Cardiomyopathic Chagas Disease: An Exploration of Diagnostic Ability via Nanoparticle Biomarker Capture GluOx Pathway, Mass Spectrometry, and Perseus-Based Machine Learning

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Chagas is a South American disease induced by the Trypanosoma cruzi parasite. With 8 million patients every year, Chagas presents with mild symptoms in the acute stage, followed by heart failure and sudden death. Since its symptoms are so mild, doctors often empirically diagnose Chagas as the common cold or flu. We developed two novel diagnostic methods: an in-solution immunoassay and biomarker tests using Perseus-Based Machine Learning. As opposed to existing technology, the in-solution immunoassay provides an easy visual diagnosis through a color change for a positive diagnosis. The immunoassay utilizes hydrogel Nanotrap particles linked with a reactive enzyme, horseradish peroxidase, which alters colors when exposed to the GluOx pathway and biomarker of interest. This novel immunoassay is rapid (10 minute incubation), extremely sensitive (detects <100 pg/mL), and inexpensive (around $2 USD/test). To prevent false positive results, we identified a blocking agent for the Nanotrap particles unbound to pathogen molecules. Among five common blocking agents, Polyethylene glycol had the lowest pellet absorbance of 0.55, and was deemed the best candidate. Finally, a machine learning algorithm was tested to detect changes in the human proteome in presence of Chagasic Cardiomyopathy. The best fitting model was identified as a 10th Degree Polynomial Support Vector Machine (SVM) with statistical K-Fold validation (K=10. With a sample size n=29 samples 17P, 12N from Bolivian Chagas patients). The model then ranked the expressed proteins most indicative of a positive diagnosis via a Recursive Feature Elimination SVM. From these proteins, Secreted and Transmembrane Protein Isoform X1 and Creatine Kinase B-type were deemed candidate Chagas-specific biomarkers.