Brief Report

Exercise Rehabilitation is Underutilized Among Veterans With Pulmonary Hypertension

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Pulmonary hypertension (PH) is being diagnosed with increasing frequency in modern cohorts.[1] The clinical classification of PH consists of 5 groups based on the pathophysiological mechanisms, including (1) group 1, pulmonary arterial hypertension (PAH); (2) group 2, PH associated with left heart disease (i.e., heart failure); (3) group 3, PH associated with lung diseases or hypoxia (i.e., chronic obstructive pulmonary disease); (4) group 4, PH associated with pulmonary artery obstructions (i.e., chronic thromboembolic PH); and (5) group 5, PH with unclear or multifactorial mechanisms.[2]

Current treatment recommendations for patients with PAH (group 1),[3,4] heart failure (group 2),[5] chronic lung disease (group 3),[6] and chronic thromboembolic PH[4] recommend the use of exercise rehabilitation, often in the form of either cardiac or pulmonary rehabilitation. The potential benefits of rehabilitation across these conditions include decreased symptoms, improved exercise capacity, reduced admissions, and improved quality of life.[6,7] The extent to which exercise rehabilitation is used in the expanding population of PH patients is unknown.

We sought to describe exercise rehabilitation participation among patients diagnosed with PH in the Veterans Health Administration (VA) healthcare system. The VA is an integrated healthcare system with access to exercise rehabilitation and is thus uniquely positioned to provide insights into interventions being used in the management of patients newly diagnosed with PH. We hypothesized that exercise rehabilitation use would be low.

We used electronic health care and purchased care data from the VA's Corporate Data Warehouse, including inpatient, outpatient, laboratory, and pharmacy encounters, to identify Veterans with newly diagnosed PH from January 1, 2010, to December 31, 2016. Adults ≥18 with PH were identified and classified by etiology of PH based on identifying co-morbidity diagnostic codes during the 5 years before the index visit using published, validated algorithms.[1,8] The PH index visit was defined as the earliest inpatient primary or secondary discharge diagnosis or an outpatient clinic diagnosis during the ascertainment period, using International Classification of Diseases (ICD), Ninth Revision codes 416.0, 416.1, 416.8, or 416.9 or ICD, Tenth Revision codes I27.0, I27.1, I27.2, I27.8, or I27.9. Patients were excluded if they had a diagnosis of PH in the 5 years before or if they died within 30 days. A patient could be classified as having multiple etiologies of PH, except for group 1. Patients were classified as unknown if they had only a nonspecific ICD code.[8]

Exercise rehabilitation participation was defined as participation in one or more sessions within the 3 months before to 1 year after diagnosis. We queried VA data, non-VA data (care purchased by VA), and Medicare Part B data to identify participation. Our primary outcome of interest was exercise rehabilitation participation. Sessions were identified by ≥1 Current Procedural Terminology code for either cardiac rehabilitation (93,797; 93,798; S9472; S9473; G0422; G0423) or pulmonary rehabilitation (G0237, G0238, G0239, G0424, S9473) or a cardiopulmonary stop code specific to VA medical coding (231). Trends in use overall and by group were determined using the Cochran-Armitage trend test.

We identified 103,039 patients with an incident diagnosis of PH. Characteristics of the cohort by PH etiology are shown in Table 1. Of the 103,039, 7,639 (7.4%) had group 1 PAH, 65,753 group 2 (63.8%) and 39,183 group 3 PH (38.0%). Patients with group 1 PAH were younger, more likely to be female, and had a lower prevalence of common co-morbidities than those with either group 2 or group 3 PH.

Overall, exercise rehabilitation was used in 4.0% (n = 4,134) of the cohort. Group 1 PAH had the lowest usage of rehabilitation (2.5%; n = 188). Rehabilitation use increased across all groups, including group 1 from 1.3% to 3.1% (p <0.001), group 2 from 3.1% to 6.7% (p <0.001), group 3 from 3.8% to 7.0% (p <0.001), and group 4 from 2.6% to 5.0% (p = 0.002) (Figure 1).

In this study of over 100,000 incident cases of PH among veterans, overall exercise rehabilitation participation was

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See page 6 for Declaration of Competing Interest.

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Table 1
Characteristics of 103,039 patients with incident pulmonary hypertension

	All groups	Group 1	Group 2	Group 3	Group 4	Unknown
N (% of entire pop)	103,039*	7,639 (7.4%)	65,753 (63.8%)*	39,183 (38.0%)*	3,716 (3.6%)*	15,736 (15.3%)
Age (years)	70.8 ± 11.6	66.9 ± 12.4	72.3 ± 11.2	69.3 ± 10.6	69.8 ± 11.9	69.8 ± 12.2
Male	98,340 (95.4%)	6,993 (91.5%)	63,500 (96.6%)	37,508 (95.7%)	3,558 (95.7%)	14,797 (94.0%)
Race						
White	73,482 (71.3%)	5,145 (67.4%)	46,857 (71.3%)	28,797 (73.5%)	2,561 (68.9%)	11,278 (71.7%)
Black	17,335 (16.8%)	1,451 (19.0%)	11,304 (17.2%)	6,146 (15.7%)	786 (21.2%)	2459 (15.6%)
Am Ind/Alaskan Native	3,990 (3.9%)	362 (4.7%)	2,452 (3.7%)	1,526 (3.9%)	135 (3.6%)	556 (3.5%)
Asian	1,552 (1.5%)	143 (1.9%)	942 (1.4%)	529 (1.4%)	31 (0.8%)	277 (1.8%)
Unknown/Missing	6,680 (6.5%)	538 (7.0%)	4,198 (6.4%)	2,185 (5.6%)	203 (5.5%)	1,169 (7.4%)
Married	51,937 (50.4%)	3,752 (49.1%)	32,487 (49.4%)	20,868 (53.3%)	1,772 (47.7%)	8,152 (51.8%)
Comorbidities						
HTN	90,418 (87.8%)	5,754 (75.3%)	60,622 (92.2%)	35,713 (91.1%)	3,344 (90.0%)	12,434 (79.0%)
CAD	55,000 (53.4%)	2,148 (28.1%)	42,340 (64.4%)	22,508 (57.4%)	2,288 (61.6%)	5,390 (34.2%)
CKD	31,066 (30.1%)	1,225 (16.0%)	24,909 (37.9%)	12,597 (32.1%)	1,486 (40.0%)	2,518 (16.0%)
Obesity	42,572 (41.3%)	2,293 (30.0%)	28,196 (42.9%)	22,776 (58.1%)	1,778 (47.8%)	4,813 (30.6%)
Thyroid Disease	17,039 (16.5%)	1,044 (13.7%)	11,762 (17.9%)	7,162 (18.3%)	713 (19.2%)	2,044 (13.0%)
DM	48,465 (47.0%)	2,510 (32.9%)	34,680 (52.7%)	21,746 (55.5%)	1,928 (51.9%)	5,315 (33.8%)
Connective tissue disease	3,823 (3.7%)	980 (12.8%)	2,168 (3.3%)	1,675 (4.3%)	167 (4.5%)	0 (0.0%)
Congenital heart disease	1,181 (1.1%)	178 (2.3%)	875 (1.3%)	480 (1.2%)	57 (1.5%)	0 (0.0%)
HIV	652 (0.6%)	192 (2.5%)	355 (0.5%)	220 (0.6%)	36 (1.0%)	0 (0.0%)
Liver disease	4,502 (4.4%)	1,205 (15.8%)	2,703 (4.1%)	1,673 (4.3%)	182 (4.9%)	0 (0.0%)
COPD	9,706 (9.4%)	0 (0.0%)	5,817 (8.8%)	9,706 (24.8%)	440 (11.8%)	0 (0.0%)
Interstitial lung disease	7,149 (6.9%)	0 (0.0%)	4,670 (7.1%)	7,149 (18.2%)	368 (9.9%)	0 (0.0%)
OSA	28,042 (27.2%)	0 (0.0%)	19,269 (29.3%)	28,042 (71.6%)	1,210 (32.6%)	0 (0.0%)
Diastolic/systolic dysfunction	52,594 (51.0%)	0 (0.0%)	52,594 (80.0%)	22,135 (56.5%)	2,241 (60.3%)	0 (0.0%)
Mitral/Aortic valve disease	28,678 (27.8%)	0 (0.0%)	28,678 (43.6%)	9,701 (24.8%)	977 (26.3%)	0 (0.0%)
Cardiomyopathy	18,057 (17.5%)	0 (0.0%)	18,057 (27.5%)	7,144 (18.2%)	843(22.7%)	0 (0.0%)
Chronic Thromboembolic PH	3716 (3.6%)	0 (0.0%)	2,561 (3.9%)	1,696 (4.3%)	3,716 (100.0%)	0 (0.0%)
Exercise rehabilitation	4,134 (4.0%)	188 (2.5%)	2,847 (4.3%)	2,009 (5.1%)	125 (3.4%)	458 (2.9%)

* Patients could be categorized as belonging to more than one of the World Health Organization Groups 2, 3, and 4 pulmonary hypertension.
Am Ind= American Indian; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HIV = human immunodeficiency virus; HTN= hypertension; OSA = obstructive sleep apnea; PH = pulmonary hypertension.

consistently low across all etiologies of PH. However, the use of rehabilitation increased among Veterans over the 6 years examined. Patients with group 1 PAH had the lowest participation, with <3% attending. Collectively, these findings suggest an opportunity to improve the care of patients with PH.

Exercise rehabilitation is an evidence-based guideline recommendation for the treatment of patients with groups 1, 2, 3, and 4 PH.[3–6] Despite evidence of benefit, previous work has shown underuse of cardiac rehabilitation and pulmonary rehabilitation among patients with cardiopulmonary diseases such as heart failure or chronic obstructive

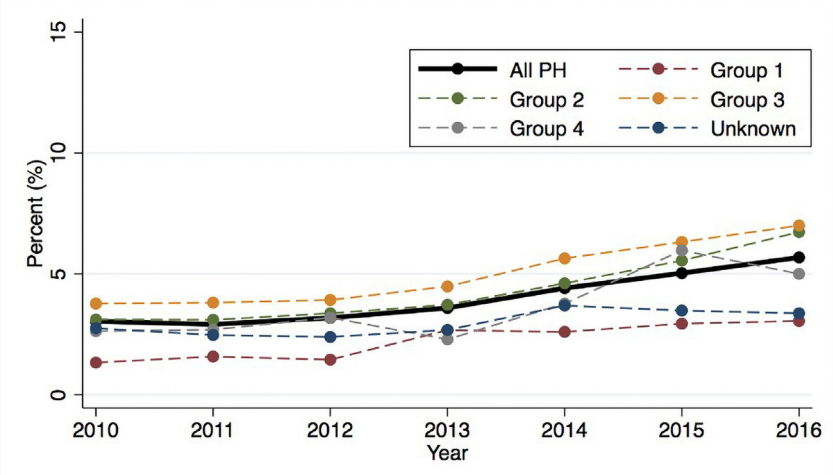

Figure 1. Trends in the use of exercise rehabilitation among patients with pulmonary hypertension.

pulmonary disease.[6,7,9] The present study builds on this previous work by demonstrating real-world low utilization among patients with PH, regardless of etiology and without significant patient-cost burden. Identification of this potential underuse is a necessary first step in increasing access.

Despite these findings from a large dataset, our study has limitations. We cannot determine why participation in exercise rehabilitation is low, including whether patients were referred and didn't participate. The barriers to enrollment for exercise rehabilitation are multifactorial and may include health system, provider, and patient-level factors such as lack of broad insurance coverage, cost, and living in remote or rural areas.[9] Importantly, the VA is independent, meaning insurance coverage and therapy reimbursement are not reasons for low use. It is further unknown how the increasing use of home-based programs in the VA would impact these findings though one would hypothesize that access should be improved. Next, we used a computable phenotype algorithm that relied on ICD, Ninth Revision and ICD, Tenth Revision codes to identify cases that may be subject to misclassification though these codes have been validated previously.[10] The one-component algorithm using only ICD codes was chosen to be most sensitive as recommended by current best practice methodology to describe practice patterns for PH.[10] However, given low utilization across all etiologies, correct classification is less important as there is a need and opportunity to increase use for all patients with PH.

In conclusion, we found low use of exercise rehabilitation for the treatment of PH across all etiologies. A better understanding of the barriers to referral, attendance, and completion is necessary to determine strategies for improving access to exercise rehabilitation and optimizing the medical care of patients with PH.

Declaration of Competing Interest

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