Barthel Index: creation and validation of two cut-offs using the BRASS Index

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Abstract. *Background and aim:* Hospital discharge should be planned during the first days of stay to avoid an inappropriate length of stay and an early rehospitalization. Blaylock Risk Assessment Screening Score Index (BRASS index) evaluates the risk of difficult discharge, Barthel Index the level of autonomy in "activities of daily living" (ADL). This is a prospective observational study, performed in Padua's Hospital (Italy), with the purpose of validating two cut-offs in the Barthel Index using the BRASS Index, in order to find three bands for difficult discharges: low, medium and high risk. *Methods:* Two studies have been conducted: a pilot study in 2017 with 153 patients and a validation study in 2018 with 253 patients, in order to validate data emerged from the pilot study. Using a statistical method, two cut-offs have been identified in the Barthel Index. *Results:* Both of study showed that the grade of autonomy is correlated with the risk of difficult discharge. A Barthel score between 0 and 35 corresponds to a high risk, between 35 and 70 to a medium and over 75 to a low. *Discussion:* This study suggests that, by the use of only Barthel Index, it may be possible to identify patients who may have difficulty in early discharge. This result suggests that the degree of functional dependence is predictive of the risk of difficult discharge. Further studies are needed to confirm the correlation between these data also in other realities (e.g. outside hospital departments). *Conclusion:* Nurses could use a single instrument to evaluate the autonomy and the risk of difficult discharge in order to identify early patients that need a discharge plan. (www.actabiomedica.it)

Key words: Barthel, BRASS, nurse, difficult discharge, cut-off

1. Introduction

A difficult discharge occurs when, in accordance with the continuity of care and treatment, it requires greater economic, organizational and human resources, which go beyond the capabilities of the assisted people and their families (1). The discharge is always a critical moment for the patient. The responsibility for discharge is shared between the doctor and the nurse. In fact it is not only the clinical condition that defines when a patient can be discharged, but also health professionals must ensure that the patients feels ready to return home and that a good assistance can be guar-

anteed by the caregivers, through the ability to manage the situation at home in the most autonomous way possible and to provide them the appropriate care (2).

Scheduled discharge may reduce hospitalization days and cases of rehospitalization in the first three months after discharge, and may also increase the patient's satisfaction and trust in healthcare professionals (3).

The discharge should be planned for patients who have complex medical needs to ensure safety and continuity in the care process, even after returning home, through the taking in charge and collaboration of several professionals. The resignation planning process

should start as soon as possible, especially in older patients, who are most at risk of having difficulties at this stage (2).

The Blaylock and Cason Index (Blaylock Risk Assessment Screening Score Index - BRASS Index) could be used to identify patients at high risk of difficult discharge. This scale was developed in 1992 by Blaylock and Cason as an instrument to help the healthcare personnel in planning discharge for patients over the age of 65. According to their experience in geriatric nursing, they considered the following factors as most predictive of a difficult discharge: age, gender, living situation/social support, functional status, cognition, behavior pattern, mobility, sensory deficits, number of previous admission/emergency room visits, number of active medical problems, number of drugs.

The score identifies three classes of risk: low (pts <10), medium (pts 10-19), high (pts >20).

The evaluation should be executed by a nurse in the early days of hospitalization to identify patients that need the activation of territorial network and to avoid an inappropriate length of hospital stay precociously (4). It is simple and quick (for compilation only about 3 minutes is necessary) (5).

A study developed in 1999 demonstrates that the BRASS Index correlates significantly with problems experienced after discharge and that it has high specificity to predict patients with problems after discharge(6).

The efficacy of the BRASS Index has been validated also in a sample of patients in Cunic et al.'s study. It's been useful to identify patients with a BRASS Index > 8 that are likely to stay in hospital five or more days and should receive pre-emptive social work consultations to facilitate discharge planning (7).

A prospective study, conducted in 2013 in six different Italian hospitals, validated the BRASS Index as a useful instrument to identify patients at risk of prolonged hospitalization (5).

The Barthel Index is an instrument, created in 1955 by Dorothea W. Barthel that, as the BRASS Index, evaluates the functional status and the level of autonomy in daily-life activities such as: feeding, bathing, grooming, dressing, bowels-control, bladder-control, toilet use, transfers (bed to chair), mobility (on

level surfaces), and stairs. A score of 100 represents the upper level of autonomy and 0 the totally dependence on someone. The process of filling the papers in requires just few minutes and the information can be taken through a short interview with the patient or his caregiver.

The validity of the Barthel score has been described by several studies, also in correlation with mortality, in particular in the rehabilitation setting and in patients affected by ictus (8).

A recent research confirms this instrument as a valid scale to evaluate the level of autonomy of patients with previous ictus (9).

The usefulness of this study is to find out if, through the compilation of a single instrument, in this case the Barthel Index, is possible to identify more information avoiding the compilation of two or more scales. Barthel Index provides a judgment, through a score, of the patient's ability to cope with activities of daily life. Brass index, instead, gives a judgment of the risk of difficult discharge. If we could identify, with the use of Barthel Index, the degree of risk of difficult discharge, correlating this score with the BRASS Index, we will be able to check with a single score both information, difficulties in ADL and risk of difficult discharge.

It is expected that staff will engage in the use of this instrument, simple and fast, optimizing the information already held and avoiding the administration of more scales.

2. Aim

The purpose of the research is validating two cut-offs in the Barthel index, a continuous scale, correlating it with the BRASS Index, a three bands scale, in order to find three bands for difficult discharges: low, medium and high risk.

The correlation between the two scales helps to suggest if it is possible to use the Barthel Index also to identify the risk of difficult discharge, studied by BRASS Index.

The identification of two cut-offs confirms the overlap of the data between the two scales and the possibility of using, through a band-scale, a data easily and immediately expendable at a care level.

3. Methods

Study design

This is a prospective observational study, performed in Padua's Hospital (Italy).

The study has been divided into two parts:
- a pilot study, conducted on a convenience sample of patients in 2017, with the aim to identify a correlation between Barthel and BRASS Index;
- a study of validation, conducted on a predefined sample of patients, which validated data emerged in the first part of the study and identified the two cut-offs.

3.1 Pilot study

The Barthel Index has been divided in 4 different levels of score using a division that is not validated (100-91: completely independence, 90-61: slight level of dependence, 60-21: moderate, >20 severe) conventionally decided in the Veneto Region, in order to evaluate the grade of autonomy of patients.

In this first step, 153 patients have been included, 80 males and 73 females, recovered in two different medical divisions. Data have been collected for four weeks in August 2017.

Each patient has been evaluated using both, BRASS and Barthel Index, through an interview or by observing their functional abilities at the moment of admission. If the patient cannot answer, a caregiver or a member of clinical staff was consulted.

Both scales were administered by the same nurse per patient.

3.1.1 Eligibility criteria:
Patients >18 years old, who were accepted to participate to the study and who were evaluated with both scales.

3.1.2 Exclusion criteria:
Patients who could not be evaluated with both scales at the admission, unable to communicate or without a caregiver that was able to help them with communication.

This is an observational study that didn't influence the clinical practice in any way. The consent at the treatment of sensible data was orally collected maintaining the guaranty of anonymity.

3.2 Study of validation

It was estimated to enroll a sample size of 240 patients, divided in the three bands of BRASS Index. The sample size of 80 patients, for single band, was calculated assuming a type I error of 0,05 and a type II error of 0,20.

253 patients were included in the study, considering a potential withdrawing rate of 5% from the study: 134 male and 119 female, hospitalized in the same medical divisions of the pilot study.

Data collection started on July 2018 till the end of August, after reaching the required sampling number. The belonging of one of the three risk categories has been identified through the BRASS Index.

Eligibility and exclusion criteria were the same of the pilot study.

Barthel and BRASS Index were administered to each patient at the moment of admission in the unit, from 23 July 2018 to 27 August 2018. Age and gender were also detected to evaluate the presence of any relationship risk between age or gender and risk of difficult discharge.

This phase of the study did not influence the routine clinical practice. Also at this stage the consent was collected in oral form by patients or their caregiver, maintaining the guarantee of anonymity.

3.3 Statistical analysis

The data were analyzed with Excel (Office Premium 2003, Microsoft Corporation, Redmond, WA, USA). Descriptive statistics were used to provide summaries of the characteristics about the study population.

The analysis of the data required multiple tests; a p-value of <0.001 was considered statistically significant.

Computations have been performed in R 3.5 with ThresholdROC package. An ordinal regression model was fitted to assess the impact of age and sex on Bar-

thel Index classes. The relationship between age and Barthel Index classes was modeled with a restricted cubic spline with 3 knots to allow a non-linear effect. Anova test was used to test both the significant impact of age and sex and the linearity of relationship between sex and Barthel Index classes.

4. Results

4.1 Pilot study

The sample of the pilot study is represented by 153 subjects, 70 males and 83 females.

The Graphic 1 shows as a high score in the Barthel scale is correlated with a low risk of difficult discharge.

According to the division of the Barthel Index, all the patients with a Barthel score between 100 and 91 belong to the low risk of difficult discharge of the BRASS Index.

Subjects with a Barthel Index between 90 and 61 are collocated 66% in the low risk and 33% in the medium risk.

The 65% of patients with Barthel Index between 60 and 21 are collocated in the medium level, 12% in the high level and 23% in the low level.

23% of subjects with an elevate grade of dependence (Barthel <21) belong to the medium risk and 67% to the high risk.

These data are reported in Table 1.

From the distribution of the data of the pilot study, a correlation was observed between the degree of functional dependence and the risk of difficult discharge, so that a decrease in the level of autonomy is associated with an increase in the latter.

The study of validation aims to confirm the hypothesis emerged in the first study through a targeted collection of data on a generic sample.

4.2 Study of validation

In this step 253 patients participated in the study: 118 females and 135 males. 82 patients belong to the low risk class (39 females and 43 males), with a middle age of 63 years; 83 patients belong to the medium risk class (39 females and 44 males), with a middle age of 79 years; 88 patients belong to the high-risk class (40 females and 48 males), with a middle age of 82 years.

A sample size estimation has been performed on an optimal cut off definition problem(10). Three normal distributed populations have been assumed for a patient with low, medium and high-risk BRASS In-
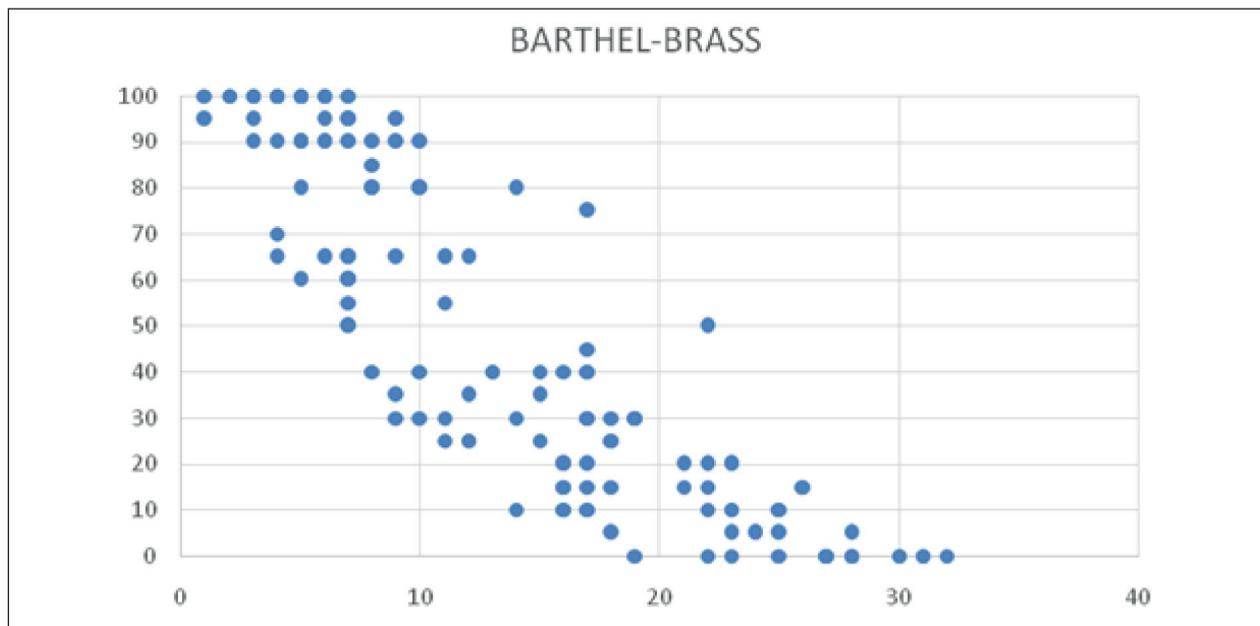
Graphic 1. Correlation between Barthel and BRASS Index

Table 1. Correlation between BRASS and Barthel Index

		Brass score			
		Low risk	**Medium risk**	**High risk**	**Total**
Barthel Index	**100-91**	27 (100%)	0	0	**27**
	90-61	19 (66%)	8 (33%)	0	**27**
	60-21	12 (23%)	33 (65%)	6 (12%)	**51**
	20-0	0	11 (23%)	36 (67%)	**47**

dex. In Table 2 distribution of variables across classes of BRASS Index are reported. Continuous variables are reported as median (I and III quartile), whereas categorical variables are reported as frequencies (percentages). From the table we deduce that the median age increases with the increase of the risk band (Table 2).

In table 3 cut offs on Barthel Index computed given BRASS classes are reported. Moreover, 95% Bootstrap Confidence Intervals (computed with 1000 bootstrap replicates) are reported. Computations have been performed in R 3.5 with Threshold ROC package.

The first cut off identified on the Barthel Index is 27.7; the second cut off identified is 71.3.

The approximation to 35 and 70 of the two cut offs were chosen.

The three risk bands identified as such are shown to be, high risk of difficult discharge for Barthel Index from 0 to 30; medium risk for Barthel Index from 35 to 70; low risk of difficult discharge for Barthel Index from 75 to 100 (Table 3).

Table 4 reports the distributions of variables across Barthel Index classes given the estimated thresholds. Continuous variables are reported as median (I and

III quartile), whereas categorical variables are reported as frequencies (percentages). Also here, as the risk increases, there is an increase of patients' age (Table 4).

An ordinal regression model was fitted to assess the impact of age and sex on Barthel Index classes (Table 5). The purpose is to check if differences on Barthel Index in classes were present for subjects with higher ages or between males and females. The relationship between age and Barthel Index classes was modeled with a restricted cubic spline with 3 knots to allow for non-linear effect. Anova test was used to test both the significant impact of age and sex and the linearity of relationship between sex and Barthel Index classes.

Age has a significant effect on Barthel Index (p-value <0.001) and the effect is supposed to be non-linear (p-value = 0.041). Gender doesn't show any significant effect on Barthel Index (p-value = 0.630). Age and gender do not significantly interact in defining Barthel Index (p-value = 0.421.) (Table 5).

Table 3. Thresholds

Thresholds	Lower_95_CI	Upper_95_CI
27.66748	24.10016	30.63333
71.33588	68.23614	75.25900

Table 2. Descriptive statistics for variables across Brass score classes

	Level	Low_risk	Medium_risk	High_risk
Number		82	83	88
Gender (%)	F	39 (48.1)	39 (47.0)	41 (46.0)
	M	43 (51.9)	44 (53.0)	47 (54.0)
Age_years (median [IQR])		67.00 [52.00, 78.00]	81.00 [75.50, 86.50]	83.00 [79.00, 88.50]
Barthel_0_100 (median [IQR])		95.00 [85.00, 100.00]	50.00 [35.00, 65.00]	5.00 [0.00, 15.00]

**Table 4.** Distribution of variables across Barthel score classes given the estimated thresholds

	Level	Low_risk	Medium_risk	High_risk	p	test
Number		80	80	91		
Gender (%)	F	36 (45.0)	37 (46.2)	45 (49.5)	0.833	
	M	44 (55.0)	43 (53.8)	46 (50.5)		
Age_years (median [IQR])		68.50 [52.75, 80.00]	80.00 [72.75, 85.00]	84.00 [79.00, 88.50]	<0.001	nonnorm
Brass_0_10 (median [IQR])		6.00 [2.00, 9.00]	15.00 [12.00, 18.00]	24.00 [22.00, 26.00]	<0.001	nonnorm
Barthel_0_100 (median [IQR])		95.00 [88.75, 100.00]	50.00 [40.00, 65.00]	5.00 [0.00, 15.00]	<0.001	nonnorm

Table 5. Anova table to test the impact of age and sex on Barthel score classes

Term	Chi-square	Degrees of freedom	P-value
Gender	1.729	3	0.630
Age	27.213	4	0.000
Age (non-linear)	6.377	2	0.041
Gender X Age	1.729	2	0.421
Gender X Age (non-linear)	1.551	1	0.213
Non-linear Total	6.377	2	0.041
Non-linear total + interactions	7.662	3	0.054
Total	27.410	5	0.000

In Figure 1 the higher the age of the patients, the higher the risk of being in the higher risk class of the Barthel Index (Figure 1).
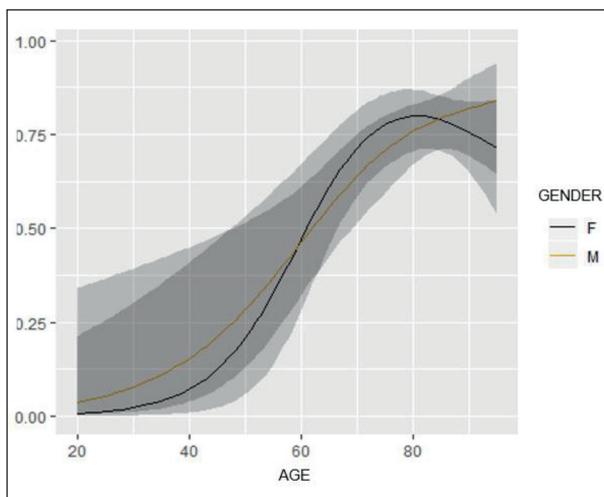
Figure 1. Effect of age by sex on Barthel score classes

Table 6. Odds-Ratio of age

Gender	Age	OR (95% CI)
Male	60 – 80	3.64 (1.94 - 6.83)
Female	60 – 80	4.46 (1.8 - 11.04)

Even from age odds ratios it is clear that being over 60 is a risk factor for incurring a difficult discharge (Table 6).

5. Discussion

The use of Barthel allows a greater compliance by the health worker as it instantly assesses the situation while for the BRASS Index it is often necessary to interview a caregiver to find information regarding the therapy in progress and previous admissions in hospital.

Both scales are easy and quick to complete (5), as they are shown by administering them at the time of patient entry. Using only one of the two scales would allow an equally effective and faster evaluation.

The analysis of the results of the pilot study conducted on a convenience sample shows that there is a correlation between the level of dependence assessed by the Barthel scale and the risk of difficult discharge. The two scales are overlapped as regards the extreme values: no subject with a Barthel score higher than 60 was presumed to be at high risk of difficult discharge and no subject completely dependent was placed in the low risk of difficult discharge. The results that differed were the fewest number of cases (13%): in most cases the level of dependence was related to the risk of difficult discharge (87%).

These results suggest that the Barthel scale is predictive of the risk of difficult discharge.

From the analysis of the results of the validation study it has emerged that age is a parameter that directly affects the risk of difficult discharge: the higher the age, the higher the probability of belonging to the high risk class. It is therefore necessary to have further consideration for older patients, even if they are self-sufficient, so that the risk is not underestimated. As far as sex is concerned, it does not appear to be any relationship of dependence with the risk of difficult discharge: it can therefore be said that being a man or a woman is not a relevant parameter.

The cut-offs obtained through the use of the BRASS Index correspond to the Barthel scores of 30 and 70: these cut-offs want to add a further information to the evaluation of autonomy in ADL. Through the use of the Barthel Index alone, it may be possible to identify patients who may have difficulty in early discharge. This result suggests the degree of functional dependence, although not the only predictive factor analyzed by the BRASS Index is predictive of the risk of difficult discharge. The data emerging from this study agree with other literature studies according to which a condition of fragility, in which age and the level of autonomy are decisive, is commonly associated with a substantial increased risk of early readmission (within 30 days) or death, after discharge from medical departments (2, 11).

6. Conclusion

The use of a single scale, which evaluates both the level of functional dependence and the risk of difficult discharge, reduces the time and workload of nurses. Nurses find themselves favored in the evaluation of two information with the use of a single instrument.

A single evaluation can be useful for an early screening of subjects at risk, but, if a risk condition emerges, it will still be necessary to carry out a targeted assessment to assess the actual need for a protected discharge.

The study has some limitations. It involved patients admitted exclusively in medical departments, not considering, for example, surgical patients. The age of the patient to fit the BRASS Index should be more than 65 years, while for Barthel it is not specified, but in this study all patients over the age of 18 were involved. The assessments were carried out by personnel with different training on the administration of the Barthel and BRASS Index. It has not been evaluated how much the BRASS parameters individually affect the risk of difficult discharge.

The study has as well some remarkable strenghts. The subjects of the study were homogeneous, with similar medical problems. The sample size for the study was defined a priori and was homogeneous for the three risk classes identified by the BRASS Index.

It is necessary to carry out another study with a larger sample to confirm the findings. It may be useful to repeat the same study in a surgical reality where functional autonomy varies rapidly before the hospitalization, during hospitalization, and at the time of discharge.

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