# Relationship between Stroke Volume and Pulse Wave Velocity

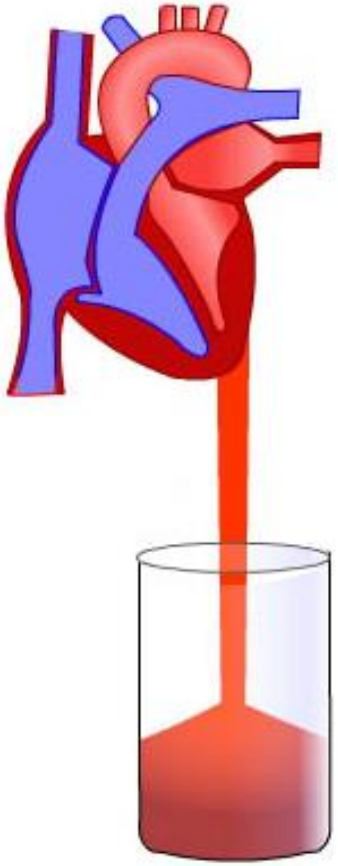
***Shun Kamoi***[1], C.G.Pretty[1], Y.S.Chiew[1], S.Davidson[1], A.Pironet[2], T Desaive[2], GM Shaw[3], JG Chase[1]

[1]*Department of Mechanical Engineering, University of Canterbury, New Zealand*
[2]*GIGA Cardiovascular Science, University of Liege, Belgium*
[3]*Intensive Care Unit, Christchurch Hospital, New Zealand*

# Stroke Volume

Stroke Volume measurements are essential for evaluating patient hemodynamic status

- Fluid responsiveness
- Response to inotropic therapy



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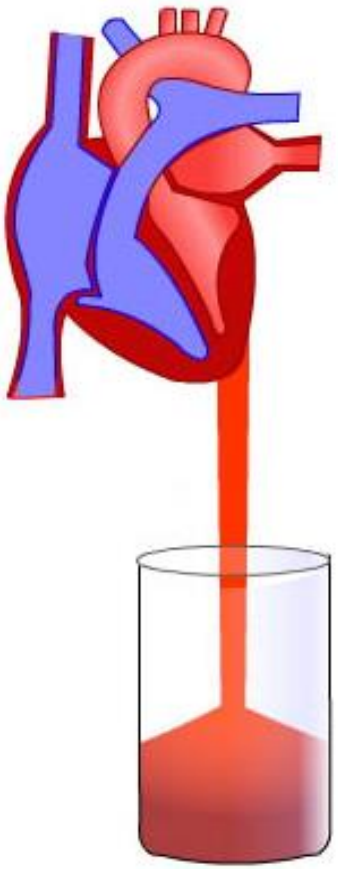
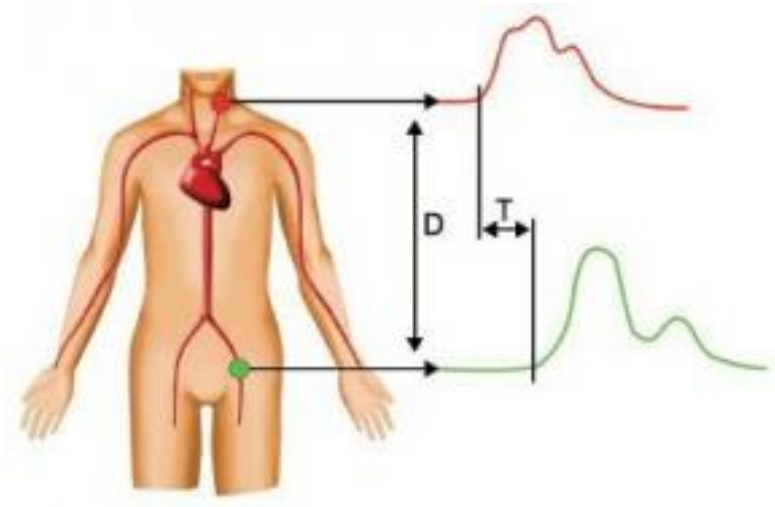


## Problem (Hard to measure)

- Additionally invasive measurement
- Specialised equipment required
- Time consuming

# Pulse Wave Velocity (PWV)

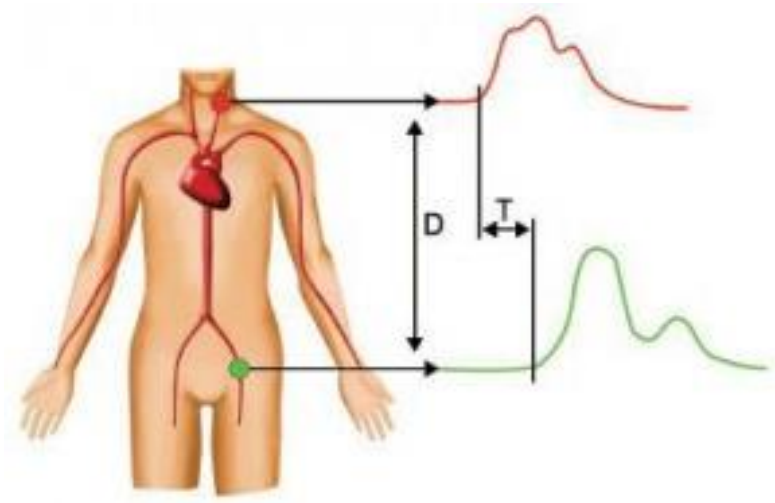


**What and How?**

PWV is a measure of arterial stiffness.

PWV can be measured non-invasively or minimally invasively

# Pulse Wave Velocity (PWV)



**What and How?**

PWV is a measure of arterial stiffness.

PWV can be measured non-invasively or minimally invasively

SV becomes easier to measure if PWV relates to SV

# How does SV relates to PWV?

**Bramwell - Hill**

PWV is related to Stiffness

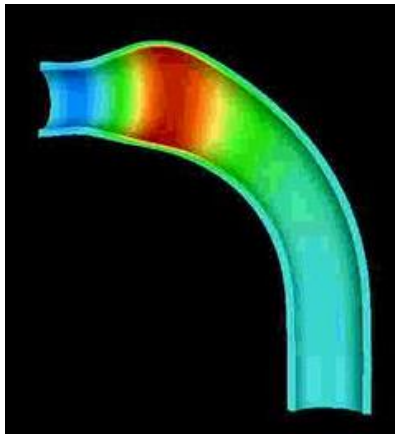
# How does SV relates to PWV?

**Bramwell - Hill**

PWV is related to Stiffness

**Arterial Wall Property**

Stiffness is related to Arterial Volume



# How does SV relates to PWV?

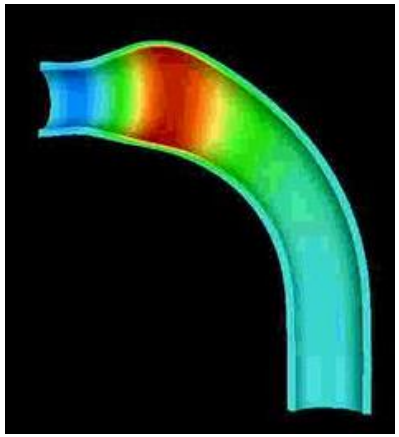
**Bramwell - Hill**

PWV is related to Stiffness

**Arterial Wall Property**

Stiffness is related to Arterial Volume (AV)

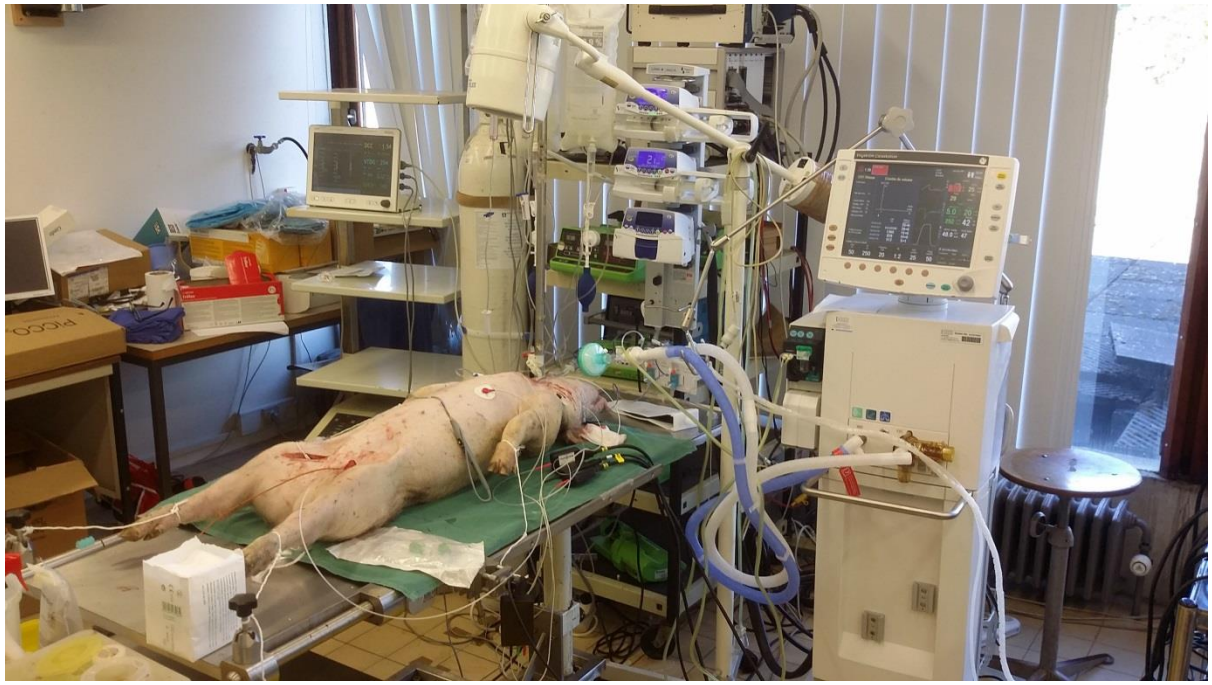
**Relationship?**



SV ↑ AV ↑ Stiff ↑ PWV ↑

# Experiment

To investigate the relationship between SV and PWV, data from porcine experiment were used (Six Pigs n = 6).



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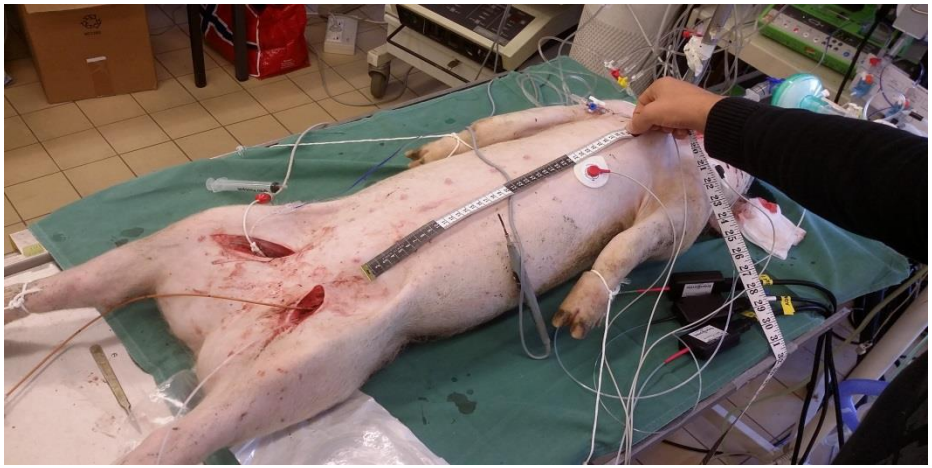
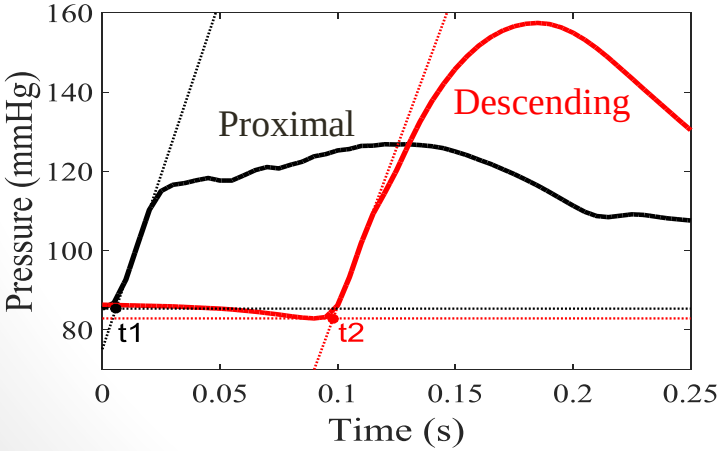
# PWV Measurement

**Two spatially separated pressure measurements**



**Aortic Pressures**




**Value of PWV**

$$PWV = \frac{distance}{t2 - t1}$$

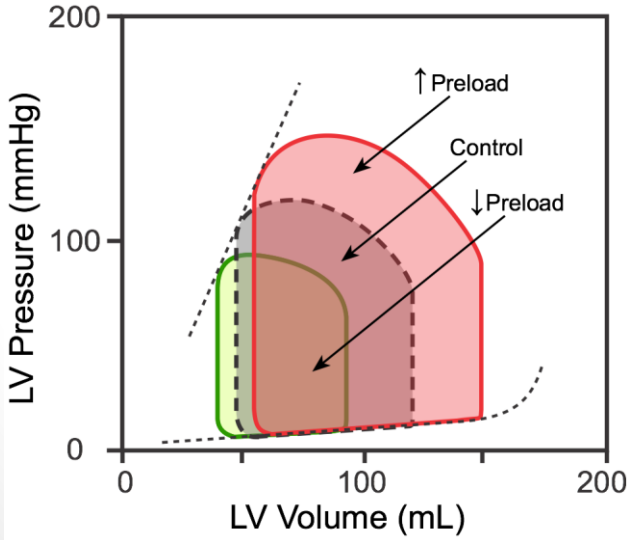
# Stroke Volume Changes

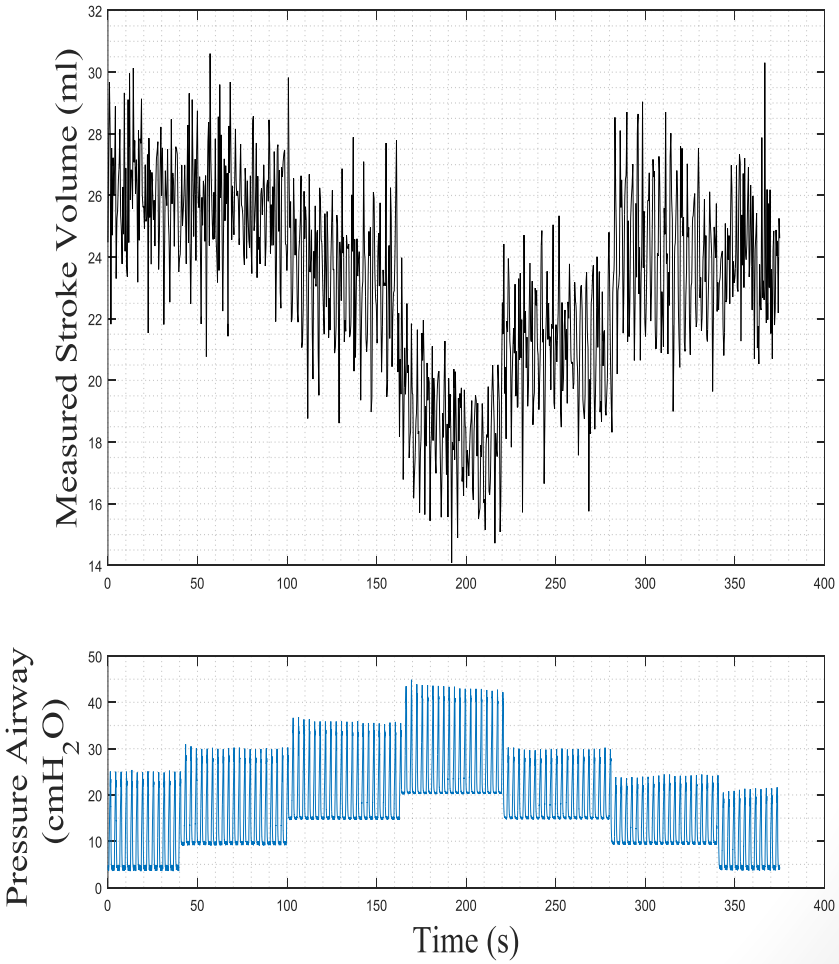
**Mechanical ventilation settings**

Step-wise changes in positive end expiratory pressure were made

**Preload**

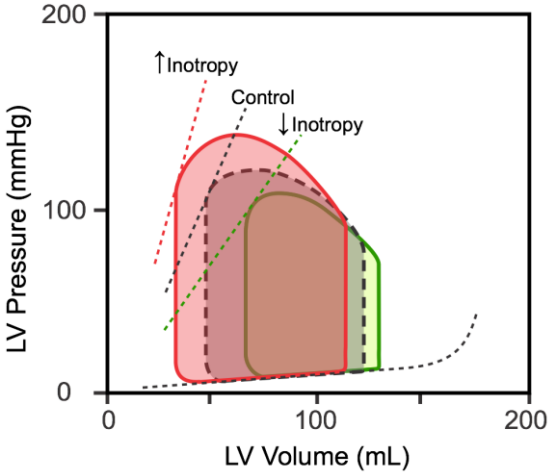
Increase/decrease in airway pressure changes the amount of blood flowing into the ventricle during diastole.



# Dobutamine Infusion

- Increased Contractility
- Increased response from Preload Changes
- Increased Heart Rate




## Vasodilation

- Reduced arterial resistance
- Reduced arterial stiffness

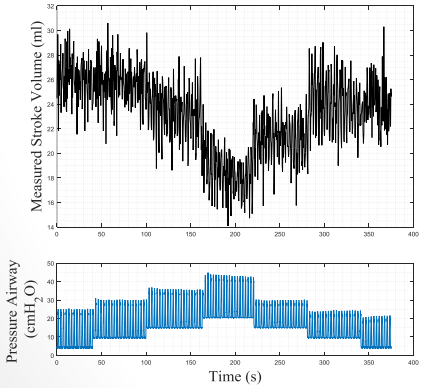
Normal Vessel

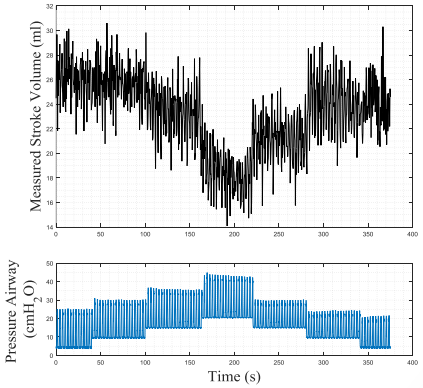
Dilated Vessel

# Experiment details

**First Half** **Second Half**

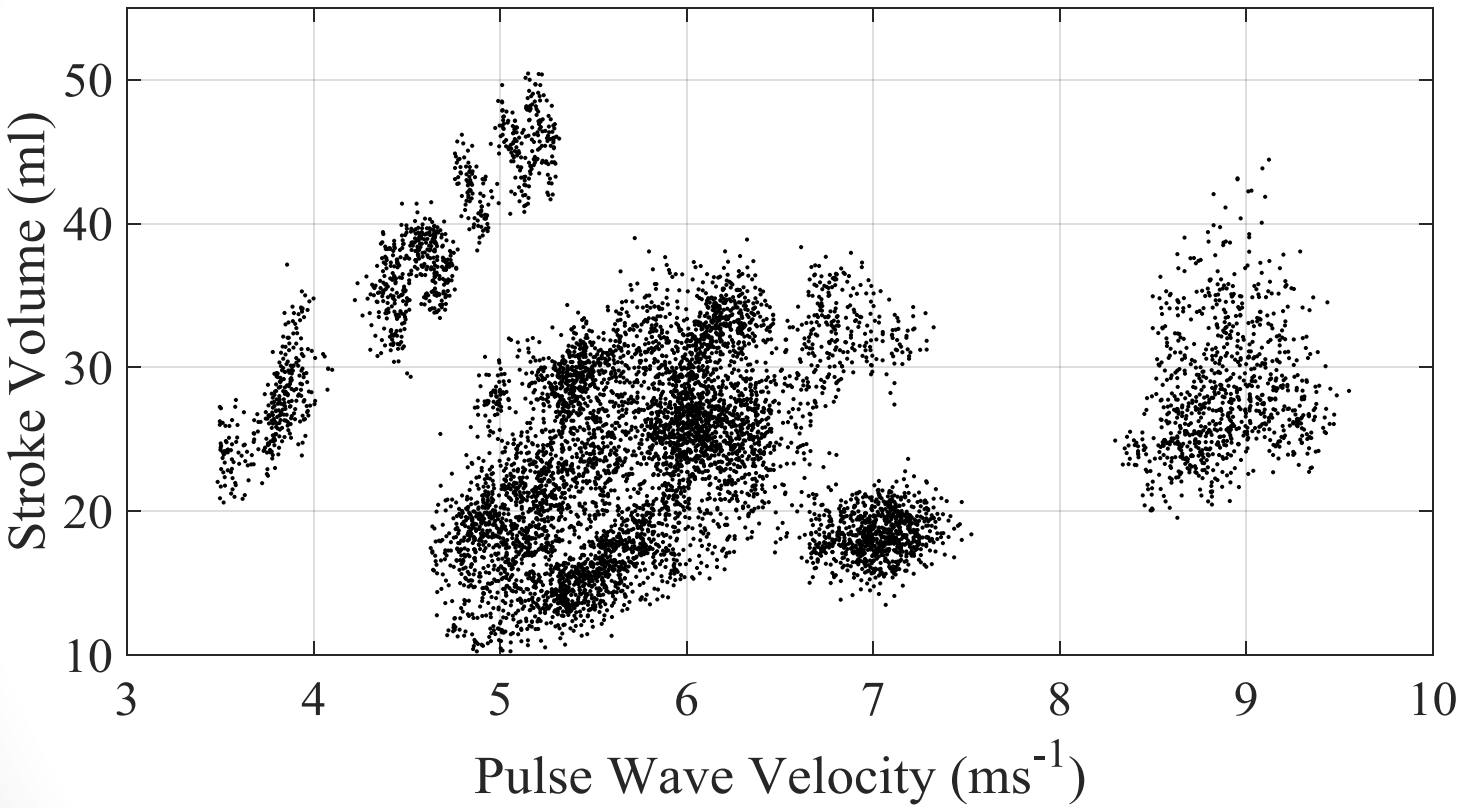
Preload Change → Continuous Dobutamine Infusion → Preload Change





# Results

**Correlation between absolute value of SV and PWV for all pigs**

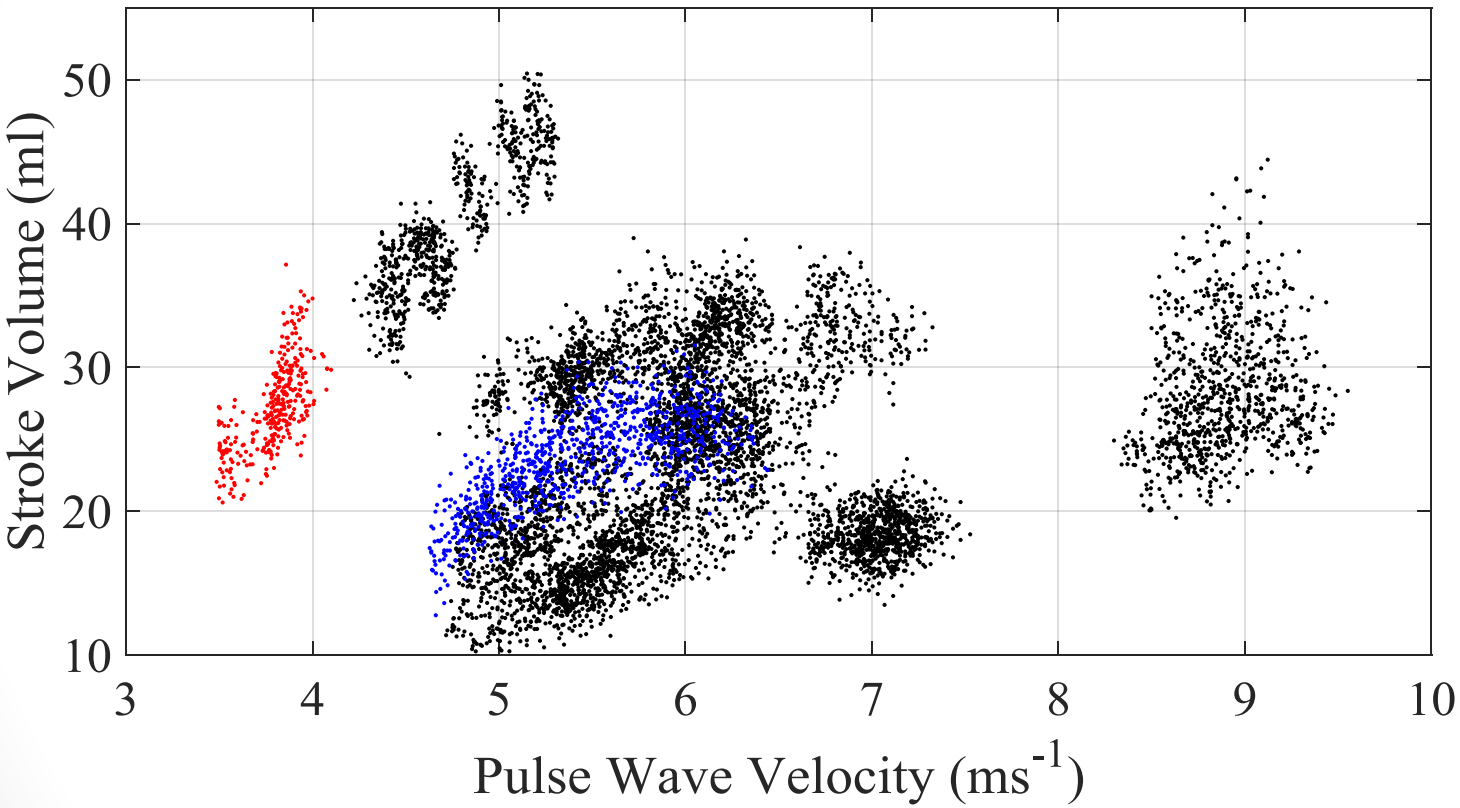



Correlation coefficient was R=0.029

No relation between SV and PWV ?

# Results

**Correlation between absolute value of SV and PWV for one pig**




Red dots – No dobutamine

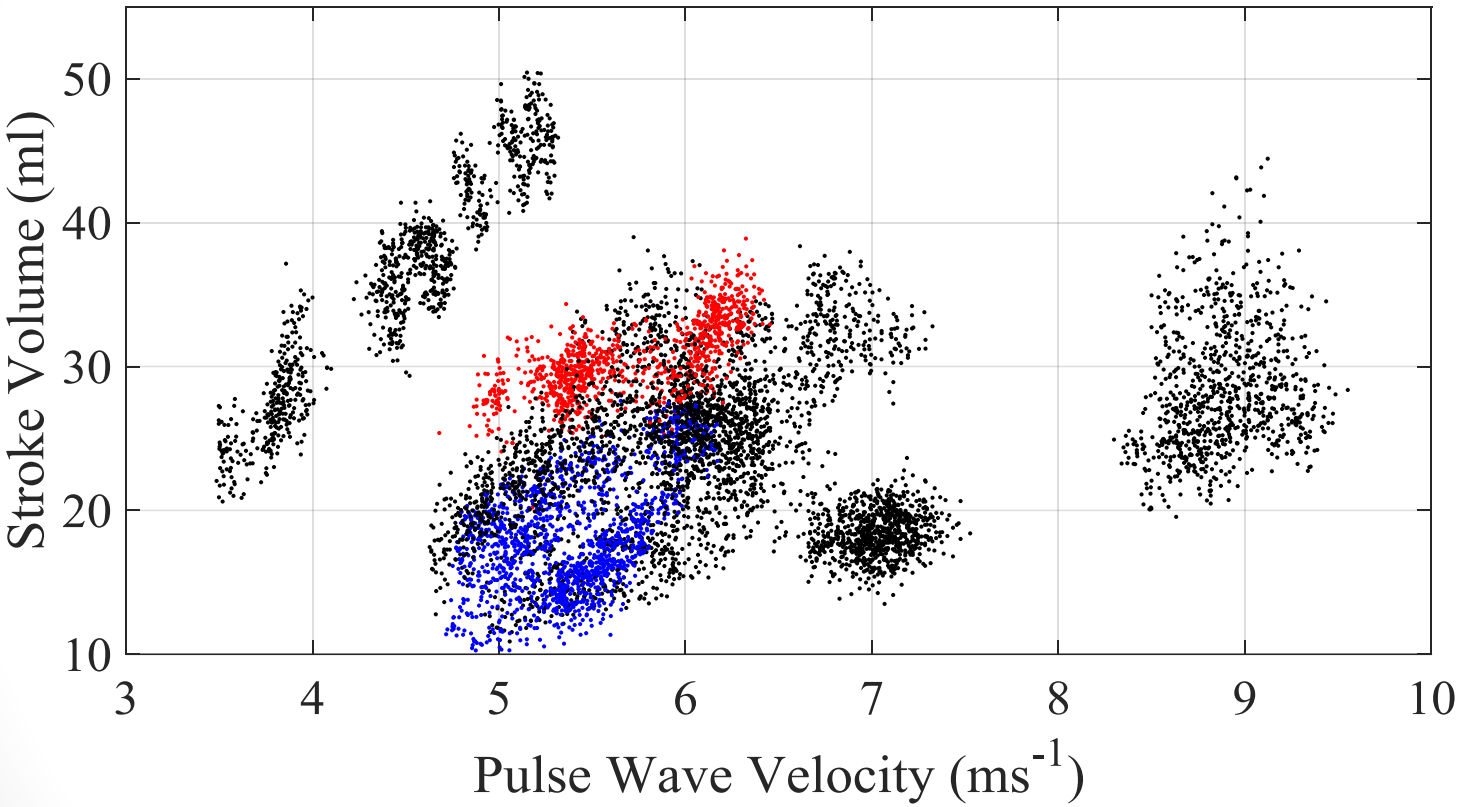
Correlation Coefficient R= 0.67

Blue dots - dobutamine

Correlation Coefficient R= 0.70

# Results

**Correlation between absolute value of SV and PWV for one pig**




Red dots – No dobutamine

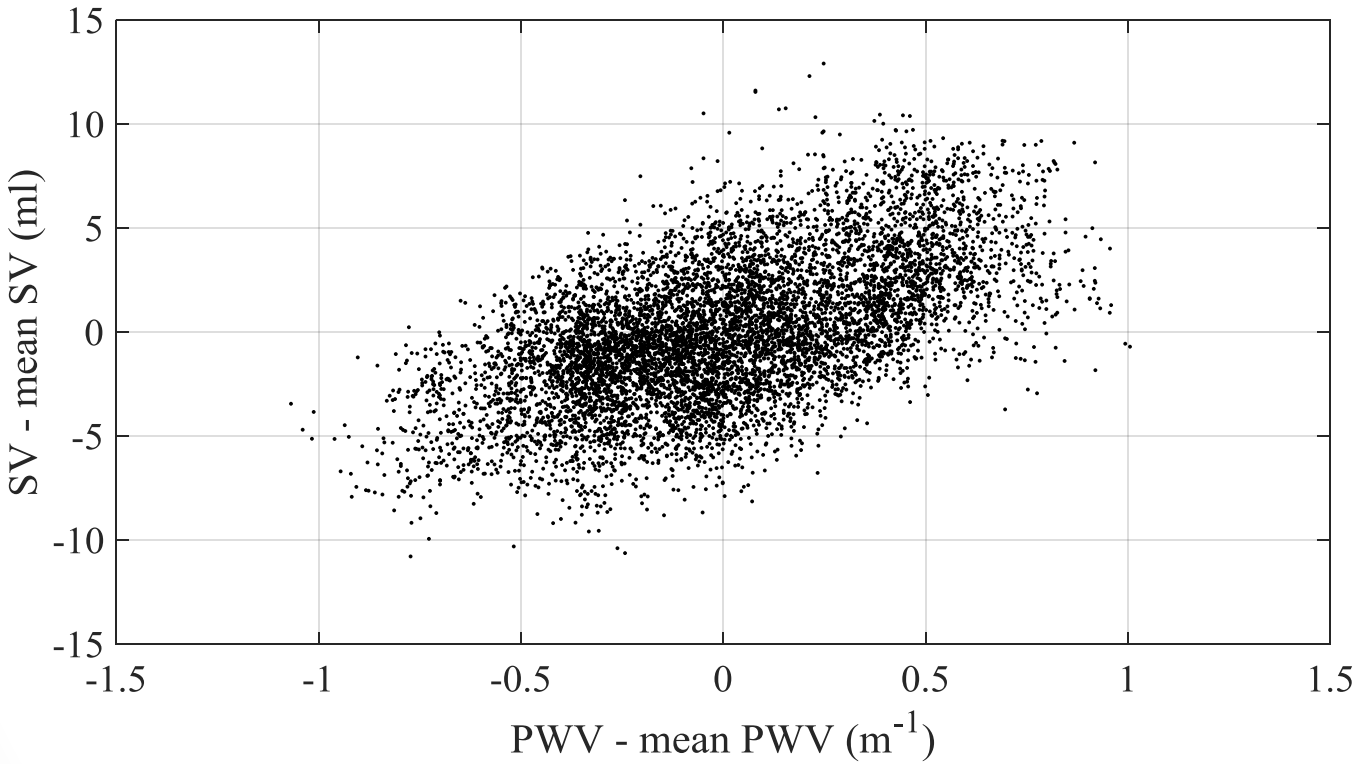
Correlation Coefficient R= 0.70

Blue dots - dobutamine

Correlation Coefficient R= 0.43

# Results

**Correlation between Trend value of SV and PWV for all pigs**




Correlation coefficient was R=0.59

There are relationship between SV and PWV

# Limitations

- Relation between SV and PWV are poor when there are PWV changes due to afterload changes
- Highly invasive PWV measurements were used in this study
- Data from healthy pigs were used for this study and further study must be conducted to verify the relationship under CV failure

# Summary

- PWV can reliably identify SV, if SV are changed from preload condition
- If there are changes in the afterload condition the relationship between SV and PWV are poor

# Future Work

- Validation of the relationship with non-invasive or minimally invasive measurement of PWV
- How much information on afterload condition can we retrieve from the shape of arterial blood pressure

# Acknowledgement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