Monitoring Of Breast Cancer Patients Left Ventricular Ejection Fraction Using AI-Augmented Electrocardiograms

Zachi Itzhak. Attia, MSc, Suraj Kapa, MD, FHRS, Peter A.. Noseworthy, MD, FHRS, Samuel J.. Asirvatham, MD, FHRS, Patricia A.. Pellikka, Dorothy J Ladewig, MBA, Gaurav Satam, MBA, Francisco Lopez-Jimenez MD MS, Paul A.. Friedman, MD FHRS and Joerg Herrmann, MD

[1] Cardiovascular Diseases, Mayo Clinic, Rochester, MN; [2] Mayo Clinic Ventures, Mayo Clinic, Rochester, MN; [3] Statistics, Mayo Clinic, Rochester, MN

Introduction

- Trastuzumab has revolutionized treatment for women with HER-2 positive breast cancer, but cardiotoxicity remains one of the leading side effects.
- For this reason, three-monthly echocardiograms (TTEs) are recommended while on therapy. However, there has been considerable debate regarding the need and cost-effectiveness of such practice.
- For the general population we had developed an artificial intelligence (AI) model that can detect low ejection fraction (EF≤35%)

Methods

- We identified all women treated with trastuzumab for HER-2 positive breast cancer at Mayo Clinic Rochester between 01/01/ 2000 and 02/28/2019 with pre- and on-therapy TTEs available for review
- Overall, we had 403 TTE and ECG pairs 14 days apart or less from 257) unique patients, of these 61 values showed an EF<50%, 14 had EF≤40% and 9 had EF≤35
- We used a deep neural network model that was trained for the detection and prediction of low ejection from an ECG during treatments and at baseline

Results

- The AUC of the model was as following: for an EF=35%: 0.95, EF≤ 40%: 0.89, and EF<50%:0.78
- the AUC of the model was 0.84 for EF≤ 40% or 40%<EF<50% and an EF drop of ≥10% from baseline
- Screening patients for an EF≤40%, the AI 12-lead ECG algorithm could reduce 143 TTEs (30% reduction) without missing 1 patient (NPV and sensitivity of 100%)
- Screening for an EF<=40% or 40%<EF<50% and a ≥10% EF drop from baseline, the number of TTEs can be reduced by 32%, missing only 1 (97.5% sensitivity)
- When using the AI model on the ECGs at baseline in the month before the first dose of trastuzumab, the baseline AI score could predict a drop of EF from 50% to 40% at any time during treatment with an AUC of 0.869

Conclusions

- The AI-augmented ECG is able to detect and to reliably rule out an EF<40% in breast cancer patients on trastuzumab therapy; this level of cardiac dysfunction commonly equates cessation of trastuzumuab therapy
- AI-augmented ECG could thus save as a gatekeeper to costly serial TTE monitoring in this patient cohort
- Further studies are needed to validate and optimize this AI ECG algorithm further, especially for the detection of less severe forms of cardiotoxicity with trastuzumab therapy

Figure 1

ESMO EF screening guidelines in trastuzumab pts

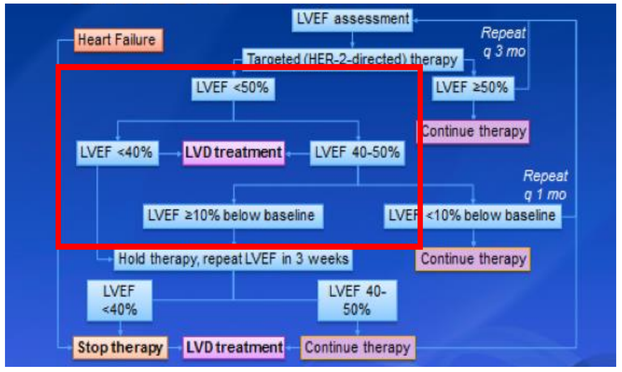
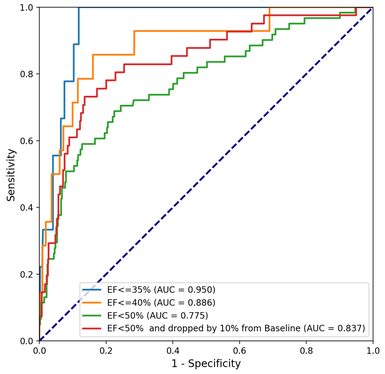


Figure 2

ROC for EF prediction by EKG – trastuzumab pts



References

- Curigliano G, et al. ESMO Clinical Practice Guidelines. Ann Oncol. 2012;23 Suppl 7:vii155-66
- Nowsheen S et al. J Am Heart Assoc. 2018;7:e008637. doi: 10.1161/JAHA.118.008637.
- Attia ZI et al. Nat Med. 2019;25:70-74.

Disclosure Information

Mayo Clinic has filed a patent around the work described in the publication and both Mayo Clinic and Drs Friedman, Lopez-Jimenez and Kapa and Zachi Attia will receive compensation if the patent is licensed

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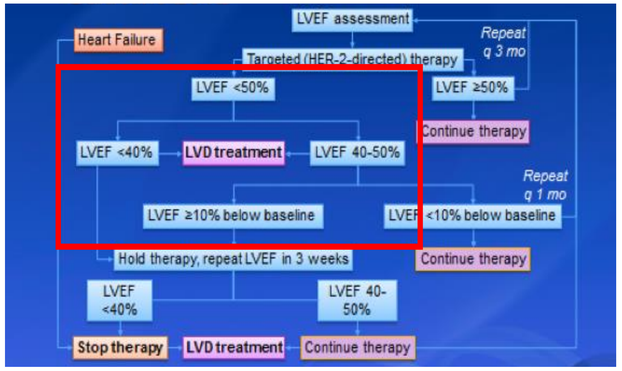


Figure 2

ROC for EF prediction by EKG- general population

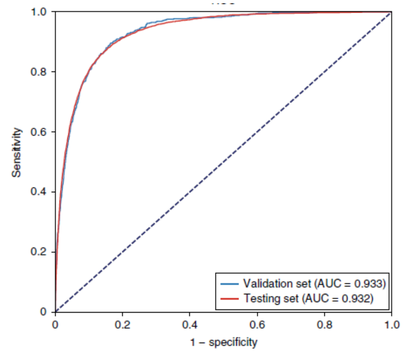
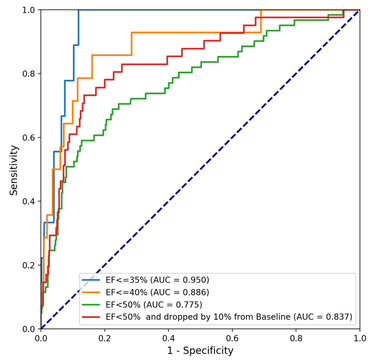


Figure 3

ROC for EF prediction by EKG – trastuzumab pts



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