Can the one-minute sit-to-stand test replace the six-minute walk test in community pulmonary rehabilitation programmes?

Written Project Submission for the 2015 Canterbury DHB Quality Improvement and Innovation Awards

Canterbury Clinical Network
Service of Canterbury District Health Board
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Project title
Can the one-minute sit-to-stand test replace the six-minute walk test in community pulmonary rehabilitation programmes?

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<tr>
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</tr>
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</tbody>
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Word Count (limit 3000)
3,147

Which category do you think best fits your project?

| Improved quality, safety and experience of care | x |
| Improved health and equity for all populations   | x |
| Best value for public health system resources   | x |

(Please note Assessors make the final decision)
Abstract

**Background:** Sit-to-stand testing (STST) has been proposed as an acceptable replacement for the six-minute walk test (6MWT) in measuring exercise tolerance in patients with respiratory disease. After the Canterbury earthquakes building damage prompted the need to find a replacement for the 6MWT.

**Objective:** The purpose of this study is to determine whether STST can replace the 6MWT as an accurate measure of exercise capacity in patients with respiratory disease attending a community pulmonary rehabilitation programme.

**Design:** Observational study in a community setting.

**Methods:** 62 participants with respiratory disease (mean age 68 years) attending the Canterbury Community Pulmonary Rehabilitation Programme (CCPRP) undertook STST and 6MWT as part of the pre-assessment for the programme. A second 6MWT was undertaken approximately one week later. Tolerability of the tests was assessed by change in heart rate, SpO2 and BORG score. Descriptive and correlational statistics (Pearson’s correlation) were used to determine the correlation between the two tests.

**Results:** Mean STST was 17 with mean first 6MWT being 348m. There was a mean learning effect increase in 6MWT of 21m. Comparison of the STST results with the 6MWT revealed a positive and significant correlation between the two tests in the initial assessment ($r = 0.69$, $p < 0.0001$), and the second assessment of the 6MWT ($r = 0.63$, $p = 0.0001$).

**Conclusions:** This study supports the use of STST over 6MWT as a functional measure of exercise capacity in a pulmonary rehabilitation setting. STST is a leaner, quicker and more adaptable assessment tool with savings achieved in patient and clinician time and health dollars without compromising the quality of service delivery.
Introduction and Background

Measuring exercise capacity is essential for providing an accurate measure of disability and responsiveness to intervention in patients with chronic respiratory diseases such as Chronic Obstructive Pulmonary Disease (COPD). Typical, the six-minute walk test (6MWT) is used as a standardised outcome measure for exercise capacity in chronic respiratory conditions. In the early 2000’s, the 6MWT was chosen by the American Thoracic Society Pulmonary Function Standards Committee to be the main exercise capacity measure because of its well-researched background, ease to administer compare to other walking tests, better participant tolerance and better reflection on participants activities of daily living. However the test is highly resource intensive, specifically in terms of clinician time and physical space required in a community rehabilitation setting. To accurately perform a 6MWT requires a straight walk track of 30m. In addition there is a recognized learning effect of 6MWT.

The 2010/11 earthquakes in the Canterbury region of New Zealand destroyed a number of community facilities which had previously been used to undertake pulmonary rehabilitation and had been suitable for assessments, including the 6MWT. This prompted the need to investigate the possibility of replacing the 6MWT with an alternative test of exercise capacity to be performed within the Canterbury Community Pulmonary Rehabilitation Programme (CCPRP). On top of investigating an alternative exercise capacity test, the CCPRP service group has always been searching for more evidence-based ways to further streamline the quality of CCPRP delivery and patient’s journey with the service. This is a project with a lot of collaboration and integration. The CCPRP team is a community based service reporting to the Integrated Respiratory Services, Canterbury Clinical Network. The CCPRP team proposed the quality initiative. Working together with the Christchurch School of Physiotherapy and respiratory physiotherapists at the Physiotherapy Department Christchurch Hospital the data was collected and analysed. The Project team consisted of a community based CCPRP physiotherapist, a respiratory physician who worked both in the
hospital and in the Integrated Respiratory Services, a School of Physiotherapy Research tutor with three final year physiotherapy students.

The CCPRP is an eight-week community rehabilitation programme consisting of two, two-hour sessions per week focusing on exercise and education for people with chronic respiratory disease including COPD.
Planning and Implementation

In 2013, the Pulmonary Rehabilitation Working Group (PRWG), the monitoring body of the CCPRP which consists of nurse specialists, physiotherapists, physicians, administrator and members of the management team, in its continuous pursuit of streamlining the CCPRP patient journey the physiotherapist member suggested literature searches on alternative fitness assessment tools for the community programmes. The alternative assessment tools will need to be practical, effective and not compromising the high standards of CCPRP service delivery. In July 2013, a report on alternative assessment tools was brought to the PRWG for consideration.

One alternative test of exercise capacity favoured by the PRWG was the sit-to-stand test. Similar to the 6MWT, the STST involves components of strength and muscular endurance but also incorporates balance. There are multiple variations of the sit-to-stand test. For example, some versions involve counting the number of STS repetitions in a given time frame, whilst others use a specific number of STS’s and record the time taken. They are all quick and simple to implement, use minimal equipment and therefore use minimal time, resources and cost.

A number of studies have investigated correlations between the one-minute sit-to-stand test and functional ability in a variety of populations. The one minute sit-to-stand test (STST) has been shown to correlate closely with the 6MWT in patients with stable COPD in an outpatient setting following admission to hospital. There is also a correlation between STST and lower limb strength as demonstrated in healthy adults aged 55-70 in a community setting and in a population sample of adults aged 20-79. The STST has been validated as a reliable and accurate measure of exercise capacity in the pulmonary rehabilitation population. The test represents an action performed in everyday life, that frequently precedes walking and is performed on average 60 times per day in the healthy adult population. Furthermore, it is a key prerequisite for independent living.
Ozalevli et al\textsuperscript{5} compared the 6MWT to the STST in a sample of patients with COPD and found a strong positive correlation between the two tests. Their population sample consisted of 53 outpatients with stable COPD, a mean FEV1 of 46\% and mean 6MWT of 112m, and 15 healthy volunteers. Participants completed each test once. A stronger correlation between the tests was seen in the group with COPD ($r = 0.75$, $p = <0.001$) than in the healthy group ($r = 0.54$, $p = 0.01$). This supports the hypothesis that the STST is a comparable measure to the 6MWT for exercise capacity in patients with COPD.

After the evidence was presented to the PRWG, the 1-minute STST was positively but cautiously accepted by the group as a potential replacement for fitness testing in the CCPRP. As the STST would allow the CCPRP assessment process to evolve further to meet the needs of the patients instead of asking the patients to meet our needs. This project aligns well with the Canterbury District Health Board (CDHB) and National Health strategic goals and priorities. The STST would break down physical barriers, instead of a venue with the capability of hosting a 20-metre unobstructed walking course in a 6MWT, the assessment could be carried out anywhere in the community including the patient’s home. The STST would also allow the PRWG to explore different options of programme delivery. Instead of the centre-based CCPRP, a homebased CCPRP could also be considered. The PRWG understood the potentials and endless opportunities that a change in this assessment tool could bring. However, the PRWG requested further research and validation for the STST for the Canterbury population. An integrated research team was formed in 2014 with the School of Physiotherapy.

The aims of the project are to strengthen the current evidence for the applicability of the STST as a replacement for the 6MWT and to explore its potential positive effects in service delivery in the community pulmonary rehabilitation setting.

The project was approved by the University of Otago Human Ethics Committee (reference number HD13/7). Subjects studied were 62 patients (mean age 68
years) enrolled in the Canterbury Community Pulmonary Rehabilitation Programme (CCPRP). The majority of patients had COPD, though five patients had other respiratory diagnoses (see Table 1 for details). Patients are predominantly referred to this programme from primary care settings. To be included in the CCPRP, patients must have a clinical diagnosis of a chronic respiratory condition and shortness of breath in day to day life. Patients are considered not appropriate for the programme, if they have decompensated heart failure, severe hypertension, uncontrolled cardiac arrhythmias, severe aortic valve stenosis and any other medical problems that severely restrict exercise or compliance with the programme (e.g. dementia, severe arthritis).

As part of the CCPRP, both 6-MWT and STST were being undertaken during preassessment, including a second 6-MWT 1 week later, to identify the learning effect in this test. De-identified data from all programme attendees were included in this analysis except for attendees whose data did not contain measurement of all relevant tests and whose descriptive characteristics i.e. ethnicity, gender and age were not recorded.

**Procedure for collection of data**

All data was collected as part of standard practice for the CCPRP. On initial assessment, a registered nurse or physiotherapist obtained verbal consent to attend the programme, and demographic information from participants. Physiological measures of heart rate, oxygen saturation, blood pressure and the modified Borg scale for self-perceived fatigue and shortness of breath were recorded with the patient in sitting position, to obtain resting values. Heart rate and oxygen saturation were recorded using a pulse oximeter (Nellcor Oximax N-65, Covidien, Colorado). Before the testing, participants were informed about the use of the modified Borg scale to evaluate the self-perceived intensity of fatigue and shortness of breath at rest and in response to exercise. The STST was then performed (see below). A 15-minute recovery period was allowed before the 6MWT was performed, with the physiotherapist administering the test in the standardized manner. Supplemental oxygen was not used for any of
the assessments. Following each test physiological measures, including heart rate, oxygen saturation and modified Borg were repeated.

Sit-to-stand test
A 46-48cm height armless chair was used for the STST. Participants were instructed to keep their legs shoulder-width apart with approximately 90 degrees knee flexion, placing hands on hips, laps or across the chest to eliminate upper limb assistance. A practice STS was performed to ensure safety and familiarity with the movement. The standard verbal instructions were “The sit to stand test will go for one minute. You should do as many repetitions as possible at a speed you are comfortable with. When you are standing up, you should not be using the arms for support. You can have short breaks as needed.” Initiation of the test began with “attention, ready, go”; participants were reminded when there was 15 seconds of the test remaining and when to stop. One repetition comprised full knee extension in standing followed by a controlled return to a seated position. Any partial repetitions were excluded from the result.

Six-minute walk test
The 6MWT was carried out based on American Thoracic Society guidelines; however due to building size constraints a 15 metre length was used instead of 30 metres. The final distance was recorded to the nearest metre. In order to explore the learning effect of 6MWT we request that participants in the CCPRP attend a second 6MWT approximately one week later. Data from a second 6MWT was available from a sub-group (n =31) of participants.
Results and Findings

The study population comprised 62 participants (28 male, 34 female), predominantly NZ European, with a mean age of 68.6 years (s.d. 8.6). Further details of demographics can be found in Table 1. COPD was the most common respiratory diagnosis in this population with a total of 57 in this category. FEV1 ranged from 18% to 90% predicted value with a mean predicted value of 44.6% (see Table 1 for more details). Mean 6MWT in this population was 348m (s.d. 114m). There was a statistically significant positive correlation between STST and 6MWT when completed on the same day (r = 0.69, p < 0.0001) (Figure 1). Figure 2 shows the correlation between the initial STST and the second 6MWT in the subgroup of patients who completed this a week later (r = 0.63, p = 0.0001, n=31). Comparison of the subgroup of participants with a diagnosis of COPD resulted in a similar correlation (r = 0.69, p < 0.0001).

There were significant differences in the before and after physiological measurements when comparing the STST and 6MWT (Table 2). Heart rate showed a mean increase of 14.1bpm (10.2) following STST compared with an increase of 22.4bpm (16.0) for 6MWT (p = 0.0002). For oxygen saturation there was a mean decrease of 2.0% (3.9) for the STST and 5.5% (7.1) for 6MWT (p = 0.0002). The mean increase in Borg scale for dyspnea was 1.8 (1.5) for the STST and 2.6 (1.3) for the 6MWT. There was no statistically significant difference between the two tests with regards to fatigue. In other words, the STST caused the participants a good work out but it is less stressful to do when compare to the 6MWT.

The time and money that can be saved by a full implementation of the STST in the CCPRP are explained in the following flow charts.

What we used to do
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<table>
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</table>
| 1 | • Initial Assessment (~45min)  
   • Nurse and Physiotherapist assessments with 6MWT |
| 2 | • Pre Assessment (~30 min) on another day a week later  
   • Questionnaires: CRQ, EQ-5D, HADS and 6MWT |
| 3 | • Programme: 8-week long exercise and education |
| 4 | • Post Assessment (~30 min)  
   • Questionnaires: CRQ, EQ-5D, HADS and 6MWT |

What we could be doing when in full STST implementation

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<th></th>
</tr>
</thead>
</table>
| 1 | • Pre Assessment (~30 min)  
   • Questionnaires: CRQ, EQ-5D, HADS and STST |
| 2 | • Programme: 8-week long exercise and education |
| 3 | • Post Assessment (~20 min)  
   • Questionnaires: CRQ, EQ-5D, HADS and STST |

A total saving of about one hour of the patient, clinician and hall hiring time per patient per programme once the change is fully implemented.
Conclusions and Future Direction

This study explored the relationship between the STST and 6MWT in a sample of patients with chronic respiratory disease attending a community pulmonary rehabilitation programme. The aim of this project was to determine the applicability of the STST as a replacement for the 6MWT for measurement of exercise capacity. Our study group consisted predominantly of patients with COPD but also included patients with other chronic respiratory diseases. The STST score was positively correlated with both initial and repeated 6MWT distance. In addition the 6MWT was subjectively and objectively more demanding as measured by change in heart rate, SpO₂ and Modified Borg Scale (SOB). As a measurement of exercise capacity STST is therefore as useful as 6MWT, requires fewer resources, and is better tolerated. For this reason we propose the use of the STST as replacement for the 6MWT in patients with chronic respiratory disease participating in pulmonary rehabilitation.

Previous studies of the relationship between STST and 6MWT have been undertaken in different patient groups with different disease severity. A study by Ozalevli and coworkers studied elderly patients previously admitted with COPD exacerbations, in an outpatient setting. Their patient group had more severe disease than our patients as measured by 6MWT (112m versus 348m). Their resultant STST repetitions were also fewer than in our patient group (15 versus 17). There was a similar correlation between 6MWT and STST in the two studies (r=0.75 versus r=0.69). This suggests that the relationship between STST and 6MWT is similar across the severity spectrum in chronic lung disease. Similarly in their patient group they identified that STST was both subjectively and objectively better tolerated. Tolerability and acceptability of a test of exercise capacity prior to embarking on a rehabilitation programme is likely to improve uptake and compliance with the programme itself.

We identified a similar correlation between STST and both the first and second 6MWT. There is controversy about the learning effect of the 6MWT distance. The ATS guidelines for pulmonary rehabilitation do not require repeat 6MWT,
because some authors have argued that the improvement seen with learning
does not reach clinical significance, and the information gained from a second
test does not justify the effort and resource.\textsuperscript{3, 19, 22} We did identify a change in
6MWT between first and second assessments (21m) however the 6MWT on
the first visit was preceded by the STST whereas the second 6MWT did not
have an exercise test prior. We were therefore unable to differentiate between
learning effect and the effect of fatigue. We did not investigate the learning
effect on STST given the constraints on the community rehabilitation
programme. However Jones et al\textsuperscript{23} showed that there was no significant
difference between an initial 30STST versus a second 30STST 3-5 days later.
Furthermore, Ritchie et al\textsuperscript{6} reported that the 60 second STST had good
reliability when tests were done one week apart. It will be important to explore
the learning effect on STST in more detail if this test is to replace the 6MWT.

Potential limitations for our study arise from the nature of collecting data in a
clinical
setting. As the information was gained as part of a community pulmonary
rehabilitation programme, a variety of clinicians performed the testing, and this
could have altered the results. However, this may not be a real limitation, as
studies have
shown high inter-rater reliability in clinicians of equal expertise for similar
tests.\textsuperscript{15, 18} The data for this study was obtained from the Canterbury Community
Pulmonary
Rehabilitation Programme (CCPRP), and therefore represents a “real life”
clinical setting. One could argue that ideally a correlational study should use
data from a
“laboratory setting” where data would be collected in a more standardized
manner and therefore a more accurate correlation could be ascertained.
However such data would not then be representative of clinical rehabilitation
environments in a health service.

There are very few studies investigating the responsiveness to change of
STST’s. Patel et al\textsuperscript{24} suggested the 5 times sit to stand test may be responsive
to change following pulmonary rehabilitation, but we could not identify sufficient literature to draw conclusions for the one minute STST. Research has been done to suggest responsiveness to change for the 6MWT but research on the STST would be useful to determine how accurately the STST can measure progress through pulmonary rehabilitation.\textsuperscript{15, 25} Finally, it would be important to identify the minimally important difference for the one minute STST, as it has been thoroughly elucidated for the 6MWT.\textsuperscript{21, 26} This knowledge would provide clinicians with information regarding the effectiveness of a pulmonary rehabilitation intervention.

The implementation of the STST shortened the assessment time and demonstrated a positive impact on patient’s quality of life. The saving and positive effects made for the CCPRP participants from the new assessment process are hard to quantify. Talking to the participants of CCPRP revealed most participants living with breathing conditions would limit their daily activities to one or two appointments a day due to their breathlessness and fatigue levels. In other words, when a participant decided to come to attend a 45min CCPRP assessment session, they were in fact dedicating the whole day to the programme. The new STST assessment process will mean one less unnecessary assessment or appointment day for the participant to plan and worry about. The participant then can spent the “extra” free day on things s/he enjoys doing instead of turning up to a health appointment.

Lastly, the economic benefit that can be achieved from replacing the 6MWT with the STST in the community is significant. It is estimated that, by using the STST, a total saving of approximately one hour of patient and clinician time is achieved per programme. A reduction of one hour per programme means a saving on the cost of CCPRP personnel (normally, there would be three clinicians and one administrator on site), the cost of venue hiring and, most important of all, a saving on patient time. A conservative estimation on the saving to the CDHB attained from running nine programmes per year amounts to over NZ$81,000 per year.
In conclusion, this project demonstrated the leaner, quicker and flexible approach the STST can bring to the new assessment process as a measure of exercise capacity in a community pulmonary rehabilitation setting. The STST provides similar information to the 6MWT and is both less resource intensive and easier for the patient.

**Future Direction**

Currently the 1-minute STST test is in full implementation in the CCPRP and continues to create savings in patients’ and clinicians’ time. As discussed previously, the implementation of this project will allow this expert service to save on health dollars (both reducing patients’ hospital admission and the cost of running the programmes) and at the same time reaching out to more places and more people who need the service.

This year, together with the School of physiotherapy, University of Otago Christchurch, we are continuing to validate the use of the 1-minute STST. We will be carrying out further researches to establish the “minimum clinical significant change value” for the STST and also to explore on the possibility of a “learning effect” in the STST.
References


Table 1. Participant demographics

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<tr>
<td></td>
<td>N</td>
<td>62</td>
</tr>
<tr>
<td>Gender</td>
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<tr>
<td></td>
<td>Females</td>
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<td>Mean age in years</td>
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<td>Respiratory diagnosis</td>
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<tr>
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<tr>
<td></td>
<td>Moderate (50% &lt; FEV1 &lt; 80%)</td>
<td>22</td>
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<tr>
<td></td>
<td>Severe (30% &lt; FEV1 &lt; 50%)</td>
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<td></td>
<td>Very Severe (FEV1, 30%)</td>
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Table 2. Change in cardiorespiratory parameters for the first STST and 6MWT.

<table>
<thead>
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<th>6MWT</th>
<th>P</th>
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<td>Heart rate (beats/min) (n = 45)</td>
<td>14.1 (10.2)</td>
<td>22.4 (16.1)</td>
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</tr>
<tr>
<td>SpO2 (%) (n = 46)</td>
<td>-2.0 (3.9)</td>
<td>-5.5 (7.1)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Dyspnoea, Modified Borg Scale (n = 44)</td>
<td>1.8 (1.5)</td>
<td>2.7 (1.3)</td>
<td>0.0007</td>
</tr>
<tr>
<td>Fatigue, Modified Borg Scale (n = 44)</td>
<td>1.1 (1.5)</td>
<td>1.3 (1.9)</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Data presented as mean (SD).

Figure 1. Relationship between the first STST and 6MWT.

\( n = 62, r = 0.69, p < 0.0001 \)
Figure 2. Relationship between the first STST and the second 6MWT, which was performed approximately one week later (subset of study sample).

\[ n = 31, r = 0.63, p = 0.0001 \]