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Initial Rehabilitation and Physical Therapy Management in the ICU Following an Orthotopic Heart Transplant: A Case Report

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Abstract

Introduction: Many articles in the literature discuss physical therapy management for patients who have undergone Orthotopic Heart Transplants (OHT) 3 to 12 months after the procedure. However, relatively few articles address the immediate rehab which takes place in the ICU the first two weeks following transplant. The purpose of this report is to provide a case example of the physical therapy management of a patient following an OHT in the ICU setting. **Case Description**: A 45-year-old male with a 14-year history of non-ischemic cardiomyopathy was hospitalized for thirty days for management of cardiogenic shock. After failed attempts to manage the condition the patient underwent an OHT. Starting on post-op day one the patient received physical therapy in the ICU for a total of two weeks. **Interventions**: Treatment sessions were performed 5 days/week for 30-40 minutes. There was an emphasis on improving the performance of functional movements such as bed mobility, transfers, and ambulation. **Clinical Outcomes**: Outcome measures were based on the level of assist required for functional tasks. The Inpatient Basic Mobility Screen & Gait and Mobility Assessment were the two functional scales utilized for the patient during the plan of care. **Discussion**: Patients with end-stage heart failure (HF) present with dysfunctions in several body systems. It can be difficult to assess the chronic effects of HF and the transient effects of bed rest and inactivity on overall performance. However, evidence supports that early mobilization is safe and effective for the patient population and leads to greater mobility. Maintaining sternal precautions, reviewing daily labs, assessing EKGs, and minimizing the potential risk of infection are all vitally important with each patient encounter.

Keywords: Physical Therapy; Rehabilitation; Heart Failure; Heart Transplant; ICU

Introduction

The choice to receive an Orthotopic Heart Transplant (OHT) is largely reserved for patients with end-stage heart failure (HF). Essentially, HF can be defined as the inadequate ability of the heart to meet the metabolic demands of the body. Negative systemic changes can occur in body structure and function due to the HF that are not easily reversed by an OHT. The amount to which pre-transplant HF can influence an individual is largely dependent of the type of HF and the length of time the disease is present, which can be years or decades . A new heart does not immediately resolve the issues of the patient population; in-fact the road to recovery involves overcoming a multitude of complicating factors – especially in the ICU setting immediately following surgery. To provide patient-centered care and evidenced-based practice for patients who have experienced end stage HF and have received a new heart, therapists must understand the pre and post transplant implications which can have significant effects on the initial progress made during rehabilitation; especially in the first several weeks following transplant.

Intuitively, one would think HF would primary impact the function of the heart, however, there are many systems affected by the progressive-worsening HF. Besides cardiac limitations, HF can result in skeletal muscle dysfunction, vascular changes, systemic proinflammatory state, and pulmonary abnormalities. When you compound the years of end stage HF with the in-hospital period which will be defined as the time from admission to surgery which often includes bed rest and inactivity as the patient is medically managed prior to surgery, a patient can develop orthostatic intolerance, muscle wasting, and a significant reduction in strength. There is the potential for multiple surgeries to be performed during a single admission for the patient population termed ‘bridging procedures’ in an attempt to prolong the impending OHT. The OHT itself involves a median sternotomy which includes 8-12 weeks of sternal precautions that limit arm use during early stage mobility. While preserving the patient’s life, the surgical procedures themselves are traumatic events that the body has to recover from which include the tissue damage, anesthesia, and medications.

When the patient is finally back in their room and ready to be mobilized there are still several obstacles to overcome. Namely, the sternal precautions which restrict the patient from producing meaningful body movement with their arms and the heart denervation which makes it difficult for the heart to respond immediately to changes in activity. The purpose of this report is to provide a case example of the acute management of a patient following an OHT in the ICU setting considering the cumulative effects of pre-transplant heart failure, the deconditioning aspect of the in-hospital period prior to surgery, implications of the surgical procedures, the medically controlled immunosuppression, and the post transplant heart denervation.

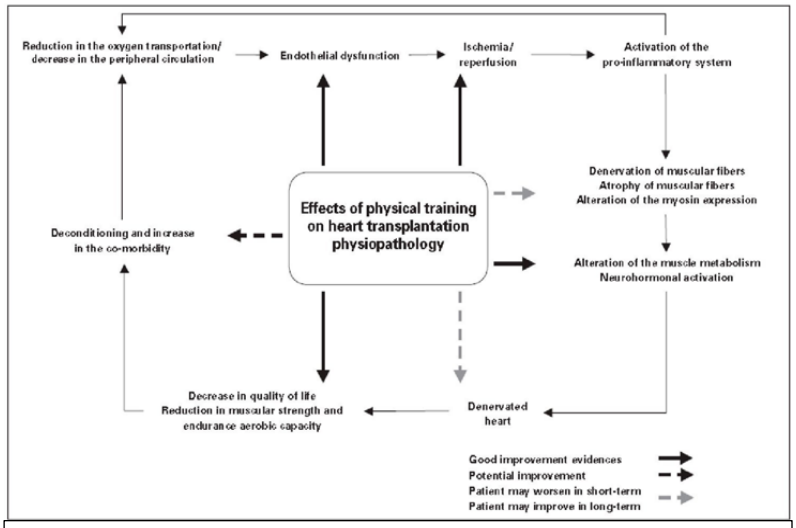

Fig. 1. Association between physical capacity and heart transplant and the potential role of physical training on the systemic improvement of the physio-pathological effect, on quality of life, and on functional capacity (resource 1).

I believe this to be a relevant topic of discussion considering that much of the literature discusses cardiac rehabilitation in the 3-12 month range after many of the initial clinical problems have resolved or been managed adequately; primary focusing on VO2peak which is widely used to assess aerobic work capacity in patients who have undergone OHT because it reflects the integrated function of the heart, lungs, and blood

vessels (Granado, 2017). Figure 1 summarizes that there is good evidence in the literature that improvements in endothelial dysfunction, ischemia/reperfusion, and muscle metabolism occur with exercise and rehabilitation. However the timing in which most of the improvements take place is in the greater than six months post heart transplant time period, making it seemingly more important for research purposes that the initial two to four weeks after the procedure where the focus of rehabilitation is managing the acute issues which include but not limited to sternal precautions, orthostatic intolerance, hemodynamic instability, and reduced independence with functional tasks.

Case Description

The patient was a 45-year-old male with a 14-year history of non-ischemic cardiomyopathy, a disease of the myocardium associated with mechanical or electrical dysfunction. He originally arrived at an outside hospital for medical management of acute renal failure, stage three chronic kidney disease, and decompensated HF with a left ventricular ejective fraction of less than 15%. A normal ejection fraction is 65% to put the level of decompensation in perspective. Two weeks later he was transferred to a major tertiary medial center for further management of cardiogenic shock. To reduce body fluid levels he was diuresed for several days. He was also given a dobutamine infusion to increase the contractility of his heart to improve the ejection fraction percentage. A couple days later an intra-aortic balloon pump (IABP) was placed to increase myocardial oxygen perfusion and decrease afterload in an effort to reduce the overall workload on the heart which was not improving. Despite aggressive attempts at diuresis, his kidney function continued to worsen and he became fluid overloaded. The medical decision was made to take him to the operating room (OR) for placement of an Impella, a device which fully unloads the left ventricle and reduces the workload of the heart. However, the surgeon had difficulty placing the Impella and after leaving the OR his labs and overall health began to worsen.

Because of these factors the patient was intubated, sedated, and placed on VA ECMO for three days. VA ECMO fully supports the heart and lungs by taking deoxygenated blood from the femoral vein, pumps it through the ECMO machine at which time the blood is oxygenated, and then it is returned to the patient through the femoral artery (Different Types of ECMO, 2019). There are many potential complications from ECMO such as bleeding, infection, and thrombosis; however, it should not be overlooked that the patient was also intubated and on bedrest which produces complications with orthostatic intolerance, reduced muscular strength, and muscle atrophy. It was not certain that the patient would be matched with a donor in time to save his life; but given the severity of his condition he has placed on the ‘highest priority’ list.

After 29 days since he originally presented to an outside hospital the patient returned to the OR for an OHT. A median sternotomy approach was taken which involved a midline incision of the sternum so the pericardium could be accessed. The surgeon cannulated the aorta, inferior vena cava, and superior vena cava in preparation for cardiopulmonary bypass. Cardiopulmonary bypass lasted for 257 minutes as the heart was removed and replaced with the donors. Once he became hemodynamically and physiologically stable, the patient was separated from cardiopulmonary bypass and temporary pacing wires were set in place to provide a consistent and stable heart rate. After hemostasis was achieved, the chest was closed, and preparation for transport to the intensive care unit was commenced (Soltesz). After returning to his room, he had two mediastinal tubes, two chest tubes, IV [Epinephrine, Milrinone, Vasopressin, and Norepinephrine], an arterial line, and a foley catheter. The patient was extubated the day after the procedure and was deemed hemodynamically stable by surgeons and other medical providers. At this time, physical therapy was referred to evaluate and treat this patient.

Initial Examination

The initial examination was performed on post operation day one (POD1). Prior to seeing the patient, a comprehensive screening process was performed to check lab values and vital signs and confirm they were within treatable ranges. Primarily for a heart transplant patient there will be goals for both heart rate, 100-110bpm and systolic blood pressure, <110mm Hg, respectively. Hemoglobin levels

should remain above 7.5g/dL to ensure adequate oxygenation of peripheral tissues. Potassium levels are generally ranged between 3.5-4.0; anything lower may result in an abnormal rhythm, likely atrial fibrillation, and anything greater may result in bradycardia. Creatinine levels are also closely monitored because it is a sign of overall renal function. White blood cell counts will be elevated after an OHT because the body is attempting to combat any infections and try to heal, however, the therapist should expect a downward trend throughout the duration of care as the patient heals.

It is also important to confirm that activity recommendations are up to date and specific documentation from the surgeon and medical staff are in the patient's chart stating that the patient is safe to be mobilized. There will also be daily notes from several specialities including anesthesia, thoracic surgery, nursing, social work, etc. which may include pertinent information for the physical therapist that may affect the care provided that specific day. Generally, the last step before seeing the patient involves interacting with the RN and collecting the most recent updates on their overall state of health. This entire process should be performed each time prior to seeing the patient.

After checking the labs and vitals, reading daily notes, confirming activity recommendations, and discussing the patient's health with the nurse we examined the patient. The patient was still relatively confused and disoriented to his situation but overall he was able to talk and follow directions. We educated him on his sternal precautions which were 'no lifting more than five pounds for eight weeks' and he had to reminded of the precautions throughout the session. To allow time for the denervated heart to adequately 'warm up' prior to physical activity, bed exercises were performed. They included: 20 ankle pumps, 10 assisted heel slides, 10 assisted hip abduction and adduction, and 10 short arc quads, all of which were performed bilaterally.

Manual muscle testing is not recommended for this patient population therefore the patient was assessed as to how much assistance he needed for arm, leg, and trunk movement throughout the initial examination. Overall his muscle activation was slow and general muscle recruitment was reduced. After exercise, the head of the hospital bed was slowly elevated to an upright position to allow for brief episodes of orthostasis to resolve. He was assisted to the edge of the bed with two people providing max assist for trunk lift and one person providing max assist for leg management. He sat at the edge of the bed with max assist of two people and remained there for 3 minutes before feeling 'lightheaded' at which time he was placed back into bed with all needs within reach.

Vitals were monitored throughout the session and the EKG strips were reviewed to assess for any potential changes in heart rhythm. Heart rate remained at 110bpm throughout due to atrial-ventricular pacing. Blood pressure and mean arterial pressure dropped slightly during the session but was still within treatable levels throughout the session. EKG strip did not show ST segment changes or arrhythmias that could suggest poor pacing. He was encouraged to cough to mobilize secretions while upright but was acutely painful and unable to do so. His initial evaluation demonstrated his limited functional independence, even with bed mobility, generalized muscle weakness throughout, and most notably limited cardiovascular endurance, all resulting in his need for moderate to maximal levels of assistance. It was suggested to nursing staff that the patient should be positioned in a progressively more upright posture throughout the day in an effort to reduce orthostasis.

Interventions

After the initial examination and evaluation was completed, a treatment plan was constructed which focused on improving independence with functional tasks. To note, all activity was preceded by a 3-minute warm up period consisting of ankle pumps, heel slides, hip abduction/adduction, and short arc quads.The first week consisted of improving and modifying the bed mobility progression, sitting, and standing. Some of the early modifications included increasing the patient's head of bed to an upright position to examine for signs of orthostasis and hemodynamic changes. With each passing day the patient spent more time in a gravity dependent manner. The first task completed with the patient was rolling so that he could improve his ability to prevent pressure sores while spending much of his time in bed; the task required two people providing max assistance. Supine to sit transfers were accomplished

with max assistance of three people and the modification of increasing the head of bed. He dangled at the edge for between 5-7 minutes while intermittently performing ankle pumps and long arc quads.

He became more alert and oriented each day. On POD4 the patient stood up for the first time requiring maximal assistance of two people to help with hip and trunk extension and to block both of his knees. He stood for approximately 10 seconds before needing to rest. He continued to demonstrate limited cardiopulmonary and muscular endurance and muscular strength. However, hemodynamics were more stable with positional changes, static sitting balance was improving, and he was closer to accomplishing sit to stand transfers.

The first day we found the patient sitting up in the chair prior to the start of the session was POD5. However, even with maximal assist of two people he was unable to stand from the chair which was a lower seated surface than the bed itself. He was subsequently sky lifted to the bed, the bed height was elevated, and sit to stands were then performed with the same level of assist as provided before. On POD6 the patient performed supine to sit transfers with only moderate assist of one person with the head of bed elevated; he also stood up twice with max assist of two. On the last day of the first week, the patient progressed to short distance in room ambulation, walking 3 times for distances of 3ft, 5ft, and 4ft with a wheeled cart and assist of two people providing max assist for hip and trunk extension, weight shifts, upright support, and the blocking of the stance leg. The first week was characterized also by a drop in systolic blood pressure with upright posture, standing, and ambulating; which is different than what occurred during week two where elevations were more likely on a session by session basis.

Table 1. Results of inpatient basic mobility screen assessment from weeks one and two.

WEEK 1 & 2 RESULTS		
Inpatient Basic Mobility Screening – How Much Help From Another Person Do You Currently Need		
Turning from your back to your side while in a flat bed without using bedrails?	A little	None
Moving from lying on your back to sitting on the side of a flat bed without using bedrails?	A lot	A little
Moving to and from a bed to a chair?	A lot	A lot
Standing up from a chair using your arms?	A lot	A lot
To walk in a hospital room?	A lot	A little
Climbing 3-5 steps with a railing?	Total	Total
Basic Mobility Total Score	12	16

Table 2. Results of gait and mobility assessment from weeks one and two

WEEKS 1 & 2 RESULTS		
Gait and Mobility Assessment		
Moving Sit to Supine	Mod Assist of 1	Min Assist
Sitting	Min Assist	Standby Assist
Moving Sit to Stand	Max Assist of 2	Max Assist of 1
Standing	Max assist of 2	Min Assist of 1
Walking	Max assist of 2	Mod/Min Assist of 1 with FWW

The second week of treatment was focused on ambulation and sit to stand transfers. The patient had to wear the mask outside of the room for infection control due to the immunosuppression from the medications. On POD8 the patient ambulated 3 times for distances of 12ft, 15ft, and 5ft with max assist of two people. On POD9 the patient increased his ambulatory distances to 10ft, 15ft, 20ft, and 20ft with the same level of assist. On POD10 distances increased dramatically to 40ft, 60ft, and 60ft; still with a wheeled cart and physical assist.

It wasn't until POD13 that the patient was able to use a FWW with max assist of one person; ambulating 150ft and 100ft. His gait pattern was slow, steady, and symmetrical. He required brief but frequent standing breaks (every 5ft) and demonstrated increased hip and trunk sway with fatigue. During the second week, the Borg scale was used to monitor how hard the patient was working while ambulating. Most of the time we were able to discontinue with the patient reporting scores between 11-15/20; however, there were times where he would fatigue more quickly than expected and impulsively try to sit. During ambulation, heart rate would not exceed 125 beats per minute, but systolic blood pressure would elevate and potentially be the limiting factor as to when exercise needed to be discontinued due to recommendations and guidelines for what is considered safe for the patient.

20-Grade Scale	
6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

Figure 2. Borg Scale
The patient would generally be regulated between 11-14 throughout his two week stay in the ICU.

The biggest obstacle that limited his breathing during the trials of walking outside the room was the surgical mask that needed to be worn due to infection control purposes. In order to reduce the potential of acute rejection of the new heart tissue immunosuppressants are given daily which limit the effectiveness of the patient's immune system.

On POD14, the last day in the hospital before being transferred, all functional activities were performed during the 40 minutes session. He ambulated only one time for 140ft with a FWW and moderate assist of one person for upright standing balance; at times only requiring minimal assist. The most difficult tasks for the patient to perform before leaving the hospital was standing up from a seated position. On the last day we spent about ten minutes practicing sit to stands by raising the bed high enough to be challenging but also safe for him to complete independent hip and trunk extension. In standing the bed was then lowered several inches and the patient practiced eccentrically lowering himself to the new level; this was repeated five times before the patient could no longer tolerate the activity.

Week two was characterized by an increased independence with functional tasks, improved hemodynamic stability, and the transition from being limited by SOB to being limited by lower extremity muscular fatigue. He understood his symptoms well and maintained proper breathing techniques throughout activity. However, he continued to demonstrate reduced muscular strength limiting his ability to stand up from a seated position.

Outcomes

Outcome measures were based on the level of assist required for functional tasks. The Inpatient Basic Mobility Screen & Gait and Mobility Assessment were the two functional scales utilized for the patient during the plan of care during the first two weeks when the patient was in the CVICU and for

weeks three and four when the patient was at an inpatient rehab facility and readmitted back to the hospital. To summarize how much the patient improved; immediately following transplant, the patient required max assist of 2-4 people for bed mobility and bed transfers. He was unable to stand or ambulate at that time.

At discharge, the patient required MOD assist of 1 for sit to stand transfers and ambulation; he walked 160ft with a FWW. He attended an Inpatient Rehab Facility for one week and improved his performance with functional tasks. He became independent with all activities except for ambulation (SBA) and stair climbing (MIN). He returned to the CVICU one week later for surgical management of a pleural effusion. A subxiphoid window procedure was performed which increased his pain levels and reduced his functional abilities for a few days. His 8-week period of sternal precautions had to re-start because the surgeon had to reduce the fluid build up around his heart.

It is also worth mentioning that the patient lost approximately fifty pounds while in the hospital with significant calf atrophy noticeable. The first several treatment visits following his readmission to the hospital he used a front wheeled walker and required moderate assistance for sit-to-stand. However eventually he was able to ambulate without the front wheeled walker as well as navigate steps to a degree where he no longer would qualify for inpatient rehab. The patient met all therapy goals and was able to return home safely with his family. He soon began outpatient cardiac therapy.

Table 3. Results of inpatient basic mobility screen from weeks three and four

WEEKS 3 & 4 RESULTS		
Inpatient Basic Mobility Screening – How Much Help From Another Person Do You Currently Need		
Turning from your back to your side while in a flat bed without using bedrails?	None	None
Moving from lying on your back to sitting on the side of a flat bed without using bedrails?	None	None
Moving to and from a bed to a chair?	A little	None
Standing up from a chair using your arms?	A little	None
To walk in a hospital room?	A little	None
Climbing 3-5 steps with a railing?	Total	None
Basic Mobility Total Score	19	24

Table 4. Results of gait and mobility scores from weeks three and four

WEEKS 3 & 4 RESULTS		
Gait and Mobility Assessment		
Moving Sit to Supine	Standby Assist	Independent
Sitting	Independent	Independent
Moving Sit to Stand	Standby Assist	Independent
Standing	Standby Assist	Independent
Walking	Standby Assist with FWW	Independent
Stair Climbing	Mod Assist of 1	Independent

Discussion

Patients with end-stage heart failure present with dysfunctions in several body systems. It can be difficult to differentiate the chronic effects of the heart failure and the transient effects of the in-hospital period of inactivity on overall performance at the time of the examination. However, early rehabilitation helps the patient regain independence with functional tasks and resolve many of the transient effects of inactivity besides muscular atrophy which takes more than 8 weeks to regain.

Physical activity has been demonstrated to revert or diminish the physiological alterations in transplanted patients (Kobashigawa, 1999). However, addressing physical activity immediately following transplant is complex and less straight forward because patients are severely deconditioned, limited by pain, more susceptible to infections, and generally have several lines which are monitoring vitals, draining fluid, and administering medications.

Both early and later phases of rehabilitation are focused on maximizing strength and endurance, however, in contrast to the rehabilitation that takes place several months to years after surgery, the initial goals of acute rehab include preventing the deleterious effects of immobility, improving pulmonary function, improving independence with functional tasks, improving safety awareness during activity, and educating the patient to maintain sternal precautions. The role of every therapist involves influencing the patient's movement pattern by manipulating the environment and the treatment task. This was done several times throughout the plan of care to enable the patient to leave the hospital after recovering much of his independence with functional tasks.

It can be difficult to assess a patient who is 6'2 and 275 pounds. The level of assist he required throughout the two weeks in the ICU was more than someone else who may have required the same relative level of assist but of smaller stature. Over the course of his hospital stay the patient lost approximately 50 pounds; a lot of which was muscle mass as was demonstrated by the reduced calf circumference. The first several sessions the patient was limited by shortness of breath, however toward the end of the plan of care, he became more limited by muscle fatigue. This event demonstrated his improve cardiopulmonary endurance and a transition to muscle strengthening and endurance focused therapy.

The most difficult task for the patient to perform was a sit-to-stand, likely due to proximal muscle weakness from the immunosuppression steroids and the muscular atrophy of hip and trunk extensors. He could initiate the stand with good momentum, but the last 30% of hip and trunk extension was slowly performed likely due to the reduced level of muscle recruitment. One of the limiting factors for ambulation was wearing a surgical mask outside of the room which caused anxiety for the patient due to the hotness of breath and lack of perception of oxygen exchange. Due to the denervated heart, an adequate 3-5 minute warm up and cool down period was required to allow circulating catecholamines enough time to produce and finish its action. The four primary clinical impressions made during the management of the patient have been consolidated for the reader's convenience and are as follows.

Clinical Impression #1 Pre-Transplant Heart Failure

The 14-year history of pre-transplant heart failure likely had worsening effects on the patient's heart, skeletal muscle, vasculature, and pulmonary system. The specific cardiac limitations include decreased cardiac output which is the volume of blood pumped by the heart each minute, decreased ejection fraction which is the percent of blood pumped out of the left ventricle after ventricular filling has taken place, impaired ventricular filling which is the decreased volume of blood in the ventricle prior to ejection, and decreased stroke volume which is the total volume of blood pumped out of the left ventricle per contraction. As these changes occur, the body believes there is not enough fluid inside its vessels to maintain adequate perfusion of central and peripheral tissues. Therefore, it attempts to compensate by utilizing the body's hormone and nervous systems (Senduran, 2011). Some of the heart's attempts to compensate for these problems include: increasing blood volume through salt and water retention, pumping more blood per minute by increasing heart rate, and improving ejection fractions by pumping more forcefully (Senduran, 2011). Eventually as they become more chronic

compensations the mechanisms begin to fail which leave the patients with fewer options as they progress closer to end stage heart failure and cardiogenic shock.

The skeletal muscular dysfunction includes muscle atrophy, loss of strength, decrease in oxidative enzymes, decreased mitochondrial size and density, and increased number of type II muscle fibers (Yardley, 2018). Overall these changes result in a reduced exercise capacity. They also put the patient in a difficult place as they can not rely on strength to compensate for the the other implications follow the surgical procedure that will be discussed below. The vascular changes include elevated levels of neurohormones, higher resting sympathetic tone, increased total peripheral resistance, decreased NO production, and abnormal endothelial dysfunction (Bocchi, 2004). These changes negatively stress the body and also reduce overall exercise capacity. Pulmonary abnormalities include restrictive physiology, increased dead space, pulmonary edema, and diminished respiratory muscle endurance. Difficulty breathing and shortness of breath are both assessment tools following transplant, and it can be challenging to differentiate the patients baseline level breathing with the decompensated levels that follow an OHT. Primarily this dysfunction could be assessed with the Rate of Perceived Dyspnea and Borg Scale of Exertion. Lastly, the proinflammatory state that develops is characterized by elevated markers of inflammation (IL-6, 1L1B, TNF, and C-reactive proteins) and anemia (Nygaard 2019). Proinflammatory states have been associated with obesity and valvular disease both of which impact the complexity of the patient's case.

Clinical Impression #2 In Hospital Period

After considering the chronic effects of the 14-year history of pre transplant heart failure and how it influenced the initial rehabilitation, it would be logical to then consider the more acute, transient effects of the month long period of inactivity and bed rest the patient experienced while he was being medically managed. We are unaware of the amount of daily activity the patient received during the first two weeks at the outside hospital, however much of the research examining the effects of immobility describe a time period of about two weeks – the amount of the time the patient was at the tertiary hospital. For example, signs of orthostatic intolerance can develop within 3 days of inactivity (Topp, 2002) and the patient was on three days of complete bed rest during VA ECMO prior to his heart transplant. Muscle wasting occurs early and rapidly in the critical care setting with up to 30% of muscle mass lost within the first 10 days of an ICU admission (Convertino, 1982), which is three days less than the patient was in the CVICU prior to his heart transplant. Up to 40% of muscle strength can be lost within the first 7 days of immobilization (Parry, 2015). The patient was relatively 'immobile' for twice that period of time except for a few occasions. While the majority of immobility related pathophysiology normalizes upon mobilization and reduction in sedation, the effects of skeletal muscle do not.

Clinical Impression # 3 Surgical Procedures

The patient had three surgical procedures in a span of three days. The amount of anesthesia, tissue damage, and overall stress to the body involved during that time was elevated because of the level of inactivity the patient experienced leading up to the procedures. Regaining independence with functional tasks is the priory of acute management of a patient immediately following surgery. However, understanding and staying up to date with the restrictions and precautions for mobility can be challenging due to the number of procedures that occurred in such a short period of time. The biggest residual challenge following the heart transplant itself was the sternal precautions; no lifting or pushing more than five pounds with both upper extremities; followed by an additional 4 weeks of no lifting or pushing more than 10 pounds. Encouraging the patient to cough and mobilize secretions despite the sternal pain should take place throughout the treatment because it improves gas exchange and reduces the risk of lung infections. Early mobility and exercise are also important factors immediately following a median sternotomy and transplant because it aims to restore pulmonary capacity and reduce the risk of lung infection, thromboembolism, and bed sores. It also serves to attenuate and improve peak oxygen consumption (VO2peak) and related cardiovascular parameters which may regress approximately 26% within the first 1 to 3 weeks of sustained bed rest (Braith, 2000).

Clinical Impression # 4 Heart Denervation

Following transplant the patient no longer has direct neural control of their heart rate due to the removal of vagal stimulation. Therefore, resting heart rate is generally around 100 beats per minute for the population. In order to achieve the increase in heart rate and blood pressure required for activity, additional time is needed to allow circulating catecholamines in the blood stream to bind to receptors on the heart which initiate the change. Researchers have concluded that a 3 to 5-minute delay in the onset of cardiac acceleration occurs early after transplant. A gradual heart rate increase may even continue into the recovery period and there is a slower-than-normal return to pre exercise heart rate values after activity has been discontinued (Verani, 1994). Clinically speaking, a longer warm up and cool down is needed to keep the patient safe and hemodynamically stable throughout the treatment session. Because the direct connections between the heart and nervous system are removed during surgery, researchers have investigated whether or not the connections can regenerate over a period of time. With that in mind research by Givertz reports that the heart rate responses to exercise can remain abnormal for up to five years after transplant which suggests no functionally significant cardiac reinnervation. Heart denervation also influences medication regulation because without an increase in heat rate to prevent hypertension during periods of activity, the condition may lead to graft dysfunction and cardiovascular morbidity. It is important not to manual muscle test or implement isometric related exercises especially early on because there is an increased blood pressure response without the accompanying increase in heart rate.

Despite the limited research on optimal rehabilitation following a heart transplant and the likely variations between individuals that may occur, there are several issues that will likely be common themes for therapists who treat this population. This case provides a good example of what to expect from patients who receive a heart transplant after experiencing end stage heart failure, the amount of deconditioning that can occur during the in hospital period, how to initiate reconditioning and manage heart denervation and its effects on heart rate response. With the patients safety, quality of life, and improved performance with functional tasks at the forefront of our treatment approach in the first two to four weeks of therapy, the ICU-based rehabilitation can be instrumental with preventing setbacks and enhancing a patients ability to begin participation in cardiac rehabilitation to improve their overall strength and aerobic capacities to optimize movement and improve their human experience.

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