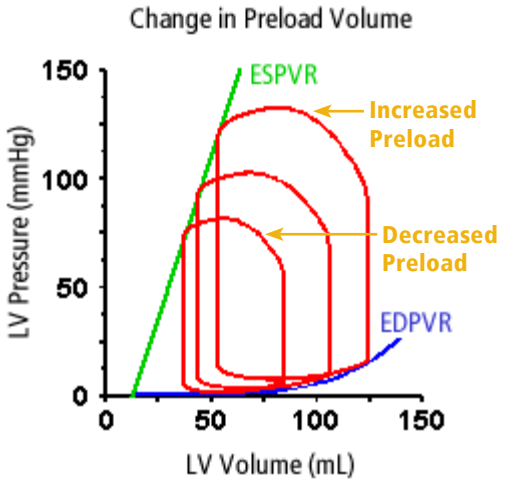
Scisense PV Technical Note

Understanding Preload

Preload is known as the load imposed on the ventricle at the end of diastole. At a cellular level, preload is defined as the maximum degree of myocardial fiber stretch or tension before ventricular contraction, determined by the mean sarcomere length at the end of diastole. Since sarcomere length cannot be determined in the intact heart, other indices of preload such as ventricular end diastolic volume (EDV) or pressure (EDP) are used. In general, EDV offers a better estimation of preload than EDP.

The relationship between the changes in preload and stroke volume depends on the morphology and Frank-Starling curve, which are determined by the contractile capacity of the heart and the ventricular afterload. Increasing preload increases stroke volume by a non-linear relationship. Cardiac preload can also be described as the passive filling properties of ventricles.



Different PV loops are obtained with different preloads, modeled by constant contractility (ESPVR and EDPVR boundaries) and afterload.

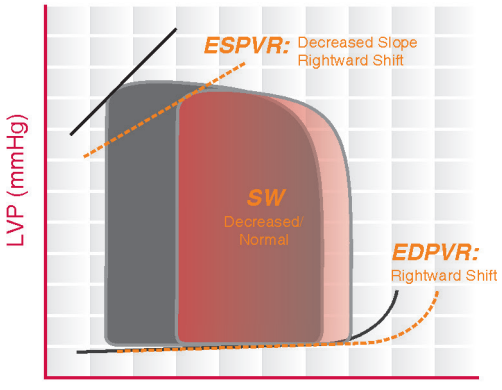
FACTORS CAUSING PRELOAD (EDV) INCREASE

- Increased ventricular compliance
- Venoconstriction
- Increased venous return (skeletal muscle activity and respiratory activity during physical activity or position and gravity)
- Decreased heart rate (increased filling time)
- Neuro-endocrine stimulation of venous tone increases (excitement)
- Increased blood volume (e.g. post-transfusion)

FACTORS CAUSING PRELOAD (EDV) DECREASE

- Compliance of ventricle decreases or stiffness increases (multiple muscle diseases leading to hyperthrophy, post-tissue graft implantation)
- Increased heart rate (reduced filling time)
- Venodilatation (peripheral or central) causing blood to pool in legs, abdomen, liver etc.
- Atrial arrhythmias (impaired contraction)

Dilated



During Dilated Cardiomyopathy Frank-Starling curves shifts down and to the right due to a decrease in contractility. During this dysfunction, stroke volume is reduced and preload increases as a consequence. The final result is a more compliant LV chamber, as seen by the increase in ESV and decreased slope/rightward shift of ESPVR.

transonic
THE MEASURE OF BETTER RESULTS.

Understanding Preload Cont.

Preload is described by end diastolic volume and can be measured by a variety of methods.

THERMODILUTION

Thermodilution can be used to obtain a global EDV index to evaluate biventricular preload. Alternatively, right ventricle EDV can be obtained using a pulmonary artery catheter with a rapid response thermistor in the right ventricle.

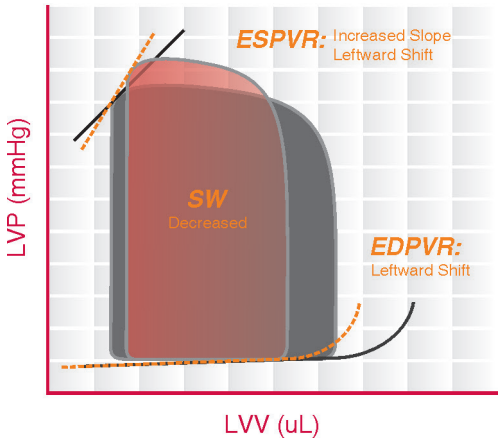
ECHOCARDIOGRAPHY

Echocardiography (both transthoracic and transesophageal) gives reliable measures of end diastolic surface areas. End-diastolic volume can then be calculated using Simpson's method or a similar approach. Long axis Doppler echocardiography can measure increases in stroke volume (SV) during the period of increased preload.

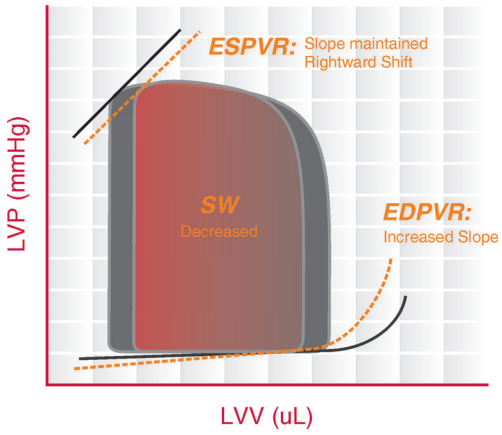
PRESSURE-VOLUME LOOPS

Pressure-volume loops give a direct measurement of end diastolic volume as derived by admittance. PV loops have the advantage of also providing information on heart contractility based on the end systolic and end diastolic pressure volume relationships (ESPVR and EDPVR). Additionally, PV loops provide stroke volume and end diastolic pressure measurements for determining the Frank-Starling curve.

Hypertrophic



Restrictive



Both left ventricular hypertrophy and restrictive cardiomyopathy exhibit a reduced stroke volume and thus preload. The LV becomes less compliant as seen by the leftward shift in EDPVR.

transonic
THE MEASURE OF BETTER RESULTS.

www.transonic.com

Transonic Systems Inc. is a global manufacturer of innovative biomedical measurement equipment. Founded in 1983, Transonic sells "gold standard" transit-time ultrasound flowmeters and monitors for surgical, hemodialysis, pediatric critical care, perfusion, interventional radiology and research applications. In addition, Transonic provides pressure and pressure volume systems, laser Doppler flowmeters and telemetry systems.

AMERICAS
Transonic Systems Inc.
34 Dutch Mill Rd
Ithaca, NY 14850
U.S.A.
Tel: +1 607-257-5300
Fax: +1 607-257-7256
support@transonic.com

EUROPE
Transonic Europe B.V.
Business Park Stein 205
6181 MB Elsloo
The Netherlands
Tel: +31 43-407-7200
Fax: +31 43-407-7201
europe@transonic.com

ASIA/PACIFIC
Transonic Asia Inc.
6F-3 No 5 Hangsiang Rd
Dayuan, Taoyuan County
33747 Taiwan, R.O.C.
Tel: +886 3399-5806
Fax: +886 3399-5805
support@transonicasia.com

JAPAN
Transonic Japan Inc.
KS Bldg 201, 735-4 Kita-Akitsu
Tokorozawa Saitama
359-0038 Japan
Tel: +81 04-2946-8541
Fax: +81 04-2946-8542
info@transonic.jp