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Biomarkers and Omics: Combined Opportunities for Understanding Our Mental Health

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My awe of the biology of cancer led me to work around biomarkers for breast cancer. I have considered great importance in this venture to find the cause and the potential cure for this dreaded disease. We hope that one day, our novel biomarkers discovered from our sophisticated instruments and advanced bioinformatics tools will end breast cancer (Cation & Ramos, 2022). But unlike most types of cancer, mental disorders are presented differently in each patient, and their diagnosis is challenging to date. A mental illness is a medical disorder that affects a person's thoughts, feelings, or behavior (or all three) and results in functional challenges, suffering, and discrimination for the individual. Just like other diseases, mental illness can vary from mild to severe conditions and are treatable. The dynamic and ongoing process of searching for mental health biomarker discovery was born to address this emerging condition. Biomarker for mental health refers to measurable biological indicators that can be used to assess and monitor various aspects of mental health conditions (Glannon, 2022). These biomarkers include genetic, neurochemical, hormonal, neuroimaging, and physiological measurements. The development and utilization of biomarkers hold promise for improving the diagnosis, treatment, and understanding of mental health disorders.

Research supported the evidence stating that mental health is likely multifaceted by nature, that includes genetic, biochemical, physiological, and environmental factors. The Human Genome Project, completed in 2003, opened new avenues for genetic research. Since then, genome-wide association studies (GWAS) and other genetic analyses have identified specific *genetic variants* associated with mental health disorders. Genetic variations can contribute to an individual's susceptibility to mental health disorders.

Over the years, researchers have made significant progress in identifying and understanding various biomarkers associated with mental health disorders. In the mid-20th century, researchers started investigating the relationship between neurotransmitters and mental health. Scientists have learned that alterations in neurochemicals are related to mental diseases. For instance, the significant milestone was the discovery of antipsychotic drugs in the 1950s, which specifically targeted dopamine receptors and shed light on the involvement of neurotransmitters in conditions such as schizophrenia (Sawa &Snyder, 2003). Another early discovery was the neurotransmitter serotonin. These neurochemicals are released into the synaptic region in depressed individuals than in healthy individuals. Selective serotonin reuptake inhibitors (SSRIs), a class of drugs, work by increasing the quantity of serotonin in the synaptic region, which alleviates symptoms of depression (Bethesda, 2007). Several

combinations of single nucleotide polymorphisms in an individual's genetic makeup and some environmental stressors may contribute to these mental conditions. When a person is stressed, the cortisol hormone is released into the bloodstream (Cay et al., 2018). In the 1980s and 1990s, the role of cortisol as a prognostic biomarker in mental health disorders gained attention. Studies found dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, leading to abnormal cortisol levels. Cushing's syndrome (Lacroix et al., 2015) is caused by too much cortisol, while Addison's disease (Charmandari et al., 2014) is caused by adrenal damage and is associated with too little cortisol. Drugs related to cortisol (e.g., prednisolone) will suppress cortisol secretion from the adrenal gland if taken for a period. The inherited genetic error can cause disorders in the human body, such as Huntington's disease (HD). HD is caused by the mutation in the gene resulting in increased repetition of cytosine, adenine, and guanine (CAG). This error in the DNA codes for genes makes defective nerve cells in the brain gradually break down and die, causing the body to lose important signals to keep it in its proper function and response.

These breakthroughs emphasized the significance of neurotransmitter imbalances in mental health disorders and paved the way for further research in this field. Measuring these chemicals in the blood or the cerebrospinal fluid with neuroimaging techniques, mass spectrometry, and genetic testing can help identify these biomarkers. Advances in neuroimaging techniques like positron emission tomography (PET), magnetic resonance imaging (MRI), and functional MRI (fMRI) can reveal structural and functional brain abnormalities associated with mental health disorders. Brain imaging biomarkers help understand brain circuitry, identify treatment targets, and evaluate treatment response.

Multi-omics approaches, such as integrating multiple biological data sources, such as genomics, proteomics, metabolomics, and transcriptomics, have opened new avenues for biomarker discovery. These multi-omics approaches allow researchers to explore complex interactions and networks underlying mental health disorders. It's important to note that the field of mental health biomarkers is still evolving. Many biomarkers are in the early stages of research and require further validation and standardization before they can be implemented in clinical practice. Nonetheless, the ongoing discoveries in this field hold great promise for personalized approaches to diagnosis, treatment, and understanding of mental health disorders.

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