CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Daniel D. Zhang

Project Number

S0528

Project Title

Genome-Based Discovery of Novel CpG Biomarkers for Early Diagnosis and Prognosis of Leukemia

Abstract

Objectives/Goals

The goals of this project is to a)identify and validate novel CpG biomarkers for early diagnosis and prognosis of leukemia; b) Develop a low-cost, non-invasive, rapid screening method for clinical leukemia diagnosis

Methods/Materials

The blood samples from leukemia patients and normal individuals were from UCSD. Reagents for DNA extraction, bisulfite conversion, PCR and sequencing were commercially available. Comprehensive analysis of genome-wide methylation data was performed with a customized software bis-Readmapper, followed by data classification with nearest shrunken centroids classifiers. The identified novel CpG biomarkers were further validated by machine learning and computational analysis for early diagnosis of leukemia. For prognostic analysis, I developed a semi-supervised approach with selected CpG biomarkers for prediction of five-year overall survival of leukemia patients.

Results

My results can be summarized as the followings

1)First-ever discovered and validated 10 novel CpG biomarkers, which enabled a CpG methylation based methodology for early leukemia diagnosis with more than 97% accuracy.

2)Provided proof-of-concept results of methylation specific PCR (MPCR) as a low-cost, rapid leukemia screening method in clinical settings

3) Developed methylation-based survival classifiers for prognostic prediction

4) Identified 10 CpG controlled genes critical for early cancer development

Conclusions/Discussion

This project has demonstrated the feasibility of using CpG methylation signatures for early leukemia diagnosis and prognosis. My study has significant implications in the current clinical diagnosis. First, the CpG methylation offers a platform for early cancer diagnosis, which can capture the biological state of a cell much earlier than the current morphology based approach. Second, the CpG methylation exhibits excellent accuracy and reproducibility. Third, the CpG biomarker detection utilizes blood samples with non-invasive procedures. Fourth, my low-cost MPCR method can be widely used for early cancer screening. In combination of circulating tumor DNA and liquid biopsy, this CpG methylation based technology can be potentially applicable to many different cancer types, with broader impacts in the field.

Summary Statement

This project has demostrated a reliable and practical method for early cancer diagnosis and prognosis with newly identified CpG biomarkers through genome-based study

Help Received

My supervisor provided lab reagents, instruments and training. I independently initiated my ideas, performed experiments, analyzed the data and wrote my research report.