



Preventing Heart Failure Hospitalizations with Artificial Intelligence

Date: April 17th, 2020

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Disclosure

I have no relevant disclosures



Why do we want to predict risk of hospitalization.....to intervene sooner.....



Risk Prediction Scores Monitoring tools



Meta-Analysis Global Group in Chronic (MAGGIC) Heart Failure Risk Score





Systematic Review of Predictive models

Circles are mean C-statistic values for each model

RED = mortality PURPLE = mortality/readm GREEN = readmission

C-statistics for models predicting: Mortality = 0.71 Mortality or HF hospitalization = 0.63 **HF hospitalization = 0.68**



Ouwerkerk et al, JACC HF 2014;2:429-36

Models





Why do predictive models fail at such a high rate?

- Storage of data in medical silos prevents deployment and creation of algorithms
- Algorithms are <u>NOT</u> sufficiently transparent/explainable
- Algorithms are there but not used....
- Lack of <u>trust</u> of clinicians in predictions that are generated by algorithms
- But most importantly....
- Predictive models are insufficiently predictive





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1824-1907



Data

1909-2005









Amount of Data

The promise of a healthy heart.

Adapted from Johnson, K.W. et al. J Am Coll Cardiol. 2018;71(23):2668–79; Obermeyer and Lee, 2017; 377:1209.

ARTIFICIAL INTELLIGENCE

Programs with the ability to learn and reason like humans

MACHINE LEARNING

Algorithms with the ability to learn without being explicitly programmed

DEEP LEARNING

Subset of machine learning in which artificial neural networks adapt and learn from vast amounts of data

AI, ML, DL

Learning Types

- Supervised
 - Algorithms use a dataset labeled to predict the desired and known outcome
 - Great for classification and regression problems
 - Time consuming
 - Requires labelling
- Unsupervised
 - Seeks to identify novel disease mechanisms, genotypes, or phenoytpes from hidden patterns present in the data...
 - Find the hidden pattern without feedback from humans
- Reinforcement
 - A hybrid of supervised/unsupervised learning
 - Aim is to maximize the accuracy of algorithms using trial and error



Uses of AI: assisted, augmented, automatic AI

Assisted Al

Considered a weak form of AI and it is mainly used to automate simple tasks



Augmentation Al

Support human decisions, rather than simulate independent intelligence

Automatic Al

The final and most feared state of artificial intelligence; <u>autonomous</u> intelligence that can make decisions without human intervention





https://www.tgdaily.com/technology/assisted-augmented-and-autonomous-the-3-flavours-of-ai-decisions

A Remote Patient Monitoring Platform

Clinical Application

້ **`med**lyອະ ໌



Patrick Ware

Mala Dorai





Dr. J. Cafazzo **Executive Director**



TRCHR Nursing Professors: Meredith Linghorne and Nadia Thomson

















Many connections are required to allow for incorporation of physiological information obtained from patients at home to trigger interventions and potentially improve outcomes by means of heart-failure disease management.

Adapted from Desai and Warner Stevenson, NEJM 2010;363;24

• medly 🕫

Medly's brain is a decision tree

- Designed to mimic clinicians decision making process
- Mathematical rules based algorithm can only handle a limited number of factors for decision
- Decision process tends to be conservative
 - can generate many false positives



Seto et al, JMIR 2012 Jan-Feb; 14(1): e31 Seto et al, Int J Med Inform 2012:81:556-65 Seto et al, JMIR 2012;10:14(1):e25. doi:10.2196/jmir.1923 Seto et al, J Cardiovasc. Nurs 2011;26:377-85. Seto et al, JMIR 2010;12(4):e55. doi: 10.2196/jmir.1627.

Clinical Outcomes

Limitations -pre and post analysis





Ware et al, J Med Internet Res 2020;22(2):e16538) doi: 10.2196/16538

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The LINK-HF Multicenter Study N=100

An ML analytics algorithm using continuous remote monitoring data from a wearable sensor will predict HF rehospitalization with ≥70% sensitivity at a specificity level of 85%.





87 completed 30 days 74 completed 90 days

Clinical alerts preceded hospitalization by a median time between 6.5 and 8.5 days

Stehlik et al, Circ Heart Fail. 2020;13:e006513



The promise of a healthy heart.

1-Specificity

Al challenges

- HYPE??? AI winter
 - Disconnects between reality and expectation
- Biased data for AI model development
- What is our goal? Do we real expect CI = 1???
- Applying AI outside of populations represented in the training and validation sets
- Disregarding the 'law of unintended consequences'
 - Impact on care or pt clinical relationship
- Limited data on ACTUAL effects on pt outcomes and cost of care







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