Investigating Artificial-Intelligence Derived Electrocardiographic aging-Disease Risk relationships Through the OHDSI Network

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INTRO

- As aging affects electrocardiogram (ECG) signals, we've developed a deep learning model to predict age from ECGs of 855 935 patients.
- As common data model (CDM) enables data-driven phenome-wide analysis across millions of records, the purpose of this study is to investigate the effect of discrepancy between deep learning-derived age from ECG (ECG-age) and chronologic age on future disease risk.

METHODS

1. The discrepancy between ECG-age and chronological age (delta age) was calculated in the institutional 15% hold-out split (121 702 patients). The dataset was divided into normal (delta age<+7) and ECG-aging (delta age≥+7) group.
2. We investigated the association of ECG aging with all recorded conditions in Severance CDM database (v.5.4).
3. Patients with at least 1-year observation period prior and posterior to the ECG acquisition date were included. Patients who died between 1-year posterior observation period were also included.
4. The relationship between ECG aging group and future conditions were calculated. To ensure sample size in each conditions, conditions with at least 1% of total population were investigated.
5. We used a sex and age adjusted logistic regression model yielding odds ratio (OR) with 95% confidence interval (CI) (R v.4.1.2). Benjamini-Hochberg adjustment (α=0.05) was done for multiplicity correction.

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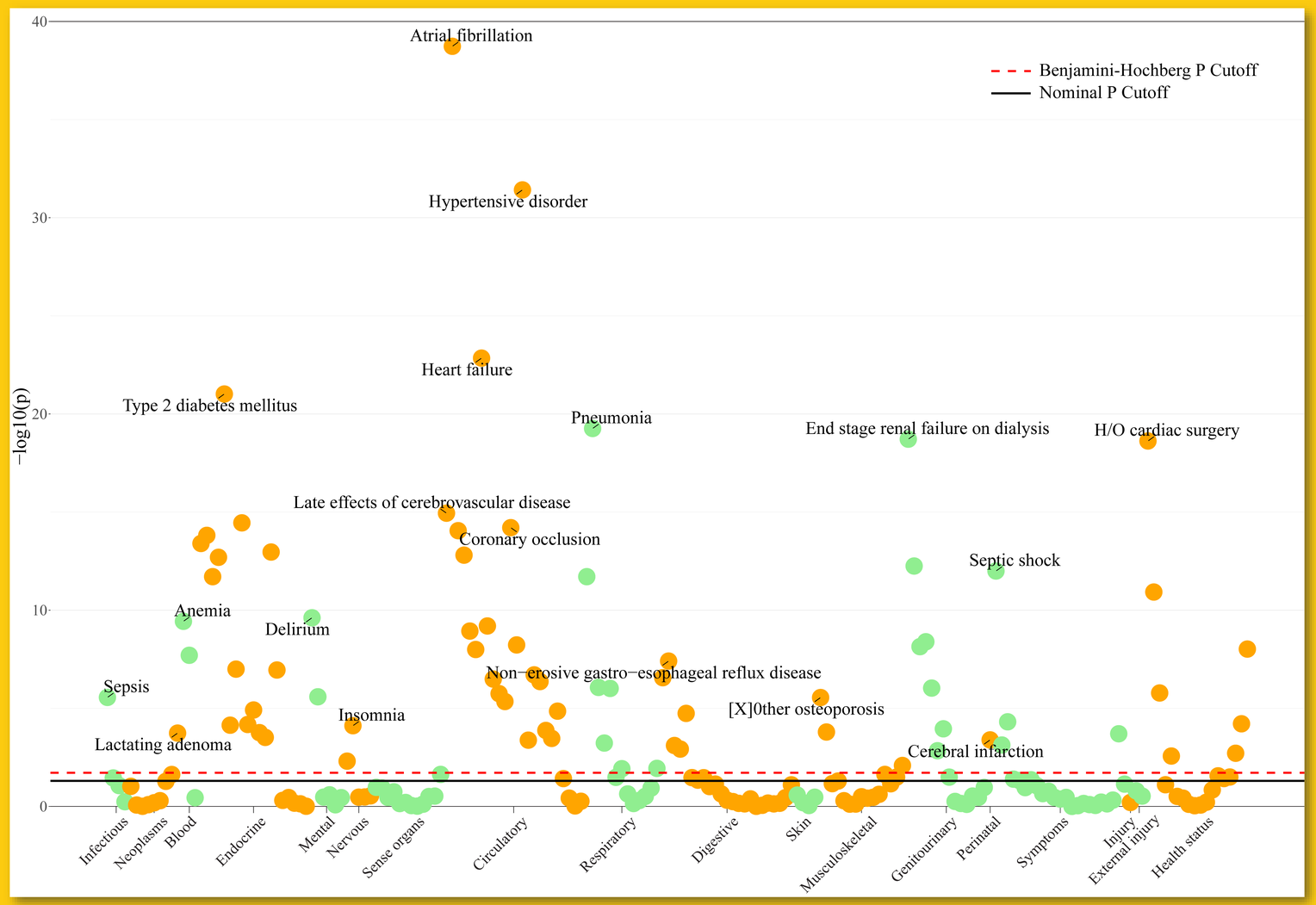
AI derived ECG aging is associated with risk of **chronic cardiovascular** diseases.



Manhattan plot showing ECG-aging and disease associations in ICD-10 categories

Take a picture to see **full results**.

RESULTS

- Out of 196 conditions investigated on 41 847 people, 76 conditions showed statistically significant associations with ECG aging after multiplicity correction. 24 of 76 conditions were circulatory conditions including atrial fibrillation (OR 2.51, P<.001), paroxysmal atrial fibrillation (OR 1.98, P<.001), heart failure (OR 1.84, P<.001), coronary occlusion (OR 1.63 P<.001) and hypertensive disorder (OR 1.56, P<.001). A Manhattan plot visualizes our results by ICD-10 disease category (figure).

- **Results of association between ECG aging and condition with OR (Top 10 p-values)**

Condition name	OR (95% CI)	P-value
Atrial fibrillation	2.51 (2.19, 2.88)	<.001
Hypertensive disorder	1.56 (1.45, 1.68)	<.001
Heart failure	1.84 (1.63, 2.07)	<.001
Type 2 diabetes mellitus	1.60 (1.46, 1.77)	<.001
Pneumonia	1.71 (1.52, 1.92)	<.001
End stage renal failure on dialysis	2.39 (1.97, 2.88)	<.001
H/O cardiac surgery	2.04 (1.74, 2.38)	<.001
Late effects of cerebrovascular disease	2.55 (2.02, 3.20)	<.001
Diabetes mellitus	1.52 (1.37, 1.68)	<.001
Coronary occlusion	1.63 (1.44, 1.84)	<.001

CONCLUSION

- In this data-driven phenome-wide analysis, ECG-aging group was associated with higher risk of chronic cardiovascular diseases including atrial fibrillation and hypertensive disorder. Our results imply that the ECG derived age may represent the aging status of cardiovascular system.

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