



UNIVERSIDADE
ESTADUAL DE LONDRINA

ANDREA AKEMI MORITA

**QUAL É O MELHOR PROTOCOLO DO TESTE *SIT-TO-
STAND* EM PACIENTES COM DOENÇA PULMONAR
OBSTRUTIVA CRÔNICA?**

Londrina
2016

ANDREA AKEMI MORITA

**QUAL É O MELHOR PROTOCOLO DO TESTE *SIT-TO-
STAND* EM PACIENTES COM DOENÇA PULMONAR
OBSTRUTIVA CRÔNICA?**

Dissertação apresentada ao Programa de Pós-Graduação em Ciências da Reabilitação (Programa Associado entre Universidade Estadual de Londrina [UEL] e Universidade Norte do Paraná [UNOPAR]), como requisito parcial à obtenção do título de Mestre em Ciências da Reabilitação.

Orientadora: Profa. Dra. Vanessa S. Probst.

Londrina
2016

Ficha de identificação da obra elaborada pelo autor, através do Programa de Geração Automática do Sistema de Bibliotecas da UEL

Morita, Andrea Akemi .

Qual é o melhor protocolo do teste sit-to-stand em pacientes com doença pulmonar obstrutiva crônica? / Andrea Akemi Morita. - Londrina, 2016.
75 f. : il.

Orientador: Vanessa Suziane Probst .

Dissertação (Mestrado em Ciências da Reabilitação) - Universidade Estadual de Londrina, Centro de Ciências da Saúde, Programa de Pós-Graduação em Ciências da Reabilitação, 2016.

Inclui bibliografia.

1. Testes funcionais - Teses. 2. Doença pulmonar obstrutiva crônica - Teses. 3. Capacidade de exercício - Teses. 4. Avaliação - Teses. I. Probst , Vanessa Suziane . II. Universidade Estadual de Londrina. Centro de Ciências da Saúde. Programa de Pós-Graduação em Ciências da Reabilitação. III. Título.

ANDREA AKEMI MORITA

**QUAL É O MELHOR PROTOCOLO DO TESTE *SIT-TO-STAND* EM
PACIENTES COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA?**

Dissertação apresentada ao Programa de Pós-Graduação em Ciências da Reabilitação (Programa Associado entre Universidade Estadual de Londrina [UEL] e Universidade Norte do Paraná [UNOPAR]), como requisito parcial à obtenção do título de Mestre em Ciências da Reabilitação.

BANCA EXAMINADORA

Orientadora: Prof^a Dr^a Vanessa S. Probst
Universidade Estadual de Londrina - UEL

Prof. Dr. Fabio Pitta
Universidade Estadual de Londrina - UEL

Prof^a Dr^a Simone Dal Corso
Universidade Nove de Julho - UNINOV

Londrina, 09 de março de 2016.

Dedico este trabalho as pessoas que dão sentido à minha vida e que acreditaram sempre em mim: miha mãe Elza, meu pai Mario e minha irmã Luciene.

AGRADECIMENTOS

Agradeço primeiramente a Deus, por ter me proporcionado a vida, por permitir que eu chegasse até aqui e realizasse mais esse sonho. Por estar sempre comigo, nos momentos felizes e difíceis, por ter me dado uma família maravilhosa e por ter enviado anjos (conhecido como amigos) no meu caminho.

A minha imensurável gratidão a minha família, o meu alicerce e o meu bem mais valioso. Obrigada a minha mãe, meu pai e minha irmã por todo o amor, dedicação e auxílio. Aos meus pais, agradeço pelos valores que me ensinaram. E se hoje cheguei aqui, foi graças a vocês. Vocês sempre me ensinaram que a educação, a dedicação e o respeito eram os caminhos para um dia ser alguém. E fazendo disso um ideal, nunca mediram esforços para proporcionar a mim e a minha irmã tudo o que vocês não tiveram. Muito obrigada mesmo, amo vocês para sempre. Obrigada à minha irmãzinha querida que amo infinitamente. Obrigada por sempre estar perto e me ajudar em todos os momentos. Agradeço aos demais membros da família, tios, primos e agregados queridos, que mesmo estando longe sempre estiveram na torcida para que eu continuasse crescendo.

O meu muitíssimo obrigado à minha orientadora, professora e amiga Vanessa Probst. Você realmente foi um presente de Deus nessa caminhada chamada “mestrado”. Obrigada por ter aceitado me orientar durante esses dois anos, período esse que eu a conheci melhor, e a admiração que eu tinha por você só cresceu. Além de ser uma profissional competente e dedicada, é também uma mulher de características admiráveis. Tenho me inspirado muito em você para ser uma pessoa e uma profissional melhor. Obrigada pela amizade, pela paciência, por sempre estar disposta a sanar as minhas dúvidas, por ser tão humana na solução dos meus problemas, por ter acreditado e confiado em mim, muito mais do que eu acreditava e merecia. Muito obrigada!

O meu muito obrigada ao professor e amigo Fabio Pitta. Obrigada por ter me acolhido no laboratório há algum tempo atrás e por ter confiado em mim. Você é uma pessoa por quem tenho um grande respeito e admiração, e é um grande exemplo de profissional e de pessoa que quero seguir.

Agradeço à professora Dra. Simone Dal Corso, por ter aceitado participar da minha banca prontamente e pelas valiosas contribuições para este trabalho. É um prazer e uma honra tê-la como parte da banca examinadora.

Agradeço a todos os colegas do LFIP, pela convivência e por toda a ajuda. Em especial, quero agradecer algumas pessoas que foram entrando devagar na minha vida, as quais hoje não consigo viver sem. Vocês, Fernanda Morakami, Antenor Rodrigues, Igor Brito, Thaís Paes, Mahara Proença e mais recentemente Larissa Castro e Débora de Carvalho, foram e são essenciais no meu processo de aprendizado e de crescimento pessoal. Com certeza, o período do mestrado foi um dos mais agradáveis da minha vida por causa de vocês.

Quero agradecer também aos meus queridos: Juliana Zabatiero, Leandro Mantoani, Mahara Proença e Karina Furlanetto por terem me acolhido no EPAFT e por terem me ajudado muito em um início não muito fácil. Obrigada por toda a paciência e serenidade para que eu pudesse aprender um pouco mais sobre pesquisa.

Agradeço também a minha dupla infalível, Gianna Bisca. Tudo não teria dado tão certo, se não fosse você. Obrigada por toda a paciência, por aceitar o meu jeito de ser e as minhas manias, por me ensinar muito sobre pesquisa e a vida, e obrigada sobretudo pela amizade. É uma amiga admirável que vou levar para a vida toda.

Obrigada também aos alunos da linha do exercício do LFIP. Agradeço por serem tão prestativos, compreensivos e por terem me ajudado nesse trabalho. Tenho um carinho muito grande por todos vocês e torço muito pelo sucesso de cada um.

Quero agradecer a professora Carrie Galvan, uma amiga e profissional que eu admiro e adoro. Obrigada por estar sempre perto de mim, por me ajudar com ensinamentos e conselhos tão valiosos e por toda a confiança depositada.

Agradeço a professora Laryssa Bellinetti, por ter proporcionado a primeira oportunidade do contato com a pesquisa durante a minha graduação. Com certeza, esse foi um pontapé inicial para que eu continuasse seguindo em frente e chegasse aqui.

À todos os meus amigos, muito obrigada por estarem perto de mim e por me entenderem mais do que eu mesma. Estar com vocês é sempre uma alegria imensa e que me faz muito bem.

Agradeço também aos pacientes que participaram do estudo e que colaboraram com essa pesquisa.

Por fim, agradeço a tudo e a todos que acreditaram em mim e no meu trabalho!

*“ Escolha um trabalho que você ame e não terá
de trabalhar um único dia de sua vida.”*

Confúcio

MORITA, Andrea Akemi. **Qual é o melhor protocolo do teste *sit-to-stand* em pacientes com doença pulmonar obstrutiva crônica?** 2016. 75f. Dissertação (Mestrado em Ciências da Reabilitação) - Universidade Estadual de Londrina, Londrina, 2016.

RESUMO

INTRODUÇÃO: Existem diferentes protocolos do teste *sit-to-stand* (STS) para avaliação da capacidade funcional em pacientes com doença pulmonar obstrutiva crônica (DPOC). Entretanto, não existem evidências sobre qual é o melhor protocolo a ser utilizado nessa população. **OBJETIVOS:** Correlacionar cada protocolo do STS (5-repetições [5-rep], 30-segundos [30-seg] e 1-minuto [1-min]) com desfechos clínicos importantes avaliados em pacientes com DPOC; comparar os três protocolos do STS assim como verificar a associação e a concordância entre eles; verificar se os três protocolos são capazes de prever a capacidade funcional de exercício e atividade física de vida diária (AFVD). **MÉTODOS:** Vinte e três pacientes com DPOC (11 homens; VEF_1 : $53 \pm 15\%$ pred) realizaram três protocolos do teste STS de forma aleatorizada. Considerando que os desfechos dos protocolos foram obtidos em unidades de medida diferentes, a velocidade (número de repetições por segundo [rep/seg]) foi utilizada para a análise dos três testes. Além disso, os pacientes foram submetidos às seguintes avaliações: *Incremental Shuttle Walking Test* (ISWT), Teste de Caminhada de 6 Minutos (TC6min), *4-metre gait speed test* (4MGS), 1-repetição máxima (1RM) de quadríceps femoral, avaliação da atividade física de vida diária (AFVD) e questionários de qualidade de vida e estado funcional. **RESULTADOS:** O protocolo de 1-min correlacionou-se significativamente com o TC6min ($r=0,40$), 4MGS ($r=0,64$) e AFVD ($r \geq 0,47$). Para os testes de 5-rep e 30-seg, as melhores correlações obtidas foram com o 4MGS ($r=0,54$ e $r=0,52$, respectivamente). Foi encontrada diferença na velocidade de execução dos três protocolos (5-rep: $0,53 \pm 0,16$ rep/seg; 30-seg: $0,48 \pm 0,13$ rep/seg; 1-min: $0,45 \pm 0,11$ rep/seg; $P=0,01$), ou seja, entre o STS de 5-rep e 1-min. Apesar dessa diferença, eles apresentaram boa concordância ($CCI \geq 0,73$ para todos) e houve moderada associação entre eles ($r \geq 0,68$). Foram verificadas maiores mudanças na saturação periférica de oxigênio, frequência cardíaca, pressão arterial e sintomas de dispneia e fadiga após o protocolo de 1-min ($P \leq 0,01$ para todos). Além disso, os três protocolos foram capazes de discriminar pacientes com capacidade de exercício baixa e preservada (Área sob a curva [AUC] $\geq 0,71$). No entanto, isso não ocorreu com a AFVD (AUC $\leq 0,67$). **CONCLUSÃO:** O teste de 1-min apresenta maior demanda hemodinâmica, e é o que melhor correlaciona-se com importantes desfechos clínicos avaliados em pacientes com DPOC. Apesar de ter sido verificada diferença na velocidade de execução e na resposta fisiológica entre o STS de 5-rep e 1-min, há boa concordância e correlação entre os três diferentes protocolos do STS. Adicionalmente, todos os protocolos possuíram poder discriminativo para pacientes com capacidade de exercício baixa e preservada.

Palavras-chave: Doença pulmonar obstrutiva crônica. Exercício. Atividade motora. Atividades cotidianas. Hemodinâmica. Avaliação de desempenho.

MORITA, Andrea Akemi. **Which is the best protocol of the sit-to-stand test in patients with chronic obstructive pulmonary disease?** 2016. 75p. Dissertation (Master in Rehabilitation Sciences) - Universidade Estadual de Londrina, Londrina, 2016.

ABSTRACT

BACKGROUND: Different protocols of the sit-to-stand test (STS) are available to assess functional capacity in patients with chronic obstructive pulmonary disease (COPD). However, it is unclear which is the best protocol to assess this population. **AIMS:** To correlate each protocol of the STS (5-repetition [5-rep], 30-second [30-sec] and 1-minute [1-min]) with important clinical outcomes in patients with COPD; to compare three STS, as well as to verify their association and agreement; and to verify whether the three protocols are able to predict functional exercise capacity and physical activity in daily life (PADL). **METHODS:** Twenty-three patients with COPD (11 men; FEV₁:53±15%pred) performed three protocols of the STS in a randomized sequence. Since the outcomes units of measure were different, the speed (number of repetitions per second [rep/sec]) was used for the analysis of all three tests. Patients also underwent the following assessments: Incremental Shuttle Walking Test (ISWT), 6-minute walk test (6MWT), 4-metre gait speed test (4MGS), 1-repetition maximum (1RM) of quadriceps muscle, PADL and questionnaires of health-related quality of life and functional status. **RESULTS:** The 1-min presented significant correlations with the 6MWT ($r=0.40$), 4MGS ($r=0.64$) and PADL ($r\geq0.47$). Regarding the 5-rep and 30-sec test, the best correlation obtained were with the 4MGS ($r=0.54$ and $r=0.52$, respectively). The speed differed among protocols (5-rep:0.53±0.16 rep/sec; 30-sec: 0.48±0.13rep/sec; 1-min: 0.45±0.11rep/sec; $P= 0.01$), i.e. between the 5-rep and 1-min STS. However, they presented moderate agreement ($ICC\geq0.73$ for all) and correlated well with each other ($r\geq0.68$). More marked changes in peripheral oxygen saturation, heart rate, blood pressure, dyspnea and leg fatigue were observed after the 1-min protocol ($P\leq0.01$ for all). Furthermore, the three protocols were able to discriminate patients with low and preserved exercise capacity (area under the curve [AUC] ≥0.71) but did not predict PADL (AUC ≤0.67). **CONCLUSION:** The 1-min STS generates higher hemodynamic demands and correlates better with clinical outcomes in patients with COPD. Although there was difference between the 5-rep and 1-min protocol in terms of speed performance and physiologic demand, there was good level of agreement among the STS. In addition, all three protocols discriminated patients with low and preserved exercise capacity.

Keywords: Pulmonary disease. Chronic obstructive. Exercise test. Motor activity. Activities of daily living. Hemodynamics. Patient outcome assessment.

LISTA DE ILUSTRAÇÕES

Figura 1 – Valores de referência para o teste STS de 1 minuto.....18

Artigo

FIGURA 1 – Comparison of the speed among the 5-repetition_STS, 30-second_STS and 1-minute_STS protocols of the sit-to-stand test. * $P= .01$. STS: sit-to-stand; rep/s: repetitions per second; 5-rep: 5-repetition; 30-sec: 30-seconds; 1-min: 1-minute.46

FIGURA 2 – Bland & Altman plots of the difference between two STS protocols plotted against the mean value of the two STS (5-rep_STS vs 30-sec_STS [A]; 5-rep_STS vs 1-min_STS [B] and 30-sec_STS vs 1- min_STS [C]). ICC values: $P< .0001$ for all.....47

FIGURA 3 – Comparison among the areas under the curve (AUC) of the 5-repetition_STS, 30-second_STS and 1-minute_STS protocols in patients with (A) low and preserved exercise capacity in the 6MWT and in patients classified as (B) active and inactive regarding PADL.....48

LISTA DE TABELAS

Artigo

TABELA 1 – Characteristics of the patients with COPD.	49
TABELA 2 – Correlations between the 5-rep_STS, 30-sec_STS and 1-min_STS protocol of the STS and clinical variables in patients with COPD.	50
TABELA 3 – Comparisons of oxygen saturation, cardiovascular and symptoms variables measured before each STS protocols.	51
TABELA 4 – Comparisons of the changes on oxygen saturation, cardiovascular and symptoms of each STS protocol.....	52
TABELA 5 – Comparisons of oxygen saturation, hemodynamic and symptom variables measured pre and post each STS protocol.....	53

LISTA DE ABREVIATURAS E SIGLAS

%pred	<i>percentage of predicted</i>
1-min	Teste <i>sit-to-stand</i> de 1 minuto, <i>sit-to-stand test of 1 minute</i>
1-RM	<i>1-repetition maximum</i> , 1-repetição máxima
30-seg	Teste <i>sit-to-stand</i> de 30 segundos
30-sec	<i>Sit-to-stand test of 30 seconds</i>
4MGS	<i>Four-metre gait speed</i>
5-rep	Teste <i>sit-to-stand</i> de 5 repetições, <i>sit-to-stand test of 5 repetitions</i>
6MWT	<i>Six-minute walk test</i>
ACMS	<i>American College of Sports and Medicine</i>
AFVD	Atividade Física de Vida Diária
ANOVA	<i>Analysis of variance</i>
AUC	<i>Area under the curve</i>
BODE	<i>Body mass index, airflow Obstruction, Dyspnea and Exercise capacity</i>
BP	<i>Blood pressure</i>
CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
CCQ	<i>Clinical COPD Questionnaire</i>
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
COPD	<i>Chronic Obstructive Pulmonary Disease</i>
DAM	<i>Dynaport Activity Monitor</i>
DPOC	Doença Pulmonar Obstrutiva Crônica
FEV ₁	<i>Forced expiratory volume in the first second</i>
GOLD	<i>Global Initiative for Chronic Lung Disease</i>
HR	<i>Heart rate</i>
ICC	<i>Intraclass Correlation Coefficient</i>
IQR	<i>Interquartile range</i>
ISWT	<i>Incremental Shuttle Walking Test</i>
LFIP	Laboratório de Pesquisa em Fisioterapia Pulmonar
MET	<i>Metabolic equivalent</i>
MID	<i>Minimal Important Difference</i>
MRC	<i>Medical Research Council</i>
OMS	Organização Mundial da Saúde
PAD	<i>Physical activity duration</i>

PADL	<i>Physical Activity in Daily Life</i>
PFSDQ-M	<i>Pulmonary Functional Status and Dyspnea Questionnaire Modified version</i>
rep/sec	<i>number of repetitions per second</i>
ROC	<i>Receiver Operating Characteristics</i>
SD	<i>Standard deviation</i>
SGRQ	<i>St. George's Respiratory Questionnaire</i>
SpO ₂	<i>Oxygen saturation</i>
SPSS	<i>Statistical Package for the Social Sciences</i>
STS	<i>Teste sit-to-stand, sit-to-stand test</i>
SWA	<i>SenseWear Armband</i>
TC6min	<i>Teste de Caminhada de Seis Minutos</i>
UEL	<i>Universidade Estadual de Londrina</i>
UNOPAR	<i>Universidade Norte do Paraná</i>
VEF ₁	<i>Volume expiratório forçado no primeiro segundo</i>

SUMÁRIO

1	INTRODUÇÃO	12
2	REVISÃO DE LITERATURA – CONTEXTUALIZAÇÃO	14
2.1	DOENÇA PULMONAR OBSTRUTIVA CRÔNICA	14
2.2	Doença Pulmonar Obstrutiva Crônica e capacidade funcional	15
2.3	TESTE <i>SIT-TO-STAND</i> EM INDIVÍDUOS SAUDÁVEIS	16
2.4	TESTE <i>SIT-TO-STAND</i> E DOENÇA PULMONAR OBSTRUTIVA CRÔNICA	19
3	ARTIGO ORIGINAL	21
4	CONCLUSÃO GERAL	54
5	REFERÊNCIAS	55
6	APÊNDICE	58
	APÊNDICE A - Ficha de avaliação do teste <i>sit-to-stand</i>	59
	APÊNDICE B - Ficha de avaliação da espirometria	60
	APÊNDICE C - Ficha do Teste de Caminhada de Seis Minutos.....	61
	APÊNDICE D - Ficha do Incremental Shuttle Walking Test.....	62
	APÊNDICE E - Ficha do <i>4-metre gait speed test</i>	63
	APÊNDICE F - Ficha de avaliação de 1 repetição máxima (1RM)	64
7 ANEXOS	65
ANEXO A -	Termo de Consentimento Livre e Esclarecido do estudo.....	66
ANEXO B -	Parecer do Comitê de Ética	69
ANEXO C -	Normas de formatação do artigo no periódico Respiratory Care	70

1 INTRODUÇÃO

A Doença Pulmonar Obstrutiva Crônica (DPOC) é considerada uma doença sistêmica que não pode ser analisada somente pelo seu comprometimento pulmonar. Os efeitos extrapulmonares são diversos, e características como a disfunção muscular, alterações cardiovasculares e metabólicas[1] e limitação da capacidade funcional são potenciais fatores de risco para o prejuízo do estado de saúde a longo prazo[2]. Dentre esses fatores, a limitação da capacidade funcional é uma característica que merece notoriedade nesse cenário. Essa condição implica limitação de atividades físicas básicas diárias[3], tais como vestir-se, banhar-se e realizar atividades domésticas. Por esse motivo, a sua avaliação faz-se necessária e é de extrema importância[4].

Uma das formas mais comuns e conhecidas de avaliar a capacidade funcional desses indivíduos, é por meio do Teste de Caminhada de Seis Minutos (TC6min)[5, 6]. Esse é um teste válido, reprodutível e bem descrito na literatura em pacientes com DPOC[5]. Embora seja um teste simples, a realização do TC6min requer uma equipe treinada, necessita de espaço (um corredor de pelo menos 30 metros), e demanda tempo (intervalo de no mínimo trinta minutos entre dois testes)[5]. Portanto, testes ainda mais simples, como o teste *sit-to-stand* (STS), têm surgido na literatura como uma alternativa para obter informações sobre a capacidade funcional nessa população. O teste STS e o TC6min possuem uma excelente correlação[7] e apresentam respostas fisiológicas similares, corroborando assim o STS como uma opção[8].

O teste *sit-to-stand* é um teste prático, amplamente utilizado e primeiramente descrito[9] para avaliar a funcionalidade em idosos saudáveis[10-12]. Os movimentos de sentar e levantar são importantes funções da vida diária, e a incapacidade de realizá-los está associada à mortalidade, assim como prejuízos na mobilidade e funcionalidade[13]. Estudos do STS em diversas populações como em condições neurológicas[14] e ortopédicas[15, 16] têm sido realizados; no entanto, apenas recentemente estudos tem explorado o tema em profundidade nas doenças pulmonares crônicas[17-19]. O teste é considerado válido, reprodutível, responsivo[17, 20] e é um preditor de mortalidade em indivíduos com DPOC[19].

Uma variedade de estudos descrevem a associação do STS e desfechos clínicos importantes comumente avaliados na DPOC, tais como:

capacidade de exercício, dispneia, qualidade de vida, força muscular periférica, entre outros[17, 21-25]. Entretanto, esses resultados têm sido observados em protocolos diversificados[20], como no STS de 5 repetições (5-rep), 30 segundos (30-seg) e um minuto (1-min). O teste de 5-rep considera o tempo (em segundos) gasto para que o indivíduo sente-se e levante-se cinco vezes de uma cadeira [17]. Por outro lado, nos protocolos de 30-seg[21] e 1-min[7], é necessário realizar o mesmo movimento durante 30 e 60 segundos, respectivamente. Assim, o desfecho avaliado é o número de repetições obtido nos intervalos de tempo supracitados. Embora haja resultados consistentes sobre o uso de diversos protocolos do STS como uma ferramenta de avaliação funcional em pacientes com DPOC, é possível observar uma lacuna na literatura relacionada às diferenças de protocolos nessa população. Por conseguinte, os objetivos do estudo foram: 1) Correlacionar cada protocolo (5-rep, 30-seg e 1-min) com desfechos clínicos importantes em pacientes com DPOC, tais como: capacidade máxima e submáxima de exercício, força muscular periférica, atividade física de vida diária (AFVD), qualidade de vida e estado funcional; 2) Comparar três protocolos do STS, assim como verificar a associação e concordância entre eles em pacientes com DPOC; 3) Verificar se os três protocolos propostos são capazes de predizer a capacidade funcional de exercício e a AFVD.

A hipótese inicial para o estudo foi a de que houvesse diferença na velocidade dos protocolos, principalmente entre o de 5-rep e 1-min. Além disso, esperava-se que protocolos mais longos, como o STS de 1 minuto, pudesse ser discriminativo e portanto, correlacionasse melhor com capacidade funcional, força muscular periférica, capacidade máxima de exercício, qualidade de vida e AFVD do que protocolos mais curtos como o de 5 repetições e 30 segundos.

2 REVISÃO DE LITERATURA – CONTEXTUALIZAÇÃO

2.1 DOENÇA PULMONAR OBSTRUTIVA CRÔNICA

A Doença Pulmonar Obstrutiva Crônica é definida como uma “doença prevenível e tratável, caracterizada pela limitação persistente ao fluxo aéreo que é geralmente progressiva e está associada ao aumento da resposta inflamatória crônica nas vias aéreas e à partículas e gases nocivos nos pulmões”, segundo a *Global Initiative for Chronic Obstructive Lung Disease*. A limitação ao fluxo aéreo observada nesses pacientes é causada por alterações estruturais (ex. destruição do parênquima pulmonar) e estreitamento de vias aéreas decorrentes da resposta inflamatória crônica, induzidas principalmente pelo uso do cigarro e inalação de gases prejudiciais. Como consequência dessas alterações, é possível verificar o aumento da resistência de vias aéreas, diminuição na complacência pulmonar, assim como sintomas de dispneia e tosse produtiva nesses pacientes[26].

De acordo com a Organização Mundial de Saúde (OMS), aproximadamente 65 milhões de pessoas no mundo possuem o diagnóstico de DPOC, com grau de obstrução moderada a grave. Além disso, em 2002, a doença foi considerada a quinta maior causa de morte no mundo. Estima-se que mais de três milhões de indivíduos morreram em 2005 pela doença, o que corresponde a 5% da taxa de mortalidade global. No entanto, a perspectiva é a de que daqui a 10 anos, a porcentagem de óbitos possa aumentar em 30%, caso não haja medidas públicas para evitar a doença[27].

Embora a DPOC seja considerada uma doença que acomete o sistema respiratório, manifestações extrapulmonares e comorbidades podem estar associadas, causando complicações ao curso natural da doença. Dentre as condições agravantes estão: a disfunção muscular, osteoporose, câncer pulmonar, doenças cardiovasculares, distúrbios metabólicos e nutricionais, ansiedade e depressão[1, 26]. Desses, indubitavelmente, as alterações cardiovasculares são as que estão mais relacionadas à morbidade e mortalidade[28]. Esses fatores estão diretamente associados ao prognóstico e declínio da qualidade de vida dos pacientes. Além disso, todas as alterações sistêmicas geradas pela doença promovem a intolerância ao exercício, limitação da capacidade funcional, dessaturação ao esforço, diminuição da atividade física, fraqueza muscular e dispneia[1].

Sabendo-se da complexidade das manifestações apresentadas pela DPOC, é necessário encontrar estratégias para a melhor forma de avaliação e tratamento. Assim, a terapia deve considerar as alterações sistêmicas e as comorbidades, e não somente o controle dos sintomas e redução de exacerbações. Para isso, além do tratamento farmacológico, a reabilitação pulmonar pode ser a melhor alternativa para abranger o amplo espectro de manifestações sintomatológicas da doença[29].

2.2 DOENÇA PULMONAR OBSTRUTIVA CRÔNICA E CAPACIDADE FUNCIONAL

Pacientes com DPOC apresentam intolerância ao exercício, a qual não pode ser explicada singularmente pela limitação ventilatória[30]. Dentre os fatores contribuintes, está a redução na capacidade funcional de membros inferiores e que concomitantemente com a fraqueza muscular periférica, contribui para a limitação ao exercício e desenvolvimento de condições incapacitantes da doença[31]. A redução da capacidade funcional de exercício reflete uma limitação nas atividades cotidianas, tais como banhar-se, realizar compras e atividades domésticas[4, 31].

A capacidade funcional tem importante papel no impacto sobre a DPOC. Eisner et al. (2011) verificaram em seu estudo que fatores como limitação funcional e o desenvolvimento de limitações “não-respiratórias”, como fraqueza muscular, redução da capacidade de exercício e mobilidade, são potenciais fatores de risco para o desenvolvimento de condições incapacitantes após dois anos de seguimento. Portanto, a avaliação e o tratamento somente relacionados ao aspecto pulmonar não são suficientes para prevenir essa progressão[2]. Assim, a avaliação quanti e qualitativa da capacidade funcional em pacientes com DPOC é de extrema importância. Uma avaliação adequada irá fornecer informações relacionadas à doença, o que possibilita um manejo mais efetivo e auxilia os pacientes no enfrentamento da doença[4]. A avaliação funcional compreende a análise de dados, objetivos e subjetivos relacionados à doença no intuito de obter uma descrição do estado funcional e das reais condições do paciente em realizar atividades de vida diária. As indicações para que essa avaliação seja realizada abrangem: determinação da causa da alteração do estado funcional, verificação do grau de limitação física,

determinação da terapia adequada e dos riscos pré-operatórios. Embora inúmeras sejam as opções disponíveis para avaliar a condição funcional, faz-se necessária determinar a mais adequada para contribuir com um tratamento mais efetivo[4].

Dentre as opções de avaliação da capacidade funcional, o TC6min é o recurso que avalia de forma objetiva e é amplamente utilizado nessa população[5]. O TC6min é um teste válido, reproduzível e responsivo aos programas de reabilitação pulmonar. Além disso, é considerado importante preditor de mortalidade e hospitalizações em pacientes com DPOC[5]. No entanto, alguns aspectos técnicos relacionados ao teste, como o tempo e espaço, além da necessidade de equipe treinada, dificultam sua ampla utilização na prática clínica[6]. A praticidade do teste é comprometida, pois para a sua realização, são necessários dois testes com um intervalo mínimo de 30 minutos entre eles, demandando um tempo prolongado. Da mesma forma, é necessário um corredor de 30 metros para que o teste seja aplicado, limitando a sua aplicação em espaços menores. Embora alguns TC6min com corredores menores tenham sido propostos, como por exemplo em um corredor de 10 metros, sabe-se que corredores menores podem alterar a interpretação do teste[32]. Portanto, novos testes que avaliam a capacidade funcional de membros inferiores dos indivíduos com DPOC, como o *4-metre gait speed* (4MGS), teste do *sit-to-stand* e o teste do degrau, têm surgido como alternativas viáveis na prática clínica[20].

2.3 TESTE SIT-TO-STAND EM INDIVÍDUOS SAUDÁVEIS

O teste *sit-to-stand* (STS) foi primeiramente descrito por Csuka e McCarty (1985) como um método alternativo para avaliar a força muscular de membros inferiores em idosos saudáveis. O protocolo consistia na realização de 10 repetições de movimentos de sentar e levantar o mais rapidamente possível, utilizando o tempo como desfecho. Dessa forma, o teste mostrou ser um método simples, rápido, e reproduzível de avaliar o constructo proposto em idosos[9]. Após esse estudo, outros foram surgindo seqüencialmente, para investigar o teste em profundidade[33, 34].

O STS é considerado um teste prático que avalia a capacidade funcional e abrange uma atividade comum no cotidiano: movimentos de sentar e levantar de uma cadeira. Em idosos saudáveis, a incapacidade de realização desse

movimento básico na vida diária está relacionada com institucionalizações, limitações de mobilidade e funcionalidade. Portanto, a avaliação do ato de sentar e levantar torna-se importante e tem sido utilizada como uma das ferramentas para identificação do estado funcional[13].

Vários estudos têm explorado a associação do teste STS com desfechos clínicos importantes em indivíduos saudáveis, tais como: força muscular de membros inferiores[34-37], quedas[11, 38], equilíbrio[39] e até mesmo com incapacidades cognitivas[33]. Essa variedade de estudos inclui diferentes protocolos do STS, como o teste que utiliza 5 repetições[11, 34, 38], 30 segundos[35], e 1 minuto[40]. Além da diversidade de protocolos, alguns aspectos técnicos também diferem entre si, como a altura da cadeira, velocidade, posição dos membros inferiores e do tronco[13]. Sabe-se que a altura da cadeira pode influenciar no resultado do teste, pois cadeiras mais baixas dificultam a realização do movimento. Há um aumento da velocidade angular do tronco, quadril e joelhos ao levantar-se e maior necessidade de estabilização dos pés[13]. Chorin et al. (2015) demonstraram que uma diferença de 19 cm na altura da cadeira aumenta em 12% o tempo despedido para levantar[41]. Da mesma forma que a altura da cadeira, a velocidade do teste pode influenciar nos resultados obtidos, visto que há uma variação de 60% na duração do movimento quando realizados de forma auto ritmada e rápida. A velocidade pode modificar a angulação da flexão do quadril, a extensão dos joelhos e a dorsiflexão dos tornozelos. Embora alguns autores tenham realizado o STS com uma velocidade rápida, ou ditada por um metrônomo ou auto selecionada pelo indivíduo, a melhor escolha é a velocidade rápida. Isso ocorre pois uma velocidade usual fornece dados subjetivos, isto é, o indivíduo pode ajustar a velocidade para uma condição que seja confortável enquanto isso não acontece com a velocidade rápida[41]. O posicionamento dos pés, do tronco e dos membros superiores também são aspectos importantes na execução do teste. Quando os pés estão posicionados posteriormente à cadeira e o quadril inicia-se em flexão, o tempo exigido para a realização do movimento é maior[13]. Portanto, a posição ideal para a realização do teste é sentado com 90° de flexão de quadril, joelhos e tornozelos[41]. Quando os membros superiores estão livres, a propensão dos idosos é utilizá-los para auxiliar no movimento. Por isso, é necessária uma padronização da posição de membros superiores para que isso não ocorra[13]. A melhor opção demonstrada por Chorin et al. (2015) é mantê-los cruzados sobre o tórax[41].

Valores de referência foram desenvolvidos para o STS a fim de fornecer uma melhor interpretação da capacidade funcional. Os protocolos que possuem esses valores estabelecidos são o de 5 repetições, 30 segundos e 1 minuto[10, 40, 42]. Bohannon (2006) encontrou valores de referência para a população de idosos saudáveis e determinou um intervalo do tempo gasto para sentar e levantar em 5 repetições de acordo com a idade. Os indivíduos que excedem o limite de tempo estabelecido, de 60 a 69 anos (11,4 segundos), de 70 a 79 anos (12,6 segundos) e de 80 a 89 anos (14,8 segundos), podem ser classificados com um desempenho ruim no teste[10]. No protocolo de 30 segundos, Rikli e Jones (2012), determinam o número de repetições conforme a idade: 60 a 64 anos (14 a 19 repetições), de 65 a 69 anos (12 a 18 repetições), de 70 a 74 anos (12 a 17 repetições), 75 a 79 anos (11 a 17 repetições), de 80 a 84 anos (10 a 15 repetições), de 85 a 89 anos (de 8 a 14 repetições) e de 90 a 94 anos (7-12 repetições)[42]. Já no teste de 1 minuto, Strassmann et al. (2012) propõem uma tabela com o número de repetições necessários para os limites de idade[40], como mostra a Figura 1.

Figura 1. Valores de referência para o STS de 1 minuto (Strassmann et al.,2012)[40].

Age group (years)	Number of STS repetitions									
	Men					Women				
	p2.5	p25	p50	p75	p97.5	p2.5	p25	p50	p75	p97.5
20–24	27	41	50	57	72	31	39	47	55	70
25–29	29	40	48	56	74	30	40	47	54	68
30–34	28	40	47	56	72	27	37	45	51	68
35–39	27	38	47	58	72	25	37	42	50	63
40–44	25	37	45	53	69	26	35	41	48	65
45–49	25	35	44	52	70	25	35	41	50	63
50–54	24	35	42	53	67	23	33	39	47	60
55–59	22	33	41	48	63	21	30	36	43	61
60–64	20	31	37	46	63	20	28	34	40	55
65–69	20	29	35	44	60	19	27	33	40	53
70–74	19	27	32	40	59	17	25	30	36	51
75–79	16	25	30	37	56	13	22	27	30	43

2.4 TESTE *SIT-TO-STAND* E DOENÇA PULMONAR OBSTRUTIVA CRÔNICA

O teste *sit-to-stand* tem sido melhor explorado na DPOC nos últimos anos, sendo que o primeiro estudo comparou e correlacionou o STS realizado durante um minuto com respostas obtidas no TC6min[7]. Outros estudos mostram que o STS é um teste válido[21], reprodutível e responsivo em pacientes com DPOC, com valor de *Minimum Important Difference* (MID) estabelecido em 1,7 segundos para o STS de 5 repetições[17].

Algumas vantagens podem ser observadas no STS como uma ferramenta de avaliação em pacientes com DPOC. O teste é considerado rápido, ao contrário do TC6min e do *Incremental Shuttle Walking Test* (ISWT), que necessitam de corredores maiores e um tempo maior; é acessível, pois necessita somente de uma cadeira e um cronômetro e requer pouco espaço, possibilitando a sua prática em clínicas e na beira dos leitos de hospitais. A avaliação de sentar e levantar também pode ser utilizado como um acessório de estratificação para aqueles que possuem capacidade de exercício reduzida[17].

Puhan et al. (2013) demonstraram que o STS de 1 minuto é um importante preditor de mortalidade em pacientes com DPOC (AUC=0,78), com valores melhores que o índice de massa corporal (AUC=0,52), VEF₁ (AUC=0,61), dispneia (AUC=0,63) e força muscular (AUC=0,62). Para complementar o valor prognóstico do STS, o número de repetições obtido no teste foi inserido no índice *Body mass index, airflow, Obstruction, Dyspnea and Exercise capacity* (BODE) no lugar do TC6min, e o valor discriminativo permaneceu excelente [19]. Essa semelhança no valor discriminativo do STS de 1 minuto e do TC6min pode ser explicada pelo fato de ambos os testes possuírem aspectos similares que compõe a capacidade de exercício [19], como a interação do sistema respiratório, cardiovascular e muscular [43].

Além de ser um preditor de mortalidade, o STS associa-se com outras variáveis comumente avaliadas na DPOC, como: capacidade de exercício[7, 17], força muscular periférica[17, 21, 22], qualidade de vida[17], mobilidade[24] e AFVD[25]. Adicionalmente, é possível verificar que pacientes com DPOC possuem maior déficit de controle postural para a execução do teste, em relação a indivíduos saudáveis. Esse dado foi confirmado por Janssens et al. (2014) que compararam dois

grupos (DPOC vs idosos saudáveis) enquanto realizavam o movimento de sentar e levantar da cadeira durante 5 repetições, posicionada em cima de uma plataforma de força. Os indivíduos com DPOC demandaram maior tempo para realizar o teste em comparação aos idosos, o que foi explicado pelo maior tempo na posição em pé e em pé para sentado, fases essas que requerem maior controle postural[18].

Assim como em estudos com idosos saudáveis, existe uma variedade de protocolos propostos para avaliação da capacidade funcional em indivíduos com DPOC. Os protocolos descritos na literatura são: sentar e levantar da cadeira utilizando 5 repetições, ou durante 30 segundos, 1 minuto e 2 minutos[20]. Os testes mais utilizados internacionalmente são o de 5 repetições, 30 segundos e 1 minuto e em apenas 2 estudos brasileiros foram utilizados o protocolo de 2 minutos[20]. Somente um estudo foi encontrado com um protocolo diferente dos demais, descrito por Aguilaniu et al. e denominado “*3-minute chair rise test*”. Nesse protocolo o avaliador dita um ritmo durante o primeiro minuto, e nos dois minutos seguintes, o indivíduo realiza o teste para perfazer o maior número de repetições[8]. Existem também diferenças técnicas em relação à altura da cadeira, no entanto, somente no estudo de Janssens et al. (2014) a altura da cadeira foi ajustada para manter 90° de flexão de quadril, joelhos e tornozelos[18].

A avaliação funcional pelo STS é de extrema importância, visto que essa atividade de sentar e levantar faz parte do cotidiano de muitos indivíduos. O teste tem se mostrado prático e simples, capaz de refletir a capacidade funcional de pacientes com DPOC, embora haja diferenças metodológicas. Portanto, é necessário conhecer as diferenças existentes entre os três STS mais comumente utilizados e verificar qual teste possui melhor relação com aspectos como força muscular, capacidade de exercício, qualidade de vida e AFVD e, assim, fazer a escolha do protocolo que melhor auxilie na investigação de comprometimentos funcionais nessa população.

3 ARTIGO ORIGINAL

Which is the best protocol of the sit-to-stand test in patients with chronic obstructive pulmonary disease?

Andrea Akemi Morita, MSc^{1, 2}; Gianna Waldrich Bisca, MSc¹; Felipe Vilaça Cavallari Machado, PT¹; Nidia Aparecida Hernandez, PhD¹; Fabio Pitta, PhD¹; Vanessa Suziane Probst, PhD¹.

¹ Laboratory of Research in Respiratory Physiotherapy (LFIP), Department of Physiotherapy, State University of Londrina (UEL), Londrina, Brazil.

² Program of Masters and Doctoral degree in Rehabilitation Sciences, State University of Londrina (UEL) and University North of Paraná (UNOPAR), Londrina, Brazil.

Author contributions:

Ms. Andrea Akemi Morita: literature search, data collection, study design, data analysis, manuscript preparation, review of manuscript.

Ms. Gianna Waldrich Bisca: literature search, data collection, study design, data analysis, review of manuscript.

Mr. Felipe Vilaça Cavallari Machado: data collection, study design, data analysis, review of manuscript.

Dr. Nidia Aparecida Hernandez: study design, data analysis, review of manuscript.

Dr. Fabio Pitta: study design, data analysis, review of manuscript.

Dr. Vanessa Suziane Probst: study design, data analysis, manuscript preparation, review of manuscript.

The study was carried out at the Laboratory of Research in Respiratory Physiotherapy (LFIP) of State University of Londrina, Paraná, Brazil.

Ms. Morita has presented this research data at the 25th Annual Congress of the European Respiratory Society, in September 26–30 2015, in Amsterdam, Netherlands.

Financial support:

Andrea Akemi Morita is supported by a MSc grant from CAPES, Brazil.

Gianna Waldrich Bisca is supported by a PhD grant from CAPES, Brazil.

Fabio Pitta is supported by a research grant from CNPq, Brazil.

Vanessa Suziane Probst is supported by a research grant from Fundação Araucária, Brazil.

All authors have no conflict of interest to disclose.

Corresponding author:

Vanessa Suziane Probst, PhD

Departamento de Fisioterapia – Centro de Ciências da Saúde, Hospital Universitário de Londrina

Avenida Robert Koch, 60 – Vila Operária, 86038-350 - Londrina, Paraná, Brazil

E-mail: vanessaprobst@gmail.com

Abstract:

BACKGROUND: Different protocols of the sit-to-stand test (STS) are available to assess functional capacity in patients with COPD. **AIMS:** To correlate each protocol of the STS (5-repetition [5-rep_STS], 30-second [30-sec_STS] and 1-minute [1-min_STS]) with clinical outcomes in patients with COPD; to compare three protocols of the STS as well as to verify their association and agreement; to verify whether the three protocols are able to predict functional exercise capacity and physical activity in daily life (PADL). **METHODS:** Twenty-three patients with COPD (11 men; FEV1:53±15%pred) performed three protocols of the STS. Patients also underwent the following assessments: Incremental Shuttle Walking Test, 6-minute walk test (6MWT), 4-metre gait speed test (4MGS), 1-repetition maximum of quadriceps muscle, assessment of PADL and questionnaires of health-related quality of life and functional status. **RESULTS:** The 1-min_STS presented significant correlations with 6MWT ($r=0.40$), 4MGS ($r=0.64$) and PADL ($0.40 \leq r \leq 0.52$) and the 5-rep_STS and 30-sec_STS were associated with 4MGS ($r=0.54$ and $r=0.52$, respectively). The speed differed between 5-rep_STS and 1-min_STS protocols (5-rep_STS: 0.53 ± 0.16 rep/sec; 30-sec_STS: 0.48 ± 0.13 rep/sec; 1-min_STS: 0.45 ± 0.11 rep/sec; $P=.01$). However, they presented good agreement ($ICC \geq 0.73$ for all) and correlated well with each other ($r \geq 0.68$ for all). More marked changes in peripheral oxygen saturation, heart rate, blood pressure, dyspnea and leg fatigue were found after the 1-min_STS protocol ($P \leq .01$ for all). Furthermore, the three protocols were equally able to discriminate patients with low and preserved exercise capacity. **CONCLUSION:** The 1-min_STS generates higher hemodynamic demands and correlates better with clinical outcomes in patients with COPD. Despite the difference in speed performance and physiologic demand

between the 5-rep_STS and 1-min_STS there is good level of agreement among the three different protocols. In addition, all three tests were able to discriminate patients with low and preserved exercise capacity.

KEY WORDS: pulmonary disease, chronic obstructive; exercise test; motor activity; activities of daily living; hemodynamics; patient outcome assessment.

Introduction

It is well known that chronic obstructive pulmonary disease (COPD) is outlined as a systemic disease and not only by pulmonary impairment. The extra-pulmonary effects, such as muscle dysfunction, cardiovascular and metabolic disorders¹ and decreased functional capacity are potential risk factors for health status decline over time². Concerning these factors, the marked impairment observed in subjects with COPD is the functional capacity limitation. This condition implies in constrains for basic physical actions³. For this reason, assessment of functional capacity is extremely important and necessary⁴.

One of the most common and reliable tools to assess functional capacity in patients with COPD is the six-minute walk test (6MWT)^{5, 6}. Although it is considered a simple test, it requires space, time and trained staff⁵. To overcome these barriers, recent studies have suggested the use of the sit-to-stand test (STS) as an alternative in this population. The STS and the 6MWT correlate well with each other⁷ and present similar responses such as hemodynamic and symptoms, supporting the STS as an option⁸.

The STS is a simple and practical test, widely adopted to evaluate functionality in community-dwelling elderly⁹⁻¹¹. The movement of standing up and sitting down are important functions of daily life and the inability to perform these basic skills is associated with mortality, functioning and mobility impairment¹². The application of the STS in different populations such as in neurologic¹³ and orthopedic^{14, 15} conditions has been largely investigated; conversely, in COPD, only recent studies have explored the test in depth¹⁶⁻¹⁸. Among the available information, it is known that the test is considered valid, reliable, responsive¹⁶ and it is a predictor of mortality in patients with COPD¹⁸.

Additionally, many studies describe the relationship between the STS and commonly measured outcomes in subjects with COPD, such as exercise capacity, dyspnea, health-related questionnaires and muscle strength, amongst others^{16,19-23}. However, these results were observed in a variety of protocols (i.e. 5-repetition [5-rep_STS], 30-second [30-sec_STS] and 1-minute [1-min_STS])²⁴ and it is unknown which is the best protocol to assess this population. Therefore, the aims of this study were: 1) to verify which is the best protocol concerning the correlation of each test (5-rep_STS, 30-sec_STS and 1-min_STS), with important clinical outcomes in subjects with COPD such as maximal and functional exercise capacity, peripheral muscle strength, physical activity in daily life (PADL) and questionnaires of health-related quality of life and functional status; 2) to compare three protocols of the STS as well as to verify their association and agreement in patients with COPD; 3) to verify whether the three protocols are able to predict functional exercise capacity and PADL. The initial hypothesis was that there was difference among protocols, mainly between the 5-rep_STS and 1-min_STS. Furthermore, it was hypothesized that longer lasting tests, such as the 1-min_STS could be a more discriminative test and therefore, would be better correlated to functional capacity, muscle strength, maximal exercise capacity, health-related questionnaires and PADL.

Methods

Study Design

This is a cross-sectional and observational study conducted from January 2014 to May 2015 at the Laboratory of Research in Respiratory Physiotherapy of State University of Londrina (UEL), Brazil. All subjects with COPD underwent the following assessments:

lung function, maximal and functional exercise capacity, peripheral muscle strength, PADL and health-related quality of life and functional status questionnaires. Individuals were also submitted to three different protocols of the STS (5-rep_STS, 30-sec_STS and 1-min_STS) in a randomized sequence. The study was approved by the ethics committee of the State University of Londrina, Brazil (080/2014) and all patients signed a written informed consent.

Participants

The inclusion criteria of this study were: subjects with diagnosis of COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria²⁵, clinical stability (absence of exacerbations within the previous 3 months) and no participation in regular rehabilitation or physical exercise programs in the last year.

Participants were excluded if they had any severe comorbidity that could impair performance in the tests such as severe cardiovascular, orthopedic or neuromuscular conditions; or in case they, for any reason, did not complete all the assessments.

Sit-to-stand test protocols

Three protocols of STS (5-rep_STS, 30-sec_STS and 1-min_STS) have been chosen in order to make comparisons among tests. The reason for choosing them was that these three protocols are the most usually described in the literature in patients with COPD²⁴. All three tests were performed in an armless chair with a height of 46 cm; subjects were instructed to fold their arms across their chest and perform the movement of stand up and sit down as fast as possible. According to the protocol of Jones et al.¹⁶, in the 5-rep test, patients performed five movements of standing up and sitting down as fast as they could and the stopwatch was used to measure the time

spent in the activity. On the other hand, in the protocol of 30 seconds and 1 minute, patients were instructed to sit down and stand up as many times as possible within 30 seconds¹⁹ and one minute⁷, respectively; and the number of repetitions was recorded. Moreover, since the outcomes of these three protocols were different (time and number of repetitions), the speed (number of repetitions per second) was considered in the analysis. Heart rate (HR), oxygen saturation (SpO₂), blood pressure (BP) and symptoms of dyspnea and fatigue (rated by the Modified Borg Scale²⁶) were measured before and after each test. The order of the tests was randomized and the rest period between them was empirically standardized. After the 5-rep_STS test, there was at least five minutes of interval; after the 30-sec_STS protocol, at least, 15 minutes; and after the 1-min_STS, at least 30 minutes of rest.

Assessments

Lung function was assessed by spirometry using a portable spirometer (Spiropalm®; COSMED, Italy). The test was performed according to the American Thoracic Society/European Respiratory Society (ATS/ERS) statement²⁷ and the predicted values were calculated using a specific equation for the Brazilian population²⁸.

Maximal and functional exercise capacity were assessed by the Incremental Shuttle Walking Test (ISWT) and 6MWT, respectively. The ISWT and the 6MWT were performed following the ERS/ATS technical standard of field walking tests in chronic respiratory disease⁵, and reference values described for Brazilians were used for each test^{29, 30}. Oxygen supplementation was provided when necessary. Patients were separated into two groups according to the percentage of predicted value of the six-minute walk distance (6MWD): low and preserved exercise capacity group. The ones who had less than 82% of predicted distance³¹ were classified as having low exercise

capacity, and those above this threshold were considered with preserved performance. Functional capacity was also evaluated by the 4-metre gait speed test (4-MGS), in which patients were instructed to walk at their own pace, with a self-selected speed, in a 4-meter corridor³². Two tests without rest were performed and the fastest one was considered.

Quadriceps muscle strength was assessed by the one-repetition maximum (1RM) test in a multi-gym equipment (CRW 1000, Brazil). The test was performed according to the Procedures Recommendations for Accurate Assessment of Muscular Strength and Power guideline³³.

Two activity monitors assessed PADL: the DynaPort Activity Monitor (DAM) (McRoberts BV, The Hague, the Netherlands) and the multisensor SenseWear Armband (SWA) (BodyMedia Inc., Pittsburgh, PA, USA). The main variables obtained by these devices were: time spent walking, standing, sitting, lying and locomotion per day (assessed by the DAM); total energy expenditure and time spent in sedentary, moderate, intense and very intense activities (assessed by the SWA). Patients were instructed to wear both devices during one week, for 12 hours per day, and the mean of the seven days was considered. For statistical analysis, patients were separated into two groups: active and inactive according to the American College of Sports and Medicine (ACSM) recommendations³⁴. The active and inactive groups performed respectively above or below 30 minutes per day of physical activity at least at moderate intensity. In order to classify moderate intensity of physical activity, the metabolic equivalents (METs) threshold was considered, according to the ACSM (4.0 to 5.9 METs for patients with 40-64 years old and 3.2 to 4.7 METs for subjects older than 65 years old)³⁴.

Health-related quality of life was assessed by the St. George's Respiratory Questionnaire (SGRQ)³⁵ and self-reported functional status by the Pulmonary Functional Status and Dyspnea Questionnaire modified version (PFSDQ-M)³⁶.

Statistical Analyses

All analyses were performed using the statistics software packages SPSS version 20.0 (Statistical Package for the Social Sciences Inc., Chicago, Illinois, USA), GraphPad Prism 6.0 (GraphPad Software Inc., San Diego, California, USA) and Medcalc version 15.8 (MedCalc Software, Ostend, Belgium). The normality of continuous variables was checked by the Shapiro-Wilk test and described as mean \pm SD or median [IQR]. Correlations between the STS test and clinical outcomes were obtained using the Pearson or Spearman correlation coefficients. Comparisons amongst three protocols of STS test and variables measured before and after each test were analyzed by repeated measures ANOVA or Friedman test followed by the Tukey or Dunn's post-hoc tests, respectively. Likewise, the differences of HR, SpO₂, BP and scores of dyspnea and fatigue before and after each test were assessed by the Students' t-test or the Wilcoxon test. To analyze agreement between protocols, the intraclass correlation coefficient (ICC) and Bland & Altman plot³⁷ were used. $P \leq .05$ was set as statistically significant.

The Receiver Operating Characteristic (ROC curve) analysis³⁸ was used in order to show the ability of each STS protocol to discriminate patients with low or preserved functional exercise capacity (6MWT) and as physically inactive or active in terms of PADL. The comparisons of areas under the ROC curve (AUC) were performed by the Hanley & McNeil method³⁹.

The sample size calculation was performed with the GPower 3.1.3 software (Franz Faul, Universitat Kiel, Germany) considering the study of Ozalevli et al.⁷ Taking into account a correlation between the 6MWT and the 1-min_STS test of -0.75, alpha value of 0.01, power of 90% and 20% of loss during the evaluation period, the number of subjects for this study was 23 patients.

Results

Twenty-nine patients with COPD took part in the study; however, six subjects were excluded due to the following reasons: two patients for vascular and orthopedic limitations, one had an exacerbation during the assessment period, one did not complete all the assessments for personal reason and two patients died during this period. Thus, data from 23 patients were available for analyses and their characteristics are described in Table 1. Overall, majority of the sample was composed by patients with moderate degree of airflow obstruction and was classified as GOLD II. Subjects walked 476 ± 63 m in the 6MWT and nine (39%) patients used oxygen supplementation during the test.

Association of STS protocols with clinical outcomes

Table 2 presents the correlations found between the three protocols of the STS and clinical outcomes such as functional exercise capacity, functional status and PADL. A significant association was found between the 5-rep_STS and functional capacity evaluated by the 4-MGS. The 30-sec_STS protocol was also correlated with the 4-MGS. Some variables of PADL measured by the DAM, such as walking and locomotion were also associated with this protocol (Table 2).

Many other variables such as 6MWT, activity score of the PFSDQ-M questionnaire, physical activity duration (PAD) and standing position were associated with the 1-min_STS; as well as the 4-MGS, walking and locomotion variables. The values of correlation of this protocol and the 4-MGS and PADL outcomes were higher than for the other two STS tests (Table 2).

None of the other assessed outcomes such as lung function, ISWT, SGRQ and quadriceps strength were associated with the 5-rep_STS, 30-sec_STS and 1-min_STS protocols ($P > .05$).

Comparisons among protocols

The speed (number of repetitions per second) of the three STS protocols was different (5-rep_STS: 0.53 ± 0.16 rep/s vs 30-sec_STS: 0.48 ± 0.13 rep/s vs 1-min_STS: 0.45 ± 0.11 rep/s; $P = .01$) (Figure 1). The post-hoc analysis showed difference between the 5-rep_STS and 1-min_STS, thus patients performed the 5-rep_STS protocol faster than in the 1-min_STS ($P = .01$).

Patients started all the tests with similar SpO₂, HR, systolic and diastolic BP. Moreover, there were no differences on symptoms of dyspnea and fatigue measured before each protocol (Table 3).

The comparisons of the changes in oxygen saturation, hemodynamic and symptom variables, described in Table 4, differed among protocols, except for the diastolic BP. The 1-min_STS protocol had a greater variation of SpO₂, HR, systolic BP and symptoms of dyspnea and fatigue when compared to the 5-rep_STS. Differences were also found between the delta of SpO₂, HR and symptoms of fatigue between the 1-min_STS and 30-sec_STS protocols. Finally, the 30-sec_STS presented higher

changes in terms of HR, systolic BP and symptoms of dyspnea when compared to the 5-rep_STS protocol (Table 4).

In addition to the aforementioned analysis, Table 5 shows the differences between oxygen saturation, hemodynamic and symptom variables measured before and after each protocol. In the 5-rep_STS, the final HR, systolic BP and symptoms of dyspnea were higher than at the beginning of the test. The protocol of 30-sec_STS and 1-min_STS showed significant desaturation, and increase in HR, systolic BP and symptoms of dyspnea and fatigue. The diastolic BP significantly increased in the 1-min_STS and did not present changes in the 30-sec_STS protocol.

Correlation and agreement among protocols

The 5-rep_STS, 30-sec_STS and 1-min_STS had a significant correlation with each other, with r values higher than 0.68 (Table 2). Additionally, they showed a good agreement pairwise (ICC: 5-rep_STS and 30-sec_STS of 0.85 [95% CI 0.61- 0.93; $P < .0001$]; 5-rep_STS and 1-min_STS of 0.73 [95% CI 0.22- 0.89; $P < .0001$]; 30-sec_STS and 1-min_STS of 0.77 [95% CI 0.46- 0.90; $P < .0001$]), illustrated by the Bland & Altman plot (Figure 2).

Sit-to-stand test to predict functional exercise capacity and physical activity in daily life

Concerning functional exercise capacity assessed by the 6MWT, fifteen (65%) patients were considered as having preserved capacity and eight (35%) subjects with the predicted distance lower than 82%. The AUC calculated for the three protocols had discriminative values for poor and preserved exercise capacity: 0.71 (5-rep_STS), 0.85 (30-sec_STS) and 0.82 (1-min_STS). Subsequently, the comparison of AUCs

(Figure 3) did not present any difference (difference between areas: 5-rep_STS vs 30-sec_STS: 0.14, $P= .11$; 5-rep_STS vs 1-min_STS: 0.11, $P= .13$; 30-sec_STS vs 1-min_STS: 0.02, $P= .73$).

An analysis regarding PADL showed that 11 (48%) patients were classified as active and 12 (52%) as inactive. The 5-rep_STS had an AUC of 0.67, the 30-sec_STS of 0.65 and the 1-min_STS of 0.57, which did not allow discriminating active and inactive subjects. There were no differences between these AUCs (Figure 3) and the values of the differences between areas were: 0.02 for the 5-rep_STS vs 30-sec_STS ($P= .79$), 0.10 for the 5-rep_STS vs 1-min_STS ($P= .22$) and 0.08 for the 30-sec_STS vs 1-min_STS ($P= .42$).

Discussion

This study showed which is the best STS protocol concerning the strongest correlation of each protocol (5-rep_STS, 30-sec_STS and 1-min_STS) with important clinical outcomes in patients with COPD. All three protocols exhibited associations with functional capacity measured by the 4-MGS. The 30-sec_STS protocol correlated with PADL and the 1-min_STS was associated with the 6MWT, PFSDQ-M questionnaire and PADL. Additionally, there is difference among the three STS protocols in patients with COPD. This difference appears between the 5-rep_STS and 1-min_STS protocol, in which patients stood-up and sat-down faster in the 5-rep_STS than in the 1-min_STS protocol. The comparison among deltas of oxygen saturation, cardiovascular and symptom variables revealed that the STS performed within one minute was more stressful, excepted for the diastolic BP. Furthermore, there was more desaturation, and increment of HR, systolic and diastolic BP and symptoms of dyspnea and fatigue

at the end of the 1-min_STS test. In spite of these differences, the three protocols correlated well with each other and had a good agreement. Moreover, the three protocols were able to discriminate patients with low and preserved exercise capacity in the 6MWT with $AUC > 0.71$, however, this was not the case for PADL. None of the three STS protocols were able to adequately predict patients classified as active and inactive.

The STS test was firstly described by Csuka and McCarty⁴⁰, in which the protocol of ten repetitions was used. It was considered an inexpensive, simple, rapid and reproducible test to assess lower limb muscle strength in healthy subjects. After this study, many other protocols of the STS were risen to test functional capacity of lower limbs in a variety of populations, including patients with COPD. A large number of protocols are available and the present study is the first to describe the differences among them in this population. Indeed, we observed that patients in the present study completed the 5-rep_STS faster than in the 1-min_STS. This fact might have occurred due to an increase of symptoms during the 1-min_STS test compared to the 5-rep_STS protocol (Table 4), resulting in lower performance. Similar results are demonstrated in the gait speed test, in which healthy elderly had a higher value of speed in shorter distances (comparison of 5 m and 10 m)⁴¹. Moreover, the 1-min_STS test presented a higher oxygen desaturation, hemodynamic and symptom demands in comparison to the other two tests (Table 4 and 5). It is reasonable that the longest test (1-min_STS) demanded higher physical effort. Despite this difference, the three STS protocols had moderate association ($r \geq 0.68$) and good agreement ($ICC \geq 0.73$) among them.

All three protocols were associated with the 4-MGS, which is also considered a functional test²⁴. This result was expected, since both tests have the purpose to

assess lower limb function with movements usually adopted in daily life. Ozalevli et al. showed that the STS correlated with the score of the physical function domain (consisted of daily walking activities) of the Nottingham Health Profile Survey questionnaire in patients with COPD⁷. Likewise, Whitney et al. verified moderate correlation between the 5-rep STS and Dynamic Gait Index in subjects with balance disorders⁴². Other important correlation found in the present study was between PADL and the 30-min_STS protocol, as well as with the 1-min_STS protocol. The 1-min_STS had better association with PADL in COPD, similarly to the study by Van Gestel et al²³, in which they showed correlation between the 1-min_STS and objectively measured physical activity²³. Indeed, this association could be explained because motion sensors devices (i.e. accelerometers) are reliable to provide kinetic and kinematic data from the STS in elderly⁴³⁻⁴⁵. Only the 1-min_STS correlated with other variables such as the 6MWT and the activity score of the PFSDQ-M questionnaire. There is some evidence in the literature suggesting the STS as an option to the 6MWT to measure functional capacity^{7, 8}. Both tests have good correlation and the advantage of the STS is that it causes less hemodynamic stress to patients with COPD⁷. Moreover, the functional status obtained by the PFSDQ-M questionnaire was significantly associated with the 1-min_STS test. This finding reinforces the STS as a tool to assess functional condition.

Lower limb strength is a meaningful factor that could potentially limit the ability of standing up and sitting down from a chair in elderly⁴⁶. Even though many studies in the literature have shown correlation between the STS and quadriceps muscle strength, both in healthy⁴⁶⁻⁵¹ and COPD^{16,19-22} in this study we did not find any correlation between these variables. One plausible explanation for this could be related to the limitation of the assessment method for muscle force used in the present study (i.e.,

the 1RM). The use of a more accurate tool to assess muscle strength, for instance, dynamometry, could have led to different findings. The absence of association between STS and quadriceps muscle strength could also be explained by the requirement of other abilities in daily life rather than muscle force, such as postural and balance control^{17, 42}, hip and ankle motion⁵⁰.

In a discriminative analysis, patients with COPD with low and preserved exercise capacity according to the 6MWT were adequately identified by the proposed STS protocols. All three tests showed similar AUC meaning that they have similarity to predict exercise capacity. Similar results were found in the study by Jones et al., in which the STS was considered a stratification tool to identify impaired walking capacity obtained by the ISWT (AUC= 0.82)¹⁶. On the other hand, none of the tests was able to predict active and inactive patients. This finding resembles the study of Van Gestel et al., which the STS was also not able to predict inactive lifestyle in COPD (AUC= 0.31)²³. This result was expected since there was no correlation with the STS and physical activity duration variable in this study. Additionally, considering the STS as a functional capacity test, Pitta et al. showed that tests such as 6MWT might predict activities in daily life better than single variables of physical functioning⁵².

Although many protocols of the STS are available in the literature, choosing one of the three most broadly used in patients with COPD is important to evaluate lower limb function. Hence, this study suggests that the 1-min_STS protocol of STS could be better to evaluate functional capacity in this population, since it had better correlations with important clinical outcomes. Albeit the time spent performing the 1-min_STS protocol is longer than the other two protocols, it still remains a quick, practical and useful test in clinical settings.

Limitations

Firstly, although it is known that the chair height can influence the performance of the STS⁵³⁻⁵⁵, this study could not ensure that patients were positioned to have exactly 90 degrees of hip and knee flexion in the chair. However, we standardized the same chair of 46 cm height to all the patients, similarly to the majority of previous studies^{16, 18, 21}. Additionally, we believe this limitation did not negatively affect the study results, since in our daily life, the chair height is standardized to the overall population and it is not possible to adjust the chair individually²⁴.

Secondly, the three protocols of the STS were performed in a randomized sequence and resting time after each test was empirically determined. Even though this study did not analyze this recovery time in depth, this period between the tests appeared to be adequate, since there were no differences among SpO₂, HR, systolic and diastolic BP, and symptoms of dyspnea and fatigue recorded before each test (Table 3).

Finally, there was no patient classified as GOLD I in the present sample. The lack of subjects classified in the mild stage of COPD and the average FEV₁ as well, restricts these results to patients with moderate to severe degree of airflow obstruction.

Conclusion

In summary, the 1-min_STS seems to be the best protocol to evaluate patients with COPD, since it was better associated with important clinical outcomes such as functional exercise capacity, functional status and PADL; and it generates higher hemodynamic demands than the other studied tests. The 5-rep_STS and 1-min_STS protocols were significantly different in terms of speed performance and physiologic demand; however, they were correlated and had a good level of agreement.

Furthermore, all of the three protocols were able to identify patients with low and preserved exercise capacity, nevertheless, they could not discriminate subjects classified as active and inactive in daily life.

Acknowledgements

All the authors are grateful to the colleagues of the Laboratory of Research in Respiratory Physiotherapy of State University of Londrina – Brazil and CAPES for the contribution to the study.

References

1. Couillard A, Muir JF, Veale D. COPD recent findings: impact on clinical practice. *Copd* 2010;7(3):204-213.
2. Eisner MD, Iribarren C, Blanc PD, Yelin EH, Ackerson L, Byl N, et al. Development of disability in chronic obstructive pulmonary disease: beyond lung function. *Thorax* 2011;66(2):108-114.
3. Eisner MD, Blanc PD, Yelin EH, Sidney S, Katz PP, Ackerson L, et al. COPD as a systemic disease: impact on physical functional limitations. *Am J Med* 2008;121(9):789-796.
4. Downs CA. Functional assessment of chronic obstructive pulmonary disease. *J Am Acad Nurse Pract* 2011;23(4):161-167.
5. Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J* 2014;44(6):1428-1446.

6. Kocks JW, Asijee GM, Tsiligianni IG, Kerstjens HA, van der Molen T. Functional status measurement in COPD: a review of available methods and their feasibility in primary care. *Prim Care Respir J* 2011;20(3):269-275.
7. Ozalevli S, Ozden A, Itil O, Akkoçlu A. Comparison of the Sit-to-Stand Test with 6 min walk test in patients with chronic obstructive pulmonary disease. *Respir Med* 2007;101(2):286-293.
8. Aguilaniu B, Roth H, Gonzalez-Bermejo J, Jondot M, Maitre J, Denis F, et al. A simple semipaced 3-minute chair rise test for routine exercise tolerance testing in COPD. *Int J Chron Obstruct Pulmon Dis* 2014;9:1009-1019.
9. Bohannon RW. Reference values for the five-repetition sit-to-stand test: a descriptive meta-analysis of data from elders. *Percept Mot Skills* 2006;103(1):215-222.
10. Zhang F, Ferrucci L, Culham E, Metter EJ, Guralnik J, Deshpande N. Performance on five times sit-to-stand task as a predictor of subsequent falls and disability in older persons. *J Aging Health* 2013;25(3):478-492.
11. Millor N, Lecumberri P, Gomez M, Martinez-Ramirez A, Izquierdo M. An evaluation of the 30-s chair stand test in older adults: frailty detection based on kinematic parameters from a single inertial unit. *J Neuroeng Rehabil* 2013;10:86.
12. Janssen WG, Bussmann HB, Stam HJ. Determinants of the sit-to-stand movement: a review. *Phys Ther* 2002;82(9):866-879.
13. Silva PF, Quintino LF, Franco J, Faria CD. Measurement properties and feasibility of clinical tests to assess sit-to-stand/stand-to-sit tasks in subjects with neurological disease: a systematic review. *Braz J Phys Ther* 2014;18(2):99-110.
14. Abujaber SB, Marmon AR, Pozzi F, Rubano JJ, Zeni JA, Jr. Sit-To-Stand Biomechanics Before and After Total Hip Arthroplasty. *J Arthroplasty* 2015.

15. Bouchouras G, Patsika G, Hatzitaki V, Kellis E. Kinematics and knee muscle activation during sit-to-stand movement in women with knee osteoarthritis. *Clin Biomech (Bristol, Avon)* 2015;30(6):599-607.
16. Jones SE, Kon SS, Canavan JL, Patel MS, Clark AL, Nolan CM, et al. The five-repetition sit-to-stand test as a functional outcome measure in COPD. *Thorax* 2013;68(11):1015-1020.
17. Janssens L, Brumagne S, McConnell AK, Claeys K, Pijnenburg M, Goossens N, et al. Impaired postural control reduces sit-to-stand-to-sit performance in individuals with chronic obstructive pulmonary disease. *PLoS One* 2014;9(2):e88247.
18. Puhan MA, Siebeling L, Zoller M, Muggensturm P, ter Riet G. Simple functional performance tests and mortality in COPD. *Eur Respir J* 2013;42(4):956-963.
19. Benton MJ, Alexander JL. Validation of functional fitness tests as surrogates for strength measurement in frail, older adults with chronic obstructive pulmonary disease. *Am J Phys Med Rehabil* 2009;88(7):579-583; quiz 584-576, 590.
20. Butcher SJ, Pikaluk BJ, Chura RL, Walkner MJ, Farthing JP, Marciniuk DD. Associations between isokinetic muscle strength, high-level functional performance, and physiological parameters in patients with chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis* 2012;7:537-542.
21. Rausch-Osthoff AK, Kohler M, Sievi NA, Clarenbach CF, van Gestel AJ. Association between peripheral muscle strength, exercise performance, and physical activity in daily life in patients with Chronic Obstructive Pulmonary Disease. *Multidiscip Respir Med* 2014;9(1):37.
22. Roig M, Eng JJ, MacIntyre DL, Road JD, Reid WD. Deficits in muscle strength, mass, quality, and mobility in people with chronic obstructive pulmonary disease. *J Cardiopulm Rehabil Prev* 2011;31(2):120-124.

23. van Gestel AJ, Clarenbach CF, Stowhas AC, Rossi VA, Sievi NA, Camen G, et al. Predicting daily physical activity in patients with chronic obstructive pulmonary disease. *PLoS One* 2012;7(11):e48081.
24. Bisca GW, Morita AA, Hernandez 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.
25. Global strategy for the diagnosis, management and prevention for chronic obstructive pulmonary disease (updated 2015). *Global Initiative for Chronic Obstructive Pulmonary Disease* 2015:1-117.
26. Mahler DA, Wells CK. Evaluation of clinical methods for rating dyspnea. *Chest* 1988;93(3):580-586.
27. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. *Eur Respir J* 2005;26(2):319-338.
28. Pereira CA, Sato T, Rodrigues SC. New reference values for forced spirometry in white adults in Brazil. *J Bras Pneumol* 2007;33(4):397-406.
29. Probst VS, Hernandez NA, Teixeira DC, Felcar JM, Mesquita RB, Goncalves CG, et al. Reference values for the incremental shuttle walking test. *Respir Med* 2012;106(2):243-248.
30. Britto RR, Probst VS, de Andrade AF, Samora GA, Hernandez NA, Marinho PE, et al. Reference equations for the six-minute walk distance based on a Brazilian multicenter study. *Braz J Phys Ther* 2013;17(6):556-563.
31. Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. *Eur Respir J* 1999;14(2):270-274.
32. Kon SS, Patel MS, Canavan JL, Clark AL, Jones SE, Nolan CM, et al. Reliability and validity of 4-metre gait speed in COPD. *Eur Respir J* 2013;42(2):333-340.

33. Lee EB, Weir JP. Procedures Recommendation I: Accurate Assessment Of Muscular Strength And Power. *Journal of Exercise Physiology* 2001;4(3):1-21.
34. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc* 2011;43(7):1334-1359.
35. Sousa TCd, Jardim JR, Jones P. Validation of the Saint George's Respiratory Questionnaire in patients with chronic obstructive pulmonary disease in Brazil. *J Pneumol* 2000;26(3):119-128.
36. Kovelis D, Segretti NO, Probst VS, Lareau SC, Brunetto AF, Pitta F. Validation of the Modified Pulmonary Functional Status and Dyspnea Questionnaire and the Medical Research Council scale for use in Brazilian patients with chronic obstructive pulmonary disease. *J Bras Pneumol* 2008;34(12):1008-1018.
37. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1(8476):307-310.
38. Hanley JA, McNeil BJ. The meaning and use of the Area Under a Receive Operating Characterist (ROC) Curve. *Radiology* 1982;143(1):29-36.
39. Hanley JA, McNeil BJ. A method of comparing the areas under receiver operating characteristic curves derived from the same cases. *Radiology* 1983;148(3):839-843.
40. Csuka M, McCarty DJ. Simple method for measurement of lower extremity muscle strength. *Am J Med* 1985;78(1):77-81.
41. Graham JE, Ostir GV, Kuo YF, Fisher SR, Ottenbacher KJ. Relationship between test methodology and mean velocity in timed walk tests: a review. *Arch Phys Med Rehabil* 2008;89(5):865-872.

42. Whitney SL, Wrisley DM, Marchetti GF, Gee MA, Redfern MS, Furman JM. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the Five-Times-Sit-to-Stand Test. *Phys Ther* 2005;85(10):1034-1045.
43. Schwenk M, Gogulla S, Englert S, Czempik A, Hauer K. Test-retest reliability and minimal detectable change of repeated sit-to-stand analysis using one body fixed sensor in geriatric patients. *Physiol Meas* 2012;33(11):1931-1946.
44. Millor N, Lecumberri P, Gomez M, Martinez-Ramirez A, Izquierdo M. Kinematic parameters to evaluate functional performance of sit-to-stand and stand-to-sit transitions using motion sensor devices: a systematic review. *IEEE Trans Neural Syst Rehabil Eng* 2014;22(5):926-936.
45. Janssen WG, Bussmann JB, Horemans HL, Stam HJ. Validity of accelerometry in assessing the duration of the sit-to-stand movement. *Med Biol Eng Comput* 2008;46(9):879-887.
46. Hughes MA, Myers BS, Schenkman ML. The role of strength in rising from a chair in the functionally impaired elderly. *J Biomech* 1996;29(12):1509-1513.
47. Hardy R, Cooper R, Shah I, Harridge S, Guralnik J, Kuh D. Is chair rise performance a useful measure of leg power? *Aging Clin Exp Res* 2010;22(5-6):412-418.
48. McCarthy EK, Horvat MA, Holtsberg PA, Wisenbaker JM. Repeated chair stands as a measure of lower limb strength in sexagenarian women. *J Gerontol A Biol Sci Med Sci* 2004;59(11):1207-1212.
49. Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in

addition to strength in older people. *J Gerontol A Biol Sci Med Sci* 2002;57(8):M539-543.

50. Netz Y, Ayalon M, Dunsky A, Alexander N. 'The multiple-sit-to-stand' field test for older adults: what does it measure? *Gerontology* 2004;50(3):121-126.

51. Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport* 1999;70(2):113-119.

52. Pitta F, Troosters T, Spruit MA, Probst VS, Decramer M, Gosselink R. Characteristics of physical activities in daily life in chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2005;171(9):972-977.

53. Chorin F, Rahmani A, Beaune B, Cornu C. Determination of reliable force platform parameters and number of trial to evaluate sit-to-stand movement. *Aging Clin Exp Res* 2015;27(4):473-482.

54. Ng SS, Cheung SY, Lai LS, Liu AS, leong SH, Fong SS. Five Times Sit-To-Stand test completion times among older women: Influence of seat height and arm position. *J Rehabil Med* 2015;47(3):262-266.

55. Ng SS, Cheung SY, Lai LS, Liu AS, leong SH, Fong SS. Association of seat height and arm position on the five times sit-to-stand test times of stroke survivors. *Biomed Res Int* 2013;2013:642362.

FIGURA 1

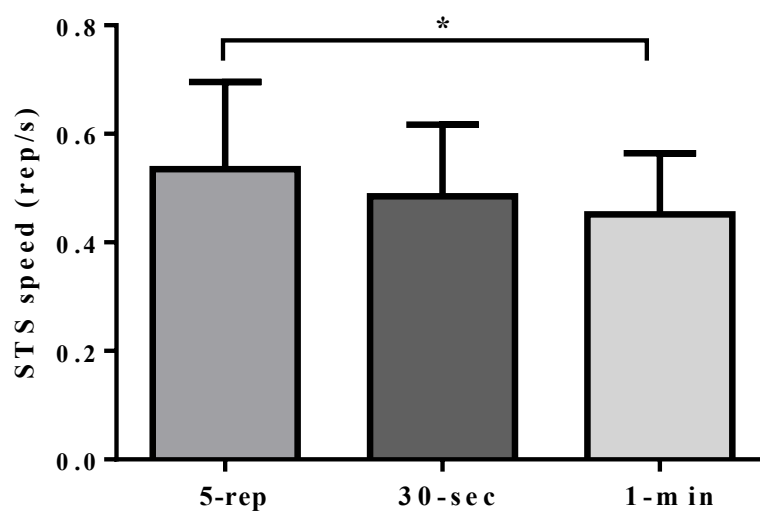


Figure 1. Comparison of the speed among the 5-repetition_STS, 30-second_STS and 1-minute_STS protocols of the sit-to-stand test. * $P = .01$. STS: sit-to-stand; rep/s: repetitions per second; 5-rep: 5-repetition; 30-sec: 30-seconds; 1-min: 1-minute.

FIGURA 2

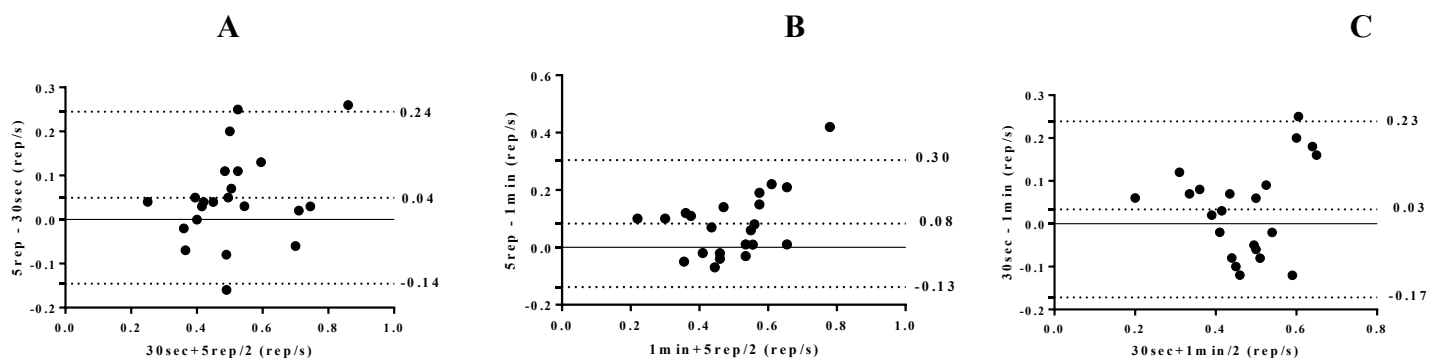
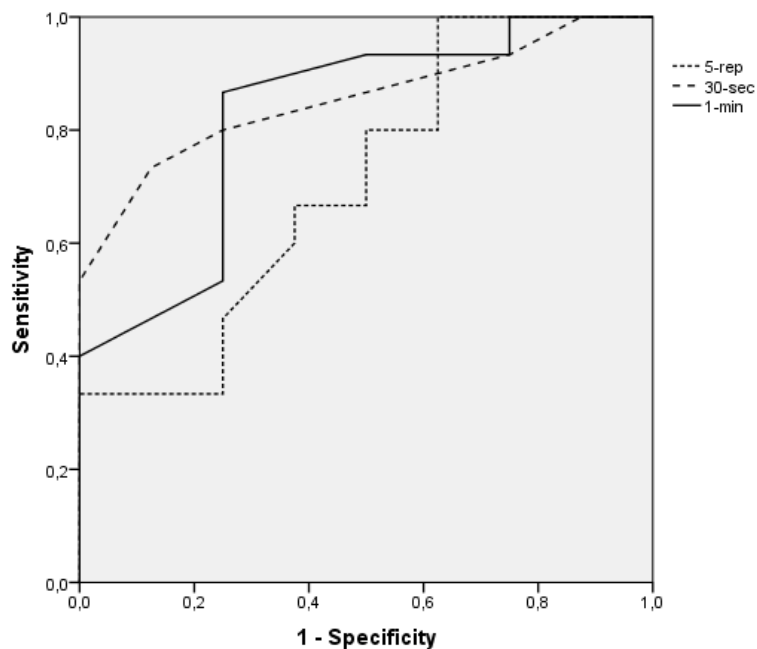


Figure 2. Bland & Altman plots of the difference between two STS protocols plotted against the mean value of the two STS (5-rep_STS vs 30-sec_STS [A]; 5-rep_STS vs 1-min_STS [B] and 30-sec_STS vs 1-min_STS [C]). ICC values: $P < .0001$ for all.

FIGURA 3

A



B

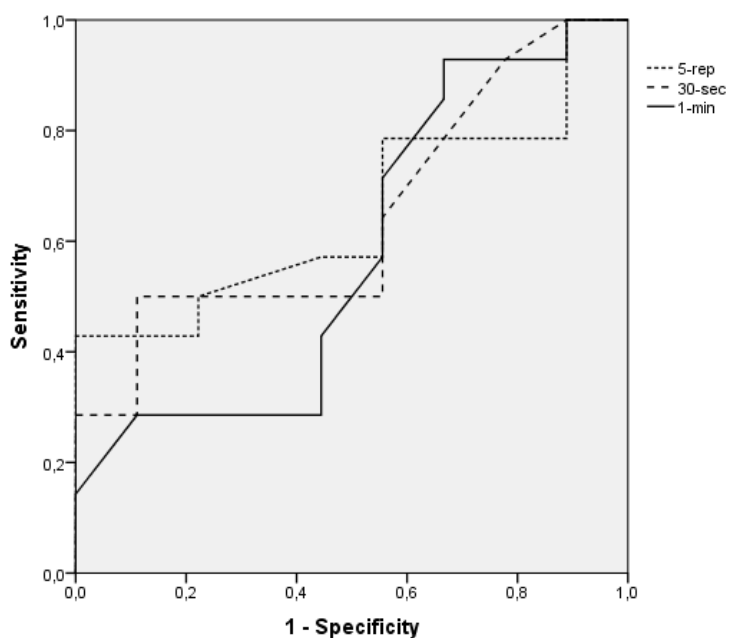


Figure 3. Comparison among the areas under the curve (AUC) of the 5-repetition_STS, 30-second_STS and 1-minute_STS protocols in patients with (A) low and preserved exercise capacity in the 6MWT and in patients classified as (B) active and inactive regarding PADL.

TABELA 1

Table 1. Characteristics of the patients with COPD.

	n=23
Gender (M/F)	11/12
Age (years)	68±8
BMI (kg.m ⁻²)	26±5
VEF ₁ (L)	1.31±0.43
VEF ₁ (%predicted)	53±15
FEV ₁ /FVC (%)	55±11
GOLD (II/III/IV)	16/6/1
5-rep_STS (sec)	10±3
30-sec_STS (repetitions)	14±3
1-min_STS (repetitions)	27±6
6MWT (m)	476±63
6MWT (%predicted)	90±14
ISWT (m)	448±102
ISWT (%predicted)	77±26
1-RM Quadriceps (kg)	16±7
4-MGS test (m/s)	1.42±0.27
SGRQ total score	38 [22-42]
PFSDQ-M dyspnea score	6 [2-13]
PFSDQ-M fatigue score	5 [0.75-10]
PFSDQ-M activity score	5 [0.75-9]
PAL index	1.47±0.11
TEE (kcal)	2029±395
PAD > moderate intensity (min)	48 [18-138]

Data expressed as absolute frequency, mean±SD or median [IQR]. M:male; F:female; BMI:body mass index; FEV₁:forced expiratory volume in the first second; FVC: forced vital capacity; GOLD: Global Initiative for Chronic Lung Disease; 5-rep_STS: 5-repetition sit-to-stand test; 30-sec_STS: 30-second sit-to-stand test; 1-min_STS: 1-minute sit-to-stand test; 6MWT: six-minute walk test; ISWT: incremental shuttle walking test; 1-RM: one-repetition maximum; 4MGS: four-metre gait speed; SGRQ: St' George's Respiratory Questionnaire; PFSDQ-M: Modified Pulmonary Functional Status and Dyspnea Questionnaire; PAL: physical activity level index; TEE: total energy expenditure; PAD: physical activity duration.

TABELA 2

Table 2. Correlations between the 5-rep_STS, 30-sec_STS and 1-min_STS protocol of the STS and clinical variables in patients with COPD.

	5-rep_STS (rep/s)		30-sec_STS (rep/s)		1-min_STS (rep/s)	
	r	P	r	P	r	P
5-repetition_STS (rep/sec)	NA	NA	0.71	.0001*	0.71	.0001*
30-second_STS (rep/sec)	0.71	.0001*	NA	NA	0.68	.0003*
1-minute_STS (rep/sec)	0.71	.0001*	0.68	.0003*	NA	NA
6MWT (m)	0.16	.46	0.26	.21	0.40	.05*
4MGS test (m/s)	0.54	.009*	0.52	.01*	0.64	.001*
PFSDQ-M activity score	0.38	.08	0.04	.85	0.43	.04*
PAL index	0.33	.13	0.30	.30	0.48	.02*
Walking (min)	0.19	.37	0.46	.02*	0.40	.05*
Standing (min)	0.35	.10	0.17	.42	0.49	.01*
Locomotion (min)	0.37	.08	0.48	.02*	0.52	.01*

* Statistical significant correlations; r: Pearson or Spearman correlation coefficient value. STS: sit-to-stand test; 5-rep: 5-repetition; 30sec: 30-second; 1-min:1-minute; 6MWT: six-minute walk test; 4MGS: 4-metre gait speed; PFSDQ-M: Modified Pulmonary Functional Status and Dyspnea Questionnaire; PAL: physical activity level index; NA: not applicable.

TABELA 3

Table 3. Comparisons of oxygen saturation, cardiovascular and symptoms variables measured before each STS protocols.

	5-rep STS	30-sec STS	1-min STS	<i>P</i>
SpO ₂ (%)	96 [92-97]	96 [93-98]	95 [94-97]	.29
HR (bpm)	87±13	86±12	86±12	.39
Systolic BP (mmHg)	120 [110-140]	120 [110-130]	130 [120-140]	.28
Diastolic BP (mmHg)	80 [70-90]	80 [70-90]	80 [80-90]	.96
Dyspnea	0 [0-1]	0 [0-1]	0 [0-2]	.08
Fatigue	0 [0-2]	0 [0-0.5]	0 [0-0.5]	.30

Data expressed as mean ±SD and median [IQR]. STS: sit-to-stand test; 5-rep: 5-repetition; 30sec: 30-second; 1-min: 1-minute; SpO₂: pulsed oxygen saturation; HR: heart rate; bpm: beats per minute; BP: blood pressure; Dyspnea: score according to Borg scale; Fatigue: score according to Borg scale.

TABELA 4

Table 4. Comparisons of the changes on oxygen saturation, cardiovascular and symptoms of each STS protocol.

	5-rep_STS	30-sec_STS	1-min_STS	<i>P</i>
Δ SpO ₂ (%)	-1±2	-1±2	-3±4 ^{*†}	.0042
Δ HR (bpm)	7±7 [†]	16±10 [*]	22±13 ^{*†}	< .0001
Δ Systolic BP (mmHg)	0 [0-10] [†]	20 [0-30] [*]	30 [10-40] [*]	< .0001
Δ Diastolic BP (mmHg)	0 [0-10]	0 [0-0]	0 [0-10]	NS
Δ dyspnea	0 [0-0.5] [†]	1 [0.5-2] [*]	2.5 [1-3] [*]	< .0001
Δ fatigue	0 [0-0.5]	0.5 [0-2]	2 [1-3] ^{*†}	< .0001

Data expressed as mean ±SD and median [IQR]. STS: sit-to-stand test; 5-rep: 5-repetition; 30sec: 30-second; 1-min: 1-minute; SpO₂: pulsed oxygen saturation; HR: heart rate; bpm: beats per minute; BP: blood pressure; Dyspnea: score according to Borg scale; Fatigue: score according to Borg scale.

* *P* ≤ .05 versus 5-repetition STS

† *P* ≤ .05 versus 30-second STS

TABELA 5

Table 5. Comparisons of oxygen saturation, hemodynamic and symptom variables measured pre and post each STS protocol.

	5-rep STS			30-sec STS			1-min STS		
	pre	post	<i>P</i>	pre	post	<i>P</i>	pre	post	<i>P</i>
SpO ₂ (%)	95±3	94±2	.12	95±2	94±3	.01	95±2	91±5	< .0001
HR (bpm)	87±13	95±13	< .0001	86±12	102±13	< .0001	86±12	109±17	< .0001
Systolic BP (mmHg)	120	130		120	140		130	150	
	[110-140]	[120-140]	.003	[110-130]	[130-150]	< .0001	[120-140]	[140-180]	< .0001
Diastolic BP (mmHg)	80	90		80	80		80	90	
	[70-90]	[80-90]	.11	[70-90]	[70-90]	.88	[80-90]	[80-100]	.007
Dyspnea	0 [0-1]	0 [0-2]	.03	0 [0-1]	2 [1-3]	< .0001	0.5 [0-2]	3 [2-5]	< .0001
Fatigue	0 [0-2]	0 [0-2]	.24	0 [0-0.5]	1 [0-3]	.0001	0 [0-0.5]	2 [1-5]	< .0001

Data expressed as mean ±SD and median [IQR]. STS:sit-to-stand test; 5-rep: 5-repetition; 30sec: 30-second; 1-min:1-minute; SpO₂: pulsed oxygen saturation; HR: heart rate; BP: blood pressure; Dyspnea: score according to Borg scale; Fatigue: score according to Borg scale.

4 CONCLUSÃO GERAL

O presente estudo revela que o protocolo de 1-min do STS é o melhor para avaliar pacientes com DPOC, visto que este está melhor associado com desfechos clínicos importantes avaliados na DPOC, como: capacidade funcional de exercício, estado funcional e AFVD. Além disso, o teste de 1-min apresenta maiores demandas hemodinâmicas e sintomatológicas comparado aos outros dois testes estudados. O STS de 5-rep e 1-min são diferentes quanto à velocidade de execução e à resposta hemodinâmica e sintomatológica, no entanto, apesar dessa diferença, os testes correlacionam-se e apresentam uma excelente concordância entre si. Adicionalmente, todos os protocolos são capazes de discriminar os pacientes que apresentam capacidade de exercício no TC6min baixa e preservada.

Assim, a partir dos resultados mostrados no presente estudo, sugere-se que o protocolo de 1-min, embora apresente maior estresse hemodinâmico e sintomatológico, seja o mais indicado para avaliar a capacidade funcional de pacientes com DPOC na prática clínica.

5 REFERÊNCIAS

1. Couillard A, Muir JF, Veale D. COPD recent findings: impact on clinical practice. *Copd*. 2010;7(3):204-13.
2. Eisner MD, Iribarren C, Blanc PD, Yelin EH, Ackerson L, Byl N, et al. Development of disability in chronic obstructive pulmonary disease: beyond lung function. *Thorax*. 2011;66(2):108-14.
3. Eisner MD, Blanc PD, Yelin EH, Sidney S, Katz PP, Ackerson L, et al. COPD as a systemic disease: impact on physical functional limitations. *Am J Med*. 2008;121(9):789-96.
4. Downs CA. Functional assessment of chronic obstructive pulmonary disease. *J Am Acad Nurse Pract*. 2011;23(4):161-7.
5. Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J*. 2014;44(6):1428-46.
6. Kocks JW, Asijee GM, Tsiligianni IG, Kerstjens HA, van der Molen T. Functional status measurement in COPD: a review of available methods and their feasibility in primary care. *Prim Care Respir J*. 2011;20(3):269-75.
7. Ozalevli S, Ozden A, Itil O, Akkoçlu A. Comparison of the Sit-to-Stand Test with 6 min walk test in patients with chronic obstructive pulmonary disease. *Respir Med*. 2007;101(2):286-93.
8. Aguilaniu B, Roth H, Gonzalez-Bermejo J, Jondot M, Maitre J, Denis F, et al. A simple semipaced 3-minute chair rise test for routine exercise tolerance testing in COPD. *Int J Chron Obstruct Pulmon Dis*. 2014;9:1009-19.
9. Csuka M, McCarty DJ. Simple method for measurement of lower extremity muscle strength. *Am J Med*. 1985;78(1):77-81.
10. Bohannon RW. Reference values for the five-repetition sit-to-stand test: a descriptive meta-analysis of data from elders. *Percept Mot Skills*. 2006;103(1):215-22.
11. Zhang F, Ferrucci L, Culham E, Metter EJ, Guralnik J, Deshpande N. Performance on five times sit-to-stand task as a predictor of subsequent falls and disability in older persons. *J Aging Health*. 2013;25(3):478-92.
12. Millor N, Lecumberri P, Gomez M, Martinez-Ramirez A, Izquierdo M. An evaluation of the 30-s chair stand test in older adults: frailty detection based on kinematic parameters from a single inertial unit. *J Neuroeng Rehabil*. 2013;10:86.
13. Janssen WG, Bussmann HB, Stam HJ. Determinants of the sit-to-stand movement: a review. *Phys Ther*. 2002;82(9):866-79.
14. Silva PF, Quintino LF, Franco J, Faria CD. Measurement properties and feasibility of clinical tests to assess sit-to-stand/stand-to-sit tasks in subjects with neurological disease: a systematic review. *Braz J Phys Ther*. 2014;18(2):99-110.
15. Abujaber SB, Marmon AR, Pozzi F, Rubano JJ, Zeni JA, Jr. Sit-To-Stand Biomechanics Before and After Total Hip Arthroplasty. *J Arthroplasty*. 2015.
16. Bouchouras G, Patsika G, Hatzitaki V, Kellis E. Kinematics and knee muscle activation during sit-to-stand movement in women with knee osteoarthritis. *Clin Biomech (Bristol, Avon)*. 2015;30(6):599-607.
17. Jones SE, Kon SS, Canavan JL, Patel MS, Clark AL, Nolan CM, et al. The five-repetition sit-to-stand test as a functional outcome measure in COPD. *Thorax*. 2013;68(11):1015-20.

18. Janssens L, Brumagne S, McConnell AK, Claeys K, Pijnenburg M, Goossens N, et al. Impaired postural control reduces sit-to-stand-to-sit performance in individuals with chronic obstructive pulmonary disease. *PLoS One*. 2014;9(2):e88247.
19. Puhan MA, Siebeling L, Zoller M, Muggensturm P, ter Riet G. Simple functional performance tests and mortality in COPD. *Eur Respir J*. 2013;42(4):956-63.
20. Bisca GW, Morita AA, Hernandez 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.
21. Benton MJ, Alexander JL. Validation of functional fitness tests as surrogates for strength measurement in frail, older adults with chronic obstructive pulmonary disease. *Am J Phys Med Rehabil*. 2009;88(7):579-83; quiz 84-6, 90.
22. Butcher SJ, Pikaluk BJ, Chura RL, Walkner MJ, Farthing JP, Marciniuk DD. Associations between isokinetic muscle strength, high-level functional performance, and physiological parameters in patients with chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2012;7:537-42.
23. Rausch-Osthoff AK, Kohler M, Sievi NA, Clarenbach CF, van Gestel AJ. Association between peripheral muscle strength, exercise performance, and physical activity in daily life in patients with Chronic Obstructive Pulmonary Disease. *Multidiscip Respir Med*. 2014;9(1):37.
24. Roig M, Eng JJ, MacIntyre DL, Road JD, Reid WD. Deficits in muscle strength, mass, quality, and mobility in people with chronic obstructive pulmonary disease. *J Cardiopulm Rehabil Prev*. 2011;31(2):120-4.
25. van Gestel AJ, Clarenbach CF, Stowhas AC, Rossi VA, Sievi NA, Camen G, et al. Predicting daily physical activity in patients with chronic obstructive pulmonary disease. *PLoS One*. 2012;7(11):e48081.
26. Global strategy for the diagnosis, management and prevention for chronic obstructive pulmonary disease (updated 2015). Global Initiative for Chronic Obstructive Pulmonary Disease. 2015:1-117.
27. World Health Organization - Chronic obstructive pulmonary disease (COPD) <http://www.who.int/respiratory/copd/en/2015>.
28. Choudhury G, Rabinovich R, MacNee W. Comorbidities and systemic effects of chronic obstructive pulmonary disease. *Clin Chest Med*. 2014;35(1):101-30.
29. Nussbaumer-Ochsner Y, Rabe KF. Systemic manifestations of COPD. *Chest*. 2011;139(1):165-73.
30. Maltais F, Decramer M, Casaburi R, Barreiro E, Burelle Y, Debigare R, et al. An official American Thoracic Society/European Respiratory Society statement: update on limb muscle dysfunction in chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2014;189(9):e15-62.
31. Eisner MD, Iribarren C, Yelin EH, Sidney S, Katz PP, Ackerson L, et al. Pulmonary function and the risk of functional limitation in chronic obstructive pulmonary disease. *Am J Epidemiol*. 2008;167(9):1090-101.
32. Beekman E, Mesters I, Hendriks EJ, Klaassen MP, Gosselink R, van Schayck OC, et al. Course length of 30 metres versus 10 metres has a significant influence on six-minute walk distance in patients with COPD: an experimental crossover study. *J Physiother*. 2013;59(3):169-76.
33. Annweiler C, Schott AM, Abellan van Kan G, Rolland Y, Blain H, Fantino B, et al. The Five-Times-Sit-to-Stand test, a marker of global cognitive functioning among community-dwelling older women. *J Nutr Health Aging*. 2011;15(4):271-6.

34. Bohannon RW, Bubela DJ, Magasi SR, Wang YC, Gershon RC. Sit-to-stand test: Performance and determinants across the age-span. *Isokinet Exerc Sci.* 2010;18(4):235-40.
35. Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport.* 1999;70(2):113-9.
36. Gross MM, Stevenson PJ, Charette SL, Pyka G, Marcus R. Effect of muscle strength and movement speed on the biomechanics of rising from a chair in healthy elderly and young women. *Gait Posture.* 1998;8(3):175-85.
37. Hughes MA, Myers BS, Schenkman ML. The role of strength in rising from a chair in the functionally impaired elderly. *J Biomech.* 1996;29(12):1509-13.
38. Buatois S, Miljkovic D, Manckoundia P, Gueguen R, Miget P, Vancon G, et al. Five times sit to stand test is a predictor of recurrent falls in healthy community-living subjects aged 65 and older. *J Am Geriatr Soc.* 2008;56(8):1575-7.
39. Whitney SL, Wrisley DM, Marchetti GF, Gee MA, Redfern MS, Furman JM. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the Five-Times-Sit-to-Stand Test. *Phys Ther.* 2005;85(10):1034-45.
40. Strassmann A, Steurer-Stey C, Lana KD, Zoller M, Turk AJ, Suter P, et al. Population-based reference values for the 1-min sit-to-stand test. *Int J Public Health.* 2013;58(6):949-53.
41. Chorin F, Rahmani A, Beaune B, Cornu C. Determination of reliable force platform parameters and number of trial to evaluate sit-to-stand movement. *Aging Clin Exp Res.* 2015;27(4):473-82.
42. Rikli RE, Jones CJ. Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. *Gerontologist.* 2013;53(2):255-67.
43. Sue DY, Wasserman K. Impact of integrative cardiopulmonary exercise testing on clinical decision making. *Chest.* 1991;99(4):981-92.

APÊNDICES

6 APÊNDICE

APÊNDICE A

Ficha de avaliação do teste *sit-to-stand*

____/____/____

SIT-TO-STAND TEST

Pcte: _____

O₂: ____ L/min. Horário: _____

	5 rep ()		30" ()		60" ()	
SpO ₂						
FC						
Borg D						
Borg F						
PAS						
PAD						
TOTAL						

OBS.: _____

APÊNDICE B

Ficha de avaliação da espirometria

Espirometria

Nome: _____ Data: _____
 ____ / ____ / ____

Idade: _____ Peso: _____ Altura: _____

Avaliador: _____

Treinamento: Endurance e força () RCTP ()

Avaliação: Pré-tto () 3 meses () 6 meses () 6 meses pós-tto ()

Espirometria

Pré-Bd	CVF (L / %): _____	Pós-Bd	CVF (L / %): _____
	VEF ₁ (L / %): _____		VEF ₁ (L / %): _____
	VEF ₁ /CVF: _____		VEF ₁ /CVF: _____

Qualidade: _____ Qualidade: _____

Laudo: _____ GOLD: _____

OBS.1: O laudo é dado segundo as Diretrizes para Teste de Função Pulmonar, da Sociedade Brasileira de Pneumologia e Tisiologia (2002), enquanto o GOLD é segundo as diretrizes do *Global Initiative for Chronic Obstructive Lung Disease*.

OBS.2: Os valores de referência deverão ser segundo - Pereira CAC, Sato T, Rodrigues SC. New reference values for forced spirometry in white adults in Brazil. J Bras Pneumol. 2007; 33(4):397-406.

Observações:

APÊNDICE C

Ficha do Teste de Caminhada de Seis Minutos

Nome: _____
 Idade: _____ Peso: _____ Altura: _____
 Data: _____ Hora: _____
 Oxigênio: ___ l/min
 Obs.: _____

	Antes	Depois	Recup.	
			7min	8min
<u>SaO₂</u>				
<u>FC</u>				
<u>Borg D</u>				
<u>Borg F</u>				
<u>PA</u>				
	<u>SaO₂</u>	<u>FC</u>	<u>SaO₂</u>	<u>FC</u>
30		420		
60		450		
90		480		
120		510		
150		540		
180		570		
210		600		
240		630		
270		660		
300		690		
330		720		
360		750		
390		780		

Distância: _____

Nome: _____
 Idade: _____ Peso: _____ Altura: _____
 Data: _____ Hora: _____
 Oxigênio: ___ l/min
 Obs.: _____

	Antes	Depois	Recup.	
			7min	8min
<u>SaO₂</u>				
<u>FC</u>				
<u>Borg D</u>				
<u>Borg F</u>				
<u>PA</u>				
	<u>SaO₂</u>	<u>FC</u>	<u>SaO₂</u>	<u>FC</u>
30		420		
60		450		
90		480		
120		510		
150		540		
180		570		
210		600		
240		630		
270		660		
300		690		
330		720		
360		750		
390		780		

Distância: _____

APÊNDICE D

Ficha do *Incremental Shuttle Walking Test*

Nome: _____ Idade: _____ Peso: _____ Altura: _____ Data da avaliação: _____ Horário término: _____ Obs.: _____					Nome: _____ Idade: _____ Peso: _____ Altura: _____ Data da avaliação: _____ Horário término: _____ Obs.: _____						
		Antes	Depois	Recuperação				Antes	Depois	Recuperação	
FC						FC					
PA						PA					
SpO ₂						SpO ₂					
Borg D						Borg D					
Borg F						Borg F					
Niv el	Nº de Shuttle (10 m cada)	FC (bpm)	SpO ₂ (%)	Velocidade (m/s)	Distância total (m)	Niv el	Nº de Shuttle (10 m cada)	FC (bpm)	SpO ₂ (%)	Velocidade (m/s)	Distância total (m)
1	0.0.0			0,5	30	1	0.0.0			0,5	30
2	0.0.0.0			0,67	70	2	0.0.0.0			0,67	70
3	0.0.0.0.0			0,83	120	3	0.0.0.0.0			0,83	120
4	0.0.0.0.0.0			1	180	4	0.0.0.0.0.0			1	180
5	0.0.0.0.0.0.0			1,16	250	5	0.0.0.0.0.0.0			1,16	250
6	0.0.0.0.0.0.0.0			1,33	330	6	0.0.0.0.0.0.0.0			1,33	330
7	0.0.0.0.0.0.0.0.0			1,5	420	7	0.0.0.0.0.0.0.0.0			1,5	420
8	0.0.0.0.0.0.0.0.0.0			1,66	520	8	0.0.0.0.0.0.0.0.0.0			1,66	520
9	0.0.0.0.0.0.0.0.0.0.0			1,83	630	9	0.0.0.0.0.0.0.0.0.0.0			1,83	630
10	0.0.0.0.0.0.0.0.0.0.0.0			2	750	10	0.0.0.0.0.0.0.0.0.0.0.0			2	750
11	0.0.0.0.0.0.0.0.0.0.0.0.0			2,16	880	11	0.0.0.0.0.0.0.0.0.0.0.0.0			2,16	880
12	0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,33	1020	12	0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,33	1020
13	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,5	1170	13	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,5	1170
14	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,66	1330	14	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,66	1330
15	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,83	1500	15	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0			2,83	1500
$\dot{V}O_{2\max}$ indireta = 4.19 + 0.025 x distância (m) $\dot{V}O_{2\max}$ calculada = _____ ml. min ⁻¹ . Kg ⁻¹						$\dot{V}O_{2\max}$ indireta = 4.19 + 0.025 x distância (m) $\dot{V}O_{2\max}$ calculada = _____ ml. min ⁻¹ . Kg ⁻¹					

APÊNDICE E

Ficha do 4-metre gait speed test

4 MGS

Pcte: _____

	4 m (/ /)		8 m (/ /)	
	USUAL ()	MAX. ()	USUAL ()	MAX. ()
Cron.				
Cron.				
Vídeo				
Vídeo				

FC		
SpO ₂		
Borg D		
Borg F		
PA		

OBS.: _____

ANEXOS

7 ANEXOS

ANEXO A

Termo de Consentimento Livre e Esclarecido do estudo

Título da pesquisa:

“Qual teste funcional de exercício reflete melhor as mudanças na atividade física de vida diária após programa de treinamento físico em pacientes com doença pulmonar obstrutiva crônica?”

Prezado(a) Senhor(a):

Gostaríamos de convidá-lo (a) a participar da pesquisa “Qual teste funcional de exercício reflete melhor as mudanças na atividade física de vida diária após programa de treinamento físico em pacientes com doença pulmonar obstrutiva crônica?” realizada no Laboratório de Pesquisa em Fisioterapia Pulmonar da Universidade Estadual de Londrina (Londrina, Brasil). O objetivo da pesquisa é: identificar o teste funcional de exercício que reflete melhor a atividade física de vida diária (AFVD) após programa de treinamento físico em pacientes com DPOC. A sua participação é muito importante e ela se daria da seguinte forma: os pacientes incluídos serão submetidos a algumas avaliações em dois momentos: no início do protocolo e ao término (após 12 semanas de tratamento). Serão realizadas as seguintes avaliações: função pulmonar por meio do teste de espirometria, capacidade funcional de exercício por meio do teste da caminhada de 6 minutos, *4-meter-gait-speed* e do *Sit-to-stand test*, capacidade máxima de exercício por meio do *Incremental Shuttle Walk Test*, força muscular de pernas e braços por meio do teste de uma repetição máxima, e a atividade física de vida diária que será realizada durante 7 dias consecutivos pelos aparelhos Dynaport (DynaPort Activity Monitor, McRoberts, Holanda) e Armband (SenseWear Armband, BodyMedia, Estados Unidos). Esses aparelhos são pequenos e leves, utilizados um na cintura e o outro no braço acima do cotovelo, de manuseio extremamente simples que monitoram todas as atividades físicas realizadas pelo paciente, permitindo saber o quanto ativo ele é. Nos 7 dias de avaliação, o paciente permanecerá durante 24 horas com os aparelhos, havendo a necessidade de retirá-los apenas durante o banho e atividades realizadas em piscina (por exemplo: natação, hidroginástica). O paciente não deverá

fazer nenhuma atividade extra, ou seja, será orientado a não mudar suas atividades de rotina. Após a avaliação inicial, os pacientes realizarão um programa de treinamento baseado em exercícios aeróbicos e de força para braços e pernas realizado 3 vezes por semana, 1 hora por sessão, durante 12 semanas. Todas as avaliações e as sessões de treinamento físico serão realizadas no Laboratório de Pesquisa em Fisioterapia Pulmonar da Universidade Estadual de Londrina (Londrina, Brasil). Gostaríamos de esclarecer que sua participação é totalmente voluntária, podendo você: recusar-se a participar, ou mesmo desistir a qualquer momento sem que isto acarrete qualquer ônus ou prejuízo à sua pessoa. Informamos ainda que as informações serão utilizadas somente para os fins desta pesquisa e serão tratadas com o mais absoluto sigilo e confidencialidade, de modo a preservar a sua identidade.

Os benefícios esperados são: os participantes do estudo receberão tratamento baseado em exercício físico o qual resultará em redução dos sintomas (falta de ar e cansaço), melhora da capacidade física e redução do risco de crises respiratórias. Também esperamos contribuir com a prática clínica visto que alguns testes funcionais de exercício talvez possam refletir o nível de AFVD e assim tornar possível a sua utilização como alternativa às técnicas complexas e de alto custo. Neste estudo, nenhum dos procedimentos utilizados constitui risco direto para a integridade física ou moral dos participantes. Informamos que o(a) senhor(a) não pagará nem será remunerado por sua participação. Garantimos, no entanto, que todas as despesas decorrentes da pesquisa serão ressarcidas, quando devidas e decorrentes especificamente de sua participação na pesquisa.

Caso você tenha dúvidas ou necessite de maiores esclarecimentos pode nos contactar nos telefones (43) 3371-2477 ou 3371-2252 ou pessoalmente no Ambulatório de Fisioterapia Respiratória do Hospital Universitário Regional Norte do Paraná: Av. Robert Koch, 60 – Vila Operária – Londrina – PR (perguntar pelo Professor Fábio de Oliveira Pitta – fabiopitta@uol.com.br), ou no telefone (43) 9647 4010 (falar com Gianna Bisca), ou ainda procurar o Comitê de Ética em Pesquisa Envolvendo Seres Humanos da Universidade Estadual de Londrina, na Avenida Robert Kock, nº 60, ou no telefone 3371-2490. Este termo deverá ser preenchido em duas vias de igual teor, sendo uma delas, devidamente preenchida e assinada entregue a você.

Londrina, ___ de _____ de 2014.

Prof. Fábio de Oliveira Pitta

RG: 3626743-7

Pesquisador Responsável e Coordenador do Projeto

_____ (nome por extenso do sujeito de pesquisa),
tendo sido devidamente esclarecido sobre os procedimentos da pesquisa, concordo em
participar **voluntariamente** da pesquisa descrita acima.

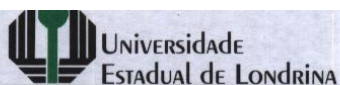
Assinatura (ou impressão dactiloscópica): _____

Data: _____

Obs: Caso o participante da pesquisa seja menor de idade, deve ser incluído o campo para assinatura do menor e do responsável.

ANEXO B

Parecer do Comitê de Ética em Pesquisa Envolvendo Seres Humanos (UEL)



COMITÊ DE ÉTICA EM PESQUISA ENVOLVENDO SERES HUMANOS
 Universidade Estadual de Londrina
 Registro CONEP 5231

Parecer CEP/UEL:	080/2014
CAAE:	31112714.3.0000.5231
Data da Relatoria:	26/05/2014
Pesquisador(a):	Fábio de Oliveira Pitta
Unidade/Órgão:	CCS - Progr. de Pós-Grad. em Ciências da Reabilitação

Prezado(a) Senhor(a):

O "Comitê de Ética em Pesquisa Envolvendo Seres Humanos da Universidade Estadual de Londrina" (Registro CONEP 5231) – de acordo com as orientações da Resolução 466/12 do Conselho Nacional de Saúde/MS e Resoluções Complementares, avaliou o projeto:

“QUAL TESTE FUNCIONAL DE EXERCÍCIO REFLETE MELHOR AS MUDANÇAS NA ATIVIDADE FÍSICA DE VIDA DIÁRIA APÓS PROGRAMA DE TREINAMENTO FÍSICO EM PACIENTES COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA?”

Situação do Projeto: **Aprovado**

Informamos que deverá ser comunicada, por escrito, qualquer modificação que ocorra no desenvolvimento da pesquisa, bem como deverá apresentar ao CEP/UEL, via Plataforma Brasil, relatório final da pesquisa.

Londrina, 03 de junho de 2014.

Prof. Dra. Paula Mariza Zedu Alliprandini
 Vice-coordenadora do Comitê de Ética em Pesquisa Envolvendo Seres Humanos
 Universidade Estadual de Londrina

ANEXO C

Normas de formatação do artigo no periódico Respiratory Care

RESPIRATORY CARE welcomes original manuscripts related to the science of respiratory care. The Journal is published in both print and electronic formats and appears online at www.rcjournal.com.

Manuscripts must be submitted electronically using Manuscript Central. Prepare your manuscript according to these instructions. For consultation regarding manuscript types or for queries about the submission process, contact the editorial office at rcjournal@aacrc.org.

PREPARING THE MANUSCRIPT

Title Page

For each author include:

- First name, middle initial, last name
- Academic degrees (eg, MSc, PhD, EdD). The Journal does not publish bachelor degrees
- Credentials (eg, RRT, MD, RN)
- FAARC (Fellow of the American Association for Respiratory Care). The Journal does not publish any other honorary titles
- Institutional affiliation and location (division, department, hospital, university, city, state/province, country)
-

Indicate the specific contributions of each author to the paper:

- Literature search
- Data collection
- Study design
- Analysis of data
- Manuscript preparation
- Review of manuscript
-

Title Page must also include:

- Name and location of the institution where the study was performed
- Name, date, and location of any meeting or forum where research data were previously presented, and who presented
- Sources of financial support
- Conflict of interest statement. If no potential conflicts of interest exist, a statement to this effect must be included
-

Identify corresponding author and provide contact information

Abstract

Structured Abstract includes these sections: Introduction, Methods (how the study was performed, including the number of subjects or patients), Results (brief summary of the data), and Conclusions. Abstracts must not contain any facts or conclusions that do not also appear in the text.

Narrative Abstracts are written as a narrative paragraph and fewer than 300 words. Include the Abstract in the main manuscript text file.

Key Words

List 6–10 key words or phrases that reflect the content of your manuscript. Key words may be selected from the Medical Subject Headings (MeSH terms) used by MEDLINE.

Text

Double-space all text (including Tables and References). Number the pages. Center and bold 1st level headings; flush-left and bold 2nd level headings; indent and bold 3rd level headings.

References

References must be listed and numbered in the sequence in which they are first cited in the text. Citations must conform to Journal style; see examples below. Authors are responsible for accuracy of their references.

EndNote contains the style for Respiratory Care: <http://endnote.com/downloads/style/respiratory-care>
Journal Article

Article. List the first 6 authors, then “et al”. Exception – in a paper with 7 total authors, list all 7:

Wallet F, Delannoy B, Haquin A, Debord S, Leray V, Bourdin G, et al. Evaluation of recruited lung volume at inspiratory plateau pressure with PEEP using bedside digital chest x-ray in patients with acute lung injury/ARDS. *Respir Care* 2013;58(3):416–423.

Corporate authors:

Chang SY, Dabbagh O, Gajic O, Patrawalla A, Elie MC, Talmor DS, et al; on behalf of the United States Critical Illness and Injury Trials Group: Lung Injury Prevention Study Investigators (USCIITG–LIPS). Contemporary ventilator management in patients with and at risk of ALI/ARDS. *Respir Care* 2013;58(4):578–588.

Article in a supplement:

del Giudice MM, Leonardi S, Ciprandi G, Galdo F, Gubitosi A, La Rosa M, et al. Probiotics in childhood: allergic illness and respiratory infections. *J Clin Gastroenterol* 2012;46(Suppl):S69–S72.

Corrected article:

Mireles–Cabodevila E, Hatipoğlu U, Chatburn RL. A rational framework for selecting modes of ventilation. *Respir Care* 2013;58(2):348–366. Erratum in: *Respir Care* 2013;58(4):e51.

Articles e-published online ahead of print:

Nozoe M, Mase K, Murakami S, Okada M, Ogino T, Matsushita K, et al. The relationship between spontaneous expiratory flow-volume curve configuration and airflow obstruction in elderly COPD patients. *Respir Care* 2013 [Epub ahead of print] doi: 10.4187/respcare.02296

Abstract. Citing abstracts is highly discouraged. Those more than 3 years old should not be used:

Blakeman TC, Rodriguez D, Branson RD. Evaluation of five chemical oxygen generators (abstract). *Respir Care* 2012;57(10):1751.

Editorial:

Rouby JJ, Arbelot C, Brisson H, Lu Q, Bouhemad B. Measurement of alveolar recruitment at the bedside: the beginning of a new era in respiratory monitoring? (editorial). *Respir Care* 2013;58(3):539–542.

Editorial, no author given:

Asthma: not just for kids (editorial). *Johns Hopkins Med Lett Health After 50* 2012;24(8):6.

Letter:

Haynes JM. Expiratory reserve volume maneuver may be the preferred method for some patients during spirometry testing (letter). *Respir Care* 2013;58(2):e14–e15. author response: e15.

Books

Book. Corresponding pages should be cited whenever reference is made to specific statements or content:

Wilkins RL, Stoller JK, Kacmarek RM. Egan's fundamentals of respiratory care, 9th edition. St Louis: Mosby|Elsevier; 2009:400–404, 917.

Corporate authors:

Panel on Understanding Cross–National Health Differences Among High–Income Countries; Committee on Population Division of Behavioral and Social Sciences and Education; Board on Population Health and Public Health Practice; National Research Council; Institute of Medicine of the National Academies. U.S. health in international perspective: shorter lives, poorer health. Washington, DC: National Academies Press; 2013.

Chapter:

Heffner JE. Chronic obstructive pulmonary disease. In: Hess DR, MacIntyre NR, Mishoe SC, Galvin WF, Adams AB. Respiratory care principles and practice, 2nd edition. Sudbury, MA: Jones & Bartlett; 2012:735–764.

Online Material

Static material must be listed in the References and include the digital object identifier (DOI). Use a DOI for content published online only. Because these items are static, there is no need to include an access date:

Ng S, King CS, Hang J, Clifford R, Lesho EP, Kuschner RA, et al. Severe cavitary pneumonia caused by a non-*equi Rhodococcus* species in an immunocompetent patient. *Respir Care* 2013;58(4):e47–e50. doi:10.4187/respcare.02017

Frequently changing material, such as an organization's homepage, should be cited in the text using the URL and access date. Do not include in References:

"...as recommended by the American Association for Respiratory Care

(<http://www.aarc.org>, Accessed January 27, 2015) ..."

News sources:

Productivity at work improved for sleep apnea patients using CPAP. *Medical News Today*: April 15, 2013. <http://www.medicalnewstoday.com/releases/259016.php> Accessed January 27, 2015.

Unpublished Work

Manuscript accepted but not yet published. A copy of cited unpublished manuscripts should be uploaded:

Strickland SL. Year in review: airway clearance. *Respir Care* 2015 (in press).

Research not yet accepted for publication should be cited in the text as personal communication. You must obtain written permission from the authors to cite unpublished data.

"Recently, Smith et al found this treatment effective in 45 of 83 patients (Smith R, personal communication, 2015)."

Your own unpublished work that has not been accepted for publication should be mentioned in the text: "We found this type of aerosol is no more effective than placebo (unpublished data)."

Figures

Use of Figures is encouraged. Include only Figures that clarify and augment the text. All Figures must be called-out in the text. Number consecutively as Figure 1, Figure 2, etc.

The first Figure in the report of a clinical trial must be a flow diagram showing phases of the trial (ie, enrollment, subject allocation, follow-up, and analysis). See CONSORT.

Each Figure must be uploaded to Manuscript Central as a separate image file, NOT embedded in the text.

Minimum 1200 dpi required for line art (graphs or drawings), 600 dpi required for images with labeling, and 300 required dpi for images (color or black and white) without labeling. Radiographs must clearly identify the relevant details and contain no patient identifiers. Any identifiable image must be accompanied with written consent (see Ethics of Investigation). Identify stains and magnifications for all photomicrographs. Arrows, numbers, letters, lines and other markers used to identify parts of a Figure must be defined in the Figure Legend. Figures are redrawn for stylistic consistency. Contact the Editorial Office if you would like assistance in creating an original Figure.

Figure Legends

Every Figure must have a legend explaining every component of the Figure. The legend should be self-sufficient and allow the reader to understand the figure without referring to the text. Legends are placed at the very end of the manuscript text file. Do not include legends in the Figure image files.

Tables

Each Table must be uploaded to Manuscript Central as a separate Microsoft Word file, NOT embedded in the text. Tables must have a title. The title should be self-sufficient and allow readers to understand the Table without referring to the text.

Tables should be numbered and cited consecutively in the text, Table 1, Table 2, etc. Any abbreviations and symbols must be explained in footnotes at the bottom of the Table. For footnotes use the following symbols, superscripted, in the following order: *, †, ‡, §, ||, ¶, **, ††.

Borrowed Figures and Tables

To include previously published Figures and Tables, you must obtain permission from the original copyright holder. Provide the reference citation in the Table footer so that appropriate credit can be acknowledged in accordance with copyright law.

Copyright is most often held by the publisher of the journal or book in which the Figure or Table originally appeared. It is the author's responsibility to secure permission. Payment of any fees required for borrowed material is the responsibility of the author.

Upload permissions documentation with your manuscript files.

Acknowledgements

Names of persons not eligible for authorship, and their contribution and institutional affiliation, should be listed in the Acknowledgments. You must obtain written permission from all individuals named in the Acknowledgments because inclusion can be taken as the individuals' approval of the paper's contents.

Equations

Write equations as normal text. Do not use the equation function in Microsoft Word or other mathematics software.

Statistical Analysis

For original research papers, the Editor recommends working with a biostatistician to assure appropriate analysis. The Editor may request a letter from your biostatistician assuring that the analysis is correct.

In the Methods section, identify the statistical tests used to analyze the data. Indicate the *P*-value that was taken to indicate significance. State whether tests were one-tailed or two-tailed; justify the use of one-tailed tests. Identify post-hoc analyses. Cite references to support your choice of tests and identify any statistical analysis software used. Indicate how the power analysis was conducted to determine appropriate sample size.

Report measurements with an appropriate degree of precision. Report both numerators and denominators for percentages.

For continuous data, description statistics should be expressed as mean and standard deviation (not standard error). For ordinal data, median and interquartile range should be reported.

For ratios (odds ratio, relative risk, etc.), provide 95% confidence interval.

Report actual *P* values rather than thresholds. Example: write "*P* = .18", not "*P* > .05" or "*P* = NS." Note that *P* cannot equal 0 or 1.

P values should be expressed to 2 digits for $P \geq .01$. $P < .001$, rather than $P < .0001$ or $P = .00001$. If $P > .99$, $P = .999$ for example, it should be expressed as $P > .99$.

An exception is *P* values between .07 and .03, which the Journal expresses to 3 digits. This is to preserve potential meaning of values near .05.

Authors are encouraged to enlist the expertise of a local statistician. If questions arise during the peer review process regarding the statistical analysis, the Editor may ask for proof of input from a statistician when the revised manuscript is submitted.

Units of Measurement

Always report the units of measurement according to current scientific usage. Standard units of measurement and scientific terms may be abbreviated without explanation (eg, L/min, mm Hg, pH, O₂). The Journal uses most values in Systeme Internationale (SI) units. For blood gas values, we prefer mm Hg to kPa. For airway pressure, we prefer cm H₂O rather than millibars.

Pulmonary Terms and Symbols

Use the Preferred Pulmonary Terms and Symbols (Appendix 1). Use abbreviations sparingly. Do NOT invent new abbreviations for terms with long-held standard abbreviations. Use an abbreviation only if the term occurs 4 or more times in the manuscript.

The following commonly used abbreviations do not need to be defined: ARDS, CI, COPD, CPAP, DNA, FDA, FEV₁, F_{IO2}, FVC, ICU, P_{aO2}, P_{aCO2}, P_{O2}, P_{CO2}, PEEP, SD, S_{pO2}. We also do not define units (eg, mL, cm, μm, μL).

Drugs and Commercial Products

Precisely identify all drugs and chemicals, doses, and methods of administration.

Use generic names instead of trade (proprietary) names for both drugs and equipment.

At first mention, trade names may be given parenthetically after generic names, including the name and location of the manufacturer. For equipment, provide model numbers if available.

Subjects versus Patients

Individuals enrolled in research are referred to as subjects, not patients. This applies to both retrospective and prospective studies.

Ventilator Modes

Use the Preferred Ventilator Mode Nomenclature (Appendix 2).

Language Editing Services

Poorly written papers will not be accepted. Particularly for authors whose native language is not English, it is strongly recommended to work with someone fluent in English science writing. If the quality of the English is not acceptable, the Editor may ask the author to submit evidence of help by someone fluent in English science writing when the revised manuscript is submitted. If you need assistance, below are some companies that provide language and copyediting services. Use of such a service is at the discretion and cost of the authors, and does not guarantee acceptance. Inclusion on this list does not represent endorsement by the Journal.

American Journal Experts

Bio Science Writers

Boston BioEdit

Enago

ScienceDocs

SPI Publisher Services

Text Check

The Medical Editor