

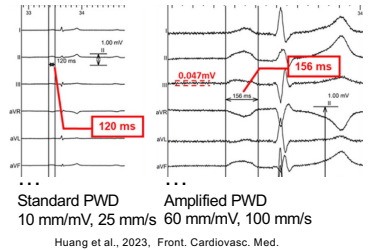
Bidirectional LSTM to Automatically Annotate Amplified P-wave Duration

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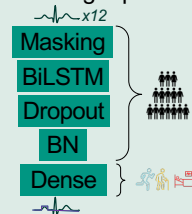
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Introduction

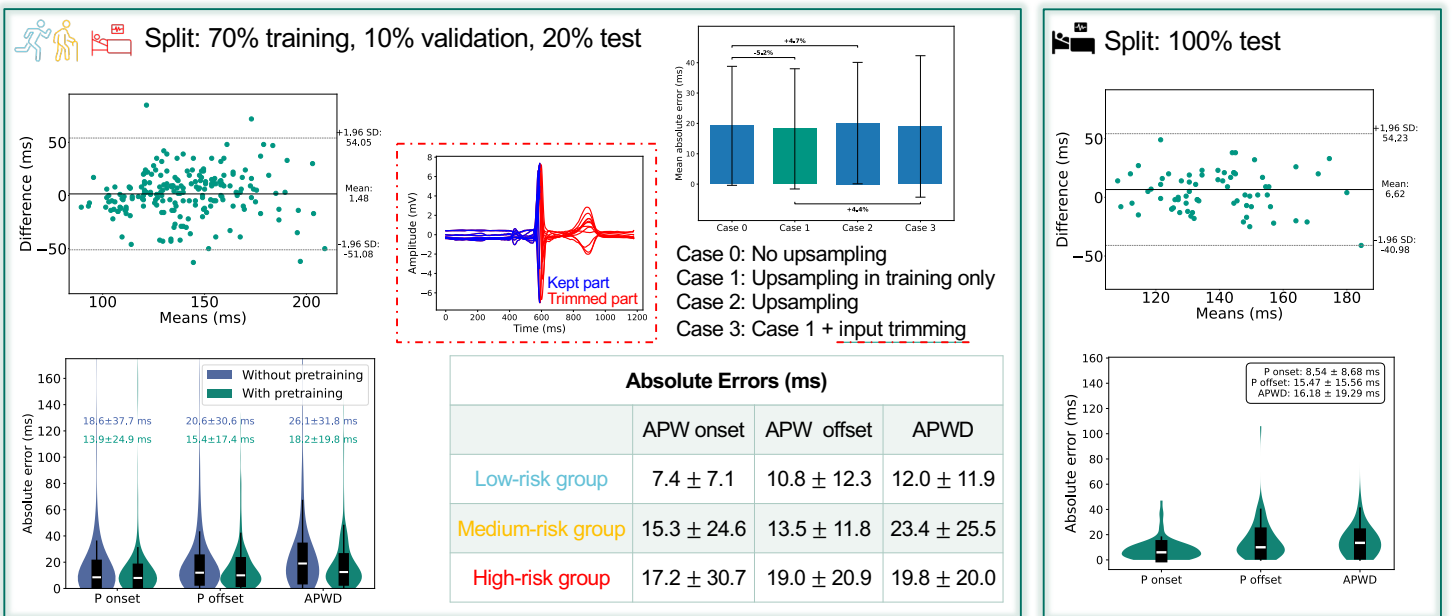
Atrial cardiomyopathy (AtCM) is linked to new-onset atrial fibrillation (AF), heart failure, and a possibly increased risk of cardio-embolic stroke. By analyzing the amplified P-wave duration (APWD), atrial conduction delay in patients with AtCM can be quantified non-invasively [1–3]. However, analysis of APWD requires manual annotation by experts as of now, which limits its use. This work developed an automated APWD algorithm that enables reproducible, machine-based APWD analysis as a basis for large-scale screening and risk stratification of AtCM.



Methods

Architecture	Pretraining Dataset	Main Dataset	Independent Dataset	Analyzed Effects
- BiLSTM 16 hidden units - Class weighting of 20 - Batch size 18 - Learning rate 0.001 - Adam optimizer - Dropout 10% - Batch normalization - Categorical cross-entropy loss	129,302 sinus rhythm ECGs of unique patients [4,5] 57 ± 20 years 53% male - P-wave labels generated by ECGdeli [6]	1,044 sinus rhythm ECGs of unique patients 314 ECGs from young individuals (18-30 years) [4,5,7,8] 212 ECGs from older cardiovascular patients without AF diagnosis 518 ECGs from patients with diagnosed AF with and without additional left atrial thrombus 24 ± 4, 69 ± 7, 89 ± 24 years 39%, 64%, 78% male - Expert APW labels	73 sinus rhythm ECGs of unique patients - All undergoing first pulmonary vein isolation 64 ± 9 years 69% male - Expert APW labels (consensus of 3 experts)	- Pretraining - Input Trimming - Resampling
				Training Pipeline 

Results



Discussion & Conclusion

- Deep learning-based annotation of APWD shows promise for enabling screening of large cohorts
- Highest absolute errors were observed in the high-risk group, likely due to late, low-amplitude segments of the P-wave
- Pretraining and upsampling to 1 kHz during training lead to improved model performance
- The model exhibits good generalization to unseen data, supporting its potential for broader clinical application

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