Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Trends in Anaesthesia and Critical Care 39 (2021) 5–9

Contents lists available at ScienceDirect

Trends in Anaesthesia and Critical Care

journal homepage: www.elsevier.com/locate/tacc

One minute sit-to-stand test as a potential triage marker in COVID-19 patients: A pilot observational study

Subhrashis Guha Niyogi [a], Ritesh Agarwal [b], Vikas Suri [c], Pankaj Malhotra [c], Divya Jain [a], Goverdhan Dutt Puri [a,*]

[a] Anaesthesia and Intensive Care, PGIMER, Chandigarh, India
[b] Pulmonary Medicine, PGIMER, Chandigarh, India
[c] Internal Medicine, PGIMER, Chandigarh, India

ARTICLE INFO

Article history:
Received 31 January 2021
Received in revised form
22 April 2021
Accepted 22 April 2021

Keywords:
COVID 19
Exertional dyspnea
Triage

ABSTRACT

Background: The crisis of critical care resource allocation during the novel coronavirus infectious disease 2019 (COVID-19) pandemic has underscored the importance of triage. COVID-19 is associated with increased hypoxemia and desaturation on exertion. We hypothesized that desaturation after 1-min sit-to-stand test (1MSTS), a validated field exercise test can serve as a potential marker for triage of COVID 19 patients.

Methods: Subjects with proven COVID 19 without hypoxemia on ambient air at presentation underwent the 1MSTS. The demographic details, clinical profile, pre and post-test vitals and pulse oximetric saturation was recorded and they were followed up for outcome throughout the hospital stay and after discharge.

Results: 55 mild cases of COVID-19 and 6 cases of recovering severe COVID-19 were included. The mild cohort had a median age of 35 years (IQR, 27–41.5) and a median hospital stay of 16 days (IQR 14,20). The severe cohort had a median age of 47.5 years (IQR, 42.3,54.3) and median intensive care and hospital stays of respectively 9 (IQR, 7.5,9) and 23.5 (IQR, 21.5,27) days. The two cohorts showed median desaturations of 0% (IQR, 0.5–1) and 5.5% (IQR, 4.3–6) respectively. No subjects in the mild cohort needed oxygen therapy or escalation of care to intensive care.

Conclusions: Significant desaturation after 1-MSTSin severe COVID 19 patients demonstrates the potential role of 1-MSTS both in triage for planning care and as a discharge criteria from intensive care unit. However, larger prospective studies are warranted for its evaluation and establishment of relevant cut-offs.

1. Introduction

The novel coronavirus infectious disease 2019 (COVID-19) is characterized by hypoxemic respiratory failure, later progressing to acute respiratory distress syndrome (ARDS) [1].The COVID-19 is also associated with covert hypoxemia, and desaturation on ambulation and exertion, both in the early and late phases of the disease. An unprecedented strain placed on critical care setups worldwide makes triage and allocation of limited intensive care resources important for COVID-19 [2]. In this scenario, domiciliary treatment and isolation of subjects has been practiced worldwide. Recently, the Indian Ministry of Health and Family Welfare has recommended that mild/asymptomatic patients be discharged to quarantine centres [3]. Conversely, early recognition and intervention has shown to improve outcomes in the initial phases of the disease. Most scoring and triage systems described for COVID-19 require laboratory investigations and thus take time [4].

Exertional desaturation has been widely used for the assessment of chronic respiratory diseases, with proven efficacy and safety in ventilatory disorders as well as disorders of oxygen diffusion [5–8]. Exercise tests like the 6-min walk test (6MWT) have also been proposed as a triage for risk stratification in COVID-19 [9]. The 1-min sit-to-stand test (1MSTS) is an established

* Corresponding author. Department of Anaesthesia and Intensive Care, PGIMER, Sector 12, Chandigarh, 160012, India.
E-mail addresses: 09renol@gmail.com (S. Guha Niyogi), riteshpgi@gmail.com (R. Agarwal), surivikas9479@gmail.com (V. Suri), malhotrapankaj@hotmail.com (P. Malhotra), jaindivya77@rediffmail.com (D. Jain), gdpuri007@hotmail.com (G.D. Puri).

https://doi.org/10.1016/j.tacc.2021.04.007
2210-8440/

surrogate for the 6MWT, with concordance, validity, and test-retest reliability [10,11]. It requires less time and space, both the factors advantageous in the limited area of an isolation unit.

We hypothesized that desaturation after 1MSTS would be helpful in the triage of patients with COVID-19.

2. Methods

This prospective study was conducted in the COVID block of our Institute after being approved by the **Institute Ethics Committee (NK/6248/Study/145) on May 8, 2020 under chairmanship of Prof Savitri Kumari** and written informed consent was obtained from all subjects. All consecutive subjects ranging in age from 18 to 80 years with a diagnosis of COVID-19 by reverse transcriptase polymerase chain reaction (RT-PCR) were eligible for inclusion. Subjects with chronic respiratory disorders on long-term oxygen therapy or those with neuromuscular or orthopedic disorders precluding performance of the 1MSTS were excluded.

Subjects were managed according to the existing institutional protocol for COVID-19 (Supplemental document 1). **The criteria for severe disease requiring ICU admission were pulse oximetric saturation (SpO_2) less than 94% on ambient air, persistent tachypnoea of more than 25 breaths per minute, or hypotension (Category C). Patients with SpO_2 > 94% on ambient air, HR <100/minute, RR <25/minute and SBP >90 mm Hg were considered as mild disease (Category A).**

The 1-min sit-to-stand test (1MSTS) was evaluated in mild COVID-19 cases(not requiring intensive care unit [ICU] admission on initial evaluation if their SpO_2 was more than 95% while breathing ambient air.

As a surrogate for severe cases, 1MSTS was also performed in subjects initially requiring ICUadmission once they were weaned off oxygen therapy.

The demographic parameters, baseline investigations, comorbidities and treatment were noted for all subjects. The subjects were followed up throughout the hospital stay and after discharge (for a period of 1 week). The 1MSTS was carried out after recording the baseline heart rate, blood pressure, respiratory rate, and SpO_2 with a chair of standard height placed next to a wall, as previously described [11]. The subject was seated on the chair, feet a hip-width apart on the floor, knees and hips at right angle and hands stationary on hips. The subjects were requested to repeatedly stand up and sit down at a pace they felt comfortable at, as many times as possible, for a duration of 1 min. They could rest if required, but not use their arms for support while standing up or sitting down. Saturation was monitored during and after exercise till it returned to the baseline. The nadir of the desaturation was noted, along with post-exercise heart rate and respiratory rate.

2.1. Statistical analysis

All the study parameters were checked by the Shapiro-Wilks test for normalcy and reported as mean and standard deviation or median and interquartile range. The Wilcoxon signed rank test was used to compare the desaturations in the two groups. R 4.0.0 (R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analysis. A p-value less than 0.05 was considered significant.

3. Results

We included 55 mild cases of COVID-19 in isolation ward and 6 cases of recovering severe COVID-19 in ICU (Fig. 1) admitted and discharged between May 2020 to June 2020. None of the ICU cohort had required mechanical ventilation. The demographic and clinical characteristics are shown in Table 1. In the 55 non-ICU subjects, the median pulse oximetric desaturation was 0 (IQR, 0.5–1) while it was 5.5% (IQR, 4.3–6) in the ICU subjects ($p < 0.001$) (Fig. 2) after the 1-MSTS. The peak desaturation was 3 and 4% points in two subjects, both with high baseline D-dimer values. However, none of them required oxygen therapy throughout hospital stay. The desaturation decreased on repeat testing after 4 days. The desaturation persisted for around 2–3 days in the ICU cohort, and the disappearance of exertional desaturation was used as a shifting criterion from the ICU to the general medical ward. No subject required escalation of care from the isolation ward to intensive care. All the subjects have since been discharged from hospital, and no complications noted on a follow up-period of at least seven days.

4. Discussion

To our knowledge, this is first series reporting the results of exercise testing in mild COVID-19. Subjects with mild disease not requiring oxygen therapy demonstrated minimal desaturation on the 1-min-sit-to-stand test while recovering subjects with severe disease showed higher desaturation, which resolved with cure.

Pulse oximetry has been used as a basic monitoring device in COVID 19 patients. With the coming up literature there is evidence of desaturation with mild exertion in patients with COVID 19, warranting escalation of care. Late transfer and escalation of management in patients with exertional desaturation has been identified as a cause of poor outcome in COVID patients.

6 Minute walk test has been considered as a gold standard non invasive test to evaluate cardio pulmonary reserve in patients with chronic lung diseases. The use of 6 min walk test with modification has been proposed as a potential marker for triage in COVID patients [9]. The test involves having the patient walk as far as possible ona straight track ideally 100 feet in length. The relationship between the distance walked and peak oxygen uptake on a progressive incremental cardiopulmonary exercise testing (CPET) has been found to be moderate to strong, thereby making it a reliable test to detect exertional desaturation. However, the major limitation of this test in COVID settings is the space restraints [12].

Bohannon et al. concluded 1 MSTS as a practical, reliable, valid, and responsive alternative for measuring exercise capacity [10].1MSTS can be particularly useful in COVID patients staying in isolation with limited space. There is still no data evaluating 1MSTS as a potential marker for triaging COVID 19 patients.

This was a single centre study in a small group of subjects. Also, no subject in the isolation wards needed an escalation in care on follow-up, precluding us from evaluating exertional desaturation as a predictor of clinical worsening. However, the results indicate that desaturation on exercise testing may be useful in discriminating between mild and severe manifestations of COVID-19. It was feasible in most subjects with mild disease as well as recovering subjects. While the negative exercise testing in the non-ICU cohort indicates the safety of late domiciliary treatment of mild COVID-19, it may also find use in numerous other scenarios. It may be useful as discharge criteria for domiciliary treatment as well as for safe de-escalation from critical care.

In the present study, criteria for ICU admission was kept as pulse oximetric saturation of less than 94% of in ambient air, which can be considered a relatively high cut off value to define a severe case of COVID 19 in the current scenario. Following the sigmoid shape Oxygen Dissociation Curve, the change in Spo2 is small during the initial stages of decrease in PaO2. PaO2 may drop to 60–65 mm Hg when the saturation is still 94% [13]. Therefore involvement of around 15% of lung may lead on to drop in PaO2 to 60 mm Hg or below and that might still show 94–95% oxygen saturation. Due to this reason, we wanted to elicit drop in saturation with exercise so

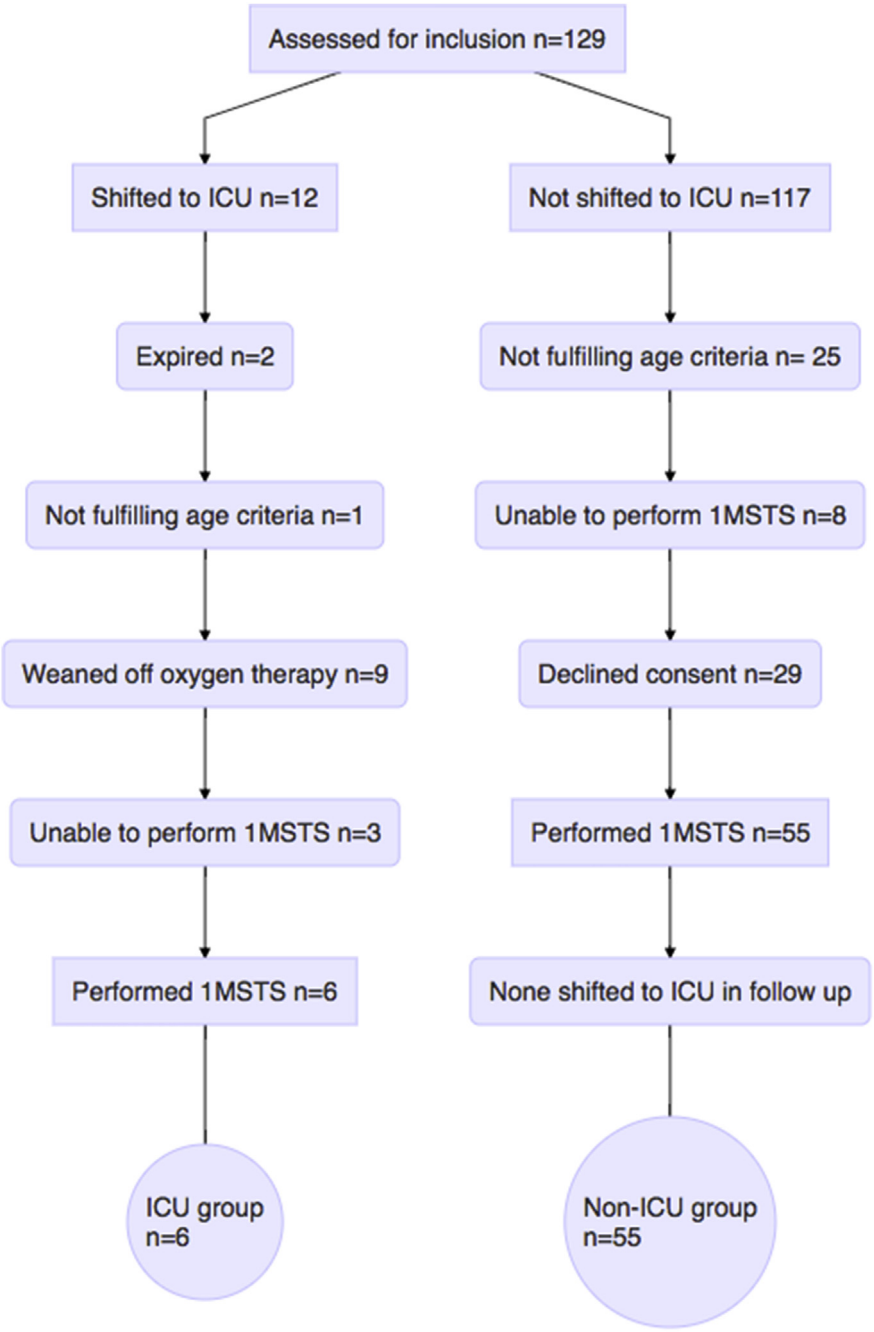

Fig. 1. Patient flow diagram in the study.

that we could detect subclinical hypoxia even when theSpo2 was above 95%. Therefore, we admitted the patients in the ICU when absolute Spo2 is less than 95 or 94 as it would correspond to around 15% shunt fraction [14].

Moreover, as this study was conducted in the early phase of the pandemic and the health care resources were not overwhelmed, we could manage to provide ICU care to the patients with a relatively high cut-off value of 94% being defined as severe case of COVID 19.

However, the implication of the results is all the more valuable in the current scenario, when there is overwhelming of the healthcare facilities. A simple 1MSTS test can be used to triage COVID patients for hospital admissions.

The major limitations of the study were the observational nature and the small cohort of patients. **Moreso, there was a huge difference in the number of patients between the two cohorts. This could be attributed to the observational nature of the study, recruiting all consecutive patients diagnosed with COVID 19 on RTPCR. The study was conducted during the initial part of the pandemic, between May to June 2020when all diagnosed COVID 19 patients were being admitted in the heath care centre**

Table 1
Demographic and clinical characteristics in the subjects requiring and not requiring ICU admission. Data presented as median (interquartile range) [range] or number (percentage).

Parameter	Non-ICU (n = 55)	ICU (n = 6)
Age (Year)	35 (27,41.5) [18–65]	47.5 (42.3,54.3) [40–59]
Female gender	25 (35%)	2 (33%)
Presenting symptoms		
Fever	17 (31%)	4 (66%)
Cough	6 (11%)	6 (100%)
Sore throat	2 (4%)	3 (50%)
GI disturbance	1 (2%)	1 (17%)
Comorbidities		
Hypertension	7 (13%)	4 (66%)
Diabetes mellitus	5 (9%)	3 (50%)
Pulmonary disease	2 (4%)	1 (17%)
CKD	0	1 (17%)
Baseline investigations		
TLC	6100 (5025,7700) [3400–15400]	7150 (5650,12325) [4000–15200]
N/L ratio	1.9 (1.3,2.6) [0.6–8.9]	6.09 (5.6,18.5) [3.9–36.9]
D-dimer (ng/ml)	340 (220,510) [30–20000]	560 (320,1520) [127–3130]
Creatinine (mg/dl)	0.72 (0.59,0.86) [0.08–1.08]	0.98 (0.78,1.16) [0.57–7.3]
CRP (mg/l)	2.19 (0.91,4.97) [0.06–162]	37.8 (11.8,96.9) [5.5–251]
Ferritin (ng/ml)	98 (50,160) [8–1522]	432 (315,612) [8.1–840]
Procalcitonin (ng/ml)	0.03 (0.02,0.04) [0.02–0.8]	0.06 (0.05,0.09) [0.02–0.18]
Hospital stay	16 (14,20) [13–39]	23.5 (21.5,27) [19–29]
ICU stay		9 (7.5,9) [5-12]

(GI: Gastrointestinal; CKD: Chronic Kidney Disease; TLC: Total leucocyte count; N/L ratio:Neutrophil:leucocyte ratio; CRP: C-reactive protein).

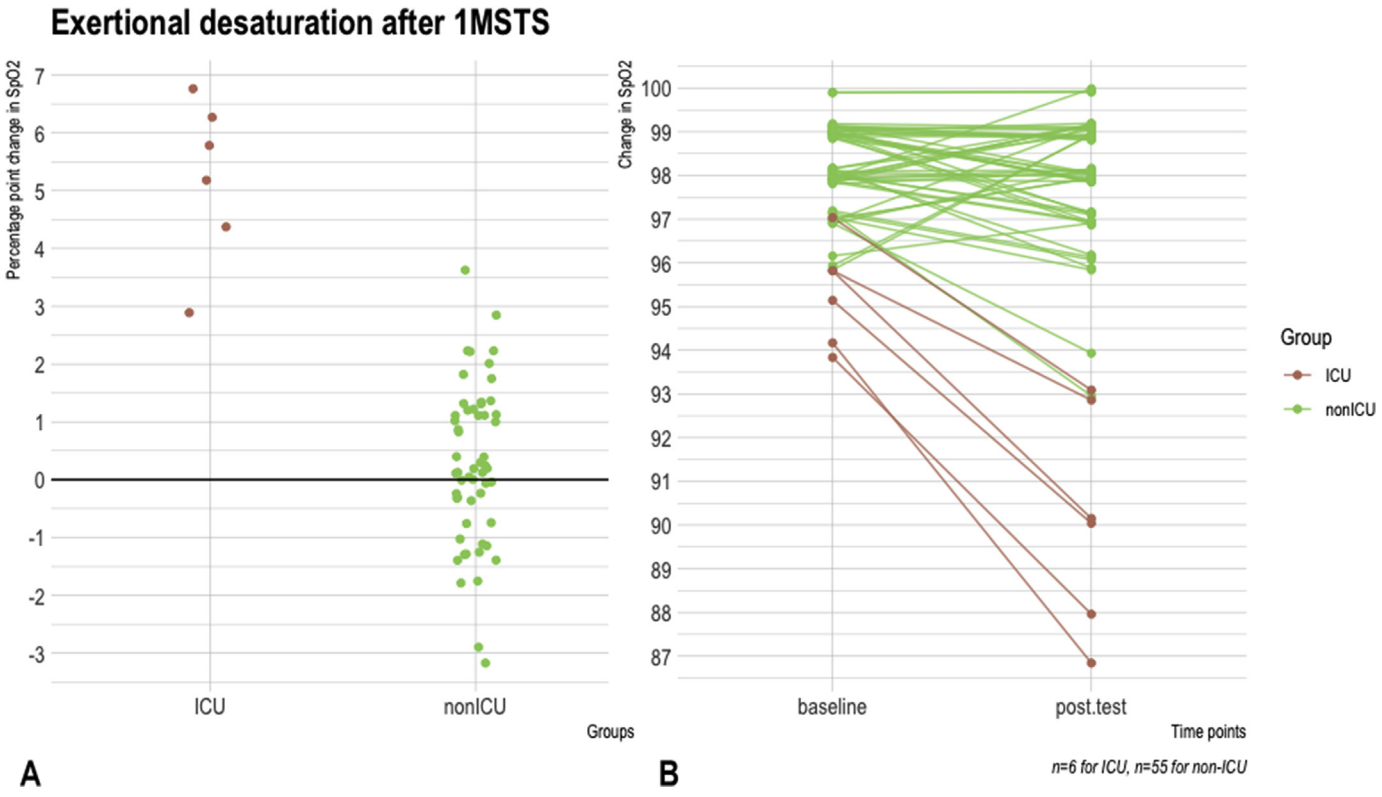

Fig. 2. Desaturation after 1 min sit-to-stand test in the ICU and non-ICU cohorts in percentage points (**A**) and absolute SpO_2 (**B**).

as the home quarantine policy had not been implemented. Majority of COVID 19 patients, remain asymptomatic or with mild symptoms, the same pattern was observed in our admissions which resulted in this major difference in number of patients in the two groups.

The measured metrics need wider study and prospective evaluation to establish their external validity.

To conclude, our results demonstrate potential role of 1-MSTS in COVID 19 patients both in triage for planning care and as a discharge criteria from intensive care unit. However, larger prospective studies are warranted for its evaluation and establishment of relevant cut-offs.

Author contributions

Dr.Subhrashis Guha Niyogiwas involved in conceptualization of the study, data collection, analysis and manuscript preparation. Dr.Ritesh Aggarwal conceptualized the study and helped in data analysis and manuscript preparation. Dr. Vikas Suri helped in conceptualization of the study , was involved in the management of the patients and approved the final manuscript. Dr. Pankaj Malhotra helped in conceptualization of the study and was involved in the management of the patients. Dr.Divya Jainwas involved in conceptualization of the study, collection of the data and approved the final manuscript. Dr.Goverdhan Dutt Puri conceptualized the study and helped in data analysis and and approved the final manuscript.

Financial disclosures

No funding was utilized for the study

Declaration of competing interest

None.
The authors declare that no conflicts of interest are present.

Acknowledgment

The authors thank all the healthcare workers, nursing staff, physicians and the management team in COVID-19 unit, PGIMER, Chandigarh for their invaluable help in conducting this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tacc.2021.04.007.

References

[1] L. Gattinoni, D. Chiumello, P. Caironi, M. Busana, F. Romitti, L. Brazzi, L. Camporota, COVID-19 pneumonia: different respiratory treatments for different phenotypes? Intensive Care Med. (2020) 1–6. Available at, http://link.springer.com/10.1007/s00134-020-06033-2.
[2] T. Leclerc, N. Donat, A. Donat, P. Pasquier, L. Nicolas, E. Schaeffer, E. D'aranda, J. Cotte, B. Fontaine, P. Perrigault, F. Michel, L. Muller, E. Meaudre, B. Veber, Prioritisation of ICU treatments for critically ill patients in a COVID-19 pandemic with scarce resources, Anaesth. Critic. Care Pain Med. (2020), https://doi.org/10.1016/j.accpm.2020.05.008. Available at.
[3] Ministry of Health and Family Welfare Govt. of India, Revised discharge policy for COVID-19, Available at, https://www.mohfw.gov.in/pdf/ReviseddischargePolicyforCOVID19.pdf.
[4] Q. Sun, H. Qiu, M. Huang, Y. Yang, Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province, Ann. Intensive Care 10 (2020) 2–5, https://doi.org/10.1186/s13613-020-00650-2. Available at.
[5] A.L. Lee, S.L. Harrison, M.K. Beauchamp, T. Janaudis-Ferreira, D. Brooks, Alternative field exercise tests for people with respiratory conditions, Curr. Phys. Med. Rehabi.l Rep. 3 (2015) 232–241.
[6] D.E. Smith, J. Wyatt, A. Mcluckie, B. Gazzard, Severe exercise hypoxaemia with normal or near normal x-rays: a feature of pneumocystis carinii infection, Lancet 332 (1988) 1049–1051. Available at, https://linkinghub.elsevier.com/retrieve/pii/S0140673688900669.
[7] Y.H. Khor, N.S. Goh, I. Glaspole, A.E. Holland, C.F. McDonald, Exertional desaturation and prescription of ambulatory oxygen therapy in interstitial lung disease, Respir. Care 64 (2019) 299–306. Available at, http://www.rcjournal.com. (Accessed 27 April 2020).
[8] C. Kim, J.B. Seo, S.M. Lee, J.S. Lee, J.W. Huh, J.H. Lee, S.W. Ra, J.-H. Lee, E.-K. Kim, T.-H. Kim, W.J. Kim, S.-M. Lee, S.Y. Lee, S.Y. Lim, T.R. Shin, H Il Yoon, S.S. Sheen, Y.-M. Oh, Y.B. Park, S.-D. Lee, Exertional desaturation as a predictor of rapid lung function decline in COPD, Respiration 86 (2013) 109–116. Available at, https://www.karger.com/Article/FullText/342891. (Accessed 27 April 2020).
[9] S. Mantha, S.L. Tripuraneni, M.F. Roizen, L.A. Fleisher, Proposed modifications in the 6-minute walk test for potential application in patients with mild COVID-19: a step to optimize triage guidelines, Anesth. Analg. 131 (2) (2020) 398–402, https://doi.org/10.1213/ANE.0000000000004986.
[10] R.W. Bohannon, R. Crouch, 1-Minute sit-to-stand test: systematic review of procedures, performance, and clinimetric properties, J. Cardpulm. Rehabil. Prev. 39 (2019) 2–8.
[11] J. Briand, H. Behal, C. Chenivesse, L. Wémeau-Stervinou, B. Wallaert, The 1-minute sit-to-stand test to detect exercise-induced oxygen desaturation in patients with interstitial lung disease, Ther. Adv. Respir. Dis. 12 (2018) 1–10.
[12] S.J. Singh, M.A. Puhan, V. Andrianopoulos, et al., An official systematic review of the European Respiratory Society/American Thoracic Society: measurement properties of field walking tests in chronic respiratory disease, Eur. Respir. J. 44 (2014) 1447–1478.
[13] J. Petersson, R.W. Glenny, Gas exchange and ventilation-perfusion relationships in the lung, Eur. Respir. J. 44 (2014) 1023–1041.
[14] G. Zhou, W. Karlen, R. Brant, M. Wiens, N. Kissoon, J.M. Ansermino, A transformation of oxygen saturation (the saturation virtual shunt) to improve clinical prediction model calibration and interpretation, Pediatr. Res. 86 (2019) 732–737.