Original Article

Timed Up and Go Test: An Underutilized Tool in Patients with Chronic Respiratory Disease

Nikita Kulsange, Mariya Prakash Jiandani
Physiotherapy School and Centre, Seth GSMC and KEMH, Mumbai, Maharashtra, India

Abstract

Background: Patients admitted with chronic respiratory diseases (CRDs) find it difficult to return to their day-to-day activities postdischarge due to muscle dysfunction and cardiorespiratory load. The Timed Up and Go (TUG) test is extensively used for predicting falls; however, it is underutilized to assess the cardiorespiratory load. The study was designed to assess the time in seconds, the cardiorespiratory load including desaturation with TUG, and also the correlation if any between TUG time in seconds with oxygen saturation (SpO2) and Barthel Index score. **Materials and Methods:** Hundred and twenty-eight patients admitted with CRDs in the age range of 40–70 years were included. Activities of daily living were scored on Barthel Index. TUG was carried out and changes in cardiorespiratory parameters, i.e., heart rate (HR), blood pressure (BP), respiratory rate (RR), and SpO2 were noted. **Results:** All cardiorespiratory parameters HR, BP, and RR showed a statistically significant change ($P < 0.0001$). There was a significant drop in SpO2 (mean 9%) post TUG. There was a significant but weak inverse correlation ($r = 0.5069$) observed between TUG in seconds and SpO2 at rest. There was no correlation between TUG and Barthel score. The mean time for TUG was 16.73 ± 3.11 s indicating a moderate risk of fall. **Conclusions:** TUG leads to a significant change in cardiorespiratory parameters including SpO2. It can be used as a test to assess activity tolerance and the need for oxygen supplementation.

Keywords: Barthel index, cardiorespiratory responses, chronic respiratory diseases, oxygen desaturation, Timed Up and Go test

Introduction

Chronic respiratory diseases (CRDs) include a spectrum of disorders of airway and lung parenchyma with varied etiological factors, leading to a chronic disability.[1] Admissions to the hospital due to exacerbation are the major cause of mortality and morbidity. Inpatient rehabilitation also known as hospital-level, or acute rehabilitation care aims to improve functional mobility and the ability to perform activities of daily living (ADLs) independently.[2,3] Physiotherapy plays an integral aspect of care along with pharmacotherapy during hospitalization. In contrast to cardiac rehabilitation, there is no clear discrimination between inpatient and phase I rehabilitation. However, the ultimate goal of an inpatient remains the ability to achieve basic ADL. Performing basic ADL is an arduous task for patients with CRD, needing continuous assistance and at times oxygen support due to desaturation with activities. Mobilization in bed and out of bed is an important aspect of physiotherapeutic care along with respiratory therapy. This calls for assessing if the patient's cardiorespiratory response is adequate enough and if he is ready to be mobilized.

Access this article online

Quick Response Code:

Website: www.ijrc.in

DOI: 10.4103/ijrc.ijrc_110_22

Cardiorespiratory parameters such as respiratory rate (RR), pulse rate, rate of perceived exertion (RPE), and saturation level are among those that play a vital role in determining the initiation and progression of mobilization. Ambulatory oxygen monitoring using a 6-min walk test (6-MWT) which is routinely used to evaluate functional capacity can be performed for admitted patients with CRD only after the patient is mobilized at the bedside and he can walk to evaluate desaturation and oxygen titration needed. However, to assess whether the patient is ready for such mobilization and testing is a call that clinicians take with trial and error. The Timed Up and Go test (TUG) is found to be a reliable, simple, and functional mobility test in patients with chronic obstructive pulmonary disease (COPD).[4]

Address for correspondence: Dr. Mariya Prakash Jiandani, Physiotherapy School and Centre, Seth GSMC and KEMH, Parel, Mumbai - 400 012, Maharashtra, India.
E-mail: mpjiandani@gmail.com

How to cite this article: Kulsange N, Jiandani MP. Timed up and go test: An underutilized tool in patients with chronic respiratory disease. Indian J Respir Care 2022;11:373-7.

Received: 04-06-2022 **Revised:** 17-08-2022
Accepted: 02-09-2022 **Published:** 12-11-2022

TUG is commonly applied to predict falls in the elderly. The validity and reliability of TUG are good as a measure of physical function.[5] It evaluates the minimum mobility and transitions as are required for self-care within the home and community.[6] It can assess quickness of mobility, dynamic balance, and overall strength and requires effort on the part of respiratory patients, leading to changes in their cardiorespiratory parameters and oxygen saturation (SpO2). TUG has never been evaluated to measure cardiorespiratory load to assess readiness for mobility. Hence, the aim of this study was to evaluate the cardiorespiratory changes with the TUG test and if it can be used to assist in clinical decision-making for mobilization and the need for oxygen during walking. As achieving ADL is the prime goal during the in-hospital phase of rehabilitation, it also attempts to measure the level of independence on the Barthel Index and if there exists a correlation between time in seconds of TUG and SpO2 and the score of ADL on the Barthel Index.

Materials and Methods

It was an observational analytical study. The study was approved by the institutional ethics committee. Patients admitted with CRDs in the age range of 40–70 years of either sex who were willing to consent were included. Patients with locomotor impairment due to a neurological or musculoskeletal disorder or with visual impairment were excluded.

The patients were instructed and explained the procedure of TUG. TUG test consists of different mobility skills and measures the time taken to complete the test. As seen in Figure 1, it includes transitions from sit to stand and stand to sit on the chair, turning around, and walking a distance of 3 m. Heart rate (HR), blood pressure (BP), RR and SpO2, and RPE were noted pre and post-test in patients sitting. Those who were on oxygen support continued the test with oxygen. RR was measured using the palpatory method. HR and SpO2 were measured using a standardized finger probe pulse oximeter which was checked for zero errors in reading. RPE was measured using the BORG 10-point scale. Patients were evaluated for their ADL on the Barthel Index[7] which assesses activities of day-to-day life over the past 24 h or few days of time interval. It consists of 10 components with a total score of 100. Activities include feeding, bathing, grooming (scored 0 or 5), dressing up, bowels, bladder, toilet use (scored 0,5,10) and transfers (bed to chair and back), mobility (on level surfaces), and stairs (scored as 0.5, 10 or 15). The greater the score more is the activity in everyday life.

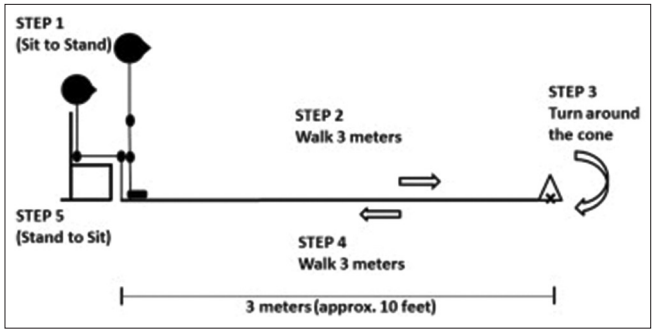


Figure 1: Course layout of Timed Up and Go test

Results

Data analysis were performed using the SPSS (Statistical Package for the Social Sciences, SPSS for Windows, Version 16.0. Chicago, SPSS Inc) for Windows version 16. $P < 0.05$ was considered statistically significant at a confidence interval (CI) of 95%. Normality was tested using Kolmogorov–Smirnov normality test. As the data were not normally distributed, nonparametric tests were used. Post-TUG values of HR, RR, and SpO2 were analyzed using Wilcoxon signed-rank test. A two-tailed Spearman correlation test was applied to study the correlation between SpO2% and the score of the Barthel Index with time in seconds of TUG.

Total number of patients included were 128, out of which 60% ($n = 77$) were males and 40% ($n = 51$) were females. The mean age was 54.50 ± 9.00 years and the mean body mass index was 25.27 ± 4.14 kg/m^2. Graph 1 depicts the spectrum of CRDs of patients included. The mean disease duration was 9.33 ± 4.381 years. The SpO2 at rest in 9% ($n = 12$) patients was between 90% and 94% and 91% ($n = 116$) had between 95% and 99%. About 87.5% ($n = 112$) of patients were on 1.5–2 L/min of supplemental oxygen with nasal prongs. None of them used walking aids. The RPE on 10-point BORG scale was zero for 27% ($n = 34$) of the patients; 0.5 for 60% ($n = 77$) of the patients and 1 for 13% ($n = 17$) of the patients with a mean of 0.45 ± 0.36 as prevalue. Post TUG, the RPE had a mean of 2.2 ± 0.73 which was a statistically significant difference ($P < 0.0001$). As seen in Table 1, the pre–post analysis shows that all the cardiorespiratory variables, i.e., HR, BP, and RR have statistically significant elevation ($P < 0.0001$) compared with baseline values at the end of TUG indicating sufficient effort. A statistically significant drop in SpO2 ($P < 0.0001$) has been observed post TUG. The rise in systolic and diastolic BP by more than 20 mmHg and 10 mmHg, respectively, a rise in RR of more than 7 breaths/min, and a decrease in SpO2 of more than 4% reflects increased cardiorespiratory load.

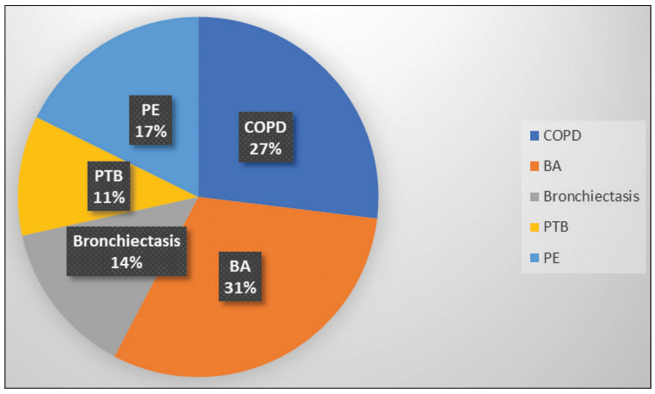
Meantime in seconds taken with TUG was 16.73 ± 3.11 with a range of 95% CI lower–upper bound as 9.33–26.2 s indicating a moderate risk of falling. On the evaluation of the Barthel score, 100% of the patients were independent in feeding, 93.84% of the patients were independent in bathing and grooming, and 84.61% of the patients were independent in dressing. However, 88.46% and 89.23% of the patients required minimal assistance while transfers and mobility, respectively. About 56.92% of the patients were unable to climb stairs, whereas 41.53% of the patients required minimal assistance to climb. About 58.46% of the patients complained of occasional accidents while bladder activity.

As seen in Graph 2 Correlation between the time of TUG in seconds with SpO2 showed that there is a statistically

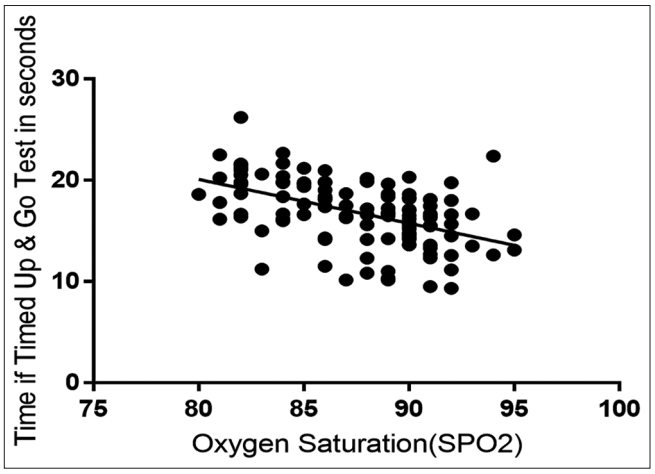
Table 1: Pre post analysis of Cardiorespiratory parameters with Timed Up and Go test

variable	Pre Mean±S.D. CI (LB-UB)	Post Mean±S.D CI (LB-UB)	Pre-post difference Mean±S.D CI (LB-UB)	*P*
Heart Rate Beats/min	73.26±8.38 (71.82-74.71)	103.26±12.31 (101.14-105.38)	30±3.93 (29.31-30.66)	*P*<0.0001*
Systolic BP	114.1±7.97 (112.7-115.5)	136.12±15.42 CI (133.4-138.8)	22.02±7.44 CI (20.7-23.3)	*P*<0.0001*
Diastolic BP	74.77±8.95 (73.22- 76.32)	94.58±8.74 (93.07-96.1)	19.81±-0.21 (19.85-19.78)	*P*<0.0001*
Respiratory Rate	22.75±2.14 (22.38- 23.12)	31.53±2.97 (31.02-32.02)	8.78±0.82 (8.64-8.9)	*P*<0.0001*
Oxygen saturation	97.08±1.52 (96.82-97.34)	87.83±3.50 (87.23-88.44)	-9.25±1.98 (-9.58- -8.9)	*P*<0.0001*

*Statistically significant, CI- confidence Interval, BP- Blood Pressure. Two Tailed Spearman's rho (*r*)= -0.5069; *P*<0.0001 indicating significant but moderate correlation



Graph 1: Diagnostic distribution of patients



Graph 2: Correlation of time in seconds with Timed Up and Go test and resting oxygen saturation. Two-tailed Spearman's rho ($r = -0.5069$; $P < 0.0001$) indicating significant but moderate correlation

significant (negative) and very moderate correlation ($r = -0.5069$). However, there was no significant correlation observed between TUG in seconds with the overall Barthel Index score ($r = -0.0633$) and individually with transfers ($r = -0.0191$), mobility ($r = -0.0476$), and stairs ($r = -0.1573$) components of the Barthel Index.

Discussion

Pulmonary rehabilitation is a multicomponent multidisciplinary evidence-based nonpharmacological intervention shown to improve mortality, morbidity, and functional outcomes. Respiratory care and peripheral muscle conditioning are the key components of rehabilitation. Patients with CRDs are often admitted due to exacerbation and hence the measurement of the functional status and capacity of such patients is an integral component of determining the prognosis. When a patient with CRD is hospitalized, functional outcomes can be measured in a variety of ways including return to work, return to ADLs, quality of life measures, and functional capacity tests. These patients, when they are symptomatically better and hemodynamically stable, in-bed mobilization exercises are started and progressed to bedside mobilization and ambulation as a part of the inpatient pulmonary rehabilitation program. Basic cardiorespiratory responses form guidance for the hospital-based pulmonary rehabilitation program. The respiratory response is generally reflected by changes in SpO2, RR, RPE, and breathing patterns. Based on these changes, along with HR, the rehabilitation program is considered. The 6-MWT is the most popular functional capacity measure in practice as it correlates with measures of cardiopulmonary fitness, is an indicator of prognosis, and provides a measure of day-to-day function and quality of life.

The mean value of the TUG test in our study population was 16.73 ± 3.1 which was much prolonged than normal individuals.[8] Greater the TUG test time in seconds poorer is the mobility. It has been stated that a score of <10 s is considered normal, 10–15 s as the mild risk of falling, 16–19 s as the moderate risk of falling, and more than 19 s as a high (severe) risk of falling. Further evaluation is needed in COPD with a TUG cutoff of more than 8.42 s.[5,9] A TUG of 11.2 s identifies a baseline 6-min walk distance of <350 m and of 13.8 s indicates a 6-min walk distance of <200 m[10] which is a discriminatory threshold predicting mortality[11] providing insight into patients' exercise capacity. Furthermore, a TUG of ≥12 s is sensitive to predict falls a year ago[6] and can help in the prescription of exercises for fall prevention as well.

As the main goal of in-hospital pulmonary rehabilitation is to help resume ADL, we evaluated basic ADL activities using the Barthel ADL index. This revealed a mean score of <85 out of 100 as most of the patients had already experienced the episode of dyspnea and had a fear that they may have similar episodes during activities such as walking and stair climbing. The Barthel score also indicated an increased need for

assistance in functions of mobility and transfer and an inability to achieve staircase climbing as a function by more than half the population studied. Sarcopenia, associated inflammation, and loss of function can be a cause of impaired physical function in patients with CRD. There was no correlation seen in total and mobility components of Barthel Index score and TUG time as patients could perform feeding, dressing, grooming, and bathing activities independently. Barthel score although evaluates the ability to carry out ADL with or without assistance it does not measure the time taken to carry out these activities. The change in saturation while performing these activities was not studied.

To evaluate the cardiorespiratory load to TUG test pre–post difference of HR, BP, RR, and RPE, and change in SpO2 were measured. The mean difference in HR was 30 ± 3.93 beats/min with a 95% CI of 29.31–30.66. This response is similar to those obtained with 400-m walk test and 6-MWT as reported in the literature.[11] The rise in systolic BP post TUG corresponds to a normal physiological response with exercise[12] indicating a sufficient load. The diastolic pressure showed a significant rise indicating increased peripheral vascular resistance. This could be due to isometric work involved during transfer and sit-to-stand activity.

Desaturation of more than 4% was observed in all patients except two (mean drop of 9%). The maximum duration of TUG is less than a minute; however, it involves transitions and physical activity involving lower extremity work including walking. Desaturation within 1 min can be an important predictor of desaturation over a 24-h period as observed with COPD patients (PaO_2: 60–70 mmHg) who desaturated within the first minute of the 6MWD test.[13] Hence, desaturation with TUG can be considered of substantial significance and reflects the inability of the cardiorespiratory system to support oxygenation.

Although 24 h ambulatory oximetry best reflects real-life SpO2[14,15] and 6-MWT is widely used for oxygen titration,[16] TUG can be a useful bedside clinical tool to assess the same.

The 6-MWT is capable of generating a submaximal, physiological requirement but before testing functional capacity, it is important to assess patient readiness for the same. Mobility is a component of physical function and is required for performing ADL. A positive correlation has been observed between functional mobility and cardiovascular endurance. More than half the number of patients were unable to carry out staircase climbing and significant proportion needed assistance for transfers. Quadriceps strength of respiratory patients is known to be reduced.[17] and a sit-to-stand component of TUG reflects the strength of the quadriceps and gluteal muscles. The results of the present study show that TUG can be applied as a measure to test cardiorespiratory endurance, especially when there is a lack of space and limited time. It exerts a sufficient cardiorespiratory load of moderate intensity with the ability to assess desaturation with mobility. There was a moderate correlation between time to TUG and resting SpO2 as there may be many other factors associated with increased TUG time in seconds. The measure of TUG in these patients also reflected a moderate risk of falls in them and hence it can also facilitate education for fall prevention strategies and exercises.[18]

Our study demonstrates the cardiorespiratory responses of CRD patients to TUG and its ability to assess desaturation with activity. TUG appears to be a preferable alternative assessment for the readiness of mobilization and appears to be a prelude to performing a 6-MWT. It can be used for functional assessment of patients with CRDs in both indoor and outdoor settings for both the prescription and outcome evaluation of pulmonary rehabilitation programs.

Strength and limitations

This study explores the utility of TUG in assessing oxygen desaturation and cardiorespiratory load during essential task components of activity of daily living. The limitation of the study was a convenient sampling from a single-tertiary center. We did not carry out a titration assessment for oxygen supplementation and comparison of parameters with 6-MWT.

Conclusions

TUG leads to a significant change in cardiorespiratory parameters including SpO2. Most studies measure TUG as a parameter of balance and predictor of falls. However, TUG can be a bedside clinical tool before performing a 6-MWT for clinical decision-making with reference to cardiorespiratory load and desaturation assessment. It can be used to assess readiness for mobilization besides predicting falls to plan an exercise program. Hence, its utility in patients with CRD is multifold.

Acknowledgment

The author would like to thank Professor Amita Mehta, Head, P T School and Centre, and Dr. Amita Athavale, Head, Department of Chest Medicine; Seth G S Medical College and KEMH for their continuous support.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Chronic Respiratory Diseases. Available from: https://www.who.int/health-topics/chronic-respiratory-diseases#tab=tab_1. [Last accessed on 8 Sep 2022].
2. Heldmann P, Werner C, Belala N, Bauer JM, Hauer K. Early inpatient rehabilitation for acutely hospitalized older patients: A systematic review of outcome measures. BMC Geriatr 2019;19:189. doi: 10.1186/s12877-019-1201-4. PMID: 31288750; PMCID: PMC6617943.[Last accessed on 8 Sep 2022].
3. British Thoracic Society Standards of Care Subcommittee on Pulmonary Rehabilitation. Pulmonary rehabilitation. Thorax 2001;56:827-34.
4. Bisca GW, Morita AA, Hernandes NA, Probst VS, Pitta F. Simple lower limb functional tests in patients with chronic obstructive pulmonary disease: A systematic review. Arch Phys Med Rehabil 2015;96:2221-30.
5. Albarrati AM, Gale NS, Enright S, Munnery MM, Cockcroft JR,

Shale DJ. A simple and rapid test of physical performance inchronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 2016;11:1785-91.
6. Al Haddad MA, John M, Hussain S, Bolton CE. Role of the timed up and go test in patients with chronic obstructive pulmonary disease. J Cardiopulm Rehabil Prev 2016;36:49-55.
7. Collin C, Wade DT, Davies S, Horne V. The Barthel ADL index: A reliability study. Int Disabil Stud 1988;10:61-3.
8. Bohannon RW. Reference values for the timed up and go test: A descriptive meta-analysis. J Geriatr Phys Ther 2006;29:64-8.
9. Khant N, Dani VB, Patel P, Rathod R. Establishing the reference value for "timed up-and-go" test in healthy adults of Gujarat, India. J Educ Health Promot 2018;7:62.
10. Mesquita R, Wilke S, Smid DE, Janssen DJ, Franssen FM, Probst VS, *et al.* Measurement properties of the timed up & go test in patients with COPD. Chron Respir Dis 2016;13:344-52.
11. Girotra S, Kitzman DW, Kop WJ, Stein PK, Gottdiener JS, Mukamal KJ. Heart rate response to a timed walk and cardiovascular outcomes in older adults: The cardiovascular health study. Cardiology 2012;122:69-75.
12. Newman AB, Haggerty CL, Kritchevsky SB, Nevitt MC, Simonsick EM, Health ABC Collaborative Research Group. Walking performance and cardiovascular response: Associations with age and morbidity – The health, aging and body composition study. J Gerontol A Biol Sci Med Sci 2003;58:715-20.
13. García-Talavera I, García CH, Macario CC, de Torres JP, Celli BR, Aguirre-Jaime A. Time to desaturation in the 6-min walking distance test predicts 24-hour oximetry in COPD patients with a PO2 between 60 and 70mmHg. Respir Med 2008;102:1026-32.
14. Fussell KM, Ayo DS, Branca P, Rogers JT, Rodriguez M, Light RW. Assessing need for long-term oxygen therapy: A comparison of conventional evaluation and measures of ambulatory oximetry monitoring. Respir Care 2003;48:115-9.
15. Pilling J, Cutaia M. Ambulatory oximetry monitoring in patients with severe COPD: A preliminary study. Chest 1999;116:314-21.
16. Poulain M, Durand F, Palomba B, Ceugniet F, Desplan J, Varray A, *et al.* 6-minute walk testing is more sensitive than maximal incremental cycle testing for detecting oxygen desaturation in patients with COPD. Chest 2003;123:1401-7.
17. Albarrati A, Gale N, Enright S, Munnery I, Munnery M, Cockcroft J, *et al.* The timed up & go test and quadriceps strength in COPD. Eur Respir J 2013;42:P2400.
18. Beauchamp MK, Hill K, Goldstein RS, Janaudis-Ferreira T, Brooks D. Impairments in balance discriminate fallers from non-fallers in COPD. Respir Med 2009;103:1885-91.