Evidence Based Intervention Program for an Adult Female with Cerebral Palsy and Congestive Heart Failure

A Capstone Project for PTY-768
Presented to the Faculty of the Physical Therapy Department
The Sage Colleges
School of Health Sciences

In Partial Fulfillment
Of the Requirements for the Degree of
Doctor of Physical Therapy

Claudia Andrejuk
Nichole Veltri
Yelena Vovna
May 2012

Approved:

Acknowledgements:

We would like to thank Marjane Selleck, Jim Brennan, and Danielle Vittone for assisting with development of the case.

The Sage Colleges

School of Health Sciences

Doctor of Physical Therapy Program

May 2012

Evidence Based Intervention Program for an Adult Female with Cerebral Palsy and Congestive Heart Failure

Nichole Veltri SPT

Claudia Andrejuk, SPT

Yelena Vovna, SPT

Background/Purpose. The purpose of this report is to describe a physical therapy intervention program for an individual with a combined diagnosis of cerebral palsy (CP) and congestive heart failure (CHF) based on current research. **Case Description.** The patient was a 40 year old adult female who presented with CP and CHF. She presented with limitations in strength, range of motion, balance, endurance, posture, pelvic floor muscle weakness, breathing, and tone resulting in an overall impaired functional mobility. **Outcomes.** A 13 week evidenced based physical therapy program was designed to generate improvements in several of the patient's limitations resulting in an overall improvement in gait, quality of life, strength, endurance, balance, ADLs, and overall level of function. **Discussion and Conclusion.** It is expected that through this plan of care the patient would improve her ability to carry out functional activities and enjoy a more enhanced quality of life (QOL). However, the patient is expected to make greater improvements in cardiopulmonary and QOL outcome measures than in neuromuscular outcome measures. Incorporation of activities that address cultural needs is expected to have a positive correlation with QOL measures. **Key words:** Cerebral palsy, spastic diplegia, congestive heart failure, physical therapy, intervention strategies.

Cerebral palsy (CP) is a non-progressive, neuromotor disorder, which is caused by a lesion in the brain during the prenatal period. It is a disability that usually occurs with prematurity, with risks being higher for infants born before 28 weeks of gestation.[1]As of date, the number of adults with CP in the United States is estimated to be approximately 400,000.[2] The most common type of CP is spastic CP, most notably spastic diplegia and quadriplegia. Spastic diplegia accounts for 60-75% of people with this condition and affects the trunk and lower extremities.[3,4] The upper extremities are affected to a slighter degree. A diagnosis of spastic diplegia offers an individual a 60-90% potential for ambulation into adulthood. Those affected by spastic diplegia often have the following presentation: foot and ankle pain, difficulty walking, toe-walking, cavus foot deformities, valgus/varus deformities, and knee pain.[5] Choreoathetoid CP, hemiplegia, and ataxia occur less frequently.[4]

The exact cause of CP remains unknown. Risk factors include low birth weight and brain damage that could have occurred at any time frame from embryonic development to the first 4 weeks after birth.[4] Damage to the brain could be a result from cerebral anoxia, hemorrhage below the lining of the ventricles (subependymal), central nervous system malformations, ischemia, or hypoxia causing encephalopathy.[4] However, hemorrhage of the germinal matrix (the cells from which the nervous system arises) into the lateral ventricle is commonly caused in cases with CP and can result in venous infarction of the periventricular area with a cystic lesion in that area of the brain. Hypoxic-ischemic injury in the mature neonate most commonly results from selective neuronal cell damage or parasagittal brain damage.[4] Focal or multifocal brain damage can result from either arterial embolism or venous thrombosis and is more common in the more mature neonate. Persistence of immature layers of the primary cortex is often present and many of the other layers show

abnormalities, often those with projections to the pyramidal tract.[4] Damage to the brain causes those afflicted with CP to exhibit a plethora of impairments.

CP causes an individual to have reduced mobility, motor function, coordination, balance, and postural development.[3,6] As a result of involuntary control, abnormal movement patterns are evident in this population. Individuals with cerebral palsy exhibit the following impairments: increased muscle tone (spasticity), muscle weakness, joint restrictions and contractures, paresis, involuntary movements, postural instability, and delayed reactions.[3] Other deformities of orthopedic nature include degenerative arthritis, osteoarthritis, and foot abnormalities.[2,7] Pathological fractures of the lower extremities are common throughout the lifespan of a person with this condition.[7] These types of fractures occurs when there is no known trauma to the bone. It results from a combination of osteoporosis, long lever arms, and contractures as previously mentioned.[7] Additional impairments can include deficits in speech, vision, hearing, perceptual function, and bowel and bladder incontinence.[4] Other co-morbidities, which may be associated with CP include mental retardation, seizures, hydrocephalus, microcephalus, learning disabilities, and communication disorders.[4,7]

Scoliosis is another deformity noted with CP.[2] It often can cause pelvic obliquity, subluxations and dislocations of the hip.[7] This can lead to asymmetrical weight bearing on the ischial tuberosities and the sacrum. As a result, these individuals who are constantly at risk for excessive compression are vulnerable to pain and pressure ulcers.[7] If scoliosis is significantly curved, it places one at jeopardy for losing the ability to be mobile, feed, and participate in hygiene maintenance.[7] This deformity can lead to respiratory dysfunction, which causes difficulties with breathing. Labored breathing as a result can cause disturbances during slumber, which will further contribute to overall weakness and fatigue during the

daylight hours.[2] Additionally, having scoliosis increases energy expenditure with all functional tasks and activities.[2]

Musculoskeletal impairments associated with this condition affect an individual's locomotor abilities.[8] There is variability observed ranging from those who have the potential to ambulate versus those who are immobile or wheelchair bound. A deterioration of locomotor skills and functional mobility occurs before an individual reaches 35 years of age.[9,10] Unfortunately, locomotion is limited overall and individuals are at risk for developing obesity, osteoporosis, urinary tract infections, cardiovascular disorders, depression, pain, spinal cord compression, and ulcers.[7,8] The patient exhibits a crouched gait, mild hip flexion, adduction, internal rotation, mild knee flexion, ankle eversion, pronation, and bears weight on her navicular bones. Therefore, all of these musculoskeletal impairments will affect an adult with CP's overall ability to ambulate efficiently.

Fatigue is defined as a feeling of exhaustion, weakness, and lack of energy levels.[11] Evidence suggests that fatigue, in addition to stress intensifies pain levels, whereas exercise, rest, and physical therapy mitigates pain levels.[5,12] The balance between activity and rest has been strongly emphasized in patients with CP.[5] Individuals with CP also experience more physical fatigue as opposed to mental fatigue when compared to the general population.[10] They also require 3-5 times more energy (O_2 rate and O_2 cost) during ambulation than those not afflicted with CP.[11] It has been reported that by the age of 25 years, 75% of people with CP stopped ambulating as a result of fatigue.[7]

Pain is typically experienced on a daily basis in patients with a diagnosis of CP that can range from moderate to severe intensity and is usually experienced in at least one body part.[12,13] However, it has been reported that individuals experience constant pain in all weight

bearing joints, such as the hip, knee, ankle, lumbar and cervical spine which has been shown to limit ambulation.[7] Pain experienced in these larger joints is usually the result of degenerative arthritis.[7] Those individuals with a diagnosis of spastic CP endure a greater intensity of pain and more joints involved as compared to non spastic CP.[7] Regardless, as age advances, the frequency and intensity of pain has an exponential effect.[7] Pain is also associated with increased headaches.[5] According to studies conducted, individuals have also reported increased pain with weather changes, immobility, overexertion, and depression. Increased pain fostered mental distress when individuals had to resort to using a wheelchair, reduce working hours, and request more frequent home service.[5] Pain has also led the majority of individuals to restrict their daily activities, and consequently, lose function.[7]

Individuals with CP present with limitations in function and activities of daily living. They experience difficulties with independent living and day to day tasks such as eating, bathing, dressing, and toileting.[8] These activities contribute to dependency on others for assistance.[8] Mobility restrictions make it difficult for these individuals to utilize public transportation.[7] As a result, individuals with CP are limited in their opportunities for recreation, face social isolation, and underemployment. They also are confronted with relationship problems and intimacy.[7]

A number of patients with CP have undiagnosed cardiovascular problems[6], a patient's condition is further complicated if they present with similar additional comorbidities such as a diagnosis of congestive heart failure (CHF). CHF is a chronic and progressive medical condition in which the heart is weakened and is unable to maintain adequate cardiac output by filling up with blood and efficiently ejecting it to the rest of the body.[14] A diagnosis of CHF is the leading cause of death with incidence, or the number of new cases each year,

increasing based on aging, life style behaviors and increased recovery after acute cardiac episodes.[14] People older than age 65 and of an average age of 75 tend to be most commonly affected. Both genders are equally at risk for developing this condition, however, 52% of the population are women.[15] This condition is also a major contributor to the health care expenditures as reported by Chan et al, during the first 3 months after discharge, 33-40% of older adults with CHF are re-hospitalized placing an increased socio-economic burden on the community.[16]

CHF is most commonly seen in the elderly population; however, younger patients with numerous risk factors are predisposed to being diagnosed at some point in their life. Risk factors may include hypertension, obesity, myocardial infarction, diabetes, high cholesterol, smoking, as well as damaged valves.[17] Some of the symptoms that a patient may present with include shortness of breath, edema, fatigue, chest congestion, dyspnea on exertion, orthopnea, and decreased endurance which all contribute to a decrease in the quality of life of the person diagnosed with CHF.[17] For most patients, CHF begins to develop secondary to impairments in the left ventricular function. However, each patient with this diagnosis may present with a different type of left ventricle functional abnormality. They may present with a normal left ventricle size yet decreased ejection fracture, and range up to presenting with severe dilation and decrease in ejection fracture.[18] Therefore, variability of treatments offered for HF target individual differences, based on symptom presentation, in order to deliver the most appropriate care.[18]

CHF may be right sided, left sided, or both and is differentiated based on patient presentation.[15] A patient with a diagnosis of a left sided CHF experiences a decreased ability of the left ventricle to empty efficiently. Pooling of the blood in the left ventricle and the

atrium as well as the pulmonary circulation is eventually the result of the ineffective pumping ability leading to pulmonary edema. These patients most commonly experience shortness of breath, due to inadequate gas exchange, as well as fluid overload in the lungs, also dyspnea on exertion or in prone, dizziness, and orthostatic hypotension.[14,15] Symptoms of a right sided HF are more systemic in nature as there is a decreased output into the pulmonary circulation resulting in systemic fluid collection. Bilateral peripheral edema in the lower extremities is the most common symptom experienced by patients with a right sided HF.[14] Other signs and symptoms associated with CHF include fluid retention, a non-productive cough, jugular venous distension, diminished vital capacity, and cardiomegaly or hypertrophy of the heart.[15,18] A combination of these symptoms have a direct effect on patients endurance levels in participating in activities of daily living requiring the patient to increase their need for increased assistance.

CHF is classified into four different classes based on the New York Heart Association Classification (NYHA). Classifications range from class I characterized by no limitations in physical activity to class IV characterized by presentation of symptoms at rest Class II represents slight limitations in activity and fatigue with ordinary activity. Marked limitations in activity with symptoms of dyspnea, palpitations and increased fatigue are characteristic of Class III.[17] This classification system indicates a subjective assessment of the patient by a healthcare practitioner and is subject to frequent changes as the disease progresses or patient recovers.[18]

As the diagnosis of CHF is highly prevalent in this country more attention should be geared towards medical management and rehabilitation programs for these individuals. This would enhance patient recovery, well being and quality of life. Previous research looking at

programs promoting self care activities in management of HF, has shown to be effective with improving quality of life as well as decreasing hospital readmission rates.[16] Great emphasis should also be placed on adherence to the programs as the combination of the two aspects will be most effective.[16] In their research study, Chan et al looked to evaluate the effectiveness of an inter-disciplinary cardiac rehabilitation program (CRP) and patient-specific post discharge extended maintenance program (EMP) on functional capacity, quality of life and hospital readmissions in patients diagnosed with CHF in a Chinese community.[16] The researchers also investigated whether a high adherence rate to the programs were at all associated with lower hospital readmission rates.[16] Although the mortality rates of both the CRP and EMP did not differ from those who underwent no rehabilitation, survival rate without hospital readmission was higher in the rehabilitation group as compared to non-rehabilitation group. Participation in a rehabilitation program demonstrated an increase in exercise capacity, walking distance, improvements in quality of life and no deterioration of functional levels. The study also revealed that patients not participating in any rehabilitation program made improvements in their function however they were much lower compared to those who underwent a maintenance program.[16]

Limited literature exists concerning comprehensive specialized training programs for adult patients with CP in addition to other co-morbidities. The purpose of this case study is to identify the most appropriate evidence based interventions and develop a rehabilitation program for a patient of Chinese descent diagnosed with CP and CHF who is also an active member of a Christian Science Church. In the process of devising an intervention plan, sensitivity will be demonstrated towards the patient's cultural background and religious beliefs. To elaborate on this concept, attention needs to be focused on the patient's Buddhist

background, which her grandparents practiced, and Christian Science philosophy, which she currently practices. For instance, Christian Scientists are opposed to vaccinations, immunizations, quarantining during contagious diseases, and even object to emergency care when warranted.[19,20] Also spiritual leaders are often sought after rather than medical doctors.[20] As for Buddhism principles, mindfulness and meditation are embraced for optimal healing.[21]

Case Description

Patient

The patient was a 40 year old female who was admitted to the hospital and referred to inpatient physical therapy following complaints of shortness of breath, excessive fatigue, light headedness, and swelling of the lower extremities. After successful completion of acute physical therapy, the patient was discharged to an outpatient physical therapy program where she continued cardiopulmonary rehabilitation and her orthopedic concerns were addressed. She had a medical diagnosis of cerebral palsy and presented with cervical and thoracic pain. The patient self-reported a history of severe low back, hip, knee, and ankle pain prior to her pregnancy a few years ago.

Prior to hospital admission the patient ambulated using loftstrand crutches within the home and work environment and a motorized wheelchair for community distances and during periods of skin break down and/or pain in the navicular area of bilateral ankles. The patient also reported a history of stress incontinence and allergies to dust and mold. She is receiving Botox injections to her bilateral gastrocnemius and hamstring muscles when she was 4.5 years old. At 6 years old she underwent a selective posterior rhizotomy (SDR). The patient has sustained a motor vehicle accident (MVA) when she was six and sustained a right

femoral fracture (rod implant) and a right non-displaced colles fracture at the age of 10. Medications included Flovent twice daily (prescribed for relief of asthma symptoms), Ventolin inhaler (prescribed for relief of asthma symptoms), and Intal inhaler as needed (prescribed for allergy relief). The patient reported a recent history of falls, which have occurred three times, one of which was on the stairs. Her own home is a one story house with an easily accessible bathroom. The patient was independent with eating, grooming, and transferring from a scooter and wheelchair prior to hospital admission. She did require assistance with donning and doffing pants, shoes, socks, stockings, and transferring in and out of the shower secondary to safety concerns.

Prior to her hospitalization, the patient was working as a teacher in a local middle school and participating in the Christian Scientist church. As part of the Christian Science religion the patient may have varying views on typical social habits and medical intervention. In Christian Science a spiritual route is taken during the healing process which is solely based on prayer as medical intervention and current procedures are forbidden.[22] She was married and had a five year old child via C-section. Her child actively participated in swimming lesson, T-ball and soccer. The patient denies a formal exercise regime herself. Her husband was recently demoted from a full-time to a part-time position at his job and was preparing to lose all benefits in three months. He had been looking for further employment, but was unsuccessful and as a result, created tension within the family.

The patient goals for physical therapy upon discharge were to reduce pain, improve control of bowel/bladder function, increase endurance for ambulation, and receive information and resources regarding a Helping Hands Dog.

Systems Review

The patient demonstrated changes in cardiopulmonary presentation from pre-admission to post admission to the hospital. Elevation in heart rate (HR) and respiratory rate (RR) were demonstrated upon admission to the hospital paired with an onset of pedal edema. Refer to Table 1 for detailed heart rate, respiratory rate, and blood pressure measurements.

Upon admission to the hospital the patient presented with integumentary concerns including a hard callous under the navicular region bilaterally. The patient's skin appeared to be cool and clammy on palpation.

The patient also presented with postural deficits as demonstrated by a midthoracic kyphosis, bilateral rounded shoulders, and a pectus excavatum deformity. On further inspection the patient presented with decreased rib cage mobility with the greatest restrictions in her mid-chest. Height, weight, and body mass index are presented in Table 2. Based upon the patient's height and weight values, she is considered obese according to American College of Sports Medicine.[23]The patient presented with moderate lower extremity spasticity and minimal upper extremity spasticity. The patient's cognitive status appears to be intact with above average capabilities.

Examination and Evaluation

An initial examination and accurate evaluation are essential for patients admitted to the hospital with signs and symptoms of cardiac or pulmonary distress. A thorough assessment of vitals, systems review, and performance of other diagnostic testing will gear clinicians towards a more conclusive and precise diagnosis. This will also lead towards the development of the most appropriate intervention plan.

The patient in the current case report was admitted to an acute care setting. Prior to hospital admission, the patient demonstrated marked endurance limitations (<5 minutes

tolerance) especially with higher level activities. She also exhibited dyspnea, which was precipitated by exercise, change in temperature, and exposure to smoke. Refer to Table 1 in the appendix for initial vitals and other tests and measures.

The patient presented to be 5'2" tall and weighed 175 pounds. Patient's Body Mass Index was reported to be 32.2 kg/m^2. The normal range for heart rate (HR) in a healthy individual is between 60-100 bpm.[24] The patient's HR was high, recorded as being 110 bpm at rest. A high HR indicates that increased efforts to pump are placed on the heart, which can impair aerobic capacity. The normal range for blood pressure (BP) is <120 for systolic and <80 for diastolic.[24] The patient exhibited low BP. It is important to note that her usual BP prior to hospital admission was 95/60 mmHg, and dropped down to 70/45 mmHg in sitting and 90/50 mmHg in supine. Systolic values of <90 and diastolic values of <60 are indicative of low blood pressure.[25] A decrease in BP causes the patient to experience orthostatic hypotension, therefore, caution needs to be taken when getting her in and out of bed as well as during transfers. The normal range for respiratory rate (RR) in adults is between 18-20 breaths/min.[24] The patient's RR was elevated to 32 breaths/min. This indicated labored breathing and was also noted by an increased use of accessory muscles. Vitals are effective examination tools for assessing cardiovascular and pulmonary abnormalities. Literature suggests that systolic and diastolic BP values are reliable predictors for determining CHF.[26]

Arterial oxygen saturation (SaO_2) is a reliable value used in measuring the percent of oxygen bound to hemoglobin in the arterial blood. Evidence suggests that pulse oximeters are accurate and reliable noninvasive tools for measuring SaO_2.[27] They are easy to use and provide continuous monitoring of oxygenation. Pulse oximeters are useful for determining any decreased levels of saturation, detecting hypoxia, and any changes in pulse rate. It has

been found that the most accurate readings obtained were derived from finger probes, as opposed to ear probes.[26] It has also been reported that the use of pulse oximetry during hypotension, hypothermia, dyshemoglobinemia, low perfusion states, and rapid or severe desaturation, may fail to provide accurate SaO_2 readings.[27]

Normal values for arterial oxygen saturation (SaO_2) are 97-99% in a healthy adult.[28] However, an oxygen saturation value of 95% is clinically accepted in a patient with a normal hemoglobin level.[28] The patient's SaO_2 was at 82%, which is considered to be a poor value and is indicative of hypoxemia.[4] During physical therapy sessions, it is crucial for the SaO_2 stats to be monitored and maintained above 88%. If this value happens to drop below 88%, then supplemental oxygen or an increase in the oxygen already in use would be needed.

Left ventricular ejection fraction (EF) measures the percentage of blood that is ejected from the left ventricle after each heartbeat.[25] The normal values are between 55-70%.[25]The patient's EF was 29%, therefore, her heart demonstrated an inability to effectively pump enough blood to supply the demands of her body.[4] This suggests left ventricular dysfunction and therefore, heart failure. This condition is characterized by an ejection fraction of <35%.[29] It has been shown to be a reliable tool that assess the systolic function of the heart.[30] EF is commonly measured using imaging techniques such as the echocardiography (echo), radionuclide ventriculography, and cardiovascular magnetic resonance. However, it has been suggested that the most reliable device for determining EF is the cardiovascular magnetic resonance.[30] The reason being that this method eliminates ionizing radiation, employs the use of 3D imaging, offers the best image quality, and provides increased speed and less time for testing.[31] The use of echo has also demonstrated reliability in the prediction of ejection fraction, especially among patients with low EF (<30%). Tissue Doppler echo has been

shown to be 91% accurate in the diagnosis of acute CHF.[30] Additionally, Maddox concluded that the assessment of regional left ventricular function through ejection fraction imaging proved to be a valid measure.[32]

Peak expiratory flow rate (PEFR) measures the maximum flow rate that is produced during a forceful exhalation, starting with full lung inflation.[33] The normal range of PEFR for a female who is 40 years old and ~157 cm tall should be between 420-430 L/min.[34] The patient presented with a lower PEFR value of 350 L/min. This decrease in peak flow, which is accompanied by dyspnea and wheezing indicates pulmonary airway obstruction.[35] PEFR is utilized in determining the severity of asthma and airway obstruction of the lungs.[33] It is also considered an effective tool in determining a patient's response to exercise.[4] Jamison highlights the significance of peak flow as valid tests for the diagnosis of asthma. The author also emphasizes that daily PEFR monitoring is effective in determining the patterns of variability in airflow limitation.[36]

CHF results in an altered breathing pattern and ventilatory neural drive.[37] The patient presents with a paradoxical breathing pattern, which is a result of pectus excavatum. This is characterized by an excessive rise of the abdomen during diaphragmatic contraction and a collapse of the chest wall. The cause of this pattern is a result of intercostal musculature absence and inadequate abdominal muscle function or reduced tone.[14] The patient also presented with midthoracic kyphosis and rib cage mobility restrictions, which contribute to her breathing impairments. Additionally, pain in the midthoracic area can be experienced. Commonly observed with paradoxical breathing is an increase in respiratory frequency, such as frequent forced inhalations. Possible causes are narrow airways, fluid in the distal airways, or bronchospasms.[14,37] Since the patient's lungs were compromised, she used her accessory

muscles for respiration. This is indicative of decreased respiratory muscle strength causing labored breathing.[14,37] However, patients have been shown to exhibit an increase in neural drive to inspiratory muscles.[37] Observation and analysis of a person's breathing pattern is a useful tool during the examination process.

The patient presented with expiratory wheezes in the bilateral upper lobes during auscultation prior to hospitalization. This occurs as a result of bronchospasms (narrowed airways) in individuals who have asthma.[38] It has been shown that wheezing is the first reported symptom in patients over 40 years of age and is often related to heart failure.[14] On hospital admission, she demonstrated similar symptoms in addition to fine late inspiratory rales (crackles) in bilateral bases of the lungs in sitting during auscultation. The presence of inspiratory crackles is a sign of CHF. Karnath et al validates the use of the stethoscopes in pulmonary auscultation.[38]

The patient was admitted to the hospital with complaints of excessive SOB and orthopnea. Upon admission she also presented with decreased SaO_2 of 82% as well as expiratory wheezes. In addition to her other system impairments including musculoskeletal and cardiac, her functional ability has been greatly limited. Along with her previous limitations, a breathing complication had further decreased her functional status and quality of life. For patients with cardiac or pulmonary disease diagnoses, measurement of breathlessness may be one of critical components in their evaluation and treatment.[39] There are various assessment tools to assess breathlessness. Assessments which were used to evaluate the patient's progress included the Modified Borg Scale, University of California San Diego Shortness of Breath Questionnaire (UCSD SOBQ), as well as the fifteen count breathlessness score. Throughout the course of therapy, the patient is expected to make

progress as far as her breathing is concerned and return to her previous level of function. In order to find out whether our therapeutic interventions are effective in improving the patient's daily activities the UCSD SOBQ was used. During the initial evaluation she was asked to rate her degree of dyspnea at rest, while walking and performing ADLs to obtain a baseline measure. The patient was also asked to do the same during a reevaluation to detect any changes or progress.

Upon admission, the patient also demonstrated signs and symptoms associated with bilateral heart failure. Distended jugular veins and pedal edema signify a right-sided CHF.[4] Excessive dyspnea, orthopnea, and interstitial pulmonary edema from chest X-rays signify a left-sided CHF.[4] Chest X-rays also revealed a markedly enlarged heart with evidence of pulmonary venous hypertension. With the presence of pulmonary venous hypertension, the patient was at a risk for developing a common-end stage of pulmonary disease known as Cor Pulmonale. This is know as right-sided heart failure, where the right ventricle becomes thickened, enlarged and overworked.[25] Such complications can become life threatening.

As stated in the Framingham criteria, in order to diagnose a patient with heart failure there needs to be the presence of 2 major criteria or 1 major criterion and 2 minor criteria given that the minor criteria are not related to other present medical conditions. Refer to table 2 within the appendix for criteria to diagnose a patient with heart failure.[40] Based on this classification and our patient presentation of more symptoms than required, it would be safe to conclude that her symptoms are consistent with a CHF diagnosis.

Further examination of ECG revealed intermittent premature ventricular complexes (PVCs). These abnormal heartbeats indicate cardiomyopathy. They interrupt the regular rhythm of the heart.[25] Since PVCs are displayed on the ECG, caution needs to be taken with

activity. Evidence suggests that CHF identification via the use of chest X-rays proved to be an effective tool. Most importantly, the diagnostic skill of the clinician is a huge factor in determining reading accuracy.[30] Studies conducted by Kataoka suggest that the use of an ECG is a valuable tool in monitoring patients with heart failure.[41]

Additionally, the patient presented with decreased coordination, variety of movements and delayed equilibrium responses while in standing. However, she was able to sit independently and stand with support. She demonstrated more difficulty with eccentric contraction than concentric and notable reduced strength in bilateral upper extremities. Refer to Table 3 for lower extremity muscle strength testing. Furthermore, neuromotor development examination revealed greater spasticity in lower extremities than upper extremities as well as underlying reduced tone in core muscles. An appropriate measure to administer to further classify the patient's level of spasticity in upper and lower extremities is a Modified Ashworth Scale (MAS). This tool has been shown to be valid and reliable in assessing muscle spasticity in patients with a range of neurological conditions as well as CP.[42]

A combination of the findings mentioned above correlate with her reports of poor endurance and not being able to ambulate longer distances during family outings. A decrease in LE muscle strength increases her energy expenditure during ambulation not allowing her to exhibit appropriate gait patterns which poses a greater need for an assistive device. In addition, displaying increased spasticity, decreased coordination, and delayed equilibrium responses while standing directly affects her base of support (BOS). This further increases the patient's risk for falls and need of assistance with ADLs and other functional activities.

As compared to the normal measurements, the patient demonstrated significant limitation in LE ROM which has a direct influence on her ability to ambulate and transfer in a safe manner. Specifically, her limitations in knee and hip ROM contribute to changes in her center of gravity, decreased base of support and most importantly causes balance impairments. These components are essential for normal ambulation. Also, her limitations in popliteal angle ROM, indicate a reduced functional hamstring length, which is impeeding her ability to ambulate longer distances effectively.[43] In addition, her impaired UE joint mobility and ROM is limiting her ability to perform self care and activities of daily living (ADLs) independently and efficiently. The patient's ROM and strength ranges are listed within tables 3 and 4 of the appendix. [24]

Further examination of the patient's gait, locomotion and balance revealed the following results: static balance tested to be 15 seconds. In a healthy individual, static balance norms are recorded as 29.5 ± 2.5 seconds.[44] Research has shown that balance problems are not only prevalent in the pediatric CP population. In many instances they are more severe in the adult population.[2] With decreased balance, safety during ambulation becomes a great concern. It has also been reported as one of the determinants in changes in walking ability and decreases in functional abilities directly affecting independence.[2] The patient was able to ambulate a distance of 80 feet with a crouched gait and mild hip flexion, adduction and internal rotation; mild knee flexion; ankle eversion, pronation, and weight bearing on the navicular. As evidence suggests, a six minute walk test (6MWT) is highly reliable and a valid measure to assess walking ability in patients who have walking impairments.[45] This test was also found to be useful when measuring functional exercise capacity in patients diagnosed with chronic heart failure as well as respiratory disease. The

authors of this study reported that during a 6MWT the shortest distance ambulated by a patient diagnosed with CP was 316 meters (1036.7 feet). For a healthy adult 20 to 85 years old, an average walking distance is 350 to 700 meters (1148.3 to 2296.6 feet) in six minutes.[45] The patient's ambulation distance is well below the shortest distance walked by other subjects with CP diagnosis. This poses a great concern for her functional exercise capacity and endurance during short distance ambulation. This test would also be appropriate to administer in the later stages of rehabilitation as her condition stabilizes. In order to demonstrate significant improvements in ambulation, she would have to be able to ambulate 44 meters longer with a walking aid.[45]

At the time of study, the patient was independent with eating and grooming, however requires assistance with dressing, specifically pants, shoes, socks, and stockings. She was able to transfer to and from her scooter independently, yet required assistance when transferring in and out of the shower for safety reasons. Patient was occasionally using a wheeled walker at work and at home while her primary means of mobility in the community is a motorized wheel chair. Consequently, she was only able to participate in community activities that are accessible by motorized wheelchairs. Other social and leisure activities are centered around her child's activities. At the time of study, the patient had no routine or consistent fitness activities.

Additional tests and measures are necessary in obtaining further information regarding a patient's medical condition. These tests shall provide more accuracy in ruling in or out a specific diagnosis. For instance, a beneficial test to perform for this patient is the arterial blood gases test (ABG's). This would assist in further identification of the patient's respiratory and pulmonary status, specifically oxygenation (pO_2), respiratory function

(pCO_2), and acid-base pH levels. Studies indicate that patients with a diagnosis of congestive heart failure will present with lower PaCO2 values.[37] It has also been shown that blood gases tend to be normal in patients with well compensated heart failure. However, if test results demonstrate a decrease of arterial oxygen saturation, this should prompt further evaluation for other diagnoses. This ABG analysis is necessary to perform in all patients experiencing severe respiratory distress.[46]

Another useful test that should be ordered is the complete blood count (CBCs). A study conducted by Bekwelem et al, revealed that elevated levels of white blood cells (WBC), especially granulocytes (neutrophils, eosinophils, basophils), of >7000/mm^3 and C-reactive protein (CRP) of >7.0mg/L are positively correlated with an increased risk of heart failure in middle-aged adults.[47] These laboratory tests measure the systemic inflammation in the body, which is associated with an increased risk for coronary heart disease (CHD). This in turn, is a predisposing factor for heart failure. An increase of white blood cells, (WBC) can cause vessel obstruction, the aggregation of leukocytes, injury to the endothelial lining of cells, and decreased perfusion of the heart muscle. CRP can stimulate cytokine production and cause the loss of myocytes. The result leads to an abnormal functioning of the heart.[47] This test would indicate whether there are any infectious conditions present or any other blood related abnormalities.

The measurement of brain natriuretic peptide (BNP) levels is useful in determining the presence of CHF. BNP is produced by both the right and left cardiac ventricles as a result of increased wall tension. BNP levels are increased in both systolic and diastolic CHF. BNP values that are greater than 300 pg/mL is indicative of heart failure.[30]

Pulmonary function testing is an important differential diagnostic component of examination. An enlarged heart (cardiomegaly) is a result of CHF, which ultimately causes restrictions in the pulmonary system. For instance, lung volumes and capacities will be decreased, resulting in impaired breathing and dyspnea.[48] A routine spirometry is useful in evaluating the extent of obstructive airway disease. However, it is important to consider the presence of pulmonary congestion as it may influence the final test results.[46]

The BODE index is a measure which is used to predict the risk of death in patients with Chronic Pulmonary Obstructive Disease (COPD). It consists of the body-mass index (B), the degree of airway obstruction (O), dyspnea (D), and exercise capacity (E) as measured by a 6MWT.[49] This index is a multi-dimentional grading system that is able to predict the risk of death from any cause including respiratory conditions in patients with COPD, and has been shown to be better than the FEV1 as it correlates with the disease progression.[49] This study had validated the use of this index as it includes "one domain that quantifies the degree of pulmonary impairment (FEV1), one that captures the patient's perception of symptoms (the MMRC dyspnea scale), and two independent domains (the distance walked in six minutes and the body-mass index) that express the systemic consequences of COPD**.**[49] Since the patient also has asthma, using a BODE index would assist in predicting her mortality risk in conjunction with CHF condition.

The patient was classified under primary practice pattern 6D: Impaired Aerobic Capacity/Endurance Associated with Cardiovascular Pump Dysfunction or Failure. Secondary to her CP diagnosis she was also classified into practice pattern 5C: Impaired Motor Function and Sensory Integrity Associated With Nonprogressive Disorders of the Central Nervous System-Congenital Origin or acquired in Infancy or Childhood.[50] She

displayed specific patient identified problems (PIP's) related to her condition. They consisted of thoracic pain, stress urinary incontinence, impaired posture, endurance limitations, and the request and need for a helping hands dog. Thoracic pain can affect posture, which in turn can affect overall gait. Stress urinary incontinence is a result of pelvic floor weakness and can negatively impact voiding. An impaired posture, such as midthoracic kyphosis, rounded shoulders, rib cage mobility restriction in the mid chest, and pectus excavatum can lead to increased pain and further functional declines. Non-PIP's included impaired skin integrity, posture, joint mobility, muscle performance, gait, cardiopulmonary performance, and edema in the lower extremities. Overall, the patient demonstrated decreased balance, strength, ROM, endurance, coordination, and equilibrium responses. Also, impairments were noted in gait, and cardiopulmonary performance. She was also at a risk for skin breakdown and callus formation based on her style of ambulation and weight bearing distribution.

The extent of the patient's CHF places her under Class IV of the NYHA. Therefore, she exhibited severe activity limitations, experienced symptoms at rest, and she was bed-bound. The patient was restricted in physical activity and demonstrated shortness of breath with exertion. The NYHA classification will help guide the patient's intervention program. All of her impairments need to be addressed in therapy and targeted in a way so as not to compromise her cardiovascular and pulmonary system.

Intervention

The patient will receive treatment in an inpatient physical therapy program consisting of cardiac rehabilitation and functional/gait training. During the hospital stay, treatment sessions will be held twice daily; one hour session in the morning and 30 minute session in the afternoon. Following discharge she will receive treatment in an outpatient physical

therapy program that shall focus on cardiac concerns, spasticity/contractures, balance deficits, and pelvic floor dysfunction. For specific information regarding interventions please see appendix.

Phase I: Inpatient Rehabilitation

During the patient's initial visit, she will be provided instructions for activity pacing, energy conservation techniques, dietary factors, and daily weighing. The patient will be educated in modifiable risk factors, how to identify symptoms of worsening CHF, and how to identify symptoms of adverse reactions to her medications. The patient will be scheduled to be seen every day for 45-60 minute sessions twice daily until discharge from inpatient physical therapy.

The goals for phase 1 will include; the patient will be able to demonstrate proper breathing techniques while at rest and with activity, the patient will be able to stand in rhomberg stance with good posture for 2 minutes without experiencing any loss of balance (LOB), the patient will be able to increase her 6 minute walk test distance to 100 meters on a flat surface using loft-strand crutches with stable vital signs, the patient will be able to independently transfer to the toilet/commode in patient room, the patient will be able to safely demonstrate sit to stand transfer using proper hand placements without verbal cues, and the patient will decrease her beck depression inventory to 9.

In this phase of treatment, therapy sessions will consist of: instruction in patient education, participation in techniques in order to prepare for physical therapy intervention, breathing exercises, endurance exercises, balance exercises, transfer/gait training, and a series of cool down activities.

The patient will be provided education in medication use related to physical therapy, side effects of her medications to be aware of, her postural deviations and how they contribute to her pain, the benefits of regular activity, integumentary concerns, and signs and symptoms of worsening CHF. The patient will also be educated in orthostatic hypotension and the possibility of getting compression stockings.[51] The patient will be instructed in breathing techniques which include diaphragmatic breathing, pursed lip breathing (PLB), active cycles of breathing, and PNF patterns with breathing.

Diaphragm weakness is a common impairment in patients with CHF, causing impaired exercise capacity and dyspnea.[52] The diaphragm is thought to undergo a fiber-type shift and contractile property changes.[52]The fiber type shifts from fast twitch fibers (type 2) to slow twitch fibers (type 1) which increases the oxidative capacity of the diaphragm while also decreasing its glycolytic capacity.[52] This shift occurs secondary to the diaphragm being forced to work harder at both rest and with exertion in patients with CHF.[52] Evidence shows that diaphragmatic breathing facilitates deep breathing by slowing the respiratory rate (RR) which will also decrease the burden on the diaphragm.[52] It does not however change the patients VO2.[53] The patient will be asked to go into a supine position with her knees flexed. The therapist will then put their hand under the anterior thorax and ask the patient to breathe into their hand.

PLB has been shown to improve ventilator efficiency by lowering breathing frequency (secondary to prolonged expiration) and improvement in the patient's tidal volume and gas exchange with each breath.[54] PLB keeps the airways open to allow secretions to move through them. The patient will be instructed to inhale to a count of 1 and then exhale to a count of 4. The patient will be instructed to incorporate this technique into her regular

breathing habits. Following mastery of PLB, PNF patterns will be introduced. The patient will be instructed in a bilateral upper extremity D-2 flexion pattern during inspiration and to expire for a count of 4 during rest. The patient will perform 3 sets of 15 repetitions of this.

The active cycles of breathing technique has been shown to maintain oxygen saturation levels.[55] The patient will be instructed to breathe 2-3 times using the diaphragmatic technique then to take a deep inhalation (to inspiratory capacity) with a relaxed exhalation. The patient will then be instructed to breathe to inspiratory capacity and then breathe out to expiratory capacity. The patient will then be instructed to perform "huff's" at the end of 1-2 breaths. The patient will perform 3-4 cycles of this series 2-3 times.[55]

Balance training and gait training will also be a part of this patient's plan of care (POC). Prior to balance/gait training the therapist will perform a series of preparatory techniques which will include static manual stretching, low frequency vibration, and a myofascial release.

The therapist will perform static manual stretches to the patient's lower extremities (LE's) in order to address the patient's spasticity and decreased ROM. The therapist will provide static stretches to all joints in the patient's bilateral LE's for a total of 30 minutes. Research suggests that torque relaxation is 53% greater with static stretching than with cyclic stretching. Static stretching has also been shown to improve scores on the ashworth scale, improve both active and passive ROM, and reduce feelings of stiffness.[56]

The therapist will use low frequency vibration on areas of high tone (her LE's) for a 6 minute time period. Low frequency vibration has been shown to be beneficial in helping muscles relax which would be beneficial to use on her LE's as they present with spasticity. Vibration when combined with exercise directly following has been shown to decrease

spasticity, increase muscle strength, and increase motor performance in patients with CP.[57] For this patient, whole body vibration (WBV) will be avoided, as she presents with cardiopulmonary concerns which are a contraindication for WBV. Therapist need to use caution when using vibration with this population and should avoid proximal areas including the trunk.

A myofascial release technique will be used on restricted muscle groups using a multi level rigid roller (MRR). Myofascial release techniques are used to treat myofascial restrictions and to restore soft tissue extensibility. The MRR has been shown to be beneficial in that it can produce high pressure to an isolated contact area.[58] The therapist will hold the roller onto a restriction for 90-120 seconds (or until release) and then move to the next barrier or restriction in the same muscle. This will be repeated for each muscular restriction.[59]

The patient will complete a series of edge of bed (EOB) exercises to work on sitting balance and core strength (2-3 METS). The patient will first be instructed to sit upright in her bed without upper extremity (UE) support for 2 minutes. Perturbations will be added for 30 second intervals 5 times. Forward, backward and side leaning with a return to midline will be done 10 times in each direction. To practice bed mobility/transfers, the patient will lay with feet off the bed while laying on her side by her elbow. She will then be instructed to push up off her elbow to a midline position. She will repeate this 5 times to each side. Once sitting balance will be established, the patient will be asked to reach for various objects across midline and overhead for 2 minutes. Aerobic endurance will also be addressed with a UE cycle ergometer for 5 minutes. Core strengthening will also help the patient with her cervical/thoracic pain as poor posture is thought to be her primary concern in regards to pain.

The patient will also be referred to pain management in order to better participate in physical therapy.

The patient will be instructed in balance activities that will progress as the patient will be able to complete the first balance challenge. The patient will be instructed to stand shoulder width apart while shifting her body weight side to side. Once the patient is able to do this for 30 seconds without losing her balance she will progress to performing the same activity on a foam mat. The patient will stand within parallel bars and have contact guard by the therapist at all times throughout balance training.[60]

Transfer training will be provided to get in and out of the shower, a bed, a chair with arm rests, a car, and on and off of the toilet. That patient was still presenting with strength and balance deficits that prevent this from being an independent activity by inpatient discharge. Family instruction will be provided for proper guarding and assistance techniques to aid the patient with self care.

The patient will then be instructed in ambulation using loft-strand crutches (3-5 METS). She will be asked to walk 25 feet on a flat surface. The patient will progress in distance throughout outpatient physical therapy to 300 feet on a flat surface. The patient vitals will be monitored prior to walking and at the completion of walking.

The patient will participate in cool down activities that will comprise mainly of relaxation techniques such as meditation and vibration. The meditation component will be taught to the patient for independent relaxation post treatment sessions. The patient will be instructed in relaxation response meditation which is a thoughtless awareness type of meditation for 15 minutes. This has shown to be beneficial in decreasing anxiety and stress with patients who have various diagnoses.[61] The lights will be dimmed and ocean sounds will

be played on a CD player while the patient will focus on her breathing. This was done for 15 minutes. Vibration for her cool down will be completed using the same methods and parameters as before.

The end points for all activities in phase 1 will include a heart rate increase of 20-30 bpm above rest or a decreased 10 bpm with activity, SBP decrease greater than 10-20mmHg from rest, or SBP increase greater than 40mmHg from rest. Activity will be stopped if the patient presents with angina, S-T segment changes, dyspnea, diaphoresis, dizziness, or a sudden onset of leg pain. Vital signs and signs of distress will be monitored. Activities will be limited to an appropriate MET level of 3-5.

The target heart rate for this phase will be 145 bpm (RHR was 110 bpm) based on the karvonen method at 50 percent intensity. Activity will be terminated when systolic blood pressure increases to 135 mmHg (an increase of 40 mmHg), when diastolic blood pressure decreases to 40-50 mmHg (a decrease of 10-20 mmHg).

Phase II: Outpatient Rehabilitation

In the next phase of treatment, the patient will be seen in outpatient physical therapy 3 times a week for 12 weeks for 45-60 minute sessions.

The goals for phase 2 include; the patient will be able to increase her 6 minute walk test distance to 350 meters (beyond community ambulation distance) with loft-strand crutches on cement, carpet, and solid floor, the patient will be able to increase her PFIQ-7 score to 16 points, the patient will be able to decreased back pain to 2/10 at worst, the patient will be able to bike for 10 minutes at level 2 without experiencing dyspnea, the patient will

be able to stand in rhomberg stance for 5 minutes without experiencing a LOB, and the patient will decrease her score on the beck depression index to 4.

The patient presented with decreased aerobic endurance and decreased LE strength during the initial evaluation. Research suggests that a stationary bike can help improve both endurance and strength in the LE's which will help the patient improve her gait as she was only able to walk 80 feet with loft-strand crutches at hospital admission.[62] The patient will be instructed to bike at an RPE ranging from 2-3 (light) for 5 minutes. The intensity and duration will be progressed to a RPE of 4-5 (moderate) for 10 minutes by discharge from outpatient physical therapy. Vitals will be continually assessed throughout aerobic activity. RPE will be used to assess activity tolerance, as HR is not reliable measure secondary to CHF medications.

The patient will then be instructed in a lower extremity strengthening and functional activity exercise. The patient will be instructed to ascend 6 steps using a railing on the right and then to turn at the top of the stairs in a counter clockwise direction and then descend the 6 steps using the railing on the right. The therapist will provide contact guard throughout this exercise. The patient will perform this 3 times and then rest at the bottom by sitting in a chair for 1 minute. The patient will complete this sequence 4 times.

The patient will continue to progress on the balance sequence noted in the inpatient portion of her rehabilitation. During this phase of treatment the patient will be asked to stand on a foam mat with her feet together for 30 seconds or until she lost her balance. Once the patient is able to perform this, she will be asked to add arm movements while standing on the foam mat. The patient will be instructed in a bilateral UE PNF pattern. The patient will be instructed to do this for 30 seconds or until she loses her balance. For each challenge the

patient will perform 5 attempts and will be given contact guard while in the parallel bars for each.

The patient presented with a midthoracic kyphosis, which is the most likely the cause of her pain in the spine. During the initial evaluation the patient reported her back pain as an 8/10 at its worst. As the kyphosis is most likely the result of weakness in her trunk musculature, the patient will be educated in posture and will be given a level 1 theraband (yellow) and will be instructed in an extension exercise while sitting on a physioball. This will help engage the patient's trunk musculature while improving her posture.

The patient will be given information on stress incontinence and exercises to strengthen the pelvic floor. The patient will be taught how to perform kegel exercise and instructed to perform for 5 minutes at least 5 times per day. She will also be given an exercise log and a bladder diary so she can track progress. Copies of the logs used are found within the referred website.[63]

The patient will be instructed in a home exercise program (HEP). The HEP will include walking for at least 20-30 minutes per day. The patient will be given a yellow theraband to take home and will be instructed to do 3 sets of 15 repetitions per day of the back extension exercise on a physioball. The patient will be instructed to perform a sit to stand exercise from her bed and chair 10 times each per day. All exercises will be provided with instructions to a family member, so that exercises will be supervised. The patient will be sent home with a gait belt from which the family will be instructed in its use. As part of a HEP the patient will also be informed about yoga and tai chi video tapes that could be performed from a chair. The patient will also be informed about community resources

providing yoga and tai chi sessions as well as swimming at the local YMCA which she will benefit from participating in.

The patient and her family will be instructed in various lifestyle modification recommendations. The family will be instructed to remove any throw rugs in the house, get no slip grips for the shower floor, get a shower chair, 3 in 1 commode, grab bars for the shower, and a call button necklace in case of another fall as she has already experienced 3 falls. The patient will also be instructed in various energy conservation techniques to use while performing ADLs. The patient will also be instructed to use her motorized wheelchair for community outings when possible. The patient will also be given additional information on helping hands dogs and places where they can be adopted from. She will also be educated on barriers to getting a dog and the possibility of hazards for falling. The patient's family will be encouraged to look at a variety of dogs and try to find a breed with a calm temperament and is low maintenance to decrease the burden of care giving.

During the course of outpatient physical therapy the patient will be referred out to a psychologist, her primary care physician, and a nutritionist. The patient will be referred to a psychologist secondary to reporting increased stress at home. The patient will be referred to her physician as she is still presenting with skin breakdown in her LE's. The patient will be referred to a nutritionist secondary to a BMI that classifies her as obese and to discuss nutritional needs associated with CHF.

The patient reported that her goals for discharge from physical therapy are to decrease back pain, get relief from incontinence, increase her endurance in order to participate in family outings, and to get a helping hand dog.

The endpoints for activity in phase 2 are the same as those mentioned in phase 1. Activity will be stopped for the same above mentioned changes in status. Vital signs and signs of distress will be monitored. Activities will be limited to an appropriate MET level of 5-6.

Contraindications for phase 2 include exceeding before mentioned endpoints and an inability to perform tasks under a MET level of 6 (which is required for most ADLs). As stated above, activity tolerance will be assessed via RPE as HR is not a reliable measure of aerobic function in this population secondary to CHF medications. The target RPE will be set for each phase of treatment which is not to be exceeded. Activity will be terminated in the event the activity provided a higher RPE than indicated in the POC.

Outcome measures

UCSD Shortness Of Breath Questionnaire (UCSD SOBQ)

The UCSD SOBQ is a questionnaire that asks the patient to indicate how frequently they experience SOB during 21 ADL's on a 7 point scale that was adopted specifically for pulmonary rehabilitation.[39] There are also 3 additional questions about limitations they experience secondary to SOB making the questionnaire a 24 item scale. The reliability of this test was shown to be 0.94.[39] The MCID has been reported to be 5 units.[39] This questionnaire will allow us to measure the frequency and activities that cause SOB in our patient.

15 Count Breathlessness Score

The 15 count breathlessness score was designed to quantify breathlessness in both children and adults. This assessment is able to differentiate the degree of breathlessness induced by exercise of varying intensities.[64] The patient is instructed to take a deep breath

and then count out loud to 15. The number of breaths it takes to get to 15 including the initial breath is the final score. The reliability of this test ranges from moderate to high (0.54-0.92). The sensitivity was found to be 33.2% and the specificity was found to be (93.3%) indicating its ability to rule in breathless in a population.[65,66] The MCID is not reported in literature to date. This scale will help the therapist get a baseline score along with determining if the patient made any improvements throughout the physical therapy POC.

Modified Borg (RPE)

The modified borg is a scale used to determine dyspnea of perceived exertion in patients during activity. It is a rating scale ranging from 0 (no breathlessness) to 10 (maximum breathlessness).[67] The reliability to this test was shown to be 0.45.[68]The MCID for the RPE has been reported variably throughout literature, on article emphasized that an MCID of 1 is appropriate for patients with cardiopulmonary concerns.[67]The RPE is a good measure in determining how well the patient is tolerating an activity. As stated previously it is especially useful in this population.

6 Minute Walk Test (6MWT)

The 6MWT is a test where the participants are instructed to walk as far as they can for 6 minutes without running or jogging and can use an assistive aide. The participant is also allowed to take breaks as the final measure is the final distance walked. The test is considered to be a good indicator of a patient's ability to perform daily activities.[69] The 6 MWT had a sensitivity ranging from 80-89% and a specificity of 60-83%. The 6MWT has shown to have good reliability, moderate validity, and a significant ability to predict functional capacity for patients who have been diagnosed with CHF.[70] The MCID for the

6MWT for patients with cardiac concerns was reported as 25 meters for meaningful improvement.[71] This will help get a baseline of the patient's aerobic capacity and serve as an outcome as the patient improves her aerobic capacity.

Modified Ashworth Scale

The Modified Ashworth scale is a 5 point ordinal scale for grading the resistance encountered during passive muscle stretching at a high velocity. The scale ranges from 0-4 (0 being normal muscle tone and 4 being rigid). This scale has been shown to have face validity and it has a reliability of 0.85.[72] An MCID is not reported in the literature for this scale to date. The patient presents with LE spasticity, this scale will help the therapist determine areas of increased or reduced tone.

Sharpened Romberg Static Balance Test (SRT)

The SRT is a balance test that first tests the patient with eyes open and then with their eyes closed. Data was not found on the reliability and validity of this test. One article however compared the SRT with the functional reach test and found that the SRT was more effective in determining subjects at risk for falls than the functional reach.[73] An MCID is not reported in the literature for this scale to date. The patient presents with balance deficits and a significant history of falls, this measure will help determine improvements in her balance over time.

Pelvic Floor Impact Questionnaire (PFIQ-7)

The PFIQ-7 is compromised of 7 questions relating to an activity of daily living. The participant is asked to say if each activity has an effect on bladder/urine, bowel/rectum, or vagina/pelvis. Once the participant picks the involved category they pick if the symptoms

occur; not at all, somewhat, moderately, or quite a bit. This questionnaire has a reliability of 0.96.[74] An MCID is not reported in the literature for this scale to date. The participant in this study has a diagnosis of stress urinary incontinence, this from will help determine improvement in accidents over time.

Minnesota Living with Heart Failure (MLWHF)

The MLWHF is a self administered 21-item questionnaire in which 2 dimensions (physical and emotional) of heart failure are addressed. The questionnaire assesses an individual's quality of life (QOL), placing emphasis on work, recreation, energy levels, emotional status, and relationships.[75] The items are scored on a 0-5 scale in which 0 indicated no effect on QOL and 5 indicated that is "very much" affected QOL. The reliability is 0.80 and was reported to be valid although no values were given. MCID value for this outcome measure is unavailable. This questionnaire will provide the therapist with information about how the patient is dealing with her new diagnosis of CHF. As this also assesses QOL it would be most beneficial to use once the patient is in outpatient physical therapy setting as it could assess how she is integrating back into her life.[76]

Montgomery-Borgatta Caregiver Burden Scale

The Montgomery-Borgatta Caregiver Burden scale is a 22-item scale designed to measure the four dimensions of the caregiver's experience which includes 3 scales and a fourth measure of fulfillment. The three scales include relationship burden, stress burden, and objective burden. Scores between the categories may provide a framework for intervention as a caregiver may score more poorly in one category when compared to the others.[77] An MCID is not reported in the literature for this scale to date. As the patient is now relying on her

caregivers more secondary to a new diagnosis it is important to screen the caregivers for possible burn out. If the caregiver scores poorly on this scale it could negatively impact the patient's prognosis.

Outcomes- Inpatient Rehabilitation

Cardiovascular

Following breathing interventions consisting of diaphragmatic breathing, pursed lip breathing (PLB), active cycles of breathing, and PNF patterns with breathing, the patient is expected to demonstrate improvements with her breathing. Specifically, we anticipate the patient to demonstrate a decrease of at least 5 points on the final score on the UCSD SOBQ to represent meaningful improvement in her ability to perform ADLs with a lesser degree of dyspnea.[39] Performing this assessment will demonstrate how much difficulty she has with ADLs secondary to her breathing impairments and will reflect the improvement with therapy.

The fifteen count breathlessness score will be performed during and after activities performed in therapy sessions. It is speculated that her score on the fifteen count breathlessness assessment would be 2 at the start of physical therapy program and improve to 1 towards the end of the program.[64]

Anticipated results of the Modified Borg scale throughout the patient's treatment program is expected to decrease from 5.1 to approximately 4.4 as a baseline measure during inpatient rehabilitation.[78]

As the patient was diagnosed with Stage IV heart failure when hospitalized, in addition to having cerebral palsy and ambulating with loftstrand crutches, it is expected that

she will be able to ambulate a distance ranging between 100-150 feet (30-46 meters) in the acute care setting on the 6MWT.

The patient's overall breathing pattern is expected to improve. With the breathing interventions in place, the patient should be able to depend less on her accessory muscles and more on her diaphragm and intercostals muscles. Her paradoxical breathing pattern and frequent forced inhalations are also expected to be controlled through efforts of minimizing the respiratory work load.

After patient education, it is anticipated that the patient will be able to verbalize three modifiable risk factors 5/5 times with no verbal cues within one week from the start of therapy. Also, the patient is expected to verbalize three energy saving techniques 5/5 times with no verbal cues within one week. With anticipated improvements in cardiovascular system, the patient is expected to demonstrate all transfers and bed mobility safely 100% of the time with an assist of one therapist. The patient's HR is anticipated to remain less than or equal to 85 bpm within one week.

Neuromuscular

The patient is expected to make minimal improvements in ROM in this setting. The patient is expected to increase hip flexion, abduction, and adduction ROM by 5 degrees. She is not expected to make gains in hip external rotation and flexion ROM. She is expected to increase knee flexion and extension ROM by 5 degrees. The patient is not expected to make improvements in ankle ROM at this time. The patient is expected to increase all shoulder motion by 15 degrees. She is expected to increase wrist flexion and extension ROM by 5 degrees.

The patient is expected to make functional strength gains in her UE and some of the muscles of her LE on a manual muscle test (MMT). Trunk extension and flexion is expected to increase to 4/5 as the patient is able to sit EOB independently. Hip flexion and knee extension are expected to increase to 4+/5. Hip extension, hip abduction and knee flexion are expected to increase to 3/5. Dorsiflexion and plantarflexion are expected not expected to improve.

The patient is expected to make functional improvements in posture throughout the course of inpatient rehabilitation. The patient should increase her ability to co-contract trunk musculature to decrease midthoracic kyphosis.

The patients tone was assessed via the modified ashworth scale. It is suspected that the patient would not make significant improvements in this area secondary to a neurological diagnosis of CP. Upon evaluation the patient scored a 3 out 4 on the modified ashworth scale for LE flexor tone. She may demonstrate short term improvements after relaxation techniques (possibly a 2/4) which will help improve function for a particular task but will not be lasting. True decreases in tone would not be expected without medical management. It is not expected that her tone will decrease to 0/4 (normal tone).

The patients balance was assessed by the Sharpened Rhomberg Test (SRT). Through a combination of strength and balance training the patient is expected to make gains in both her static and dynamic balance. It is expected that in the course of 10 days that the patient would make minor improvements in her balance.

Pain

The patient is expected to decrease her pain level on the VAS by 2 points (7/10).

Outcomes – Outpatient Rehabilitation

Cardiovascular

In the outpatient setting, the patient is expected to ambulate 300 feet or greater with loftstrand crutches on flat surfaces. It is expected that the patient would make further improvements in gait secondary to functional exercise capacity gains. With further rehabilitation, the patient is expected to demonstrate cardiovascular and endurance improvements which would reflect in functional activity levels including ambulating longer distances with the use of a walking aid and negotiating one flight of stairs. Specifically, we anticipate that the patient will demonstrate the ability to maintain their heart rate at or less than 85 bpm and respiratory rate in the range of 12 to 22 breaths per minute during functional activities. However, the expected results may vary in the patient described in this study secondary to other co morbidities which may influence her progress in therapy.

Neuromuscular

The patient is expected to make functional improvements in ROM in this setting. The patient is expected to increase hip flexion, abduction, and adduction ROM by 15 degrees. She is not expected to make gains in hip external rotation and flexion ROM. She is expected to increase knee flexion and extension ROM by 10 degrees. The patient is not expected to make improvements in ankle dorsiflexion or plantarflexion ROM. The patient is expected to increase all shoulder motion by 10 degrees. She is expected to increase wrist flexion and extension ROM by 10 degrees. The patient is expected to make functional strength gains in her UE and some of the muscles of her LE on a manual muscle test (MMT). Trunk extension and flexion is expected to increase to 4+/5 as the patient is able to sit EOB independently.

Hip flexion and knee extension are expected to increase to 5/5. Hip extension, hip abduction and knee flexion are expected to increase to 4-/5. Dorsiflexion and plantarflexion are expected not expected to improve.

The patient is expected to make functional improvements in posture throughout the course of outpatient rehabilitation. The patient should increase her ability to co-contract trunk musculature in both static and dynamic positions. This activation of core musculature and improved shoulder motion and strength should decrease both her midthoracic kyphosis and rounded shoulders. As changes in tone are not expected, it is not expected that the patient would make significant improvements on the modified ashworth scale in the outpatient setting.

The patients balance will be assessed by the Sharpened Rhomberg Test (SRT) in the outpatient setting. It is expected that the patient would make significant improvements in balance on the SRT within the 13 week time frame in physical therapy.

It is expected that over time, she will increase her pelvic floor muscle strength and be able to control her condition.

Pain

The patient is expected to make significant improvements in cervical and midthoracic pain by outpatient rehabilitation discharge. It is expected that the patient would decrease her score on the VAS by 4 points (4/10).

Quality of Life/Caregiver Burden

It is expected for the patient to improve her score to at least 28 by discharge. It is also anticipated that the patient will score between 42 and 63 on the MLWHF after completing outpatient physical therapy. The patient may score on the higher end because they also have a diagnosis of CP, which greatly limits functional abilities. Also, the severity of CHF condition, being female and under 65 years of age can lead us to conclude that feelings of depression and significantly lower QOL would be reported. Upon continuation of outpatient physical therapy services, it would be expected for the patient's condition to improve, resulting in an MLWHF score possibly between 21-42 points. Additional improvements could be noticed with medication monitoring for CHF. Therefore, she would be strongly encouraged to seek consultation services from her MD and pharmacist. With continued physical therapy, it is expected that the patient's QOL will improve.

Caregiver burden was assessed by the Montgomery-borgatta caregiver burden scale. It is expected that the caregiver would obtain a score of 58 on the Montgomery-Borgatta Caregiver Burden Scale.

Patient education

With inclusive patient education during treatment sessions, the patient is expected to demonstrate independence in monitoring of vitals and compliance with the HEP. The patient is also expected to report participation in at least one complementary activity per week. The activity will be of the patient's preference including yet not limited to yoga, tai chi, or swimming at the local YMCA.

Discussion

Numerous interventions are available for patients with both CP and CHF. The challenge for physical therapists is to identify the most appropriate POC based on the most

current literature and feasibility of each intervention in the clinic for a patient presenting with both these conditions. Our case report describes a POC specific to a patient with both CP and CHF and the potential outcomes expected with this POC.

The patient presented in this case report is a 40 year old female with a diagnosis of CP and CHF. She was admitted to the hospital where she was medically stabilized. After being discharged from acute care, the patient completed a course of outpatient physical therapy where the treatment was focused on addressing her impairments and functional limitations. Musculoskeletal, cardiopulmonary, and neuromuscular systems were primarily addressed. The patient is expected to demonstrate improvements in all areas of treatment. The patient is anticipated to return to previous level of function with some adaptations and modifications in ADLs and functional activities. In order to determine this patient's ability to respond to the interventions outlined above her diagnoses of CP and CHF must be taken into consideration.

As a child with CP transitions into adulthood, a number of complications persist that negatively impact the adult life. Overall functional declines are experienced, co-morbidities exacerbated, and dissatisfaction with the QOL have been reported.[80] Participation in society, relationships, and employment is also reduced during adulthood.[81] Physical therapy interventions, on the other hand, can reduce impairments, enhance community participation, increase independence, and most importantly, optimize QOL.[81] Evidence shows that therapy can increase muscle strength, ROM, balance, endurance, ambulatory status, improve cardiopulmonary processes, and increase overall physical function.[82] As a result, life satisfaction and QOL is expected to be maximized. There are numerous benefits for an

individual with CP who is involved with outpatient physical therapy within the course of 12 weeks.

Cardiovascular

The patient presents with a number of limitations that affect her overall respiratory capacity and efficiency. Exhibiting breathing impairments such as a pectus excavatum, decreased rib cage mobility, restrictions in the midchest, increased use of accessory muscles, and dyspnea with exertion will all have an impact on scores for the UCSD SOBQ, the 15 count breathlessness score, and the Modified Borg. Interventions such as diaphragmatic breathing, PLB, active cycles of breathing, and PNF patterns with breathing should enhance the quality of respiration and correlate with improved scores on the outcome measures mentioned. The encouragement of meditation and relaxation techniques should further improve the patient's breathing habits. In a study conducted by Nield et al, it was found that PLB exercises improved scores on the UCSD SOBQ in a population with chronic obstructive pulmonary disease (COPD) with the average age of 65 years.[84]

Throughout the course of rehabilitation, the most significant reduction of scores was noted during weeks four and twelve. Scores were recorded after the 6MWT.[84] In accordance with the literature; the patient should have improved scores on the UCSD SOBQ and other pulmonary outcome measures. However, although improvements with SOB with exertion is expected to be seen, the improvements may not be as high as expected as a result of cardiac and musculoskeletal impairments, which the patient presented with at the time of treatment. Also, the patient's impaired posture can also affect scores, since posture and ease of breathing are connected. It is expected that the UCSD SOBQ score will be improved by a

decrease of 5 points, the 15 count breathlessness score will improve to 1, and a score of 4.4 will be obtained for the Modified Borg scale. Literature also shows that a decrease in scores on the Modified Borg scale is correlated with an increase in PEFR. As the peak flow increases with treatment, the Modified Borg score decreases demonstrating improvement in symptoms.[78]. Overall, it is expected that the patient will demonstrate improvements in functional activities and tolerance with minimal labored breathing and SOB during ambulation, negotiation of stairs, and all ADL's.

A study conducted by Breslin, showed that PLB can improve dyspnea, SaO_2 levels, and enhance ventilation.[88] Data suggests that this breathing technique is responsible for recruiting muscles in the chest wall and diaphragm, while decreasing the working capacity of accessory muscles.[88] Numerous other studies have investigated the effects of diaphragmatic breathing on respiration.[89] It was also found to decrease dyspnea and help to increase the total lung capacity.[89] The upper neck and thorax muscles have also benefited from diaphragmatic breathing through relaxation of these regions.[89] This breathing practice has also helped to increase the expiratory phase of respiration and normalize breathing patterns.[89] Breathing has been enhanced with the use of the abdomen, while reducing use of the upper chest.[89] Therefore, based on the findings from the literature, the patient will experience improvements with dyspnea, SaO_2 levels, and an enhancement in ventilation.

The patient presents with the following impairments and limitations that influence her ambulatory status: dyspnea, altered breathing pattern, decreased endurance, postural deviations, skin integrity, and crouched gait pattern. Apart from endurance exercises, postural correction and breathing exercises have been implemented to increase her

ambulation distances with an assistive device. In order to establish an expected value for the patient's 6MWT, both diagnosis of CP and CHF need to be considered because each will have an impact on her distance ambulated. We can expect the patient to increase their walking distance to 300 feet on the 6MWT. In contrast, higher values are reported in the literature. Meyer et al investigated hospitalized individuals with severe CHF and walking distances achieved at baseline with the 6MWT.[85] On average, distances ambulated were reported to be 761 feet .[85] A study conducted by Cahalin et al reported 688 feet for the 6 MWT with patients diagnosed with end-stage CHF.[86] In his study, Andersson investigated the distances ambulated by individuals with CP with the mean age of 36 years.[45] The subjects in this study had no documented cardiac diseases. The mean distances recorded were 1036, 1102, 1118 and 1131 feet.[45] However, it was noted that subjects who required an assistive device for walking ambulated shorter distances.[45] Guyatt delved into the distance ambulated during the 6MWT by the elderly population (mean age was 64 years) with CHF. His results revealed a range of 1312-1476 feet as illustrated in his charts.[87] Studies conducted by Pollentier et al, determined ambulatory distances for CHF patients ranging from 984 to 1607 feet.[70]

Compared to the literature, the expected modest improvement in the patient is attributed to her combined diagnosis of CP and CHF which presents a myriad of complications. Also, it should be pointed out this patient presents with impaired skin integrity, especially the navicular region, which is susceptible to breakdown. Any kind of breakdown will hinder her gait performance and capabilities. Addressing all these factors will help the patient ambulate efficiently to her maximum potential achievable, and be able to perform daily activities with ease and independence.

Neuromuscular

Evidence suggests that prolonged static stretching in patients with chronic contractures produce significant gains in ROM when stretching is performed at least 3 days per week.[90] As the patient is instructed in self-stretching techniques to perform before every treatment session (3 days per week) and as part of her HEP it is expected that she will make functional improvements in ROM. As patient education and lifestyle changes were emphasized greatly it would also be expected that the patient would maintain these gains once discharged.

The extent of a patients ROM limitations could negatively affect their strength as it will shorten the lever arm for the muscle decreasing the force production of that muscle. As a stretching program was implemented in this program it would be expected that as more normal ROM was acquired by the patient, it would improve muscle strength. Specifically once the patient is able to lengthen her hip flexors it would be likely that she would be able to generate a larger force with a contraction.[91]

The patient presents with stress urinary incontinence. It is expected that the patient will achieve a score of 36 on the PFIQ-7. This score is expected secondary to an increase in pelvic floor muscle strength, with an overall improvement in the condition. According to Barber et al, the patient is expected to score 16 points on the urinary incontinence section.[79] There is also a section on fecal incontinence and pelvic organ prolapse, in which case she does not currently have, but could be at risk for developing in the future, secondary to weak pelvic floor muscles. As conservative therapy for pelvic floor dysfunction does not always treat the dysfunction, surgery would be another option. The literature links pelvic floor

strengthening to higher scores on the PFIQ-7, which is in accordance with our expectation for the patient.[79]

The patient presents with increased spasticity in the lower extremities as compared to the upper extremities. It is expected that tone will not change because of the neurological aspect of the CP. Scores on the MAS on average should be 3/4 and possibly 2/4 after interventions such as static stretching, low frequency vibrations, and myofacial release. However, results are not expected to carry over permanently. Ostensjo examined the spasticity of the LE's of children with CP using the MAS. Data revealed that on average, scores remained within the range of 2-3 for the ankle, knee, and hip.[94] Although this information was taken from the pediatric population, it can also be applied for the adult population. Andersson et al examined the effects of progressive strength training on spasticity for the adult population with CP. It was shown that strength training neither increases, nor decreases the degree of spasticity in the extremities.[46] The literature suggests that tone is unaffected long term through therapy intervention, with MAS scores remaining the same.[46] This is what we expect to happen with our patient as well.

For the SRT balance test, it is expected that the patient would make significant improvements in balance by the end of physical therapy. The patient's steadiness and stability in standing is expected to increase and the number of falls to decrease. One article found the participants with CP who improved their balance especially with left to right weight shifting made significant improvements in gait.[95] Another study looked at balance training combined with strength training over a 12 week period and found that both strength and balance improved over that time period along with improving gait.[96] Therefore, the patient's strength and gait, in addition to balance would all exhibit overall improvements.

Pain

One study looked at chronic back pain rated on the VAS and factors that contribute to changes in pain level. The most significant factor for decreasing a patient's back pain was lifestyle changes.[97] The patient was given activities to do on a daily basis and educated in posture in order to make significant lifestyle changes. These changes are expected to contribute to a significant decrease in pain on the VAS for this patient by discharge.

Quality of Life/Caregiver Burden

The patient presents with a number of functional limitations, impairments, and disabilities that would influence her score on the MLWHF. Physically, she exhibits symptoms of CHF, altered breathing pattern, diminished endurance, limited mobility, decreased ROM and strength, impaired balance and coordination, spasticity, stress incontinence, and pain. The patient is independent with transfers, eating and grooming, requires assistance with dressing, specifically pants, shoes, socks, and stockings. On the positive emotional level, she has a supportive husband, has a career in teaching, and is involved with her religious community. On the other hand, negative emotions may arise from financial struggles, having to care for a 5 year old child, and being limited to community participation that is only accessible with a motorized wheel chair.

According to a study by Parajon et al, the median score among participants on this questionnaire was about 28.[75] Therefore, we expect the patient to obtain a score within this range. However, this test was administered specifically in a cardiac unit, not an outpatient setting. However, scores are influenced based on the severity of this syndrome, with higher scores indicating a more diminished quality of life.[75] Results also indicated that women in

general reported higher scores on the MLWHF compared to men.[75] Also, a study by Gottlieb et al, showed that depression is highly prevalent with the CHF population, and those taking beta blockers reported lower scores on the questionnaire. Gottlieb et al[98] reports that depression as a result of CHF was more common in individuals under 65 years of age, and those who were also re-admitted to the hospital more frequently. However, improvements in scores were documented with those individuals who received medications to improve their condition.[98]

Luttik et al investigated how much burden is placed on a caregiver if they are providing care to their spouse with CHF.[87] The Caregiver Reaction Assessment scale was used in this study and participants rated higher with a 'disrupted daily schedule' and 'loss of physical strength'.[99] Other studies have reported higher scores with psychosocial distress, poor QOL, and diminished well-being.[99] Additionally, another study reports that physical health among caregivers is deteriorated with increased distress.[100]Luttik et al[99] found that there is no correlation between caregiver burden and the severity of the disease. Another study reported that caregiver burden is experienced in all domains of objective (OB), relationship (RB), and stress burdens (SB).[100] Also, OB scores are higher when ADL assistance needs to be provided.[100]

The patient’s spouse is responsible for assisting her with ADL's such as donning and doffing pants, shoes, socks, and stockings. He also needs to help her transfer in and out of the shower for safety reasons. There is an increased level of stress at home because the husband's hours have been cut and there is tremendous tension in the home. Activities involving their 5 year old child that the patient is incapable of performing would become the husband’s

responsibility. In addition to having CP, she also has CHF, which will result in an increased need for assistance.

There are a number of implications to consider for clinical practice when working with a patient with a diagnosis of both CHF and CP. Patients with CHF are deconditioned and have reduced physical endurance. Therefore, frequent monitoring of vitals and respiration is essential in order to deliver the best treatments possible. Attempts to reduce hospital re-admission rates and attain medical management of CHF will advance progress, as opposed to prolonging or setting a patient back. It is also important to take into account the limitations a person demonstrates with CP and alter individualized treatment plans in order to target specific impairments. Providing appropriate medical durable equipment is important for increasing independence with ADL's. Also to consider is an interdisciplinary approach that targets not only the physical, but also the emotional, social, religious, caregiver training and educational aspects that enhance a person's quality of life. A supportive team and an encouraging atmosphere are key in administering successful interventions.

Cultural and Community Resources

The patient's Christian Science faith will have an impact on mental attitude and overall progress in therapy. It is expected that the patient's involvement with religious services could ensure the most effective and promising outcomes. Knowledge of the faith and cultural needs of the patient could also help facilitate progress in therapy. Additionally, the integration of community resources for the patient is expected to further reinforce positive outcomes in therapy. Participation in resources such as the YMCA, yoga, Tai Chi, meditation, support groups for CHF and CP, Canine Companions, and a Helping Hands Dog is expected to enhance motivation and optimize results.

A limitation of this study is that this is a single case report that is considered lower on the hierarchy of evidence secondary to lack of generalizability. Both CHF and CP are individualized diagnoses as it affects patient differently, therefore, our speculated POC based on a typical patient for both diagnoses may have to be modified to fit the patient specific presentation. Treatments may have to be modified on a daily basis depending on the patient's current status and progress in therapy. Another important factor to consider in planning a treatment is the patient's ability to tolerate long treatment sessions which again may vary depending on how the patient feels that day. As mentioned previously both these diagnoses present differently among patients which make it difficult for a true comparison among this population. Research thus far on these diagnoses has poor external validity, lack homogeneity and lack specific standardized protocols. Research presented up to date, consists of small sample sizes which directly affects generalization and making predictions about a greater population of patients with the same diagnosis. Another limitation to the study is that many of the outcome measures used are lacking a reported MCID which limits the researcher's ability to detect meaningful change.

Future research should focus on combining diagnoses such as CP and CHF to allow clinicians to design interventions that address multiple systems Also, research that addresses cultural needs while developing treatment strategies is much needed. Designing an intervention program which is well suited to a patient's social and cultural needs will provide better compliance. As noted earlier, many outcome measures lack MCIDs. It is important as a physical therapist to have this information to determine the effectiveness of their interventions. Studies examining MCIDs in complex and multisystem diagnosis is

imperative. Lastly, there was no literature available online for the 15 count breathlessness score for purposes of this case study.

CP and CHF are both complex diagnoses that result in a plethora of impairments and functional limitations. Research was conducted to determine the best physical therapy interventions in order to address all deficits associated with these conditions. It is the physical therapist's responsibility to use their expertise during the evaluating process and over the course of therapy to correct impairments and identify the specific needs of every patient. Once these needs have been determined, therapists are to delve into the latest research and evidence based practices in order to formulate the most appropriate POC. The POC outlined in this study could serve as a base for clinical use with appropriate modifications to tailor each patient's unique need.

References

1. O'Shea. Cerebral Palsy. *Seminars in Perinatology*. 2008;32(1):35-41.

2. Hirsh A, Gallegos J, Gertz K et al. Symptom burden in individuals with cerebral palsy. *J Rehabil Res Dev*.2010;47(9)863-876.

3. Hurkmans L, Van Den Berg E, Stam J. Energy expenditure in adults with cerebral palsy playing Wii sports. *Arch Phys Med Rehabil.* 2010;(10):1577-1581.

4. Goodman C, Fuller K, Boissonnault W. *Pathology:Implications for the Physical Therapist. 2nd ed.* Pennsylvania: Saunders; 2003.

5. Jahnsen R, Villien L, Aamodt G et al. Musculoskeletal pain in adults with cerebral palsy compared with the general population. *J Rehabil Med.* 2004;36(2):78-84.

6. Rapp CE, Toress MM. The adult with cerebral palsy. *Arch Fam Med.*2000;9:466-472.

7. Gajdosik C, Cicirello N. Secondary conditions of the musculoskeletal system in adolescents and adults with cerebral palsy. *Phys Occup Ther Pediatr*. 2001;21(4):49-68.

8. Henderson C, Rosasco M, Robinson L et al. Functional impairment severity is associated with health status among older persons with intellectual disability and cerebral palsy. *J Intellectual Disabil Res.* 2009;53(11):887-897.

9. Opheim A, Jahnsen R, Olsson E et al. Walking function, pain, and fatigue in adults with cerebral palsy: a 7-year follow-up study. *Dev Med Child Neurol.*2009;51(5):381-388.

10. Kembhavi G, Darrah J, Kelsey P et al. Adults with a diagnosis of cerebral palsy: a mapping review of long-term outcomes. *Dev Med Child Neurol.* 2011;53(7):610-614.

11. Jahnsen R, Villien L, Stanghelle J, et al. Fatigue in adults with cerebral palsy in norway compared with the general population. *Dev Med Child Neurol.* 2003;45(5):296-303.

12. Engel J, Jensen M, Schwartz L. Coping with chronic pain associated with cerebral palsy. *Occup. Ther. Int.* 2006;13(4):224-233.

13. Hirsh A, Kratz A, Engel J et al. Survey results of pain treatments in adults with cerebral palsy. *Am J Phys Med Rehabil.* 2011; 90(3):207-216.

14. Frownfelter D, Dean E. Cardiovascular and Pulmonary Physical Therapy: Evidence and Practice. 4th Edition. St. Louis: Mosby Elsevier;2006.

15. Anderson R, et al. Development of a congestive heart failure protocol in a rehabilitation setting. *Rehabil Nurs.* 2010;35(1):3-7.

16. Chan C, Tang, D, Jones, A. Clinical outcomes of a cardiac rehabilitation and maintenance program for Chinese patients with congestive heart failure. *Disabil Rehabil*.2008;30(17):1245-1253.

17. Ancheta IB. A retrospective pilot study: Management of patients with heart failure. *Dinens Crit Care Nurs*. 2006;25(5):228-233.

18. Hunt SA,et al. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Update the 2001 Guidelines for the Evaluation and Management of Heart Failure). American College of Cardiology Web Site. Available at: http://www.acc.org/clinical/guidelines/failure//index.pdf.

19. Cadwell V. Christian science and emergency care: a case of reconciling conflicting beliefs. *J Emerg Nurse.* 1995;21:489-1990.

20. Gibb SL. Transcending the Body: The Role of Divine Mind in the Practice of Christian Science Healing [dissertation]. Ann Arbor, MI:Master of Arts in Sociology, University of New Hampshire;2007.

21. Wada K, Park J. Integrating buddhist psychology into grief counseling. *Death Stud.* 2009;33(7):657-683.

22. Cadwell V. Christian science and emergency care: a case of reconciling conflicting beliefs. *J Emerg Nurs.* 1995;21(6):489-490.

23. American College of Sports Medicine. *ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription*. 6th ed. Lippincott Williams & Wilkins; 2009.

24. Magee D. *Orthopedic Physical Assessment.* 5th ed. Missouri: Saunders;2008.

25. Mayo clinic. Blood pressure chart: What your reading means. Available at http://www.mayoclinic.com/health/blood-pressure/HI00043. Accessed February 12, 2012.

26. Halder A, Larson M, Franklin S et al. Systolic blood pressure, diastolic blood pressure, and pulse pressure as predictors of risk for congestive heart failure in the framingham heart study. *Ann Intern Med.* 2003;138(1):10-16.

27. Jensen L, Onyskiw J, Prasad N. Meta-analysis of arterial oxygen saturation monitoring by pulse oximetry in adults. *Heart Lung*. 1998;27(6):387-408.

28. Schutz S. *Procedure Manual for Critical Care.* 4th ed. Saunders;2001.

29. Francis G, Benedict C, Johnstone D, et al. Comparison of neuroendocrine activation in patients with left ventricular dysfunction with and without congestive heart failure. A substudy of the studies of left ventricular dysfunction (SOLVD). *Circulation.* 1990;82(5):1724-1729.

30. Kennedy S, Simon B, Alter H, Cheung P. Ability of physicians to diagnose congestive heart failure based on chest X-ray. *J Emerg Med.* 2011;40(1):47-52.

31. Bellenger N, Burgess M, Ray S et al. Comparison of left ventricular ejection fraction and volumes in heart failure by echocardiography, radionuclide ventriculography, and cardiovascular magnetic resonance. Are they interchangeable? *Eur Heart J.* 2000;21(16):1387-1396.

32. Maddox D. Ejection fraction image: A noninvasive index of regional left ventricular wall motion. *Am J Cardiol.* 1978;41(7):1230-1238.

33. Medscape. Peak flow rate measurement. Available at http://emedicine.medscape.com/article/1413347-overview. Accessed on October 22, 2011.

34. Clement Clarke International. Peak expiratory flow rate-normal values. Available at http://www.somatco.com/3103001_1078-5.pdf Accessed on October 22, 2011

35. University of Maryland Medical Center. Available at http://www.umm.edu/ency/article/003443res.htm. Accessed on October 22, 2011.

36. Jamison J. Validity of peak expiratory flow rate variability for the diagnosis of asthma. *Clin Sci.* 1993;85(3):367-371.

37. Ambrosino N, Opasich C, Crotti P, et al. Breathing pattern, ventilatory drive and respiratory muscle strength in patients with chronic heart failure. *Eur Respir J.* 1994;7(1)17-22.

38. Karnath B, Boyars M. Pulmonary Auscultation. *Hospital Physician.* 2002;22-26.

39. Wilson CR. Outcome measure in cardiopulmonary physical therapy: Focus on the university of Califormia San Diego Shortness of Breath Questionnaire. *Cardiopulm Phys Ther J.* 2007;18(2):28-30.

40. Gopal M, Karnath B. Clinical diagnosis of heart failure. *Hosp Physician.* 2009;9-15.

41. Kataoka H, Madias J. Changes in the amplitude of electrocardiogram QRS complexes during follow-up of heart failure patients. *J Electrocardiol.* 2011;44(3):394-403.

42. Damiano DL, QUinlivan JM, Owen BF, Payne P, Nelson KC, Abel MF. What does Ashworth scale really measure and are instrumented measures more valid and precise? *Dev Med Child Neurol.* 2002;44(2):112-118.

43. Maanum G, Jansen R, Froslie K, Larsen KL, Keller A. Walking ability and predictors of performance on the 6-minute walk test in adults with spastic cerebral palsy. *Dev Med Child Neurol.* 2010;52(6):126-132.

44. Willow Grove Physical Therapy. Balance norms. Available at http://www.willowgrovept.com/default.asp?contentID=57 Accessed October 23, 2011

45. Andersson C, Asztalos L, Mattsson E. Six minute walk test in adults with cerebral palsy. A study of reliability. *Clin Rehabil*. 2006;20(6):488-495

46. Dickstein K, et al. ESC Guidelines for of the diagnosis and treatment of acute and chronic heart failure 2008. *Eur Heart J.*2008;29(19):2388–2442.

47. Bekwelem W, Lutsey P, Loehr L et al. White blood cell count, C-reactive protein, and incident heart failure in the atherosclerosis risk in communities (ARIC) study. *Ann Epidemiol.* 2011;21(10):739-748.

48. Olson T, Beck K, Johnson B. Pulmonary function changes associated with cardiomegaly in chronic heart failure. *J Cardiac Fail.* 2007;13(2):100-107.

49. Celli BR, Cote CG, Marin JM, Casanova C. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *N Engl J Med*. 2004;350(10):1005-1012.

50. American Physical Therapy Association. Guide to Physical Therapist Practice. Phys Ther. 2nd ed.2003;81:9-744.

51. Gupta V, Lipsitz LA. Orthostatic hypotension in the elderly: diagnosis and treatment. *Am J Med.* 2007:120(10);841-847.

52. VanHees HW, et al. Diaphragm single-fiber weakness and loss of myosin in congestive heart failure rats. *Am J Physiol Heart Circ*. 2007:293(1):819-828.

53. Tikunov B, Levine S, Mancini D. Chronic congestive heart failure elicits adaptations of endurance exercise in diaphragmatic muscle. *American Heart Association*. 1997:95(4):910-916.

54. Fregonezi GA, Resqueti VR, Guell Rous R. Pursed Lip Breathing. *Arch Bronconeumol.* 2004:40(6):279-282.

55. Eaton T, Young P, Zeng I, Kolbe J. A randomized evaluation of the acute efficacy, acceptability and tolerability of flutter and active cycles of breathing with and without postural drainage in non-cystic fibrosis bronchiectasis. *Chron Respir Dis*. 2007:4(1):23-30.

56. Bovend'Eerdt TJ, et al. The effects of stretching in spasticity: a systematic review. *Arch Phys Med Rehabil.* July 2008:89(7):1395-1406.

57. Ahlborg L, Anderson C, Julin P. Whole-body vibration training compared with resistance training: effect on spasticity, muscle strength and motor performance in adults with cerebral palsy. *J Rehabil Med.* 2006:38(5):302-308.

58. Curran PF, Fiore RD, Crisco JJ. A comparison of the pressue on soft tissue by 2 myofascial rollers. *J Sport Rehabil*. 2008;17(4):432-442.

59. Barnes MF. The basic science of myofascial release: morphologic change in connective tissue. *J Bodyw Mov Ther.* 1997:1(4):231-238.

60. Page P. Sensorimotor training: A global approach for balance training. *J Bodyw Mov Ther*. 2206:10;77-84.

61. Arias AJ, Steinberg K, Banga A, Trestman RL. Systematic review of the efficacy of meditation techniques as treatments for medical illness. *J Altern Complement Med*. 2006:12(8):817-832.

62. Lee JH, Sung IY, Yoo JY. Therapeutic effects of strengthening exercise on gait function of cerebral palsy. *Disabil and Rehabil.* 2008:30(19):1439-1444.

63. Kegal Support for Men and Women. Kegal exercises. Available at: http://kegel-exercises.com/index.html. Accessed December 26th, 2011.

64. Williams M, De Palma L, Petkov J. Fifteen-count breathlessness score in adults with COPD. *Respirology.* 2006;11(5):627-632.

65. Williams M, Sorich M, Cafarella P, Petkov J. Thirty-count breathlessness score: reliability, sensitivity, specificity, and validity. *Respirology*. 2007;12(5):724-31.

66. Hommerding PX, Donadio VF, Paim TF, Marostica PJ. The borg scale is accurate in children and adolescents older than 9 years with cyctic fibrosis. *Respir Care.* 2010:55(6):729-733.

67. Eakin EG, Sassi-Dambron DE, Ries AL, Kaplan RM. Reliability and validity of dyspnea measures in patients with obstructive lung disease. *Int J Behav Med.* 1995:2(2):118-134.

68. Johnson MJ, Oxberry SG, Cleland JG, Clark AL. Measurement of breathlessness in clinical trials in patients with chronic heart failure: the need for a standardized approach: a systematic review. *Eur J Heart Fail*.2010;12(2):137-147.

69. Segura-Orti E, Martinez-Olmos FJ. Test-restest reliability and minimal detectable change scores for sit-to-stand-to-sit tests, the six-minute walk test, the one-leg heel-

rise test, and handgrip strength in people undergoing hemodialysis. *J Phys Ther.* August 2011:91(8):1244-1252.

70. Pollentier,B, et al. Examination of the six minute walk test to determine functional capacity in people with chronic heart failure: a systemic review. *Cardiopulm Phys Ther J.* 2010:21(1);13-21.
71. Gremeaux V, et al. Determining the minimal clinically important difference for the six-minute walk test and the 200 meter fast-walk test during cardiac rehabilitation program in coronary artery disease patients after acute coronary syndrome. *Am J Phys Med Rehab.* 2011;92(4):611-619.
72. Bohannon RW, Smith MB. Interrater reliability of a modified ashworth scale of muscle spasticity. *Phys Ther.* 1987:67(2):206-207.
73. Cho CY, Karmen G. Detecting balance deficits in frequent fallers using clinical and quantitative evaluation tools. *J Am Geriatr Soc.* 1998;46(4):426-430.
74. Barber, Walters MD, Bump RC. Short forms of two condition-specific quality of life questionnaires for women with pelvic floor disorders (PFDI-20 and PFIQ-7). *Am J Obstet Gynecol.* 2005 Jul;193(1):103-113.
75. Parajon T, Lupon J, Gonzalez B et al. Use of the "Minnesota living with heart failure" quality of life questionnaire in Spain. *Rev Esp Cardiol.* 2004;57(2):155-160.
76. Rector TS, Cohn JN. Assessment of patient outcome with the Minnesota living with heart failure questionnaire: reliability and validity during a randomized, double-blind, placebo-controlled trial of pimobendan. *Am Heart J.* 1992:124(40):1017-1025.

77. Moore CD. The impact of family functioning on caregiver burden among caregivers of veterans with congestive heart failure. *Journal of family and social work.* 2010:13:451-462.

78. Kendrick KR, Baxi SC, Smith RM. Usefulness of the modified 0-10 Borg scale in assessing the degree of dyspnea in patients with COPD and asthma. *J Emerg Nurs*. 2000;26(3):216-22.

79. Barber M, Spino C, Janz N et al. The minimum important differences for the urinary scales of the pelvic floor distress inventory and pelvic floor impact questionnaire. *Am J Obstet Gynecol***.** 2009;200(5):580-587.

80. Sandstrom K, Alinder J, Oberg B. Descriptions of functioning and health and relations to a gross motor classification in adults with cerebral palsy. *Disabil Rehabil.* 2004;26(17):1023-1031.

81. Liptak G. Health and well being of adults with cerebral palsy. *Curr Opin Neurol.* 2008;21(2):136-142.

82. Heller T, Ying G, Rimmer J et al. Determinants of exercise in adults with cerebral palsy. *Public Health Nurs.* 2002;19(3):223-231.

83. Dall'Ago P, Chiappa GRS, Guths H, Stein R, Ribeiro JP. Inspiratory muscle training in patients with heart failure and inspiratory muscle weakness. A randomized trial. *J Am Coll Cardiol*. 2006;47(4):757–763.

84. Nield M, Soo Hoo G, Roper J, et al. Efficacy of pursed-lips breathing: a breathing pattern retraining strategy for dyspnea reduction. *J Cardiopulm Rehabil Prev.* 2007;27(4):237-244.

85. Meyer K, Schwaibold M, Westbrooks S et al. Effects of exercise training and activity restriction on 6-minute walking test performance in patients with chronic heart failure. *Am Heart J.* 1997;133(4):447-453.

86. Cahalin L, Mathier M, Semigran M et al. The six-minute walk test predicts peak oxygen uptake and survival in patients with advanced heart failure. *Chest.* 1996;110(2):325-332.

87. Guyatt G, Sullivan M, Thompson P et al. The 6-minute walk:a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J.* 1985;132(8):919-923.

88. Breslin E. The pattern of respiratory muscle recruitment during pursed-lip breathing. *Chest.* 1992;101(1):75-78.

89. Cahalin L, Braga M, Matsuo Y, et al. Efficacy of diaphragmatic breathing in persons with chronic obstructive pulmonary disease: a review of the literature. *J Cardiopulm Rehabil.* 2002;22(1):7-21.

90. Ito,CS. Conservative management of joint deformities and dynamic posturing. *Orthop Phys Ther Clin N Am*. 1993;2(1);25-38.

91. Darrus N, Et al. Lower extremity strength comparison among normal, CP, diplegic, and quadriplegic subjects referred for gait analysis. *Gait & Posture.* 2009;30(2):100-101.

92. Keller K. Exercise therapy for low back pain: a narrative review of the literature. *J Chiropr Med*. 2006;5(1): 38-42.

93. Barber M, Walters M, Bump R. Short forms of two condition-specific quality of life questionnaires for women with pelvic floor disorders (PFDI-20 and PFIQ-7). *Am J Obstet Gynecol.* 2005;193(1):103-113

94. Ostensjo S, Carlberg E, Vollestad N. Motor impairments in young children with cerebral palsy: relationship to gross motor function and every day activities. *Dev Med Child Neurol*. 2004;46(9):580-589.

95. Liao HF, Jeny SF, Lai JS, Cheng CK, Hu MH. The relationship between standing balance and walking function in children with spastic diplegic cerebral palsy. *Dev Med Child Neurol*. 1997: 39(2);106-112.

96. Judge JO, Underwood M, Gennosa. Exercise to improve gait velocity in older persons. *Arch Phys Med Rehabil*. 1993:74(4);400-406.

97. Ogon M, et al. Chronic low back pain measurement with visual analogue scales in different settings. *Pain*. 1996;64(3);425-428.

98. Gottlieb S, Khatta M, Friedmann E et al. The influence of age, gender, and race on the prevalence of depression in heart failure patients. *J Am Coll Cardiol*. 2004;43(9):1542-1549.

99. Luttik M, Jaarsma T, Veeger N et al. Caregiver burden in partners of heart failure patients; limited influence of disease severity. *Eur J Heart Fail.* 2007;9(6-7):695-701.

100. Savundranayagam M, Montgomery R, Kosloski K. A dimensional analysis of caregiver burden among spouses and adult children. *Gerontologist.* 2011;51(3):321-331.

Table 1. Vitals and other tests and measures

Heart rate at rest	110bpm
Maximal heart rate with activity	90bpm
Maximal blood pressure	102/60 mmHg
Lying blood pressure	90/50 mmHg
Sitting blood pressure	70/45 mmHg
Maximal respiratory rate	32 breaths/min
SaO_2	82%
Left ventricular EF	29%
PEFR	350L/min

Table 2. Framingham Criteria for Congestive Heart Failure[39]

	Major	Minor
History		
Paroxysmal nocturnal dyspnea	X	
Orthopnea	X	
Dyspnea on exertion		X
Nocturnal cough		X
Weight loss in response to treatment	X	
Physical examination		
Neck vein distention	X	
Rales	X	
S_3 gallop	X	
Hepatojugular reflux	X	
Hepatomegaly		X
Bilateral ankle edema		X
Tachycardia		X
Chest radiograph		X
Cardiomegaly	X	
Pulmonary edema	X	
Pleural effusion		X
Pulmonary function testing		
Vital capacity decreased one third from maximum		X

Table 3. Lower extremity strength

Trunk extensor and flexor	3/5
Hip flexion and quadriceps bilaterally	4/5
Hip extension, hip abduction and knee flexion	2/5
Dorsiflexion and plantar flexion bilaterally	2/5

Table 4. ROM measurements

	Patient ROM	**Normal ranges[24]**
Bilateral hip flexion	30-90^{o}	110 -120^{o}
Hip abduction with flexion	0-10^{o}	30 - 50^{o}
Hip adduction with flexion	0-10^{o}	30^{o}
Hip internal rotation with flexion	0-40^{o}	30 - 40^{o}
Hip external rotation with flexion	0^{o}	40 - 60^{o}
Popliteal angle[41]	85^{o}	51^{o}
Knee flexion	10-100^{o}	0 - 135^{o}
Dorsiflexion	0-15^{o}	20^{o}
Plantar flexion	0^{o}	50^{o}
Shoulder flexion	90^{o}	180^{o}
Shoulder extension	0-10^{o}	50 - 60^{o}
Shoulder abduction	0-90^{o}	180^{o}
Shoulder IR at 90^{o} of flexion	90^{o}	60 - 100^{o}
Shoulder ER at 90^{o} of flexion	10^{o}	80-90^{o}
Wrist extension	0-50^{o}	70 - 90^{o}
Wrist flexion	0-50^{o}	80 - 90^{o}

Table 5. Cardiopulmonary measurements pre and post hospital admission.

	Prior to Hospital Admission	**On Hospital Admission**	**Overall Change**
Heart rate	73 bpm	110bpm	37 bpm
Respiratory rate	18 bpm	35 bpm	17 bpm
Blood pressure	95/60 mmHg	NT	---

Table 6. Plan of Care: Phase 1 – Inpatient Rehabilitation

	Activity	Duration	Progression	Treatment Sessions
Breathing Exercises/ Education	Diaphragmatic breathing	30 minutes	Independent as part of HEP	1
	PLB			
	Active cycles of breathing			
	Breathing with PNF.			
Preparation Techniques	Static stretching	30 minutes	Independent self stretching prior to each treatment session	1,2
	Vibration	6 minutes	N/A	3-20
	Myofascial release	10 minutes	N/A	
EOB	Upright without UE support	2 minutes	Perturbations	2-20
	Forward/ backward/ side leaning	1 set of 10	Manual resistance	
	Pre-transfer training	1 set of 5 to each side	Manual resistance	
	UE cycle ergometer	5 minutes	8 minutes	
Standing balance activities	Right to left weight shifting on flat surface	30 seconds x 5 (5 minutes)	On foam mat	2,3-20
Transfer training education	Shower Bed (1 rail) Chair Car Toilet	15 minutes	Decreased assistance without rails	3,4,5,10, 15, 17, 20
Gait training	Walking on level surface with loftstrand crutches	25 ft x 4	>300 ft (community distances) on unlevel surfaces	3-20
Cool Down	Vibration	6 minutes	Independent as part of HEP	3,4-20
	Meditation	15 minutes		4

Table 7. Plan of Care: Phase 2 – Outpatient Rehabilitation

	Activity	Duration	Progression	Treatment Sessions
Aerobic	Recumbant bike	5 minutes	10 minutes (4-5 RPE level)	1-36
Strengthening	Stairs	4 sets of 3 repetitions with 1 minute rest between each set	Decreased rest time to 30 seconds	5,7,9,11-36
Standing balance	Feet together on foam mat	5 sets of 30 second intervals (5 minutes total)	Add arm movements via UE PNF pattern	1-36
Posture	Thoracic extensions	3 sets of 15	Increased theraband resistance	1-36
	Education	10 minutes	N/A	1,2,35,36
Pelvic Floor strengthening	Kegal exercises	10 minutes in clinic (instructed to perform 5 minutes 5 times per day)	Resistance	1-36