



Evolving Role of Artificial Intelligence and Radiomics in Precision Population Medicine for Cancer Care: Brain Tumors



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INTRODUCTION

- While brain tumors are mostly benign, protection from the blood-brain barrier and late presentation in a sensitive, confined space contribute to a five-year survival rate of 33.4% [1,2].
- Pharmacological agents have been developed to target more commonly presenting brain tumor biomarkers, but intratumor heterogeneity and nonadherence to common presentations leave gaps in overall brain tumor management [3].
- Population Precision Medicine (PPM) seeks to individualize the management of brain tumors based on their unique molecular fingerprint. The use of genomics, artificial intelligence (AI), and radiomics may increase efficiency in characterizing tumors individually and maximize cost avoidance.

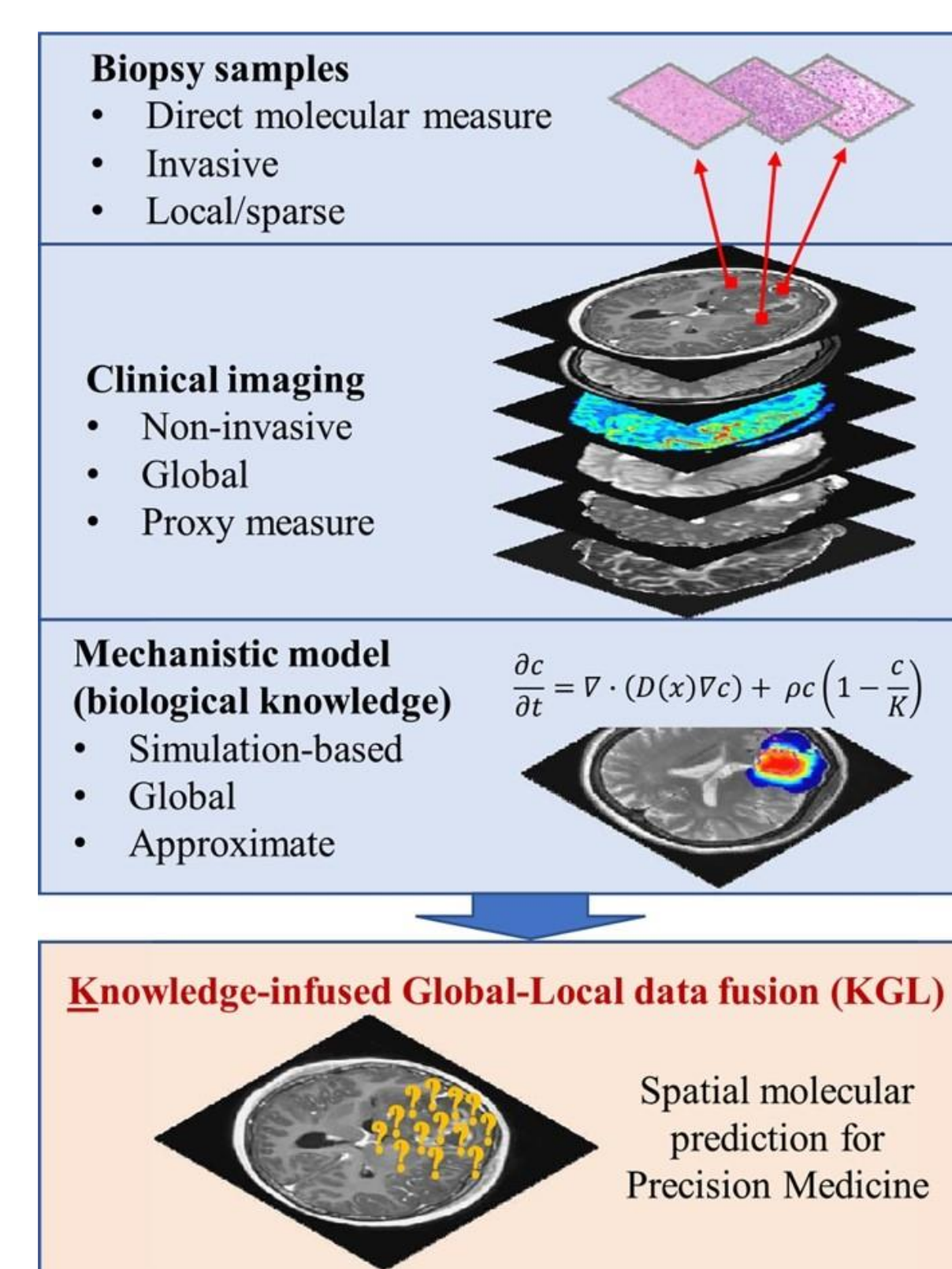
METHODS

- Databases such as Medical Literature Analysis and Retrieval System Online (MEDLINE), PubMed, and Google Scholar were used for the literature search between 1998 and 2023.
- Key words: “brain tumor”, “nervous system tumor”, “artificial intelligence”, “big data”, “radiomics”, “population medicine”, “precision population medicine”
- Editorials, commentaries, and unpublished works were excluded.

RESULTS

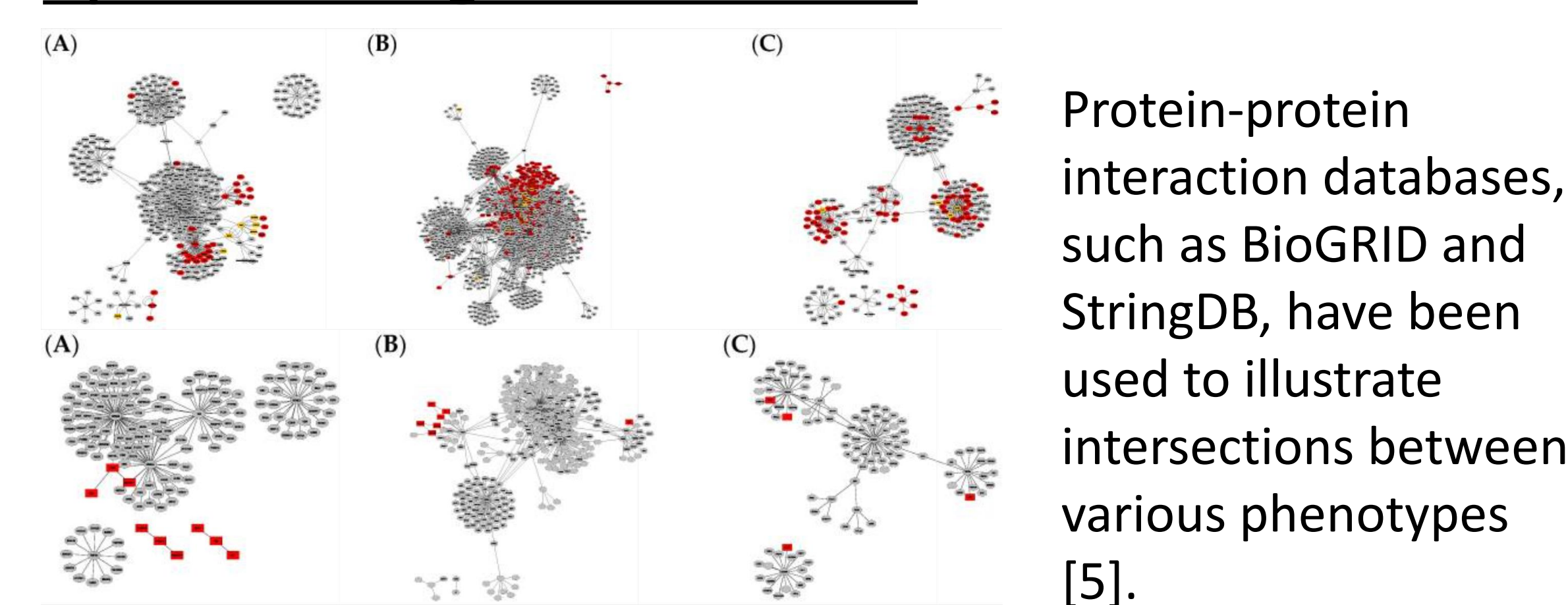
Model for Achieving PPM Using Multitopic Approaches:

- To overcome the shortcomings of MRI, the machine learning Knowledge-infused Global-Local data fusion model was developed [4].
- This model, when applied to precision medicine, can effectively integrate diverse data types such as biopsy, imaging, and clinical data, thereby enhancing the potential of AI in healthcare [4].



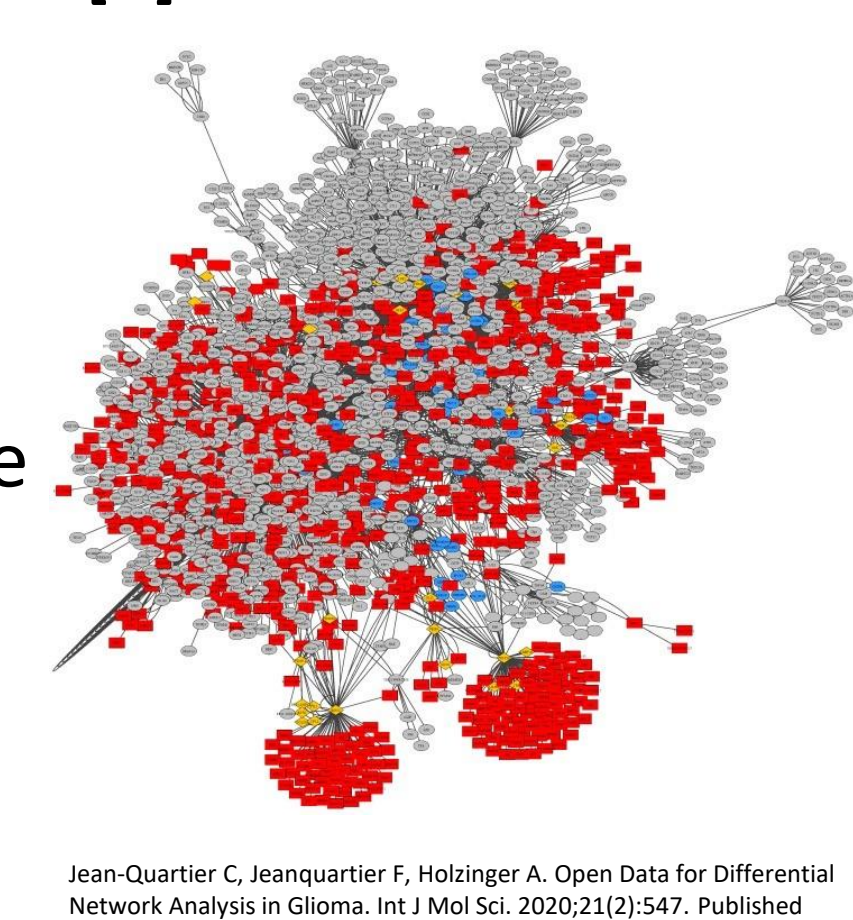
Wang L, Hawkins-Daarud A, Swanson KR, Hu LS, Li J. Knowledge-infused Global-Local Data Fusion for Spatial Predictive Modeling in Precision Medicine. *IEEE Trans Autom Sci Eng.* 2022;19(3):2203-2215. doi:10.1109/tase.2021.3076117 [4]

Open-Source Big Data Utilization:



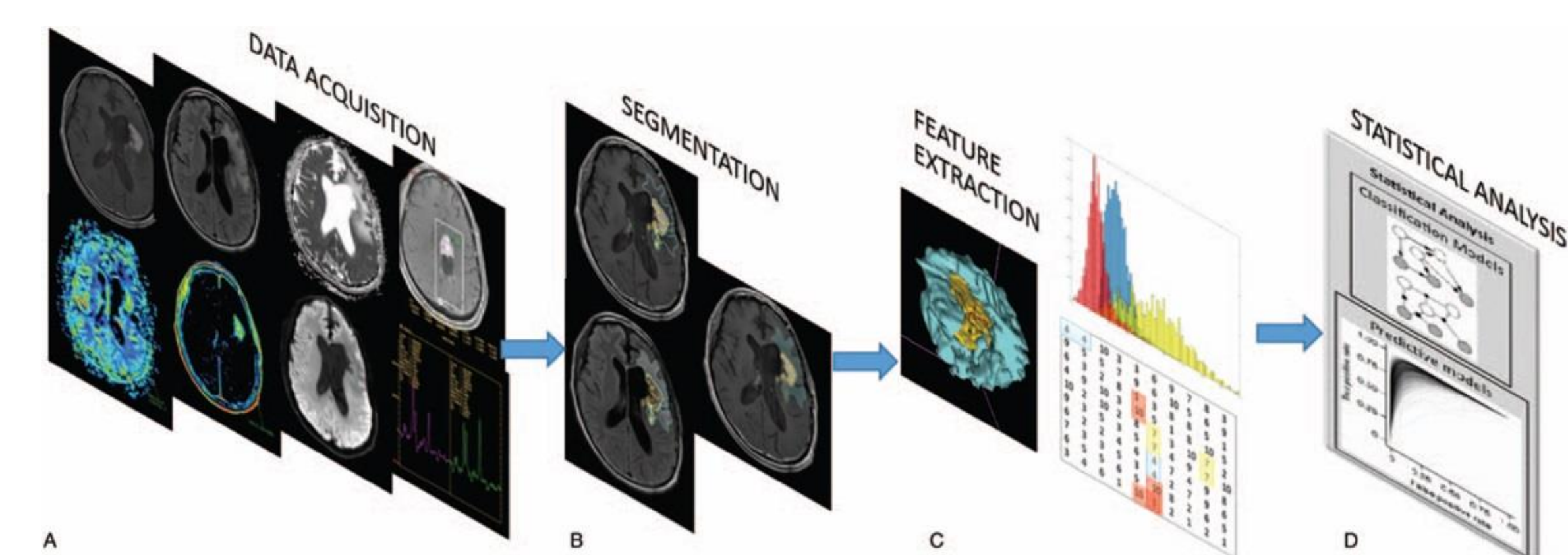
Protein-protein interaction databases, such as BioGRID and StringDB, have been used to illustrate intersections between various phenotypes [5].

- Cytoscape was employed to visualize the protein-protein interaction comparisons between glioma, glioblastoma multiforme, and low-grade astrocytoma [5].
- This use of a Merged Union Network model exemplifies the utility of open data in PPM.



Radiomic Image Processing Protocol:

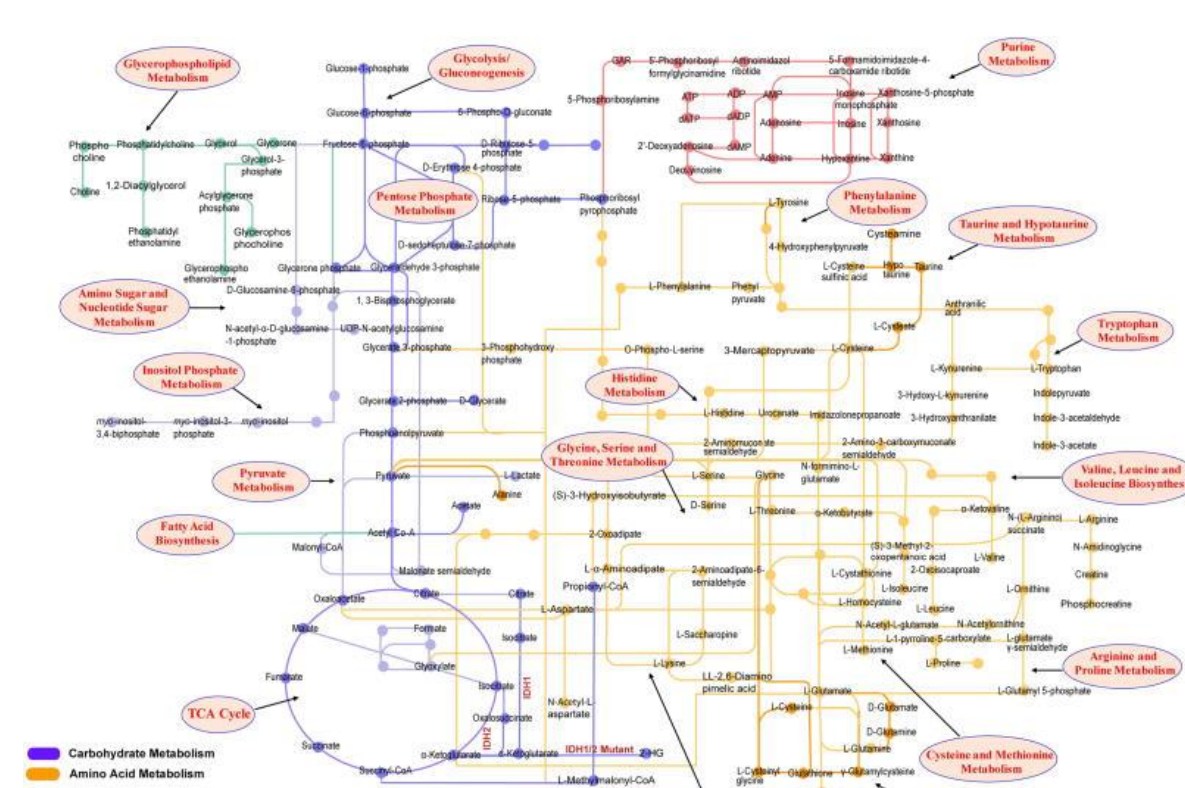
- A systemic process of radiomic phenotyping of brain images for potentially unrecognized information has been developed [7]:
 - **Data Acquisition** – harvesting images
 - **Segmentation** – identifying regions of interest
 - **Feature Extraction** – building an information database
 - **Statistical Analysis** – data mining and predictive modeling



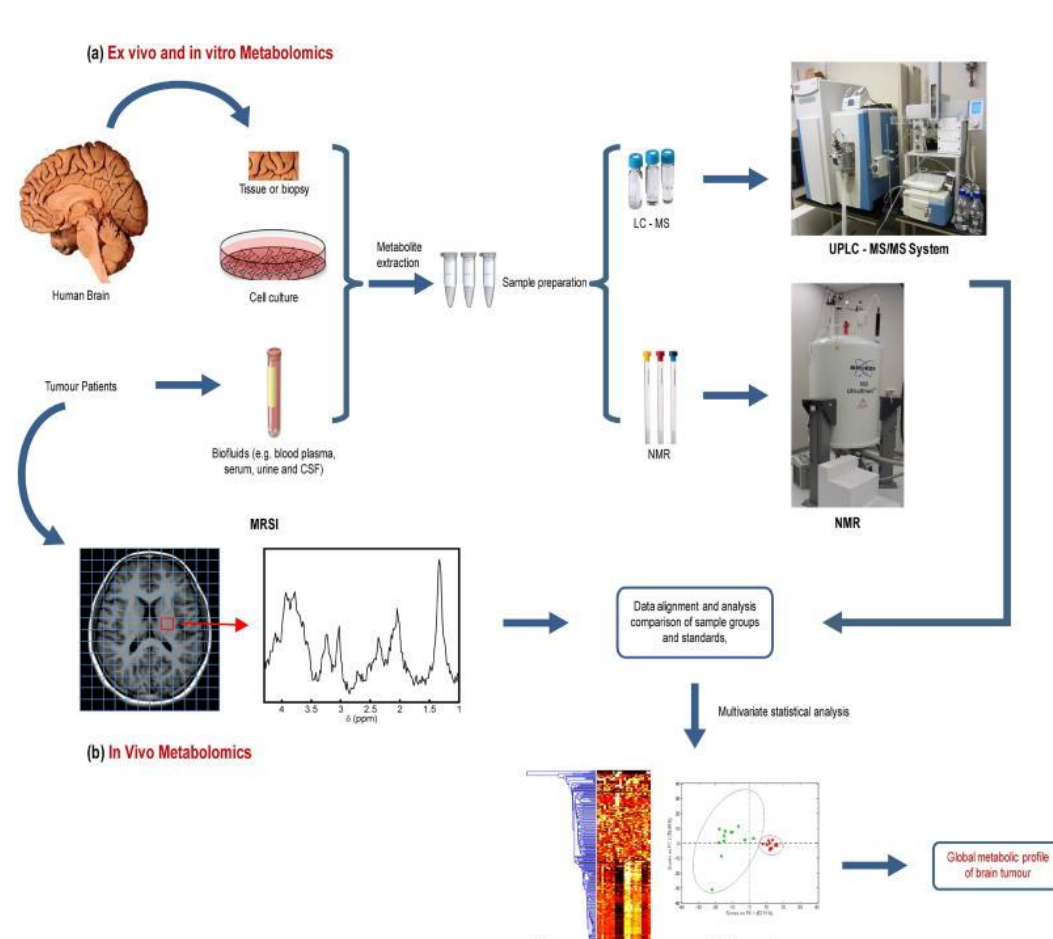
Abrol S, Kotrotsou A, Salem A, Zinn PO, Colen RR. Radiomic Phenotyping in Brain Cancer to Unravel Hidden Information in Medical Images. *Top Magn Reson Imaging.* 2017;26(1):43-53. doi:10.1097/RMR.0000000000000117 [7]

Metabolomics Approach:

- The metabolic pathways involved in brain tumor are widespread, complex, and interconnected [6].
- Metabolomics may be helpful for tumor characterization and clinical intervention [6].



Pandey R, Cafilisch L, Lodi A, Brenner AJ, Tiziani S. Metabolomic signature of brain cancer. *Mol Carcinog.* 2017;56(11):2355-2371. doi:10.1002/mc.22694 [6]



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- Metabolites are extracted and analyzed using liquid chromatography-mass spectrometry and nuclear magnetic resonance spectroscopy [6].
- Raw data is processed by MS-based metabolomics software, such as XCMS and SIEVE [6].

CONCLUSION

- While each brain tumor arises with unique inherent challenges, using PPM with AI as an adjunct is promising in the characterization and treatment of brain tumors on an individualized basis.
- Proving the utility of AI in the clinical setting is integral for its integration into everyday practice.
- The potential of AI to synthesize the most relevant aspects of individual brain tumors cannot be overstated.

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7. Abrol S, Kotrotsou A, Salem A, Zinn PO, Colen RR. Radiomic Phenotyping in Brain Cancer to Unravel Hidden Information in Medical Images. *Top Magn Reson Imaging.* 2017;26(1):43-53. doi:10.1097/RMR.0000000000000117

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