Artificial Intelligence in Genomic Surveillance: Mitigating Lung Cancer Risk and Metastasis in Aviation and Space Warfighters

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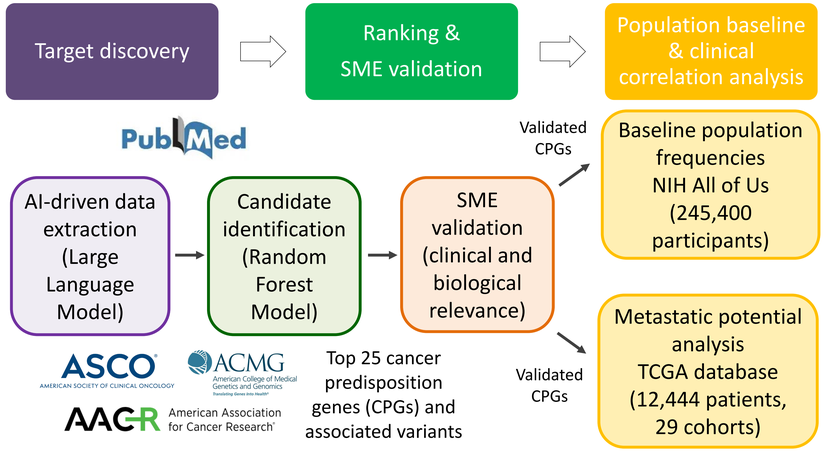
Background

- Ionizing radiation from space is a major cancer risk for DoW pilots and aircrew, who frequently operate at high altitudes and/or high latitudes, and a primary threat to USSF Guardians and astronauts during their extended or deep space missions.
- Lung cancer, a leading cause of cancer-related death in the U.S., is not only common in DoW personnel but also highly sensitive to radiation.
- Currently, there is a significant gap in understanding how genetic predispositions interact with occupational radiation exposure, particularly concerning the development and metastasis of lung cancer.
- This lack of knowledge limits the effectiveness of current strategies for cancer prevention and early detection among high-risk groups like pilots, astronauts, and aircrew.

Methods



Results

- Prevalent pathogenic CPG mutations in the US population include *TP53, TSC2, TERT, PALB2, ERCC2, BRCA2, CHEK2, CDKN2A, BLM,* and *ATM*.
- Our AI/ML-powered big data analysis revealed significant links between specific mutations in genes like *EGFR, ALK, TP53, STK11, ATM, PALB2, CDKN2A, TSC2,* and *TERT* and higher rates of lung cancer metastasis.
- Direct impact on risk stratification, providing a genomic basis for identifying personnel who would benefit from enhanced surveillance and proactive risk mitigation.

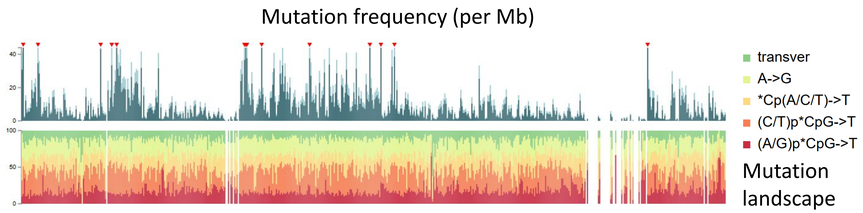


Fig. 1: Mutation signature of lung cancer patients in TCGA database

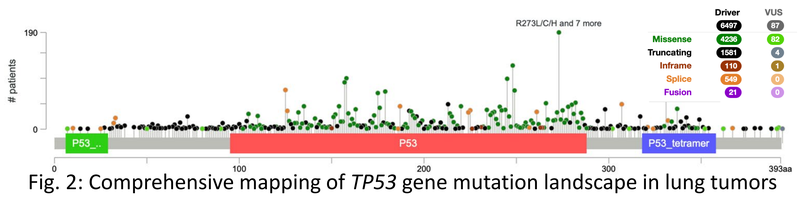


Fig. 2: Comprehensive mapping of *TP53* gene mutation landscape in lung tumors

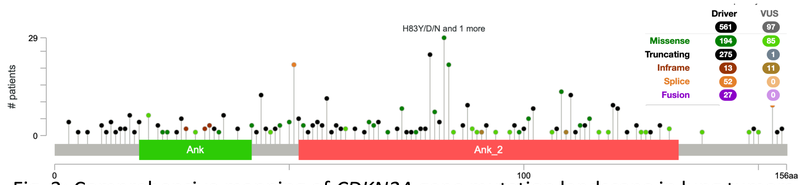


Fig. 3: Comprehensive mapping of *CDKN2A* gene mutation landscape in lung tumors

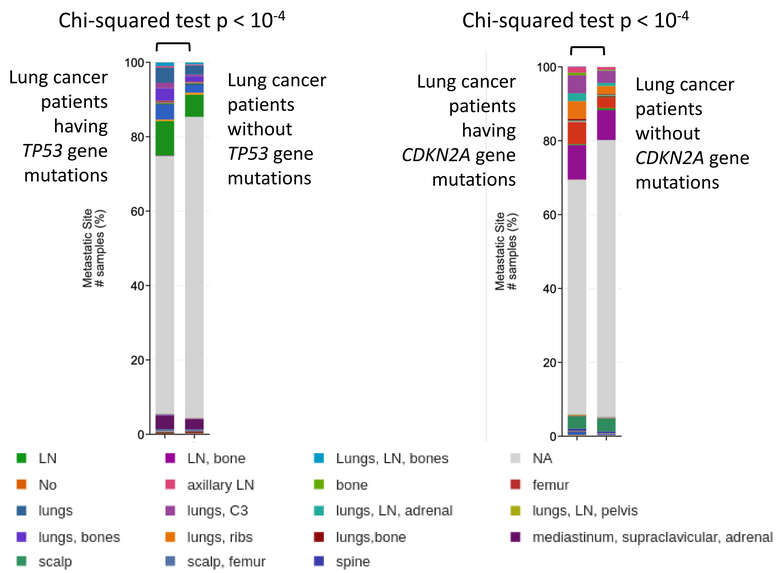


Fig. 4: Significant increase in lung cancer metastasis in the presence of *TP53* and *CDKN2A* cancer predisposition gene mutations

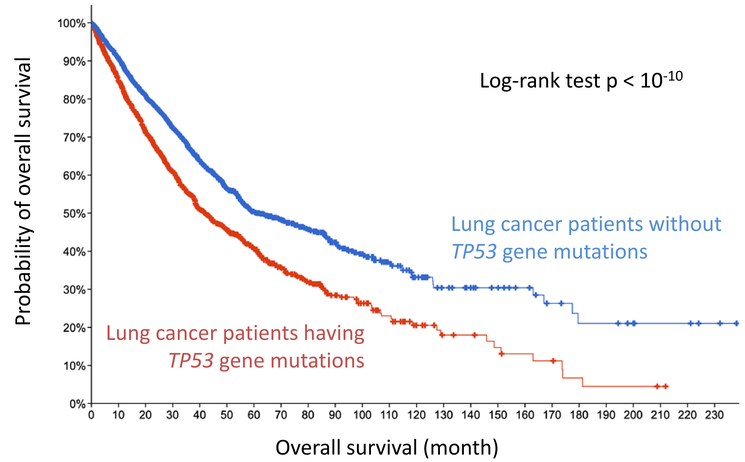


Fig.5: *TP53* cancer predisposition gene mutations are associated with significantly shortened overall survival in lung cancer patients

Conclusion

- This research underscores the role of CPGs in personalized healthcare for high-risk occupational groups.
- Individuals with specific CPG mutations linked to lung cancer metastasis may benefit from intensive screening and proactive interventions.
- Further investigation into the prevalence of these mutations in DoW/USAF/USSF flying forces is necessary.
- Future work includes refining our AI/ML analysis with data from these cohorts to enhance the precision of lung cancer prevention and treatment strategies in at-risk DoW personnel populations.

References

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This study was conducted under Defense Health Agency-approved Clinical Investigation Numbers FDG20240051R and FDG20240062R.