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Commentary

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Artificial Intelligence and Machine Learning in Risk Prediction and Care Planning for Cardiovascular Disease: A New Vision

Patrick Dunn[1]*, Srikanth Sri Banerjee[2], Scott Conard[3], Roger Ng[4]

[1]Center for Health Technology & Innovation, American Heart Association and Walden University, USA
[2]College of Health Sciences and Public Policy, Walden University, USA
[3]Converging Health, USA
[4]NOBELMIND, USA

***Corresponding Author:** Patrick Dunn, Center for Health Technology & Innovation, American Heart Association, Dallas, TX, USA; E-mail: pat.dunn@heart.org

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Abstract:

Two fundamental concepts in achieving better health outcomes include improving risk prediction and having more effective interventions. New artificial intelligence and machine learning techniques, using large language models and computer vision, have the potential to dramatically improve risk prediction, by quickly analyzing data in a manner not previously possible in a clinical setting, leading to more precise and targeted therapy. Models can be trained on a large volume of data, including factors commonly overlooked with traditional methods. Rather than having to analyze a spreadsheet to interpret the results, these models have the additional advantage of communicating with natural language to both professionals and patients. To achieve better outcomes for healthcare requires the use of deep learning models and convolutional neural networks and the use of random forest classifiers. This new vision also provides an opportunity for a symbiotic relationship between healthcare professionals and Artificial Intelligence/Machine learning models, leveraging the strengths of each.

Keywords: *Artificial Intelligence and Machine Learning; Cardiovascular Disease; Cost of healthcare*

Introduction

The cost of healthcare in the United States continues to be a burden to individuals, the government, and employers [1]. Achieving the goals of improving quality, achieving better outcomes, reducing cost, and increasing meaning in life comes down to two relatively straight forward concepts, who is likely to require healthcare services, and is there anything that can be done to improve the quality, care, cost, and meaning equation? [2].

Risk prediction models are used to predict individuals that are high risk for requiring healthcare services, especially ones that have a high clinical impact and significantly increase cost, including cardiovascular disease. A clinical strategy has the advantage of also being able to connect the risk of the patient to a plan of care designed to prevent, treat, and/or manage a condition. A clinical strategy, however, needs a systematic process for identifying, planning, and treating patients in an equitable and cost-effective way. Recent advances in Artificial Intelligence and Machine Learning (AI/ML) have created the opportunity to take a new approach to this problem [3-4]. AI/ML has made significant contributions to healthcare, revolutionizing various aspects of the industry [5-6]. AI/ML will empower and enable clinicians to increase effectiveness, efficiency and scope of influence. As opposed to completely autonomous machines there will be an interaction and symbiosis between man and computer [7].

This new vision and way of caring for patients will reduce costs, improve quality and efficiency of the healthcare system – all changes that are desperately needed for the health of our government and the US economy. To accomplish this additional data that historically has not been considered in predictive risk modeling, but now are clearly needed for an effective whole person integrated variables that all must be taken together to impact engagement and delivery of care. Large volumes of information coming in from multiple sites that historically have been ignored or overlooked will be required. Examples include lifestyle, biometric, specialist/facility data, pharmacy, compliance, social events at the country- regional level and personal social activities, compliance and adherence, plan benefit and social determinant

variables and/or changes. Taking these variables into account and integrating the computing power of AI/ML with NLP will transform the real time engagement and ability to predict the needs, most effective interaction strategy and behavior of an individual. Coupling this with the latest up to date therapeutic strategies and tactics will transform what is done, who will do it, and the probability of success.

AI/ML systems that predict outcomes

Machine learning models can leverage patient data, including electronic health records (EHRs), genetic information, and lifestyle factors, to predict the likelihood of developing certain diseases, and can help tailor treatment plans to individual patients. Concepts are learned by training the machine on examples or experiences from behaviors that provide the result we want. AI/ML is about obtaining the desired results without having to define the rules or instructions to outcomes in a complex environment. Therefore, data collection in the era of Large Language Models (LLM) is paramount and there will be new types of clinical inputs from the collection of decision-making patterns, the possible different choices and patient outcomes from these decisions. Because LLM are based in natural language, both understanding and communicating fluently, it can generate and express a full range of instructions that can now also be given to it in writing such as the standard guidelines advancing over prior AI/ML models that narrow in on a specific task like labeling, classification and even regression models where the outputs are rigid, breakable with unsuspected new classes, and models new classes. By making language the vector space for the model's output the vocabulary between human and AI is shared and its limitation becomes bound to the edge of human expressivity. As we share more of our knowledge, it will understand human disease, epidemiology, pathophysiology, and patient presentations. We want to understand all of those things but often lack the time, the capacity, the specialization, and only access to what the patient feels and experiences in a very sparse way. These models will be able to span the human population, comprehensively listen to our patients, explore with them their experience with illness, and access far deeper understanding of what it means to be our patients than we have ever before, and its knowledge grows with ours.

Risk prediction is inherent to the models based on data and presentation and how they deal with the input. As these models train with larger amounts of data, the clinical experience and understanding of practice from a wide range of patients, their clinical presentations, best practices, treatment responses, and outcomes are transferred to the weights.

Using AI and machine learning to reduce risk

ML algorithms can also aid in diagnosing diseases by analyzing symptoms, medical history, and test results, help tailor treatment plans to individual patients, and analyze patient data, including genetic information, medical history, and treatment outcomes, to identify the most effective interventions for specific individuals. This supports the concept of precision medicine, optimizing treatment strategies and minimizing adverse effects.

Computer vision can analyze images to enable machines to extract meaningful information, recognize patterns, and make decisions based on visual inputs. This includes tasks such as image classification, object detection, image segmentation, facial recognition, gesture recognition, scene understanding, and more. These algorithms may leverage machine learning and deep learning methods to train models on large, labeled datasets, enabling them to recognize and understand visual patterns.

Deep learning techniques can be used to improve imaging quality [8]. There are deep learning techniques such as Convolutional Neural Networks (CNNs) and random forest classifiers. These are commonly used deep learning architecture in computer vision tasks. Additionally, random forest classifiers can be used for improved imaging. Random forests are comprised of ensemble of decision trees. Deep learning methodologies can be combined to diagnose coronary artery disease derived from cardiac MRI [9]. The Gini importance, or mean decrease in impurity, is then used to rank the importance of predictors. Artificial Intelligence has been integrated into many medical disciplines including enhanced imaging in cardiology.

Conclusions

Artificial Intelligence and machine learning using deep learning, convolutional neural networks and random forest classifiers provide a unique opportunity to improve health outcomes, reduce cost, and result in a better quality of life for patients with cardiovascular conditions. These outcomes can be achieved by improving risk prediction, resulting in more precise and targeted therapy, compared to traditional statistical models, and can be trained on data from a variety of sources, including pharmacy, biometric, psychometric, genetic, and lifestyle/social factors. Combining large language models with computer vision, including ECG, echocardiography, and CTA can result in breakthroughs in both risk prediction and interventions. This new vision for healthcare will allow for better clinical decision-making by healthcare professionals and their patients, with the added benefit of allowing the healthcare professionals to spend more time in patients care and less time attending to administrative functions.

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