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Aphasia after traumatic brain injury: Recovery and prediction of verbal communication outcome after inpatient rehabilitation

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Abstract

In aphasia the ability to communicate is severely affected, causing a great impact in the lives of patients, family and caregivers. Thus far, little is known about the recovery of aphasia and prognosis of verbal communication outcome after traumatic brain injury (TBI). We analyzed data from different language assessment tests at admission and discharge from inpatient rehabilitation of patients who suffer from aphasia after TBI in the period between 2010 and 2017. We also compared the scores at admission between TBI patients with patients suffering from aphasia after stroke. Further, we used a prognostic model that was originally developed for predicting verbal communication outcome in patients suffering from stroke, to investigate if this model can also be used to predict verbal communication outcome in patients suffering from aphasia after TBI. Results show a significant overall improvement of TBI patients with aphasia between admission and discharge on all language tests. These patients experience significant word finding problems but are able to compensate and express themselves in daily life. Both TBI patients and stroke patients experience difficulties in the linguistic components but the TBI patients experience less problems communicating in everyday situations. The prognostic model did not accurately predict verbal communication outcome in patients suffering from aphasia after TBI. Future research investigating recovery and prognosis of aphasia after TBI can help inform patients, family and caregivers about the future, set accurate rehabilitation goals and help patients get appropriated treatment.

Introduction

Aphasia is a language disorder that can occur after acquired brain injury, resulting in problems with the production and/or comprehension of written and spoken language (El Hachioui, 2012). Patients suffering from aphasia are likely to experience word finding problems, have difficulty producing sentences, problems understanding language and not being able to speak, read or write (Bastiaanse, 2010; El Hachioui, 2012).

Since the ability to communicate with others can be severely affected, the impact on not only the patient but also on family and friends is enormous. Patients suffering from aphasia are more socially isolated, have fewer friends, smaller social networks, and experience more frustrations and feelings of not being involved in everyday live. In addition, they report more negative emotions and symptoms of depression (Code, Hemsley & Herrmann, 1999; Davidson, Howe, Worrall, Hickson & Togher, 2015). Other studies show that caregivers are more stressed and show more symptoms of depression and loneliness compared to caregivers of non-aphasic stroke patients (Draper, Bowring, Thompson, van Heyst, Conroy & Thompson, 2007). Caregivers also report the need for more realistic and positive prognostic information about aphasia (Avent, Glistra, Wallace, Jackson, Nishioka & Yip, 2005).

Over the past years, research on aphasia after stroke has increased. Since early prediction of the potential outcome on verbal communication is important in order to set accurate rehabilitation goals, to choose the appropriate speech and language therapy and to make sure the patient is getting adequate care, researchers have tried to identify prognostic factors for predicting the outcome of aphasia after stroke (El Hachioui, Lingsma, van der Sandt-Koenderman, Dippel, Koudstaal & Visch-Brink, 2012; Blom-Smink, van de Sandt-Koenderman, Kruitwagen, El Hachioui, Visch-Brink & Ribbers, 2017). Another reason for early prediction is, as mentioned above, the need for family, friends, and caregivers to be informed about what can be expected in the future regarding verbal communication outcome. So far, prognostic factors that have shown to play a significant role in worse aphasia outcome after stroke include higher age (El Hachioui et al., 2012), more severe aphasia in the acute phase (Perdersen, Vinter & Olsen, 2004; Fucetola, Connor, Perry, Leo, Tucker & Corbetta, 2006), cognitive problems in other domains, such as abstract reasoning, visual memory and executive functioning (El Hachioui, Visch-Brink, Lingsma, van de Sandt-Koenderman, Dippel, Koudstaal & Middelkoop, 2014), stroke type: cardioembolic infarction compared to a intracerebral hemorrhage (El Hachioui, 2012), and a lower educational level (El Hachioui et al., 2012). Recent studies have focused on specific impairments in the main linguistic components to predict aphasia outcome after stroke. These components consist of semantics (word meaning), phonology (word structure and sounds), and syntax (sentence structure). El Hachioui and colleagues (2012) showed that phonology is a strong prognostic factor on the verbal outcome of aphasia, explaining 46.5% of the variance. Higher scores on the Phonology subscale of the ScreeLing in the first two weeks post stroke are correlated with a better verbal communication outcome one year post stroke. Comparable results were found by Glize and colleagues (2016): less impaired phonology proved to be the strongest linguistic prognostic factor for higher recovery of verbal communication in aphasia. Blom and colleagues (2017) found similar results in a study on stroke patients at inpatient rehabilitation. They developed a prognostic model for predicting everyday verbal communicative ability at discharge measured by the Amsterdam-Nijmegen Everyday Language Test (ANELT) scale A, in inpatient rehabilitation in patients with moderate-to-severe aphasia at admission. With this model, verbal communication at discharge can be predicted by using the score on the Phonology subscale of the ScreeLing and the ANELT-A score at admission in inpatient rehabilitation.

Research on the recovery and prognosis of aphasia after TBI is scarce. Most information comes from outdated research or single case studies. Available research shows that patients suffering from aphasia after TBI experience significant word finding problems. They are often diagnosed with anomic aphasia, which is characterized by word retrieval difficulties but fluent speech (Heilman, Safran & Norman, 1971; Levin, Grossman & Kelly, 1976). Vukovic, Vuksanovic & Vukovic (2008) compared recovery patterns of 37 stroke and 34 TBI patients and concluded that in patients suffering from language processing deficits after TBI the degree of recovery was higher compared to patients suffering from aphasia after stroke.

Currently, outcome predictions are mostly based on information regarding aphasia after stroke. Despite the fact that this might not be optimal for TBI patients with aphasia, since TBI results more often in diffuse brain damage compared to stroke (Bigler, 2000). The impact of not being able to communicate with family and friends, the need for proper treatment and care and the need for information regarding the future is, however, similar for both TBI and stroke patients. Therefore, the aims of the current study are threefold. First, we will investigate whether TBI patients with aphasia recover from admission to discharge. We will provide descriptive data on the recovery of aphasia after TBI during inpatient rehabilitation. For each individual patient enrolled in the current study, scores on different aphasia tests at admission and at discharge are provided. Second, test scores at admission for TBI patients that suffer from aphasia will be compared to the test scores at admission for stroke patients suffering from aphasia, to investigate if the two patient groups differ in the language problems they experience at the start of the rehabilitation. Third, we will investigate whether the prognostic model developed by Blom et al (2017) can also be used to predict verbal communication outcome in patients suffering from aphasia after TBI. If the model that Blom and colleagues (2017) developed also accurately predicts the verbal communication outcome in TBI, it is likely that the recovery of aphasia in stroke patients is comparable to the recovery of aphasia in TBI patients.

Methods

Participants

This was a retrospective study. Data were collected from patients who were admitted to the inpatient rehabilitation program at Rijndam Revalidatie in Rotterdam, the Netherlands, between 2010 and 2017. The diagnosis of TBI was done by the neurologist in the hospital where the patients were admitted before being referred to inpatient rehabilitation. Patients were included in this study according to the following inclusion criteria: (1) aphasia as a result of TBI, (2) available data on language tasks at the start of the rehabilitation as well as at discharge, (3) native Dutch speaker, and (4) 18 years or older at the start of the rehabilitation. Aphasia was defined as: 1) experiencing word finding problems (Boston Naming Test (BNT) score <149.6) in which typical aphasic errors are made (e.g. phonological paraphasia's such as: saying 'mork' instead of 'fork'), and 2) experiencing significant problems with language comprehension (Token Test score <29/36, indicating aphasia).

Data collection

As part of the inpatient treatment of patients with TBI and aphasia, several language measurements were performed, including the ANELT-A, the ScreeLing and the BNT. Tests used in this study are standard aphasia tests recommended by the guidelines of diagnostics and treatment of aphasia in the Netherlands and administered on predetermined moments (Berns et al., 2015). These measurements were assessed by a speech-language therapist at admission and at discharge from inpatient rehabilitation. Thus, data used for this study were already available and selected from an already existing database to form a new database. Some data were missing from the already existing database. These data were searched in the patients files and added manually to the newly formed database.

Measures

<u>ANELT-A:</u> To measure verbal communication, the ANELT scale A was used. This test can be used for assessing verbal communication skills a patient uses in daily life, despite the aphasia.

The test consists of ten scenarios that mimic everyday situations, in which the patient has to tell the examiner what he or she would say in that particular situation. Examples of these situations are calling the doctor, buying a television, or meeting a new neighbor. Scores are given for understandability (scale A) and intelligibility (scale B), and can range from 1 (bad) to 5 (good), resulting in a maximum total score of 50. Validity and reliability research show that the ANELT-A is a valid test for assessing verbal communication skills (Blomert, Kean, Koster & Schokker, 1994).

ScreeLing: The ScreeLing is a screening test for aphasia after brain damage. It examines the three main linguistic components: semantics, phonology and syntax. The test can be administered in the first week after stroke or TBI. The test consists of three subscales: Phonology, Semantics and Syntax, each with 24 items, measuring one of the three linguistic components. Scores 0 or 1 can be given resulting in a maximum total score of 72 (Visch-Brink, van de Sandt-Koenderman & El Hachioui, 2010).

Boston Naming Test (BNT): The BNT is a test for diagnosing word finding problems. The test consists of 60 pictures of different objects, with a graded difficulty based on word frequency, ranging from words that occur frequently in daily life (e.g. a tree) to words that occur less frequently such as an abacus. A score of three is given when the patient correctly names the object on the picture (Roomer, Brok, Hoogerwerf & Linn, 2011).

Statistical analyses

For the first research question (difference from admission to discharge on group level), scores at admission and at discharge on the ANELT-A, the ScreeLing (including all subscales) and the BNT were used to preform a Wilcoxon signed-rank test to detect whether there was a significant difference between the scores at admission and at discharge.

For the second research question (comparing stroke and TBI patients), scores were provided on the ANELT-A and ScreeLing subscales Phonology and Semantics to compare the test scores at admission for patients that suffer from aphasia after TBI with the test scores at admission for stroke patients suffering from aphasia. No statistical analyses could be performed with the scores provided in the article of Blom et al., (2017), therefore the scores were compared in a descriptive manner.

For the third research question (predict the verbal communication outcome), the following regression equation developed by Blom and colleagues was used (2017):

$$\textit{Discharge ANELT-A score} = 7.53 + (0.88 \times \textit{admission ScreeLing Phonology score}) + (0.55 \times \textit{admission ANELT-A score})$$

This model includes the score on the ANELT-A at admission and the score on the ScreeLing subscale Phonology at admission. This equation shows that an increase of 1 point on the ScreeLing Phonology at admission predicts an improvement of 0.88 points on the ANELT-A at discharge if the ANELT-A score at admission is kept the same. An ANELT-A score of 1 point higher at admission is associated with an increase of 0.55 on the ANELT-A at discharge if the ScreeLing Phonology score remains constant. This means that a patient with a ScreeLing Phonology score of 16.5 and an ANELT-A score of 24 at admission would have an ANELT-A score of 35 at discharge (Blom et al., 2017).

The prognostic model given above was used to calculate the estimated ANELT-A score at discharge (e.g. verbal communication outcome) by entering the ScreeLing Phonology and ANELT-A scores at admission in the regression equation. This was done on an individual level (scores on the test will be entered separately for each individual). Only the patients that made the ScreeLing at admission and the ANELT-A at admission and at discharge were included. To see whether or not this model provides an accurate prognosis for verbal communication outcome in patients with TBI, the estimated scores were compared to the actual obtained scores on the ANELT-A at discharge. An improvement of 7 points on the ANELT-A between two measurement points is considered to be a clinically significant improvement (Blomert et al., 1994). So, if the actual obtained score and the estimated score does not differ more than 7 points, we considered the model of Blom et al. (2017) to accurately predict communication outcome in patients with aphasia after TBI. The statistical analyses were performed with IBM SPSS Statistics version 22.

Results

Patients

In the period between 2010 and 2017 a total of 177 patients with TBI were admitted at Rijndam Revalidatie for inpatient rehabilitation. Of these 177 patients, 13 patients met the criteria of aphasia after TBI and were included in the database. This means that the incidence of aphasia after TBI, at the inpatient rehabilitation program at Rijndam Revalidatie in the period between 2010 and 2017, is 7.3%. The group consisted of 11 men and 2 women with a mean age of 49 years (SD = 17, range 21-70). The median amount of days spent in inpatient rehabilitation was

65 days (IQR = 56, range 20-187). Total hours of speech therapy (individual and group therapy) for each individual varied between 7 hours to 63 hours (Median = 25, IQR = 30). Time between TBI and admission to inpatient rehabilitation varied between 11 days and 444 days (Median = 35, IQR = 52).

Recovery on group level

Table 1 shows the median score, inter quartile range, range and the number of patients that performed the ANELT-A, ScreeLing and BNT, including the subscales for each test at admission and discharge.

Table *1*
Median scores and interquartile range on the ANELT-A, ScreeLing and Boston Naming Test[a].

Test (possible range)	*n*	**Admission** median (IQR), range	*n*	**Discharge** median (IQR), range
ANELT Understandability (A) (0-50)	13	32.0 (31.0), 10-50	11	42.0 (37.0), 10-49*
ScreeLing total (0-72)	10	36.0 (42), 14-56	8	60.8 (15.6), 27-71*
Semantics (0-24)	10	11.5 (12.3), 5-20	8	20.0 (8.3), 11-24*
Phonology (0-24)	10	14 (10.3), 2-19	8	19.8 (4.9), 7-23*
Syntax (0-24)	10	12.0 (6.8), 4-18	8	22.0 (9.3), 9-24*
Boston Naming Test total correct (0-60)	13	7 (21.5), 0-44	11	27.0 (11.0), 0-49*

[a] n = number of patients; IQR= Interquartile Range.

* significant improvement between admission and discharge p <0.05

The comparison between the scores at admission and at discharge on the ANELT-A showed a significant improvement between the scores at admission and at discharge (Z = -2.201, *p* = .028). Analysis of the ScreeLing subscales Phonology (Z = -2.313, *p* = .021), Semantics (Z= -2.032, *p* = .042) and Syntax (Z = -2.103, *p* = .035), all show a significant improvement between admission and discharge. Changes in the scores on the BNT also revealed to be a significant improvement between admission and discharge (Z = -2.666, *p* = .008).

Individual recovery patterns

Figures 1 to 5 show the scores of each individual on the ANELT-A, the ScreeLing (including subscales) and the BNT at admission and at discharge from inpatient rehabilitation. This way, the recovery pattern for each individual is visualized. Only the participants who performed the tests at both times were included in the graphs.

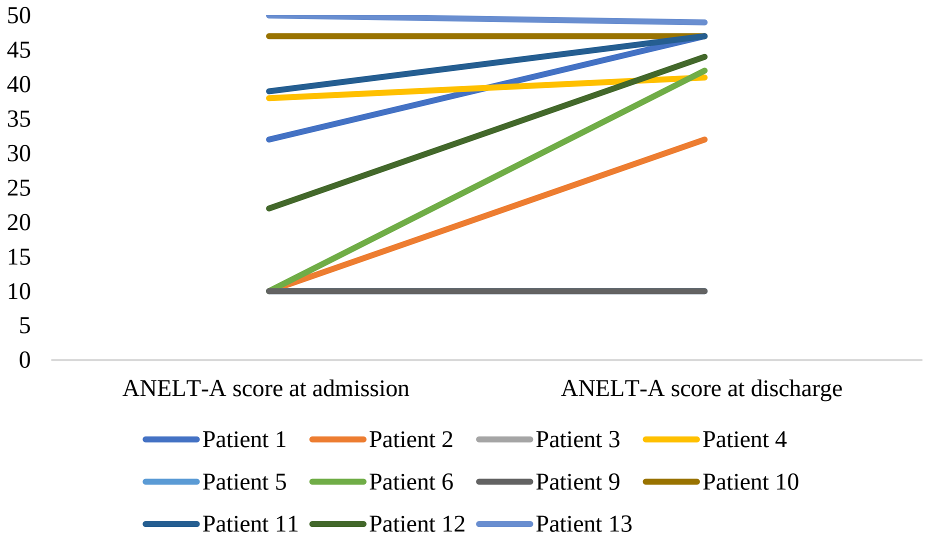

Figure 1. Scores on the ANELT-A at admission and at discharge for each individual.

Figure 1 shows that the recovery pattern differs between the patients, but most patients improve. Patients 3, 5 and 9 were unable to complete the test at admission as well as at discharge. Patient 10 did not improve over time. Patient 13 performed at ceiling on both assessments.

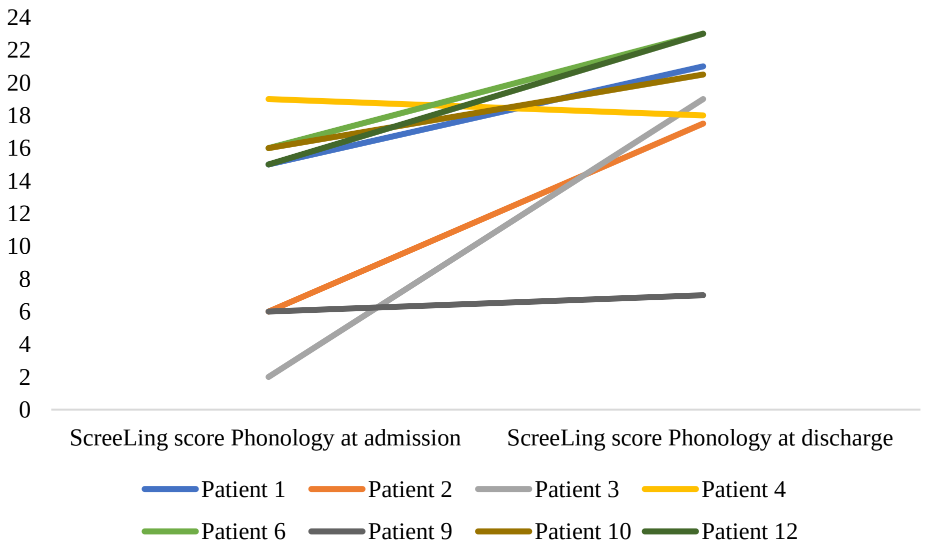

Figure 2. Scores on the ScreeLing subscale Phonology at admission and at discharge.

Figure 2 shows the course of each individual patient that was assessed at admission and at discharge with the ScreeLing test, subscale Phonology. The figure shows an overall improvement except for patients 4 and 9, who roughly obtain the same score at admission and discharge.

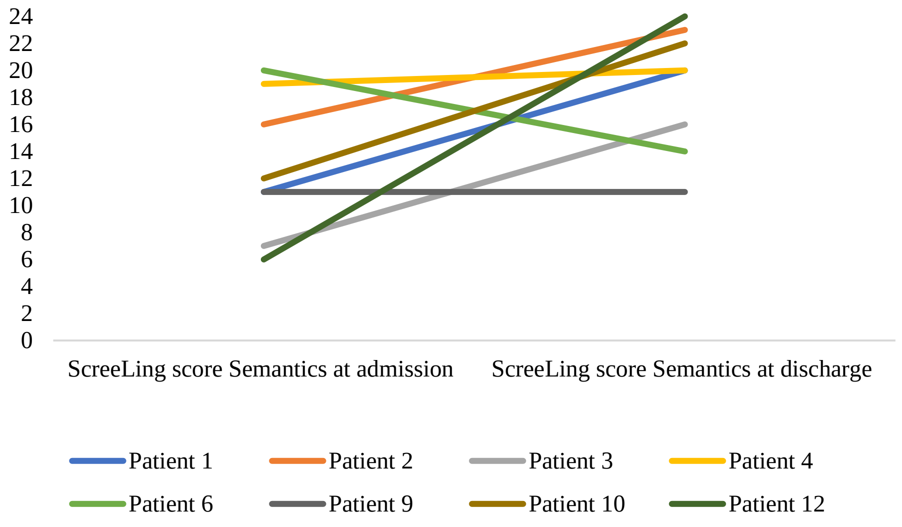

Figure 3. Scores on the ScreeLing subscale Semantics at admission and at discharge.

Figure 3 shows the scores on the ScreeLing subscale Semantics at admission and at discharge for each individual. The scores at admission differ greatly between the patients. Patient 6 scored higher at admission than at discharge. Patients 4 and 9, again, did not improve on this subscale over the time spent on inpatient rehabilitation. All of the other patients did improve during the time they spent at inpatient rehabilitation.

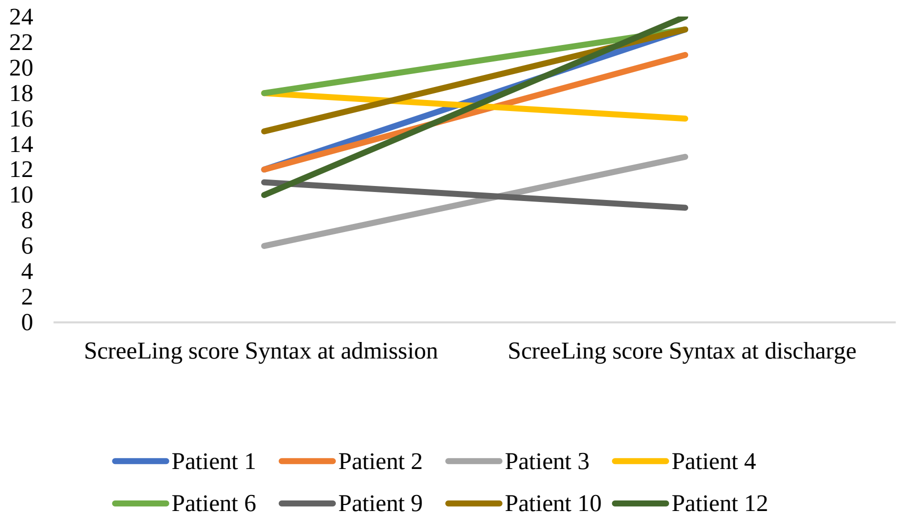

Figure 4. Scores on the ScreeLing subscale Syntax at admission and at discharge.

Figure 4 shows the individual scores on the ScreeLing subscale Syntax at admission and at discharge. Again, the scores between the patients at discharge vary greatly. Patients 4 and 9 did not improve. The other patients all improved over the time spent in inpatient rehablitation.

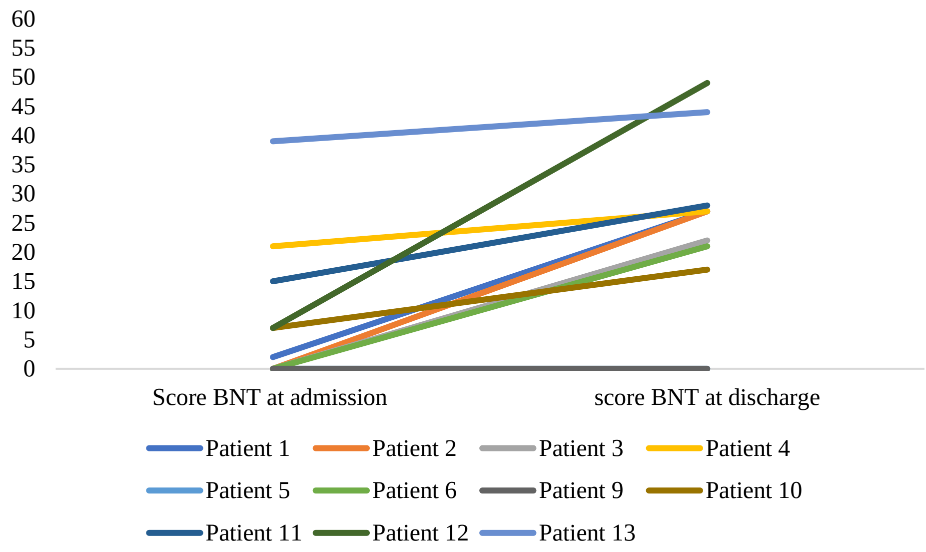

Figure 5. Scores on the BNT at admission and at discharge.

Figure 5 shows the scores on the BNT at admission and at discharge. It shows that almost all the patients scored low on the test at the beginning of their inpatient rehabilitation. Patient 5 and 9 did not improve over the time the spent at inpatient rehabilitation. They scored 0 points at admission and at discharge. All the other patients did improve over time, but the amount of improvement differs between the individuals.

Overall, the figures visualize a great difference between the scores on an individual level. Scores at admission on the ANELT-A vary among the individual patients, whereas scores on the ScreeLing subscale Phonology at admission can be divided into two groups of patients: one group that scores relatively high and a group that scores relatively low. Patients obtain considerably high scores on the ANELT-A and on the subscale Phonology at discharge. Scores on the subscale Semantics seem to vary more between the individual patients at admission as well as at discharge. Subscale Syntax shows scores that differ between the individual patients at admission, but come out in the higher range at discharge. At admission, the individual patients appear to score at the lower range on the BNT, and even though all patients improve over the course of the inpatient rehabilitation, except for two patients, at discharge most patients are not able to correctly name more than half of the shown objects.

Looking at the individual patients more closely, a couple of patients stand out. Both patients 4 and 9 made little to no progress on the different tests over the course of the time they spent in inpatient rehabilitation. Patient 6 made progress on each test except for a steep decline on the ScreeLing subscale Semantics. Patient 12 made a sharp progress on each test. No clear reason was found in the patients files explaining these results

Comparison test scores stroke and TBI patients at admission

In order to compare the scores on the different tests at admission between the TBI and stroke patients, the scores provided in the article from Blom et al., (2017) were used. In accordance with Blom et al., (2017) we present the median an IQR scores for the ANELT-A and the mean and SD scores for the ScreeLing. The results can be found in table 2.

Table 2
Test scores on the ANELT-A and ScreeLing for aphasic TBI and stroke patients at admission and the difference between the scores for TBI and stroke patients.

	n	TBI	*n*	Stroke
ANELT-A[a], median (IQR)	13	32.0 (31.0)	78	15 (10)
Phonology[b], mean (*SD*)	10	11 (6)	78	12 (*7*)
Semantics[b], mean (*SD*)	10	13 (6)	78	16 (*6*)

[a] median and interquartile range

[b] mean and standard deviation

n = number of patients

When comparing the scores between the patients suffering from aphasia after TBI and the patients suffering from aphasia after stroke, it is important to keep in mind that the patients suffering from aphasia included in the study from Blom et al., (2017) were all diagnosed with moderate to severe aphasia (a score below 4 on the Aachen Aphasia Test communicative behavior scale), whereas in this study, all patients diagnosed with aphasia were included (e.g. mild aphasia was also included). This means the patient groups did not only differ in their etiology, but can also differ in the severity of the aphasia. Table 3 shows a considerable difference on the ANELT-A at admission. It shows no difference between both groups on the ScreeLing scores.

Prediction model

A total of nine patients was included in this analysis. Table 3 shows the predicted score on the ANELT-A at discharge by using the prognostic model Blom et al., (2017) developed. It also shows the actual obtained scores on the ANELT-A at discharge and the difference between the two scores. Figure 6 shows the predicted score on the ANELT-A set out against the actual obtained score.

Table 3
The predicited score on the ANELT-A at discharge, the actual obtained score on the ANELT-A at discharge, the difference between the two scores and a indication (+/-) if the difference is clinical significant.

Patient number	Predicted score	Actual obtained score	Difference	Criterium difference of 7 points
1	38.3	47	-8.7	-
2	18.3	31	-13.7	-
3	14.8	10	4.8	+
4	45.2	41	4.15	+
5	17.4	10	7.4	+
6	27.1	42	-14.9	-
9	18.3	10	8.31	-
10	47.5	47	0.5	+
12	32.8	44	-11.2	-

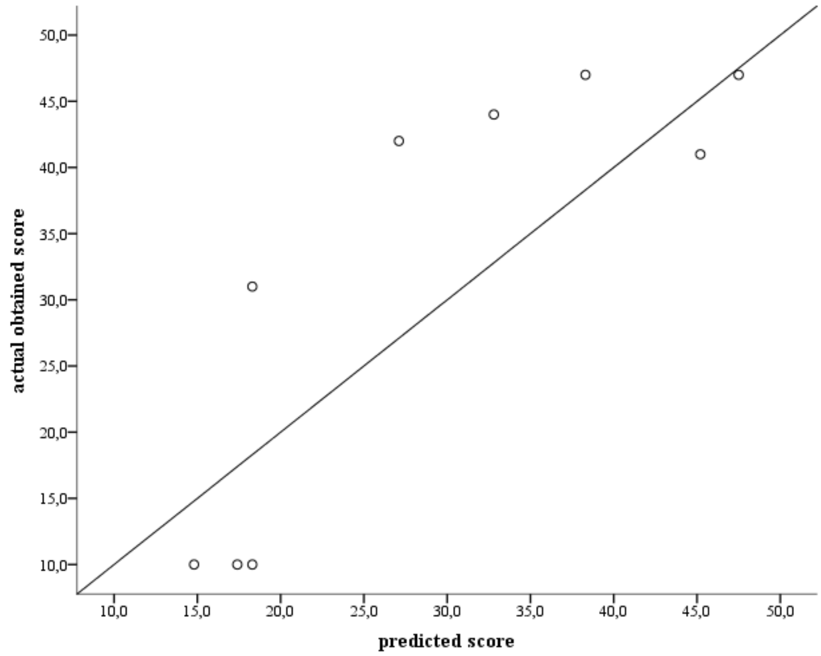

Figure 6. Scatterplot of the actual obtained score in relation to the predicted score

Table 3 shows that four out of the nine predictions for the outcome measurement on the ANELT-A was accurate. Five out of the nine predictions showed more than a 7-point difference between the predicted score and the actual obtained score and did not accurately predict verbal communication outcome after TBI. Of these five predictions, four predictions were lower than the actual obtained score. This means that the prediction model developed by Blom et al., (2017) is not able to correctly predict verbal communication outcome on individual level in patients suffering from aphasia after TBI. The scatter plot in figure 6 provides visual information on how the prognostic model accurately predicted the outcome score on the ANELT-A.

Discussion

The aim of this study was to provide information on the recovery and prognosis of aphasia after TBI. We presented data on several language tests on both admission and discharge from inpatient rehabilitation on group level and individual level, compared test results at admission with stroke patients, and investigated if a prognostic model developed for stroke patients was capable of predicting verbal communication outcome in TBI patients.

Aphasia was diagnosed in 7.3% of the TBI patients that were admitted to the inpatient rehabilitation program at Rijndam Revalidatie between 2010 and 2017. This low percentage could be the reason why there is so little known about the recovery and prognosis of aphasia after TBI. Differences in the nature of brain damage between stroke and TBI patients, more focal compared to more diffuse, could perhaps explain why aphasia after TBI is less common than aphasia after stroke (Bigler, 2000). The diffuse brain damage in TBI patients often results in communication difficulties that regularly do not meet the criteria of aphasia but are strongly related to cognitive impairments, indicating fronto-temporal brain damage and diffuse axonal injuries (Togher, 2007). In this study, the specific criteria for diagnosing aphasia after TBI match the criteria usually set for diagnosing aphasia after stroke.

Furthermore, the results on the different language tests that were administered all show an overall significant improvement between admission and discharge. The findings of Vukovic et al., (2008), Levin et al., (1976) and Heilman et al., (1971), that patients suffering from aphasia after TBI experience significant word finding problems are replicated in the current study. The three studies all showed patients who were verbally fluent and were able to compensate for these difficulties by, for example, substituting names of objects for related ones. Patients in the current study also suffered from significant word finding problems at admission as well as at discharge, but were able to overcome these difficulties and communicate verbally in everyday life (especially at discharge from inpatient rehabilitation). These specific language problems raises the question which treatment could be most beneficial for patients with aphasia after TBI and what speech therapy should be focused on. Another question is to what degree patients with TBI can compensate for the word finding problems they experience, and if they are also able to express themselves in more complex situations or if the words they cannot find are of great importance.

When looking at the results on an individual level it shows that some patients make a minimum to no improvement on the language tests, while others show considerable improvements on the different tests. The patients that made little to no improvement also scored the lowest scores on the test measuring the severity of the aphasia. This means these patients suffered from severe aphasia and perhaps therefore show less recovery over time. In the patients files no other reasons were found that might explain the lack of improvement.

When we compared the scores of the stroke patients from the study from Blom et al., (2017) and TBI patients at admission, we found that stroke and TBI patients seem to expierence the same difficulties with the linguistic components (semantics and phonology) despite the initial severity of the aphasia, but TBI patients experience less problems in everyday verbal communication than stroke patients. The difference between the two patient groups on verbal communication outcome is not completly unexpected since the patients groups differ regarding the severity of the aphasia. Blom et al., (2017) included patients with more severe aphasia, probably resulting in more difficulties communicating in everyday life. Future research investigating the difference in aphasia between stroke and TBI patients should try to include patients that suffer from same severity of the aphasia, so that results are more valid.

The prognostic model developed by Blom et al., (2017) cannot be used to accurately predict verbal communication outcome in individual patients suffering from aphasia after TBI. This result could be explained because of differences between TBI and stroke patients in the ability to verbally communicate in everyday life at the start of the inpatient rehabilitation. These differences imply that both stroke and TBI patients experience language problems in different language modalities after suffering from brain injury. Another explanation might come from taking a closer look at table 3, which shows that four out of the five times the prediction model did not accurately predict verbal communication outcome; the predicted score was lower than the actual obtained score, suggesting that the model perhaps underestimates the verbal communication outcome in patients suffering from aphasia after TBI. This could mean that over the time spent in inpatient rehabilitation, verbal communication outcome in TBI patients is higher than in stroke patients. This is in line with earlier research showing that, in patients suffering from language processing deficits after TBI, the degree of recovery appears to be higher compared to patients suffering from aphasia after stroke (Vukovic et al., 2008), suggesting that the course of the recovery of aphasia between the two patient groups is different.

These results mean we still do not know which prediction factors play a significant role in predicting verbal communication outcome inpatients suffering from aphasia after TBI, while there is the same need for information regarding stroke patients. This stresses the need for further research to investigate the predictor factor(s) that can accurately predict verbal communication outcome in patients suffering from aphasia after TBI.

This study has several limitations. The sample size used in this study was smaller than expected. Also, because of the design, the data that were used in this study came from a clinical setting in which patients sometimes were discharged at unexpected times; for this reason sometimes not all test were administered, hence, resulting in missing data. Therefore, not all the preferred analysis could be performed and due to the lack of statistical power, strong conclusions should not be made. Results of this study are primarily descriptive. Future research should aim for more prospective research and strive for inclusion criteria that are more strict and kept constant over different patients groups, so that the data collection is more controlled, results are more robust, more analysis could be performed and missing data could be avoided.

Despite these shortcomings, the results of this study serve as a new step in investigating the course and prognosis of patients suffering from aphasia after TBI, who were admitted to an inpatient rehabilitation program. The importance of further research is to provide patients, family and caregivers with information about the course of aphasia after TBI and what can be expected regarding the future, and help set clinicians rehabilitation goals, choose the appropriated treatment and make sure the patient is getting adequate care.

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