Optimising Thresholds for the Detection of Pulmonary Hypertension (PH) and Pre-capillary PH Using Automatic Measurement of TRJV on Echocardiography

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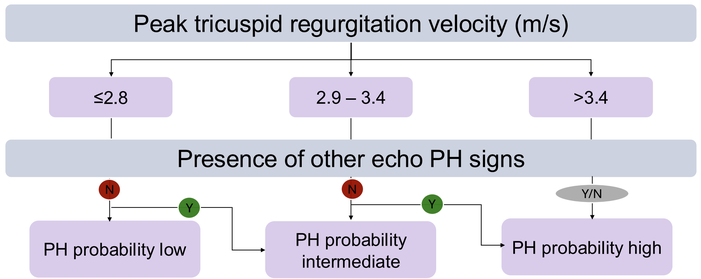
Background

- Pulmonary Hypertension (PH) **affects 1%** of the population
- Diagnosed late due to **non-specific** symptoms
- Right heart catheterisation (RHC) is the **gold standard** diagnostic test
- Echocardiogram can be used to **predict** the presence of PH as per ESC/ERS guidelines

ESC/ERS Guidelines



Artificial Intelligence solutions

- Tools have been developed for **automated evaluation** of echocardiograms
- **US2.AI** is a deep learning algorithm which was trained using 1,145 echocardiograms from 1076 patients with heart failure
- **Validated** using an **internal holdout** approach on 406 echocardiograms from 406 patients
- **Externally validated** using two datasets with a total of 32,270 echocardiograms from 9,910 patients

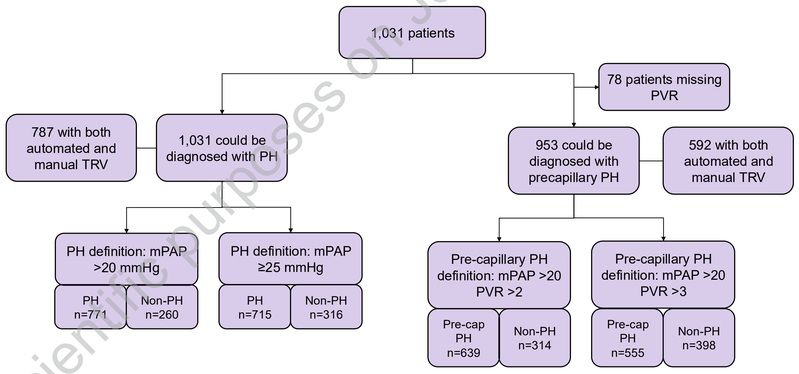
Aims

- Evaluate the **performance** and **utility** of US2.AI in a consecutive cohort of patients with suspected PH.
- Compare the **diagnostic accuracy** of detecting PH based on TRV alone.
- Identify the **optimal TRV threshold** for detecting PH.

Methods

- **Patient ID Source:** ASPIRE Registry**.** Suspected PH between 2009 and 2021 who had both echocardiography and RHC
- **PH diagnostic criteria:** RHC results of mPAP ≥25 mmHg OR mPAP >20 mmHg
- **Pre-capillary PH diagnostic criteria** : mPAP >20 mmHg and (PVR) >3 Wood Units (WU), OR PVR >2 WU
- **Evaluation:** echocardiogram evaluated manually and by the US2.AI to yield TRV measurements.
- **Comparison Criteria:** Mean values of TRV measurements (paired T-test, significance threshold $p < 0.05$), agreement (intraclass correlation coefficient, ICC) and bias (Bland-Altman analysis).
- **Diagnostic Accuracy Criteria:** Receiver Operating Characteristic (ROC) for manual & AI measurements

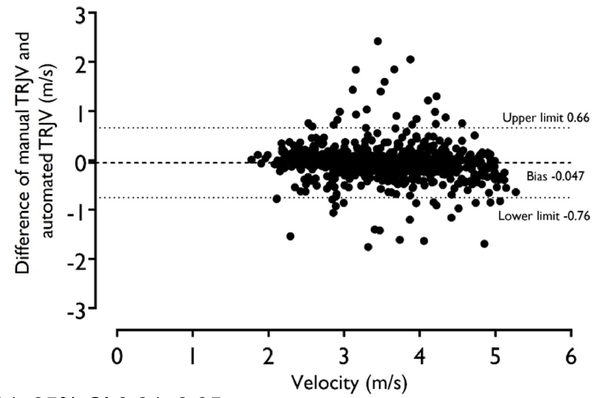
Patients



Results - Optimal TRV Threshold

	Manual				Automatic			
	PH (n = 754)		Pre-capillary PH (n = 716)		PH (n = 754)		Pre-capillary PH (n = 716)	
	mPAP ≥25 mmHg	mPAP >20 mmHg	mPAP >20 mmHg, PVR >3 WU	mPAP >20 mmHg, PVR >2 WU	mPAP ≥25 mmHg	mPAP >20 mmHg	mPAP >20 mmHg, PVR >3 WU	mPAP >20 mmHg, PVR >2 WU
Threshold	**3.54**	**3.54**	**3.57**	**3.57**	**3.42**	**3.42**	**3.69**	**3.42**
Accuracy	0.80	0.76	0.81	0.81	0.81	0.78	0.79	0.81
Sensitivity	0.76	0.72	0.78	0.78	0.79	0.75	0.72	0.79
Specificity	0.91	0.93	0.86	0.89	0.85	0.89	0.90	0.86

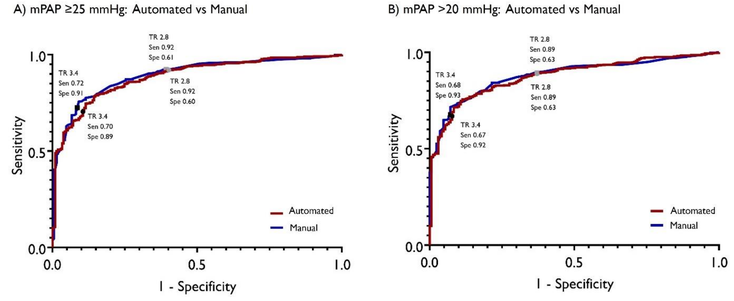
Results – Agreement and Bias



ICC 0.94, 95% CI 0.94–0.95

Bland-Altman analysis – -0.05 ± 0.36, 95%, CI -0.76 – 0.66

Results – ROC Curve



ROC curve comparing automated (red) and manual (blue) measurements for diagnostic accuracy of TRJV at low (black) and high (grey) thresholds for (A) mPAP >25 mmHg (P = 0.58) and (B) mPAP ≥20 mmHg (P = 0.31).

Conclusions

- **1031 patients included:** mean age 64 years, 65% female
- **87% automatic** TRV measurements vs **80% manual** reads
- **Excellent agreement** between manual and automatic TRV (ICC 0.94, 95%CI 0.94 - 0.95) with minimal bias.
- **Automated** TRV showed **high diagnostic accuracy** for PH (AUC 0.89 vs AUC of 0.90 for manual).
- **Optimal threshold** was consistent with those reported in ESC/ERS guidelines for high probability.
- **Automated measurement of TRV** on echocardiography is **feasible, accurate and reliable**.
- The study supports the implementation of AI-based approaches to echocardiogram evaluation and diagnostic imaging for PH.