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Occupational and Physical Therapy Outcome Measures with a Patient Implanted with a Total Artificial Heart: A Case Report

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Abstract

Background

A single case report regarding the occupational and physical therapy rehabilitation and medical course of a 54-year-old Caucasian male diagnosed with idiopathic restrictive cardiomyopathy New York Heart Association – Class IV with bridge to transplant with a Total Artificial Heart (TAH).

Methods

The subject's electronic medical record was retrospectively reviewed to measure rehabilitation and medical course during hospitalization. A phone interview was conducted to obtain patient's experience with rehabilitation therapy process during TAH implantation until heart transplant.

Results

The subject made functional gains in his daily mobility and self-care activities. His cognition was assessed and remediated to supported return to occupational performance with home and work tasks. The subject's report of rehabilitation experience during implantation was positive and highlighted the importance of develop goals toward independence while awaiting transplant

Discussion

This single case report is an example of collaborative effort between medical and therapy teams to ensure care was optimized during hospitalization from TAH to heart transplant.

Background

Heart failure (HF) affects 5.8 million Americans, with an expanding prevalence as over 670,000 new cases are diagnosed each year (Lloyd-Jones et al., 2010; Starling et al., 2014). It accounts for $40 billion in health care spending and represents the top Medicare diagnosis-related group for hospital billing (Massie & Shah, 1997). Survival at five years is only 50% from the time of initial diagnosis (Yancy et al., 2013). Mechanical circulatory support (MCS) been shown to dramatically improve survival and quality of life among patients with end-stage heart failure (Rose et al., 2001). Unlike cardiac transplantation, which is limited by a donor pool of around 2,000 organs with over 4,000 patients on a waiting list that increases annually, MCS has the potential to offer treatment to an expanding population of recipients. Based on national inpatient data, an estimated 150,000 patients are currently managed medically despite qualifying for MCS, making it one of the most underutilized treatment options with around 3,000 implants performed annually (Joyce et al., 2009).

Aim

This single case report highlights the acute medical and rehabilitation procedures and experience of a patient implanted with a MCS device, Total Artificial Heart (TAH), while awaiting heart transplant. This patient was seen as part of a routine clinical service in an acute care medical institution. All procedures for this case report were performed in compliance with relevant laws and institutional guidelines and the appropriate institutional committee approved them. Informed consent was completed through the medical institution prior to review and interview of the patient's case.

Case History

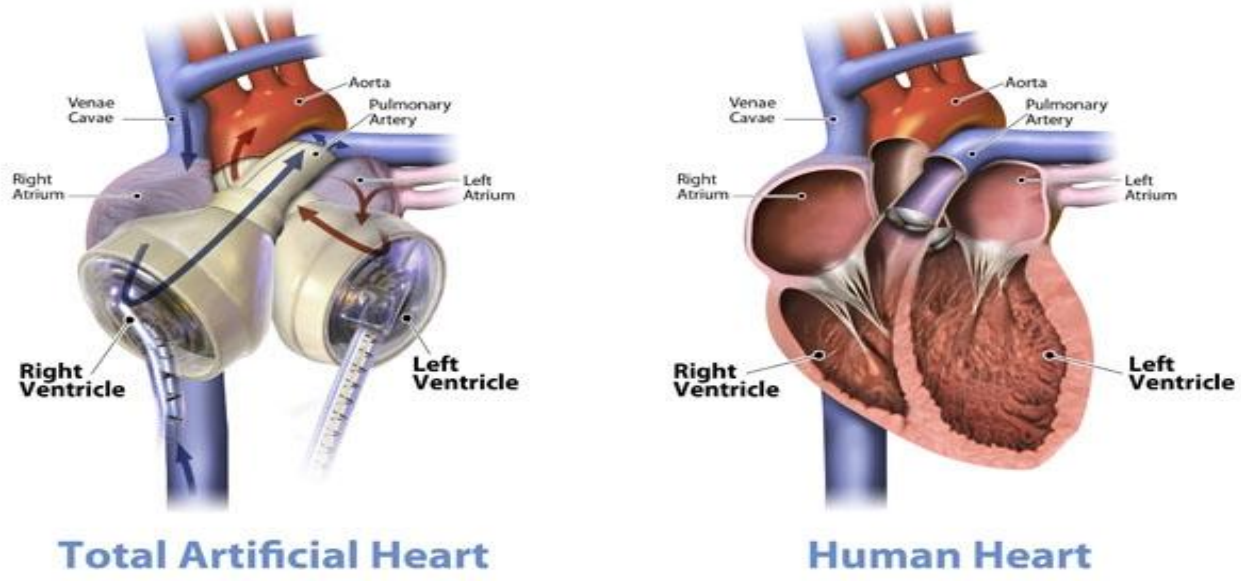
Medical Course & Functional Level

The patient is a 54-year-old male that came to our attention at an outpatient cardiac clinic with severe biventricular failure due to restrictive cardiomyopathy. He was classified as New York Heart Association – Class IV. He was admitted to the intensive care unit (ICU) and a right heart catheterization was performed with initiation of dopamine drug therapy. His cardiac index at presentation was 1.5 with a VO2 of 5.8. His comorbidities included stage III chronic kidney disease with a creatine of 1.9 mg/dL, mild restrictive lung disease due to prior tobacco use, atrial fibrillation with previous failed ablation, implantable cardioverter defibrillator (ICD), previous pericardiectomy, and previous cardiac arrest.

Once hospitalized, he was taken to the operating room for redo-sternotomy, implantable cardioverter defibrillator removal, and implantation of a Syncardia© Total Artificial Heart (TAH) (Figure 1). Post-operatively he was transferred to the ICU on low doses of norepinephrine and vasopressin with fill percentages of 50. He was extubated from ventilator support post-operative day one, and despite initially demonstrating adequate urine output, he subsequently developed acute kidney injury and was started on continuous renal replacement therapy on post-operative day two.

Figure 1

SynCardia© TAH Side-by-Side Human Heart



The post-operative course was complicated by a gastrointestinal bleed at 30 days post-implant of the TAH. The gastrointestinal bleed was attributed to an ischemic etiology with ulcerative lesions identified in the left colon. These were biopsied and the lesions were clipped with no further recurrence of this complication. The recovery thereafter was uneventful, resulting in a successful heart transplant after 163 days of TAH support.

At the time of consult for rehabilitation services, the patient had not been immobilized post implantation of TAH for at least 48 hours. Several weeks prior to

implantation the patient reported a decline in strength and endurance for community distance ambulation and ability to complete his self-employment duties specific to cattle ranching. Patient reported he had not used a gait aid at baseline and was independent with cognitive activities such as home and business financial management for his cattle ranch.

The patient was referred to occupational therapy and physiotherapy for functional decline and weakness regarding mobility and self-cares due to surgical procedure and immobility due to hospitalization. He was referred to therapy services post implantation of TAH upon patient's arrival to the intensive care unit. The time to consult for therapy services was one day post implantation of TAH. At time of evaluation, patient presented with decrease strength in all extremities and decrease activity tolerance with multiple mobility activities. At time of evaluation, sensory, visual perceptual, and neurological aspects were intact. Occupational and physical therapy services followed laboratory parameters specific from cardiothoracic surgeon orders as well as American Physical Therapy Association (APTA) guidelines to ensure patient safety during therapy sessions (Table 1). The patient's heart rate was set at 130 beats per minute. The cardiovascular medical team recommended mean arterial pressure (MAP) be within 60-70 during any activity.

Table 1

Laboratory Parameters Used for Guidelines for Therapy Intervention

Lab	Range
Hemoglobin	> 7.0 gm/dL
International Normalized Ratio	2.0-3.0
Activated Partial Thromboplastic Time	70-120
Hematocrit	42-52% (male); 37-47% (female)
Platelets	> 5,000 cells/m3
White Blood Cell Leukocytes	> 5,000 mm3
Sodium	134-142 mmol/L
Potassium	3.0-5.0 m Eq/L

During occupational and physical therapy evaluation, the patient reported being independent in daily self-cares as well as home and community ambulation without gait aid support prior to being hospitalized. The patient reported several weeks prior to his implantation he easily fatigued with completing daily activities and mobility. The patient was self-employed as a full-time cattle farmer, with management of several farm related responsibilities. At time of occupational and physical therapy evaluation the patient verbalized weakness, which was attributed to his medical course and required bedrest three days due to implantation precaution and procedures. During the evaluation, strength and endurance testing with preparatory self-cares and mobility tasks indicated weakness and decrease activity tolerance post TAH implantation.

Methods

The patient's electronic medical record was retrospectively reviewed to obtain demographics and time to referral for occupational and physical rehabilitation services. The researchers also reviewed the rehabilitation process specific to assessment measures, interventions, and duration of therapy services during the patient's acute inpatient hospitalization. Additionally, the researchers conducted a one-time phone interview with the patient regarding his medical and rehabilitation experience during implantation with a TAH in the hospital while awaiting a heart transplant.

Outcome Measures

There were several outcome measures administered by occupational and physical therapy practitioners during the patient's hospitalization. The first outcome measure that examined daily self-care and mobility progress was the Boston University AM-PAC™ "6 Clicks" Daily Activity Inpatient-Short Form and the Boston University AM-PAC™ "6 Clicks" Daily Mobility Inpatient-Short Form. This standardized outcome measure was used to quantify the subject's functional performance with occupational and physical therapy services. The AM-PAC™ "6 Clicks" is an outcome instrument that measures a patient's function with self-cares and mobility. This outcome measure is a reliable and valid tool (Jette et al., 2013). Both short forms were administered by occupational and physical therapy practitioners at time of evaluation with continued measurement once a week, until discharge the patient discharged from therapy services.

Another measurement tool that occupational therapy used to assess the patient's cognitive status was the Montreal Cognitive Assessment (MoCA). It is a cognitive screening tool that is sensitive and relevant to use with multiple age groups and diagnoses. This cognitive screen has multiple versions to prevent a learning effect. The MoCA versions have been used in prior studies and cases to measure cognitive status with patients having cardiac related diagnoses (Nasreddine, Phillips, & Bedirian et al., 2005). The occupational therapy discipline administered the standardized cognitive screen post implantation. Follow-up cognitive screening with alternative MoCA versions was completed on two other occasions with two to three weeks between re-administration.

Occupational therapists also administered psychological screens post implantation in order to identify and address elements of the patient's quality of life during the time patient is implanted with a TAH. The Generalized Anxiety Disorder screen (GAD-7) was administered post implantation of TAH to identify any anxiety signs and symptoms. The Patient Health Questionnaire-9 (PHQ-9), a depression screening tool, was also completed post-implantation of TAH. These screens were used to measure mood further assess coping strategies while awaiting transplant.

Results

Self-Cares and Cognition Intervention

Occupational therapy provided services for nine weeks with a total of 20 treatment visits and a total of 518 minutes of therapy being completed during the patient's hospitalization. On average, 2.2 visits were completed per week with an

average of 58 minutes per session (see Table 2). In the first four weeks as well as during the eight-week post TAH, there were several missed therapy visits due gastrointestinal bleed as well as hemodynamic changes that impacted therapy. At time of evaluation, the initial plan of care frequency was five sessions per week, by week seven patient's frequency of visits were decreased to three sessions per week until acute care goals were met. The patient's initial AMPAC™ "6 clicks" score at time of evaluation was 14 out of 24 (59.67% impairment). At the time of occupational therapy discharge his AMPAC™ "6 Clicks" score was 24/24 (0.00% impairment) (Figure 2). Occupational therapy interventions were upper body exercises, cognitive retraining and strategy use, retraining of self-care and employment occupations, energy conservation education, stress management / coping strategies, and diet assessment and modification.

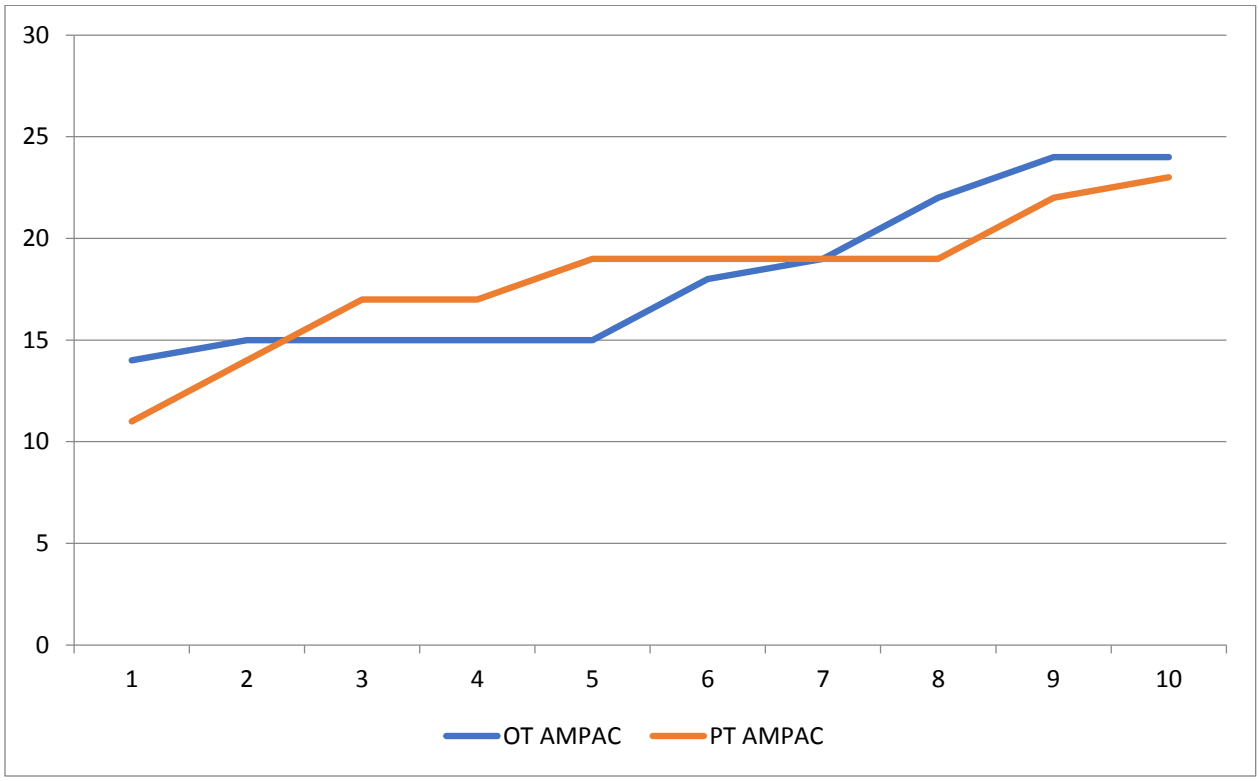
Table 2

Occupational Therapy Plan of Care and Outcome Measure Timeline

Week	OT Visits (per week)	OT Total Time (Minutes)	AMPAC™ Daily Activity "6 Clicks"	Cognition (MoCA Version)	Anxiety Scale (GAD-7)	Depression Scale (PHQ-9)
1	1	27	14 / 24			
2	1	18	15 / 24	19 / 30		
3	0	0	15 / 24			
4	1	25	15 / 24	14 / 30		
5	4	112	15 / 24			
6	4	118	18 / 24			
7	3	71	19 / 24	23 / 30	4	2
8	3	69	22 / 24			
9	3	78	24 / 24	26 / 30		

Figure 2

AMPAC™ "6 Clicks" Daily Activity and Mobility Results



Cognitive screen scores were completed on four occasions during the subject's acute hospitalization post-implantation. A score of 26 out of 30 indicates normal cognitive function. The MoCA 7.1 version was completed nine days post implantation with a score of 19 out of 30, indicating impairment. Three weeks later, MoCA 7.2 version was completed with a score of 14 out of 30, showing a decline in cognition and continued impairment. A two-week follow-up of the MoCA 7.3 version was completed with a score of 23 out of 30, showing improvement in cognition, but continued impairment. Upon discharge from acute care occupational therapy services, the subject's cognition was measured with a score of 26 out of 30, indicating normal

cognition two months post TAH implantation (Table 2). During the nine weeks of occupational therapy services, the practitioner provided cognitive interventions specific to strategy use and retraining with cognitive activities the patient was completing prior to hospitalization, such as bill paying and business ownership financial matters. The occupational therapist implemented and progressed cognitive activities specific to memory aid (i.e. calendar use), mathematical retraining, problem solving questions, financial management activities (i.e. completing tax forms, financial forms related to self-employment farm needs, and leisure activities completed prior to hospitalization (i.e. cattle scoring). Mental health strategies were implemented specific to relaxation methods and stress management techniques (i.e. sleep enhancement strategies, therapeutic listening, energy conservation methods, delegating tasks to others).

Psychological measures were administered seven weeks into the implantation while the patient awaited a heart placement. The GAD-7 was administered by an occupational therapist at seven weeks post implantation of TAH. The patient's GAD-7 score was a 4, indicating minimal anxiety with sleep disturbances being the primary concern (Table 2). Patient reported that the sound of the external compressor component of the TAH disrupted his sleep. Additionally, occupational therapy administered the PHQ-9, a depression screening tool, seven weeks post implantation of TAH. The patient scored a 2, indicating no signs or symptoms of depression (Table 2). On the PHQ-9 the patient indicated one symptom specific to difficulty falling and staying asleep.

Mobility Intervention

Physical therapy provided services for ten weeks with a total of 20 visits and a total of 427 minutes. On average, 2.0 visits were completed per week with an average of 21.4 minutes per session during hospitalization (Table 3). At time of evaluation, the initial plan of care frequency was five sessions per week, by week five the frequency of visits were three sessions per week, and by week eight the plan of care frequency was further decreased to two sessions per week. The subject's initial AMPAC™ Daily mobility score at time of physical therapy evaluation was 11 out of 24 (70.42% impairment). At the time of discharge, the subject's AMPAC™ Daily mobility score was 23 out of 24 (15.86% impairment) (Figure 2). Physical therapy interventions were lower extremity strengthening focusing on standing exercises to prepare for transplant, gait training, and physical performance testing. The physical therapy provided interventions that progressed from bed-based exercise of lower extremities and preparatory activities for gait training in the intensive care. The physical therapist progressed patient's mobility with gait training and aerobic exercise (i.e. pedal bicycle) within the patient's hospital room with progression to longer distance ambulation within the hospital building and outdoor corridors on the hospital campus. At time of evaluation patient ambulated with a gait aid and progressed to walking while pushing his cardiac mechanical device within six weeks post implantation. The subject demonstrated minimal improvement with gait speed from 0.4m/s to 0.42 m/s during the course of ten weeks.

Table 3.

Physical Therapy Plan of Care and Outcome Measure Timeline

Week	PT Visits (Per week)	PT Total Time (Minutes)	AMPAC™ Inpatient Daily Mobility "6 Clicks"
1	1	23	14 / 24
2	3	77	17 / 24
3	3	62	17 / 24
4	1	24	19 / 24
5	4	90	19 / 24
6	3	55	19 / 24
7	1	16	19 / 24
8	0	0	19 / 24
9	2	38	22 / 24
10	2	42	23 / 24

Patient Experience

The patient interview was facilitated with open-ended questions. The themes of the interview questions were to explore the patient's perceptions and feelings regarding his rehabilitation experience while implanted with a TAH. The patient felt his relationship with rehabilitation and medical staff were positive and collaborative in nature. He reported he found working on ambulation and occupations that were similar to his home or community environments most meaningful during his recovery in the hospital. He

credited his participation in daily self-cares and employment occupations as one method that helped him mentally cope and cognitively rehabilitate during the acute recovery period while implanted with a TAH. The patient suggested that future patients implanted with a TAH should coordinate with medical staff to ensure good pain management interventions are place in order to reduce pain for movement. He firmly believed that if he did not keep moving and striving for a goal while implanted with a TAH, he would not have coped well while awaiting a heart transplant. He advised future patients to have an occupation focused goal in mind to help cope during this life event.

Discussion

The aim of this case report was to provide insight and information regarding a patient's rehabilitation experience. Furthermore, the aim of the case report was to provide a descriptive overview of functional outcome tools that were used by rehabilitation professionals to measure a patient progress while implanted with a MCS device pre-heart transplant. Overall, all rehabilitation functional outcomes showed a positive descriptive change in the patient's ability to participate in self-cares, mobility, and meaningful occupation's post TAH implantation. Additionally, the subjective felt rehabilitation services were meaningful to his functional recover post-implantation.

This case study supports the current literature on safety with mobility with implantation of TAH (Nicholson & Paz, 2010). Occupational therapy role in assessing and restoring cognition demonstrated positive results with the subject's return to employment, home management, and leisure-based occupations while awaiting transplant. Physical therapy provided the opportunity for the subject to restore strength

post operatively as well as to optimize mobilization and strength in preparation for heart transplant.

The case report provided an example of occupational and physical therapy practitioners addressing physical, cognitive, and psychosocial aspects during the acute rehabilitation phase of post-implantation of a TAH. The completion of cognitive and psychological outcome measures were used to provide objective information into the patient's progress with cognitive performance as well as help guide rehabilitation professions progress therapeutic interventions that optimized the patient's ability to return to his prior level of function. The outcome measures in this case report provided a guide for rehabilitation professionals to use with future patients implanted with a TAH to aid in returning to independent with daily activities and mobility. More specifically, the instruments used in this case report provided were standardized measurement tools that can be used guide rehabilitation professions in optimizing acute rehabilitation goal achievement for the patient.

In this case report, communication between rehabilitation professionals, medical professionals, and the patient provided the opportunity for accurate and consistent care to be provided to ensure progression of rehabilitation goals and TAH device safety. With collaborative communication efforts, such as daily rounds between therapy and medical team professionals, patient safety and progressive care was optimized for this subjective. During occupational and physical therapy sessions, the patient did not experience any adverse effect with mobility or occupational activities in the acute care setting. Verbal and written communication between the medical and rehabilitation professionals in conjunction with daily vital / lab monitoring were key components to

ensure the patient was medically appropriate an safe to participate in daily rehabilitation sessions. Additionally, this daily communication effort assisted rehabilitation therapists in understanding TAH controller elements such as set heart rate, controller exchange process, and driveline site care, which are components of the device that could influence patient safety and duration of therapy sessions.

This case report supports the limited knowledge specific to the rehabilitation process and outcomes from a patient's physical, cognitive, and psychosocial standpoint post-implantation of TAH. This case report provided a positive example of rehabilitation processes specific to assessment and intervention elements related to physical and cognitive functions that can be impaired post-TAH implant. This example may provide the opportunity for future rehabilitation professionals to develop practice guides that identify and address physical, cognitive, and emotional performance components that need to be assessed and treated during a patient's the acute recovery phase. Furthermore, this case report also highlighted the importance of the patient's experience and perception regarding their rehabilitation process post implantation with bridge to heart transplant.

Limitations

This case report has several limitations. The research design and single sample size is small, which the findings cannot be extended to a wider context or population. This case report also has limitations with identifying and understanding the patient's long-term rehabilitation recovery process specific to post-heart transplant. This limitation was in part due to transfer to another medical site. Future research is needed to

understand the impact of a patient's prior level of function on their function post-implantation of a mechanical support device such as a TAH. Future comparative research studies are needed to help rehabilitation professionalism identify the most effective rehabilitation interventions that optimize a patient's function post-TAH implantation. Additionally, future research on the long-term effects of rehabilitation on physical, cognitive, and emotional performance element after a patient receives a heart transplant from the bridge with a TAH is also a needed area of study.

Conclusion

The present case report provided information regarding the rehabilitation process and procedures as well as patient perspective for a unique medical procedure and device. Occupational and physical therapy rehabilitation services provided care specific to addressing the patient's physical, cognitive, and emotional performance areas after implantation of a MCS device such as a TAH. The patient valued his rehabilitation experience during the acute recovery phase as well as the collaborative care provided by the medical staff. Further evidence is needed to investigate the most effective rehabilitation interventions and staff training processes to optimize care for patients implanted with a TAH.

Practice Implications

1. The patient valued occupational and physical therapy services to restore his ability to participate in meaningful occupations while implanted with a TAH.
2. Occupational therapists and physical therapists collaborated with cardiothoracic medical services during hospitalization to ensure the functional physical, cognitive, and psychosocial needs of the patient were measured and addressed.
3. Medical services provided a referral to therapy services early in the medical recovery process to ensure functional elements of the patient were addressed in acute care.
4. When providing rehabilitation services to patients implanted with a TAH it is important to address the physical and cognitive components to prevent functional decline from surgery as well as prepare a patient for a heart transplant.

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