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Towards a Race-Neutral System of Pulmonary Function Test Results Interpretation

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It has been observed widely that, on average, Black individuals in the United States have lower FVC than White individuals, which is thought to reflect a combination of genetic, environmental, and socioeconomic factors that are difficult to disentangle. Debate therefore persists even after the American Thoracic Society's 2023 guidelines recommending race-neutral pulmonary function test (PFT) result interpretation strategies. Advocates of race-based PFT results interpretation argue that it allows for more precise measurement and will minimize disease misclassification. In contrast, recent studies have shown that low lung function in Black patients has clinical consequences. Furthermore, the use of race-based algorithms in medicine in general is increasingly being questioned for its risk of perpetuating structural health care disparities. Given these concerns, we believe it is time to adopt a race-neutral approach, but note that more research is urgently needed to understand how race-neutral approaches impact PFT results interpretation, clinical decision-making, and patient outcomes. In this brief case-based discussion, we offer a few examples of how a race-neutral PFT results interpretation strategy will impact individuals from racial and ethnic minority groups at different scenarios and stages of life.

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KEY WORDS: health equity; occupational medicine; pulmonary function test; race-neutral interpretation; spirometry

No race is a monolith; neither does the use of race in clinical medicine mean the same across all contexts. In the case of pulse oximetry, the recognition of race-based differences can help to address the recently acknowledged inaccuracy of available commercial devices.[1] However, each race-based clinical algorithm should be evaluated separately for its ability to enhance or diminish health equity.[2] Alternatively, if true racial differences seem illusory, alternative algorithms that deliver high-quality clinical information without using race should be explored.[1] Although interpreting pulmonary function test (PFT) results via race-specific equations was long thought to be helpful, more recent work suggests that this in fact may underestimate disease severity and all-cause mortality in racial and ethnic minority groups.[3-6] A major debate has thus ensued over the continued use of race in PFT reference equations.[7-10]

ABBREVIATIONS: GLI = Global Lung Function Initiative; PFT = pulmonary function test

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It is not in physiology, but rather in social context, that medicine has failed to grapple with the meaning of race. Too little work acknowledges how profoundly the supposed genetic or biological differences between races are confounded by large socioeconomic disparities.[11] The original monograph advancing racially distinct lung function included extended references to religious texts, explicit advocacy for the contemporary proslavery movement, and errant speculation on owl metabolism.[12,13] Whether in the past or present, ignoring the broader social context of medicine has been detrimental. Science, patient care, and public policy demand a better course.

Herein, we offer a thought experiment examining the lives of hypothetical Black male firefighters in different clinical encounters. We compare race-based (Global Lung Function Initiative [GLI] race-specific) vs race-neutral (GLI-Global) PFT results interpretation through a social lens, focusing on borderline results near arbitrary definitions of normal that require careful reflection. In particular, we focus on instances of low FVC or FEV_1, because this prevalence will be much more affected by the use of race-neutral reference equations than FEV_1 to FVC ratio. Following longitudinal trends in PFT results can be extremely helpful, but for the scenarios presented herein, we assumed that no prior PFT findings were available for comparison. We conclude with a blueprint for equitable adoption of race-neutral PFT results interpretation.

Case 1: Employment

Case Presentation

A. G. is a previously healthy 22-year-old Black man who has never used tobacco and has no history of lung disease. He grew up in a loving, two-parent, nonsmoking household, but because of his family's race, they were steered toward subprime mortgages and underresourced neighborhoods.[14] Beyond an immediate negative impact on his own health outcomes, this also meant that like individuals from many racial and ethnic minority groups, A. G. grew up in a food desert with disproportionate exposure to air pollution that may have impeded lung development.[15-17] After graduating from high school, A. G. wanted to pursue a career as a firefighter. Several factors led him to consider this profession. First, A. G. wanted to help others and to give back to his community. Second, firefighting is highly unionized,[18] offering job security and fair compensation, which A. G. found appealing.[19] Additionally, although the overall picture is mixed, recent work has found less sex and racial discrimination with respect to firing decisions in public sector, rather than private sector, jobs.[20] As part of his pre-employment screening, A. G. was referred for spirometry, revealing an FVC of 4.3 L and FEV_1 of 3.3 L (Table 1).[21] When interpreted using GLI-Global guidelines, these results are 77% predicted ($z = -1.77$) and 69% of predicted ($z = -2.30$) for FVC and FEV_1, respectively (Table 1). A. G.'s job offer was put on hold.

Discussion

Few professions exist in which screening PFTs are recommended because of high levels of respiratory exposure, special requirements for respiratory fitness, or both. In the cotton industry, this once created a barrier to employment for Black individuals.[9]However, there is a serious paucity of contemporary research on how changing spirometry standards might influence employment opportunities for Black individuals.[22,23] The National Fire Protection Agency guidelines on physical examination state that a candidate's FEV_1 and FVC values each should exceed 70% predicted without other evidence of lung disease.[24] These recommendations are rooted in rationales around self-contained breathing apparatus use. We are not aware of systematic data for firefighters as to the prevalence of lung disease or reduced lung function; profession-wide compliance with National Fire Protection Agency guidelines; how much reduced lung function impacts their performance (if at all); and whether, given the actual composition of racially and ethnically diverse applicants to firefighting, this would create a meaningful barrier to career entry. A review highlighted challenges in interpreting PFT results near previously recommended normal thresholds, which often lack clinically significant evidence.[25] Each of these questions demands further investigation to facilitate a responsible transition to a new system of spirometry results interpretation.

Can PFT results predict the risk of A. G. sustaining acute or chronic occupational pulmonary injury from firefighting? This difficult question depends at least in part on the extent to which A. G. encounters toxic exposures that adversely impact his lung function. One potential concern relates to the rapidity with which he would deplete his oxygen supplies from a self-contained breathing apparatus. Although correlated to static lung function values, ventilatory response to exercise in COPD varies incrementally by specific parameters like airway resistance; some forms of mild disease show

TABLE 1] Lung Function by Case, Presented by Race-Specific vs Race-Neutral Reference Equation

Case No.	Demographic Features	Spirometry Findings, L	Spirometry Results Interpretation		Relevant Standard	Outcome
			GLI Race-Specific	Spirometry GLI-Global		
1: Employment	A. G.: 22 yo Black man, 184 cm height	FEV_1, 3.3 L; FVC, 4.3 L; FEV_1 to FVC ratio, 0.77	FEV_1, *z* score, −1.81, 77%; FVC, *z* score, −1.24, 85%; FEV_1 to FVC ratio, *z* score, 1.28[a]	FEV_1, *z* score, −2.3, 69%; FVC, *z* score, −1.77, 77%; FEV_1 to FVC ratio, *z* score, −1.29[b]	National Fire Protection Association: FEV_1 to FVC ratio, > 80%, FEV_1 > 70%, and FVC > 70%; no prior diagnosis of respiratory disease	Occupational health consultation, exercise test; is cleared for firefighting after understanding risks and with documentation he can perform the tasks for which he is hired
2: Symptom evaluation: firefighter	P. R.: 50 yo Black man, 165 cm height	FEV_1, 2.26 L; FVC, 3.1 L; FEV_1 to FVC ratio, 0.73	FEV_1, *z* score, −1.37, 80%; FVC, *z* score, −0.82, 88% FEV_1 to FVC ratio, −1.22[b]	FEV_1, *z* score, −1.79, 73%; FVC, *z* score, −1.26, 82%; FEV_1 to FVC ratio, −1.19 [a]	ATS/ERS guidelines for PFT results interpretation	The low % predicted value triggers investigation; receives diagnosis of sarcoidosis and undergoes proper treatment
3: Disability evaluation	B. R.: 60 yo Black man, 178 cm height	FEV_1, 2.4 L; FVC, 3.15 L; FEV_1 to FVC ratio, 0.76	FEV_1, *z* score, −1.13, 84%; FVC, *z* score, −0.63, 92%; FEV_1 to FVC ratio, *z* score, −0.29[b]	FEV_1, *z* score, −1.55, 78%; FVC, *z* score, −1.03, 86%; FEV_1 to FVC ratio, *z* score, −0.26[a]	*AMA Guides to the Evaluation of Permanent Impairment, Sixth Edition*: FEV_1 or FVC < 80%, FEV_1 to FVC ratio < 75% or < LLN	Qualified for disability class 1
4: Cancer resection[c]	J. H.: 62 yo Black man, 158 cm height	FEV_1, 0.72 L; FVC, 1.4 L; FEV_1 to FVC ratio, 0.51	FEV_1, *z* score, −3.73, 31%; FVC, −3.29, 48%; FEV_1 to FVC ratio, *z* score, −3.41[a]	FEV_1, *z* score, −4.15, 29%; FVC, *z* score, −3.68, 45%; FEV_1 to FVC ratio, *z* score, −3.15[b]	Postoperative predicted FEV_1 < 30%[21]	Undergoes CPET and is still able to receive resection

AMA = American Medical Association; ATS = American Thoracic Society; CPET = cardiopulmonary exercise testing; ERS = European Respiratory Society; GLI = Global Lung Function Initiative; LLN = lower limit of normal; PFT = pulmonary function test; yo = years of age.

[a]Qualifying outcome.

[b]Nonqualifying outcome.

[c]Values presented in this row are predicted postoperative values given planned resection.

minimal increase in tidal volume above that of normal control participants.[26] One way to address this would be a direct assessment of his ventilatory response to exercise, either through cardiopulmonary exercise testing or through a firefighting simulation.

Resolution

A. G. was referred for further evaluation by a pulmonologist with expertise in occupational medicine. After obtaining careful history, physical examination findings, and complete PFT results, no specific pulmonary diagnosis was obtained. After reviewing the potential risks of firefighting and the uncertainties about long-term medical consequences, A. G. elected to proceed. He subsequently was cleared for service as a firefighter with a plan for serial monitoring of lung function. In this case, the use of a race-neutral PFT results interpretation strategy with GLI-Global guidelines resulted in increased pre-employment screening.

Case 2: Symptom Evaluation

Case Presentation

P. R. is a 50-year-old previously healthy firefighter with 2 decades of experience. Although he finds his work rewarding, he has had a lingering dry cough after an upper respiratory tract infection 4 months previously and now has increasing shortness of breath. At his family's urging, he brought up these symptoms with his family physician and received in-office spirometry to assess the seriousness of his symptoms. Spirometry revealed an FEV_1 of 2.26 L and FVC of 3.1 L, with FEV_1 to FVC ratio of 0.73 (Table 1). When interpreted using GLI-Global guidelines, these results suggested a restrictive defect, and P. R. was referred to a pulmonologist for further management.

Discussion

There is ample reason for concern.[27] Compared with the general population, one recent study found firefighters had nearly four times the prevalence of interstitial lung disease.[28] Because the respiratory exposure of asbestos is greatly magnified by burning, it is unsurprising that the risk of malignant mesothelioma in this occupation is twice that of the general public.[29] Increased odds of asthma and sarcoidosis developing also have been documented.[30,31] Firefighters are at an increased risk of a variety of complex inhalational exposures because of their occupation, and medical science is only beginning to understand the consequent risk profile.

The unique challenges faced by Black patients also have come into greater focus over the past few years. Overwhelmingly, Black patients report poor experience with the medical system relative to other races.[32] One major area of concern is that their symptoms often are dismissed or minimized by treating practitioners.[33] Indeed, Black patients are less likely to receive specialist care than non-Hispanic White patients, even after controlling for insurance status.[34] They are also much less likely to receive adequate pain control.[35] Some studies suggest that directly bigoted beliefs may play a role in this undertreatment.[36] Black people with lung fibrosis undergo twice as many hospitalizations, are younger when referred for lung transplantation, and die at younger ages than Hispanic or White patients.[37] Similarly, relative to non-Hispanic White patients, both Black and Hispanic patients with colorectal cancer are at increased risk of treatment delay and undertreatment even after adjustment for socioeconomic differences.[38] These observations demand that we give serious consideration to the ways our health care systems may compound or combat these inequities.

Resolution

After completing additional PFTs, chest imaging, and bronchoscopy, P. R. received a diagnosis of stage 3 pulmonary sarcoidosis. He began prednisone treatment, and at the 3-month follow-up, his symptoms and PFT results improved. Using race-specific reference equations, P. R.'s lung function would have been assessed as normal (Table 1). The potential delay from arguably false-negative test results could have impacted his care adversely and potentially could have resulted in disease progression. By contrast, the race-neutral GLI-Global reference equation flagged his low lung function, allowing further investigation that properly identified the source of the symptoms, yielding effective treatment.

Case 3: Disability

Case Presentation

B. R. is a 60-year-old Black firefighter. For the past several years, he has experienced progressive shortness of breath. He has a 25-pack-year history of smoking cigarettes, but quit 10 years ago. He was referred for spirometry for progressive shortness of breath and was found to have preserved ratio impaired spirometry findings.[39] Despite symptom avoidance and assiduous bronchodilator use, he was no longer able to work. He asked his family physician about applying for disability. Spirometry findings were FEV_1 of 2.4 L, FVC of 3.15 L,

and FEV_1 to FVC ratio of 0.76. When interpreted using GLI-Global guidelines, the FEV_1 and FVC results were abnormal, whereas lung function would have been classified as normal using race-based approaches (Table 1).

Discussion

Static lung function is a key determinant of disability classification for pulmonary disease in the American Medical Association's sixth edition of the guide to permanent impairment.[40] Other physical examination findings or reported symptoms are afforded lower importance. However, recent work in tobacco use-related lung disease has demonstrated that among Black patients, better symptom correlation results when using a race-neutral reference equations.[3] Were American Medical Association guidelines updated to recommend the new reference equations, B. R. might have received disability ratings more concordant with other elements of his findings at presentation.

Resolution

B. R. ultimately qualified for disability using GLI-Global guidelines, matching the reported severe respiratory symptoms. Critically, although PFT results alone do not guarantee a particular outcome in a multifactorial worker's compensation evaluation, the alternate finding of normal lung function using race-based interpretation would have created an obstacle to establishing permanent disability. Because the degree of permanent disability determines the financial compensation for disability, PFT results near arbitrary thresholds have major implications for patients' financial health.

Case 4: Lung Nodule

Case Presentation

J. H., a 62-year-old Black man, incidentally showed a pulmonary nodule on chest imaging. Chest imaging and transbronchial biopsy demonstrated that it was a stage 1 pulmonary adenocarcinoma. He visited with a thoracic surgeon to investigate curative resection of the cancer. The surgeon referred J. H. for PFT, which demonstrated a predicted postoperative FEV_1 to 0.72 L, FVC of 1.4 L, and FEV_1 to FVC ratio of 0.51 (Table 1). The surgeon estimated predicted postoperative lung function after planned right upper lobectomy. Using GLI race-based interpretation, the predicted postoperative FEV_1 was $> 30\%$, whereas the predicted postoperative FEV_1 was $< 30\%$ using GLI-Global interpretation.

Discussion

Multiple levels of inequity exist in oncologic care. The structure of current screening guidelines inappropriately can exclude minoritized tobacco users, who tend to have different but still high-risk patterns of cigarette use.[41] After malignancy has been identified, racially and ethnically diverse patients are still much more likely not to be offered surgery without any specific contraindication.[42] Thus, understandable anxieties exist about whether a new interpretive standard for lung function could further reduce access to these therapies for patients from racial and ethnic minority groups.

This quandary highlights the many important unknowns in thoracic surgery. Increasingly, lung function previously labelled as marginal or unacceptable has been found to yield acceptable surgical outcomes.[43,44] However, some studies report increased odds of mortality among Black patients after surgery.[45] Is one possible consideration that, as a group, Black people have been risk-stratified inappropriately by race-specific reference equations that overestimated their pulmonary health? The answers to these questions, as well as the broader relationship between lung function and surgical outcomes, are both urgent and evolving. Ultimately, static lung function tests are a proxy for cardiopulmonary reserve. Current guidelines recommend that in cases where surgical tolerance is not clear, the patient be evaluated by a series of exercise-based tasks terminating in a cardiopulmonary exercise test.[46]

Resolution

J. H. was referred for cardiopulmonary exercise testing, which demonstrated adequate cardiopulmonary responses to exercise. J. H. qualified for lung cancer resection and successfully underwent lobectomy. The use of GLI-Global guidelines in this case resulted in J. H. undergoing additional preoperative testing to assess perioperative risk.

Conclusions

As this case review demonstrated, no interpretive strategy for PFT results is a meaningful replacement for context. Longitudinal trends of an individual's serial performance remain the single best standard for understanding pulmonary function.[47] Likewise, we similarly might appreciate that in most of these cases, PFTs were used as a proxy for some other task: ability to use self-contained breathing apparatus equipment, to tolerate cardiopulmonary stress, to complete work-related tasks, or to undergo lung resection. Alternative

methods for exploring these capacities were available in each case. In particular, patients with borderline PFT values near arbitrary thresholds of normal deserve careful attention and multiple methods of evaluation, followed by shared decision-making, to ensure the best answer. The common approach undergirding these strategies is that any PFT result should be treated as a single piece of evidence, rather than a definitive answer.

Although we have focused on the effects of the new guidelines in Black individuals, the consequences of using GLI-Global guidelines for people of other races or ethnicities are equally worthy of careful consideration. Although beyond the scope of this discussion, the potential challenge of reduced sensitivity and consequent missed cases in non-Hispanic White people should be explored further. Helpfully, the GLI-Global equation does not seem to reduce sensitivity among White people as much as it increases it among Black people in screening for potential restrictive disease.[48,49] Nonetheless, as stated already, no reference equation is a replacement for diligence and awareness among providers.

What should we make, then, of any new recommendations regarding the use of race in PFT results reporting? Like abolitionist Olaudah Equiano, we ask, "What makes any event important, unless by its observation we become better and wiser?"[21] The story of PFTs is no different. From race-specific equations, we learned the folly of overgeneralized correction factors. Herein, we laid out key advantages that make race-neutral equations another step forward. These advantages are not in bringing preferred outcomes to racially and ethnically diverse populations; no interpretative framework does so for a single racial or ethnic group across all outcomes. Instead, their greatest benefit is in revealing the work yet to be completed. We have outlined important, unanswered scientific questions that have merit even outside the present debate: quantifying occupational hazards and strategies to protect from related risk of exposures, clarifying the relationship between lung function and functional status, and enhancing equity in the structure of our health care system. Multiple stakeholders need to be engaged, especially when interpreting results that border between normal and abnormal. Broadly, this demands that we appreciate how the lives our patients lived outside the narrow view of clinics and hospital wards impacts their health. In our iterative work to answer all these questions, we can become better physicians. And in the greater quest to answer the concerns that underlie them, we can embrace a grander humanism.

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