Can artificial intelligence fill in the gaps in heart failure guidelines by providing precision medicine in medication advice?

H. Amin[1], A. Tsirkin[2], P. Ruff[2], H.P. Brunner-La Rocca[1]

[1]Maastricht University Medical Centre (MUMC), Cardiology, Maastricht, The Netherlands; [2]Exploris AG, Zürich, Switzerland

Funding Acknowledgement: Type of funding sources: Public grant(s) – EU funding. Main funding source(s): INTERREG-NWE

Background: The treatment of heart failure (HF) consists of many different types of medication. It is not yet known which patients benefit most from which medication type. Artificial intelligence (AI) may be helpful to predict the best individual combination of drugs and dosages, but such a model is lacking.

Purpose: We present an AI model that can predict optimal medication regimen per patient based on mortality and hospitalisation risk.

Methods: A total of 620 patients of the Randomized controlled multicenter Trial of Intensified vs Standard Medical Therapy in Elderly Patients With Congestive Heart Failure (TIME-CHF) study were divided into a training and a test population across different sections of patients. They were evaluated by a fixed multi-layer combination of different AI/machine learning models. The steps of the model include; (1) making segmentation by medication treatment: optimal or not optimal; (2) evaluation by general prognostic model and model optimised for patients with non-optimal medication (3); finding optimal medication recommendation for all outcomes of step 2. After optimising the model with the training population, the model was validated retrospectively on the test population. Prognosis was based on mortality and hospitalisation during up to 5 years follow-up.

Results: Of the 620 patients, 59% were male, age 76.9±7.6 years, and median follow-up was 2.2 years. The optimised model identified variables that are important to generate an accurate medication recommendation. These included biomarkers, symptoms, and patient characteristics. In the first step of clustering, data showed that at T0, 68% of the patients were not in optimal medical therapy range, and their outcome prediction was poor (Figure 1). During the follow-up period, this group decreased to 36%, and was almost equal in size to the group with good prognosis despite not optimal medication range (38%). Furthermore, the group with a good medical therapy range and good prognosis increased during the study.

Finally, validation of the medication prediction model showed that model-based therapy adjustments could significantly reduce hospitalisation rate and death. For patients who had therapy according to the AI model recommendation, the death rate and hospitalisation rate were three times lower (Table 1).

Conclusion: The AI model was successful in predicting the optimal medication regimen in the validation population. Where HF guidelines are ambiguous about optimal treatment, the model may fill these knowledge gaps. Furthermore, the model emphasises the hypothesis that a standard approach to HF treatment is not beneficial for all patients. There is a group outside the optimal medication range that has a poor outcome, but there is also a group that has a good outcome despite a non-optimal medication range. Therefore, the latter group would possibly be better off with less medication. These findings need to be validated prospectively in further research.

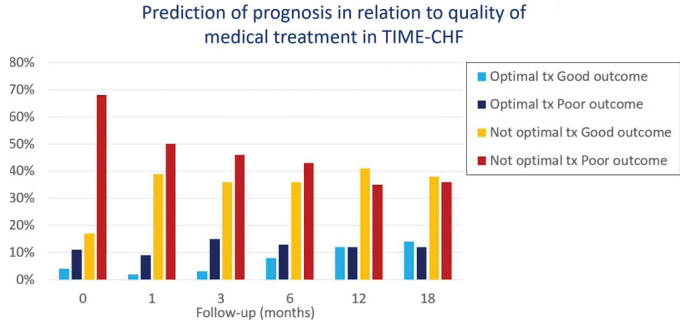

Figure 1

Comparison actual treatment versus AI model recommendation

Medication trajectory	Total		Deaths		Hospitalizations	
	n	%	n	%	n	%
Completely different	89	14	74	83	57	64
Between completely different and AI recommendation	138	22	68	49	57	41
Mostly follows AI recommendation	392	63	105	27	76	19

Note. Completely different: less than 25% of the time within recommended therapy range
Mostly follows: at least 75% of the time within recommended therapy range

Table 1