



## ORIGINAL ARTICLE

# Identifying clinical complexity in patients affected by severe acquired brain injury in neurorehabilitation: a cross sectional survey

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in Ingresso in Riabilitazione nei pazienti con grave CerebroLesione acquisita) study group ‡

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## ABSTRACT

**BACKGROUND:** Literature shows that occurrence of comorbidities in people with severe acquired brain injury (sABI) is a common problem in rehabilitation stay. Consequently, patients could require an increase of interventions for diagnosis and treatment of clinical conditions, with a reduction of the rehabilitative take in charge for both clinical and organizational aspects.

**AIM:** The first aim was to evaluate the rate of clinical conditions of sABI patients at admission in rehabilitation and the types of rehabilitative interventions performed in the first week; second objective was to explore the impact of clinical conditions on real rehabilitative take in charge.

**DESIGN:** Cross sectional study.

**SETTING:** Inpatient rehabilitation centers.

**POPULATION:** The study included data from 586 sABI patients.

**METHODS:** Collected data regarded anamnestic information, functional status assessed by means of Glasgow Outcome Scale, Levels of cognitive functioning, Early Rehabilitation Barthel Index, comorbidities at admission and type of rehabilitative interventions carried out in first week of rehabilitation stay. Spearman correlation coefficients were applied to detect possible correlations between the number of treatments in first week and clinical variables; through a multiple regression analysis the effect of patient's characteristics on rehabilitative take in charge was explored.

**RESULTS:** Data from the sABI patients: mean age  $55.1 \pm 17.1$  years; etiology of sABI was vascular in 315 patients (53.8%), anoxic in 83 (14.2%), neoplastic in 17 (2.9%), infectious in 15 (2.6%), traumatic in 150 (25.6%); 6 subjects (1%) presented a mixed etiology. Need of cardiorespiratory monitoring, pressure sores, infections or presence of multi drug resistant bacteria were the most frequent comorbidities. Passive mobilization, sitting positioning, arousal/awareness stimulation, evaluation and management of dysphagia were the interventions most frequently carried out in the first week. The regression analysis showed that severe neurological and clinical conditions, acute organ failure, cardio-respiratory instability and paroxysmal sympathetic hyperactivity significantly limit access to rehabilitative sessions.

**CONCLUSIONS:** In sABI patients clinical comorbidities requiring elevated care assistance are frequent at admission in rehabilitation from acute wards and may interfere with rehabilitative take in charge.

**CLINICAL REHABILITATION IMPACT:** The knowledge of clinical complexity of sABI patients may improve their care pathways, promoting early and appropriate transition from acute care to rehabilitation settings.

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**KEY WORDS:** Brain injuries; Comorbidity; Rehabilitation; Patient admission.

Several studies showed that people affected by severe acquired brain injury (sABI) may have a high rate of medical complications during their stay both in the Intensive Care Unit (ICU) both in rehabilitation ward.<sup>1, 2</sup> Accordingly, in this population the prognosis for functional recovery does not just depend on the cerebral injury but comorbidities or clinical conditions, individually or associated, may increase the mortality risk.<sup>1, 3, 4</sup> Therefore, if on the one hand an early discharge from the acute care to the rehabilitation ward was shown to be related to a better patients' outcome,<sup>5, 6</sup> on the other it is likely that the clinical complexity of the patients may play an unfavorable role on recovery,<sup>7</sup> sometimes requiring a readmission to acute care unit.<sup>8</sup>

In order to reconcile these two requirements and to provide the best care pathways for persons affected by sABI, in some countries transition criteria were defined,<sup>9-11</sup> providing a guidance about which patients may be considered appropriate for rehabilitation setting.

Nevertheless, it is still possible in real clinical practice that even when criteria are not completely fulfilled, sABI patients are discharged from ICU if rehabilitation needs become more evident.

Consequently, clinicians working in rehabilitation need to acquire a significant experience in dealing with different clinical complications, to ensure their optimal management and/or to prevent them.<sup>12</sup> Such an expert medical management may determine a reduction in mortality or readmissions to acute care facilities, but on the other hand requires an increase of interventions for diagnosis and treatment of clinical conditions, with a reduction of the rehabilitative take in charge for both clinical and organizational aspects (e.g., isolation for patients with Multi drug resistance [MDR], germs, need for 24 hours ventilator support, need for cardio-circulatory monitoring, etc.).

The main aim of this study was to evaluate in the real world the clinical complexity of patients affected by sABI at admission in neurorehabilitation. Moreover, in order to define in which cases, the clinical complexity of the patients still permits rehabilitation care, the kind of rehabilitative intervention performed by patients in the first week after admission was evaluated.

## Materials and methods

The study enrolled adult ( $\geq 18$  years) inpatients with a diagnosis of sABI hospitalized for rehabilitation.

sABI was defined as Central Nervous System (CNS) damage due to acute traumatic or non-traumatic (vascular,

anoxic, neoplastic or infectious) causes that led to a variably prolonged state of coma (Glasgow Coma Scale  $\leq 8$ ), producing a potential wide range of impairments affecting physical, cognitive and/or psychological functioning.<sup>13-17</sup>

The immediate relatives or the legal guardians of the patients gave informed consent to take part into the study. The study was conducted in accordance with the revised version of the Helsinki Declaration and was approved by the local Ethic Committee of the coordinator center.

### Study design and procedure

This study was designed as a cross-sectional multicenter survey. Data refer to the first week of hospitalization of all patients present in the rehabilitation units between the 1<sup>st</sup> and 7<sup>th</sup> day of March 2016 and were collected from clinical records as part of routine care.

No specific treatments were tested in this study, while hospital rehabilitation care was recorded. All the enrolled patients underwent a complete clinical, neurological and functional examination; relevant clinical and anamnestic data were also collected (Table I).

Moreover, in order to obtain a multidimensional assessment of the patients' clinical and functional status, the following measures were recorded: Glasgow Outcome Scale (GOS),<sup>18</sup> The Rancho Los Amigos Levels of Cognitive Functioning Scale (LCF),<sup>19</sup> Early Rehabilitation Barthel Index (ERBI).<sup>20</sup>

Rehabilitative treatments carried out in the first week from admission were recorded. We included passive mobilization, assisted or active exercises, sitting positioning, verticalization, walking with physical assistance or orthosis, arousal/awareness stimulation, caregiver training, exercises focused on increasing the autonomy in performing

TABLE I.—Overall description of the sample at admission.

	N (%)	Mean $\pm$ SD	Range
Gender			
M	362 (61.8)		
F	224 (38.2)		
Age (years)		55.16 $\pm$ 17.1	18-89
Etiologies			
Anoxic	83 (14.2)		
Neoplastic	17 (2.9)		
Infectious	15 (2.6)		
Vascular	315 (53.8)		
Traumatic	150 (25.6)		
Mixed	6 (1)		
GOS		2.63 $\pm$ 0.56	2-5
ERBI		(-202,5) $\pm$ 87.07	(-325)-100
LCF		3.22 $\pm$ 1.53	1-8

activity of daily living (ADL), speech therapy, respiratory rehabilitation or bronchial drainage, evaluation and management of dysphagia.

Data were collected by means of schedules and then transferred into an electronic database, after the revision of each patient's files in order to avoid missing data. Each center sent data to the coordinator center for the storage and the offline statistical analysis.

### Statistical analysis

Descriptive summary statistics, including frequencies and percentages for categorical data, mean and standard deviation (SD) for normally distributed data, were derived.

Spearman correlation coefficients were applied to detect possible correlations between the number of treatments in first week and the variables included in the database.

The effect of clinical characteristics on rehabilitation intervention was explored through multiple regression analysis, using the number of kind of treatments as dependent variable and the demographic and clinical features as explanatory variables.

All statistical tests were 2 sided, and significance was determined at the 0.05 probability level.

Statistical analyses were performed with the SPSS package for Windows® version 18.0.

## Results

The study enrolled 586 patients (362 [61.78%] males/224 [38.22%] females), the mean age ( $\pm$ SD) was  $55.16 \pm 17.1$  years (range 18-89 years). Demographic and clinical features of the study sample are reported in Table I.

The average number of days from the acute event to admission in rehabilitation was  $54 \pm 47.1$ , and 159 (27.13%) patients were admitted to rehabilitation wards within 30 days from the acute event.

Patients with brain injury due to vascular or infectious origin had a more prolonged acute phase: ( $62.47 \pm 29.75$  and  $64.76 \pm 70.17$  days respectively) than other conditions ( $53.58 \pm 46$  days), even if the difference was not statistically significant.

Patients' provenance is shown in Figure 1, while main clinical features and anamnestic data of the study sample at rehabilitation admission are reported in Table II.

Clinical conditions observed at admission in rehabilitation stay are reported in Figure 2.

Fifty-three patients (9.04%) interrupted hospitalization within the first week for complications or to perform unplanned surgeries.

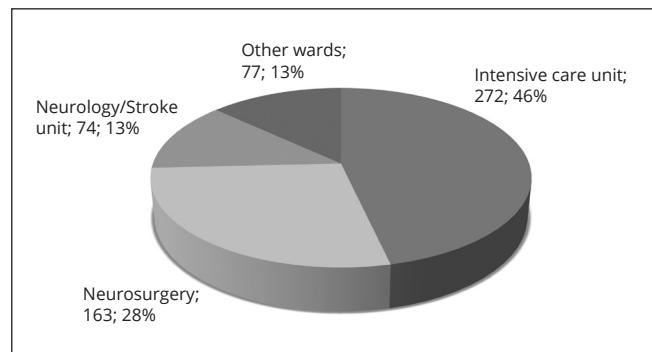


Figure 1.—Patients' provenance from acute care.

When considering the clinical scales at admission in rehabilitation, mean GOS Score was  $2.62 \pm 0.55$ ; mean ERBI Score was  $-202.15 \pm 87.39$  and mean LCF was  $3.21 \pm 1.53$ . Table III shows patient's distribution according to GOS and LCF values.

Rehabilitation treatments performed during the first week of stay are reported in Figure 3. Each patient performed at least a combination of 3 or more kind of treatments, including caregiver training.

Correlation analysis revealed that the "number of treatments" had a significant relationship with monitoring and with the score at the clinical scales (GOS, P=0.000, ERBI P=0.02, LCF, P=0.000), as described in Figure 4, 5; an inverse significant relationship was found between the "number of treatments" and the following variables: cerebral anoxia (P=0.004) and paroxysmal sympathetic hyperactivity (PSH) (P=0.04), as well as between the number of complications and the score at the GOS (P=0.01) and at the LCF (P=0.01).

At the regression analysis several factors (monitoring, organ failure, anoxia, PSH, GOS, LCF) were statistically significant in predicting the number of treatments performed by patients ( $F(28.476) = 5.214$ , P<0.0005).

## Discussion

The present study explored the clinical features of patients affected by sABI admitted to neurorehabilitation units, identifying the main medical issues that defined the complexity of these patients. Increasing literature reported that patients with sABI benefit of an early rehabilitative care,<sup>5, 6</sup> but only few studies addressed the issue if such behavior determines a push towards an earlier discharge of patients to rehabilitation wards, even when these are still not fully clinically stable.

TABLE II.—Relevant clinical features and anamnestic data at rehabilitation admission.

Clinical features	Yes N. (%)	No N. (%)	Missing data N. (%)
Nasogastric tube	250 (42.7)	331 (56.4)	5 (0.9)
Percutaneous endoscopic gastrostomy	214 (36.5)	354 (60.4)	18 (3.1)
Pressure sores	201 (34.3)	378 (64.5)	7 (1.2)
Cardiocirculatory instability with multiparametric monitoring necessary or recommended	352 (60.1)	224 (38.2)	10 (1.7)
Need for Isolation due to multi drug resistant bacteria	154 (26.3)	431 (73.5)	1 (0.2)
Nutrition ( <i>per os</i> )	133 (22.7)	445 (75.9)	8 (1.4)
Infectious disease at admission	100 (17.1)	486 (82.9)	-
Infectious disease within the first week	91 (15.5)	493 (84.1)	2 (0.4)
Assisted breathing	77 (13.1)	495 (84.5)	14 (2.4)
Paroxysmal sympathetic hyperactivity	77 (13.1)	507 (86.6)	2 (0.3)
Acute organ failure	67 (11.4)	517 (88.2)	2 (0.3)
Fungine infection	62 (10.6)	523 (89.2)	1 (0.2)
Parenteral nutrition over 7 days	51 (8.7)	535 (91.3)	-
Evidence of Brain tumor after craniolacunia	38 (6.5)	542 (92.5)	6 (1.1)
Neurogenic heterotopic ossification	30 (5.2)	523 (89.2)	33 (5.6)
Pre-existing disability	21 (3.6)	562 (95.9)	3 (0.5)
Worsening postoperative subdural hygroma	18 (3.1)	558 (95.2)	10 (1.7)
Cerebral anoxia with bilateral absence of N20 wave at SEPP	14 (2.4)	476 (81.2)	96 (16.4)
Pre-existing cancer	12 (2.0)	569 (97.2)	5 (0.8)
Anamnestic heart failure with ejection fraction <25%	8 (1.4)	575 (98.1)	3 (0.5)
Surgery within the 1 <sup>st</sup> week	5 (0.9)	581 (99.1)	-

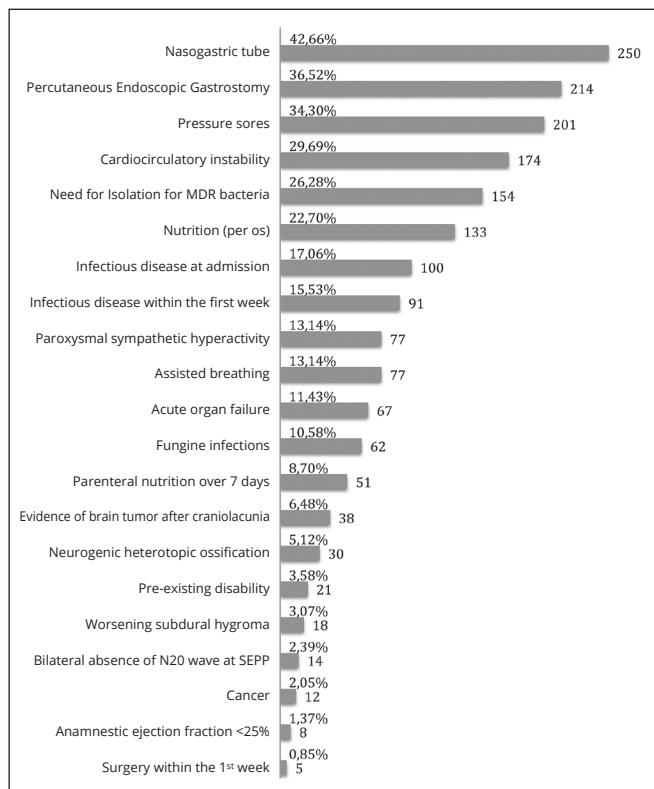


Figure 2.—Clinical conditions reported in the first week of rehabilitation stay.

TABLE III.—Patients' distribution according to GOS and LCF at rehabilitation admission.

Scales	N. (%)
GOS 1	0 (0)
GOS 2	238 (41)
GOS 3	331 (56)
GOS 4	14 (2)
GOS 5	3 (1)
LCF 1	37 (6)
LCF 2	216 (37)
LCF 3	126 (22)
LCF 4	79 (13)
LCF 5	66 (11)
LCF 6	46 (8)
LCF 7	13 (2)
LCF 8	3 (1)

This study addressed the specific research question of whether the sABI patients admitted to rehabilitation wards express a clinical complexity that may limit the rehabilitation care.

The main data from the study showed that when considering the current literature criteria for patients' admission to rehabilitation wards, only 44.7% of cases fulfilled the criteria, while the remaining showed one or more clinical conditions that would hinder admission; 12.3% of patients although not suitable for rehabilitation care were admitted to rehabilitation wards. In fact, as recently highlighted by

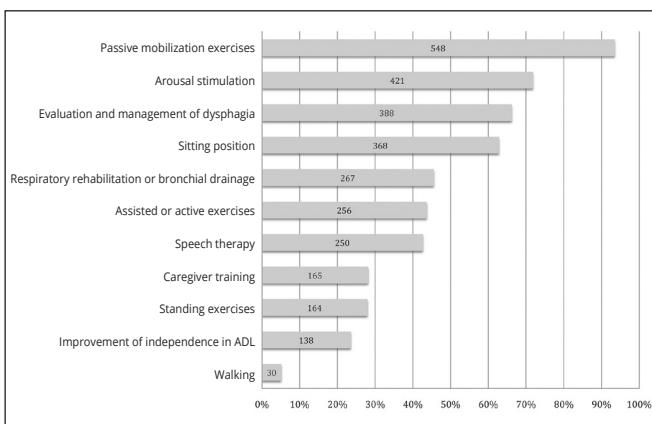


Figure 3.—Rehabilitative treatments performed during the first week.

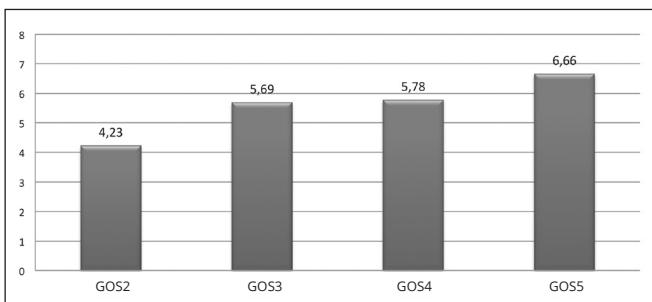


Figure 4.—Average number of rehabilitative interventions in the first week of hospitalization according to GOS value.

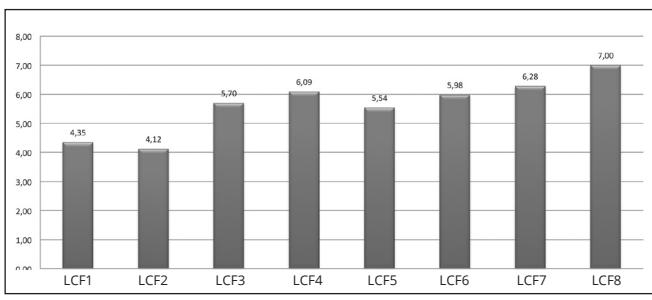


Figure 5.—Average number of rehabilitative interventions in the first week of hospitalization according to LCF value.

Intiso,<sup>8</sup> despite recommendations, pressure for transition of patients from acute care to neurorehabilitation wards is increasing for several reasons (*i.e.*, need for prompt availability of intensive care beds, cost reduction, decreasing length of stay in intensive care).

General epidemiological data showed a greater prevalence of sABI in males than in females and a higher prevalence of cerebrovascular etiology, particularly in older patients, consistently with previous literature data.<sup>16, 17</sup>

Among clinical issues, about one third of patients reported infectious diseases at admission or within the first week of rehabilitation stay, and about a quarter of the sample needed isolation because MDR bacteria.

Passive mobilization, the improvement of awareness, evaluation and management of dysphagia, sitting positioning and breathing exercises were reported as the most frequent activities performed during the rehabilitative sessions (Figure 3). Interestingly, neither mechanical ventilation or infectious diseases were linked to a reduction in rehabilitative treatments, while rehabilitative treatments were significantly lower in patients who need instrumental monitoring of vital signs. In fact, since there is no clear consensus about the definition of hemodynamic “instability,” cardiocirculatory monitoring represents a usual practice to identify vasoressor instability that according to clinical judgment is unsafe for starting exercises. On the other hand, respiratory instability/distress or ventilator asynchrony are commonly considered barriers for mobilization,<sup>21</sup> but not the presence of mechanical ventilation. At the same time, fever in the first week could be a barrier for physical therapy, while rehabilitative sessions in presence of multidrug resistant bacteria without sign of infection could be performed using routinary protocols of isolation, such as hand washing, physical isolation, gloves and masks.

Demographic data seem to confirm recent observations from studies performed in rehabilitative settings,<sup>22-25</sup> while the prevalence of cerebrovascular etiology was recently reported in two survey<sup>26, 27</sup> different from the past when traumatic etiology was the most frequent.<sup>28</sup> An increased frequency of postanoxic brain injury was also confirmed.<sup>17, 22, 27</sup>

With regard to nutritional aspects literature reports contrasting data; data from this study showed higher percentages of patients with PEG or NGT, as previously reported in patients with traumatic disorders of consciousness,<sup>11</sup> although a multicenter study showed lower percentages for PEG and NGT considered together (lower than 50%), and parenteral nutrition (3.2%).<sup>5</sup> The higher rate of enteral nutrition observed in our sample could be likely due to the increasing complexity of patients admitted to rehabilitation units with respect to older studies and to an earlier attention to global care for sABI patients already in ICU.

With respect to actual trend,<sup>5, 29-31</sup> in this study the frequency of pressure sores (34.3%) was higher. The overall prevalence of pressure injury declined in the last years<sup>32</sup> among patients in acute care hospitals, from 38% in 2003<sup>33</sup> to an actual range from 3 to 17%.<sup>32, 34-38</sup> However, higher

rates are reported in high-risk groups. A study performed in ICU patients reported that over 50 percent of patients developed a stage 1 or greater pressure injury when managed with a standard mattress bed.<sup>34</sup> These data could reflect the combined effect of clinical complexity of patients and insufficient rehabilitative treatment in ICU, due to various barriers, as described by Dubb *et al.* These authors reviewed 40 studies and identified a total of 28 unique barriers for mobilization: 14 patient-related, 5 structural, 5 related to ICU culture, 4 process-related, underlying the need of developing rehabilitative protocols in ICU.<sup>21</sup>

As reported by previous papers, it is very difficult to define the incidence of Neurogenic Heterotopic Ossification (NHO). Data from this study are in line with recent papers that demonstrated that NHO occurs in 4% up to 23% of patients after TBI.<sup>27, 39</sup>

The occurrence of PSH in literature is not well defined and contrasting data are reported with an estimated incidence following traumatic brain injury between 7.7% and 33%.<sup>40-42</sup> At the same time there is also a lack of evidence about possibility of intervention by physical therapist in these patients, that usually have longer ICU stays and worse outcomes.<sup>43</sup> Moreover, even when PSH does not appear to influence the outcome, they are more likely to undergo psychoactive medications and PSH is then perceived as a complication for rehabilitation care.<sup>44</sup> Our data seem to show a difficulty to indicate as mandatory discharging patients with PSH not controlled by drugs in rehabilitative units. This is due to lower possibility of carry out rehabilitative treatments due to need for monitoring patients.

As reported by previous studies performed in ICU, cardiocirculatory instability due to tachycardia, hypotension, arrhythmias or respiratory symptoms (e.g. dyspnea), as well as acute organ failure, can interrupt or interfere with the rehabilitative sessions.<sup>21, 45, 46</sup>

Functional scores (GOS, LCF) seem to be in line with data reported from recent studies,<sup>8, 22, 47</sup> although GOS score was lower if compared with a national prospective study<sup>28</sup> due to higher percentage of patients with GOS value 2; ERBI scores were similar to the data reported at discharge from ICU.<sup>26</sup>

Although LCF1 and 2 correspond to GOS 2, in our sample the sum of the data does not match (15 cases). In our view, it is possible that in real life, the clinical evaluation is wider showing limitation in the use of standardized clinical scales, and justifying not significant discrepancies in the data.

A significant relationship between GOS, ERBI and LCF scores, and the number of rehabilitative interventions, was

observed. Orthostatic training, exercises for the gait, or active/assisted exercise are more frequent in higher GOS and LCF scores, while training for informal caregiver are related to worse GOS and LCF scores. Conversely, an inverse relationship between the score at GOS and LCF and the number of complications was found. Overall, these data seem to indicate a greater need of intensive rehabilitation in "higher functional" patients, and also a lower indication to carry out rehabilitative session in most severe patients, except for basic procedures.

It is well known that the absence of N20 in postanoxic survivors represents an early predictor of poor outcome<sup>48-50</sup> with implications in terms of rehabilitative management that imply an intervention based only on basic procedures (*i.e.* passive mobilization, or training for caregivers). Accordingly, data from this study showed that postanoxic survivors with bilateral absence of N20 performed a lower number of rehabilitative treatments in the first week.

### Limitations of the study

This survey presents some limitations: first, the occurrence and impact of different clinical conditions (*e.g.* anemia, fractures), as well as the tracheostomy tube and seizures could be underestimated. The tracheostomy tube and seizures were not considered because it is widely accepted<sup>11, 17, 22, 27</sup> that they don't represent a limitation for transition to rehabilitative units. Second, in this study were considered the kind of treatments continuously performed during the first week, instead of the time of treatments. This in order to avoid missing data, because in a multi-center study, it would have been very difficult to calculate the minutes of treatment carried out for each patient, due to different organizational models.

Notwithstanding the above limitations, this study represents a relevant contribution to get a picture of the actual situation about the clinical conditions of sABI patients at admission in neurorehabilitation. Moreover, these data could help to improve the care pathways for sABI patients, promoting early and appropriate transition from acute care to rehabilitation settings.

### Conclusions

This study provides a picture of the actual situation about clinical conditions of sABI patients at admission in neurorehabilitation. People with sABI frequently show relevant complications or clinical conditions that need elevated care assistance.

However, overall data from this study confirmed that re-

habilitation treatments are widely possible even in patients with relevant comorbidities (need for isolation, infection by multi drug resistant bacteria, etc.), and that only few conditions seem to be related to a reduction of rehabilitative session. These data could help to improve the care pathways for sABI patients, promoting early and appropriate transition from acute care to rehabilitation settings.

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