and 8.8 days longer in inpatient stroke rehabilitation when compared to patients in CMG #101 and #102, respectively. Availability, intensity and timing of speech and language therapeutic programs in acute care facilities and rehabilitation hospitals might partially explain these results (17).

Careful interpretation of the results obtained in this regional study is warranted since meaningful comparisons of outcomes would definitively require CMG adjustments developed within similar healthcare environments. Nevertheless, publicly-funded and universal-access rehabilitation programs are frequently challenged against standards developed in other countries, such as the USA, especially by funding agencies despite very distinct socio-cultural environment as well as healthcare and social system organization. No USA-based CMG adjusted result has been found in the literature reviewed possibly due to the recent implementation of the IRF-PPS. For this reason, only a brief comparison of the overall results obtained with the latest ones published in the USA for inpatient stroke rehabilitation (18) is possible at this time despite its limitations.

The mean onset to rehabilitation interval was 23.3 (17.9) days within the publicly-funded healthcare system in Montreal compared to 12 (15) days in the USA for patients with stroke (18). In reality, one can conclude that patients with stroke within the MRHN currently have to wait an additional 11 days prior to admission to inpatient rehabilitation services compared to an average stroke survivor in the USA. Knowing that early intensive inpatient stroke rehabilitation is associated with greater functional improvement (19, 20), this prolonged delay might have detrimental effects for patients treated within the MRHN. Considerable financial incentives resulting from well-structured and integrated continuum of care in the USA might explain the rapid inpatient rehabilitation admission following stroke. In reality, it should be remembered that acute care facilities and healthcare providers are guided by Diagnostic Related Groups (DRG) (21), a system of categorizing patients, and profit can only be experienced if costs are less than the amount indicated within a specific DRG. Moreover, recent evidence also confirms that the onset to rehabilitation period is longer when patients with stroke are referred for inpatient rehabilitation compared to domiciliary or ambulatory rehabilitation services (22). Of interest, the mean onset to rehabilitation interval reported in the MRHN compares well to the ones reported in other countries (30–62.9 days) offering similar healthcare delivery models (23–25).

On average, a difference of over 18 days is found between the overall mean inpatient rehabilitation LOS (43.6 (23) days) presented in this study and the one (25 (24) days) reported in the USA for patients with stroke (18). The mean inpatient rehabilitation LOS was also prolonged by 8.0 (CMG = 112) to 41.6 days (CMG = 109) when associating the actual LOS for each CMG to the longest suggested ones for individuals within the same CMG in the USA. In addition, the mean observed/expected LOS ratio for all CMGs was 2.46 (5.4) which may further express the excessive LOS when a CMG classification system is unavailable. These additional inpatient rehabilitation days, combined to the elevated FIM scores at admission, might explain the better functional capacity at discharge in Montreal than in the USA (total-FIM at discharge = 107.7 (6.7) vs 86.5 (23)) and support the superior average rate of stroke patients discharged back into the community in Montreal (83.4%) when compared to the rate (76%) in the USA. One could argue that stroke patients are admitted with more severe disability in the USA (mean FIM score = 61.5 (22.5)) and reach similar return to the community therefore excess LOS might not provide greater outcomes in Montreal.

The LOS efficiency is drastically diminished in the MRHN due in part to the 23 extra days spent in inpatient rehabilitation (mean LOS efficiency for total-FIM = 0.536 (0.331) vs 1.36). Even if the total and the CMG-specific mean LOS measured in the publicly-funded healthcare environment of the MRHN are much longer than those suggested in USA, similar mean total LOS (42 to 46.1 days) have recently been surveyed during inpatient stroke rehabilitation in other countries (16, 23, 26). Prudence is advised toward pressure to reduce LOS during inpatient rehabilitation since a causal connection was confirmed between decreasing LOS and increasing hospital readmission rate (27). Additionally, momentary cost saving generated by a reduction in LOS might be outweighed by the lifetime cost generated by patients and by greater physical and emotional burdens placed on caregivers (28).

Despite weak evidence of a relationship between stroke rehabilitation intensity and functional gains observed during inpatient rehabilitation, few studies suggest that an increased therapy intensity during inpatient rehabilitation (subacute phase) positively contributes to an overall reduction of LOS (29, 30). It is also believed that patients with moderate disability might benefit from an increased therapy intensity (i.e. amount of time spent in therapy per day) during their inpatient rehabilitation stays (31, 32). The use of the CMG Classification Model, which allows a stratification of stroke patients into 14 distinct CMGs, could possibly determine a specific dose-response pattern for each group and refine therapy intensity for stroke patients to optimize cost-effectiveness ratio of inpatient stroke rehabilitation programs without compromising clinical outcomes. Adjusting therapy intensity represents an important clinical challenge that is closely linked to inpatient stroke rehabilitation accessibility. Other elements such as purity, specificity, dose, intensity, duration and timing of rehabilitation interventions during hospitalization in acute care before being admitted to an intensive rehabilitation program and during inpatient stroke rehabilitation would deserve additional attention when studying impacts of rehabilitation intensity following stroke (33). The promotion and applications of newly developed skills into activities of daily living and functional mobility outside direct therapeutic periods are also critical when exploring this dimension.

Targeted inpatient stroke rehabilitation LOS usually represents a consensus reached by healthcare professionals, patient and family members during an interdisciplinary team meeting. It is assumed that clinicians are capable of making reasonable decisions concerning rehabilitation potential and length of stay. However, the literature on teamwork and decision making suggests a failure to consider baseline information adequately whereas case-specific data appear to be frequently overvalued. In addition, rehabilitation professionals might be influenced by factors extraneous to the rehabilitation potential (caseloads, availability of community resources, family pressure …). For this reason, implementation of a CMG model would provide professionals with a structured clinical instrument suggesting expected LOS of individuals admitted for inpatient stroke rehabilitation and would assure the development and promotion of services that are recognized to be equitable and cost-effective. It is acknowledged that decision aid may improve knowledge and realistic expectations, enhance active participation in decision making, lower decisional conflict, decrease the proportion of people remaining undecided and improve agreement between values and choice (34).

Finally, the assignation of an individual with stroke to a specific CMG is solely based on personal attributes in this model (Table I) despite the fact that rehabilitation is known to be more than functional recovery (28). Conceptual rehabilitation models have made tremendous progress and often suggest a bidirectional interaction between personal intrinsic characteristics of an individual (impairment and disability) and various environmental factors (social, physical, cultural and political) to determine levels of social participation amongst individuals with disabilities (35). This interactive person-environment relationship is so critical that its acknowledgement appears to be, in theory, unavoidable in the development of future inpatient rehabilitation classification systems although it represents a considerable challenge.

CONCLUSION

In conclusion, the use of a CMG structure for individuals undergoing inpatient stroke rehabilitation represents an equitable methodology to assess efficiency and efficacy of inpatient rehabilitation programs and to allocate available human and financial resources among rehabilitation facilities. The methodological approach used in the USA to develop the CMG classification system might inspire other countries offering publicly-funded inpatient stroke rehabilitation. On the merge of a drastically increasing rate of stroke survivors expected in the next few years in many countries, this innovative concept might promote the development of evidence-based therapeutic approaches and the creation of alternative models of care for individuals with stroke in order to maintain, or even improve, accessibility to inpatient rehabilitation within recommended therapeutic periods. The ultimate challenge of rehabilitation professionals (clinicians, administrators and researchers) is to acknowledge the benefits of this modular model that recognizes CMG differences in rehabilitation institutions, particularly when exploring for rational methods to allocate limited rehabilitation resources.

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