Functional physical capacity measured by the 6 Minute Walk Test and the role of lung function, fatigue and dyspnea as predictors within the period of in-patient pulmonary rehabilitation.

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Foreword

I am currently working as a physiotherapist in the Nederlands Astma Centrum Davos (NAD), doing my last internship in combination with writing my bachelor thesis here. My colleague Lena Kopfhammer did the same combination in this setting in the period 2008/2009. She found out[1], that there was no correlation between the perception of dyspnea on the one hand and FEV_1, fatigue, hyperventilation and acceptation of the disease on the other hand. But she did find a moderate correlation between the perception of dyspnea and the distance covered within the 6 Minute Walk Test. The issue of my thesis is thereby resulting from her advice for further research on this correlation and underlying factors. I have always been interested in exercise physiology and all factors related to it. I wish to learn more about the factors of physical load in general and in this particular case these of asthmatic patients. Finally I will try to improve the evaluation of asthmatic patients in the pulmonary rehabilitation by writing this thesis.

Abstract

The 6-Minute-Walk-Test (6MWT) is used in clinical practice and clinical trials of lung diseases to measure the functional physical capacity; however, it is not clear whether there are influencing variables. We analyzed the values of 6MWT, Borg dyspnea pre- and post 6MWT, lung function tests and the checklist individual strength – fatigue of 126 patients which where admitted to the Nederlands Astma Centrum Davos to check their relation. Three moments of measurement were chosen to get a better view on progress in our study group. Finally 60 patients could be included in our study and let see that all values besides the Borg dyspnea post 6MWT had the same influence on the 6MWT (standardized coefficients β between 0,316 and 0,401). Thereby the running distance covered within in 6MWT is influenced by different psychosomatic factors. We concluded, that the undifferentiated use of the 6MWT should be changed into an analysis of different values including the 6MWT and other psychosomatic factors. This will diagnostically be better conclusive.

Introduction

The Nederlands Astma Centrum Davos (NAD) is a categorial medical center specialized in the clinical treatment of difficult to treat asthma. There are no other lung diseases treated in the NAD. These are thereby a contraindication for intake in the NAD. The group of patients with difficult to treat asthma comprises about 10 percent of all patients suffering from asthma. These difficult to treat patients are economically very important because they are responsible for 90 percent of all health care costs related to asthma.
In our experience the group is somatically diverse. On the one hand patients with irreversible airway obstruction and strongly impaired lung function, on the other hand patients having good lung function values but nevertheless a high level of complaints. This is often related to a psychosocial problem as we found out over the time. Approximately 50% of the patients admitted to the NAD are depending on permanent use of systemically steroids. Especially this aspect is responsible for secondary pathologies as for instance Cushing's Syndrome, higher susceptibility for injuries and steroid induced myopathy.

Generally speaking the results of psychological and medical treatment in the NAD are good. Up to now the results are evaluated by the improvement in quality of life, lung function and reducing respectively stopping the dose of systemically steroids in our setting. Some specific questionnaires are also filled in for evaluation of the results. Furthermore the department physiotherapy is evaluating improvements for example by the 6 Minute Walk Test (6MWT). The peculiarity of this test is described in the methods. In addition the subjective value of fatigue and dyspnea, the heart rate, peak flow and O_2 saturation are noted before and after the 6MWT.
The whole test procedure is hold immediately after admission, every six weeks and before layoff.

The 6MWT is currently the test of choice when using a functional walk test for clinical or research purposes. It is easy to perform with minimal equipment, inexpensive, highly reproducible and valid.[2-5]
Lena Kopfhammer's study[1] points out, that within the population admitted into the NAD subjectively perceived dyspnea negatively correlates with the walking distance.

More factors as for example orthopedic problems (steroidmyopathy[6], injuries) influence the walking distance, problems often seen in this study population. Furthermore there is no decisive meaning about a significant correlation between the lung function (FEV_1) and the 6MWT [7]. Lena Kopfhammer[5] also found out that almost all patients in the NAD scored high on the CIS-fatigue questionnaire. On the one hand additional studies[8,9,10] on sarcoidosis patients consider the fatigue also having influence on performing the 6MWT. On the other hand it is difficult to follow this aspect because all patients are tired. Another study[11] in COPD patients considers the 6MWT to test a completely unique domain.

The 6MWT is used to evaluate the success of pulmonary rehabilitation in general and the result of treatment in the NAD in particular. Therefore it is important to know which factors influence the walking distance in the 6MWT and for which patients the 6MWT is suitable in our group of patients. The influence of several factors on the 6MWT is tested by diverse studies. These are rarely done on asthma-, but on COPD-[7,11] or sarcoidosis[6,8,9,10] patients. For that reason we want to compare the change in dyspnea, fatigue and lung function with that in the 6MWT within one study. We chose for these variables because of the ambiguous meaning of the correlation of FEV_1 and 6MWT and the extreme fatigue of our patients. The third variable – Borg dyspnea – contains the values measured before and after the 6MWT instead of one measurement used in Lena's study.

Accordingly the obvious question is: Does the 6MWT measure the functional physical capacity or are there influencing variables? To have a better view on this issue and the improvement or stagnation of our patients, we intend to use three moments of measurement within admission.

Materials and methods

Study Design

We did a retrospective cohort study involving 126 asthma patients that were admitted into the NAD in a period of 20,5 month between 04.01.2008 and 17.09.2009, testing the influence of three values (change in fatigue measured by the CIS Fatigue, the suffered grade of dyspnea measured by the Borg dyspnea and lung function displayed by the FEV_1) on the covered distance within the 6MWT. We used the measurements made at three moments of hospitalization: admission, after 6 and after 12 weeks. All tests are planned by the central planning and are tried to be hold on one day.

Population

All patients admitted into our setting are Dutch, have difficult to treat asthma and correspond to the checklist "admission criteria". This checklist has to be completed together with the request for admission by the treating pulmologist at home. Furthermore the health insurance has to permit the admission as a convenient treatment. This admission procedure is set as the inclusion criteria. Exclusion criteria according to the checklist are nicotine-, alcohol- and drug addiction, diagnosed psychiatric problems, instable cardiac pathologies, adiposity that is related to the asthmatic symptoms and dependence on oxygen supply in the Netherlands. All patient's according to these criteria, means all admitted patients are included in our study. From this group we only excluded patients under 18 years, those of which one or more test results are missing or those who were admitted a second time.

6 Minute Walk Test & Borg dyspnea

The 6-Minute Walk Test was performed indoors on a 40m continuous course and hold by a physiotherapist or an exercise scientist. Our setting has chosen to also allow the patients running instead of just walking within the test. This is our only, but also the strongest deviation from the American Thoracic Society guidelines[12] for the 6 Minute Walk Test. Furthermore the patients were told the remaining time each minute. The grade of dyspnea is evaluated by showing the patients immediately before and after the 6MWT a Borg[13] dyspnea scale[14] and asking them to indicate the current degree of shortness of breath. We chose these two moments of measurement, because they could have different impacts. The grade of dyspnea suffered from before the 6MWT could influence the motivation already before

starting. The grade of dyspnea measured immediately after the 6MWT is likely the grade of dyspnea suffered from at the end of the walking distance, which could have a different impact on the motivation. The running tests are always planned between 1 pm and 2 pm.

Checklist individual strength (CIS)– fatigue

From our own experience, almost all of our patients suffer from extreme fatigue[5]. To measure the grade of fatigue, we chose to use the CIS-fatigue questionnaire, which is part of the CIS[15,16], covering 8 of the 20 questions. This questionnaire, originally written in Dutch and translated into English and Swedish, contains four parts (fatigue, concentration, motivation and physical activity) whereas we only used the sub-category "fatigue" which has a reliability of 88%[15]. The patients rate the extend to which each statement is true for him in the past two weeks on a seven-point Likert scale ranging from 1 = "Yes, that's true" to 7 = "No, that's not true". Scoring 27 or higher is an indication for abnormal fatigue; a score of 37 or above is indicating severe fatigue.[17] The CIS-Fatigue is part of a computer based test procedure.

Lung function (FEV_1)

Pulmonary function tests were carried out by a lung function assistant using a spirometer (MasterScreen Body, Jaeger, Höchberg, Germany) and the software LAB manager V5.2.0. The test was performed according to the guideline "Standardization of spirometry" provided by the American Thoracic Society and the European Respiratory Society[18]. The standard medication had to be used before doing the first part of the measurement. After that, ten minutes before the second measurement, all patients got 4x 0,1mg Ventolin aerosol for bronchus dilatation.

Statistical Analysis

Statistical analysis was performed using a statistical software package (SPSS 16, SPSS Inc.; 233 S. Wacker Drive, Chicago, Il). We did a multivariate linear regression analysis to determine relationships between the 6MWT and potential predictors. All measurements have a normal distribution besides the CIS-fatigue. But the CIS-fatigue has a numerous scale and thereby may be included in this analysis. We analyzed all three moments separately to have a better view on the progress within our study group.

Results

Finally 60 out of 126 patients - admitted into our setting in the period between 04.01.2008 and 17.09.2009 - have been included in our study. 64 patients were excluded because of missing values, 2 patients were admitted into our setting for a second time within the period our study covers. 39 out of the 60 patients were female, 21 were male. The average age was 48 years and the averaged admission was 16 weeks.

The patients ran an average distance of 475,7 meters (SD=184,2) after admission, 540,4 meters (SD=191,8) 6 weeks later and 602.4 meters (SD=215,9) 12 weeks after admission. (Figure 1)

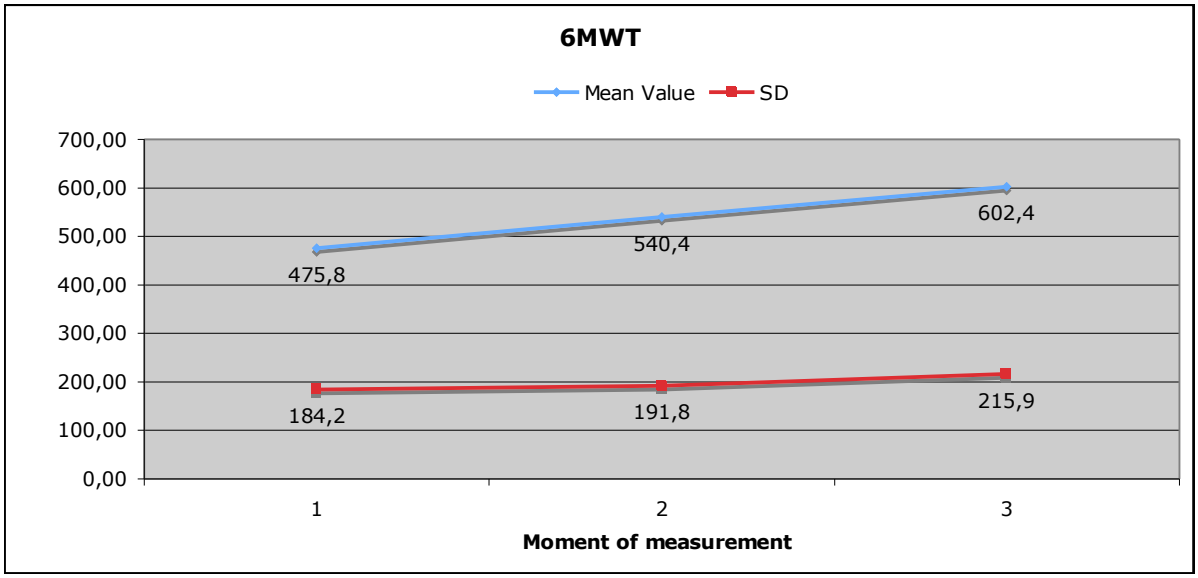

Figure 1: Development of the running distances

The Borg dyspnea value measured before the 6MWT has a declining average of 2,3 (SD=1,4) after admission, 1,5 (SD=1,8) after 6 weeks and 1,2 (SD=1,2) after 12 weeks. (Figure 2)

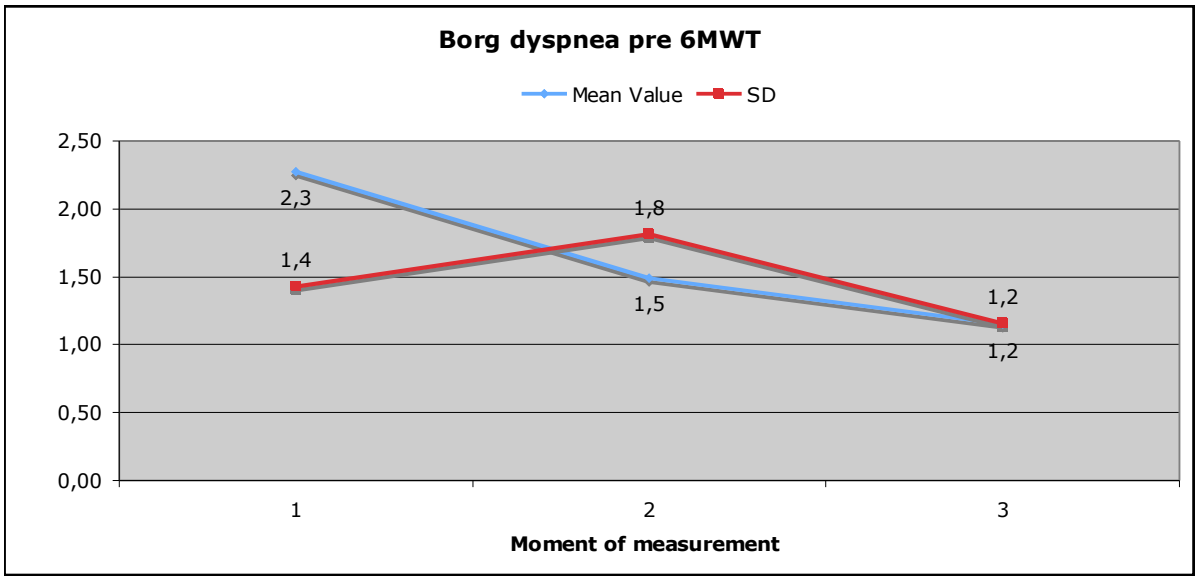

Figure 2: Development of the Borg dyspnea measured before the 6MWT

Measurement of the Borg dyspnea after the 6MWT gave almost the same declining graph although the Borg values had an higher average of 4,4 (SD=2,1) after admission, 3,1 (SD=2,1) after 6 weeks and 2,9 (SD=1,8) after 12 weeks. (Figure 3)

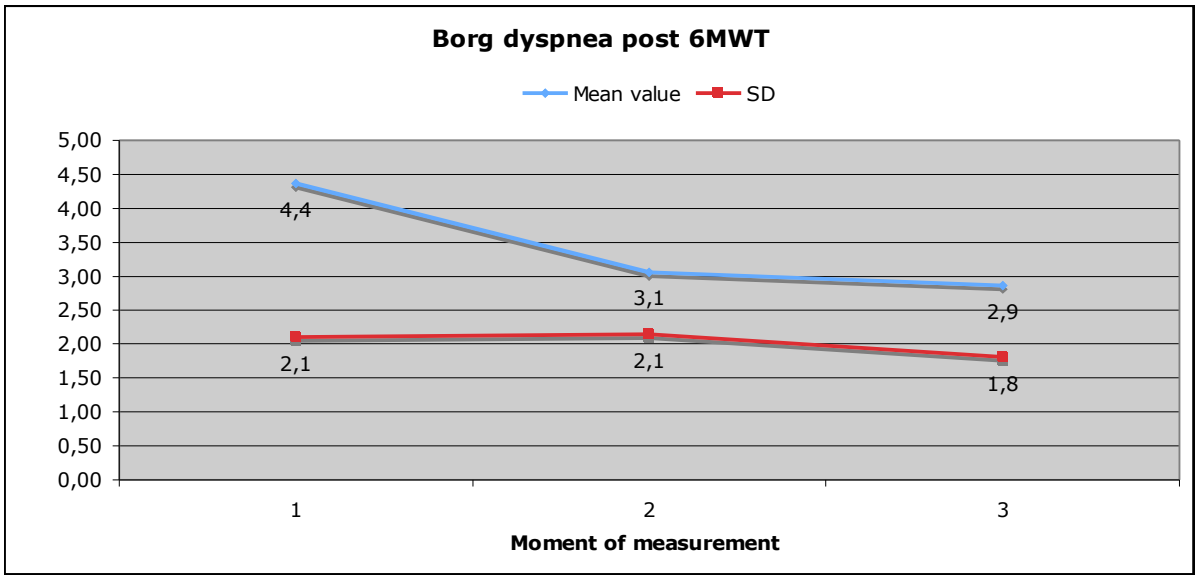

Figure 3: Development of the Borg dyspnea measured after the 6MWT

Almost all patients suffered from severe fatigue when they were admitted into our setting. The average result of the CIS fatigue questionnaire was 47,9 (SD = 7,6). It declined to 35,2 (SD=13,1) after the first six weeks and further to 27,9 (SD=12,8) after 12 weeks of admission. (Figure 4)

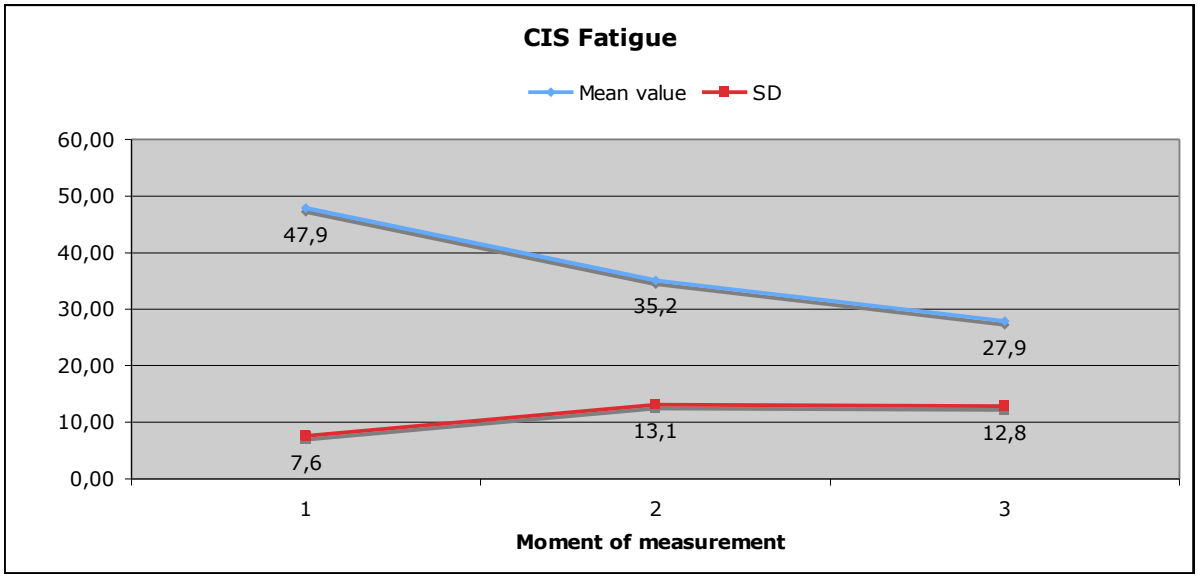

Figure 4: Development of the CIS fatigue values

The Patients' lung function represented by the FEV_1 value improved within admission. The average of 2,68 liters (SD=0,87) after admission increased up to 2,92 liters (SD=0,91) six weeks later and went up to 2,98 liters (SD=0,89) twelve weeks after admission. (Figure 5)

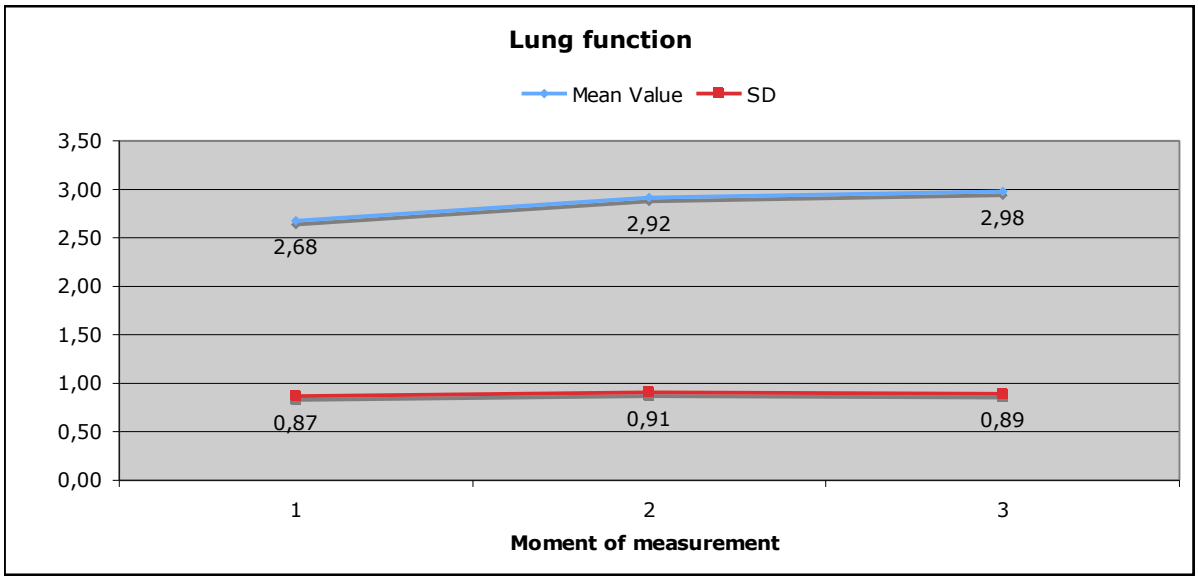

Figure 5: Development of the FEV_1 values

	Stand. coefficient β admission	Significance T admission	Stand. coefficient β 6 weeks	Significance T 6weeks	Stand. coefficient β 12 weeks	Significance T 12 weeks
Borg dyspnea pre 6MWT	-0,330	0,050	-0,380	0,024	-0,316	0,028
Borg dyspnea post 6MWT	-0,032	0,849	0,082	0,630	0,154	0,261
CIS Fatigue	-0,252	0,028	-0,361	0,001	-0,354	0,010
FEV_1	0,359	0,002	0,401	0,000	0,294	0,011

Table 1: Outcome of the multivariate linear regression analysis

Admission: The standardized regression coefficient of the FEV_1 value (β = 0,359) is the highest and (p = 0,002) significant. It is followed by the Borg dyspnea pre 6MWT (β = -0,330) which is (p = 0,050) is significant (p = 0,050). The CIS fatigue has a moderate influence (β = -0,252) on the walking distance with a significance of p = 0,028. The result of the Borg dyspnea post 6MRT (β = -0,032) does not show any influence on the constant factor and also had no significance (p = 0,849).

Six weeks: Again the FEV_1 value shows the highest influence on the 6MWT (β = 0,401) with a significant (p = 0,000) outcome. The second influencing factor was the perception of dyspnea before the 6MWT (β = -0,380) with a significance of p = 0,024. This was slightly higher than on the first moment of measurement. The suffered fatigue (β = -0,361) did not have considerably less influence on the constant. This value was significant (p = 0,001). The Borg dyspnea measured after the 6MWT did not have any influence (β = 0,082) nor significance (p = 0,630) again.

Twelve weeks: The CIS fatigue showed the highest regression coefficient (β = -0,354). This result is with p = 0,010 significant. Constantly the Borg dyspnea pre 6MWT had the second highest coefficient (β = -0,316) with about the same significance as on the second moment of measurement (p = 0,028). The Lung function this time had the lowest usable influence (β = 0,294). The significance (p = 0,011) of the result also was significant. Outlier again was the Borg dyspnea post 6MWT (β = 0,154) with a non-significant result.

In total the influence of all the values, “Borg dyspnea pre 6MWT”, “CIS fatigue” and “FEV_1” on the constant “6MWT” can be described as moderate till medium. No one of the three variables constantly stood out with a high influence on the running distance covered. Nevertheless the values of “CIS fatigue” and “FEV_1” were further under the significance level than those of the “Borg dyspnea pre 6MWT”.

Discussion

We found out, that all factors improved individually. The lung function displayed by the FEV_1 had the biggest influence on the distance covered within the 6 Minute Walking Test. Within this study the influence of fatigue (CIS fatigue) and dyspnea (Borg dyspnea pre 6MWT) is quite comparable whereas the significance is a good index for more reliable values of the CIS fatigue. No measurements of the suffered dyspnea after the 6MWT do display any influence on the running distance.

Our study group only consisted of patients suffering from asthma. Most other studies that can be found on this topic had a study group consisting of patients suffering from chronically obstructive pulmonary disease (COPD) or sarcoidosis. As we are a setting specialized on the treatment of asthmatic patients we wanted to have more precise results for our patients.
However we could confirm the finding of another study[7] that pointed out a correlation between the lung function displayed by the FEV_1 and the Six Minute Walk Test.

This issue also has to be seen as a weak point of this study as well. We have chosen to differ from the guidelines[12] for the 6MWT allowing the patients to run within the test because we consider this to be more functional for our patients. Furthermore we also use the Six Minute Walk Test for evaluation of the patients dealing with this situation. If you take a look at studies on the 6MWT you will find an extremely high number using COPD- and cardiac patients in their population which are not allowed to run. The University of Maastricht, Netherlands currently performs studies on the evidence of this deviation. Unfortunately the comparability of our study with others suffers from that.
Nevertheless we used the well-established admission criteria for our setting as the basic inclusion criteria. This ensured a high quality in the choice of our population. All measurements besides the already named 6MWT are evidence based or measured according to internationally accepted guidelines (FEV_1 [18]). Furthermore all tests were carried out by educated therapists to ensure comparable results.
Furthermore our study group seems to be heterogeneous. All patients were suffering from difficult to treat asthma, but as already said in the introduction it is not always just a poor lung function getting the patient into our setting. Many psychological and behavioral aspects play a decisive role when a patient is admitted into our setting. This could cause somehow lower

regression values. Nevertheless we can surprisingly see quite homogeneous results in our study.

In our study group the lung function was the first factor to think of which could influence the physical capacity. A poor lung function displayed by a low FEV_1 should expectably lead to a shorter walking distance. We saw a moderate till medium influence by the FEV_1 in our study, which actually has not been as strong as expected but yet was the strongest predictor.
As already mentioned in the introduction we expected the patients to score outstandingly high on the CIS fatigue, which would display an extreme fatigue. This expectation was answered by the high mean value after admission (47,9 points), which is far above the threshold to severe fatigue (37 points). A relatively poor influence of this variable after admission, which improved in the following two moments of measurement could point out that the patient obtains a different relation to his fatigue.
We did not find any appropriate results to our findings about the influence of suffered dyspnea on the walking distance in other studies. But this predictive relation still seems to be logical since a higher degree of suffered dyspnea, even if only experienced subjectively, could limit the motivation to bring good physical performance.

So far the 6 Minute Walk Test is primarily used to evaluate the functional physical capacity of the patient in our setting. The results of our study indicate that the physical factor (FEV_1) indeed has an influence on the walking distance but that this influence is not as strong as expected. Two other factors, fatigue and dyspnea, rather had almost the same influence as the lung function. Therefore it is questionable if results of the 6MWT should be used that undifferentiated for the evaluation of the patient in the future. The 6MWT should better be evaluated together with other (psychological) factors in a more differentiated way.

The answer to the question leading to this study should be: The influence of the suffered degree of fatigue, dyspnea and FEV_1 on the Six Minute Walk Test is considerable. This result induces advice to perform further studies on the influence of psychological factors on the 6MWT due to the fact that our factors were relatively subjective. A comprehensive questionnaire as the SF 36 could give helpful information in this context. Furthermore the great number of missing values should be reduced in our setting to give a more precise view on the patients and also to allow better studies.

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