The Role of Rehabilitation on the Evolution of Disability and Self-Sufficiency in a Population of Hospitalized Older Adults

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Abstract: Frailty is characterized by increased vulnerability, which impairs the ability to cope with stressors and represents a risk factor for the development of disability. Moreover, the population of older adults is continuously increasing. For this reason, frailty and aging represent very important social and health topics. The management of elderly patients, especially when they are hospitalized, is complex and requires the collaboration of multiple professionals and different approaches to intervene in the multi-morbidity that characterizes this population. A significant percentage of hospitalized older patients present several comorbidities that cause prolonged hospital stays. This condition could lead to clinical complications, increased costs of care, and a higher likelihood of in-hospital death. Aging is a concept that encompasses several symptoms and requires a multidisciplinary and specific approach, especially during hospitalization and in acute care settings. The present study aims to evaluate how intensive rehabilitation treatment is accompanied by improvement in some hematological and clinical parameters and could contribute to an evolution in disability among elderly patients. The results of the present research show the crucial role of rehabilitation treatment in the development of disability, independence, and self-sufficiency in a population of older inpatients in a post-acute care setting. Further research should be conducted to identify other biomarkers useful in the management of frail patients.

Keywords: rehabilitation; aging; frailty; multimorbidity; clinical complications; personalized medicine

1. Introduction

With the increase in life expectancy, a rapid and progressive aging of the population is being observed. Globally, growth has been recorded in recent years, both in terms of size and in terms of the percentage of older adults in the worldwide population. The World Health Organization (WHO) has estimated that by 2030, 1 in 6 people will be 60 years of age or older, and that by 2050, the population of elderly people will reach 2.1 billion. The population of the oldest (over 80 years old) people will triple to 426 million by 2050 [1]. In particular, Italy represents the second country with the oldest population worldwide [2].

Age-related evolution is a gradual and continuous process that involves a series of physical and cognitive changes that, however, do not have a real “onset” age. In fact, rather than based on chronological age, the concept of “elderly” is based on the degree of self-sufficiency and independence of the individual. Biologically, aging is the sum of changes at the molecular and cellular levels that occur over time and lead to multisystem functional impairment [3]. The aging process is characterized by several elements, including genomics instability, telomere attrition [4], epigenetic alterations, loss of proteostasis,
mitochondrial dysfunction, stem cell depletion, altered intercellular communication and cellular senescence [3], and deregulation of nutrient sensing [5]. Moreover, it is a process directly related to frailty, falls, and disability [4,6–8].

Frailty is a state characterized by an increased vulnerability that impairs the ability to cope with stressors; according to Fried, some criteria that contribute to frailty include low grip strength, low energy, and low physical activity, among others [7]. In addition, frailty has been identified in recent years as a risk factor for the development of disability [9,10]. This can result in reduced health-related quality of life, particularly in older adults [11], and, in terms of treatment and disease management, reduced adherence to drug and rehabilitation therapy [12,13].

With the involvement of different functional systems, the management of the elderly patient is complex and requires the collaboration of multiple professionals to intervene in the multi-morbidity that characterizes this population. Aging is a concept that encompasses several symptoms and requires a multidimensional and specific approach, especially during hospitalization and in acute care settings [14,15]. In these particular settings, it is crucial—especially for older adults—to assess the presence or absence of comorbidity and consequently make an estimate of mortality [16]. The most widely used tool is the Charlson Comorbidity Index [17–19].

A significant percentage of hospitalized older patients present several comorbidities that cause prolonged hospital stays, increased costs of care, and an increased likelihood of in-hospital death [20]. A significant association with prolonged length of stay was found for diseases of white blood cells and hematological malignancies, neurological disorders, and chronic ulcers of the skin. Prolonged hospitalization was associated with the variety and number of chronic diseases and, overall, with the number of body systems involved [20]. In particular, a study conducted on a population of hospitalized patients in a rehabilitation unit reported the role of comorbidities and clinical complications on functional and motor rehabilitation outcomes that cause delayed discharge [21]. These factors impact rehabilitation outcomes and rehabilitation professional treatment because of the patients’ long periods of immobility. Rehabilitation plays a key role in hospitalized patients, and it is particularly influential in older adults, especially in a pandemic period [22]. A recent meta-analysis showed that rehabilitation for older adults with COVID-19 in acute or post-acute inpatient hospital settings resulted in statistically significant improvement in function [22].

These data suggest the dimension of multimorbidity in older adults has a great impact on health care costs, both direct and indirect (social costs, involvement of caregivers, etc.). Increased costs can be attributed to repeated diagnostic procedures, management of medical complications such as pneumonia, malnutrition, and infection, which are frequent but not exclusive to geriatric age, and increased multidisciplinary involvement due to longer hospital stays [23]. Moreover, a longer period of hospitalization increases the risk of infections and sepsis, muscle weakness, internal medicine complications, and, last but not least, the stress on the patient, family members, and caregivers.

In the elderly, muscle weakness can contribute to increased fatigue and reduced functional capacity; also, depletion of functional capacity may be characterized by low hemoglobin (Hb) levels [24]. Recently, a relationship has been found between Hb levels and frailty in the elderly [25,26], which is both a cause and a consequence of functional disability in this population [27]. C-reactive protein (CRP) is also associated with functional disability. Some authors have identified how high CRP levels are significantly associated with “poor outcomes” [28].

The purpose of the study is to evaluate how the evolution of disability and autonomy following intensive rehabilitation treatment is accompanied by the evolution of some hematological and clinical parameters.

2. Materials and Methods

All patients of both sexes, aged over 60 years, regardless of the type of disease that had led them to a rehabilitation hospitalization, who had given their informed consent
to participate in the study, were consecutively enrolled. Between November 2020 and July 2022, therefore, 304 elderly patients admitted to the Post-Acute Rehabilitation Unit of the Fondazione Policlinico Universitario Agostino Gemelli IRCCS in Rome, Italy, were included in the study.

All enrolled inpatients underwent a conventional treatment prescribed by clinical practice. Rehabilitation treatment is provided for at least 180 min each day. Rehabilitation programs follow international evidence and national guidelines [29].

A personalized rehabilitation project was defined for each patient and considered the specific areas of intervention, the short-term objectives, the times and methods of delivery of the interventions, the operators involved, and the verification of the interventions.

Intensive rehabilitation activities aimed at the recovery of important, modifiable disabilities, which require a high diagnostic commitment to specialist medical rehabilitation and treatment in terms of complexity and/or duration of the intervention (generally referable to at least three hours a day of specific therapy understood as those provided directly by technical rehabilitation personnel, such as, for example, the physiotherapist, the speech therapist, the occupational therapist, the professional educator, and the nurse in those acts aimed at improving the activity of daily living). The rehabilitation project and its implementation programs define the completion times of the rehabilitation cycles, usually within 120 days [30].

Demographic, anamnestic, and clinical data were recorded during the hospitalization. Specifically, data inherent in the Charlson Comorbidity Index (CCI) were collected at the beginning of hospitalization (T0), and the following blood sample values were collected: hemoglobin (Hb), white blood cells, platelets, neutrophils, lymphocytes, platelet/lymphocyte ratio, neutrophil/lymphocyte ratio, vitamin D, albumin, total protein, C-reactive protein (CRP), and procalcitonin.

In addition, patients were clinically evaluated at the beginning (T0) and end (T1) of hospitalization using the modified Barthel Index (mBI), Hand Grip Test (HGT), and Numerical Rating Scale (NRS).

The Charlson Comorbidity Index (CCI) is a tool developed to identify the disease burden and quantify the risk of mortality at 1 year. The CCI makes it possible to classify patients into subgroups based on disease severity and the number of comorbidities present to help develop targeted care models and allocate resources [31,32]. The CCI is an index consisting of 19 comorbidities and includes two subcategories for diabetes and liver disease [33]. Each comorbidity can be assigned a weight ranging from 1 to 6, considering mortality risk and severity. The scores and comorbidities considered in the CCI are: 1 point for myocardial infarction, congestive heart failure, peripheral vasculopathy, cerebrovascular disease, dementia, chronic bronchopneumopathy, connective tissue disease, peptic ulcer disease, chronic hepatopathy, and uncomplicated diabetes mellitus; 2 points for hemiplegia, moderate or severe renal insufficiency, diabetes with organ damage, tumors, leukemia, and lymphoma; 3 points for moderate or severe hepatopathy; and finally 6 points for malignant tumors, metastases, and acquired immune deficiency syndrome (AIDS). The total score is made up of the sum of the individual scores and the addition of one point for each decade over 40 years of age [33]. Specifically, from 41 to 50 years of age, 1 point is awarded; for the 51–60 age group, 2 points are awarded; for the 61–70 age group, 3 points are awarded; and finally, over 70 years of age, 4 points are awarded.

Hb is a metalloprotein contained in red blood cells that is responsible for transporting oxygen in the blood stream. More than 98% of the oxygen in the blood is bound to HB, which in turn circulates in the blood stream and is allocated within the red blood cells. Without hemoglobin, erythrocytes would not be able to fulfill their task as oxygen carriers in the blood. Altered hemoglobin levels can be a consequence of, among others, heart disease, chronic lung disease, iron deficiency, and anemia [34].

White blood cells are cells of the immune system involved in protecting the body from infection and other diseases. An excess of white blood cells is usually due to an infection or inflammation. Less commonly, an elevated white blood cell count may indicate certain
blood cancers or bone marrow disorders. Several types of white blood cells, including neutrophils and lymphocytes, are responsible for the fight against infections caused by bacteria and fungi, the antibody response, and the fight against virus-infected and tumor cells [35].

Platelets are a blood component whose task is to intervene in the event of a blood vessel injury [36]. Their main function is to intervene in the event of endothelium rupture by participating in the formation of a platelet plug. In addition, platelets participate in intravascular immune responses [37,38].

The platelet-lymphocyte ratio is an inflammatory marker that can be used to predict inflammation and mortality in some diseases. The platelet-lymphocyte ratio can be influenced by various inflammatory conditions, such as atherosclerosis, platelet activation, or an elevated inflammatory state [39].

Vitamin D is a fat-soluble secosteroid. It is responsible, among other things, for the homeostasis and metabolism of calcium, magnesium, and phosphate and for many other biological effects [40].

Albumin is a member of a family of globular and transport proteins, whose main functions are the regulation of blood oncotic pressure; the binding of vitamin D, its metabolites, and fatty acids; and the regularization of bone mineralization [41].

Total protein is a clinical parameter that indicates the concentration of protein in the serum. Detecting the amount of protein in serum is a diagnostic and clinical monitoring tool [42].

CRP is a protein present in blood plasma, the concentration of which increases in response to an acute or chronic inflammatory phenomenon, such as rheumatic diseases, infections (bacterial, viral, or fungal), neoplasms, and tissue lesions [43].

Procalcitonin is a precursor peptide of the hormone calcitonin, the latter being involved in calcium homeostasis. Its level increases following a pro-inflammatory stimulus, especially if it is of bacterial origin [44].

The mBI is an ordinal scale that assesses a person’s independence in completing activities of daily living (ADL). Eleven ADLs are considered: feeding, dressing/undressing (clothing), personal hygiene, bathing/showering, bowel sphincter control, bladder sphincter control, chair to bed and back movements, toilet use (getting in and out of the toilet), mobility (walking on level ground), wheelchair use, and climbing and descending stairs. Each score can be assigned a value from 0 to 15, depending on the activity. There are five levels to take into account: (i) complete inability to perform the task (even with help); (ii) need for significant help to complete the task; (iii) need for moderate help and/or active supervision to complete the task; (iv) need for minimal help and/or passive supervision, i.e., the presence of someone even without active intervention; (v) ability to complete the task independently. Higher scores correspond to a greater degree of independence in performing the ADL [45].

The HGT is an instrument for measuring the maximum isometric force of the muscles of the upper limb. The test is performed with a dynamometer that records the force variations of each candidate. The patient is asked to squeeze the dynamometer as tightly as possible and maintain the contraction for at least 5 s, then release the muscles and evaluate the results. The test is repeated 3 times for both hands with a pause between attempts of at least 30–50 s. The average of the scores of the various attempts is then taken as the final value of the test [46].

The NRS is a one-dimensional, 11-point numerical quantitative scale used to assess pain. The patient is asked to select the number that best describes the intensity of their pain, from 0 to 10, where 0 indicates “no pain” and 10 indicates “worst possible pain” [47].

Finally, at the same time points (T0 and T1), the number of drugs administered to patients and the number of infections were recorded.

The study was performed in accordance with the Declaration of Helsinki. All participants provided written informed consent before participating.
Statistical Analysis

For all statistical analyses, the value was set at \( p \)-value < 0.05, and the software was Statistical Package for Social Science (SPSS), Version 20.0 (SPSS Inc., Chicago, IL, USA, 2004). Descriptive statistics were conducted to describe the study participants. Qualitative variables were expressed as absolute frequencies and percentages; quantitative variables were reported as medians and interquartile ranges.

The Shapiro–Wilk probability test was used to assess the normality of the distributions. The Wilcoxon Signed Rank non-parametric test was used to compare the data recorded at T0 and T1. The Spearman correlation test was used to evaluate the relationship between the change from baseline of the mBI (\( \Delta \text{mBI} \)) and the other clinical outcomes and between \( \Delta \text{mBI} \) and the blood sample values.

3. Results

Three hundred and four patients with a mean age of 73.02 (SD = \( \pm \) 13.97) years were included in the study. The demographic, anamnestic, and clinical characteristics of the sample are shown in Table 1. These patients originally came from different hospital wards.

Table 1. Characteristics of the sample.

<table>
<thead>
<tr>
<th></th>
<th>n (%) / Median (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>304</td>
</tr>
<tr>
<td>Gender</td>
<td>male vs. female 135 (44.41) vs. 169 (55.59)</td>
</tr>
<tr>
<td>Age</td>
<td>years 75.65 (63.23–83.26)</td>
</tr>
<tr>
<td>BMI</td>
<td>25.33 (23.37–27.68)</td>
</tr>
<tr>
<td>CCI</td>
<td>5 (3–7)</td>
</tr>
<tr>
<td>Days of hospitalization</td>
<td>22 (16–28)</td>
</tr>
</tbody>
</table>

BMI—body mass index; CCI—Charlson comorbidity index.

The most frequent operative unit of provenance was the orthopedics ward, from which 52.9% of patients came, while 34.9% of patients came from neurological wards. The remaining 12.2% of inpatients came from other hospital operative units, in particular the medical ward, where the patients were medically admitted to an acute care unit and had become debilitated and bedridden by an acute event.

Comparing data recorded at baseline (T0) and at discharge (T1), statistically significant changes in mBI, NRS, and HGT (\( p < 0.001 \)) were detected in the whole sample, in the neurological group, and in the orthopedic group. Moreover, in the other patients that came from other hospital operative units, we found statistically significant changes in mBI (\( p \leq 0.001 \)), NRS (\( p = 0.002 \)), and HGT (\( p = 0.001 \)) (Table 2).

Table 2. Clinical data values (medians and interquartile ranges) at T0 and T1 and statistical analysis results (T0 vs. T1 evaluation).

<table>
<thead>
<tr>
<th></th>
<th>Baseline Median (IQR)</th>
<th>Discharge Median (IQR)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mBI_whole sample</td>
<td>26 (19–33)</td>
<td>62 (48–75)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mBI_neurological patients</td>
<td>23 (16–33)</td>
<td>63 (49–75)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mBI_orthopedic patients</td>
<td>27 (22–35)</td>
<td>63 (50–74)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mBI_other patients</td>
<td>25 (20–30)</td>
<td>59 (44–69)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NRS_whole sample</td>
<td>2 (0–4)</td>
<td>0 (0–2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NRS_neurological patients</td>
<td>0 (0–3)</td>
<td>0 (0–1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NRS_orthopedic patients</td>
<td>2 (1–5)</td>
<td>0 (0–2)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Table 2. Cont.

<table>
<thead>
<tr>
<th></th>
<th>Baseline Median (IQR)</th>
<th>Discharge Median (IQR)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRS_other patients</td>
<td>1 (0–4)</td>
<td>0 (0–2)</td>
<td>0.002</td>
</tr>
<tr>
<td>HGT_whole sample</td>
<td>16 (10–23)</td>
<td>18 (12–25)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HGT_neurological patients</td>
<td>18 (11–26)</td>
<td>22 (15–28)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HGT_orthopedic patients</td>
<td>15 (9–23)</td>
<td>16 (10–24)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HGT_other patients</td>
<td>13 (9–21)</td>
<td>14 (10–22)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

mBI—modified Barthel Index; NRS—Numerical Rating Scale for Pain Assessment; HGT—Hand Grip Test.

Analyzing our global sample of patients, we found a positive correlation between Δ mBI and the change from baseline of the HGT (p = 0.009, ρ = 0.168) and a negative correlation between Δ mBI and CCI (p < 0.001, ρ = −0.310), between Δ mBI and the number of drugs at baseline (T0) (p = 0.001, ρ = −0.210) and at discharge (T1) (p < 0.001, ρ = −0.396), and finally between Δ mBI and NRS at T1 (p = 0.001, ρ = −0.214) (Figure 1).

Figure 1. Scatterplots. Considering the global sample of patients (N = 304), the graphic shows the correlation between the change from baseline of the modified Barthel Index (Δ mBI) and the other clinical outcomes.

Regarding the correlation between Δ mBI and the blood sample values, we found a positive correlation with Hb (p = 0.010, ρ = 0.161), with albumin (p = 0.001, ρ = 0.215), with total protein (p < 0.001, ρ = 0.228), and a negative correlation with CRP (p = 0.003, ρ = −0.210) (Figure 2).

Observing the single groups of our sample, we calculated the medians and interquartile ranges of Δ mBI: for the orthopedic group, it was 33 (24–44); for the neurological group, it was 38 (28–44); and for the inpatients coming from the other hospital wards, it was 29 (21–38) (Figure 3).
Considering only the group of orthopedic patients (52.9% of the whole sample), we found a negative correlation between $\Delta_{\text{mBI}}$ and CCI ($p < 0.001$, $\rho = -0.327$) and between $\Delta_{\text{mBI}}$ and the number of drugs at T0 ($p = 0.025$, $\rho = -0.197$) and at T1 ($p < 0.001$, $\rho = -0.403$). In addition, $\Delta_{\text{mBI}}$ was positively correlated with Hb ($p = 0.026$, $\rho = 0.196$), albumin ($p = 0.044$, $\rho = 0.185$), and total protein ($p < 0.001$, $\rho = 0.330$) (Figure S1—Supplementary Files).

In the neurological group (34.9% of enrolled patients), $\Delta_{\text{mBI}}$ was negatively correlated with CCI ($p = 0.003$, $\rho = -0.291$), number of drugs at T1 ($p < 0.001$, $\rho = -0.354$), NRS at T1 ($p = 0.001$, $\rho = -0.333$), and CRP ($p = 0.030$, $\rho = -0.244$) (Figure S2—Supplementary Files). Finally, concerning the remaining 12.2% of inpatients coming from the other hospital wards, we found a negative correlation between $\Delta_{\text{mBI}}$ and the number of drugs at T1 ($p = 0.031$, $\rho = -0.388$) and a positive correlation between $\Delta_{\text{mBI}}$ and total protein ($p = 0.027$, $\rho = 0.411$) (Figure S3—Supplementary Files).
4. Discussion

The older adult population is characterized by the coexistence of various pathologies that, when combined, increase the complexity of patient management. Following an acute event, whether of neurological, orthopedic or other origin, the complexity increases even further.

After an acute event, elderly patients may experience a significant loss of functional independence. For this reason, both discharge planning and reducing the length of stay are very important [48]. Planned and integrated multi-dimensional care management contributes to the promotion of health and the quality of care received by elderly inpatients. It is essential to preserve the functional independence and self-sufficiency of elderly patients during hospitalization [14,15]. Hospitalization of elderly patients is particularly risky because it may involve isolation, immobility, and exposure to infectious organisms. When patients are hospitalized, it is very likely that therapy will be modified and drugs will be added or changed [49,50]. Acute and post-acute hospital care for elderly patients should only last as long as necessary to allow transition to home care, a skilled facility, or an outpatient rehabilitation program.

In most cases, therefore, rehabilitation treatment becomes the pivotal point for achieving the best possible recovery from health conditions [51]. It was shown that elderly patients undergoing moderate-intensity rehabilitation treatment during hospitalization (exercises focusing on walking, endurance, and balance) did not suffer any functional decline during hospitalization [52]. Our results confirm the evidence reported in a recent systematic review about the effectiveness of rehabilitation treatment. Rehabilitation treatment improves the quality of life of older people by increasing their independence, particularly in activities of daily living. Key factors of this approach include personalized treatment, tailor-made interventions and therapies, an elder-friendly environment, and social support [53].

Identifying one or more factors that can give an idea of how the rehabilitation pathway will evolve and what the outcomes at discharge will be can be of great help in tailoring the rehabilitation approach. Some studies have proposed a prognostic logistic model, using demographic and clinical factors as predictors of length of stay, and derived an equation to estimate hospitalization time [54–56].

In the entire population of elderly patients we examined, data analysis showed that an increase in independence and autonomy in activities of daily living was directly related to a growth in strength. This result is consistent with previous studies in the literature that have linked health to hand strength [57,58]. Furthermore, several studies show that poor muscle strength is associated with cognitive decline, low quality of life, and depressive symptoms in elderly patients [59,60].

Due to the nature of older inpatients, it is crucial to consider the role played by sarcopenia in order to correctly plan a tailored rehabilitation approach. Indeed, several pathological conditions (e.g., hypertension) are characterized by dysregulation of the renin-angiotensin system (RAS) with muscle mass and muscle performance loss. Likewise, angiotensin-converting enzyme inhibitors, vitamin D, exercise, and a healthy diet can have prominent effects not only on the modulation of RAS but also on physical and cognitive functions and sarcopenia [61].

In addition, an improvement in self-sufficiency corresponds to a decrease in comorbidities, medications, and pain levels at discharge, all of which can lead to improved health. These results are also confirmed by data on certain hematocrit values. In fact, an increase in autonomy corresponds to an increase in Hb, albumin, and total protein values and a decrease in CRP. These outcomes underline the role and effects of intensive rehabilitation treatment, especially during hospitalization. Indeed, working on disability and bodily function, both physical and cognitive, results in a decrease in disability and an increase in personal autonomy [8]. In biological terms, this translates into an increase in tissue gas exchanges, proper maintenance of osmotic pressure and fluid distribution in the body, better regulation of metabolic processes, and a decrease in the inflammation index [62]. These results suggest the opportunity to combine clinical data with molecular
and cellular investigations to study the relationship between muscle and mental functions in elderly patients admitted to rehabilitation units.

Analyzing the different pathologies that make up the older adults considered, the same results were obtained. In the population of neurological patients, in fact, the improvement in terms of autonomy at the end of the rehabilitation course is manifested by a decrease in the comorbidity index, the number of medications taken, and the level of perceived pain and inflammation. Some authors have observed that CRP levels are positively correlated with functional outcomes [63] and that high CRP levels are predictors of disability [64]. In the orthopedic patient group, the improvement in autonomy correlated positively with Hb, albumin, and total protein levels; it also correlated negatively with CCI and the number of drugs, both at admission and at discharge. In the remaining patient group, an increase in autonomy corresponded to a decrease in the number of drugs and an increase in total protein.

Interestingly, both in individual populations and in the elderly population in general, the improvement of autonomy in activities of daily living corresponds to a decrease in the number of drugs. Considering the number of drug therapies that elderly patients are subjected to, this result represents a strategy, when possible, to decrease the number of drugs taken. A randomized controlled trial aimed at optimizing polypharmacy in elderly patients with chronic diseases. Both scientific evidence and patients’ own preferences were considered in the treatment indications. The authors’ aim was to provide solid scientific evidence leading to a sustainable reduction of polypharmacy, improving patient-centeredness and autonomy, and a consequent reduction of costs (direct and indirect) on the health and social systems [65].

A positive difference between the value on admission and discharge of the mBI indicates an improvement in the patient’s autonomy and thus, successful rehabilitation. Frailty is a multifactorial condition that significantly affects patients with low hemoglobin levels and high CRP levels [24]. An effective rehabilitation approach, therefore, may be able to influence frailty. A very recent article [66] analyzed the importance of training in specialization programs in physical medicine and rehabilitation (PMR), focusing on rehabilitation in frailty and age-related diseases. This can be considered a crucial point in order to enhance the diagnostic and management abilities of PMR in different rehabilitation settings. Recently, the International Society of Physical and Rehabilitation Medicine (ISPRM) prepared a diagnostic algorithm for the diagnosis of sarcopenia by combining functional tests and sonographic parameters [67]. This is an insightful approach with a functional perspective on age-related disorders that could enable early detection of frailty and pre-frailty symptoms to reduce their impact on individual quality of life and social life.

5. Conclusions

Considering the evolution and constant and exponential increase in aging of the population worldwide, older adults represent a very important target for social policies and health issues. In this context, frailty represents one of the main risk factors directly related to the increase in disability and decrease in autonomy in the elderly population. This is true when this population is hospitalized, which is a more challenging situation considering the multimorbidity and complexity of those patients. In addition to the clinical tools usually used to detect frailty evolution, it is important to identify some biomarkers to objectively define the status of elderly patients. Our data suggest a crucial role for rehabilitation treatment in the course of disability and self-sufficiency in a population of older adults and suggest some possible markers to monitor evolution. Further research should be conducted to identify other biomarkers useful in the management of more frail patients.
Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app131810330/s1, Figure S1: Scatterplots. The graphs reported the correlation between the change from baseline of the modified Barthel Index (Δ_mBI) and the other variables evaluated for the orthopaedic group; Figure S2: Scatterplots. The graphs reported the correlation between the change from baseline of the modified Barthel Index (Δ_mBI) and the other variables evaluated for the neurological group; Figure S3: Scatterplots. The graphs reported the correlation between the change from baseline of the modified Barthel Index (Δ_mBI) and the other variables evaluated for the inpatients come from the other hospital wards.

Author Contributions: Conceptualization, S.G. and C.I.; methodology, C.L.; formal analysis, C.I.; investigation, A.F, V.A. and C.C.; data curation, C.I., V.A. and C.C.; writing—original draft preparation, A.F. and L.C.; writing—review and editing, L.C. and C.L.; visualization, L.P.; supervision, S.G. and L.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting the results are not available.

Conflicts of Interest: The authors declare no conflict of interest.

References


52. Hamed, A.; Bohm, S.; Mersmann, F.; Arampatzis, A. Follow-up Efficacy of Physical Exercise Interventions on Fall Incidence and Fall Risk in Healthy Older Adults: A Systematic Review and Meta-Analysis. Sports Med. Open 2018, 4, 56. [CrossRef]


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