

Echocardiography in the Management of Patients with Left Ventricular Assist Devices: Recommendations from the American Society of Echocardiography

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Abbreviations

2D = Two-dimensional
3D = Three-dimensional
A = Mitral valve late peak diastolic velocity
AR = Aortic regurgitation
Ao = Aorta/aortic root
AS = Aortic stenosis
ASD = Atrial septal defect
ASE = American Society of Echocardiography
AV = Aortic valve
BiVAD = Biventricular assist device
BP = Blood pressure
BTT = Bridge to transplantation
CCT = Cardiac computed tomography
CF = Continuous flow
CMS = Centers for Medicare & Medicaid Services
CPB = Cardiopulmonary bypass
CT = Computed tomography
CW = Continuous wave
DT = Destination therapy
e' = Mitral annular velocity
E = Mitral valve early peak diastolic velocity
ECMO = Extracorporeal membrane oxygenation
FAC = Fractional area change
FDA = Food and Drug Administration
HF = Heart failure
HM-II = HeartMate II left ventricular assist device
HVAD = HeartWare left ventricular assist device
IABP = Intraaortic balloon pump
IAC = Intersocietal Accreditation Commission
INR = International normalized ratio

INTERMACS = Interagency Registry for Mechanically Assisted Circulatory Support
IV = Intravenous
LA = Left atrial/atrium
LV = Left ventricular/ventricle
LVAD = Left ventricular assist device
LVEDV = left ventricular end-diastolic volume
LVEF = Left ventricular ejection fraction
LVIDd = Left ventricular internal dimension at end-diastole
LVOT = Left ventricular outflow tract
MAP = Mean arterial pressure
MCS = Mechanical circulatory support
MR = Mitral regurgitation
MRI = Magnetic resonance imaging
MS = Mitral stenosis
MV = Mitral valve
PFO = Patent foramen ovale
PDA = Patent ductus arteriosus
PI = Pulsatility index
PR = Pulmonary regurgitation
PS = Pulmonary stenosis
PT = Prothrombin time
PVAD = Percutaneous ventricular assist device
RA = Right atrial/atrium
RCA = Right coronary artery
rPA = Right pulmonary artery
RV = Right ventricular/ventricle
RVAD = Right ventricular assist device
RVOT = Right ventricular outflow tract
STE = Speckle tracking echocardiography
TAH = Total artificial heart

TAPSE = Tricuspid annular-plane systolic excursion
TEE = Transesophageal echocardiography
TR = Tricuspid regurgitation
TS = Tricuspid stenosis
TTE = Transthoracic echocardiography
VC = Vena contracta
VSD = Ventricular septal defect
VTI = Velocity-time integral

INTRODUCTION

This guideline addresses the role of echocardiography during the different phases of care of patients with long-term, surgically implanted continuous-flow (CF) left ventricular (LV) assist devices (LVADs). In patients with advanced heart failure (HF) refractory to medical therapy, LVADs have been used as a bridge to transplantation (BTT),¹ as destination therapy (DT),² as a bridge to transplant candidacy, or as a bridge to recovery.³ Over the past three decades, tremendous progress has been made in the

field of mechanical circulatory support (MCS), and more than 30,000 patients worldwide have received long-term LVADs.⁴ Recent guidelines endorse the important role of echocardiography in the clinical care of LVAD patients at several stages, including preoperative patient selection, perioperative imaging, postoperative surveillance, optimization of LVAD function, troubleshooting of LVAD alarms, and evaluation of native myocardial recovery.⁴ Despite increasing clinical use of LVADs,⁵ recognition of the central role of echocardiography in their management, and presentation of an exponentially expanding outpatient LVAD population to healthcare facilities not directly associated with implantation centers, there is a lack of published guidelines for echocardiography of LVAD recipients.

This American Society of Echocardiography (ASE) document uses both published data (albeit of limited availability at this time) and expert opinion from high-volume MCS-device implantation centers to provide consensus recommendations and sample protocols for the timing and performance of echocardiography during LVAD patient selection, device implantation, and postoperative management. The authors' goal is to provide a general framework for the interactions between echocardiography laboratories and MCS teams. Although numerous types of LVADs are in clinical use or under development, the scope of this document is primarily limited to current surgically implanted CF-LVADs that have been approved by the United States Food and Drug Administration (FDA) for extended use in adults. Pediatric and adult patients with congenital heart disease represent a smaller but important and increasing subpopulation of patients receiving extended-use MCS devices. Comments or recommendations specifically relating to pediatric and congenital heart disease patients will be noted within the text and within the pediatric LVAD discussion section. Surgically implanted LVADs for short-term use, percutaneously implanted LVADs, right ventricular (RV) assist devices (RVADs), and/or biventricular assist devices (BiVADs) may also be encountered by echocardiographers. A brief discussion of these devices and their applications is included in [Appendix A](#). Other MCS devices, including cardiopulmonary bypass (CPB) pumps, extracorporeal membrane oxygenation (ECMO), intraaortic balloon pumps (IABPs), and total artificial hearts (TAHs), are not covered in this report.

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