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Original Research

# Efficacy of Inpatient Rehabilitation After Left Ventricular Assist Device Implantation

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## Abstract

**Background:** Left ventricular assist devices (LVADs) have become an increasingly popular and effective means for treating advanced heart failure. LVAD implantation requires extensive surgery and postoperative rehabilitation. The Functional Independence Measure (FIM) has been used to quantify functional gains in numerous patient populations, including those with stroke and spinal cord injury. This study investigated functional improvements in patients undergoing LVAD implantation using the FIM score.

**Objective:** To assess functional improvements in patients with advanced heart failure who underwent LVAD implantation.

**Design:** Retrospective.

**Setting:** Inpatient rehabilitation unit.

**Subjects:** Ninety consecutive patients who received acute inpatient rehabilitation after continuous flow LVAD implantation.

**Methods:** Demographic, laboratory, and functional outcomes data including inpatient rehabilitation unit (IRU) length of stay (LOS), discharge disposition, and FIM score were collected for all patients. Paired *t*-tests were used to assess change in functional measures and laboratory data.

**Main Outcome Measures:** Primary outcome measures included FIM gain, FIM efficiency, discharge disposition, rates of readmission after discharge from rehabilitation, and LOS in the rehabilitation unit.

**Results:** The FIM gain was statistically significant at  $28.4 \pm 12.3$  ( $P < .001$ ) and compared favorably with benchmarks for mean FIM gains at our facility (26.4), regionally (21.5), and nationally (22.7) for patients admitted to IRUs with a cardiac diagnosis. FIM efficiency (FIM gain/IRU LOS) was  $1.9 \pm 1.0$  compared with the mean FIM efficiency at our facility (2.2), regionally (2.1), and nationally (2.2). Seventy-four percent ( $n = 67$ ) of patients were discharged directly home after inpatient rehabilitation, 17% ( $n = 16$ ) were readmitted to the acute hospital service, and 8% ( $n = 7$ ) required additional rehabilitation at a subacute rehabilitation facility. The IRU LOS was  $16.2 \pm 6.9$  days.

**Conclusions:** Our study indicates that most patients with an LVAD achieve clinically meaningful functional gains from acute inpatient rehabilitation, with the majority of patients being discharged home. Further studies need to be performed to analyze clinical outcomes after acute inpatient rehabilitation.

## Introduction

A left ventricular assist device (LVAD) is a mechanical pump implanted inside a person's chest that is used to assist the failing heart by unloading blood from the left ventricle and returning it to the aorta, which then delivers oxygen-rich blood to remainder of the body. Modern LVADs are capable of generating up to 10 L per minute of blood flow and can dramatically improve hemodynamics, often alleviating many debilitating symptoms of heart failure [1,2]. All current

LVADs require an external power source and system controller. Consequently, patients are required to have the physical and mental capacity to manage device components [3,4]. Numerous studies have demonstrated improved survival, functional status, and quality of life after implantation of continuous flow LVADs [5].

As this technology becomes increasingly common and more hospitals develop LVAD programs, awareness of the role of acute inpatient rehabilitation units (IRUs) as part of the multidisciplinary LVAD team is crucial and

may improve patient functional outcomes, quality of life, and length of stay (LOS).

Previous studies have demonstrated the utility of the Functional Independence Measure (FIM) as a method for quantifying patient disability and level of assistance needed to carry out activities of daily living (ADLs) in numerous patient populations, including those with brain injury, Parkinson disease, spinal cord injury, and stroke [6-10]. The FIM permits quantification of the assessment of patient independence in key motor and cognitive ADLs, including eating, grooming, mobility, cognition, and bladder and bowel management [11]. Despite the prevalence of the FIM in rehabilitation centers, minimal research has been conducted to evaluate the functional status of patients with an LVAD who are enrolled in inpatient rehabilitation facilities, and accordingly, many rehabilitation facilities, therapists, and physicians are not familiar with the LVAD itself or the care of these patients. Recognizing the need for increased awareness of the importance of inpatient rehabilitation units (IRUs), we sought to characterize our experience, as a major LVAD center, using the FIM score.

## Methods

### Subjects and Rehabilitation Protocols

This study included 90 patients who underwent continuous flow LVAD implantation between March 2006 and September 2014 and subsequently required post-operative inpatient rehabilitation after discharge from the intensive care and telemetry units.

The FIM is an 18-item patient classification tool designed to uniformly assess the severity of a patient's disability. The FIM assesses 6 domains—self care, sphincter control, transfers, locomotion, communication, and social cognition. Each of the 18 items is scored on a 7-point Likert Scale, ranging from 1 = total assistance to 7 = complete independence. Final summed scores range from 18 to 126.

The FIM score at admission and discharge was determined for each patient by dedicated physical, occupational, and speech therapists, and rehabilitation nurses. A total of 18 dimensions, including eating, grooming, bathing, dressing, toileting, mobility, comprehension, problem solving, and memory, were assessed on a 7-point ordinal scale. Patients received 3 hours of standardized therapy daily along with education and family training by rehabilitation nurses and a daily physiatrist visit. Therapy for patients with an LVAD included a particular focus on improving hand dexterity and grip strength to promote safe manipulation of LVAD components during power source changes. Safe dressing practices and donning of battery holsters were reinforced to ensure that the LVAD driveline and the driveline exit site are not compromised during daily

activity. Cognitive tasks were focused on proper sequencing of LVAD-related tasks, including power source changes and troubleshooting device alarms. Pointed physical therapy focused on transfers, gait training, and stair negotiation with intent to improve balance, aerobic capacity, and independent functional mobility.

### Data Management and Statistical Analysis

Demographic data, including age, gender, race, indication for LVAD implantation, anthropometrics, comorbidities, and LVAD type, were collected from medical records. Likewise, laboratory data including serum sodium, blood urea nitrogen (BUN), creatinine, b-type natriuretic peptide (BNP), albumin, white blood cell count, and hemoglobin were gathered at both the preoperative and pre-IRU admission time points. Rehabilitative outcomes were assessed via FIM score, acute care LOS, IRU LOS, and rate of 30-day hospital readmission. FIM gain (discharge FIM – admission FIM) and FIM efficiency (FIM gain/IRU LOS) were calculated for all patients.

Continuous data were expressed as mean  $\pm$  standard deviation, and categorical data were expressed as frequency (%). Paired *t*-tests were used to evaluate change in patient functional status and laboratory parameters. A *P* value  $< .05$  was considered significant. All statistical operations were performed with SPSS, Version 23 (IBM Corp, Armonk, NY).

## Results

This study enrolled 90 patients with advanced heart failure with a mean age of 63 years. The majority of the cohort was composed of white males who underwent implantation with HeartMate II LVADs (Thoratec, Pleasanton, CA). All patients underwent extensive preoperative evaluation for LVAD candidacy and had an ejection fraction less than 25% with significant systolic dysfunction, New York Heart Association class III or IV heart failure, and hemodynamic compromise. During the study period, a total of 353 patients underwent LVAD implantation at our institution. All patients who were able to perform household mobility safely were discharged home under family supervision and home health care. Those who required acute inpatient rehabilitation but could not tolerate 3 hours of therapy per day were discharged to a subacute rehabilitation (SAR) facility. Additionally, some patients were deferred from the IRU as a result of medical stability, inability to tolerate the 3-hour rule, too low or too high level of functioning, isolation requirements, insurance barriers, and bed availability. Ten percent of these patients were implanted with LVADs as a bridge to cardiac transplantation, and 90% underwent permanent implantation, known as destination therapy (Table 1).

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