Is a Practice Incremental Shuttle Walk Test Needed for Patients with Chronic Obstructive Pulmonary Disease Admitted to Hospital for an Acute Exacerbation?

Vicki Johnson-Warrington a,b  Katy E. Mitchell b  Sally J. Singh b

a University Hospitals Coventry and Warwickshire NHS Trust, Coventry, and b Centre for Exercise and Rehabilitation Science, Glenfield Hospital, University Hospitals of Leicester NHS Trust, Leicester, UK

Background: The incremental shuttle walk test (ISWT) assesses exercise capacity in chronic obstructive pulmonary disease (COPD) patients. Guidelines suggest that 2 ISWTs should be performed. However, in inpatients with an acute exacerbation, it is unknown if 2 ISWTs are required. Objective: To investigate if a practice ISWT is needed for inpatients with an acute COPD exacerbation. Methods: Patients admitted to hospital with an acute exacerbation completed 2 ISWTs prior to discharge. Patients provided informed consent and were included if they used the same oxygen and mobility aid (if any) between tests. Results: Thirty-nine inpatients with COPD were included with a mean (SD) forced expiratory volume in 1 s (FEV1) of 1.1 litres (0.5) [42.5% predicted (13.2)] and a median (interquartile range) Medical Research Council dyspnoea grade of 4 (3–5). Participants achieved 88.2 m (96.7) on ISWT1, and there was a statistically significant increase of 14.1 m (28.4) for ISWT2 (p < 0.05).

Multiple regression explained 98.8% of the variance ($F_{(8–22)}$, $p < 0.001, R^2 = 0.988$) between ISWTs using age, FEV1/forced vital capacity (FVC)%, FVC, resting oxygen saturation, resting heart rate (HR), ISWT1 distance, ISWT1 post-HR and post-Rated Perceived Exertion (p < 0.05). Using this equation to calculate predicted ISWT2, there was good agreement and no significant difference between this and actual ISWT2 (0.01 m, p > 0.05).

Conclusions: There was a small but statistically significant increase between ISWTs, which was below the minimal clinically important difference but would have had consequences for exercise prescription. This exploratory work has shown that we may be able to predict the difference between ISWTs using a multiple regression equation which could substitute the need for a second ISWT; this needs to be confirmed prospectively.

Introduction

Patients with chronic obstructive pulmonary disease (COPD) experience exacerbations of their disease, which are characterised by increased symptoms of dyspnoea, fatigue and sputum production, some of which may require...
an unscheduled hospital admission [1]. Muscle wasting and reduced physical activity are evident after just 3 days of a hospital admission [2, 3]. Consequently, there is increasing interest in providing exercise interventions or pulmonary rehabilitation (PR) during, or shortly after, an exacerbation of COPD to prevent a decline in, and/or restore, physical function, although mixed results exist [4–6].

Prior to patients commencing PR or exercise interventions, exercise capacity is often assessed. Field walking tests, such as the incremental shuttle walk test (ISWT) [7], are frequently used. The ISWT is a valid and responsive outcome measure for patients with COPD which, along with the endurance shuttle walk test (ESWT) [8], can be used to prescribe an individually tailored exercise programme. The ISWT is also often used to assess ambulatory oxygen therapy need and prescription [9]. Guidelines suggest that a practice ISWT should first be performed to familiarise the patient to the test [7]. There should also be a 30-min break, or adequate rest time to recover dyspnoea, between ISWTs. However, these guidelines are based upon stable patients with COPD, and it is unknown if this applies to an acutely ill exacerbating population.

There have been few reports investigating the ISWT during the acute exacerbation phase of COPD. The ISWT has been found to be feasible and reproducible in those recovering from an acute exacerbation during an inpatient stay [10]. However, this small Italian study assessed inpatients 14 days after exacerbation, and therefore, these patients’ symptoms are likely to be less acute and pronounced than those of inpatients in an acute UK healthcare setting, where the mean length of hospital stay is much shorter, at just 5 days [11]. In addition, they suggest that further investigation of the ISWT during different phases of COPD is warranted.

In patients who have been admitted to hospital with an acute exacerbation of their COPD, it is unknown if a practice ISWT is required or acceptable. Increased symptoms of dyspnoea and fatigue may prevent the opportunity for a significant learning effect, therefore reducing the potential for an improved second consecutive exercise test. It would be beneficial to know if a practice ISWT is needed for this patient population as if not, this would save time for assessments. However, it is important to ensure quality data in order to accurately prescribe an exercise programme and assess the impact of PR or exercise-based interventions. The objective of this paper was to investigate if a practice ISWT is needed for inpatients with an acute exacerbation of COPD.

Methods

Patients admitted to the University Hospitals of Leicester NHS Trust or University Hospitals Coventry and Warwickshire NHS Trust with an acute exacerbation of COPD were invited to take part in a self-management study (ISRCTN84599369; ethical approval obtained from the National Research Ethics Service Committee West Midlands Solihull 12/WM/0106). Participants were included if they had an established diagnosis of COPD [forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC) <70%] and gave written informed consent. Patients were excluded if they had any locomotive, cardiac, neurological or cognitive co-morbidity that would prevent safe exercise or had attended PR in the previous 6 months. Participants were required to perform 2 ISWTs as part of their baseline assessment during their inpatient stay but as close to discharge as possible. For this analysis, all patients who were naïve to the ISWT (to limit previous learning effect) and used the same oxygen flow rate and mobility aid (if any) between the 2 ISWTs were included.

The assessment was carried out by a competent health care professional and adhered to the standard protocol. The ISWTs were performed on room air or the patient’s prescribed ambulatory oxygen therapy, if applicable. The walking tests were completed on the same day, with at least 30 min resting between tests or until resting heart rate (HR) and oxygen saturation (SpO2) had returned to baseline and the patient felt adequately recovered. SpO2, HR, Borg Breathlessness and Rated Perceived Exertion (RPE) scores were measured and recorded at rest and after each ISWT. ISWT distances were recorded, and the ESWT level was calculated from both the first (ISWT1) and second ISWT (ISWT2).

The ISWT

The ISWT is an externally paced, standardised walking test [12] where participants are required to walk around a 10-metre course, identified by 2 cones. Participants walk at a set speed, as dictated by an audio signal and the pace progressively increases each minute. The test is terminated when the participants can no longer continue due to their symptoms or are unable to keep pace with the audio signal. VO2 peak can be estimated from the furthest distance they achieve [13], which can therefore be used to prescribe an exercise programme by training patients to a specific percentage of this. This can also be used to calculate the intensity of the ESWT [8], which is a constant-pace walking test. The known minimal clinically important difference (MCID) for ISWT in a stable population is 47.5 m [14].

Data Analysis

Data were analysed using PASW Statistics 18. Descriptive statistics are expressed as mean and standard deviation for scale data and median and interquartile range for nominal data. Paired t tests were used to detect differences between the 2 ISWTs. Wilcoxon signed-rank test was used to compare differences for non-parametric data. A Bland–Altman plot was produced to illustrate the agreement between ISWT1 and ISWT2 (with the difference between the 2 ISWTs being calculated by ISWT1 distance minus ISWT1 distance). Linear regression, using a backward stepwise method, was used to investigate if gender, age, FEV1 % predicted, FEV1/FVC%, FVC (in litres), body mass index, exercise history, pack years, oxygen flow rate, disease duration, resting SpO2, HR and Borg, Medical Research Council dyspnoea grade, ISWT1
distance, post-ISWT1 SpO2, HR, Borg and RPE and reason for stopping ISWT1 could predict ISWT2 distance from ISWT1 (due to the potential for these factors to affect performance). A further Bland-Altman plot was produced to illustrate the agreement between actual ISWT2 and predicted ISWT2 distances using the regression equation (with the difference between the distances being calculated as predicted ISWT2 minus actual ISWT2).

Results

Seventy-two participants were screened between January 2013 and June 2014. Thirty-nine were included in this analysis. Reasons for exclusion were: 20 were not test naïve, 8 used a different oxygen flow rate between tests, time constraints or severe symptoms prevented the ability of 3 participants to perform 2 ISWTs, and 2 patients declined a second ISWT. Thirty-nine inpatients with COPD (20 male) were included. Table 1 shows the characteristics of the population studied.

Table 1. Characteristics of participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD or Median [IQR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>67.7 ± 7.8</td>
</tr>
<tr>
<td>Body mass index</td>
<td>24.9 ± 7.0</td>
</tr>
<tr>
<td>FEV1, litres</td>
<td>1.1 ± 0.5</td>
</tr>
<tr>
<td>FEV1, % predicted</td>
<td>42.5 ± 13.2</td>
</tr>
<tr>
<td>FEV1/FVC, %</td>
<td>47.1 ± 12.1</td>
</tr>
<tr>
<td>Medical Research Council dyspnoea scale</td>
<td>4 [3–5]</td>
</tr>
<tr>
<td>1:2:3:4:5, n</td>
<td>6:5:15:13</td>
</tr>
<tr>
<td>Resting Borg Breathlessness scale</td>
<td>2 [0.5–3]</td>
</tr>
<tr>
<td>Resting SpO2, %</td>
<td>93.6 ± 2.2</td>
</tr>
<tr>
<td>Resting HR</td>
<td>91.5 ± 15.9</td>
</tr>
<tr>
<td>Smoking history: current:ex:never, n</td>
<td>19:20:0</td>
</tr>
<tr>
<td>Exercise history: current:previous:never, n</td>
<td>4:16:14</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation or median [interquartile range].

Exercise history was defined as whether the participant currently undertook any form of exercise (current), was exercise naïve (never) or had previously exercised but did not currently (previous).

Table 2. Participant characteristics at the end of each ISWT

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ISWT1</th>
<th>ISWT2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance, m</td>
<td>88.2 ± 96.7*</td>
<td>102.3 ± 100.4*</td>
</tr>
<tr>
<td>Post-HR</td>
<td>108.5 ± 14.6</td>
<td>110.8 ± 14.7</td>
</tr>
<tr>
<td>Post-SpO2, %</td>
<td>90.1 ± 4.0</td>
<td>90.0 ± 4.1</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation or median [interquartile range].

*p < 0.05 between-group difference.

Using the multiple regression equation to calculate predicted ISWT2, there was no significant difference between this and actual ISWT2 (0.01 m, p = 0.996, and good agreement (fig. 2) was shown as the limits of agreement were narrow and well within the known MCID value). There was also no significant difference in calculated ESWT levels when using actual or predicted ISWT2 (mean change 0 levels, p > 0.05).

Discussion

This is the first study to investigate if a practice ISWT is needed in a population of patients admitted to hospital due to an acute exacerbation of COPD. We have shown
that there was a small, but statistically significant, increase between the first and second ISWTs, which was below the known MCID. However, this difference changed the ESWT level for some patients, which would have had consequences for exercise prescription.

In this exploratory work, we have shown that we can predict the difference between the ISWTs using a multiple regression equation. This could therefore substitute the need for a second ISWT, although this needs to be confirmed prospectively on a larger sample size.

This work also shows that the ISWT is feasible to perform for most patients in this setting. The mean ISWT was 88 m, which equates to the test taking less than 3 min for the patient to perform. Furthermore, even patients who walked the furthest would all have completed the ISWT in 6 min or less. However, inpatient wards in an acute hospital are busy environments, and being able to perform 2 ISWTs and an ESWT with the recommended rest periods in this setting is clinically very challenging for staff and patients, and this prevented the opportunity for a second ISWT for 3 patients. Patients are experiencing an increase in their symptoms, which may already cause a reluctance to exercise. Therefore, patients may be put off by a comprehensive physical assessment of exercise capacity during this acutely unwell period of their disease, as seen in 2 patients screened for this analysis. There have been mixed findings regarding exercise interventions during or shortly after exacerbations. If patients are over-worked during assessment, they may feel too fatigued, dyspnoeic or incapable of exercising during this period. Ensuring that assessments are appropriate and concise (such as only needing 1 ISWT) may help with this. However, it is important to ensure that we are retaining quality data and adhering to the correct test procedures and standards [15].

As a group, the ESWT level calculated based on the predicted equation or if 2 ISWTs had been performed was statistically insignificant. On an individual basis, the maximum change in ESWT level if the predicted equation was used compared to if another ISWT was performed was 1 level. This is therefore unlikely to affect a patient’s exercise training. Aerobic exercise training should be set at an intensity of >60% of the maximal work rate [16] to maximise physiological benefits. Given that the ESWT is calculated at 85% VO2 as estimated from the ISWT, a change of 1 level would be highly unlikely to reduce the work load below 60%.

As a group analysis, there was an extremely small, insignificant difference of 0.01 m between ISWT2 and predicted ISWT2. Therefore, this gives support that the equation could be an alternative to patients performing a second ISWT, if acting as an outcome measure (such as to assess services) or for purposes of stratification (such as to identify those who are at risk of readmission or poor survival) [17, 18]. However, the majority of patients included in this analysis performed less than 200 m on the
ISWT; therefore, results should be interpreted with caution for patients achieving more than this.

In conclusion, a practice ISWT may not necessarily be needed in patients admitted to hospital due to an acute exacerbation of COPD. ISWT2 (and corresponding ESWT level) may be calculated by using the equation instead, although this needs to be confirmed prospectively on a larger cohort of patients.

Acknowledgements

We would like to thank the British Lung Foundation for funding the self-management study which this data is part of. Sally J. Singh and Katy E. Mitchell were supported by the National Institute for Health Research East Midlands Collaboration for Leadership in Applied Health Research and Care (EM CLAHRC) and the Leicester Respiratory Biomedical Research Unit. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health.

References


