Journal of Primary Care & Community Health
2016, Vol. 7(1) 10–15

DOI: 10.1177/2150131915603202
jpc.sagepub.com
SAGE

The Frequency of Frailty in Ambulatory Patients With Chronic Lung Diseases

Neha Mittal[1], Rishi Raj[2], Ebtesam Attaya Islam[1], and Kenneth Nugent[1]

Abstract

Objectives: To determine the prevalence of frailty in patients with chronic lung diseases. **Methods:** We studied 120 patients with chronic lung disease using Fried's criteria (gait speed, weight loss, exhaustion, grip strength, and physical activity). **Results:** The study population (56% women) had a mean age of 64 ± 13 years, mean body mass index of 31± 9 kg/m^2, and a mean FEV_1 (forced expiratory volume in 1 second) of 60% ± 25% of predicted. The average gait speed was 52.1 ± 14.3 m/min; 18% were frail, 64% prefrail, and 18% robust. Gait speed correlated with frailty status and decreased as frailty worsened (57 m/min in robust subjects and 41 m/min in frail subjects). Slow gait speeds (<60 m/min) had a 95% sensitivity and 34% specificity to predict frailty. **Conclusions:** Patients with chronic lung disease frequently meet Fried's criteria for frailty. Gait speed can be used to screen these patients to determine if a more detailed evaluation is needed.

Keywords

frailty, gait speed, chronic obstructive pulmonary disease (COPD), lung disease

Introduction

Frailty is a distinct and complex syndrome that appears to represent a transitional state in the dynamic progression from robustness to functional decline. It results from multiple system impairments occurring in conjunction with normal aging and is associated with sarcopenia, functional decline, neuroendocrine dysregulation, and immune impairment.[1] Frailty is a construct or syndrome that helps identify patients who are at additional risk for poor outcomes beyond the usual risks associated with normal aging and/or chronic diseases. It has been studied for more than 2 decades, but a commonly accepted definition of frailty remains elusive. Chronic obstructive pulmonary disease (COPD) was associated with frailty in the Cardiovascular Health Study.[2-4] Inflammation, the lack of activity or decreased exercise performance, and reduction in maximum oxygen uptake likely contribute to its development in these patients.[5] The assessment of frailty is important because it correlates with survival, institutionalization, and disability.

Screening tools for frailty have included multiple domains. The most frequent factors used in these assessments include physical function (73%), gait speed (50%), and cognition (50%).[6] Fried's criteria include 5 markers for frailty, but this tool is relatively cumbersome, especially for routine clinical use.[2,7] A simple screening tool, such as gait speed, that identifies patients needing a more detailed frailty evaluation would be clinically useful. The aim of this study was to determine the prevalence of frailty in patients with chronic lung diseases and to determine whether gait speed could be used as a screening tool for frailty in this patient group.[8] Our selection criteria included patients who were younger than 65 years (the conventional age cutoff for geriatric patients).

Methods

Study Design

We prospectively recruited patients in the general pulmonary clinics at Texas Tech University Health Sciences Center in Lubbock, Texas, who might be candidates for pulmonary rehabilitation and patients referred to the Pulmonary Rehabilitation Program at University Medical Center in Lubbock, Texas. Any patient with a chronic pulmonary disease, including COPD, asthma, pulmonary hypertension, and interstitial lung disease, was approached at the end of the clinic visit or during the initial rehabilitation evaluation and asked to participate. The diagnoses were based on the medical records maintained by the pulmonary physicians in the clinics or the referring physicians' clinics and/or hospital

[1]Texas Tech University Health Science Center, Lubbock, TX, USA
[2]Northwestern University, Chicago IL, USA

Corresponding Author:
Kenneth Nugent, Texas Tech University Health Sciences Center, 3601 4th Street, Stop 9410, Lubbock, TX 79430-9410, USA.
Email: kenneth.nugent@ttuhsc.edu

records. This study represents a convenience sample; patients younger than 21 years or with acute respiratory illness were excluded from the study. The study was approved by the institutional review board at Texas Tech University Health Science Center (IRB# L08-051); all patients gave written informed consent.

Demographics

Study investigators collected demographic information, including age, sex, ethnicity, body mass index (BMI), smoking history, medical history, home medications, oxygen use, pulmonary function test data, and history of recent falls and hospitalizations. Falls and past hospitalization data were based on individual recall. Patients then underwent frailty assessment and performed a 100-foot walk test.

Outcomes

Frailty was assessed using Fried's criteria.[2] These criteria include weight loss, exhaustion, physical activity level using the Minnesota Leisure Time Activity Questionnaire, 15-foot walk time, and grip strength. One coauthor (EAI) and 1 clinical research nurse from the Clinical Research Institute at Texas Tech University health Sciences Center performed all evaluations. These investigators compared methods and practiced with several patients together to obtain a uniform approach to patient assessment. Both the 15-foot walk time used in Fried's criteria and the100-foot walk time were measured. Grip strengths were measured with a JAMAR hydraulic hand dynamometer (Sammons Preston Roylan, Bolingbrook, IL). Subjects received instructions and practiced with the dynamometer, and the best of 3 efforts with the dominant hand was recorded. Patients who met 2 Fried's criteria were classified as prefrail; patients who met 3 criteria were classified as frail.

The 100-foot walk test was performed according to a previously standardized protocol.[8] The patient walked 50 feet in the hall, turned, walked 50 feet, and sat down. Patients were instructed to walk at their usual pace; time was recorded with a stop watch. Pulse rate and oxygen saturation (SaO_2) were recorded before the walk, after the walk, and after 3 minutes of recovery with a pulse oximeter. This 100-foot walk test was used because it causes a reproducible increase in heart rate in healthy subjects and therefore creates a mild physiological stress. In addition, it has satisfactory repeatability and provides an opportunity to evaluate the physiological cost index.[9]

Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences V.19.0.0 (SPSS, IBM Inc, Armonk, NY). Chi-square analysis of contingency tables was used to assess group differences for discreet variables and Fisher's exact test was used when each cell had expected frequency of less than 5. Parametric tests (*t* test, analysis of variance), and nonparametric tests (Kruskal-Wallis test) were used to assess group differences for continuous variables. *P* values <.05 were considered statistically significant.

Results

A total of 120 patients were enrolled in our study; 72 patients were recruited in the pulmonary clinics and 48 patients were recruited at the Pulmonary Rehabilitation Center. Baseline demographic characteristics of the patients are detailed in Table 1. Fifty-six percent of subjects were female. The mean age was 64 ± 9 years (range 23-91 years), and the mean body mass index was 31 ± 9 kg/m^2 (range 15-63 kg/m^2). Pulmonary diagnoses included COPD (56%), asthma (31%), pulmonary fibrosis (9%), and pulmonary hypertension (13%). The mean FEV_1 (forced expiratory volume in 1 second) was 60% ± 25% of predicted (range 20% to 150% predicted). Other comorbidities included congestive heart failure (19%), cerebrovascular disease (8%), coronary artery disease (24%), peripheral vascular disease (4%), diabetes mellitus type 2 (19%), hypertension (46%), renal disease (5%), and arthritis (23%).

Based on Fried's criteria, 22 subjects (18%; 95% confidence interval [CI] 1.95% to 34.1%) were frail, 76 (64%; 95% CI 53.2% to 74.8%) were prefrail, and 22 (18%; 95% CI 1.95% to 34.1%) were robust (Table 2). Patients in the frail category had frequent weight loss (52.4%), exhaustion (90.5%), reduced grip strength (52.4%), reduced gait speed (76.2%), and decreased overall activity (61.9%) (Table 2). The mean grip strength was 22.5 ± 7.9 kg in women and 33.4 ± 9.5 kg in men. The mean grip strength in women was at the lower boundary of the 95% CI for women in the age group of 65-69 years (22.5-28.8 kg), and the mean grip strength in men was below the 95% CI for men in the age group 65-69 years (35.4-47.9 kg).[10] Patients in the frail category did not differ from other patients (prefrail and robust) when comparisons of comorbid conditions (chi-square tests), age (*t* test), gender (chi-square test), BMI (*t* test), and FEV_1 percent predicted (*t* test) were made between the 2 groups (data not shown). Frail patients had more falls within the past 1 year than the prefrail or robust patients. Thirty-eight percent, 25%, and 5% of frail, prefrail, and robust patients, respectively, had 1 to 5 falls within the past 1 year, and 14%, 9%, and 0% of frail, prefrail, and robust patients, respectively, had more than 5 falls during the past 1 year (*P* = .018, chi-square test). Frail patients had more frequent hospitalizations during the past 1 year; 76%, 60%, and 32% of frail, prefrail, and robust patients, respectively, reported being hospitalized 1 or more times during the past 1 year (*P* = .011, chi-square test).

Table 1. Baseline Characteristics of Patients.

Characteristic	
Group	All 120 patients
Age (years), mean ± SD (range)	64 ± 13 (23-91)
Body mass index (kg/m^2), mean ± SD (range)	31 ± 9 (15-63)
FEV_1 (%), mean ± SD (range)	60 ± 25 (20-150)
Gender, %	
Female	56
Ethnicity, %	
White	71.7
Hispanic	18.3
Black	6.7
Asian	0.8
Other	2.5
Tobacco use, %	
Current	17.5
Past	54.2
None	27.5
Pulmonary diagnoses, %	
Chronic obstructive pulmonary disease	56
Asthma	31
Pulmonary fibrosis	9
Pulmonary hypertension	13
Comorbidities, %	
Congestive heart failure	19
Stroke	8
Coronary artery disease	26
Peripheral vascular disease	4
Hypertension	46
Diabetes mellitus	19
Renal insufficiency	5
Osteoarthritis	23
Oxygen use, %	
None	48
At night	19
Continuous	33
Falls in past 1 year, %	
None	68
1-5	23
>5	8
Falls in the past 3 months, %	
None	83
1-5	14
>5	3
Hospitalization in past 1 year, %	
None	43
Once	36
>1	22
Frailty status, %	
Robust	18
Prefrail	64
Frail	18

Table 2. Prevalence of Individual Frailty Markers and Overall Frailty Status for the 120 Patients on the Initial Assessment.

Frailty Marker (Percent Positive for)	Overall (%)	Frail (%)	Prefrail (%)
Weight loss	30.8	52.4	33.8
Exhaustion	52.5	90.5	57.1
Reduced grip strength	26.7	52.4	27.3
Reduced gait speed on 15-feet walk	27.5	76.2	22.1
Decreased activity by MLTA questionnaire	15.0	61.9	6.5
Overall frailty assessment			
Frail	17.5	NA	NA
Prefrail	64.2	NA	NA
Robust	18.3	NA	NA

Abbreviations: MLTA questionnaire, Minnesota Leisure Time Activity questionnaire; NA, not applicable.

The mean gait speed was 52.7 ± 15.9 m/min (range 14.4-91.4 m/min) based on the 15-foot walk distance and 52.1 ± 14.3 m/min (range 20.3-87.1 m/min) based on the 100-foot walk distance. There was a good correlation between gait speed measured in using the 15-foot distance and the 100-foot distance ($r = 0.596$, $P < .001$).The linear relationship was $GS_{100} = 0.53GS_{15} + 23.9$ m/min. Gait speed based on the 100-foot walk test was decreased in prefrail and frail patients; it was 57.4 ± 13.4 m/min in the robust patients, 53.8 ± 13.7 m/min in the prefrail patients, and 40.5 ± 11.1 m/min in the frail patients ($P = .0001$, Kruskal-Wallis test) (Figure 1). Only 1 frail patient had a gait speed of more than 60 m/min (Figure 1). Analysis of the relationship between gait speed and frailty based on simple inspection of Figure 1 indicated that a gait speed less than 60 m/min was 95% sensitive and 34% specific to predict frailty calculated with a 2 × 2 table. Construction of a receiver operating curve using all gait speeds demonstrated a weak statistically significant relationship between gait speed and frailty (area under the curve = 0.211, $P < .01$). The speed with the highest accuracy for screening for frailty was 31 m/min (sensitivity 0.86, specificity 0.05).

Discussion

This study demonstrates that frailty is relatively common in ambulatory patients with chronic lung diseases who were candidates for pulmonary rehabilitation; frail patients did not differ from the other patients in this study based on comparisons of age, BMI, comorbidity, or FEV_1% predicted. Frailty has been associated with several chronic diseases and predicts worse outcomes. The Cardiovascular Health Study showed an association between frailty and cardiovascular disease (odds ratio 7.51 for patients with CV

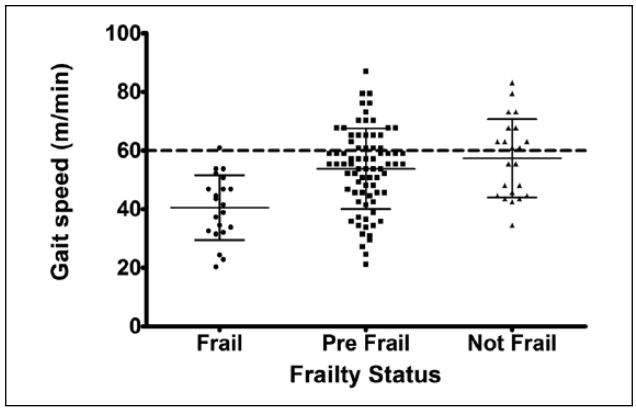

Figure 1. Scatterplot demonstrating gait speed measurements in patients divided into groups based on frailty status. Lines and error bars represent means ± standard deviation. Dotted line represents a gait speed of 60 m/min.

diseases compared with healthy controls).[11] A systematic review demonstrated that frailty was more prevalent in patients with more severe cardiovascular disease and congestive heart failure and was associated with an increased mortality (odds ratio 1.6-4.0).[12] Chronic kidney disease patients in the National Health and Nutrition Examination Survey database had a higher prevalence of frailty in patients with moderate to severe chronic kidney disease (20.9%), and frailty independently predicted increased mortality.[13] Subclinical disease diagnosed with noninvasive studies was more prevalent in frail individuals in the Cardiovascular Health Study, and a higher prevalence of chronic lower respiratory tract disease was present in prefrail and frail subjects in this study population.[2,11] Park et al[14] determined the frequency of frailty in patients using data from the National Health and Nutrition Examination Survey data set (2003-2006). Using survey responses, these investigators calculated that 57.8% of patients with COPD were frail. The frequency was lower in our study population. However, if both frail and prefrail patients in our study were combined, the frequency exceeded 80%. Galizia et al[15] studied mortality in elderly subjects with COPD and frailty. Over a 12-year follow-up, frail subjects with COPD had a higher mortality rate than subjects without COPD.[15] Subjects with increasing frailty scores had increased mortality in this study.

The prevalence of frailty and pre-frailty in our study likely reflects the characteristics of patients seen in the pulmonary clinics and at the pulmonary rehabilitation center. Frail patients in our sample had higher self-reported hospitalizations and falls and lower gait speeds as reported in other studies.[2-4,16-19] Frailty has been associated with increased risk for falls in other disease processes. Fried et al[2] used data from the Cardiovascular Health Study and found a close association between frailty status and incident falls, worsened mobility, incident hospitalization, and death over 3 or 7 years. Our study demonstrates a similar relationship between frailty and a higher risk for falls in patients with chronic lung diseases. This association has very important implications if falls result in hip fractures. Finally, the utility of screening tools for frailty probably depends on the chosen outcome, and including baseline variable(s) relevant to the outcome of interest increases the prediction accuracy.[20] Self-reported exhaustion (90.5%) and slow gait speed (76.2%) were the most common frailty criteria in our frail group. Gait speed provides more objective information than subjective criteria such as self-reported exhaustion. The International Academy on Nutrition and Aging Task Force found that gait speed calculated at the usual pace in robust community dwelling older adults predicted adverse outcomes, including cognitive decline, falls, institutionalization, and mortality.[18] A gait speed lower than 0.8 m/s was identified as an "easy to remember" cut point for risk of adverse outcomes.[18] Vermeulen et al[21] suggested that gait speed and physical activity/exercise were the most powerful predictors among Fried's criteria for disability related to activities of daily living in community dwelling elderly people. Other studies have also shown that gait speed independently predicts frailty.[14,22-25] Fritz and Lusardi[26] have suggested that walking speed should be considered the sixth vital sign. Their analysis indicates that gait speeds less than 36 m/min are associated with dependence in activities of daily living and hospitalization. Karpman and Benzo[27] recently reviewed the utility of gait speed as a measure of functional status in COPD patients and suggested that it is an excellent screening test even if calculated over 4 meters. Gait speed predicted frailty status in our study, and we noted that a gait speed of less than 60 m/min was 95% sensitive to predict frailty. This cutoff was not very specific (34%), and this result indicates that the false positive rate will be high. In some patients with slow gait speeds a formal evaluation for frailty will be needed; in others simple clinical evaluation will identify explanations for slow gait speed unrelated to frailty. Gait speed can thus be used as a quick screening tool to identify patients who need a more detailed frailty evaluation. This evaluation could include formal geriatric assessments and/or physical therapy referral. However, the overall correlation between gait speed and frailty was weak, and clinicians need better screening tools for this assessment. Ensrud et al[28] reported that the Study of Osteoporotic Fractures index predicted falls, disability, fractures, and death in older women as well as the Fried index. The Study of Osteoporotic Fractures index includes weight loss (>5%), inability to arise from a chair without use of arms 5 times, and reduced energy.

Limitations

This study has limitations. The patients were ambulatory patients recruited from subspecialty clinics at a medical

school and at a pulmonary rehabilitation center at a tertiary care hospital and may not represent the usual community-dwelling patient with chronic lung disease. We used only one frailty assessment tool; the physical activity component of this tool requires time to complete and provides only estimates about activity levels. In addition, the subjective criteria may not be stable over time and might not change with interventions. Gait speed in this study had a low specificity in identifying frailty, but this is a limitation in using a test that is also influenced by the primary disorders present in patients.

Conclusion

Frailty is common in patients with chronic lung diseases; exhaustion and slow gait speed were the 2 most common markers of frailty in our patient cohort. Frail patients have reduced gait speeds, as expected. Patients with chronic lung diseases need assessment for frailty, and gait speed is one tool for screening patients to determine who needs a more detailed evaluation. Frail patients could benefit from a complete geriatric assessment and focused attention to individual deficits. Clinicians should remember that many patients with common disease meet the criteria for frailty and that this syndrome has important clinical implications.

Acknowledgments

The authors thank Lori Stroud, CRT, RCP, at the Rehabilitation Center for providing constant support and help with patient enrollment. Chris Scott-Johnson MSN, RN, C, CCRC, at the Clinical Research Institute at Texas Tech University Health Sciences Center helped with patient enrollment and assessment.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Lang P-O, Michel J-P, Zekry D. Frailty syndrome: a transitional state in a dynamic process. *Gerontology*. 2009;55:539-549.
2. Fried LP, Tangen CM, Walston J, et al; Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56:M146-M156.
3. Bandeen-Roche K, Xue QL, Ferrucci L, et al. Phenotype of frailty: characterization in the women's health and aging studies. *J Gerontol A Biol Sci Med Sci*. 2006;61:262-266.
4. Thorpe RJ, Jr, Weiss C, Xue Q-L, Fried L. Transitions among disability levels or death in African American and white older women. *J Gerontol A Biol Sci Med Sci*. 2009;64:670-674.
5. Nussbaumer-Ochsner Y, Rabe KF. Systemic manifestations of COPD. *Chest*. 2011;139:165-173.
6. Sternberg SA, Schwartz AW, Karunananthan S, Bergman H, Clarfield AM. The identification of frailty: a systematic literature review. *J Am Geriatr Soc*. 2011;59:2129-2138.
7. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. *J Am Geriatr Soc*. 1991;39:46-52.
8. Raj R, Guerra D, Sehli S, et al. One hundred-foot walk test for functional assessment of clinic patients. *Am J Med Sci*. 2009;338:361-367.
9. Raj R, Mojazi Amiri H, Wang H, Nugent KM. The repeatability of gait speed and physiological cost index measurements in working adults. *J Prim Care Community Health*. 2014;5:128-133.
10. Bohannon RW, Peolsson A, Massy-Westropp N, Desrosiers J, Bear-Lehman JB. Reference values for adult grip strength measured with a Jamar dynamometer: a descriptive meta-analysis. *Physiotherapy*. 2006;92:11-15.
11. Newman AB, Gottdiener JS, McBurnie MA, et al; Cardiovascular Health Study Research Group. Associations of subclinical cardiovascular disease with frailty. *J Gerontol A Biol Sci Med Sci*. 2001;56:M158-M166.
12. Afilalo J, Karunananthan S, Eisenberg MJ, Alexander KP, Bergman H. Role of frailty in patients with cardiovascular disease. *Am J Cardiol*. 2009;103:1616-1621.
13. Wilhelm-Leen ER, Hall YN, Tamura MK, Chertow GM. Frailty and chronic kidney disease: the Third National Health and Nutrition Evaluation Survey. *Am J Med*. 2009;122:664-671.e2.
14. Park SK, Richardson CR, Holleman RG, Larson JL. Frailty in people with COPD, using the National Health and Nutrition Evaluation Survey dataset (2003-2006). *Heart Lung*. 2013;42:163-170.
15. Galizia G, Cacciatore F, Testa G, et al. Role of clinical frailty on long-term mortality of elderly subjects with and without chronic obstructive pulmonary disease. *Aging Clin Exp Res*. 2011;23:118-125.
16. Walston J, McBurnie MA, Newman A, et al. Frailty and activation of the inflammation and coagulation systems with and without clinical comorbidities—results from the Cardiovascular Health Study. *Arch Intern Med*. 2002;162:2333-2341.
17. Rothman MD, Leo-Summers L, Gill TM. Prognostic significance of potential frailty criteria. *J Am Geriatr Soc*. 2008;56:2211-2216.
18. van Kan GA, Rolland Y, Andrieu S, et al. Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people—an International Academy on Nutrition and Aging (IANA) Task Force. *J Nutr Health Aging*. 2009;13:881-889.
19. Buchman AS, Wilson RS, Boyle PA, Bienias JL, Bennett DA. Change in motor function and risk of mortality in older persons. *J Am Geriatr Soc*. 2007;55:11-19.
20. Viccaro LJ, Perera S, Studenski SA. Is timed up and go better than gait speed in predicting health, function, and falls in older adults? *J Am Geriatr Soc*. 2011;59:887-892.
21. Vermeulen J, Neyens JC, van Rossum E, Spreeuwenberg MD, de Witte LP. Predicting ADL disability in community-dwelling elderly people using physical frailty indicators: a systematic review. *BMC Geriatr*. 2011;11:33.

22. Hardy SE, Perera S, Roumani YF, Chandler JM, Studenski SA. Improvement in usual gait speed predicts better survival in older adults. *J Am Geriatr Soc*. 2007;55: 1727-1734.
23. Perera S, Studenski S, Chandler JM, Guralnik JM. Magnitude and patterns of decline in health and function in 1 year affect subsequent 5-year survival. *J Gerontol A Biol Sci Med Sci*. 2005;60:894-900.
24. Peterson MJ, Giuliani C, Morey MC, et al. Physical activity as a preventative factor for frailty: the health, aging, and body composition study. *J Gerontol A Biol Sci Med Sci*. 2009;64:61-68.
25. Hubbard RE, Fallah N, Searle SD, Mitnitski A, Rockwood K. Impact of exercise in community-dwelling older adults. *PLoS One*. 2009;4:e6174.
26. Fritz S, Lusardi M. White paper: "Walking speed: the sixth vital sign". *J Geriatr Phys Ther*. 2009;32:2-5.
27. Karpman C, Benzo R. Gait speed as a measure of functional status in COPD patients. *Int J Chron Obstruct Pulmon Dis*. 2014;9:1315-1320.
28. Ensrud KE, Ewing SK, Taylor BC, et al. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. *Arch Intern Med*. 2008;168:382-389.

Author Biographies

Neha Mittal is a general internal medicine faculty member in the Department of Internal Medicine at Texas Tech University Health Sciences Center in Lubbock, TX.

Rishi Raj is a faculty member in the pulmonary and critical care medicine division in the Department of Internal Medicine at Northwestern Medical School in Chicago, Illinois.

Ebtesam Attaya Islam is a fellow in the pulmonary and critical care medicine division in the Department of Internal Medicine at Texas Tech University Health Sciences Center in Lubbock, Texas.

Kenneth Nugent is a faculty member in the division of pulmonary and critical care medicine in the Department of Internal Medicine at Texas Tech University Health Sciences Center in Lubbock, Texas.