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Screening for cardiac contractile dysfunction using an artificial intelligence-enabled electrocardiogram

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1 **Supplemental Information**

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3 **Supplementary Figure 1 Legend: Distribution of Ejection Fraction based on**

4 **network classification.** Of patients classified as having a low ejection fraction using the

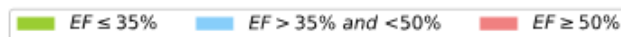
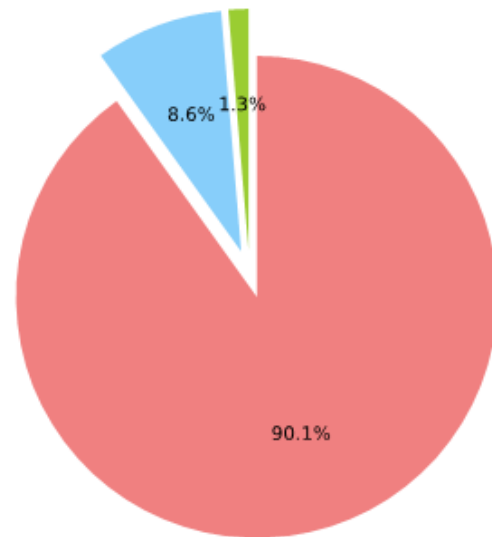
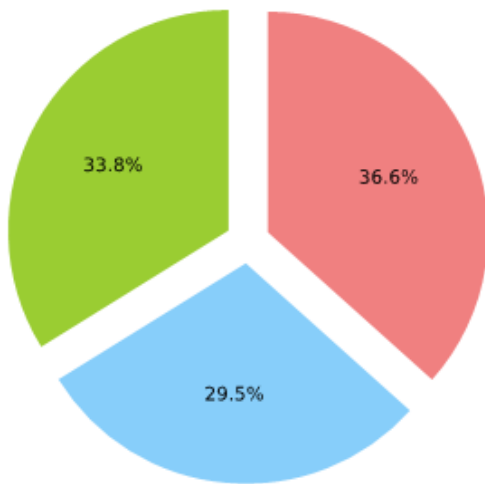
5 threshold selected to achieve similar sensitivity and specificity, 63.5% had a EF under

6 50%. If classified as normal, 1.3% had a $EF \leq 35\%$, and 90.1% had an $EF \geq 50\%$.

Distribution of EF Values by Classification

10,544 Patients classified as having Low EF

42,326 Patients classified as not having Low EF



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9 **Supplemental Figure 2 Legend: Effects of Ventricular Dysfunction on the 12-Lead**
 10 **Electrocardiogram.** Cardiac hypertrophy, ventricular enlargement, and cardiac
 11 abnormalities that lead to a reduced ejection fraction may be reflected by
 12 electrocardiographic abnormalities in several ways including but not limited to those
 13 outlined in the figure. Scarring of the ventricles may lead to changes in several
 14 electrocardiographic findings due to aberrant electrical conduction, including the
 15 presence of Q waves, QRS prolongation, or fractionation in the QRS. In turn, the
 16 hemodynamic abnormalities associated with poor forward flow may lead to other
 17 arrhythmias such as atrial fibrillation. Enlargement and scarring of the ventricles may
 18 lead to both depolarization abnormalities (reflected as abnormalities in the QRS as noted)
 19 or repolarization prolongation as reflected by a long QT interval. In addition, enlargement
 20 of the ventricle may lead to a shift in the cardiac axis which is reflected on the 12-lead
 21 electrocardiogram by the net electrical activation vector, QRS height, and other findings.
 22 All of these features may be present to different extents depending on the individual with
 23 heart failure and the cause of heart failure.



Effects of heart failure on the 12-lead electrocardiogram



QRS widening: May be due to disease in intrinsic conduction system or myopathic process resulting in delayed activation across myocardium



Atrial arrhythmias: May be due to increased stretch on atria from poor ventricular hemodynamics and atrial enlargement



Q waves / QRS fractionation: May be due to volume overload of LV or regions of infarct resulting in delayed or atypical activation patterns

Other features:

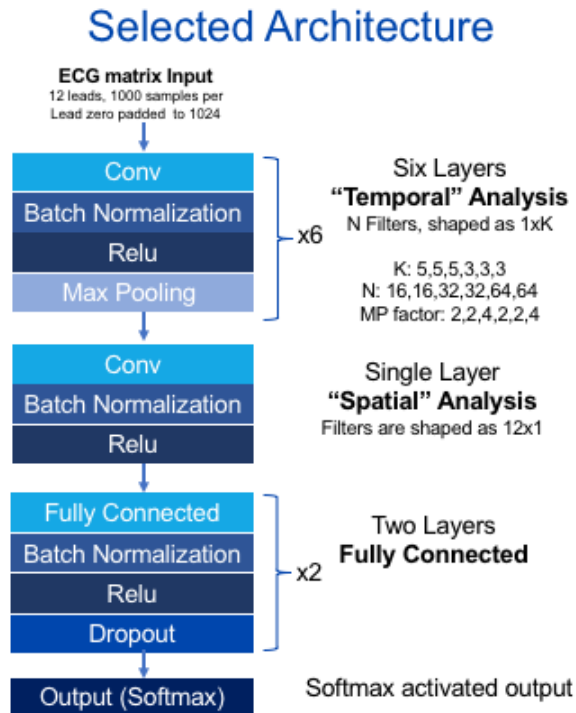
- *R wave progression:* Delayed in infarcted patients
- *Net QRS axis:* Abnormal with ventricular enlargement
- *Atrial size:* Predicted by P wave morphology
- *QRS height:* Correlates with voltage and cardiac size
- *Heart rate variability:* Correlates with autonomic state, which is often abnormal in heart failure



Repolarization abnormalities: Myocardial disease may be reflected by QT prolongation on the ECG

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25 **Supplemental Figure 3 Legend – Network Architecture:** an abstraction of the selected
 26 architecture, the network is composed of three main part : 1) temporal features extraction
 27 – using convolutional blocks on the temporal axis. 2) Spatial feature extraction – using
 28 similar convolutional blocks but with no zero padding. 3) Dense/Fully connected network
 29 to regress the visual features to the output.



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