2021

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PTJ: Physical Therapy & Rehabilitation Journal | *Physical Therapy*, 2021;101:1–11
DOI: 10.1093/ptj/pzab079
Advance access publication date February 25, 2021
Perspective

A Knowledge Translation Framework for Optimizing Physical Therapy in Patients With Heart Failure

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Abstract

The American Physical Therapy Association has supported the development of clinical practice guidelines to promote and support evidence-based practice and reduce unwarranted practice variation. Essential to the success of this effort is the generation of knowledge translation, a concept that emphasizes the translation of global knowledge to an application that can be effectively integrated into clinical practice. The Physical Therapy Clinical Practice Guideline for the Management of Individuals with Heart Failure published in the *Physical Therapy Journal* in January 2020 provides a broad base of knowledge related to evidence-based treatment interventions for patients with heart failure. However, the application and integration of this knowledge in clinical practice need further elucidation. Therefore, this perspective paper aims to serve as a complementary knowledge translation resource to the recently published practice guideline to maximize the utilization of contemporary evidence in clinical practice. This resource provides the physical therapist with practical guidance in the management of patients with heart failure by placing research findings in the context of other knowledge and practice norms that can be applied at the point of care and across the continuum of care. We propose a novel ABCDE (assessment, behavior modification, cardiorespiratory fitness, dosage, and education) practical framework. This clinical paradigm is grounded in ongoing physical therapist assessment throughout the episode of care, along with behavior modification, assessment of cardiorespiratory fitness, appropriate selection and dosing of interventions, and patient education. Examples highlighting the use of this model in patients with heart failure across the continuum of care are provided for application in clinical care.

Keywords: Evidence-Based Practice, Exercise Therapy, Exercise Tolerance, Heart Failure, Patient Care Management, Patient Education

Received: August 28, 2020. **Revised:** December 8, 2020. **Accepted:** February 7, 2021

Introduction

According to the Center on Knowledge Translation for Disability and Rehabilitation Research, knowledge translation is a 6-step process where the translation of global knowledge to the application of knowledge is enhanced by "placing research findings in the context of other knowledge and social norms" and "making decisions and taking action informed by research findings."[1] The recently published clinical practice guideline (CPG) for the management of patients with heart failure (HF) provides physical therapists with the highest level of available evidence on a variety of treatment interventions to maximize movement and function in individuals with HF.[2] The HF CPG provides physical therapists with 9 key action statements that guide treatment interventions for individuals with HF.[3] However, the application of the CPG in the care of complex patients is often challenging. Low adherence to CPGs may be because CPGs are typically based on a single condition, resulting in a mismatch between the characteristics of individuals studied in clinical trials and the complex, multimorbid nature of patients seen in clinical practice.[4–6] To this end, this perspective paper aims to facilitate knowledge translation by providing a framework for physical therapists to utilize research in the context of other knowledge and social norms, thereby facilitating the application of the HF CPG in clinical practice along the continuum of care.

The current evidence regarding exercise-based interventions for HF presented in the CPG is based on a relatively select group of individuals with HF.[3] The individuals typically investigated in clinical trials reported in the CPG were outpatient male adults, aged 50 to 60 years with reduced ejection fraction and New York Heart Association Functional Classification II to III.[3] This reflects a relatively stable population of patients with HF. Individuals in clinical trials lacked many of the acute and chronic decompensations, complications, instabilities, and comorbidities seen in clinical practice.[7] The burden of comorbidities amplifies reduced physical activity, sedentary lifestyles, and overall reductions in activity and participation commonly noted in individuals with HF. Supplementary Appendix 1 provides the physical therapists with a list of common comorbidities seen in patients with HF, their systemic pathophysiological effects, and relevant clinical considerations. This mismatch between those enrolled in clinical trials and patients commonly seen in clinical practice suggests a need for additional resources to improve knowledge translation from the HF CPG for clinicians practicing in various physical therapy settings.

In this perspective paper, we propose a 5-step assessment, behavior modification, cardiorespiratory fitness testing, dosing, education (ABCDE) framework to assist physical therapists in applying the evidence from the HF CPG into patient/client management. The ABCDE framework (Fig. 1) is a clinical framework that has utility in any setting within the continuum of care. The first step of the framework involves an assessment of patient stability, which is examined at rest and during exercise and must be performed at each visit and throughout the episode of care. We propose the assessment of clinical stability from both an absolute and relative perspective to determine whether physiologic responses to exercise-based interventions are appropriate or if adjustments are warranted. The second component of the framework involves behavior modification. Within this step, we consider the individual's readiness for behavior change and appropriate strategies to alter behavior to increase

Figure 1. ABCDE practical framework.

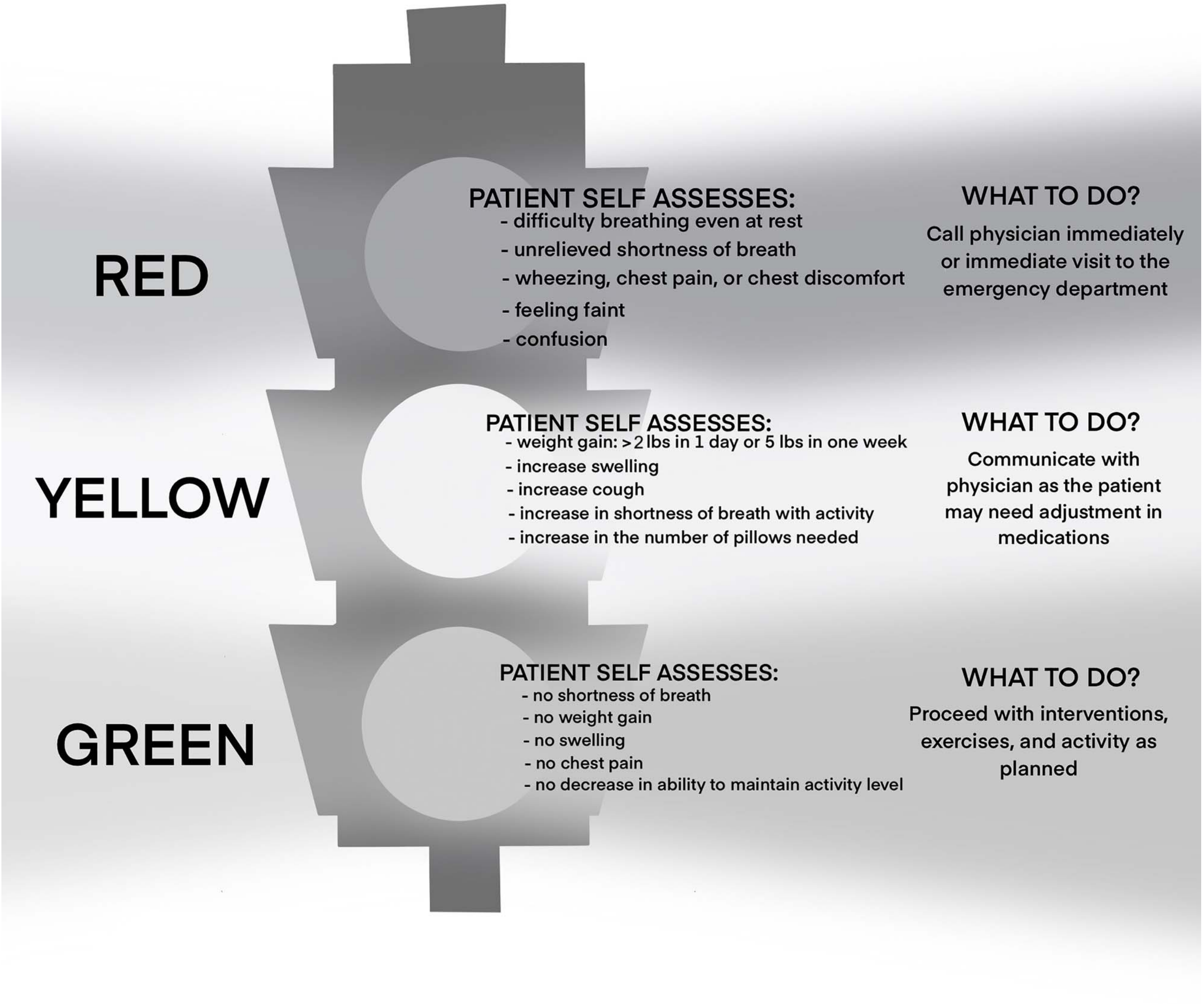

Figure 2. Self-Assessment and Action Plan on Warning Symptoms of Heart Failure Decompensation (revised from Agency for Health Research and Quality. Red-Yellow-Green Congestive Heart Failure (CHF) Tool | AHRQ Health Care innovations exchange. Available at: https://innovations.ahrq.gov/qualitytools/red-yellow-green-congestive-heart-failure-chf-tool.

activity and modify lifestyle. The third step incorporates cardiorespiratory fitness testing into the initial examination. Cardiorespiratory fitness testing is important for diagnosis of movement dysfunction and assists in effectively dosing intervention intensity. Given that higher intensity dosing generally results in greater treatment effects in patients with HF,[3] exercise testing may help to avoid under-dosing. The final step, education, reflects the importance of patient education on chronic disease self-management for reducing HF-related readmissions and maximizing health and overall quality of life.

This framework uniquely complements the International Classification of Functioning Health and Disability model, wherein the assessment of stability identifies alterations in body structure and function; behavior modification and education address personal and environmental factors that impact activity and participation; while cardiorespiratory fitness testing and dosage of interventions allow for the appropriate assessment and treatment of activity restrictions in patients with HF. A discussion of the ABCDE framework along with examples of the use of this framework across the continuum (Suppl. Appendix 2) facilitates the application of the information in the HF CPG in a safe and meaningful manner.

The ABCDE Framework

Assessment of Stability

A key component of evaluation of movement dysfunction, especially in those with HF, is the concept of clinical stability. Stability can broadly be defined as physiological processes required for the maintenance of homeostasis.[8] A reduction in stability increases the presence of a variety of signs and symptoms associated with decompensation, which include the presence of new or worsening signs/symptoms of dyspnea, fatigue, or edema that lead to hospitalization or unscheduled medical care (doctor visits or emergency department visits).[9] Typically stability, decompensation, and readmission interact, wherein a reduction in stability increases the risk of decompensation and subsequent hospital admission.[8] Therefore, ongoing and routine assessments of the stability of the patient at rest and during activity are crucial in helping to identify new or worsening decompensation that may necessitate medical intervention for preventing possible future hospital admissions and in deciding whether a patient is appropriate for exercise-based intervention.

The examination of stability at rest serves 2 inter-related purposes. It determines readiness to participate in a physical therapy session as well as provides information that may necessitate early medical intervention to prevent hospital readmission. Assessment of stability begins with both the patient and the therapist being able to recognize signs and symptoms of decompensation that indicate reduced stability. We present a modification of the Heart Failure Zones tool originally developed by The Agency for Healthcare Research and Quality that helps patients recognize relevant symptoms of decompensation and appropriate actions to take based on their symptomatology[10] (Fig. 2). It is essential for physical therapists to educate patients on this tool throughout the continuum of care to assist them in recognizing symptoms of decompensation and necessary actions to employ for each zone. Complementing self-assessed symptoms of decompensation with targeted examination tests and measures will provide physical therapists with an accurate assessment of stability and assist with clinical decision making at the initiation of treatment sessions.

We recommend the assessment of stability from an absolute and relative perspective. Absolute stability involves the appreciation of the absolute indicators of decompensation that need to be assessed and documented in their own right. Relative stability considers whether the patient is on a stable temporal trajectory and the relative changes in hemodynamic parameters over time. In other words, relative stability considers alterations that occur on a day-to-day or visit-to-visit basis relative to the patient's baseline.

Assessment of stability from an absolute or relative perspective at rest begins with an accurate evaluation of vital signs. An example of absolute, but not relative, stability is a patient with HF with a baseline resting heart rate of 60 beats per minute that acutely presents with a resting heart rate of 90 beats per minute. This relative increase in resting heart rate, although within the absolute normal range of 60 to100 beats per minute, warrants additional attention as it may signal a relative increase in neurohormonal regulation that occurs during acute decompensation. An example of a patient with relative, but not absolute, stability is a patient with HF with baseline trace to 1+ dorsal pedal edema. Although not a normal finding from an absolute perspective, it may be typical for that patient to present with some degree of peripheral edema even when in a euvolemic state. Table 1 provides indicators of stability that can be assessed at rest. The table describes the procedure for assessment of each sign as well as the clinical probability of each sign in indicating reduced stability.

A patient deemed stable at rest from an absolute and relative perspective is appropriate for initiation or progression of exercise. Stability during exercise must be continually assessed from both absolute and relative perspectives to allow the physical therapist to effectively evaluate tolerance to exercise. Absolute stability during exercise refers to the absolute degree of change in hemodynamic parameters including but not limited to a drop in blood pressure or rapid increase in heart rate that might occur with exercise. The lower section of Table 2 summarizes normal absolute changes in physiological variables that occur with exercise in patients with HF to support the recognition of stability during exercise. Relative stability relates to an appreciation of the relative changes in exercise responses that occur at the same intensity of exercise from one visit to the next. A patient who does not demonstrate signs and symptoms of exercise intolerance at the same exercise intensity from one visit to the next demonstrates relative stability with activity. Patients demonstrating absolute and relative stability at any given intensity may be appropriately dosed with a higher intensity of exercise. Conversely, patients who present with absolute or relative instability during exercise may either need a reduction in the intensity of exercise or physician consultation.

Figure 3 provides clinicians with a systematic approach to the assessment of absolute and relative stability at rest and during exercise. A patient who is stable at rest from both an absolute and relative perspective is ready for participation in exercise-based intervention. Conversely, a patient who presents with absolute and/or relative instability at rest may need immediate physician consultation.

Behavior Modification

A challenging aspect of therapeutic intervention for patients with HF is attempting to influence behavior modification that promotes adherence to optimal chronic disease management behaviors, including medication compliance, improved nutritional choices, and optimizing functional activities and exercise. In patients with HF, behavior is often influenced by personal and environmental factors, both of which significantly impact the patient's education needs and the selection of appropriate interventions that can be sustainable. The HF CPG advocates for a culture of physical activity and encourages disease self-management in individuals with HF. Therefore, considerations of behavior modification as applied to the HF CPG specifically relate to increasing physical activity, modifying lifestyle, and adhering to exercise-based interventions. Successful behavior modification requires consideration of the individual's readiness for behavior change and the incorporation of evidence-based strategies to facilitate behavior change. Examples of such strategies include the 5 As (ask, advise, assess, assist, and arrange), 5 Rs (relevance, risks, roadblocks, rewards, and repetition), and motivational interviewing. Also, it can be helpful to incorporate objective measures such as the Patient Readiness Scale for Exercise to objectify the patient's emotional capacity for behavioral change.

Routinely used in smoking cessation, the use of the 5 As is an efficient, evidence-based model that can also be implemented to promote behavior change.[11] This process takes only a few minutes and involves discussing the 5 As in a nonjudgmental way to promote greater self-efficacy and a commitment to improved health. The therapist asks the patient their current activity level and any harmful lifestyle habits, advises them to increase activity and modify lifestyle, assesses their willingness to make changes, assists the patient in increasing activity and lifestyle modification through education and exercise prescription, and arranges follow-up visits to ensure the patient abides by routine activity and dietary guidelines. For patients not yet ready to modify lifestyle and behavior, physical therapists are encouraged to use the 5 Rs.[12] By formally reviewing the relevance of physical activity and healthy lifestyle, discussing risks through the impact of reduced activity and poor diet on health and readmissions, identifying roadblocks that limit the patient's ability to change lifestyle, rewarding behaviors that positively

Table 1. Assessment of Stability at Rest[a,b]

Sign of Reduced Stability	Description	Probability of HF Exacerbation
S_3 heart sound	Low-frequency heart sound heard in early diastole. Auscultated with stethoscope bell at 5th intercostal space mid-clavicular line, preferably with patient lying on left side.[42]	Correlated with increased LVEDP and PCWP with sensitivity of 30%–50% and specificity of 80%–90%[43]
Pulmonary crackles	Represents movement of fluid in alveoli and subsequent opening of previously closed alveoli because of excess fluid	Pulmonary crackles and S_3 heart sound were present in >50% of all patients admitted to emergency department for HF decompensation.[44] Crackles and S_3 heart sound had higher readmission rates than those without these signs; OR for pulmonary crackles was 2.8 and was 2.6 for S_3 heart sound[44]
PND	Sudden episodes of SOB occurring in night	Sensitivity 39%–41% and specificity 80%– 84% in ruling in an exacerbation of HF[45]
Orthopnea	Shortness of breath that increases in recumbent position	Sensitivity of 22%–50% and specificity of 74%–77% for HF exacerbation[45]
Jugular venous distention	Patient is placed at 45-degree semi-recumbent position. Patient's head is turned away from side to be evaluated and clinician observes for distention or pulsations of jugular vein 3–5 cm above sternum[46]	Elevated jugular venous pressure associated with increased risk of HF hospitalization (RR = 1.32; 95% CI = 1.08–1.62; $P < .01$), death, or hospitalization for HF (RR = 1.30; 95% CI = 1.11–1.53; $P < .005$)[47]
Displacement of PMI	Apical impulse recorded >3 cm from mid-clavicular line may be accurate indicator of left ventricular enlargement[48]	Sensitivity of 92% and specificity of 91% in recognizing HF decompensation[48]
Weight gain	Weight gain >2 lb overnight or 5 lb in 2 d	In a nested case–control study, within the week before hospitalization, weight patterns in case and control patients that diverged more substantially (mean increases >2 and up to 5 lb, and >5 and up to 10 lb, were associated with matched adjusted ORs for HF hospitalization of 2.77 (95% CI = 1.13–6.80), and 4.46 (95% CI = 1.45–13.75), respectively compared with mean increases ≤2 lb[49]
Bendopnea	Increased shortness of breath when patient bends forward	Bendopnea associated with HF admission at 3 mo (HR = 3.1, $P < .004$). At 1 y, those with bendopnea were at increased risk of composite endpoint of death, HF admission, inotrope initiation, left ventricular assist device implantation, or cardiac transplantation (HR = 1.9, $P < .05$)[50]
Peripheral edema	Increase in peripheral pitting edema	In patients presenting with acute dyspnea to emergency department, OR for HF based on lower extremity edema (OR = 2.8; 95% CI = 1.9–4.3)[51]

[a]HF = heart failure; HR = hazard ratio; LVEDP = left ventricular end diastolic pressure; PCWP = pulmonary capillary wedge pressure; PMI = point of maximum impulse; PND = paroxysmal nocturnal dyspnea; OR = odds ratio; RR = relative risk; SOB = shortness of breath. [b]Stability of rest component of table adapted with permission from Dias K.J. Best Practice for Home Physical Therapy for Older Adults with Heart Failure.

impact the patient, and continually repeating information at follow-up appointments, the therapist can effectively assist the patient in modifying behavior.

Finally, the evidence for motivational interviewing is accumulating for multiple populations.[13–15] This patient-centered communication skill is aimed at gathering the intrinsic motivation of the patient to develop behavior change.[14,15] Motivational interviewing involves 4 overlapping processes: (1) engagement in a working relationship with the patient, (2) focusing on a problem to change, (3) evoking the patient's desire to change, and (4) planning the change with the patient.[15] To utilize motivational interviewing, therapists are encouraged to use open-ended questioning and reflective listening and support the patient's autonomy and self-efficacy.

A valuable tool for identifying readiness to make behavior modifications is the Patient Readiness Scale for Exercise, a 22-item questionnaire that categorizes patients into 5 categories of readiness to adopt a specified healthy practice.[16] The 5 categories are precontemplation (no intention to make a change), contemplation (emerging awareness of the problem, but no commitment to make a change), preparation (plan to make a change within the next 30 days), action (maintenance of a change for <6 months), and maintenance (maintenance of a change for >6 months). The physical therapist is encouraged to use this scale to determine the patient's readiness category and adjust intervention approaches accordingly.

Physical therapists have a unique opportunity to work within a multidisciplinary team to facilitate behavior modification. Interprofessional collaboration with physicians, nurses, counsellors, and other members of the health care team can ensure that patients receive necessary tools to alter behavior. As indicated above, a variety of tools are available to the physical therapist in helping the patient modify behavior. Each of these strategies can mitigate unhealthy behaviors and shift the unfavorable opportunity for exacerbations and readmissions in a more favorable direction.

Cardiorespiratory Fitness Testing

Cardiorespiratory fitness testing in patients with HF allows for identification and measurement of impairments in aerobic capacity as well as provides the physical therapist with a

Table 2. Assessment of Stability with Exercise[a]

Parameter	Stable Response with Exercise	Clinical Consideration
Heart rate	In patients with HF, increase in heart rate of 21–50 bpm from rest up to 80% of predicted maximum heart rate[52]	Chronotropic incompetence demonstrated by blunted increase in heart rate during exercise (beyond that expected with beta blockade) is associated with greater disease severity, poorer prognosis, and reduced clinical stability[52]
Heart rhythm	No arrhythmias or ectopic foci detected during exercise	Arrhythmias and ectopic foci, especially when sustained, are associated with greater disease severity, poorer prognosis, and reduced clinical stability[52]
Recovery heart rate	In patients with HF, decrease in post-exercise heart rate >12 bpm measured within 1 min following maximum exercise[52]	Delayed heart rate recovery associated with greater disease severity, poorer prognosis, and reduced clinical stability[52]
MAP	In patients with HF, minimum increase of >9 mmHg from rest to maximum exercise[53]	Blunted or decreased MAP with increasing workload indicates impaired cardiac output[53]
SBP	Increase in SBP > 13 mmHg from rest to maximum exercise with peak SBP > 120 mmHg[53]	Blunted or decreased SBP with increasing workload indicates impaired cardiac output in patients with HF[52,53]
SpO_2	Maintained >90% with exercise[54]	Decreases in SpO_2 indicate ventilation perfusion mismatch from increased lung perfusion during decompensated HF[54]
Auscultation of heart and lungs	No change in heart and lung sounds following exercise[40]	Development of inspiratory crackles and/or S3 following exertion represents exercise intolerance[54]

[a]BPM = beats per minute; HF = heart failure; MAP = mean arterial pressure; SBP = systolic blood pressure; SpO_2 = pulse oximetry.

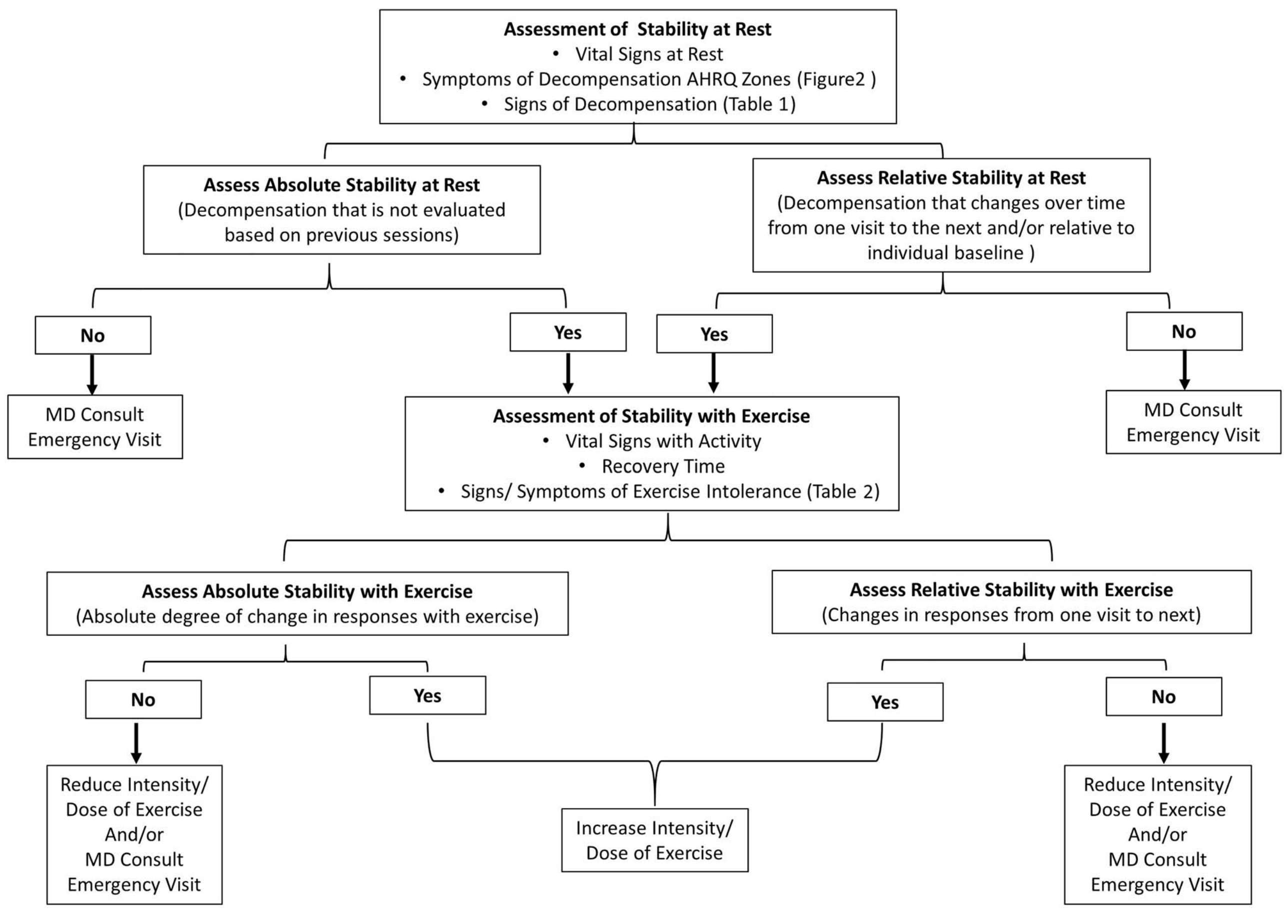

Figure 3. Assessment of stability.

determination of exercise intolerance.[17–19] The examination of reduced aerobic capacity and exercise intolerance serves as a key measure supporting the etiology of movement dysfunction while providing both a baseline for objective measurement and a barometer for safety in patients with HF. The results of a cardiorespiratory fitness test are also useful in guiding the physical therapist in intervention selection, determining prognosis, and providing the patient with the appropriate dosage of exercise intensity.[18,20] A recent statement from the American Heart Association makes a compelling case for the importance of including cardiorespiratory fitness as a clinical vital sign in patient care.[18]

The gold standard for assessing specific impairments in oxygen transport for a patient with HF is through the use of maximal cardiopulmonary exercise testing with gas analysis.[21] However, maximal exercise testing with gas exchange analysis is not always feasible in clinical practice.[22] Therefore, we propose the utilization of either a maximal graded exercise testing without gas exchange analysis or submaximal tests as a means of assessing cardiorespiratory fitness across the continuum of care. Maximal graded exercise testing without gas analysis utilizes a protocol of incremental intensity on the treadmill or bicycle ergometer until the patient fatigues and is unable to maintain the intensity.[22] The maximum speed, grade, or work achieved during exercise is utilized in metabolic equations provided by the American College of Sports Medicine to determine the estimated peak oxygen uptake of the individual.[22] Additionally, peak heart rate and metabolic equivalents (METs) can be measured at maximum exercise. METs are an estimate of the energy cost in oxygen consumption of various activities or exercises expressed as a ratio relative to energy expenditure at rest, where 1 MET = 3.5 mL of oxygen/kg/min.[22] Physical therapists can utilize the MET level, maximum heart rate, or estimated peak oxygen uptake to effectively prescribe the dose and intensity of aerobic exercise.

When maximal exercise testing is not feasible due to lack of expertise, monitoring, or safety equipment, physical therapists can utilize submaximal exercise testing to determine a baseline for cardiopulmonary fitness. Table 3 provides an overview of common exercise tests that can be used in patients with HF across a range of physical abilities and clinical settings and are organized in the table from lower level to higher level. For situations when the physical therapist utilizes a 6-minute walk test to assess cardiorespiratory fitness, the following equation can be used to predict the maximal oxygen uptake in patients with cardiopulmonary disease: mean peak oxygen uptake (mL/kg/min) = 4.948 + 0.023 × mean 6 minute walk distance (meters) with a standard error of estimate of 1.1 mL/kg/min.[23] Additionally, a noteworthy website (Exercise Prescription, www.exrx.net) provides protocols, calculators for prediction of peak oxygen consumption, and predicted normative values for many aerobic field tests.[24] However, it is important to note that the prediction equations of maximum aerobic capacity for these tests are based on heart rate responses, which are blunted in patients on beta blockers, and therefore limit their ability to effectively serve in predicting maximal exercise capacity.

The underlying premise of this third step in the framework is that baseline cardiorespiratory fitness should be measured routinely in clinical practice as it provides a wealth of information that guides patient management. The measurement of cardiorespiratory fitness provides insight into clinical stability and data that are useful in setting goals and determining intervention selection, dosage of exercise intensity, and the potential need for incorporating physical activity counseling with patients.

Dosage of Interventions

Dosing for exercise-based interventions in patients with HF should be titrated to the highest level of efficacy and safety. It is prudent to initiate exercise-based interventions at or below intensities determined during baseline cardiorespiratory fitness testing and progressively titrate the intensity according to patient tolerance and patient-specific functional goals. This approach, in addition to the utilization of evidence-based approaches to determining appropriate target exertional levels, assists the therapist in optimizing outcomes in patients with HF.

Much of the HF CPG highlights the evidence available to support this use of aerobic exercise, aerobic interval training, resistance training (incorporated alone or in combination with aerobic exercise training), inspiratory muscle training (administered with or without aerobic exercise training), and neuromuscular electrical stimulation in the treatment of patients with HF.[3] However, determining the optimal dosing can be challenging. Figure 4 provides details on 5 major categories of interventions and approaches to dosing each intervention. After considering the type of intervention, setting within the continuum of care, and available baseline data, the physical therapist can choose a specific approach to dosing any of the interventions recommended in the HF CPG.

A key consideration for dosing exercise intensity is the workload at which a given physiologic response is elicited. For example, during any timed aerobic exercise test, such as the 6-minute walk test, the workload (speed of walking, distance covered in a specific time) must be considered along with the absolute and relative responses (heart rate, blood pressure, rating of perceived exertion [RPE], pulse oximetry) documented during the activity. Progression of interventions during subsequent visits within an episode of care can then be based on that workload and whether physiologic responses indicate a readiness for a higher intensity (lower HR, RPE, etc) and progression toward the goals of the patient. The compendium of physical activities provides the MET levels for a variety of home and community activities.[25] During an episode of care, follow-up sessions can incorporate absolute intensity of an activity measured in METs and relative responses achieved during the activity to ensure the patient is stable and making progress toward their goals before increasing the intensity of the activity.

High-intensity interval training is another important option to consider for patients with HF. The HF CPG presents specific dosing parameters for high-intensity interval training in stable outpatients with HF derived from a growing body of contemporary evidence supporting the safety and efficacy of a high-intensity interval approach.[3] As presented in the CPG, for patients with stable HF in the outpatient setting, a total weekly high-intensity exercise dose should be at least 460 kcal, 114 minutes, or 5.4 MET-hours.[3] However, the interval training approach is not isolated for use in outpatient clients with HF but can also be adapted for low-level patients in inpatient and home-based settings. The dosage of the interval training protocol can be modified to suit the needs of the patient. Physical therapists designing the interval-based exercise program should consider the intensity of the exercise, the duration that a given intensity can be sustained, whether passive or active rest intervals should be used, the number of intervals, and the total volume of work required of each session. As indicated in a recent editorial, providing patients with flexibility in exercise-based interventions is paramount in improving health and unlocking the many benefits of regular exercise.[26] In light of a wealth of new knowledge demonstrating the safety of aerobic interval training coupled with improvements in functional capacity and quality of life,

Table 3. Cardiorespiratory Fitness Testing in Heart Failure[a]

Objective Measure of Endurance	Description	Outcome Measurement	Application to Exercise Prescription
Seated step test	4 Stages of seated stepping at 1 step/s with progressively increasing step heights of 6, 12, and 18 inches, and then 18 inches with alternating arm movement. Stages can be either 5 min or shortened to 3 min, and progression to next stage permitted if HR <75% of predicted maximum[55]	Stages reflect 2.3, 2.9, 3.5, and 3.9 METs, respectively	Activities with MET levels at or below those attained during test can be safely used in intervals with number and length of intervals adjusted to patient tolerance
6-Minute arm test	6 min of submaximal arm cycle ergometry with workload (W) titrated to permit HR 60%–70% of age-adjusted max HR or 11–15 RPE[56]	Collect HR and RPE in last 30 s of test; decrease in these over time indicates improved cardiovascular endurance	Using workload selected for the test, either progress duration or perform multiple repetitions of 6-min intervals to patient tolerance
2-Minute step test	Individuals march in place as fast as possible for 2 min while lifting knees to a height midway between patella and iliac crest when standing[57]	No. of right-side steps that meet criterion height and completed in 2 min	No direct application to exercise prescription but allows comparison with norms
2-Minute walk test	Goal: how far can patient walk in 2 min down a straight, 100-ft-long hallway[58]	Distance walked in 2 min	No direct application to exercise prescription but allows comparison with norms
6MWT	Goal: how far can patient walk in 6 min down a straight, 100-ft-long hallway[59]	Distance walked in 6 min	(1) Using distance walked to predict peak oxygen consumption/MET level, select activities or treadmill speeds/grades that are a percentage of that MET level. (2) Perform 10-min intervals of walking at a speed 80% of average speed walked during 6MWT
Submaximal graded exercise test	Modality (treadmill or cycle) protocol selected based on patient ability with workload progressed every 1–3 min. Test stopped at predetermined physiologic parameters specific to individual that represents intensity of exercise of at least moderate to vigorous[20]	Predicted peak workload can be interpolated as 1–2 stages beyond that achieved in submaximal test	Prescribe intensity based on percentage of predicted peak workload
Maximal graded exercise test	Modality (treadmill or cycle) and protocol selected based on patient ability and target test duration 9–12 min[60]	Peak workload attained in METs or W, peak HR	Prescribe intensity based on percentage of peak workload or peak HR
Cardiopulmonary exercise test	Modality (treadmill or cycle) and protocol selected based on patient ability and target test duration 9–12 min[60,61]	Peak workload attained in METs or W, peak HR	Prescribe intensity based on percentage of peak workload or peak HR

[a]HR = heart rate; MET = metabolic equivalent; 6MWT = 6-Minute Walk Test; RPE = rating of perceived exertion.

we propose that physical therapists strongly consider interval training-based approaches as depicted in Figure 4 to maximize functional outcomes.

There are several approaches for dosing of exercise intensity for continuous aerobic exercise. If a maximal or symptom-limited exercise test is used, training intensity can be calculated based on a percentage of measured maximal heart rate or peak workload. However, in most settings maximal/symptom-limited exercise test data are rarely available and are not feasible to perform, even in outpatient settings. An alternative is to use a percentage of a predicted maximal heart rate. Calculation of predicted maximum heart rate for an older patient is more accurate when using the Tanaka calculation ($208 - [0.7 \times \text{age in years}]$, standard error not reported) as the traditional equation ($220 - \text{age}$) underestimates the maximum heart rate for those over the age of 55.[27] For those on beta-blockers, the Brawner predicted maximum heart rate can be used ($164 - [0.7 \times \text{age in years}]$, standard error of the estimate of 18 beats per minute).[28] Additionally, for those individuals with HF on beta-blockers and those with chronotropic incompetence, the 6 to 20 RPE scale can be effectively used for dosing intensity.[29]

Appropriate dosing of resistance training should be guided by a patient's 1-repetition maximum (1RM).[30,31] As noted in the HF CPG, for patients with stable HF, the evidence supports intensities of 60 to 80% of the 1RM with 2 to 3 sets per muscle group to achieve the highest results.[30,31] However, in clinical practice, patients in acute decompensated HF or immediately after acute decompensation in home health or sub-acute rehabilitation may not be able to tolerate these intense doses of strength training. In these circumstances, physical therapists can initially choose a lower percentage of the 1RM; consider incorporating strength training through functional sit to stand movements; or utilize weight cuffs, resistance bands, or manual resistance for individual muscle groups until a compensation or change in movement quality

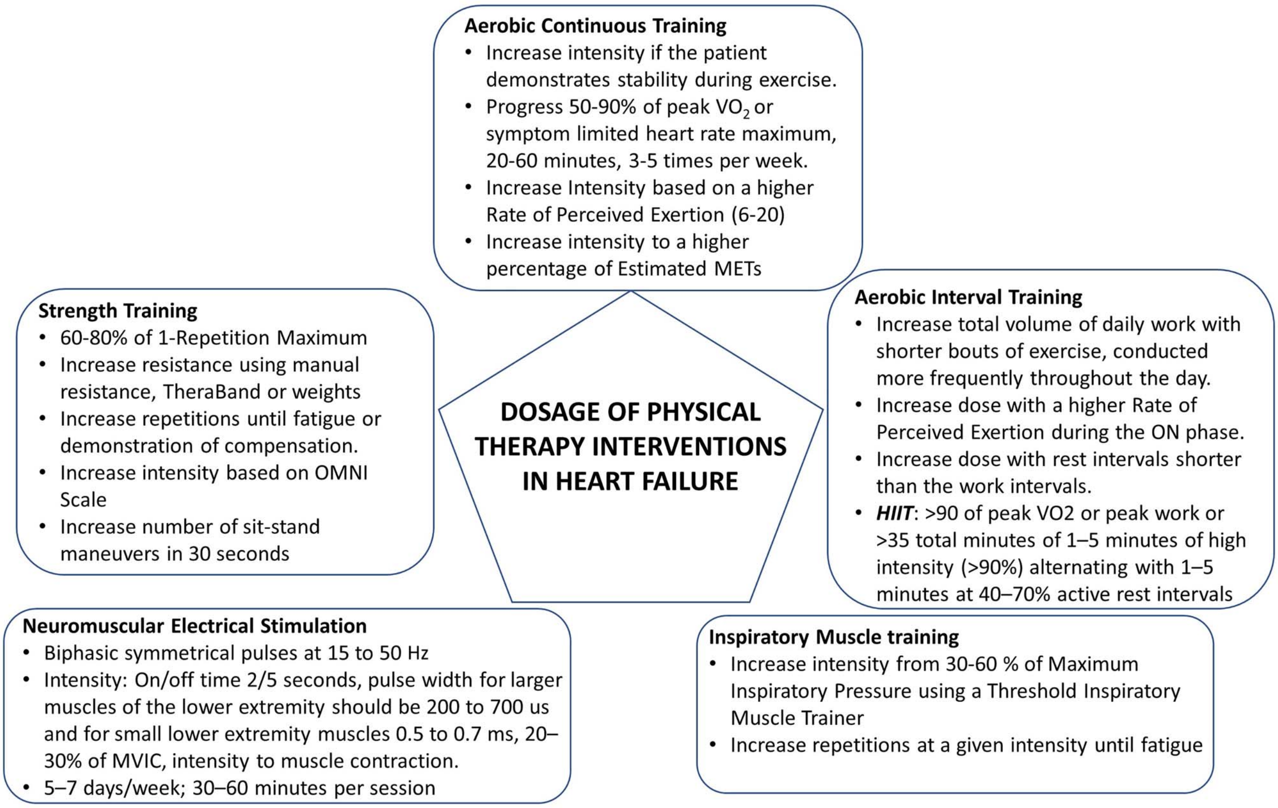

Figure 4. Dosage of physical therapist interventions in heart failure.

is noted. Additionally, dosing can also be based on the RPE scale[32] or the OMNI-Resistance Exercise Scale.[33] Resistance training is clearly an effective option for the patient with HF to maximize peripheral strength, endurance, and overall activity and participation.[34]

Dosing of inspiratory muscle training uses a target intensity as a percentage of maximum performance (ie, maximal inspiratory pressure [MIP]). The MIP can be easily measured using a negative inspiratory force meter. Low intensity (20%–30% of MIP for 30 minutes) or higher intensity (50%–80% MIP with sets and repetitions to tolerance) may be used, although higher intensities may yield greater improvements and possibly may be better tolerated.[35,36] In cases where measurement of MIP is not available, the number of repetitions performed at a specific setting on the training device can be progressively increased and utilized as an alternative approach to increasing load on the inspiratory muscles.

Finally, a wealth of contemporary evidence validates the effectiveness of neuromuscular electrical stimulation in improving strength, endurance, and oxidative capacity of peripheral muscles, and may be especially useful for acutely ill patients with HF or those who are not able to participate in exercise-based interventions.[3,37,38] The evidence indicates a typical dose for 30 to 60 minutes, 5 to 7 d/wk, for 5 to 10 weeks, using biphasic symmetrical pulses ranging from 15 to 50 Hz to the larger muscles of the lower extremity for 200 to 700 milliseconds using an estimated 20% to 30% of the maximal voluntary isometric contraction.[37,38]

In summary, a variety of interventions are available in the exercise prescription for a patient with HF. Appropriate selection and dosage of interventions are essential to increase activity and participation and achieve optimal outcomes in patients with HF.

Education

The HF CPG includes a key action statement on providing education on chronic disease management and challenges clinicians to consider 3 broad topics of skilled education.[3] These include: (1) recognition of signs and symptoms of a HF exacerbation and action planning, (2) guideline-directed nutritional recommendations, and (3) medication management.[3]

This section will highlight clinical considerations for incorporating these 3 aspects of patient education into physical therapy treatment sessions. First, physical therapists must examine and address gaps in the patient's knowledge and understanding related to the above-mentioned topics. Additionally, it is useful to identify concerns about limitations of support in the home environment or any recognized barriers to self-care.[19] This information can guide the therapist in initiating a referral to social work or trigger other appropriate consultations.[19] It is best to provide education to the patient and family that is culturally appropriate and delivered in verbal and written formats. Supplementary Appendix 3 provides a checklist of items that can be documented and discussed with the patient and family to maximize consistency and effectiveness of the education being provided to patients.

In regards to recognition of signs and symptoms of HF decompensation, we recommend that in all settings, physical therapists utilize Figure 2 to educate patients on the signs and symptoms of HF decompensation and the appropriate action plan in light of a possible HF exacerbation. One aspect of recognition of HF decompensation is daily weight assessments, which require that the patient has a weight scale and records daily weights that can be consistently reviewed for any fluctuations.

For patients with HF, diet and nutrition can directly affect recovery and function. Nutritionists and dieticians are not the only health professionals who provide nutritional advice to patients. Several other health care practitioners, including physicians and nurses, also provide nutrition consultation as part of their practice. Per the American Physical Therapy Association House of Delegates position statement, physical therapists have the opportunity to provide general education on diet and nutrition based on information that can be found in the public domain and provide appropriate referrals to nutrition and dietary medical professionals when the advice lies outside the education level of the physical therapist.[20] At a minimum, for patients with HF, it would be prudent for the physical therapist to determine the patient's daily dietary sodium and fluid intake to ensure the patient is abiding by their recommended sodium and fluid restrictions.

Finally, education on medication management is critical to promote patient safety and reduce hospital readmissions. Per the American Physical Therapy Association House of Delegates position statement, integration of pharmacology is a component of physical therapist practice, which can promote patient safety and reduce hospital readmissions.[39] Physical therapists should assist in medication reconciliation by reviewing the medications the patient is taking and comparing that with what the physician wants them to be taking.[3,40] Further, checking for interactions, duplications, and omissions and collaborating with nurses, pharmacists, and physicians within an interprofessional framework maximizes patient safety.[3,40]

Value in health care has been defined as "health outcomes achieved per dollar spent."[41] To ensure the best value, physical therapists must provide safe, effective, and patient-centered care. To this end, we translate current knowledge related to HF rehabilitation into a 5-step ABCDE practical framework to guide physical therapists in the contemporary management of patients with HF. This 5-step framework complements the recently published HF CPG and serves to guide the therapist in a systematic approach of managing patients with HF during an episode of care. Through a formal assessment of stability, addressing behavior modification, testing cardiorespiratory fitness, selecting and dosing skilled interventions, and educating patients on disease management, physical therapists can mitigate HF-related hospitalizations and readmissions and optimize overall movement to improve the human experience in patients with HF.

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Acknowledgments

The authors sincerely thank Ms Evana Dias for her expertise and assistance in creating the graphics and artwork for Figures 1 and 2.

Disclosures

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interests.

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