

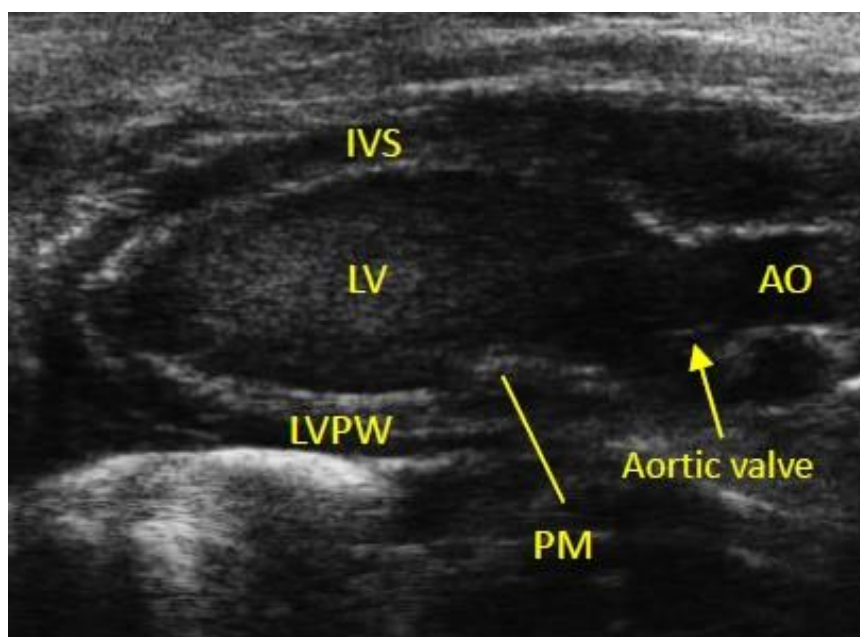
## VEVO LAB Cardiac Analysis

### I. Comments and Recommendations

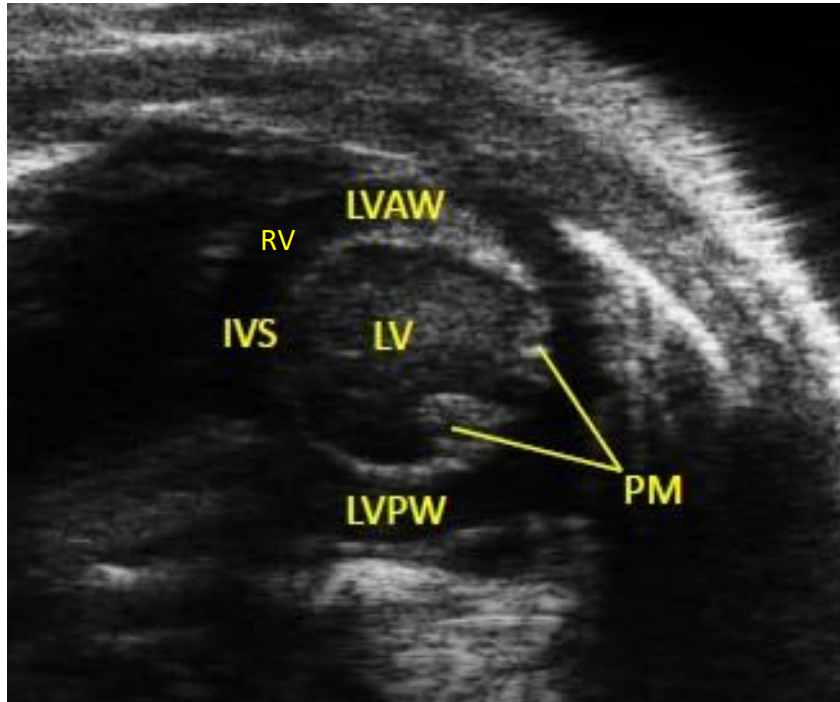
- The Vevo Lab analysis software is located on the SBMS supercomputer, allowing remote access for data analysis. An active internet connection, UQ VPN (Cisco AnyConnect) and Microsoft Remote Desktop installed are necessary requirements for it to function
- Inductions and access to Voltage is provided through SBMS Core Facilities: [sbmscorefacilities@uq.edu.au](mailto:sbmscorefacilities@uq.edu.au)
- Prior to using Vevo Lab upload Vevo files into the Vevo Lab Software folder located on the shared drive (facilities(\\sbms-voltage.its.hpc.net.uq.edu.au)). Make a Lab folder if needed
- Check booking date/s and time/s on PPMS

### Cardiac views

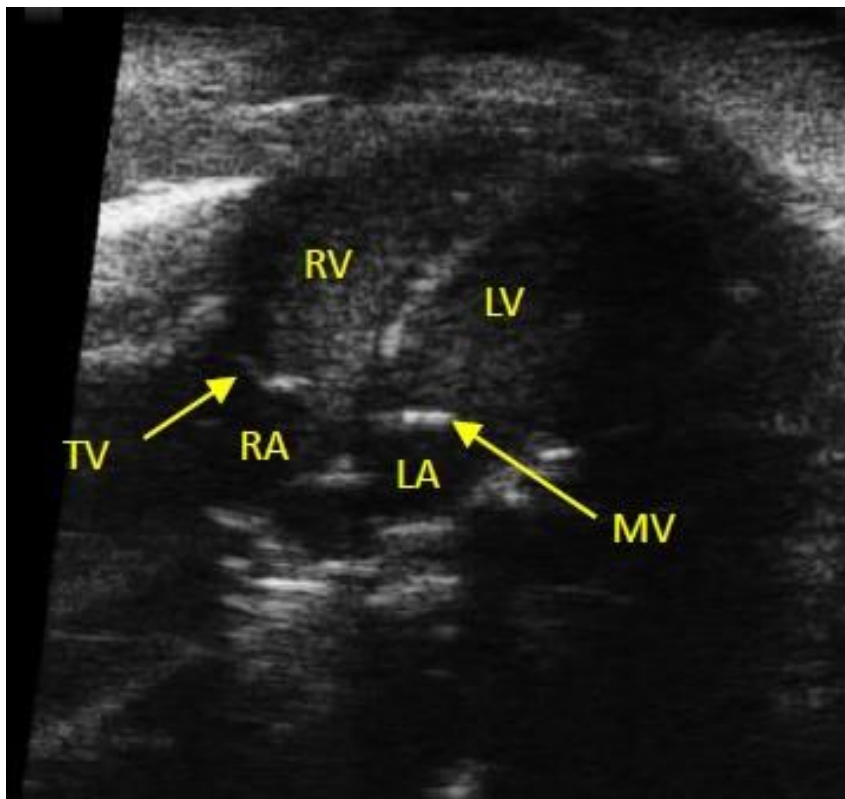
IVS	Interventricular septum
LV/RV	Left/Right ventricle
LVPW/LVAW	Left ventricle posterior wall/anterior wall
AO	Aortic orifice
PM	Papillary muscle
LA/RA	Left/Right atrium
TV/MV	Tricuspid/Mitral valve



Parasternal Long Axis (PSLAX)



Parasternal Short Axis (PSAX)

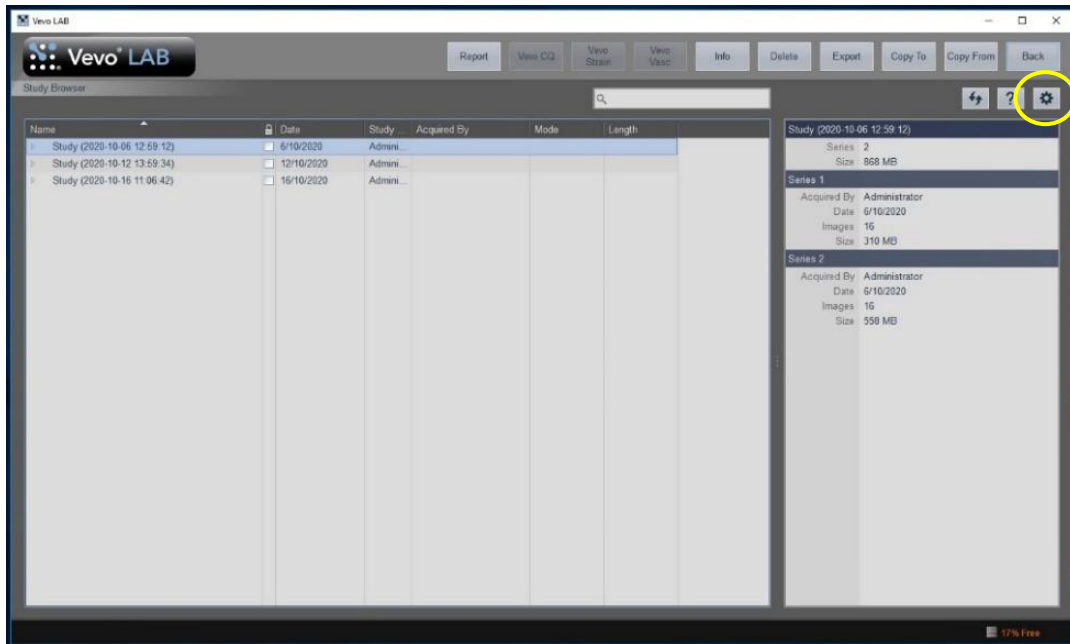


Apical four-chamber view

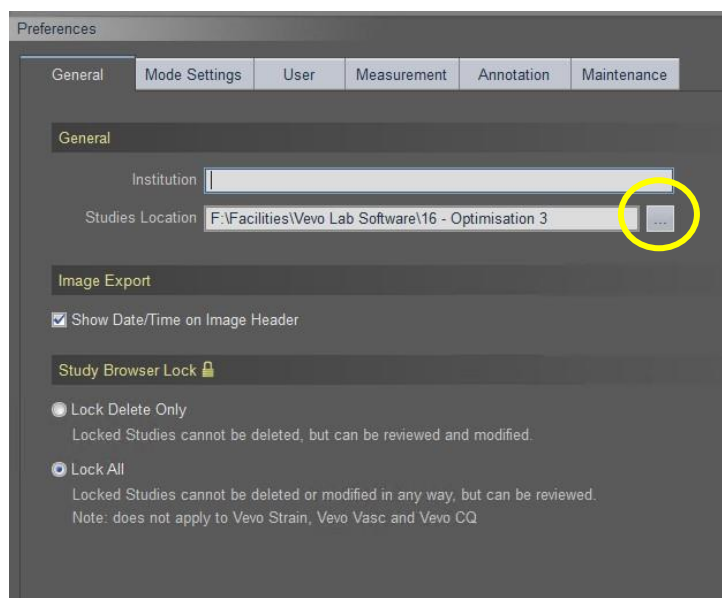
## II. Procedure

### Accessing files in Vevo LAB

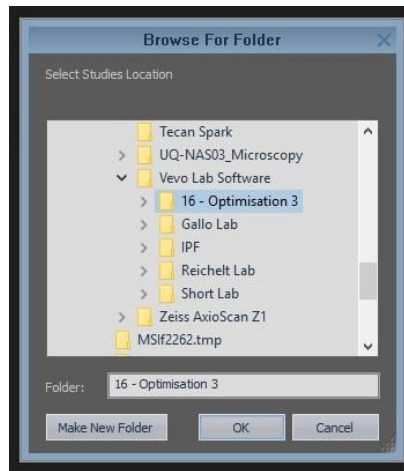
- Using Voltage → Double click on the Vevo LAB icon to access the study browser. To find files click on the cog icon, top right of screen (yellow circle).



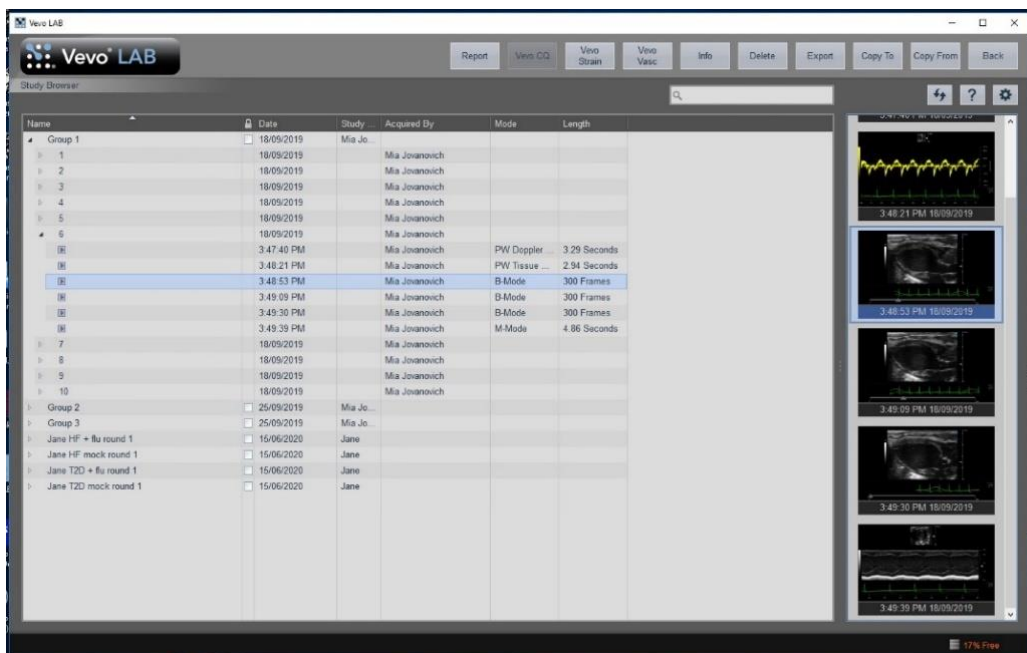
- Click on the ... tab to find your study location



- Select your folder then click OK



- Click OK again to return to the study browser
- In the study browser you can now open folders and locate individual images. Double clicking on an image (RHS of window) or on the file name will open it in Vevo LAB.



### III. Cardiac Package measurable parameters

- **B Mode – PSLAX:**  
“LV Trace” gives the following measurements:  
HR (bpm)  
Area (d/s) (mm<sup>2</sup>)  
Volume (d/s) (μL)  
SV (μL) stroke volume  
EF (%) ejection fraction  
FS (%) fractional shortening  
CO (mL/min) cardiac output

“LV Trace” PSLAX Vevo analysis: Locate diastole by scrolling through image, select the measurement tab (yellow circle), then in the table on the LHS of screen select, cardiac package, PSLAX, then LV trace. Starting at the aortic annulus, left click on the upper wall then the bottom wall to define the top of the LV, then left click at the apex, followed by 3-5 left clicks tracing along the anterior LV wall, repeat along the posterior LV wall, making the last click a right click. Advance the images to systole and repeat. Dot points can be modified after tracing is complete. Measurements are giving on the image and in the table on the LHS.



Diastole PSLAX

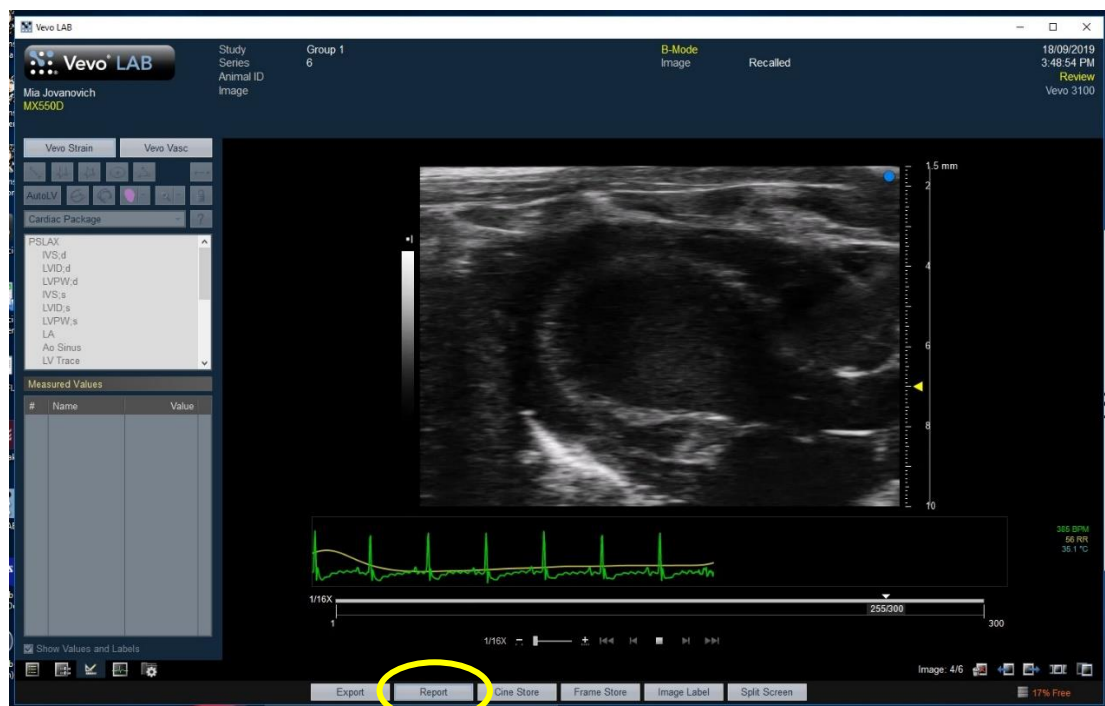


Systole PSLAX

- To return to the study browser select the bottom right button (yellow circle)



- To export your measurements (.csv file) click the report button at the bottom of the screen (yellow circle)



- M (motion) Mode – PSAX:**  
 “LV Trace” gives the following measurements:  
 HR (bpm)  
 Diameter (d/s) (mm)  
 Volume (d/s) ( $\mu$ L)  
 SV ( $\mu$ L)  
 EF (%)  
 FS (%)  
 CO (mL/min)  
 LV Mass (mg)  
 LVAW (d/s) (mm) LV anterior wall  
 LVPW (d/s) (mm) LV posterior wall

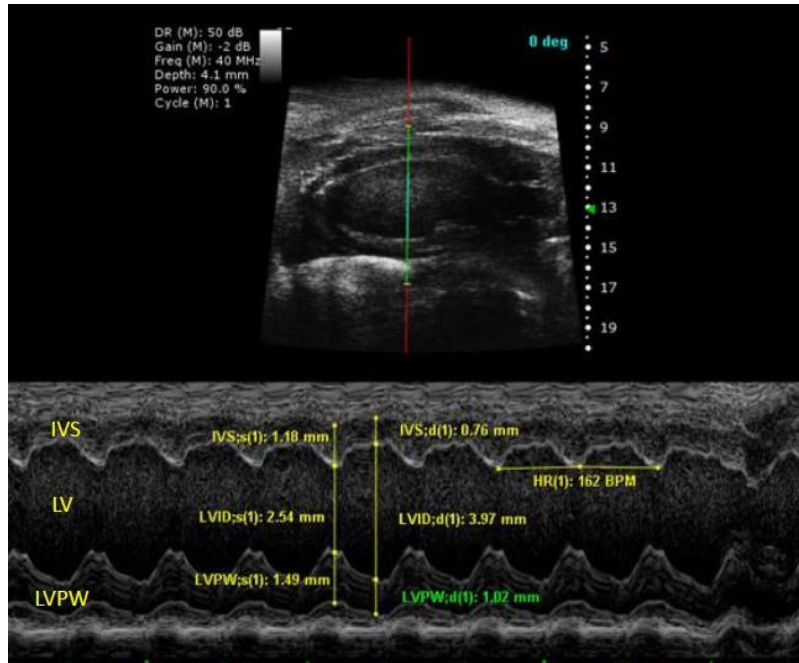
“LV Trace” PSAX Vevo analysis: Locate the section you would like to measure by scrolling through the series to where the animal is not breathing. Select the measurement tab, in the table on LHS of screen select PSAX, then LV Trace. Left click along the inner LVAW at diastole and systole points (~5 times), making the last point a right click. Repeat along the inner LVPW, then along the outer LVAW, then outer LVPW. Measurements will appear on the image and in the LHS table. Note: avoid clicking on papillary muscles that only appear in systole along the LVPW.



### M Mode – PSLAX or PSAX:

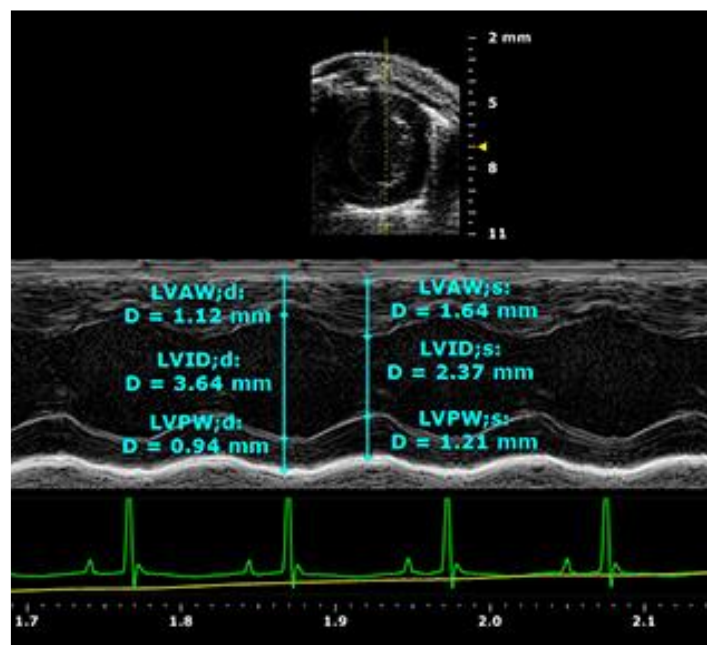
IVS thickness can be measured in either *M Mode PSLAX* or *M Mode PSAX* with predetermined chained measurements. When acquiring images sample gates need to intersect the LV, IVS and RV, the region of interest needs to be between the yellow wireframe bracket set.

“IVS (d/s)” PSLAX Vevo analysis - gives the following measurements: Scroll series to find region of interest. Select measurement tool, then PSLAX, then IVS (d). Left click on IVS (RV side) to initiate measurements, subsequent clicks and measurements are assumed in the order IVS (LV side), inner LVPW, outer LVPW. Repeat for IVS (s).



“LVAW (d/s)” or “IVS (d/s)” PSAX Vevo analysis - gives the following measurements:  
 LVAW (d/s) (mm) or IVS (d/s) (mm) Interventricular septum  
 LVID (d/s) (mm) LV interior diameter  
 LVPW (d/s) (mm)

“LVAW (d/s)” or “IVS (d/s)” SAX Vevo analysis: Scroll series to find region of interest. Select measurement tool, then PSAX, then IVS (d). Left click on the outer LVAW (RV side of the IVS) to initiate measurements, subsequent clicks and measurements are assumed in the order inner LVAW (LV side of IVS), inner LVPW, outer LVPW. Repeat for IVS (s). Below images show LVAW measurement.





## Diastolic function

Vevo can help assess the degree of diastolic function based on filling pressures, given that elevated pressure is a consequence of diastolic dysfunction (i.e. presence or absence of elevated LV filling pressures). The grade of diastolic function and filling pressures can be assessed by a combination of parameters:

1. Transmitral flow velocity (Colour Mode/PW doppler)
2. Mitral annular velocity (Tissue doppler)

### 1. Transmitral flow velocity/mitral valve flow

Transmitral flow velocities give insight to the LV filling pressures. The velocities are determined by the transmitral pressure gradient, which correlates with the peak transmitral filling rate (velocities). The Doppler signal displays:

1. E-Wave: peak early diastolic filling velocity (rapid filling)
2. A-Wave: late diastolic filling velocity (atrial contraction)
3. E/A Ratio: suggests whether diastolic filling is occurring at the proper time and rate
4. Deceleration Time (DT): early filling velocity
5. Isovolumic Relaxation Time (IVRT): time interval between aortic closure and mitral opening
6. Isovolumic Contraction Time (IVCT): time interval between closure of the mitral valve and the aortic valve opening

- **Colour Mode/PW Doppler – Apical four-chamber view**

“MV Flow” Vevo analysis - gives the following measurements:

MV E (mm/s) (Early peak)

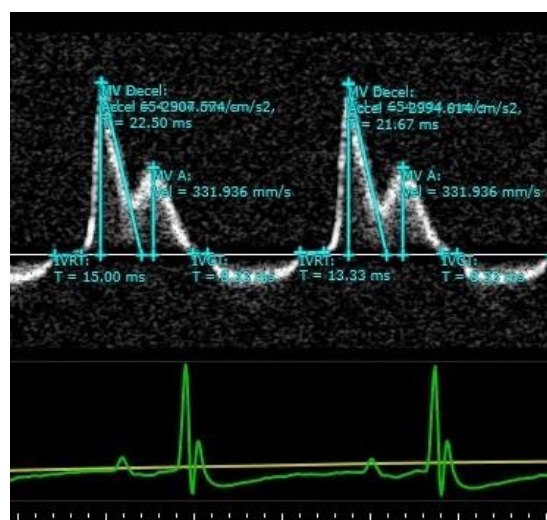
MV A (mm/s) (Atrial peak)

MV Decel – Acceleration ( $\text{mm/s}^2$ ), Time (ms)

IVRT (ms) – Isovolumetric relaxation time

IVCT (ms) – Isovolumetric contraction time

“MV Flow” Apical 4-chamber view Vevo analysis: Scroll series to find region of interest. Select measurement tool, MV flow, then MV E. Left click on the top of an E wave then at the base (repeat for 3-5 peaks). Then select MV A and repeat for 3-5 A waves. Select MV Decel, left click at the top of an E wave tracing the angle of deceleration ending with the 2<sup>nd</sup> left click on the base line. Selecting IVRT and IVCT allows you to mark these times.



Items to Consider:

- When LV relaxation is delayed or prolonged (elevated filling pressures), this causes the timing of mitral valve to open later. When this happens, the IVRT is increased, or has a long occurrence time. On the other hand, IVRT will be shortened when the LA pressure is elevated, causing the mitral valve to open earlier than normal. Therefore, IVRT is inversely related to the LA pressure and directly related to LV filling pressures.
- In the presence of atrial fibrillation: A-wave will not be present.
- Transmitral velocities are age dependent: velocity will decrease with advancing of age.

## 2. Mitral annular velocity - Mitral valve annulus

Tissue Doppler imaging allows evaluation of the lengthening of the mitral annulus. During systole, the ventricle contracts, and twist towards the apex to eject blood. Once diastole begins, the ventricle lengthens. This longitudinal motion of the ventricle lengthening occurs before filling (in a normal situation). This method evaluates the longitudinal motion and velocity of both myocardial relaxation and restoring forces during rapid filling and atrial contraction phase. In other words, tells us how compliant the ventricle is during diastole.

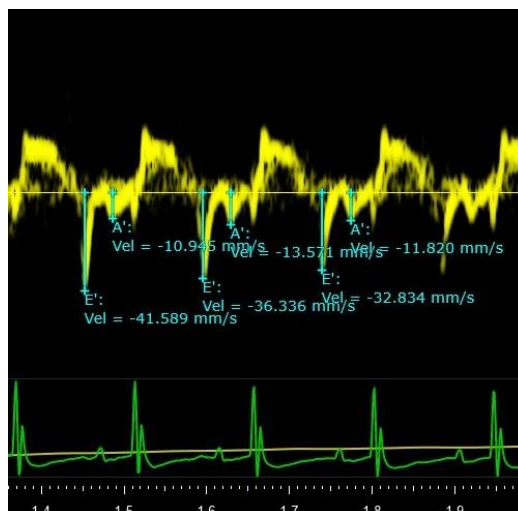
Tissue doppler displays 2 waveforms of interest:

E': early diastolic velocity - corresponds with early rapid filling

A': late diastolic velocity - corresponds with atrial contraction

- **Tissue Doppler – Apical four-chamber view**  
“MV Flow” Vevo analysis - gives the following measurements:  
E' (mm/s)  
A' (mm/s)

“MV Flow” Apical 4-chamber view Vevo analysis: Scroll series to find region of interest. Select measurement tool, MV flow, then E'. Left click on the base of an E peak then at the velocity base line (repeat for 3-5 peaks). Repeat selecting MV flow, then A'.



Notes:

- Basal regional wall motion abnormalities can alter velocities
- Right heart pathology or pulmonary hypertension can affect septal velocities