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EDITORIAL

Heart failure syndrome and left ventricular assist devices: considering physiotherapeutic evaluation tools

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Heart failure syndrome compromises systolic, diastolic function, or both. Typical manifestations of heart failure are fatigue, exercise intolerance, dyspnoea, peripheral oedema, and pulmonary oedema. In patients with heart failure, the heart is unable to generate a cardiac output sufficient to meet the body demand (Invernici et al, 2009). Significant risks of heart failure are hypertension, diabetes, ageing and obesity. Ejection fraction is the measurement expressed in percentage of how much blood the left ventricle pumps out with contraction (American Heart Association, 2019). Heart failure with reduced ejection fraction occurs when it is 45% or less (Chatterjee, 2014)

Left ventricular assist devices functioning

A left ventricular assist device (LVAD) is a mechanical pump surgically implanted to augment or replace left ventricular function: it provides an alternate parallel path for blood flow to the aorta. It helps the heart to pump blood out of the ventricle to the aorta and into the rest of the circulatory system. LVADs are used as a bridge to transplantation in those patients who are refractory to medical therapy and hospitalised with end-stage heart failure (Invernici et al, 2009). Nevertheless, LVADs are increasingly proposed as destination therapy (long-term mechanical circulatory support) given the lack of organs available and thanks to the growing clinical experience and improved technology (Miller et al, 2018); long-term mechanical support is considered the standard of care for end-stage heart failure (Potapov et al, 2019).

Contemporary continuous-flow LVADs components are a blood pump inside the ventricle, an external controller, a percutaneous driveline connecting the pump to the controller and power sources for the pump and controller (Lim et al, 2017). The external controller and batteries are worn by patients, using a shoulder bag, a pouch (belt bag), or a vest depending on models, clinical indications, and the patient's preference. It has been argued that a shoulder bag can contribute, in the long term, to muscular discomfort in the neck, scapular area, and middle thoracic spine (Polastri and Loforte, 2015).

Following LVAD implantation, physiotherapy intervention is necessary to enhance both physical and respiratory functions, as soon as the patient is cooperative in the intensive care unit (Compostella et al, 2017). As highlighted in the survey by Ben Gal et al (2015), physical exercise is beneficial in patients with an LVAD, although there are no clinical specific guidelines for such population.

Detailing clinical changes following left ventricular assist device implantation

In order to define a comprehensive approach to long-term mechanical circulatory support, the European Association for Cardio-Thoracic Surgery released a consensus document investigating all aspects regarding the management of patients with end-stage heart failure undergoing LVAD implantation (Potapov et al, 2019). In the consensus document, the importance of cardiac rehabilitation for such patients was highlighted, adopting a multimodal programme consisting of endurance and strength training combined with education on handling the device and peripherals (Potapov et al, 2019). Potapov et al (2019) also recommended that strength training should focus on lower extremities and structured walks, while at the initial stage of postoperative rehabilitation, exercise should be performed using bicycle ergometry to minimise the risk of falls and driveline accidents. Furthermore, the importance to instruct patients on fluid balance and compliance to rehabilitation was highlighted.

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The outcomes related to physiotherapy must be verified using appropriate measurement tools. In some respects, patients with an LVAD are comparable with lung transplant recipients since the latter are equally physically limited before surgery and often have similar exercise restrictions, due to fatigue and physical deterioration.

In the following sections, some assessment tools for detecting clinical changes in patients with an LVAD are discussed.

Monitoring exercise intensity during rehabilitation

Numerical Rating Scale

The patient is asked to score the severity of dyspnoea or pain by marking a point on a 10-cm line. The end of the line (10 cm) represents the maximum pain/dyspnoea perceived, and the beginning (0 cm) represents the absence of symptoms (Gift et al, 1998; Hjermstad et al, 2011). Although no specific publications describe the numerical rating scale in patients with LVADs, its use is sustained by daily clinical practice: in this regard, both dyspnoea and pain can be quickly reported by patients. It seems the numerical rating scale should be preferred to the Modified Borg scale (Burdon et al, 1982) when targeting exercise intensity during rehabilitation (Johnson et al, 2016).

Modified Borg Scale

The Modified Borg Scale is a 0–10 scale to measure dyspnoea intensity (Burdon et al, 1982); the lower the score, the better the dyspnoea (0=nothing at all; 10=maximal). The Modified Borg Scale is typically used to investigate dyspnoea intensity in patients with respiratory diseases; because several versions have been developed over time, it has also been adopted to describe dyspnoea in different classes of patients other than those with pulmonary issues. In the consensus document by Potapov et al (2019), it was suggested that exercise intensity should be monitored using the Modified Borg Scale (score range 0–10); however, the authors probably considered the modified Borg when referring instead of the Borg Rating of Perceived Exertion Scale (score range 6–20). In this regard, reading the study by Hareendran et al (2012) to get further insights on the modifications the Borg Scale has received since the first version was published by Borg (1982) is recommended.

Borg Rating of Perceived Exertion Scale

The Borg Rating of Perceived Exertion Scale (Borg, 1982) describes the exertion a person experiences, starting from 'none' (which is rated 6) to 'very, very hard', representing the maximum effort perceived (which is rated 20). The Borg Rating of Perceived Exertion Scale can be used to monitor exercise intensity in patients with an LVAD. In fact, in a review by Scheiderer et al (2013), the Borg score varied from 11–13 points among the included studies. The use of the Borg Rating of Perceived Exertion Scale scale has been recommended by Popatov et al (2019), targeting the exercise intensity around a score of 13.

Testing exercise capacity

Stair-Climbing Test

The Stair-Climbing Test is a suitable tool for evaluating the strength of lower-extremity, the ability to ascend and descend a flight of stairs, and balance (Bennell et al, 2011). The Stair-Climbing Test can be performed using a flight of stairs and a stopwatch. The patient is asked to climb 9–12 stairs, and a score is assigned by reporting the time (in seconds) needed to perform this task. The first purpose of the Stair-Climbing Test is to have a preoperative evaluation of patient candidates for thoracic surgery, as reported in the analysis by Pichurko (2012), reading that study to get further insights is recommended. In addition to being used as a test, physiotherapy-supervised stair climbing is commonly performed postoperatively in cardiac surgical patients as a rehabilitative activity (Westerdahl et al, 2010).

30-Second Chair Stand Test

This test is used to evaluate lower-body strength (Jones et al, 1999; Bennell et al, 2011). The patient is seated on a chair and then asked to stand up, reaching a fully extended

standing position. The activity is repeated for 30 seconds, and the score is recorded as the number of stands executed. To date, no published studies are describing the use of the 30-Second Chair Stand Test in LVAD patients; nevertheless, it represents a simple way to detect lower-body motor performance and will probably attract further interest for this specific population.

6-Minute Walk Test

As stated in the American Thoracic Society (2002) guidelines, the primary indication for the use of the 6-Minute Walk Test is the need to measure the response to medical interventions in patients with moderate to severe heart or lung disease. The 6-Minute Walk Test usefully evaluated functional capacity in several cohorts of patients with LVAD (Laoutaris et al, 2011; Kerrigan et al, 2014; Schmidt et al, 2018). The test should be performed along a 30-metre corridor, and it consists of evaluating how many metres a patient can walk in 6 minutes.

Detecting autonomy in activities of daily living

Barthel Index

The Barthel Index measures functional independence regarding activities of daily life (Mahoney and Barthel, 1965). A score of 0 indicates the absence of autonomy, while a score of 100 indicates maximum independence. The Barthel Index affords a broader view of patient autonomy and directs the rehabilitative focus toward movements necessary for normal activities. Even for this tool, no published studies have investigated its use in patients with LVADs, probably because it has a ceiling effect once the patient can perform motor tasks or he/she is awake. For example, a person whose score is 20 points in the first few days postoperatively, can probably be able to perform many more activities in the following days than reaching a higher score immediately. In addition, the Barthel Index is an appropriate instrument to detect changes in autonomy not more; thus, its validity is confined to a narrow timeframe.

Short Physical Performance Battery

This group of measures combines data on gait speed, standing from sitting, and balance tests (Guralnik et al, 1994). The scores range from 0 (worst performance) to 12 (best performance). The test is indicated to assess a patient's mobility, considering the ability to stand up for 10 seconds using three different positions, the time needed to complete a short walk (8 feet) and the time required to rise up from a chair for five times (Guralnik et al, 1994). The Short Physical Performance Battery to date has not been described in LVAD populations, but it could be a suitable group of measures to verify the efficacy of the postoperative recovery pathway.

Evaluating quality of life

Functional Independence Measure

The use of this tool during the inpatient rehabilitation of LVAD recipients has been described in several studies (Alsara et al, 2014; Chu et al, 2014; Yost et al, 2017). The Functional Independence Measure scale evaluates 18 functional and cognitive items: eating, grooming, bathing, upper-body dressing, lower-body dressing, toilet use, bladder and bowel function, toilet transfer, bed/chair/wheelchair transfer, bath/shower transfer, walking or wheelchair mobility, stair climbing, comprehension, expression, social interaction, problem-solving and memory. To each of these 18 items is assigned a score ranging from 1 (total assistance) to 7 (completely independent) (Yost et al, 2017). The Functional Independence Measure score ranges from 18 to 126; the higher the score, the higher the patient's independence.

Kansas City Cardiomyopathy Questionnaire

This is a 23-item questionnaire divided into five domains (symptoms, physical limitations, social function, quality of life and self-efficacy). The Kansas City Cardiomyopathy Questionnaire has been proven suitable for investigating the effects of a rehabilitation programme in a cohort of LVAD patients (Kerrigan et al, 2014). The score ranges from 0–100, with higher scores reflecting better health status.

Minnesota Living with Heart Failure Questionnaire

This is a specific self-administered 21-item questionnaire for heart failure patients: the total score ranges between 0–105, detecting best (low grading) or worst health-related quality of life (Rector et al, 1987). In a population of 14 patients underwent LVAD implantation, quality of life measured using the Minnesota Living with Heart Failure Questionnaire improved when comparing score between baseline (preoperative) and 12 months follow-up (Seo et al, 2019).

Further reflections

Outcomes of mechanical circulatory support in heart failure patients are improving not only in the short-term, but also at 5 years post-operatively. These outcomes support its use to compensate for the shortage of donated organs (Felix et al, 2020), and as a standard of care in end-stage heart failure patients who are refractory to medical therapy (Potapov et al, 2019).

The evaluation tools discussed previously can be used to determine both the intensity and progression of exercise during the postoperative recovery following LVAD implantation. Although some of them are not explicitly used in LVAD patients, considering their characteristics can be useful to learn more about outcomes. The more challenging tests should be proposed, taking into consideration the patient's clinical outlook. In this regard, it could be challenging to perform the 6-Minute Walk Test during the early phases of the postoperative time frame, because patients should be accustomed to movement first. Instead, in a somewhat more advanced stage when the patient's functional status permits a structured rehabilitation programme, the 6-Minute Walk Test can return useful information on the patient's functional capacity.

Physiotherapy plays a crucial role in the care pathway of LVAD patients (Corrà and Pistono, 2019); planning customised postoperative rehabilitation activities is essential to achieve functional improvements after implantation. At the same time, detecting clinical differences related to treatment is an integral part of the recovery pathway, contributing to optimising the physiotherapeutic regimen in such a population.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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References

Alsara O, Reeves RK, Pyfferoen MD et al. Inpatient rehabilitation outcomes for patients receiving left ventricular assist device. Am J Med Phys Rehabil. 2014;93(10):860–868. https://doi.org/10.1097/PHM.0000000000000101

American Heart Association. Ejection fraction heart failure measurement. 2019. https://tinyurl.com/y93k2ohm (accessed 18 June 2020)

American Thoracic Society. ATS statement: guidelines for the Six-Minute Walk Test. Am J Respir Crit Care Med. 2002;166(1):111–117. https://doi.org/10.1164/ajrccm.166.1.at1102

Ben Gal T, Piepoli MF, Corrà U et al. Exercise programs for LVAD supported patients: a snapshot from the ESC affiliated countries. Int J Cardiol. 2015;201:215–219. https://doi.org/10.1016/j.jcard.2015.08.081

Bennell K, Dobson F, Hinman R. Measures of physical performance assessments: Self-Paced Walk Test (SPWT), Stair Climb Test (SCT), Six-Minute Walk Test (6MWT), Chair Stand Test (CST), Timed Up

& Go (TUG), Sock Test, Lift and Carry Test (LCT), and Car Task. Arthritis Care Res. 2011;63(Suppl 11):S350–370. https://doi.org/10.1002/acr.20538

Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14(5):377–381

Burdon JG, Juniper EF, Killian KJ, Hargreave FE, Campbell EJ. The perception of breathlessness in asthma. Am Rev Respir Dis. 1982;126(5):825–828. https://doi.org/10.1164/arrd.1982.126.5.825

Chatterjee K. Heart failure: epidemiology. In: Chatterjee K, Anderson M, Heistad D, Kerber RE, eds. Manual of heart failure. New Delhi, India: Jaypee Brothers Medical Publishers; 2014:1–11

Chu SK, McCormick Z, Hwang S, Sliwa JA, Rydberg L. Outcomes of acute inpatient rehabilitation of patients with left ventricular assist devices. PM R. 2014;6(11):1008–1012. https://doi.org/10.1016/j.pmrj.2014.05.004

Compostella L, Polastri M, Lamotte M, Bellotto F, Antoine M. Physiotherapy and rehabilitation management in adult LVAD patients. In: Montalto A, Loforte A, Musumeci F, Krabatsch T, Slaughter SM, eds. Mechanical circulatory support in end-stage heart failure. Cham, Switzerland: Springer International Publishing; 2017:404–415

Corrà U, Pistono M. Early mobilization in LVAD recipients: an obligatory step towards recovery. Monaldi Arch Chest Dis. 2019;89(1):1056. https://doi.org/10.4081/monaldi.2019.1056

Felix SEA, Ramjankhan FZ, Buijsrogge MP et al. Outcome of mechanical circulatory support at the University Medical Center Utrecht. Neth Heart J. 2020. https://doi.org/10.1007/s12471-020-01375-4

Gift AG, Narsavage G. Validity of the numeric rating scale as a measure of dyspnea. Am J Crit Care. 1998;7(3):200–204. https://doi.org/10.4037/ajcc1998.7.3.200

Guralnik JM, Simonsick EM, Ferrucci L et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994;49(2):M85–94. https://doi.org/10.1093/geronj/49.2.M85

Hareendran A, Leidy NK, Monz BU et al. Proposing a standardized method for evaluating patient report of the intensity of dyspnea during exercise testing in COPD. Int J Chron Obstruct Pulmon Dis. 2012;7:345–355. https://doi.org/10.2147/COPD.S29571

Hasin T, Topilsky Y, Kremers WK et al. Usefulness of the six-minute walk test after continuous axial flow left ventricular device implantation to predict survival. Am J Cardiol. 2012;110(9):1322–1328. https://doi.org/10.1016/j.amjcard.2012.06.036

Hjermstad MJ, Fayers PM, Haugen DF et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage. 2011;41(6):1073–1093. https://doi.org/10.1016/j.jpainsymman.2010.08.016

Invernici G, Cristini S, Navone S, Canzi L, Parati EA. An innovative treatment for cardiac failure: autologous stem cell transplantation. In: Fleming CT, ed. Heart transplantation: indications and contraindications, procedures and complications. New York, NY: Nova Science Publishers; 2009:144–151

Johnson MJ, Close L, Gillon SC et al. Use of the modified Borg scale and numerical rating scale to measure chronic breathlessness: a pooled data analysis. Eur Respir J. 2016;47(6):1861–1864. https://doi.org/10.1183/13993003.02089-2015

Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. Res Q Exerc Sport. 1999;70(2):113–119. https://doi.org/10.1080/02701367.1999.10608028

Kerrigan DJ, Williams CT, Ehrman JK et al. Cardiac rehabilitation improves functional capacity and patient-reported health status in patients with continuous-flow left ventricular assist devices: the Rehab-VAD randomized controlled trial. JACC Heart Fail. 2014;2(6):653–659. https://doi.org/10.1016/j.jchf.2014.06.011

Lim HS, Howell N, Ranasinghe A. The physiology of continuous-flow left ventricular assist devices. J Card Fail. 2017;23(2):169–180. https://doi.org/10.1016/j.cardfail.2016.10.015

Laoutaris ID, Dritsas A, Adamopoulos S et al. Benefits of physical training on exercise capacity, inspiratory muscle function, and quality of life in patients with ventricular assist devices long-term postimplantation. Eur J Cardiovasc Prev Rehabil. 2011;18(1):33–40. https://doi.org/10.1097/HJR.0b013e32833c0320

Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md State Med J. 1965;14:61–65

Miller RJH, Teuteberg JJ, Hunt SA. Innovations in ventricular assist devices for end-stage heart failure. Annu Rev Med. 2018;70:33–44. https://doi.org/10.1146/annurev-med-041217-011015

Pichurko BM. Exercising your patient: which test(s) and when? Respir Care. 2012;57(1):100–110. https://doi.org/10.4187/respcare.01428

Polastri M, Loforte A. Influence of ventricular assist devices equipment wear on body posture. Artif Organs. 2015;39(7):640–641. https://doi.org/10.1111/aor.12432

Potapov EV, Antonides C, Crespo-Leiro MG et al. 2019 EACTS Expert Consensus on long-term mechanical circulatory support. Eur J Cardiothorac Surg. 2019;56(2):230–270. https://doi.org/10.1093/ejcts/ezz098

Rector TS, Kubo SH, Cohn JN. Patients' self-assessment of their congestive heart failure: II. Content, reliability and validity of a new measure – the Minnesota Living with Heart Failure Questionnaire. Heart Failure. 1987;3:128–209

Scheiderer R, Belden C, Schwab D, Haney C, Paz J. Exercise guidelines for inpatients following ventricular assist device placement: a systematic review of the literature. Cardiopulm Phys Ther J. 2013;24(2):35–42

Schmidt T, Bjarnason-Wehrens B, Bartsch P et al. Exercise capacity and functional performance in heart failure patients supported by a left ventricular assist device at discharge from inpatient rehabilitation. Artif Organs. 2018;42(1):22–30. https://doi.org/10.1111/aor.12936

Seo YG, Park WH, Oh S et al. Clinical outcomes of inpatient cardiac rehabilitation for patients with treated left ventricular assist device in Korea: 1-year follow-up. J Exerc Rehabil. 2019;15(3):481–487. https://doi.org/10.12965/jer.1938124.062

Westerdahl E, Möller M. Physiotherapy-supervised mobilization and exercise following cardiac surgery: a national questionnaire survey in Sweden. J Cardiothorac Surg. 2010;5:67. https://doi.org/10.1186/1749-8090-5-67

Yost G, Coyle L, Milkevitch K et al. Efficacy of inpatient rehabilitation after left ventricular assist device implantation. PM R. 2017;9(1):40–45. http://doi.org/10.1016/j.pmrj.2016.05.013