International Journal of
Physical Medicine & Rehabilitation

Maistreli et al., Int J Phys Med Rehabil 2017, 5:3
DOI: 10.4172/2329-9096.1000399

Review Article Open Access

The Clinical, Quality of Life and Economic Outcomes of Inpatient Rehabilitation: A Systematic Review

Stefania Maistreli[1], George Gourzoulidis[2]*, Katerina Vellopoulou[2], Georgia Kourlaba[1,2] and Nikos Maniadakis[3]

[1]*Collaborative Center of Clinical Epidemiology and Outcomes Research (CLEO), Non-Profit Civil Partenrship, Athens, Greece*
[2]*EVROSTON LP, Athens, Greece*
[3]*Department of Health Services Organization and Management, National School of Public Health, Athens, Greece*

Abstract

Objective: To systematically review the clinical, functional and economic benefits of Inpatient Rehabilitation for the most common disorders of the nervous system: stroke, spinal cord injury, and multiple sclerosis.

Methodology: PubMed, Embase, Scopus, CEA Registry, and NHS EED databases were searched using combinations of three sets of keywords using various terms for rehabilitation, benefits, and treatments. The outcomes considered included measures of independence in activities of daily living (ADL), motor function, disability, handicap, gait velocity, quality of life, and economics. Following the initial literature search, the abstracts and full texts of the identified studies were reviewed and assessed for inclusion by two independent researchers based on pre-determined criteria. The data of selected studies were extracted into a data extraction form and consequently were synthesized.

Results: Forty-six articles met the inclusion criteria. Particularly, 21 studies evaluated inpatient rehabilitation after (or following) stroke, 15 studies evaluated inpatient rehabilitation after SCI, and seven studies evaluated inpatient rehabilitation for MS patients. The remaining three studies referred to mixed patient population. The majority of studies indicated that inpatient rehabilitation can provide clinical and functional benefits for all patient groups under consideration. Moreover, economic evaluations indicate that rehabilitation may be cost saving or cost-effective in certain patient groups such as those with fractures and stroke.

Conclusion: The results of the present review demonstrate that inpatient rehabilitation may deliver significant health and economic benefits for patients suffering from stroke, spinal cord injury, or multiple sclerosis and for health systems. Further research is needed to improve the consistency and robustness of the available evidence.

Keywords: Inpatient rehabilitation; Clinical; Functional ability; Economic; Benefits

Introduction

Over a billion people, about 15% of the world's population, have some form of disability either due to injury or acute and chronic diseases [1]. Between 110 million and 190 million adults have significant difficulties in functioning. Rates of disability are increasing due to population ageing and raises in the prevalence of chronic health conditions, among other causes. Disability has a negative impact on social development and economic development [1].

Rehabilitation is instrumental in enabling people with limitations in functioning, to remain in or return to their home or community, live independently, and participate in education, the labour market and civil life. Access to rehabilitation can decrease the consequences of disease or injury, improve health and quality of life and decrease the use of health services [2].

Physical rehabilitation is a medical specialty focused on prevention, diagnosis, and therapy for patients who experience functional limitations resulting from injury, disease, or malformation. The benefits of rehabilitation could be clinical- physical, neurological, and cognitive related improvements-, functional-motor related improvements and economic- including patient's work productivity [3,4]. Rehabilitation programs can be provided in alternative settings including an acute hospital, sub-acute hospital, specialist facilities (inpatient or outpatient), or the patient's home.

While many countries have started taking action to improve the lives of people with disabilities, much remains to be done [2]. Increased collaboration amongst rehabilitation professionals in developed and developing countries is essential to implement appropriate and sustainable rehabilitative services.

In Greece, rehabilitation services are provided mainly by private specialized institutions, even though, there are also some integrated services in general hospital care public facilities. However, the provided services are fragmented, underdeveloped, underfunded and in many cases inadequate and much more attention needs to be paid to this particular medical specialty.

In this light, the objective of the present study was to systematically review the literature reporting evaluations on the clinical, quality of life, and economic benefits of inpatient rehabilitation for patients suffering from stroke, spinal cord injury (SCI), and multiple sclerosis (MS).

Methods

This review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria [5,6] to search, retrieve, and synthesized the findings of selected studies.

Search strategy

In order to identify eligible studies, PubMed, Embase, Scopus, CEA Registry, and NHS EED databases were searched using pre-determined keywords. The latter were synthesized by a group of experts with relevant

***Corresponding author:** Gourzoulidis George, EVROSTON LP, Chatzigianni Mexi 5, 115 28, Athens, Greece, Tel: +30-216-900-1701; Fax: +30-216-900-1702; E-mail: gourzoulidis.g@evroston.com

Received March 15, 2017; **Accepted** April 03, 2017; **Published** April 04, 2017

Citation: Maistreli S, Gourzoulidis G, Vellopoulou K, Kourlaba G, Maniadakis N (2017) The Clinical, Quality of Life and Economic Outcomes of Inpatient Rehabilitation: A Systematic Review. Int J Phys Med Rehabil 5: 399. doi:10.4172/2329-9096.1000399

methodological and clinical expertise. The literature search was conducted using three different combinations of keywords for: rehabilitation; outcomes and health condition, as presented in Table 1. The terms in the three major categories were combined by the Boolean "AND", whilst the terms utilized within each of the search categories were combined by the Boolean "OR". The filters "English" and "Humans" were added as to restrict our search to the relevant studies. There was no search limitation in terms of time and geographical location of the original studies. The search was limited to studies published up to December 2015. The Appendix presents the full search strategy used for MEDLINE, which was adapted appropriately for the rest of the databases.

Study selection

Consequently, the identified studies were reviewed and assessed for inclusion in the review by two independent researchers, based on the predetermined inclusion/exclusion criteria presented in Table 2. Clinical trials were excluded since the review was focused on real-world evidence data. Therefore, as presented in Table 2, observational studies were taken into consideration. The study selection procedure encompassed two stages: initially, all the identified studies were evaluated on the basis of titles and/or abstracts against the eligibility criteria; in the second stage, when the information provided by titles/abstracts was insufficient to decide on inclusion/exclusion, or when the titles/abstracts indicated that the specific studies met the inclusion criteria, the full-papers were retrieved to be screened. In cases where the amount of information reported in the full-text continued to be insufficient to make a decision about inclusion, the studies were excluded. The study selection process was documented through a flow chart showing the number of studies/papers remaining at each stage.

1.Type of rehabilitation	2.Outcomes	3.Condition/Treatment
Rehabilitation center	Benefit	Stroke
Rehabilitation centre	Outcome	SCI
Rehabilitation hospital	Cost	Spinal cord injury
Inpatient rehabilitation	Clinical	Multiple Sclerosis
Hospital-based rehabilitation	Health	
Hospital based rehabilitation	Economic	
	Functional	
	Quality of life	
	Quality-of-life	
	Productivity	
	Capability	
	Work	
	Employment	
	Hospitalization	
	Barthel	
	Mortality	
	Cost-benefit	
	Cost- effectiveness	
	Cost-utility	
	Cost-minimization	
	Early discharge	
	Cost-consequence	
	Economic modeling	

Table 1: Search terms used in searches of electronic databases.

Data extraction

A standardized data extraction form for each health condition (stroke, SCI, MS), developed for the purpose of this review, was used by the two reviewers to extract the data independently. Any disagreement in the data extraction form between the two reviewers was resolved through discussion between these two or by involving a third independent researcher. The aforementioned extraction form was designed to include data on the background information of the study, its methodological characteristic, and the key results.

Data synthesis

In this systematic review, the results are summarized in a qualitative manner collating data from studies. We synthesized the relevant and available data in a systematic manner following the review question, the inclusion and exclusion criteria.

Results

Study selection

After removing duplicate citations, 1,764 unique citations remained for screening. The manual screening of all titles and abstracts yielded 84 articles that contained information about the benefits of inpatient rehabilitation. Of the latter full articles retrieved and reviewed by the investigators, 40 met the inclusion criteria. The reference lists of all relevant papers originally selected for inclusion in the review and relevant reviews were also searched manually to identify potentially relevant articles which were not identified by the original electronic search. Consequently, six additional studies of interest were collected in full text with agreement for inclusion in the systematic review, taking the total to 46. Details of literature search strategy are shown in Figure 1.

Overall 41 out of the 46 studies examined the clinical benefits of inpatient rehabilitation (16 for stroke patients, 15 for SCI patients, seven for MS patients, and three for mixed population of stroke and SCI patients) and five studies assessed the economic benefits for post-stroke patients. Notably, there was significant heterogeneity in terms of study designs and in the way that functionality was measured.

Stroke

Overall, 24 studies examined the impact of inpatient rehabilitation on stroke patients (Table 3).

Clinical outcomes

Four studies [7-10] assessed functional disability in stroke patients using the Barthel Index (BI), which is a standardized and well validated method of measuring a patient's level of physical independence. In

	Inclusion criteria	Exclusion criteria
Studies	Full prospective studies, retrospective studies, case-control studies, observational studies, economic evaluations	Systematic reviews, meta-analysis, case studies/reports, letters to the editor, abstracts
Outcomes	Clinical, functional, quality of life, economic	Other outcomes
Conditions	Stroke, Spinal Cord Injury, Multiple Sclerosis	
Population	Adults	Pediatric
Countries	Any	
Setting	Inpatient (hospitals or centers)	Outpatients

Table 2: Inclusion and exclusion criteria considered in the search strategy.

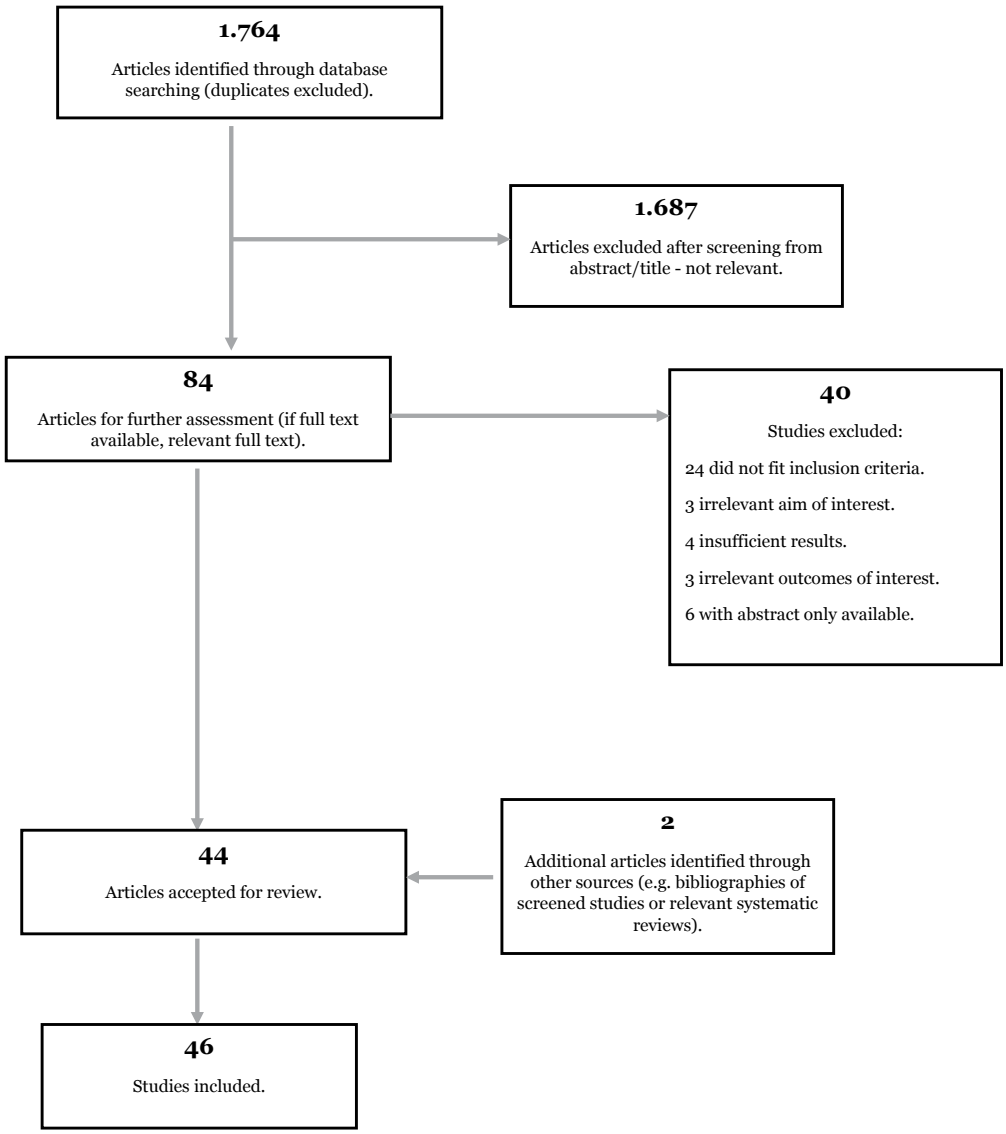

Figure 1: Flowchart of systematic review.

all of these studies, patients demonstrated a statistically significant improvement in the BI score at discharge score relative to the one at admission.

Twelve studies used the Functional Independent Measure (FIM) for the evaluation of motor and cognitive disability in stroke patients [10-21]. All of these studies indicated significant improvement in the FIM score between rehabilitation admission to rehabilitation discharge. Notably, the majority of the studies highlighted that the improvement of patients' functional ability was statistically significant [10-13,16-18,20,21].

Two studies used the Motor Assessment Scale, Item 6 Upper Arm Function (MAS6) to measure the upper arm disability [17,22]. In the first study, 83% of stroke patients demonstrated a statistically significant improvement in arm function at rehabilitation discharge, while 68% achieved a shift from severe to mild/moderate upper arm disability on discharge. The second study reported that 45% of patients had a statistically significant change in arm function recovery at rehabilitation discharge.

In addition, the study by Ee et al. [23] indicated that the percentage of totally dependent post stroke patients was statistically significantly lower in terms of the Rehabilitation Profile System (RPS) at discharge. Moreover, Gialanella et al. [24] demonstrated that patients had statistically significant improved mobility, measured by the Lindmark and the Rivermead Mobility Index (RMI), as well as neurological status, measured in terms of the National Institute of Health Stroke Scale (NIH). It is worth noting that 80.5% of patients were ambulatory independent at discharge contrary to 1.4% on admission, an impressive outcome improvement.

Four studies evaluated the long-term benefits of inpatient rehabilitation [8,21,25,26]. Sim et al. [8] demonstrated that the gains in patients' functional status were generally maintained one year after discharge, with a further statistically significant improvement in toileting. Furthermore, Mutai et al. [25] reported that 51.9% were classified as independent in terms of their Activities of Daily Living (ADL), 1-5 years after discharge. According to Mahler et al. [26] the

Study	Background information of study		Population characteristics		Outcome measures	Follow up	Main results
	Location	Study design	Sample size	Age			
Shah et al. [7]	Australia	Prospective	258	mean age Males: 68 Females: 71.6	BI: (0-100)		*On admission to rehab vs. at discharge:* BI (mean): 44 *vs.* 78 s.s.
Sim et al. [8]	Hong Kong	Retrospective/ prospective	185	mean age ± SD 69 ± 11.1	BI: (0-100) % of independent pts	1 year after discharge	*On admission to rehab vs. at discharge:* BI (median, IQR): 55 (30-75) *vs.* 90 (70-100) p<0.05 *Discharge vs. 1 year follow-up (n=112):* BI (median, IQR): 90 (85-100) *vs.* 100 (85-100) p<0.05 % independent pts 74.1% *vs.* 83.9% walking 68.8% *vs.* 85.7% toileting p<0.05
Kuptniratsaikul et al. [9]	Thailand	Prospective	327	mean age ± SD 62.1 ± 12.2	BI: (0-20) HADS: % of pts with anxiety and depression Thai WHOQOL-BRIEF: QoL assessment (24-120)		*On admission to rehab vs. at discharge:* BI (mean ± SD): 7.48 (± 3.96) *vs.* 13.27 (± 4.86) p<0.001 % of pts with anxiety: 25.5% *vs.* 6.8% p<0.001 % of pts with depression: 37.8% *vs.* 16.3% p<0.001 QoL score (mean ±SD): 69.74 (± 11.75) *vs.* 77.72 (± 10.69) p<0.001
Balaban et al. [10]	Turkey	Retrospective	80	mean age ± SD 63.54 ± 13.62	BI: (0-100) FIM: (18-126)		*On admission to rehab vs. at discharge:* BI (mean): 49.13 *vs.* 78 p<0.001 FIM (mean): 67.97 *vs.* 91.91 p<0.001
Yavuzer et al. [11]	Turkey	Retrospective	67	mean age ± SD 60 ± 11.8	FIM: (18-126)		*On admission to rehab vs. at discharge:* FIM (mean ± SD): 75.0 (± 2 4.9) *vs.* 86.7 (± 24.2) p<0.001
Gökkaya et al. [12]	Turkey	Prospective	83	mean age ± SD 58 ± 12	FIM: (18-126)		*On admission to rehab vs. at discharge:* FIM (mean ± SD): 56.5 (± 18.6) *vs.* 74.6 (± 19.0) p<0.01
Giaquinto et al. [13]	Italy	Prospective	111		FIM: (18-126)		*On admission to rehab vs. at discharge:* FIM (mean): 62 *vs.* 101 p<0.0001
Foley et al. [14]	Canada	Retrospective	123	mean age ± SD 67 ± 15	FIM: (18-126) Motor-FIM: (13-91) Cognitive-FIM: (535) % of pts discharged to community		*On admission to rehab vs. at discharge:* FIM (mean ± SD): 77 (± 25) *vs.* 103 (± 22) Motor-FIM (mean ± SD): 52 (± 22) *vs.* 74 (± 19) Cognitive-FIM (mean ± SD): 25 (± 6) *vs.* 29 (± 5) 74% returned home upon discharge
Gagnon et al. [15]	Canada	Retrospective	422	mean age ± SD 71.9 ± 10.5	FIM: (18-126) Motor-FIM: (13-91) Cognitive-FIM: (5-35) % of pts discharged to community		*On admission to rehab vs. at discharge:* FIM (mean ±SD): 86.1 (± 21.7) *vs.* 107.7 (± 16.7) Motor-FIM (mean ± SD): 58.8 (± 19.2) *vs.* 78.1 (± 13.5) Cognitive-FIM (mean ± SD): 27.2 (± 6.4) *vs.* 29.6 (± 5.6) 84% returned to their prior living arrangement
Teasell et al. [16]	United Kingdom	Retrospective	196	mean age ± SD 72 ± 11	FIM: (18-126) % of pts with higher, lower, unchanged scores % of pts discharged to community		*On admission to rehab vs. at discharge:* FIM (mean, IQR): 46 (IQR 20, range:19-96) *vs.* 70 (IQR 30, range: 18-121) p<0.0001 94.5% had higher discharge FIM scores /4.4% had lower FIM discharge scores /1.1% did not change 43.4% returned to their own home upon discharge
Hayward et al. [17]	Australia	Prospective	239	mean age ± SD 70 ± 13	Motor-FIM: (13-91) MCID: (1-point change in MAS6) shift in disability status (i.e. severe to mild-moderate)		*On admission to rehab vs. at discharge:* Motor-FIM (mean ± SD): 55 (±23) *vs.* 76 (± 17) p<0.001 83% achieved a MCID defined by a change of ≥ 17 points 85% shift from severe motor disability to mild-moderate motor disability at discharge
Hayward et al. [22]	Australia	Prospective	226	mean age ± SD 71 ± 13	MAS6: MAS6>2 mild moderate upper arm disability MAS6 ≤ 2 severe upper arm disability MCID: (1-point change in MAS6) shift in disability status (i.e. severe to mild-moderate)		*On admission to rehab vs. at discharge:* % of pts with MAS6 ≤ 2: 100% *vs.* 55% p<0.001 68% of pts achieved MCID at discharge 45% of pts shifted from severe upper arm disability (MAS6<=2) to mild-moderate upper arm disability (MAS6>2) at discharge

Madden et al. [18]	Canada	Retrospective	116	mean age ± SD 71 ± 13	FIM: (0-126) Motor-FIM: (13-91) Cognitive-FIM: (5-35) SF-36: (0-100) PCS MCS % of pts discharged to community		*On admission to rehab vs. at discharge:* FIM (mean ± SD): 79.0 (± 21.2) *vs.* 106.8 (± 20.4) p<0.001 Motor-FIM (mean ± SD): 51.7 (± 18.1) *vs.* 77.1 (± 17.1) <0.001 Cognitive-FIM (mean ± SD):27.3 (± 6.4) *vs.* 29.8 (± 5.0) <0.001 PCS (mean ± SD): 28.4 (± 6.9) *vs.* 31.3 (± 7.3) p<0.001 MCS (mean ± SD):48.8 (± 12.4) *vs.* 50.7 (± 10.8) 81% discharged home
Ee et al. [23]	Singapore	Retrospective	100	mean age ± SD 72.7 ± 5.4	RPS:(ranges 0-5) 0-1 independent 2-3 partially dependent 4-5 totally dependent		*On admission to rehab vs. at discharge:* (% of patients with RPS 4-5) ADL:46% *vs.* 16% p<0.001 Mobility: 76% *vs.* 35% p<0.001
Gialanella et al. [24]	Italy	Retrospective	72	mean age ± SD 46.5 ± 10	stroke severity NIH: (0-42, 0=normal/ 42=patient in coma) walking Lindmark scale: (7-point scale, 0=cannot walk/ 6=can walk) mobility RMI: (0-15, 0=totally unable)		*On admission to rehab vs. at discharge:* NIH (mean ± SD): 5.20 (± 2.5) *vs.* 3.41 (± 2.2) p<0.001 Lindmark (mean ± SD): 0.93 (± 0.9) *vs.* 4.22 (± 1.6) p<0.001 RMI (mean ± SD): 2.69 (± 2.2) *vs.* 9.95 (± 2.2) p<0.001 % pts walk independently: 1.4% *vs.* 80.5%
Mutai et al. [25]	Japan	Retrospective	252	mean age ± SD 72.4 ± 10.8	mRS:(6 grades, 0=no symptoms/ 5=severe disability) GDS ≥ 11 points (max 15 points) indicates depression FAI: (scores from 15-60, higher score-higher level of activity)	1-3 years after discharge	*follow-up assessment:* 52% of pts (n=159) were independent, mRS ≤ 2 21.6% of pts (n=153) scored GDS ≥ 11 FAI (mean ± SD): 26.5 ± 10.9 (n=156)
Mahler et al. [26]	Switzerland	Retrospective, cost- analysis	131	mean age ± SD 73 ± 12	Direct insurance costs for year 2002-2003 (CHF- Swiss franc) BI gain (inpatient *vs.* no inpatient rehab) % of independent pts after 1 year (inpatient *vs.* no inpatient rehab)	1 year after stroke	-cost at 1 year inpatient *vs.* no inpatient rehab: 45.031 (± 13.492) *vs.* 25.908 (± 9.869) p<0.05 -mean cost of stroke/patient: 31.115 CHF -mean cost of inpatient rehab/pts:11.471CHF(37% of the total cost) BI gain (mean ± SD): 42 (± 29) *vs.* 23 (± 26) p<0.05 inpatient rehab(n=58) *vs.* no inpatient rehabilitation (n=73): % of independent pts after 1 year: 81% (47/58) *vs.* 51% (37/73) p<0.05
Moodie et al. [27]	Australia	Economic evaluation	395	mean age ± SD 73 ± 14	Average cost per pts Incremental cost – effectiveness stroke unit *vs.* conventional care	28 weeks	ICER of stroke unit *vs.* conventional care: A$9,867 per pts achieving thorough adherence to clinical process and A $ 16,372 per pts with severe complications avoided
Khiaocharoen et al. [28]	Thailand	Economic evaluation	207		Total cost of hospitalization ICER per QALYs gained	4 months	Cost of hospitalization of rehab group and unexposed group were 16,993 and 11,401 baht per case respectively ICER per QALY gained from rehab was 24, 571 baht
Patel et al. [29]	England	Economic evaluation	447		Total healthcare costs of stroke unit, stroke team and domiciliary care ICER per % point in deaths avoided and ICER per QALYs between the interventions	12 months	Mean healthcare cost : Stroke unit : £11,450 , Stroke team: £9,527 , Domiciliary care: £6,840 ICER per % point in deaths avoided in the first year was £682 for the stroke unit over domiciliary care , ICER per QALY was £64,097 The stroke team was dominated by domiciliary care
Andersson et al. [30]	Sweden	Cost-study	124		Total cost of inpatient & Home rehab.	12 months	Total cost of inpatient rehab 126,000 sek Total cost of home based rehab 54,550 sek Total days of inpatient rehab 28 days *vs.* home rehab 36 days
Bode et al. [19]	USA	Retrospective	129	mean age ± SD 65.5 ± 12.3	Motor-FIM score: (0-100) Cognitive-FIM score: (0-100)		*On admission to rehab vs. at discharge:* Motor-FIM (mean ± SD): 40.4 (± 12.6) *vs.* 63.0 (± 20.2) Cognitive-FIM (mean ± SD): 54.7 (± 13.0) *vs.* 71.3 (± 16.8)

Ng et al. [20]	Singapore	Prospective	865	mean age ± SD 61.3 ± 15	FIM: (18-126) Motor-FIM score: (13-91) Cognitive-FIM score: (5-35)		*On admission to rehab vs. at discharge:* total FIM (mean ± SD): 67.9 (± 23.1) *vs.* 85.9 (± 23.0) p<0.01 Motor-FIM (mean ± SD): 43.2 (± 17.0) *vs.* 58.9 (± 17.5) p<0.01 Cognitive-FIM (mean ± SD): 24.7 (± 8.5) *vs.* 26.9 (± 7.7)p<0.01
Graham et al. [21]	USA	Retrospective	93.925	66% aged >65 years	FIM: (18-126) Motor-FIM score: (13-91) Cognitive-FIM score: (5-35)	80-180 days post-discharge (mean 104 days)	*On admission to rehab vs. at discharge vs. at follow up:* Motor-FIM (mean ± SD): 39.2 (± 14) *vs.* 60.7 (± 16.6) *vs.* 73.9 (± 18.1) Cognitive-FIM (mean ± SD): 21.6 (± 7.6) *vs.* 25.7 (± 6.8) *vs.* 30.9 (± 5.4) total FIM (mean ± SD): 60.8 (± 18.9) *vs.* 86.4 (±2 1.0) *vs.* 104.8 (± 21.6) *vocation follow up:* 4.6% employed 77.7% retired 79.7% maintained health follow up by their own

BI: Barthel Index (the individual's performance on 10 ADL functions for a total of 100 points-100 points for total independence), ADL: Activities of Daily Living, effectiveness: actual improvement over potential improvement, efficiency: mean improvement per day, s. s.: statistically significant, SD: Standard Deviation, IQR: Inter Quartile Range, HADS: Hospital Anxiety and Depression Scale Thai WHOQOL-BRIEF: Thai World Health Organization Quality of Life, the brief version, QoL assessment (ranges 24-120, 120 points-totally satisfied), QoL: Quality of Life, FIM: Functional Independent Measure (18-item, 7-level measure of patient's ability to perform several activities, 126 points-totally independent), Motor-FIM: (13 motor items on a 7-point scale each, 91 points-totally independent), Cognitive-FIM:(5-item, 7-level measure, ranges from 5-35 points, 5 points- cognitive disabled), MAS6: Motor Assessment Scale, Item 6 Upper Arm Function, MCID: Minimal Clinical Important Difference, SF-36: 36-item short form (8 domains HRQOL, scales from 0 to 100, higher values- better HRQOL), HRQOL: Health-Related Quality Of Life, PCS: Physical Component Summary, MCS: Mental Component Summary, RPS: Rehabilitation Profile System, NIH: National Institute of Health Stroke Scale, RMI: Rivermead Mobility Index, mRS: modified Rankin Scale, GDS: Geriatric Depression Scale, FAI: Frenchay Activities Index Rehab: rehabilitation, pts: patients

Table 3: Studies focusing on stroke patients

percentage of independent post stroke patients who underwent inpatient rehabilitation reached 81% as compared to 51% of the patients without inpatient rehabilitation, one year after stroke. Moreover, Graham et al. [21] indicated that 79.7% of patients were successfully maintaining their health status by themselves, 3-6 months after discharge.

Finally, Mahler et al. [26] assessed the effectiveness of inpatient rehabilitation as compared to traditional treatment on stroke patients. The patients who underwent the rehabilitation program had their BI score increased by 42 ± 29 points, as compared to patients without (inpatient) rehabilitation, whose functional level rose by 23 ± 26 points only (p<0.05).

Quality of life outcomes

Quality of life was assessed in three studies [9,18,25]. The study by Mutai et al. [25] indicated that 21.6% of patients suffered from depression 1-3 years after stroke. On the other hand, Kuptniratsaikul et al. [9] highlighted that the number of patients with anxiety and depression was statistically significant lower at discharge. More specifically, 25.5% of patients had anxiety and 37.8% had depression on admission. At discharge, the percentages of patients with anxiety and depression decreased to 6.8% and 16.3%, respectively. In addition, the same study reported that the quality of life scores at discharge were significantly higher than those on admission. Finally, the study by Madden et al. [18] reported that the mean improvement between admission and discharge at the SF-36 (patient-reported survey of patient health) scores was statistically significant.

Economic outcomes

A significant proportion of patients with stroke returned home after discharge. More specifically, four studies [14-16,18] reported that the percentage of patients who returned to their home (without further institutionalization 74%, 84%, 43.4%, and 81% respectively. The percentage of the third study [16] is much lower than the others because it referred to patients with severe stroke who were totally ambulatory dependent.

According to the cost analysis of Mahler et al. [26], inpatient rehabilitation is the most significant part of the total health insurance costs in the first year after stroke (37%). However, inpatient rehabilitation's crucial benefit related to the high percentage of independent patients after one year (81%), which in turn may be associated with reduced health care long-term costs. Moodie et al. [27] compared costs and outcomes of stroke patients who received either conventional care or mobile service or stroke unit care (as below). The study demonstrated that although acute Stroke Care Unit (SCU) was more expensive, it was found to be cost-effective compared to a mobile service or conventional care. Khiaocharoen et al. [28] who conducted a cost-utility analysis of rehabilitation for stroke patients in Thailand, concluded that inpatient rehabilitation services for stroke survivors were cost-effective as compared with conventional care. Patel et al. [29] highlighted that the percentages of patients who avoided death/institutionalization were 87%, 69%, and 78% in the stroke unit, stroke team, and domiciliary care groups, respectively. Finally, Andersson et al. [30] compared the outcomes of two rehabilitation groups, hospital- and home-based respectively. Although the home-based group had significantly lower costs, the number of acute care ward days after a decision about rehabilitation was made was three days in the hospital-based group and nine in the home-based group and the difference was significant. The hospital-based group thereafter had a mean duration of 28 in-hospital rehabilitation days and the home-based group had 36 days of home rehabilitation (Table 3).

SC

Overall 18 studies examined the impact of inpatient rehabilitation on SCI patients (Table 4).

Clinical outcomes

Five studies assessed physical and cognitive disability with the FIM scale [19-21,31,32]. Two of them reported a statistically significant improvement in patients' functional status from rehabilitation admission to rehabilitation discharge [31,32]. The remaining three studies indicated that the patients' total FIM score (physical and

Study	Background information of study		Population characteristics		Outcome measures	Follow up	Main results
	Location	Study design	Sample size	Age			
Yarkoni et al. [33]	USA	Retrospective	711 (n=188) complete quadriplegia (n=201) incomplete quadriplegia (n=211) complete paraplegia (n=111) incomplete paraplegia (n=389) quadriplegia(n=322) paraplegia	mean age incomplete lesions: 31 complete lesions: 26.2	MBI: (100-point scale) -self-care subscore (-2 to 53) (higher score, higher independence) -mobility subscore (0 to 47) (higher score, higher independence)		*On admission to rehab vs. at discharge:* complete quadriplegia MBI (mean): 7.7 *vs.* 21.1 s.s. incomplete quadriplegia MBI (mean): 19.5 *vs.* 60.6 s.s. complete paraplegia MBI (mean): 35.2 *vs.* 71.2 s.s. incomplete paraplegia MBI (mean): 42.4 *vs.* 80.5 s.s. quadriplegia total-MBI (mean): 13.8 *vs.* 46.1 paraplegia total-MBI (mean): 37.7 *vs.* 74.4
Ferdiana et al. [44]	Netherlands	Prospective	114	mean age ± SD 42.1 ± 11.6	% of pts in paid employment for -at least 1 h/week -at least 12 h/week	5 years after discharge	50.9% returned to work for at least 1 h/week 42.6% returned to work for at least 12 h/week median number of working hours before injury *vs.* 5 years follow-up: 44.1 *vs.* 22.6
Haisma et al. [31]	Netherlands	Prospective	182	mean age ± SD 40 ± 14	Motor-FIM: (13-91) SIP68: physical sum score: range 0-29 social sum score: range 0-22 (the higher the score, the more limited the functional status)	1 year after discharge	*On admission to rehab vs. at discharge:* Motor-FIM (mean ± SD):44 (± 18) *vs.* 69 (± 17) p<0.01 At follow-up *(n=133):* physical SIP68: 12 (± 7) social SIP68: 6 (± 4)
New et al. [32]	Australia	Retrospective	70	mean age 69	Total Rasch FIM cognitive Rasch FIM subscore:100-point scale motor Rasch FIM subscore:100-point scale		*On admission to rehab vs. at discharge:* cognitive Rasch score (mean): 80.6 (± 19.9) *vs.* 81.2 (± 20.1) not s.s. motor Rasch score (mean): 39.6 (± 16.1) *vs.* 58.7 (± 15.8) p<0.001 raw motor Rasch FIM gain (mean): ASIA grade A,B,C paraplegia: 15.8 p=0.002 ASIA grade D paraplegia: 23.8 p<0.001 ASIA grade A,B,C tetraplegia: 8.3 not s.s. ASIA grade D tetraplegia: 30.4 p<0.001
Schönherr et al. [35]	Netherlands	Retrospective	55	mean age 33	Functional outcome: 9 activities of daily living, set of 3 skills (*mean score per set 0-9 points*) -self-care skills -ambulation skills -bladder and bowel skills (*0=dependent 9=independent*)		*On admission to rehab vs. at discharge:* self-care score (mean): 4.6 *vs.* 7.6 p<0.01 ambulation score (mean):3.2 *vs.* 6.3 p<0.01 bladder and bowel score (mean): 1.3 *vs.* 5.8 p<0.01
Sturt et al. [36]	Australia	Prospective	62	mean age 67	Walking ability: TUG: time taken to complete the test and the seat height 10 mWT: time taken to complete the test and the number of steps taken 6MWT: the distance the subject could complete in 6min and the number of rests during the test		48% of pts regained some capacity to walk. *On admission to rehab vs. at discharge:* TUG mean (n=27): 57 s *vs.* 33 s normal=8.5 s p<0.001 10 mWT mean (n=27): 51 s *vs.* 29 s normal=1.35 ms for men/ 1.29ms for women 6MWT mean (n=20): 129 m *vs.* 220 m normal=659 ± 62 m
Yen et al. [37]	Singapore	Retrospective	231	mean age ± SD 39 ± 17	Neurological outcome: Frankel classification (grades A-E, A: motor/ sensory function absent E: motor/ sensory function normal) Functional outcome: Ambulatory status (independent/ non-ambulant) ADL ability (independent/ requiring assistance) Bladder outcome (pts' method of voiding) Vocational status (% of pts returned to some form of vocation)		*On admission to rehab vs. at discharge:* % of pts with *Frankel scale D/E* :26.8% *vs.* 59.6% % of pts upgraded Frankel scale from admission to discharge: initially Frankel scale A:25.7% initially Frankel scale B:23.1% initially Frankel scale C:76.2% initially Frankel scale D:16.7% % of pts totally independent in ADL: 2.7% *vs.* 20% % of pts urinary-catheter totally dependent: 63.6% *vs.* 7.8% 48.9% of pts independent with aids in ADL at discharge 21.6% of pts returned to some form of vocation 1-year post injury 87.9% discharged home

Citterio et al. [45]	Italy	Prospective	330	mean age 55.2	Neurological outcome: % of pts with AIS gain (an increase at discharge of at least 1 grade on the scale above the grade recorded on admission) % of pts returned home % of pts with pressure ulcers		30% of pts exhibited improvement in AIS 73% of pts returned home. *On admission vs. at discharge:* % of pts with pressure ulcers: 19.7% *vs.* 8.8%
Franceschini et al. [38]	Italy	Retrospective, prospective	251 (146 follow-up)	mean age 37.8	mortality rate Quality of Life: satisfaction with QoL questionnaire (two evaluation scales: autonomy and QoL, range 0-10, the higher the score the more satisfied with QoL) % of pts returned to work	6 years after discharge	mortality rate from discharge to 6-years follow up: 9.96% at follow up: -autonomy mean score:6.5 -QoL mean score:6.5 -29.5% was employed -61% left home on a daily basis -64.4% could leave home without assistance -48.6% was satisfied with partner relationships
Schonherr et al. [39]	Netherlands	Retrospective	57	mean age ± SD 33 ± 11	LSQ: (1-6) (grades 5-6: "satisfied" grades 1-4: "not satisfied") hours spent on vocational and leisure activities % of pts returned to work	2-12 years after injury	67% "satisfied" 33% "not satisfied" with vocational & leisure participation *preinjury vs. follow-up hours spent in:* paid work: 41.6 *vs.* 19.5 p<0.05 small jobs at home: 5.1 *vs.* 3.3 p<0.05 total vocational participation: 57.2 *vs.* 33.5 p<0.05 sports: 4.0 *vs.* 1.2 p<0.05 total participation (vocational+leisure): 65.9 *vs.* 39.6 p<0.05 time for self-care: 3.3 *vs.* 8.1 p<0.05 % of pts worked at time of injury *vs.* at follow-up: 86% *vs.* 60% 28% of pts reported help from the rehab team in finding new hobbies or sports
van Asbeck et al. [40]	Netherlands	Prospective	117	≥ 18	housing status (% of pts) work/household status (% of pts) sport/hobbies status (% of pts)	8-15 years after discharge	93% of pts were independent (own/rented house, adapted house) 32.4% employed 36.7% household activities 41% were still active in sport (basketball, table tennis, wheelchair racing) 86.3% had at least one hobby
Franceschini et al. [41]	Italy	Retrospective, prospective	403	mean age ± SD 41.8 ± 16.3	% of pts employed at the end of follow up	3.8 years after injury	*At the time of injury vs. at the end of follow-up:* % of employed:83.4% *vs.* 42.1% *employed vs. unemployed*: perceived quality of life:6.9 ± 2 *vs.* 5.3 ± 2.8 p<0.0001 satisfying sex life (%): 38% *vs.* 26.6% p=0.02 leave home for leisureness (%): 72.4 *vs.* 37.3 p<0.0001 practicing sports (%): 45.3 *vs.* 18.5 p<0.0001
van Velzen et al. [42]	Netherlands	Prospective	118	mean age 38	% of pts returned to paid work for at least 1h/week	1 year after discharge	33% returned to work (all participants were in paid employment before injury) median number of working hours before injury *vs.* 1-year follow-up: 40.63 *vs.* 20.69
van Velzen et al. [43]	Netherlands	Prospective	103	range 18-65	% of pts returned to paid work for at least 1hour/week	5 years after discharge	44.7% returned to work (all participants were in paid employment before injury) median number of working hours before injury *vs.* 5-years follow-up: 40 *vs.* 20 22% of RTW group were working full-time 78% of RTW group were working part-time
Bode et al. [19]	USA	Retrospective	52	mean age ± SD 35.5 ± 15.7	Motor-FIM score: (0-100) Cognitive-FIM score: (0-100)		*On admission to rehab vs. at discharge:* Motor-FIM (mean ± SD): 20.6 (± 16.7) *vs.* 86.5 (± 17.4) Cognitive-FIM (mean ± SD): 45.6 (± 15.3) *vs.* 91.9 (± 13.3)
Ng et al, 2007(20)	Singapore	Prospective	145	mean age ± SD 61.3 ± 15	FIM: (18-126) Motor-FIM score: (13-91) Cognitive-FIM score: (5-35)		*On admission to rehab vs. at discharge:* total FIM (mean ± SD): 68.5 (± 21.1) *vs.* 86.6 (± 23.6) p<0.01 Motor-FIM (mean ± SD): 37.7 (± 18.8) *vs.* 54.9 (± 20.6) Cognitive-FIM (mean ± SD): 30.8 (± 5.9) *vs.* 31.6 (± 5.7) p<0.01

Graham et al. [21]	USA	Retrospective	6.663	45% aged <45 years	FIM: (18-126) Motor-FIM score: (13-91) Cognitive-FIM score: (5-35)	80-180 days post-discharge (mean 104 days)	*On admission to rehab vs. at discharge vs. at follow up:* Motor-FIM (mean ± SD):30.3 (± 14.0) *vs.* 55.0 (± 20.0) *vs.* 66.6 (± 23.2) Cognitive-FIM (mean ± SD):29.9 (± 5.6) *vs.* 32.3 (± 4.1) *vs.* 33.6 (± 3.0) total FIM (mean ± SD):60.2 (± 16.1) *vs.* 87.3 (± 21.4) *vs.* 100.2 (± 24.3) *vocation follow up:* 8.0% employed 45.1% retired 75.4% maintained health follow up by their own
Scivoletto et al. [34]	Italy	Retrospective	117	mean age ± SD 55.1 ± 15.4	BI: (0-100) RMI:(ranges 0-15, 0=totally unable) WISCI: (ranges 0-20, 0=unable, 20=full autonomy) ASIA motor score:(100-point scale, 100 points for no weakness) % of pts walk independently % of pts with normal bladder control % of pts returned home		*On admission to rehab vs. at discharge:* BI (mean ± SD):29.4 (± 24.5) *vs.* 62.7 (± 30) p<0.001 RMI (mean ± SD): 1.6 (± 3.1) *vs.* 5.6 (± 4.7) p<0.001 WISCI (mean ± SD):1.6 (± 4.9) *vs.* 5.7 (± 7.7) p<0.001 ASIA motor score (mean ± SD):56.3 (± 16.2) *vs.* 62.5 (± 20.5) <0.001 % of pts walk independently: 11% *vs.* 41% p<0.001 % of pts with normal bladder control: 0% *vs.* 42% 90% returned home

BI: Barthel Index (the individual's performance on 10 ADL functions for a total of 100 points-100 points for total independence), MBI: Modified Barthel Index, FIM: Functional Independent Measure (18-item, 7-level measure of patient's ability to perform several activities, 126 points-totally independent), Motor-FIM: (13 motor items on a 7-point scale each, 91 points-totally independent), s.s..: statistically significant, LOS: Length of Stay, RMI: Rivermead Mobility Index, WISCI: Walking Index for Spinal Cord Injury, ASIA: American Spinal Injury Association standards, SIP68: Sickness Impact Profile 68, health-related functional status, Rasch: psychometric model for analyzing categorical data, TUG: Timed Up and Go, 10mWT: 10-m walk test, 6MWT: 6-min walk test, ADL: Activities of Daily Living, AIS: Association Impairment Scale, QoL: Quality of Life, LSQ: Life Satisfaction Questionnaire, Rehab: rehabilitation, pts: patients

Table 4: Studies focusing on spinal cord injury patients.

cognitive) was significantly higher at rehabilitation discharge [19-21]. Additionally, Graham et al. [21] reported that follow-up (3-6 months) FIM total ratings remained from table to slightly increased over time in 75.4% of patients.

Two studies indicated that the improvement of patients' functional ability was statistically significant after admission to rehabilitation program, as measured by the BI scale [33,34]. Furthermore, the study by Scivoletto et al. [34] demonstrated that all functional and neurological scales showed statistically significant improvements in SCI patients, despite the delayed onset, of rehabilitation treatment.

Four studies reported that a great number of patients showed a significant improvement in ambulation and achieved independence or assisted dependence in walking at rehabilitation discharge [34-37]. More specifically, Scivoletto et al. [34] reported that at admission only 11% of patients were able to walk independently relative to 41% at discharge whereas the same percentages were reported to be 5.3% and 45.2% respectively in the study by Yen et al. [37]

Regarding bladder status [34,35,37], self-care [35], and activities of daily living [37], inpatient rehabilitation had a significantly positive impact on patients' ability to perform independently the afore-mentioned activities.

Quality of life outcomes

Franceschini et al. [38] presented data indicating that SCI patients reported to be satisfied with their current quality of life (6,5 QoL score, 10 max score) and that 48.6% were satisfied with their partner relationships, 6 years after rehabilitation discharge. Additionally, 67% of patients were satisfied with their quality of life, 2-12 years after rehabilitation discharge, as reported by Schonherr et al. [39]. With regard to sports and hobbies, 86.3% of patients had at least one hobby 8-15 years after rehabilitation discharge whereas 41% of them were still active in sport, as reported by van Asbeck et al. [40].

Economic outcomes

As far as productivity loss is concerned, eight studies evaluated patients' ability to return to some form of vocation within a reasonable period of time after injury [37-44]. More specifically, Yen et al. [37] indicated that 21.6% of SCI patients returned to some form of vocation one year post-injury while Franceschini et al. [38] showed that 29.5% were employed six years post-injury. The study by Schonherr et al. [39] demonstrated that most people with SCI were able to resume work 2-12 years after injury. In particular, 60% of patients had a job at the time of follow-up. Franceschini et al. [41] reported that 42.1% of SCI patients were employed at the time of follow-up (3.8 years). Finally, 32.4% of patients were employed and 36.7% were housekeeping 8-15 years after rehabilitation as reported by van Asbeck et al. [40].

Three studies in where all the patients were employed at the time of injury demonstrated that the percentages of them who were able to return to paid work for at least 1 hour/week within 5 years after discharge from inpatient rehabilitation were 33%, 44.7%, and 50.9% respectively.

According to the study by Scivoletto et al. [34] 90% of patients who underwent rehabilitation returned to their home while Citterio et al. [45] and Yen et al. [37] reported those percentages to be 73% and 87.9% respectively.

Finally, there were no economic evaluation studies identified that assessed inpatient rehabilitation's outcomes for SCI patients (Table 4).

Multiple Sclerosis

Overall, seven studies examined the impact of inpatient rehabilitation on MS patients (Table 5).

Clinical outcomes

Two studies found that the patients' discharge neurological status was not significantly different from the admission's as evaluated by means of Expanded Disability Status Scale (EDSS) [46,47]. According to the study by Freeman et al., improvements were maintained in disability (Functional Independent Measure) and handicap (London Handicap Scale) for 6 months after discharge but neurological status (EDSS) demonstrated a gradual deterioration within 1 year after discharge [48]. The study by Kiddetal indicated that 17% of MS patients were improved on the EDSS [49], while Aisenetal reported that MS patients were achieved statistically significant improvement between admission and discharge EDSS mean scores [50].

Study	Background information of study		Population characteristics		Outcome measures	Follow up	Main results
	Location	Study design	Sample size	Age			
Kidd et al. [46]	United Kingdom	Retrospective	79	mean age ± SD 48.8 ± 7.4	Impairment DSS: (0-10) Disability BI: (0-20) Handicap ESS: (0-35) (the higher the score the greater the handicap)		*On admission to rehab vs. at discharge:* DSS (mean ± SD): 7 (± 0.9) *vs.* 7 (± 1.1) BI (mean ± SD): 14 (± 5.2) *vs.* 17 (± 4.9) p<0.0001 ESS (mean ± SD) n=52: 19 (± 7.5) *vs.* 19 (± 8.1) 20% improved DSS score 65% improved BI score 44% improved ESS score 18% improved neurologically (as determined by clinical examination)
Freeman et al. [48]	United Kingdom	Prospective	50	mean age ± SD 44.8 ± 9.7	EDSS: (0-10) Motor-FIM: (13-91) LHS: (0-100) SF36: (0-100) PCS max 50 MCS max 50	1 year after discharge	*On admission to rehab vs. at discharge (n=50) vs. at follow up (46):* EDSS (median): 6.8 *vs.* 6.8 *vs.* 8.0 Motor-FIM (median): 61.5 *vs.* 74 *vs.* 63.5 LHS (median): 60.3 *vs.* 64.4 *vs.* 61.6 SF36-physical component (mean): 27.8 *vs.* 46.1 *vs.* 28.4 SF36-mental component (mean): 39.2 *vs.* 43.4 *vs.* 45.0
Khan et al. [52]	Australia	Retrospective	110	mean age 52	FIM: (18-126)		*On admission to rehab vs. at discharge:* FIM (mean): 85.6 *vs.* 97.0 p<0.001
Kidd et al. [49]	United Kingdom	Prospective	47	mean age ± SD 40 ± 11	Impairment DSS: (0-10) Disability Motor-FIM: (13-91) Handicap ESS: (0-35) (the higher the score the greater the handicap)	3 months after discharge	*On admission to rehab vs. at discharge vs. at follow up* DSS median (range): 7.5 (5:0-9.0) *vs.* 7.0 (4.0-9.0) *vs.* 7.0 (2.5-9.0) Motor-FIM median (range): 66 (13-85) *vs.* 80 (18-90) *vs.* 77 (18-90) ESS median (range): 19 (2-31) *vs.* 18.5 (4-30) *vs.* 17 (3-32) *On admission to rehab vs. at discharge:* 17% improved EDSS score 87% improved motor FIM score p<0.001 47% improved ESS score *At follow up (n=44):* 14% deteriorated in motor FIM 30% improved on ESS 86% maintained functional gains
Freeman et al. [51]	United Kingdom	Randomized control study	66 treatment group:32 control group:34	mean age treatment group: 43.2 control group: 44.6	EDSS: (0-10) Motor-FIM: (13-91) LHS: (0-100)		*treatment group vs. control group (at the end of 6 weeks of rehab/ no rehab):* EDSS (median): 6.5 *vs.* 6.5 Motor-FIM (median): 67 *vs.* 69.5 p<0.001 LHS (median): 61.5 *vs.* 66.2 overall improvement in FIM motor (% of patients): 72% *vs.* 29% p<0.001 change in LHS (score)+2.9 *vs.* -2.7 p<0.01 change in LHS (% of patients): 53% *vs.* 23% p<0.01

Aisen et al. [50]	USA	Retrospective	37	mean age ± SD 46.87 ± 11.275	Impairment EDSS: (0-10) FS: (7 functional systems ranging from 0 to 5 or 6-point scale, the higher the score the greater the disability) Disability FIM: (18-126)	6-36 months after discharge	*On admission to rehab vs. at discharge:* EDSS (mean): 7.47 *vs.* 6.92 p=0.0001 FS (mean): 14.73 *vs.* 13 p=0.0001 FIM (mean): 85.25 *vs.* 96.43 p=0.0001 s.s. improvements in FIM subgroups: self-care (p=0.0001), locomotion (p=0.0001), sphincter control (p=0.0222) 81% improved in self-care 32.43% improved in sphincter control s.s. improvements in FS domains: pyramidal function (p=0.0001) cerebellar function (p=0.0033) sphincter control(p=0.048) *Follow up 6-24 months after discharge:* not significant change in mean FS or FIM Follow up 24-36 months after discharge: (n=11) not significant change in mean FS mean FIM significantly deteriorated (p=0.008) only due to deterioration in locomotion status (p=0.0133)
Grasso et al. [47]	Italy	Retrospective	230 12.61% 'mild group' EDSS<6 (ambulation with no assistance) 30% 'moderate group' EDSS 6-6.5 (ambulation with assistance) 57.39% 'severe group' EDSS>6.5 (loss of ambulation)	mean age ± SD 49.42 ± 11.5	Effectiveness EDSS: (0-10) BI: (0-100) RMI: (0-15)		*On admission to rehab vs. at discharge:* EDSS (mean ± SD):6.93 (± 1.44) *vs.* 6.83 (± 1.45) BI (mean ± SD): 54.06 (± 30.6) *vs.* 58.91 (± 31.09) p<0.001 RMI (mean ± SD): 4.83 (± 4.41) *vs.* 5.49 (± 4.49) p<0.001 Effectiveness on EDSS (mean ± SD): 1.95 ± 4.98 Effectiveness on BI (mean ± SD): 16.11 ± 25.36 Effectiveness on RMI (mean ± SD): 8.25 ± 14.42 19.6% improved on EDSS 54% improved on BI 49% improved on RMI mild and moderate group-significant higher BI effectiveness than severe group mild and moderate group-significant higher RMI effectiveness than severe group

DSS: Disability Status Scale, (10-point scale,0=no impairment, 10=death due to MS), BI: Barthel Index (the individual's performance on 10 ADL functions for a total of 100 points-100 points for total independence), ESS: Environmental Status Scale, (35-point scale, the higher the score the greater the handicap) EDSS: Expanded Disability Status Scale, FIM: Functional Independent Measure (18-item, 7-level measure of patient's ability to perform several activities, 126 points-totally independent), Motor-FIM: (13 motor items on a 7-point scale each, 91 points-totally independent), FS: Functional Systems, effectiveness: actual improvement over potential improvement, RMI: Rivermead Mobility Index, (ranges 0-15, 0=totally unable), LHS: London Handicap Scale, (6 dimensions, 6-point scale, range 0-100, of increasing disadvantage), SF-36: 36-item short form (8 domains HRQOL, scales from 0 to 100, higher values- better HRQOL), HRQOL: Health-Related Quality Of Life, PCS: Physical Component Summary, MCS: Mental Component Summary, s.s.: statistically significant, rehab: rehabilitation

Table 5: Studies focusing on multiple sclerosis patients.

Two studies showed that statistically significant improvements occurred to MS patients as evaluated by means of the BI [46,47]. Five studies used the FIM to assess MS patients in terms of functional ability [48-52]. In four of the aforementioned studies (the fifth is a cohort study [51] the FIM score at discharge was higher than the one at admission, while in two of them [50,52] the FIM gain is statistically significant. It is worth noting that significant improvements also occurred in FIM subgroupings: self-care (eating, dressing, grooming, bathing), sphincter control (bladder, bowel), and locomotion (ambulation, stair climbing, wheel chair management) for all patients [50].

Additionally, two studies highlighted the statistically significant improvement that MS patients demonstrated in functional independence and disability, as evaluated by means of the Functional Systems, the Rivermead Mobility Index, and the London Handicap Scale [47,50].

Finally, according to Freeman et al. [51], MS patients with the same neurological status were randomized to a treatment or a control group. In terms of disability and handicap level improvements, there was a statistically significant difference between the two groups, 6 weeks later. In terms of the percentage of patients who improved, deteriorated, or remained the same, overall, 53%of the treatment group had improved their total handicap score, 3% remained the same, and 44% deteriorated. In contrast, 23% of the control group improved, 12% stayed the same, and 65% deteriorated.

Quality of life outcomes

With regard to health related quality of life measurement, in terms of the SF-36, Freeman et al. [48] reported that 54% of patients achieved maximum scores at 3 months after discharge and 28.2% at 6 months (in the physical dimension). In contrast, in the mental dimension, 21% of patients peaked at 3 months, with most (61%) peaking at 6 months.

Economic outcomes

Finally, there were no economic evaluation studies identified that assessed inpatient rehabilitation's outcomes for MS patients (Table 5).

Discussion

We systematically reviewed the available literature containing studies that evaluated the clinical, functional, and economic benefits of inpatient rehabilitation for stroke, SCI, and MS patients. This study is

important as it may provide insights into the evidence produced so far and what needs further research and future studies. We identified and included 46 articles in the review. Although the types of methodologies, measures and populations studied varied widely, we were able to identify clear health and economic benefits stemming from physical inpatient rehabilitation both for patients and healthcare systems.

In particular, there was strong evidence supporting the functional and neurological benefits of post-acute inpatient rehabilitation for all patient groups and situations. Also, there was moderate evidence to report that patients had a statistically significant gain in health-related quality of life outcomes. Finally, it was shown that the gains in patients' functional and disability status were generally maintained after discharge except for the MS patients in whom neurological status demonstrated a gradual deterioration after rehabilitation discharge over time. Moreover, the evidence indicates that the effectiveness of inpatient rehabilitation may be influenced by factors such the age of patients, their medical history, socio-economic status and onset of rehabilitation.

Our findings are in line with these presented in previously conducted systematic reviews which examined specifically the outcomes of inpatient rehabilitation on stroke [53,54], SCI [55], and MS [56] patients. More specifically, the study by Knecht et al. [54] reported that well-organized acute and intermediate rehabilitation after stroke can provide patients with the best functional results. Furthermore, the study by Lam et al. [55] showed that inpatient rehabilitation focused on gait training can offer the greatest benefits to functional ambulation in sub-acute or chronic spinal cord injury. Moreover, a study by Khan et al. [56] indicated that inpatient rehabilitation does not change the level of impairment, but can improve the experience of people with multiple sclerosis in terms of activity and participation.

In terms of the economics, there is very scarce evidence. Notwithstanding, the low number of studies, it appeared that in certain settings rehabilitation may be cost-effective in patients with stroke and spinal injury. There were no studies available for multiple sclerosis patients.

In terms of the studies available, it appears that the majority of studies assessing the effectiveness of inpatient rehabilitation were prospective, with most of them, up to a year. Moreover, there is no consistency in terms of how effectiveness was quantified as many different measures were utilized. Finally, it should be noted that programs were not standardized and were also delivered in different settings. In terms of the economic studies, from a methodological point of view, most of them are short term and they mainly focus on the health care system, based on cost-effectiveness or cost minimization modelling. Hence, they may underestimate the economic benefits of rehabilitation as it is associated with longer economic benefits for the health system due to resource utilization reductions and indirect benefits for the economy and society due to higher productivity, superior functioning and return to employment. Hence, long term cost-benefit analyses are more appropriate for evaluating it. Therefore, despite the availability of several studies in the field concerning the effectiveness of inpatient rehabilitation on the three health conditions of interest, it is evident that there is lack of economic evaluations and long term studies whereas there is increased variability in terms of the outcomes considered. Therefore, further research is required in order to establish more vividly the benefits of inpatient rehabilitation and influence decision making and patient management.

The results of this review must be interpreted in light of the methodological pitfalls of studies of this kind. We should acknowledge the possibility of publication bias due to the fact that only published studies, written in English language, were incorporated in our review. In addition, the search was limited to free databases. Moreover, the studies which were identified in this review covered a wide range of methodologies, outcome measures, and patient populations and consequently the heterogeneity of these studies prevented us from any quantitative estimates, of the overall benefits of inpatient rehabilitation and from performing a formal meta-analysis. Also, our review did not take into account information such as severity of disease, intensiveness of intervention, and length of stay. Furthermore, the information regarding the perspective of economic evaluation studies is not available. Finally, it should be also acknowledged that, unlike other treatments such as drugs, rehabilitation is not homogenous and standard therapy across different settings, and often data on the content and related information on rehabilitation programs evaluated is missing or differs across studies.

Conclusion

Despite the heterogeneity of outcomes and the limitations of this systematic review, there is abundant and clear evidence supporting the effectiveness and benefits of inpatient rehabilitation. In summary, inpatient rehabilitation improves clinical outcomes for patients with disability or impairment due to stroke, spinal cord injury, and multiple sclerosis. There is also scarce evidence that inpatient rehabilitation may be cost saving or highly cost-effective, especially for patients with stroke. Additional effectiveness and economic evaluation studies may contribute more to the evidence supporting the issue of rehabilitation for patients cost to inform policy and decision making and to improve patient access and outcomes of therapy.

Funding

This research received funding from the "ANAGENNISI" Recovery ,"ANIMUS" and Rehabilitation Center S.A.

References

1. Janssen-Heijnen ML, Coebergh JW, Klinkhamer PJ, Schipper RM, Splinter TA, et al. (2001) Is there a common etiology for the rising incidence of and decreasing survival with adenocarcinoma of the lung? Epidemiol 12: 256-258.
2. European Society for Medical Oncology (ESMO) (2016) Non-small-cell lung cancer: A guide for patients.
3. European Board of Physical and Rehabilitation Medicine, Academie Europeenne de Medecine de R, European Society for Physical and Rehabilitation Medicine (2006) White book on physical and rehabilitation medicine in Europe. Europa medicophysica 42: 292-332.
4. WHO (2011) Rehabilitation.
5. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, et al. (2009) The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol 62: e1-34.
6. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol 62: 1006-1012.
7. Shah S, Vanclay F, Cooper B (1991) Stroke rehabilitation: Australian patient profile and functional outcome. J Clin Epidemiol 44: 21-8.
8. Sim TC, Lum CM, Sze FK, Or KH, Sum C, Woo J (1997) Outcome after stroke rehabilitation in Hong Kong. Clin Rehabil 11: 236-242.
9. Kuptniratsaikul V, Kovindha A, Dajpratham P, Piravej K (2009) Main outcomes of stroke rehabilitation: a multi-centre study in Thailand. J Rehabil Med 41: 54-58.
10. Balaban B, Tok F, Yavuz F, Yasar E, Alaca R (2011) Early rehabilitation outcome in patients with middle cerebral artery stroke. Neurosci Letters 498: 204-207.
11. Yavuzer G, Kucukdeveci A, Arasil T, Elhan A (2001) Rehabilitation of stroke patients: clinical profile and functional outcome. Am J Phys Med Rehabil 80: 250-255.
12. Gokkaya N, Aras M, Cardenas D, Kaya A (2006) Stroke rehabilitation outcome:

the Turkish experience. Int J Rehabil Res 29: 105-111.

13. Giaquinto S, Giachetti I, Spiridigliozzi C, Nolfe G (2010) Quality of life after stroke in a rehabilitation setting. Clin Exp Hypertens 32: 426-430.
14. Foley N, McClure JA, Meyer M, Salter K, Bureau Y, et al. (2012) Inpatient rehabilitation following stroke: amount of therapy received and associations with functional recovery. Disabil Rehabil 34: 2132-2138.
15. Gagnon D, Nadeau S, Tam V (2005) Clinical and administrative outcomes during publicly-funded inpatient stroke rehabilitation based on a case-mix group classification model. J Rehabil Med 37: 45-52.
16. Teasell RW, Foley NC, Bhogal SK, Chakravertty R, Bluvol A (2005) A rehabilitation program for patients recovering from severe stroke. Can J Neurol Sci 32: 512-517.
17. Hayward KS, Kuys SS, Barker RN, Brauer SG (2014) Clinically important improvements in motor function are achievable during inpatient rehabilitation by stroke patients with severe motor disability: a prospective observational study. Neuro Rehabil 34: 773-779.
18. Madden S, Hopman WM, Bagg S, Verner J, O'Callaghan CJ (2006) Functional status and health-related quality of life during inpatient stroke rehabilitation. Am J Phys Med Rehabil 85: 831-838.
19. Bode RK, Heinemann AW (2002) Course of functional improvement after stroke, spinal cord injury, and traumatic brain injury. Arc Phy Med Rehabil 83: 100-106.
20. Ng YS, Jung H, Tay SS, Bok CW, Chiong Y, et al. (2007) Results from a prospective acute inpatient rehabilitation database: clinical characteristics and functional outcomes using the Functional Independence Measure. Ann Acad Med Singapore 36: 3-10.
21. Graham JE, Granger CV, Karmarkar AM, Deutsch A, Niewczyk P, et al. (2014) The Uniform Data System for Medical Rehabilitation: report of follow-up information on patients discharged from inpatient rehabilitation programs in 2002-2010. Am J Phys Med Rehabil 93: 231-244.
22. Hayward KS, Kuys SS, Barker RN, Brauer SG (2014) Can stroke survivors with severe upper arm disability achieve a clinically important change in arm function during inpatient rehabilitation? A multicentre, prospective, observational study. Neuro Rehabil 35: 17-23.
23. Ee CH, Kwan PE, Tan ES (1991) Stroke rehabilitation of elderly patients in Singapore. Singapore Medical J 32: 55-60.
24. Gialanella B, Monguzzi V, Santoro R, Bertolinelli M (2007) Walking and mobility before and after rehabilitation in patients with infratentorial stroke. Clin Ter 158: 297-301.
25. Mutai H, Furukawa T, Araki K, Misawa K, Hanihara T (2013) Long-term outcome in stroke survivors after discharge from a convalescent rehabilitation ward. Psychiatry Clin Neurosci 67: 434-440.
26. Mahler MP, Zuger K, Kaspar K, Haefeli A, Jenni W, et al. (2008) A cost analysis of the first year after stroke - early triage and inpatient rehabilitation may reduce long term costs. Swiss Med Wkly 138: 459-465.
27. Moodie M, Cadilhac D, Pearce D, Mihalopoulos C, Carter R, et al. (2006) Economic evaluation of Australian stroke services: a prospective, multicenter study comparing dedicated stroke units with other care modalities. Stroke 37: 2790-2795.
28. Khiaocharoen OPS, Riewpaiboon W, Ingsrisawang L, Teerawattananon Y (2012) Economic evaluation of rehabilitation services for inpatients with stroke in Thailand: a prospective cohort study. Value in Health Regional Issues 1: 29-35.
29. Patel A, Knapp M, Perez I, Evans A, Kalra L (2004) Alternative strategies for stroke care: cost-effectiveness and cost-utility analyses from a prospective randomized controlled trial. Stroke 35: 196-203.
30. Andersson A, Levin LA, Oberg B, Mansson L (2002) Health care and social welfare costs in home-based and hospital-based rehabilitation after stroke. Scand J Caring Sci 16: 386-392.
31. Haisma JA, Post MW, van der Woude LH, Stam HJ, Bergen MP, et al. (2008) Functional independence and health-related functional status following spinal cord injury: a prospective study of the association with physical capacity. J Rehabil Med 40: 812-818.
32. New PW(2005) Functional outcomes and disability after nontraumatic spinal cord injury rehabilitation: Results from a retrospective study. Arch Phys Med Rehabil 86: 250-261.
33. Yarkony GM, Roth EJ, Heinemann AW, Wu YC, Katz RT, et al. (1987) Benefits of rehabilitation for traumatic spinal cord injury. Multivariate analysis in 711 patients. Arch Neurol 44: 93-96.
34. Scivoletto G, Morganti B, Cosentino E, Molinari M (2006) Utility of delayed spinal cord injury rehabilitation: an Italian study. Neurol Sci 27: 86-90.
35. Schonherr MC, Groothoff JW, Mulder GA, Eisma WH (1999) Functional outcome of patients with spinal cord injury: rehabilitation outcome study. Clin Rehabil 13: 457-463.
36. Sturt RN, Holland AE, New PW (2009) Walking ability at discharge from inpatient rehabilitation in a cohort of non-traumatic spinal cord injury patients. Spinal Cord 47: 763-768.
37. Yen HL, Chua K, Chan W (1981) Spinal injury rehabilitation in Singapore. Int J Rehabil Res 21: 375-387.
38. Franceschini M, Di Clemente B, Rampello A, Nora M, Spizzichino L (2003) Longitudinal outcome 6 years after spinal cord injury. Spinal Cord 41: 280-285.
39. Schonherr MC, Groothoff JW, Mulder GA, Eisma WH (2005) Participation and satisfaction after spinal cord injury: results of a vocational and leisure outcome study. Spinal Cord 43: 241-248.
40. van Asbeck FW, Raadsen H, van de Loo ML (1994) Social implications for persons 5-10 years after spinal cord injury. Paraplegia 32: 330-335.
41. Franceschini M, Pagliacci MC, Russo T, Felzani G, Aito S, et al. (2012) Occurrence and predictors of employment after traumatic spinal cord injury: the GISEM Study. Spinal Cord 50: 238-242.
42. van Velzen JM, de Groot S, Post MW, Slootman JH, van Bennekom CA, et al. (2009) Return to work after spinal cord injury: is it related to wheelchair capacity at discharge from clinical rehabilitation? Am J Phys Med Rehabil 88: 47-56.
43. van Velzen JM, van Leeuwen CM, de Groot S, van der Woude LH, Faber WX, et al. (2012) Return to work five years after spinal cord injury inpatient rehabilitation: is it related to wheelchair capacity at discharge? J Rehabil Med 44: 73-79.
44. Ferdiana A, Post MW, de Groot S, Bultmann U, van der Klink JJ (2014) Predictors of return to work 5 years after discharge for wheelchair-dependent individuals with spinal cord injury. J Rehabil Med 46: 984-990.
45. Citterio A, Franceschini M, Spizzichino L, Reggio A, Rossi B, et al. (2004) Nontraumatic spinal cord injury: an Italian survey. Arch Phys Med Rehabil 85: 1483-1487.
46. Kidd D, Howard R, Losseff N, Thompson A (1995) The benefit of inpatient neurorehabilitation in multiple sclerosis. Clin Rehabil 9: 198-203.
47. Grasso MG, Troisi E, Rizzi F, Morelli D, Paolucci S (2005) Prognostic factors in multidisciplinary rehabilitation treatment in multiple sclerosis: an outcome study. Mult Scler 11: 719-724.
48. Freeman JA, Langdon DW, Hobart JC, Thompson AJ (1999) Inpatient rehabilitation in multiple sclerosis: do the benefits carry over into the community? Neurol 52: 50-56.
49. Kidd D, Thompson AJ (1997) Prospective study of neurorehabilitation in multiple sclerosis. J Neurol Neurosurg Psychiatry 62: 423-424.
50. Aisen M, Sevilla D, Fox N (1996) Inpatient Rehabilitation for Multiple Sclerosis. Neurorehabil Neural Repair 10: 43-46.
51. Freeman JA, Langdon DW, Hobart JC, Thompson AJ (1997) The impact of inpatient rehabilitation on progressive multiple sclerosis. Ann Neurol 42: 236-244.
52. Khan F, Turner-Stokes L, Stevermuer T, Simmonds F (2009) Multiple sclerosis rehabilitation outcomes: analysis of a national casemix data set from Australia. Mult Scler 15: 869-875.
53. Pollock A, Baer G, Campbell P, Choo PL, Forster A, et al. (2014) Physical rehabilitation approaches for the recovery of function and mobility following stroke. Cochrane Database Syst Rev 4: CD001920.
54. Knecht S, Hesse S, Oster P (2011) Rehabilitation after stroke. Dtsch Arztebl Int 108: 600-606.
55. Lam T, Eng JJ, Wolfe DL, Hsieh JT, Whittaker M, et al. (2007) A systematic review of the efficacy of gait rehabilitation strategies for spinal cord injury. Top Spinal Cord Inj Rehabil 13: 32-57.
56. Khan F, Turner-Stokes L, Ng L, Kilpatrick T (2007) Multidisciplinary rehabilitation for adults with multiple sclerosis. Coch Database Sys Rev 2007: CD006036.