PARAMETER CORRELATION ANALYSIS IN FOUR MATHEMATICAL MODELS OF LEFT VENTRICULAR RELAXATION

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Introduction

- Several models of left ventricular relaxation (LVR) exist in the literature [1,2,3].
- They vary in their derivation (empirical or physiological), proven clinical utility, and number of parameters.
- Models with more parameters provide a better fit to experimental curves, but contain more uncertainty because their parameters **p** are correlated and, therefore, more difficult to precisely identify.
- This work compares four models of LVR in terms of quality of fit and parameter correlation.

Methods

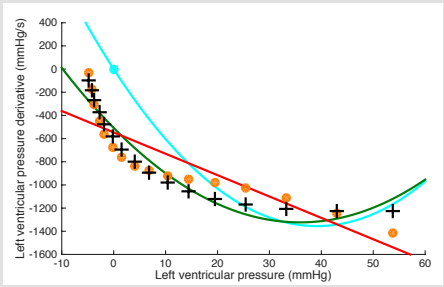
Models of LVR:

$$T\dot{P}(t) + P(t) - P_{end} = 0 \quad [1,2]$$

$$\dot{P}(t) = \frac{P_B - P(t)}{P_A T_L}[P_A + P_B - P(t)] \quad [3]$$

$$\ddot{P}(t) + \frac{1}{\mu}\dot{P}(t) + E_k(P(t) - P_{inf}) = 0 \quad [2]$$

$$\dot{P}(t) = -\frac{P(t)}{T_Q} - \frac{KP(t)^2}{T_Q} \quad \begin{matrix} K > 0 \\ K < 0 \end{matrix} \quad [1]$$



$$RSS = \sum(\dot{P}_{mes}(t) - \dot{P}_{mod}(t))^2$$

Log-likelihood:

$$l = \text{constant} - 0.5\sigma^{-2}RSS$$

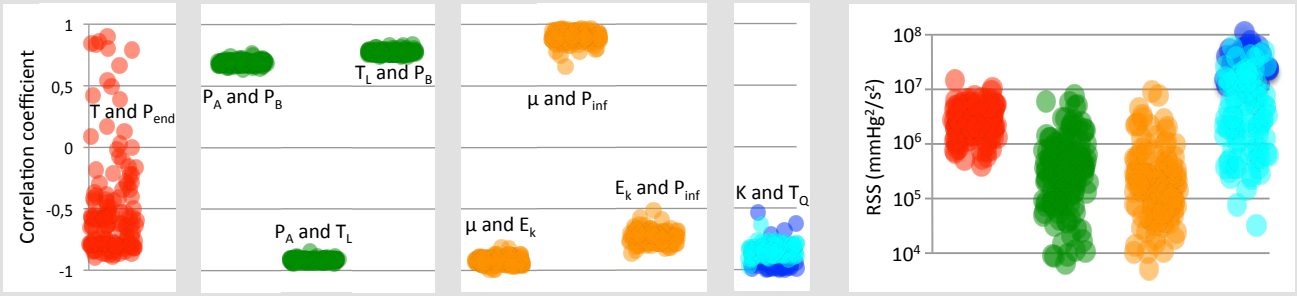
Covariance matrix:

$$\boldsymbol{\Sigma} = \mathbf{F}^{-1} = \left(\frac{\partial^2 l}{\partial \mathbf{p}^2}\right)^{-1}$$

Correlation matrix:

$$R_{ij} = \frac{\Sigma_{ij}}{\sqrt{\Sigma_{ii}\Sigma_{jj}}}$$

Results



Conclusion

- Models containing **less parameters** present **less strong correlations**.
- Models with **more parameters** provide **better fit** to experimental data.
- Besides parameter correlations and quality of fit, the choice of a model should also be based on the **clinical information** provided by the parameters.
- The 4th model provides a good trade-off between all these criteria **when K > 0**.

Thanks

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References

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