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Claudicating patients with peripheral artery disease have meaningful improvement in walking speed after supervised exercise therapy

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CME Activity

ABSTRACT

Objective: Supervised exercise therapy (SET) is a first-line treatment for patients with peripheral artery disease (PAD). The efficacy of SET is most commonly expressed by significant statistical improvement of parameters that do not clarify how each individual patient will benefit from SET. This study examined the minimal clinically important difference (MCID) in walking speed in claudicating patients with PAD after SET.

Methods: A total of 63 patients with PAD-related claudication (Fontaine stage II PAD) participated in a 6-month SET program. Self-selected walking speed was measured before and after SET. Distribution and anchor-based approaches were used to estimate the MCID for small and substantial improvement. The ability to walk one block and the ability to climb one flight of stairs questions were chosen as anchor questions from the Medical Outcomes Study 36-item Short Form questionnaire. Receiver operating characteristics curve analyses were performed to detect the threshold for MCID in walking speed after treatment.

Results: The distribution-based method estimated 0.03 m/s as a small improvement and 0.08 m/s as a substantial improvement after SET. Small and substantial improvements according to the anchor question walking one block were 0.05 m/s and

0.15 m/s, respectively. For the climbing one flight of stairs anchor question, 0.10 m/s was a small improvement. Receiver operating characteristics curve analyses identified an increase of 0.04 m/s and 0.03 m/s for improvement based on walking one block and climbing one flight of stairs, respectively.

Conclusions: We report our findings for the MCID for walking speed among claudicating patients receiving SET. Claudicating patients who increase walking speed of 0.03 m/s or greater are more likely to experience a meaningful improvement in walking impairment than those who do not. The MCID reported in this study can serve as a benchmark for clinicians to develop goals and interpret clinically meaningful progress in the care of claudicating patients with PAD. (J Vasc Surg 2021;74:1987-95.)

Keywords:

Minimal clinically important difference; Walking speed; Peripheral artery disease; Supervised exercise therapy

Supervised exercise therapy (SET) is a first-line treatment for patients with peripheral artery disease (PAD)- related claudication, leading to a significant improvement in the distance patients can walk and in quality of life.[1-6] SET outcomes are usually expressed as statistical comparisons of parameters in quality-of-life questionnaires, walking distances, and gait biomechanics obtained before and after treatment. However, these comparisons often fail to convey the relevance of the degree of change to patients.

The minimal clinically important difference (MCID) rep- resents the smallest change in an outcome measurement that is significant and relevant to patients.[7-9] The MCID seeks to express the criteria for clinically relevant improvement, deterioration, or lack of change owing to a disease or intervention rather than just state the presence or absence of a statistically significant difference. The concept of MCID was first introduced by Jaeschke et al[7] to identify the change in quality of life that would result in a clinically relevant change in individuals with asthma. Since then, the MCID concept has been used for several clinical populations and interventions including those with neurologic, cardiovascular, pulmonary, musculoskeletal and degenerative diseases.[10]

Studies that measured the MCID for patient-reported outcomes, claudication distances, and walking parameters in patients with PAD are limited.[8] Previous studies found an increase of 0.87 points in the Vascular Quality of Life and 0.11 points in the Walking Impairment Questionnaire indicative of a significant improvement after revascularization in patients with intermittent claudication and critical limb ischemia.[11-14] Gardner et al[8] re- ported MCIDs of 38 seconds, 95 seconds, and 152 seconds, respectively, for small, moderate, and large improvements in peak walking time after the completion of a SET program. There are limitations of using quality-of-life questionnaires to assess physical function[15]; measurements of walking distance with a tread- mill are technically demanding, limited to vascular laboratories, and are not practical to complete in a clinical setting.[16] Walking speed is a relatively quick and easy test that requires minimal equipment (stopwatch and known distance) and can be measured in nearly every environment. For these reasons, walking speed is a more generalizable test for which there are established threshold values for daily activities, such as the ability to cross the street, successful community ambulation, ability to carry groceries, and ability to do household activities.[10] Hence, expressing the MCID in terms of walking speed can be a helpful tool to assess whether a treatment improves the ability to perform activities of daily living while allowing comparisons across clinical populations and treatments.[9,17-22]

This study estimated the MCID in walking speed in patients with PAD after SET. The MCID values were measured by using both distribution and anchor-based methods. Receiver operating characteristics (ROC) curves were also constructed to identify the increase in walking speed that signifies any improvement after SET.

METHODS

Participants and SET protocol.

The study was approved by the Institutional Review Boards at the Nebraska- Western Iowa Veteran Affairs Medical Center and University of Nebraska Medical Center. A total of 63 patients (mean age, 64.95 6 6.60 years; body mass index, 29.24 6 5.70 kg/m^2) diagnosed with Fontaine stage II PAD were recruited through the vascular surgery clinics of these institutions. Patients' had not previously participated in any SET program or any revascularization treatments before enrollment into this study. Patient consent was obtained before study participation. Patients were free from any gait-altering musculoskeletal or neurologic conditions that limited or altered walking. Patient history and physical examination were evaluated by one of two boardcertified vascular surgeons. The demographics and clinical characteristics of patients were reported in Table I.

Each patient participated in a 6-month, three times per week (total of 72 sessions) SET program that followed the American College of Sports Medicine recommendations in line with previous studies that best increase walking distances.[23,24] The detailed SET protocol used in this study has been described previously.[1]

Experimental procedures and data collection.

Self- selected walking speed was assessed as part of a larger gait biomechanics assessment at the Biomechanics Research Building at the University of Nebraska at Omaha. Each patient was evaluated twice: (1) before (baseline) and after 6-month (postexercise) participation in SET. A reflective marker was placed at the heel of the leg most affected with PAD based on ankle brachial index and claudication symptoms. Patients walked across a 10-m pathway for at least three trials and the coordinates of the marker were recorded using a 12 high-speed infrared camera system (60 Hz, Motion Analysis Corporation, Rohnert Park, Calif). A minimum mandatory rest of 1 minute was taken between each trial to prevent the onset of claudication pain. Walking speed was calculated as the average distance traveled per second measured based on the reflective marker and averaged across three trials.[25,26]

Table I. Patient demographics and clinical characteristics

Characteristics	Mean 6 standard deviation or percent
No. of patients	63
Male	100
Age, years	64.95 6 6.60
Body mass index, kg/m^2	29.24 6 5.70
Ankle brachial index	0.50 6 0.17
Level of disease	
Aortoiliac	20.93
Femoropopliteal	30.23
Multilevel	48.84
Smoking	
Current	61.82
Former	34.55
Never	3.63
Coronary artery disease	33.93
Diabetes	28.57
Dyslipidemia	63.64
Hypertension	71.70

MCID calculation. MCID in walking speed was calculated using both distribution and anchor-based methods. The distribution-based method uses the standard deviation of the walking speed to assess the meaningful difference. Thus, this method is influenced by the group variation in walking speed at baseline. In contrast, the anchor-based method is considered a more robust approach to estimate MCID.[9] The anchor-based method correlates the quantitative change in walking speed after the disease or intervention with a measured change in function, for example, self-selected mobility response from individuals on questionnaires.[17] This method provides a more standard clinical assessment as it uses the individual's perceived change as the reference for the change in the desired outcome variables.[27]

Distribution-based method. The standard deviation of the baseline walking speed was used to measure the meaningful differences according to the distribution method. A small improvement was computed as 0.2 x s, and a substantial improvement was computed as 0.5 x s, and s is the standard deviation of the group mean baseline walking speed.[17,27]

Anchor-based method. Patient-reported outcomes were measured using the Medical Outcomes Study 36- item Short Form questionnaire (SF-36). Previous studies considered two mobility items from the SF-36 as anchor questions to calculate MCID for walking speed: (1) the ability to walk one block and (2) the ability to climb one flight of stairs.[17,27] Self-reported difficulty during walking a short distance or walking upstairs is often used as a definition of mobility disability and walking speed is an important predictor of this outcome.[17] Therefore, this study used these two questions as the anchor questions to calculate MCID.

Participants rated their ability as limited a lot, limited a little, and not limited at all while answering the two anchor questions. Participants were then categorized into groups based on their responses to the anchor questions at baseline and after exercise (substantial improvement, small improvement, no change, small decline, and substantial decline). Substantial improvement was defined as change from limited a lot to not limited at all. Small improvement was defined as change from limited a lot to limited a little, or from limited a little to not limited at all. Some participants also reported no change, or declined performance (changed from not limited at all to limited a little, from limited a little to limited a lot, and from not limited at all to limited a lot). Those participants were excluded from anchor-based analysis because we wanted to focus only on improvements in walking speed after SET.

Two approaches were used for the anchor-based method. First, we used descriptive statistics to calculate MCID for walking speed. Small MCID was estimated as the mean change in walking speed between postexercise and baseline of the patients who were in the small improvement group according to the anchor question (as defined elsewhere in this article). Similarly, substantial MCID was calculated as the mean change in walking speed between postexercise and baseline of the patients who reported substantial improvement according to the anchor question. This process was followed separately for each anchor question.

Table II. Results of two anchor questions from the Short Form (SF)-36 Health survey before and after 6 months of super- vised exercise therapy (SET)

Walking	one block				Climbing one flight of stairs	
Conditions	Baseline		After exercise		Bas eline	After exercise
Yes, limited a lot	15	(23.8)	6	(9.5)	9 (14.3)	7 (11.1)
Yes, limited a little	31	(49.2)	26	(41.3)	35 (55.6)	27 (42.9)
Not limited at all	17	(27.0)	31	(49.2)	19 (30.1)	29 (46.0)
Total	63	(100)	63	(100)	63 (100)	63 (100)

Values are presented as number of patients (% of patients/response).

Table III. Change in patient reported outcomes after 6 months of supervised exercise therapy (SET) according to the Short Form (SF)-36 Health Survey anchor questions

	Substantial decline	Small decline	No change	Small improvement	Substantial improvement	Total
Walking one block	1 (1.6)	7 (11.1)	27 (42.9)	24 (38.1)	4 (6.3)	63 (100)
Climbing one flight of stairs	2 (3.2)	6 (9.5)	35 (55.6)	18 (28.5)	2 (3.2)	63 (100)

Substantial decline/improvement was defined as change from not limited at all to limited a lot and vice versa. Small decline/improvement was defined as a change from limited a little to limited a lot, or from not limited at all to limited a little and vice versa. Values are presented as number of patients (% of patients/group).

Second, a ROC curve was used to estimate the threshold walking speed to predict improvement after SET. For the ROC analysis, the response to the anchor question was expressed as two dichotomous outcomes variables: any improvement (including small and substantial) vs no change. The participants who reported their conditions as declining (small and substantial) were excluded from ROC analysis because our aim was to determine the threshold walking speed for any improvement as compared with no improvement. The sensitivity represents the proportion of the patients who were correctly classified as showing improvement after exercise therapy. Sensitivity was plotted along the *y*-axis in the ROC graph. The *x*-axis of the ROC graph was expressed as 1 e specificity, representing the proportion of the patients who were incorrectly classified as showing improvement. A cut-point in the ROC curve (ie, the threshold walking speed), was chosen from the minimal value of the equation (1 e sensitivity)^2 þ (1 e specificity).[2,17,28] The positive predictive value was calculated using data from patients who met the threshold walking speed (ie, were predicted to respond), by dividing the number who actually responded by the total number of patients who were predicted to respond. In contrast, the negative predictive value was calculated using data from patients who did not meet the threshold walking speed (ie, were predicted to be nonresponders), by dividing the number who were actual nonresponders by the total number of patients who were predicted to be nonresponders. Positive likelihood ratio was estimated by dividing sensitivity by 1 e specificity. All analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Distribution-based MCID. The average walking speed of all patients at baseline was 1.11 6 0.15 m/s. Walking speed increased to an average of 1.16 6 0.16 m/s after 6 months of SET (4.5% improvement; $P < .001$). Based on the standard deviation of walking speed at baseline (0.15), the distribution-based method estimated a change of 0.03 m/s for small improvement and 0.08 m/s for substantial improvement after SET.

Anchor-based MCID. Fifteen patients (23.8%) were substantially limited in walking one block and this decreased to only six patients (9.5%) after SET (Table II). In contrast, the number of patients who were able to walk one block without any limitation increased from 17 (27%) to 31 (49.2%) after 6 months of SET. A similar pattern was observed for the question regarding climbing one flight of stairs. Initially, 19 patients (30.1%) were able to climb one flight of stairs without any limitation at baseline. After 6 months of SET, 29 patients (46%) answered that they could climb one flight of stairs without any limitation (Table II).

Table IV. Anchor-based minimal clinically important difference (MCID) in walking one block and climbing one flight of stairs after 6 months of supervised exercise therapy (SET)

	No change	Small improvement	Substantial improvement
Walking one block	0.03 (e0.01 to 0.06)	0.05 (0.01 to 0.10)	0.15 (e0.05 to 0.34)
Climbing one flight of stairs	0.03 (e0.002 to 0.06)	0.10 (0.05 to 0.15)	e0.02 (e1.85 to 1.82)

Values are presented as mean (95% confidence interval).

Only eight patients (12.7%) reported declines in walking one block and climbing one flight of stairs after 6 months of SET (Table III). Twenty-seven (42.9%) and 35 (55.6%) patients reported no changes in walking one block and climbing one flight of stairs, respectively, after SET. A total of 24 patients (38.1%) had a small improvement and 4 patients (6.3%) had a substantial improvement in walking one block. In contrast, for climbing one flight of stairs, 18 patients (28.5%) showed a small improvement and only 2 patients (3.2%) had a substantial improvement after SET (Table III).

The patients who reported no change in walking one block had an average 0.03 m/s increase in walking speed (Table IV). The patients who had a small improvement after SET showed an increase of 0.05 m/s in walking speed. A greater improvement in walking speed, 0.15 m/s, was observed for patients having substantial improvement in walking one block. Surprisingly, the average walking speed increased by 0.04 m/s for the small decline group. The only patient who reported substantial decline in walking one block had also increased walking speed (0.14 m/s). For the anchor question regarding climbing one flight of stairs, an improvement of 0.03 m/s was detected for patients who had no change after SET. Walking speed increased by an average of 0.10 m/s in patients reporting a small improvement. Surprisingly, the walking speed decreased by 0.02 m/s for patients who reported substantial improvement, although there were only two patients in this group (Table IV). However, the six patients who reported a small decline according to the climbing one flight of stairs anchor question decreased their average walking speed by 0.01 m/s after SET. The average walking speed increased by 0.09 m/s for those two patients who had substantial declined ac- cording to the climbing one flight of stairs question.

The ROC curve analysis.

The threshold change in walking speed that maximized the sensitivity and specificity in the ROC curve for patients who reported improvement in walking one block after SET was 0.04 m/s (Fig 1). The corresponding sensitivity and specificity were 57.1% and 44.4%, respectively. The positive predictive value was 0.52 and the negative predictive value was 0.50 with a positive likelihood ratio of 1.03. The area under the ROC curve was 0.58. In contrast, the threshold walking speed to signify improvement in climbing one flight of stairs was identified as 0.03 m/s with 80.0% sensitivity and 48.6% specificity (Fig 2). This yields a positive likelihood ratio of 1.56. The positive and negative predictive values were 0.47 and 0.81 m respectively. The area under the curve was found to be 0.65.

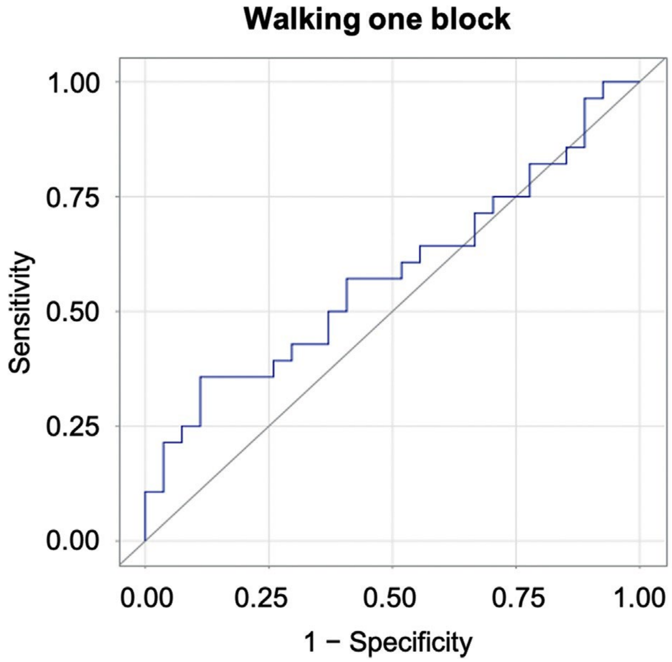

Fig 1. Receiver operating characteristic (ROC) curve to predict change (small or substantial vs no change) in the ability to walk one block after 6 months of supervised exercise therapy (SET) in patients with peripheral artery disease (PAD). Threshold change in walking speed was 0.04 m/s (sensitivity = 57.1%; specificity = 44.4%; positive likelihood ratio = 1.03; and area under the ROC curve = 0.58). The proportion of patients with any improvement in walking one block among those among those who met the threshold walking speed was 0.52, and the proportion of patients who did not improve among those who did not meet the threshold walking speed was 0.50.

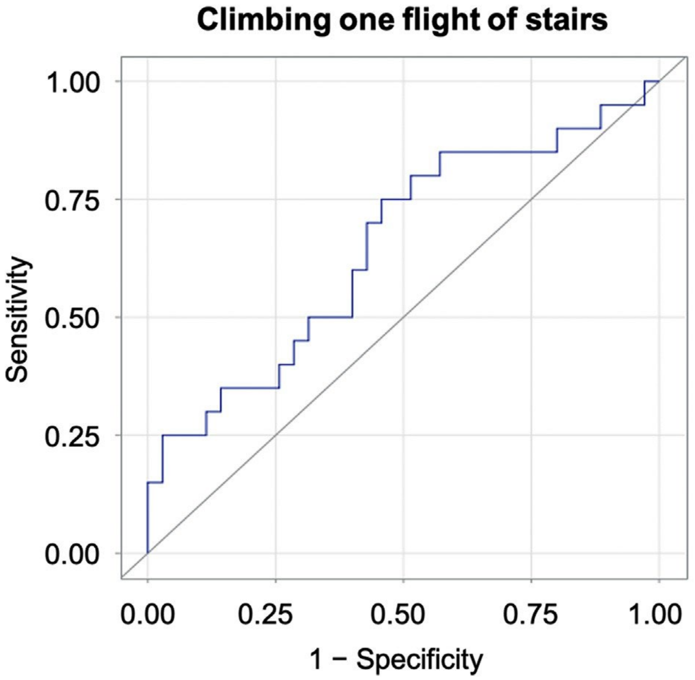

Fig 2. Receiver operating characteristic (ROC) curve to predict change (small or substantial vs no change) in the ability to climb one flight of stairs after 6 months of supervised exercise therapy (SET) in patients with peripheral artery disease (PAD). The threshold change in walking speed was 0.03 m/s (sensitivity = 80%; specificity = 48.6%; positive likelihood ratio = 1.56; and area under the ROC curve = 0.65). The proportion of patients with any improvement in climbing one flight of stairs among those who met the threshold walking speed was 0.47 and the proportion of patients who did not improve among those who did not meet the threshold walking speed was 0.81.

DISCUSSION

The purpose of this study was to estimate the MCID in walking speed after SET in patients with PAD. Both distribution and anchor-based methods were used, including the ROC curve analysis to estimate the walking speed that is relevant and predicts meaningful improvement of individual patients. The distribution-based method results suggest that an increase in walking speed of 0.03 m/s after SET predicts a small improvement and an increase of 0.08 m/s predicts a substantial improvement. The anchor-based method estimates resulted in greater increases of walking speed needed to demonstrate similar improvements. Increases in walking speed for small and substantial improvements were 0.05 m/s and 0.15 m/s, respectively, according to the walking one block anchor question. Similarly, for the anchor question of climbing one flight of stairs, an estimate of 0.10 m/s was indicative of a small improvement. We were not able to dependably calculate the walking speed that predicts a substantial improvement according to the climbing one flight of stairs question (e0.02 m/s) because we had only two such patients. A relatively large decline in one patient and a smaller in- crease in the other caused the overall change in walking speed to be negative (-0.02 m/s) for substantial improvement. We excluded the patients from the analysis who did not improve or showed deterioration based on the two anchor questions. Our primary objective was to estimate the MCID for walking speed improvement after SET using previously described method.[17] Looking at two patients whose walking speed increased although they had a substantial decline according to the climbing one flight of stairs question, we found that one of the patients was the same who also reported a substantial decline in walking one block. This patient reported him- self as substantial declined for both anchor questions (changed from not limited at all to limited a lot), although his walking speed actually increased by 0.14 m/s after 6 months in the SET program. This outcome demonstrates the challenges involved in using the anchor-based method when correlating the quantitative measurement with self-reported questionnaires with mobility limitations.[17] A previous study also suggests that using the self-report to validate performance measures such as walking speed is useful, but the limitations of self-reported questionnaires continue to be of central importance.[17] Future work with a greater number of patients who reported small and substantial declines and substantial improvement with a different set of anchor questions may provide further insight.

Previous work has reported the MCID values for walking speed in different clinical populations for several interventions. Walking speed changes ranged from 0.10 m/s to 0.17 m/s for small and 0.17 m/s to 0.26 m/s for substantial improvements after surgical repair of hip fracture.[17] The MCID in patients with chronic obstructive pulmonary disease ranged from 0.08 m/s to 0.11 m/s after 8 weeks of pulmonary rehabilitation.[21] The clinically meaningful important difference in walking speed among persons with Parkinson disease while on anti-Parkinsonian medication ranged from 0.05 m/s to 0.22 m/s by the distribution-based method and ranged from 0.02 m/s to 0.18 m/s when estimated by the anchor-based method.[22] Therefore, our estimated MCID values for walking speed in patients with PAD after SET are comparable with those demonstrated in other clinical populations and in a variety of clinical settings and interventions.

The ROC curve analyses in the present study suggest that the walking speed improvements that predict meaningful improvement after SET were 0.04 m/s and 0.03 m/s for walking one block and climbing one flight of stairs, respectively. The area under the ROC curves ranges from 0.58 to 0.65 showing a marginal discrimination.[29] A review article summarizing the MCID estimated by ROC analyses from seven different studies has re- ported that area under the curve ranged from 0.53 to 0.91.[30] Only three of seven reported studies reported area under the curve values exceeding 0.70.[30] Although the measurement of walking speed is simple and pro- vides useful information regarding patient health status, based on the ROC results, walking speed has a marginal ability to distinguish patient improvement after an intervention. It may be interesting to analyze the ROC curves by exploring additional or multiple anchor questions to see how the area under the curve values for ROC curves are impacted. If the participants do not improve walking speed after the intervention, MCID values for quality of life may be considered as an alternate to predict the efficacy of intervention. However, quality-of-life questionnaires only considers the participant’s own perception, whereas walking speed provides a quantitative outcome and an objective measurement of the intervention.

The average walking speed of the patients with claudication in this study was 1.11 m/s, which is less than the normal walking speed observed in age-matched healthy adults (1.32-1.36 m/s).[26,31] Looking at other clinical populations, the walking speed in patients with hip fracture after successful fixation and repair ranged from 0.36 m/s to 0.66 m/s.[17,18] The walking speed in stroke patients ranged from 0.18 m/s to 0.56 m/s.[9,20] The average walking speed in patients with chronic obstructive pulmonary disease, Parkinson disease, multiple sclerosis, and very mild Alzheimer disease (clinical dementia rating of 0.5 or 1.0) were 0.90 m/s, 0.98 m/s, 1.3 m/s, and 1.21 m/s, respectively.[21,22,32,33] The average walking speed in patients with incomplete spinal cord injury (both traumatic and nontraumatic) varies from 1.25 m/s to 1.39 m/s based on the time when walking speed was measured after injury.[34] Thus, on average, claudicating patients with PAD have higher walking speeds than patients with hip fracture, stroke, chronic obstructive pulmonary disease, and Parkinson disease, but lower walking speeds than patients with multiple sclerosis, mild Alzheimer disease, and incomplete spinal cord injury.

Previous studies from our group and others have re- ported significant improvement in quality of life and walking distances in patients with PAD after SET.[1-6] Our findings also show that walking speed significantly improved by an overall average of 4.5% from baseline. We found that the walking speed significantly improved by 0.05 m/s in patients with PAD after a 6-month SET program. To put this finding in the context of improvements in speed after intervention in different clinical set- tings, walking speed improved by 0.08 m/s in patients with chronic obstructive pulmonary disease after 8 weeks of pulmonary rehabilitation[21] and by 0.18 m/s after total hip arthroplasty[19]; patients with repaired hip fracture had also improved walking speed by 0.16 m/after following an exercise program with average duration of 10 months.[17] Our results suggest that an overall increase of 0.03 to 0.10 m/s is seen in patients enjoying a small improvement and 0.08 to 0.15 m/s for substantial improvement after SET. This level of improvement would correspond with a 1-mile walking time that is between 101 and 189 seconds faster.

Previous studies have measured the minimally important differences in patients with PAD with critical limb ischemia and intermittent claudication following different treatment methods. Most of these measurements were limited to patient-reported outcomes, claudication time, and claudication distances. The minimally important differences in Vascular Quality of Life questionnaire after revascularization treatment in patients with critical limb ischemia are 0.48 and 0.36 points based on the distribution and anchor-based methods, respectively.[11] Conijn et al[12] reported an increase of 0.87 in the Vascular Quality of Life and 0.11 in the Walking Impairment Questionnaire in patients with intermittent claudication as indicative of a significant and meaningful improvement after treatment (optimal medical therapy, revascularization, or SET). Another study suggested an improvement range of 1.7 to 2.2 points on the Vascular Quality of Life questionnaire as the minimum important difference in patients with intermittent claudication 1 year after revascularization.[14] A study by Van Den Houten et al[35] also reported the functional and absolute claudication distances that signify improvement as 250 m and 305 m, respectively, after 3 months of SET.[35] Gardner et al[8] estimated MCID values of 38 seconds, 95 seconds, and 152 seconds for small, moderate, and large improvements, respectively, in peak walking time. Furthermore, the 6-minute walk distance for small, moderate, and large MCID were 9 m, 24 m, and 38 m, respectively.[8] Our current study adds the MCID values of walking speed that signify small and substantial improvements after SET to the existing literature.

The measurement of walking speed is simple, inexpensive, and can be implemented easily in a clinical setting. We used a reflective marker placed in the heel to calculate the walking speed; however, several wearable technologies and inertial measurement units are being used to measure walking speed.[36] A smart phone app called 6th Vital Sign has been developed that can directly measure the walking speed from a 2-minute walk test.[37] The smartphone-based assessment of gait parameters such as step length, step time, and walking speed are reliable and valid.[38] Therefore, several wearable technologies are available to measure walking speed accurately in a clinical setting.[36] Walking speed is an outcome of the complex interplay of several body structures and their functions, including proactive and reactive postural control, lower extremity muscle strength, aerobic capacity, motor control, and visual effects.[10] Walking speed can be a significant indicator of functional recovery or deterioration and has been emerging as a sixth vital sign in health care.[10] Walking speed is a more generalizable test and is used to establish threshold values for several daily activities such as the ability to cross the street, successfully ambulate in the community, the ability to carry groceries, and the ability to perform house- hold activities.[10] Establishing improvement ranges based on walking speed could also lay the ground- work for using walking speed from wearable devices to monitor PAD progression and treatment progress in real-world environments. On the basis of this progressively increasing literature, walking speed is now considered a global indicator of overall health and functional status especially in older populations with or without chronic diseases and is being commonly used as a key reference to estimate the efficacy of a treatment.[18]

Comparing the outcomes before and after any type of treatment statistically, sample size, and patient-to- patient individual performance variability can prevent meaningful differences from reaching statistical significance.[22] Alternatively, very large sample sizes that include small differences after a treatment can lead to statistically significant differences that have little practical meaning or impact on patient quality of life.[39] In both situations, the efficacy of an intervention is more meaningfully interpreted by comparing the outcomes with established parameters of clinically important and significant improvements,[22,27] such as the MCID for walking speed.

There are limitations to this study. First, the majority of our participants were White males with claudication and the MCID estimation for walking speed may need to be evaluated for different demographics. Second, the number of patients we evaluated, in combination with the anchor questions we selected, produced a small number of patients in the substantial improvement groups. We also excluded the patients from the anchor-based analyses who did not improve or showed declined performance based on the two anchor questions. Increasing the number of patients evaluated and selecting additional anchor questions may further improve the process of estimating the MCID for treatment of patients with PAD-related claudication.

CONCLUSIONS

We measured the MCID values of change in walking speed that indicate small and substantial improvements in claudicating patients with PAD after SET. Our data indicate that the clinically important difference in walking speed among claudicating patients ranged from 0.03 m/s to 0.08 m/s by distribution-based analysis and ranged from 0.03 m/s to 0.15 m/s per level based on anchor-based metrics. The MCID reported in this study can serve as a benchmark for clinicians to develop goals and interpret clinically meaningful progress in the care of claudicating patients with PAD.

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AUTHOR CONTRIBUTIONS

Conception and design: HR, IP, JJ, GC, MW, SM Analysis and interpretation: HR, IP, JJ, GC, JT, YO, SM Data collection: MW, SM

Writing the article: HR, IP, SM

Critical revision of the article: HR, IP, JJ, GC, MW, JT, YO, SMFinal approval of the article: HR, IP, JJ, GC, MW, JT, YO, SM

Statistical analysis: HR

Obtained funding: IP, JJ, SM Overall responsibility: HR

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