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Using Machine Learning to Generate a Core Set of Echocardiographic Indices for Pediatric Research: A Sub-study in the PCS2 Cohort

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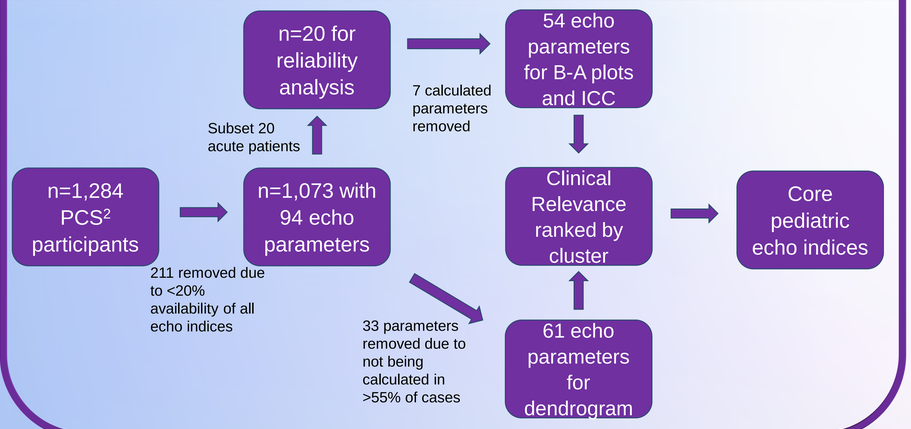
Question and Introduction

- With a multitude of echo parameters at a clinician's disposal and clinical efficiency paramount, what are the most reliably measured and clinically relevant pediatric echo indices?
- No studies have determined the most clinically relevant and reliable groupings echo parameters in pediatric patient populations
- Using the PCS^2 (Preventing Cardiac Sequelae in Pediatric Cancer Survivors) cohort of childhood cancer survivors and clustering analysis, a machine learning (ML) method, we identify related echo parameters that represent a similar dimension of the variance in a pediatric echocardiographic study

Goal

- Use machine learning to cluster echo parameters by dimensionality of information, assess reproducibility and clinical relevance to identify a core set of echo indices to guide pediatric clinical care and research

Methods



Results

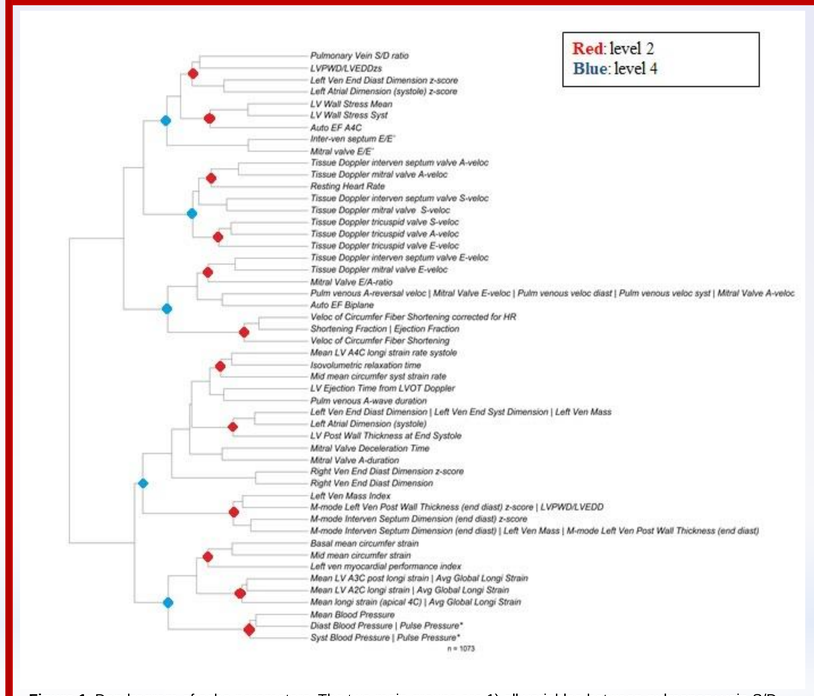


Figure 1: Dendrogram of echo parameters. The two main groups are 1) all variables between pulmonary vein S/D ratio and velocity of circumferential fiber shortening, and 2) all remaining variables. Variables that are next to each other are similar, for example mean blood pressure and diastolic blood pressure. The variables listed after the main variables and separated with a | are highly (>0.8) correlated with the main variable. Linear combinations are indicated with an asterisk, i.e. pulse pressure was identified as a linear combination of diastolic and systolic blood pressure. Coloured nodes represent levels of clusters that will be ranked in order of clinical relevance.

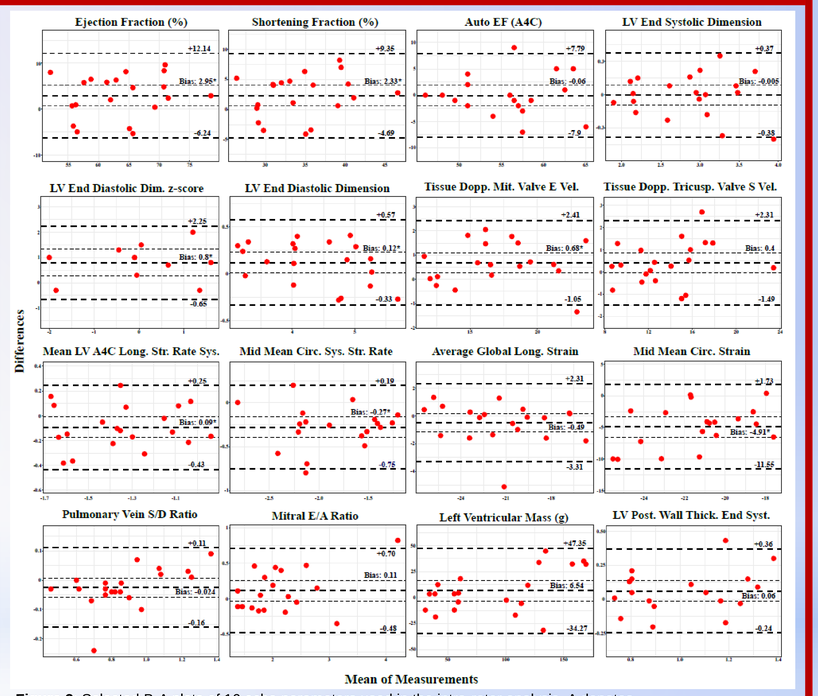


Figure 2: Selected B-A plots of 16 echo parameters used in the intra-rater analysis. A denotes S1 intra-rater and B denotes S2 intra-rater. Upper and lower limits of agreement are presented as well as mean bias. *Indicates significant bias ($p \leq 0.05$) by Wilcoxon signed-rank test.

- ≥73% of all scored parameters had good (0.60-0.74) or excellent (≥0.75) ICC in the inter- and intra-rater analyses
- Using highly reliable (>0.65 ICC) and available (>80% scored) parameters, we presented clusters of parameters to (5) pediatric cardiologists to rank within cluster clinical relevance
- Mean within cluster ranks identified a core set of 10: EF, pulmonary vein S/D ratio, auto EF A4C, tissue doppler mitral valve A-velocity, tissue doppler tricuspid valve S-velocity, mitral valve E/A ratio, mean LV A4C longitudinal strain rate systole, LV end diastolic dimension, m-mode LV posterior wall thickness (end diastole), average global longitudinal strain

Conclusions and Future Directions

- Using clustering analysis, clinical relevance rankings, and reliability we have identified 10 core echo indices that together recapitulate the information generated from the standard study set of 94 parameters.
- We aim to use these 10 parameters to guide pediatric echocardiographic research and clinical care.

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