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Rehabilitation of traumatic brain injury in Italy: A multi-centred study

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Abstract

Objectives: The aims of this study were to analyse TBI rehabilitation in Italy, identifying the main factors conditioning motor and functional recovery and destination upon discharge of traumatic severe acquired brain injury (sABI) patients who had undergone intensive rehabilitative treatment.

Design: An observational prospective study of 863 consecutive patients admitted to 52 Rehabilitation Centres from January 2001 to December 2003.

Results: The main cause of trauma was road accidents (79.8%), the mean length of stay was 87.31 ± 77.26 days and 40.4% access to rehabilitation facilities after a month. Pressure sore rates fell from 26.1% to 6.6% during the rehabilitation programme. After discharge 615 patients returned home, whilst 212 were admitted to other health facilities.

Discussion: This study highlights some major criticisms of rehabilitation of TBI. The delay of admission and evitable complications such as pressure sores are correlated to a worse outcome. While LOS causes a problem of cost-effectiveness, the rate of home discharge is prevalent and very high compared with other studies.

Keywords: *Closed head injury, rehabilitation, persistent vegetative state, outcome*

Introduction

Generally patients affected by traumatic severe acquired brain injury (sABI) have both focal and diffuse brain damage from different origins (haemorrhagic, hypoxic-ischemic, diffuse axonal injury, etc.) that are so severe as to cause a serious coma state (Glasgow Coma Scale-GCS <8) lasting more than 24 hours.

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The incidence of traumatic brain injury (TBI) due to car accidents has decreased, probably because of the introduction of stricter preventive road safety measures [1].

Rehabilitative management of sABI is one of the most complex challenges of modern rehabilitation. There is no other disability condition that requires such a huge investment of human, technological and structural resources. Recovery from TBI needs important rehabilitative intervention, even if it is not clear how much it influences the recovery itself. Studies published so far have not given decisive evidence regarding this, even if there is evident indication of the usefulness of rehabilitation [2].

Nevertheless, great difficulties can arise during rehabilitation depending on various factors: first of all, the brain damage type and severity, the patient's age and the presence of severe pre-morbid conditions.

The advanced age of patients, as well as poor neurological status, important trauma severity and poor quality of care were associated with a significantly lower probability of survival [3].

Furthermore, the clinical pathways could play a role in TBI patient outcome. Transferring TBI patients quickly to inpatient rehabilitation from acute wards improves their cognitive function and leads to a shorter length of stay [4]. The length of stay in acute hospitals and rehabilitation facilities has been getting shorter because of the increased demand for facilities and because of the resources that are available in the community for patients who are discharged early [5]. Although shorter LOS improves the efficiency of the rehabilitation it may be correlated to an increase in the mortality at follow-up [6].

The Traumatic Brain Injury Model System (TBIMS) was created by the National Institute on Disability and Rehabilitation Research (NIDRR) in 1987, to monitor rehabilitation activities on TBI patients in the US, showing the advantages of a well-coordinated rehabilitative system among various specialist centres (http://www.tbindc.org) [7, 8].

To study TBI rehabilitation in Italy a retrospective study was carried out including 16 rehabilitation centres [9]. This study gave an overview of TBI rehabilitation but was limited by the retrospective study design with limited data and missing information.

It was therefore decided to carry out a perspective observational study in order to collect more data and to have a greater possibility of analysing the criticisms and the outcome of TBI patients. The GISCAR (*Gruppo Italiano per lo Studio delle Gravi Cerebrolesioni Acquisite e Riabilitazione*) study aimed at investigating the clinical characteristics of individuals with severe acquired brain injury (sABI) including both traumatic brain injuries and non-traumatic brain injuries from the start of the rehabilitation programme to discharge. This study analysed the sub-group of traumatic brain injury.

Patients and methods

The subjects included in this study had a traumatic aetiology of brain injury. In all cases the index event had led to a comatose state, with a GCS score equal to or below 8 for more than 24 hours and possibly associated with neurological deficits. The data recorded involved unselected severe TBI cases consecutively admitted to 52 Italian Rehabilitation hospitals (cited in the Appendix) during the period from January 2001 to December 2003.

Demographic and social data (age, gender, nationality, years of education, marital status) were recoreded. Some clinical aspects were investigated:

- Causes of the trauma:
  - Domestic,
  - Car accident,
  - Work accident,
  - Casual fall;
- Substance abuse prior to trauma;
- Anti-psychotic drugs;
- Glasgow Outcome Scale (GOS);
- Disability Rating Scale (DRS);
- Level of Cognitive Functioning (LCF);
- Nutrition:
  - Oral (os), Parental, Percutaneus Endoscopic Gastrostomy (PEG), Nasogastric Tube, Mixed; and
- Central Venous Catheter (CVC), Tracheostomy, Dysphagia, Urinary Catheter, Pressure Sores, Periarticular Heterotopic Ossification (PHO), non-infective respiratory problems, Infections, Epilepsy, Peripheral Neural System (PNS) Injury, prior head trauma, thoracic damage:
  - Present (yes) or absent (no).

The Onset Admission Interval, OAI (time from trauma to admission to a Rehabilitation Department) was also calculated.

The outcome indexes investigated were the destination upon discharge and the Length of Stay (LOS) in the Rehabilitation Hospital.

All the necessary data were prospectively recorded on a specific form. Only first admissions for clinical events were considered eligible for the study. All hospitalizations with a time lapse under 15 days were not considered as new events [10].

All patients gave their informed consent to take part in the study. The Ethics committee of the Hospital approved the research protocol.

Statistical analyses

All data were entered into an SPSS database. An alpha of 0.05 was used for all statistical analyses.

Given the abnormal distribution of the data, only non-parametric tests were used. Baseline demographic and clinical features were compared across groups using a Chi-square test for categorical variables and the Kruskal-Wallis test for continuous variables.

Three outcomes were considered: differences in clinical variables before and after treatment, length of stay and destination after discharge which was divided into: home or other facility.

Chi-square and Mann-Whitney tests were used to compare clinical variables recorded at admission and upon discharge. Then, in order to determine if any factors were associated with not returning home after discharge, clinical and demographic variables measured at admission were entered into a multivariable model using logistic regression. This study examined all variables for multi-collinearity. It used the Hosmer–Lemeshow goodness-of-fit statistic to check the model fit. The findings have been reported as Odds Ratios (ORs), 95% Confidence Intervals (CI) and *p*-values. The model that best fitted with available data was developed.

Finally, to determine factors associated with length of stay, clinical and demographic variables measured at admission were entered into a multivariable model using linear regression. Given the non-normal distribution of the outcome variable 'length of stay', it was normalized using a logarithmic transformation. Again, all variables were examined for multi-collinearity and the best fitting model developed. The findings were reported as Mean Ratios (MRs), 95% CI and *p*-values.

Results

Clinical and demographic characteristics of the sample

Eight hundred and thirty-six patients were examined. Nine patients died during hospitalization. All analyses were carried out on the remaining 827 patients.

The sample was characterized as follows: mean age 35.73 ± 17.04 years, 78.5% of patients were males, 94.1% European, mean number of years of education was 10.24 ± 4.37, 63.7% of patients were employed, 64.1% were not married, 79.8% had a road accident, 6.1% had a domestic accident and 13.5% a work accident; 92% had never abused drugs, only 3.4% were prescribed anti-psychotic drugs during hospitalization, mean length of coma was 29.73 ± 42.11 days, mean length of stay was 87.31 ± 77.26 days, Onset Admission Interval was <1 month for 37.7% of cases, >1 month ≤ 2 months for 40.4% and >2 months for 21.9%. On discharge 615 patients (74.4%) returned home.

Differences between admission and discharge

A statistically significant improvement in almost all clinical variables was observed between admission and discharge. DRS score reduced from 16.48 ± 6.75 to 8.81 ± 7.04 ($p < 0.001$), patients with 'Good recovery' at GOS increased from 1.2% to 25.4% ($p < 0.001$) and those with 'Finalized-appropriate' at LCF from 3.1% to 28.1% ($p < 0.001$), patients able to feed *per os* moved from 45.8% to 84.2% ($p < 0.001$), patients with CVC reduced from 22.7% to 1.3% ($p < 0.001$), with tracheostomy from 42.1% to 7.9% ($p < 0.001$), with dysphagia from 42.3% to 13.7% ($p < 0.001$), with urinary catheter from 63.5% to 4.2% ($p = 0.001$), with pressure sores from 26.1% to 6.6% ($p < 0.001$); on the contrary patients with PHO (periarticular Heterotopic Ossification) increased from 11.5% at admission to 15.8% upon discharge ($p = 0.001$).

Destination after discharge

After being discharged 615 patients returned home, whilst 212 were admitted to other health facilities. Variables that resulted as independent predictors of being admitted to another facility were: DRS score at admission (OR = 1.122, 95% CI: 1.088–1.157), age (OR = 1.015, 95% CI: 1.005–1.025), OAI, for which 'OAI < 1 month' was assumed as the reference category, so OR for 'OAI > 1 month ≤ 2 months' was 1.588 (95% CI: 1.056–2.388) whilst OR for 'OAI >2 months' was 2.482 (95% CI: 1.576–3.907). These variables entered in the best explaining model fitted by logistic regression.

ORs for other variables were adjusted where possible for the aforementioned predictors, so the likelihood of being admitted to another facility, rather than going home, was also significantly increased by the following variables assessed at admission: being in GOS 'vegetative status' (OR = 9.56, 95% CI: 1.19–76.71), being in LCF 'No answer' or 'Generalized answer' (OR = 7.49, 95% CI: 2.79–20.11 and OR = 5.49, 95% CI: 2.57–11.71), feeding not *per os* (OR = 7.47, 95% CI: 4.57–12.21 for 'PEG', OR = 4.10, 95% CI: 2.66–6.32 for 'Nasogastric tube', OR = 3.48, 95% CI: 1.31–9.26 for 'parenteral', OR = 3.00, 95% CI: 1.58–5.72 for 'mixed'), having CVC (OR = 1.70, 95% CI: 1.17–2.47), being tracheostomized (OR = 1.726, 95% CI: 1.161–2.564), having non-infective respiratory problems (OR = 1.92, 95% CI: 1.14–3.23), presenting with dysphagia (OR = 3.40, 95% CI: 2.29–5.04), infection (OR = 1.92, 95% CI: 1.38–2.68), epilepsy (OR = 2.17, 95% CI: 1.26–3.74), urinary

catheter (OR = 3.045, 95% CI: 2.06–4.49), pressure sores (OR = 1.50, 95% CI: 1.06–2.15), PHO (OR = 1.93, 95% CI: 1.21–3.08) (Table I).

Length of stay

Variables that resulted as independent predictors of length of stay were: DRS score at admission (MR = 1.04, 95% CI: 1.03–1.05), presence of pressure sores at admission (MR = 1.15, 95% CI: 1.03–1.29), being tracheostomized at admission (MR = 1.31, 95% CI: 1.17–1.47), OAI, length of stay increased with increasing OAI (MR = 1.48, 95% CI: 1.33–1.66 for 'OAI > 1 month ≤2 months', MR = 1.75, 95% CI: 1.54–1.99 for 'OAI > 2 months').

Table I. Predictors of dichotomous outcome of destination (home vs other facility).

		Home ($n = 615$)	Other facility ($n = 212$)	OR (95% CI)
Glasgow outcome scale on admission	Good recovery	9 (1.5%)	1 (0.5%)	reference
	Mild disability	94 (15.7%)	19 (9.1%)	1.81 (0.22–15.09)
	Severe disability	408 (68.0%)	94 (45.0%)	2.06 (0.26–16.43)
	Vegetative status	89 (14.8%)	95 (45.5%)	**9.56 (1.19–76.71)**
Disability rating scale on admission		15.30 ± 6.63	19.92 ± 5.91	**1.122 (1.005–1.025)**
Level of cognitive functioning on admission	No answer	15 (2.5%)	20 (9.6%)	**7.49 (2.79–20.11)**
	Generalized answer	89 (14.7%)	88 (42.3%)	**5.49 (2.57–11.71)**
	Localized answer	89 (14.7%)	34 (16.3%)	1.95 (0.88–4.35)
	Confused-agitated	129 (21.3%)	27 (13.0%)	1.12 (0.50–2.51)
	Confused-inappropriate	109 (18.0%)	20 (9.6%)	1.02 (0.44–2.37)
	Confused-appropriated	96 (15.8%)	9 (4.3%)	0.57 (0.21–1.50)
	Automatic-appropriated	55 (9.1%)	10 (4.8%)	reference
	Finalized-appropriated	25 (4.1%)	–	–
Nutrition	Mixed	46 (7.6%)	18 (8.6%)	**3.00 (1.58–5.72)**
	Parenteral	16 (2.6%)	7 (3.3%)	**3.48 (1.31–9.26)**
	PEG	58 (9.5%)	66 (31.4%)	**7.47 (4.57–12.21)**
	Nasogastric tube	156 (25.6%)	77 (36.7%)	**4.10 (2.66–6.32)**
	P.O.	333 (54.7%)	42 (20.0%)	reference
Central venous catheter	No	480 (79.3%)	149 (71.3%)	reference
	Yes	125 (20.7%)	60 (28.7%)	**1.70 (1.17–2.47)**
Tracheostomy	No	396 (64.9%)	79 (37.4%)	reference
	Yes	214 (35.1%)	132 (62.6%)	**1.726 (1.161–2.564)**
Non-infective respiratory problems	No	477 (82.0%)	146 (73.0%)	reference
	Yes	43 (7.4%)	30 (15.0%)	**1.92 (1.14–3.23)**
	Not assessed	62 (10.7%)	24 (12.0%)	–
Dysphagia	No	334 (55.5%)	50 (23.9%)	reference
	Yes	181 (30.1%)	100 (47.8%)	**3.40 (2.29–5.04)**
	Not assessed	87 (14.5%)	59 (28.2%)	–
Infection	No	367 (62.8%)	93 (45.4%)	reference
	Yes	217 (37.2%)	112 (54.6%)	**1.92 (1.38–2.68)**
PNS injury	No	517 (85.9%)	194 (91.9%)	reference
	Yes	85 (14.1%)	17 (8.1%)	**0.498 (0.281–0.882)**
Epilepsy	No	571 (94.1%)	181 (86.6%)	reference
	Yes	36 (5.9%)	28 (13.4%)	**2.17 (1.26–3.74)**
Prior head trauma	No	594 (97.9%)	204 (97.1%)	reference
	Yes	13 (2.1%)	6 (2.9%)	1.792 (0.616–5.210)
Thoracic damage	No	335 (55.2%)	116 (55.0%)	reference
	Yes	272 (44.8%)	95 (45.0%)	1.037 (0.735–1.463)
Age		34.38 ± 16.36	39.63 ± 18.35	**1.015 (1.005–1.025)**
Gender	Male	479 (77.9%)	170 (80.2%)	reference
	Female	136 (22.1%)	42 (19.8%)	0.794 (0.523–1.207)
Urinary catheter on admission	No	257 (42.7%)	40 (19.0%)	reference
	Yes	345 (57.3%)	171 (81.0%)	**3.045 (2.06–4.49)**
Pressure sores	No	458 (76.8%)	137 (65.6%)	reference
	Yes	138 (23.2%)	72 (34.4%)	**1.50 (1.06–2.15)**
Periarticular heterotopic ossification	No	518 (90.4%)	161 (83.0%)	reference
	Yes	55 (9.6%)	33 (17.0%)	**1.93 (1.21–3.08)**
Onset admission interval	≤1 month	261 (42.4%)	51 (24.1%)	reference
	>1 month ≤2 months	242 (39.3%)	92 (43.4%)	**1.588 (1.056–2.388)**
	>2 months	112 (18.2%)	69 (32.5%)	**2.482 (1.576–3.907)**

Significant ORs are in bold.

These variables entered in the best explaining model fitted by linear regression ($R^2 = 0.347$).

MRs for other variables were adjusted where possible for the aforementioned predictors, MR of length of stay was also significantly increased by the following variables assessed at admission: being in GOS 'vegetative status' (MR = 1.92, 95% CI: 1.42–2.60), being in LCF 'no answer' or 'generalized answer' or 'localized answer' (MR = 2.44, 95% CI: 1.72–3.45; MR = 2.67, 95% CI: 2.04–3.48; MR = 1.80, 95% CI: 1.37–2.37), feeding not *per os* (MR = 1.67, 95% CI: 1.39–2.00 for 'PEG', MR = 1.50, 95% CI: 1.31–1.73 for 'Nasogastric tube', MR = 1.49, 95% CI: 1.10–2.03 for 'parenteral', MR = 1.45, 95% CI: 1.19–1.76 for 'mixed'), presenting with non-infective respiratory problems (MR = 1.32, 95% CI: 1.08–1.62), dysphagia (MR = 1.28, 95% CI: 1.11–1.46), infection (MR = 1.43, 95% CI: 1.27–1.61), epilepsy (MR = 1.21, 95% CI: 1.01–1.45), urinary catheter (MR = 1.14, 95% CI: 1.01–1.29), PHO (MR = 1.22, 95% CI: 1.04–1.44) (Table II).

Discussion

This prospective study was carried out in order to analyse the rehabilitation of sABI in Italy. This paper only considered the group of traumatic brain injuries admitted to a rehabilitation centre for the first time. The aim of the study was to analyse and discuss the clinical pathways, clinical complexity and short-term outcome of TBI patients.

This is not an epidemiological study because it only included patients admitted to a rehabilitation centre. One should also bear in mind that there is an invisible cohort of patients who over a certain age are presumably excluded from rehabilitation programmes. Furthermore, although 52 Italian centres were involved in the study, there is a portion of TBI patients who were admitted to rehabilitation facilities that were not involved in this study. However, there was a considerable sample of TBI patients to represent the Italian territory.

The average age of the sample is in line with some US [11–13] and European data [3, 14, 15]. Prevalence of male patients (78.5%) in this sample is in line with that reported in the European literature [3, 14, 15], contrary to some North American authors' data [11, 13]. In the data Caucasians prevailed over other ethnic groups, contrary to the US experience [16].

Car accident is the leading cause in this data, more than in other European Countries [3, 14, 15] and the US [13]. On the other hand violence traumas are definitely lower than in the American (TBI Model System) surveys.

In this survey it is interesting to note how large the number of patients with work (13.5%) or domestic trauma (6.1%) is. These data should make the authorities consider the creation of awareness campaigns regarding these fields to prevent trauma.

Anamnestic drug or alcohol abuse is lower than other European [14] and American statistics (TBI Model System) [13, 16].

During the period studied in Italy the organization of TBI rehabilitation pathways was complex, especially for the transfer phase from the Emergency Department to the Intensive Rehabilitation Department. This survey clearly shows that more than 60% of patients were moved to the Rehabilitation Department more than 30 days after the trauma, yet it is known from the literature how important an early rehabilitative approach is for a positive outcome. European [14, 15, 17] and American (TBI Model System) data show an OAI which is definitely lower than that of Italy [13, 16].

Furthermore, the duration of LOS in this data is longer than in other European [14] and American ones [13, 16] (TBI Model System). This is probably due to the different welfare organization models (especially Italy vs US) and to the problematic Italian Rehabilitation pathways also for discharge from rehabilitation centres.

Presence of PEG and tracheostomy at admission is lower than in some other literature data [15], even if samples are too different to be compared. On the other hand the presence of PHO and dysphagia in the data is at an intermediate stage compared to the literature [15, 18, 19].

The percentage of pressure sores (26.1%) at admission is quite high [19]. Probably a longer OAI causes some problems in rehabilitation nursing and consequently a higher probability of this complication.

Unlike North American data (TBI Model System), a huge percentage of these patients return home after discharge. This is probably due to a longer LOS and to a different social/family background. As might be expected younger patients have a higher probability of returning home.

DRS and OAI values play an important role in favouring a positive outcome in terms of LOS and return home, as can be seen in the regression model results. The positive role of an early admission to a rehabilitation department is confirmed by the literature [4, 11, 20], hence the need for Italian Health Organizations to pay more attention to improving the transferal from the emergency department to the rehabilitation one.

The presence of pressure sores and tracheostomy at admission contributes to lengthening LOS. In this sample during the stay in a rehabilitation ward a

Table II. Predictors of continuous outcome of length of stay.

		Length of stay ($M \pm SD$)	Mean ratio (MR) (95%CI)
Glasgow outcome scale on admission	Good recovery	54.5 ± 51.14	reference
	Mild disability	42.17 ± 52.08	**0.53 (0.39–0.72)**
	Severe disability	77.74 ± 58.11	1.04 (0.78–1.39)
	Vegetative status	147.44 ± 101.76	**1.92 (1.42–2.60)**
Disability rating scale on admission			1.04 (1.03–1.05)
Levels of cognitive functioning on admission	No answer	136.26 ± 113.30	**2.44 (1.72–3.45)**
	Generalized answer	150.09 ± 97.79	**2.67 (2.04–3.48)**
	Localized answer	96.77 ± 63.93	**1.80 (1.37–2.37)**
	Confused-agitated	70.35 ± 50.44	1.33 (1.02–1.74)
	Confused-inappropriate	59.60 ± 39.11	1.11 (0.85–1.47)
	Confused-appropriated	54.33 ± 47.63	0.96 (0.68–1.27)
	Automatic-appropriated	48.92 ± 54.94	0.83 (0.62–1.13)
	Finalized-appropriated	51.44 ± 45.54	reference
Nutrition	Mixed	92.81 ± 74.24	**1.45 (1.19–1.76)**
	Parenteral	112.35 ± 102.57	**1.49 (1.10–2.03)**
	PEG	139.45 ± 87.00	**1.67 (1.39–2.00)**
	Nasogastric tube	108.56 ± 77.46	**1.50 (1.31–1.73)**
	P.O.	56.49 ± 45.92	reference
Central venous catheter	No	78.95 ± 68.50	reference
	Yes	118.75 ± 91.92	1.21 (0.99–1.26)
Tracheostomy	No	62.46 ± 51.06	reference
	Yes	124.42 ± 91.90	**1.31 (1.17–1.47)**
Non-infective respiratory problems	No	85.30 ± 75.57	reference
	Yes	104.30 ± 76.16	**1.32 (1.08–1.62)**
Dysphagia	No	54.70 ± 44.92	reference
	Yes	111.20 ± 79.10	**1.28 (1.11–1.46)**
Infection	No	74.09 ± 64.40	reference
	Yes	107.87 ± 87.96	**1.43 (1.27–1.61)**
PNS injury	No	90.29 ± 80.35	reference
	Yes	78.18 ± 53.31	0.95 (0.82–1.11)
Epilepsy	No	84.70 ± 74.36	reference
	Yes	134.83 ± 98.54	**1.21 (1.01–1.45)**
Prior head trauma	No	88.62 ± 77.89	reference
	Yes	79.16 ± 59.25	1.44 (0.83–1.58)
Thoracic damage	No	88.52 ± 79.47	reference
	Yes	87.86 ± 74.39	0.97 (0.88–1.07)
Age			1.00 (0.99–1.00)
Gender	Male	90.33 ± 80.56	reference
	Female	80.97 ± 63.48	0.93 (0.83–1.04)
Urinary catheter on admission	No	57.91 ± 49.43	reference
	Yes	106.35 ± 85.06	**1.14 (1.01–1.29)**
Pressure sores	No	78.07 ± 69.22	reference
	Yes	115.80 ± 87.93	**1.15 (1.03–1.29)**
Periarticular heterotopic ossification	No	80.95 ± 71.24	reference
	Yes	130.83 ± 83.74	**1.22 (1.04–1.44)**
Onset admission interval	≤1 month	59.36 ± 53.10	reference
	>1 month ≤2 months	99.21 ± 85.41	**1.48 (1.33–1.66)**
	>2 months	118.12 ± 80.38	**1.75 (1.54–1.99)**

Significant MRs are in bold.

significant reduction was found in the presence of both of these (Table II). Lengthy LOS is probably due to the time required to treat these problems.

In summary, while this study confirms the data of other studies it also underlines some critical data related to the organization of the health system. In particular, the delay of admission to a rehabilitation facility is correlated with a worse outcome and an increase of complications such as pressure sores. Therefore, early admission to a rehabilitation programme could improve the outcome and should be considered in the definition of the clinical pathways.

From the outcome results of the rehabilitation programmes, an improvement of the general clinical and functional status of the patients was observed. These data show the importance of a comprehensive rehabilitation programme.

A prolonged LOS was found in this study, compared with other countries. An adequate LOS is necessary to allow better recovery, but when it is too prolonged (often due to the difficulties of in-dwelling in the community) the cost-effectiveness decreases.

The rate of home discharge in Italy is higher compared with other studies, indicating a cultural predisposition to accepting these patients at home.

In conclusion, while this study focuses on the pathways of rehabilitation care in Italy, the results and indications could be extended to improve the rehabilitation of sABI in general. This experience allowed the authors to create a permanent database to continuously monitor the outcome and the issues related to the rehabilitation of sABI. In the future these data could be compared with the permanent databases of other countries, allowing benchmarking between the different approaches.

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Appendix: Participating centres

Ospedale Marino Alghero, U.O.R.R.F., Alghero (Ss), Diana Giovanni, Oggiano Vittoria; Cooperativa Onlus Luce Sul Mare – Reparto 'Ridente' ad Alta Specializzazione Neuroriabilitativa, Bellaria – Igea Marina (Rn), Morrone Elvira, Neri Cristina, Verri Giancarla; Az. Osp. Ospedali Riuniti di Bergamo, U.O. Recupero e Rieducazione Funzionale C/O Rota Matteo, Bergamo (Bg), Ghislandi Ivo, Melizza Giovanni, Algeri Lorella, Biffi Lino, Severgnini Roberta, Bianco Micaela, Manara Luisa; Irccs 'Eugenio Medea' Bosisio Parini, U.O. Neuroriabilitazione dell'età Evolutiva, Bosisio Parini (Lc), Castelli

Enrico, Strazzer Sandra, Bernasconi Simona; Ospedale di Correggio (Re), Reparto di Riabilitazione Intensiva, Correggio (Re), Brianti Rodolfo, Lombardi Francesco; Ospedale Valduce Costamasnaga (Lc), Centro di Riabilitazione Villa Beretta, Costamasnaga, (Lc), Lissoni Alberto, De Tanti Antonio, Lanfranchi Maurizio, Gasperini Giulio, Brambilla Emanuela, Colli Lucia; Azienda Ospedaliera Macchi Varese, U.O. Recupero e Rieducazione Funzionale, Ospedale Cuasso al Monte (Va), Di Stefano Maria Grazia, Baggiani Giulia, Baranzelli M. Linda, Grossi Alberto, Generani Ester; Presidio Ospedaliero di Caraglio – Asl 15 Cuneo, S.S. di Medicina Riabilitativa, Cuneo (Cn), Lamberti Gianfranco, Carena Giorgio, Antonino Elena, Az. Usl Ravenna, Medicina Riabilitativa P.O. di Faenza, Faenza (Ra), Testa Evole, Gatta Giordano; Azienda Ospedaliera Universitaria 'Arcispedale S. Anna – Ferrara – Dipartimento di Riabilitazione-Lungodegenza', Unità Operativa di Alta Specialità per la Riabilitazione Delle Gravi Cerebrolesioni (Ugc), Ferrara (Fe), Boldrini Paolo, Lavezzi Susanna, Bergonzoni Antonella, Cantagallo Anna, De Filippo Fernando, Gianisella Barbara; Centro Cardinal Ferrari Fontanellato (Pr), Centro di Riabilitazione per Gravi Cerebrolesioni, Fontanellato (Pr), Gradenigo Bruno, Cavatorta Sabina, Casanova Emanuela, Marchetti Paola, Miniello Stefania, Saviola Donatella; Presidio Ospedaliero Longone Al Segrino (Co), U.O. Recupero e Rieducazione Neuromotoria, Longone Al Segrino (Co), Tallarita Enrico, Semiglia Giorgia, Sbernini Maria Susi, Cesana Regina, Bertelè Anna; Azienda Ospedaliera 'G. Salvini', U.O. Rieducazione Neuromotoria, Garbagnate (Mi), Feller Sandro, Chierici Stefania, Ausenda Carlo, Foglia Patrizia, Di Troia Amalia, Sassi Luigi, Cometa Cataldo; Fondazione S. Maugeri – Clinica Del Lavoro E Della Riabilitazione Montescano – Irccs – Unità Operativa Neurolesi 1, Montescano (Pv), Pistarini Caterina, Fizzotti Gabriella, Contardi Antonella, Bazzini Giacomo; Fondazione S. Maugeri – Clinica Del Lavoro E Della Riabilitazione – Irccs – Istituto Scientifico di Montescano – divisione di Recupero E Rieducazione Funzionale Ii – Neurolesi 2 – Montescano (Pv), Guarnaschelli Caterina, Boselli Mirella, Achilli Maria Pia, Arrigoni Nadia; Ospedale S. Cuore Don Calabria – Negrar (Vr), dipartimento di Riabilitazione (Unità Gravi Cerebrolesioni – Servizio di Riabilitazione), Negrar (Vr), Rigoli Gianfranco, Avesani Renato, Salvi Luca, Armani Giuseppe; Azienda Ospedaliera di Parma, U.O. Complessa di Medicina Riabilitativa, Parma (Pr), Franceschini Marco, Mammi Patrizia, Perelli Ercolini Daniela, Corsini Delfina, Zaccaria Barbara; Centro Ospedaliero di Riabilitazione Intensiva, Centro Ospedaliero di Riabilitazione Intensiva – Passignano Sul Trasimeno (Pg), Sciarrini Francesco, Orecchini Giuliana, Preiti Nicola; Azienda Ospedaliera 'G. Salvini', U.O. di Riabilitazione, Passirana di Rho, (Mi), Taricco Mariangela, Adone Roberto, Simeoni Fabrizia; Azienda Ospedaliera Universitaria Pisana, U.O. di Neuroriabilitazione Universitaria, Pisa (Pi), Rossi Bruno, Carboncini Maria Chiara, Bonfiglio Luca, Chiocca Silvia; Irccs Stella Maris, Sezione di Riabilitazione, Pisa (Pi), Cipriani Paola; Istituto S. Stefano P. Potenza Picena, Unità di Risveglio, Porto Potenza Picena (Mc), Serafini Paolo, Gironelli Luca, Celentano Antonietta, Tulli Daniela; Az. Usl Ravenna, Servizio Medicina Riabilitativa P.O. di Ravenna (Ra), Testa Evole, Gatta Giordano, Taroni Beatrice; Fondazione Santa Lucia Irccs, Unità Post-Coma, Roma, Formisano Rita, Rigon Jessica, Bivona Umberto, Penta Francesca; Ospedale Bellini di Somma Lombarda – Az. Ospedaliera – Sant'antonio Abate – Gallarate, Dipartimento di Riabilitazione – Reparto Riabilitazione Post-Acuti, Somma Lombarda (Va), Zaro Francesco, Cornaro Carlo Maurizio, Galli Stefano; Ospedale Maria Adelaide Torino U.O. A. Recupero e Rieducazione Funzionale U.O.S. 'Gravi Cerebrolesioni', Torino (To), Actis Maria Vittoria, Rossini Rocco, Emanuel Carlo, Tessari Paolo; Presidio Ospedaliero Ausiliatrice Torino, Centro di Riabilitazione per Gravi Cerebrolesioni, Torino (To), Rago Roberto, Perino Claudio, Pietrapiana Paolo; Ospedali Riuniti 'Lancisi-Salesi-Umberto I' di Ancona, Clinica di Neuroriabilitazione, Torrette di Ancona (An), Ceravolo Maria Gabriella, Coccia Michela; dip. Riabilitazione Valle Umbra Sud Trevi (Pg), Unità Organica di Riabilitazione Intensiva Neuromotoria Trevi (Pg), Todeschini Elisabetta, Cecconi Michela, Proietti Anna Rita, Damiani Maria Pia; Ospedale Ca' Foncello Treviso – Azienda Ulss N° 9 Regione Veneto – Medicina Fisica E Riabilitazione – Dipartimento di Riabilitazione e Lungodegenza Post-Acuzie, Treviso (Tv), Zorzi Gianalberto, Bargellesi Stefano, Gaiotto Stefano, Bonivento Giampietro, Soncin Anna, Khan Sefid Maryam; Ospedale S. Camillo – Venezia, Unità di Neuroriabilitazione, Venezia Lido (Ve), Tonin Paolo, Casson Salvino, Sale Eleonora, Busetto Alessandro, Pirlali Cristina; Fondazione Clinica del Lavoro S. Maugeri – Veruno, divisione Recupero E Rieducazione Funzionale, Veruno, (No), Galante Massimo, Vecchio Anna, Corra Tiibbo, Cossa Federico, Laialoma Marcella, Angelino Elisabetta; Azienda U.L.S.S. N°6 – Vicenza – U.O. Medicina Riabilitativa – Unità Gravi Cerebrolesioni – Vicenza (Vi), Cortese Feliciana, Bertagnoni Gianettore, Sensi Giovanni; Università Milano Bicocca – Dip.

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