# C22 - Medical Imaging and Mental Health Disorders

Objectives

- Discuss common mental health disorders and how medical imaging can improve the diagnosis and treatment of these disorders.

- Provide a general history of psychiatry and the modern view of common psychiatric disorders will be discussed.

- Discuss current use of medical imaging, as it relates to mental health disorders.

- Outline limitations of using medical imaging tools in these studies.

- Discuss possible future applications.
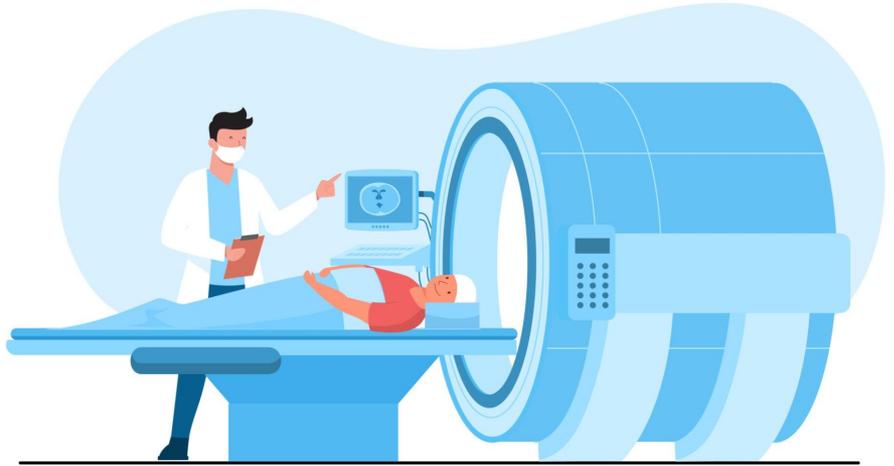
Introduction

History of Mental Illness
- Societies believed that mental illness was caused by demon possession or witchcraft.

- Individuals were abused and murdered.

- Patients were subjected to harsh conditions and abuse in asylums.

- 1960s - Antipsychotic medications became popular and the treatment of psychiatric disorders started to evolve into the modern practices we see today.

As medical imaging advances, it is being increasingly used to advance research efforts involving mental health disorders. Medical imaging has potential to be a beneficial tool in the early detection, accurate diagnosis, and effective treatment of mental health disorders.

Current Diagnostic Criteria in Psychology

Current diagnoses are based upon clinical evaluations.

Limitations with current diagnostic criteria:
- Subjective (observations of doctors)
- Overlapping symptoms between different disorders

Result: delay in diagnosis and treatment, immense distress as patients navigate life with their disorders

"
Patients with BD wait on average 10 years before an accurate diagnosis and are often misdiagnosed with unipolar depression for years. As for MDD, it is often underdiagnosed even though fast and accurate diagnosis could avoid long-term cognitive impairment in under-treated patients.
"

- Brossollet, Gallet, Favre, & Houenou, 2023

Common Mental Health Disorders

- Affective disorders
    - Bipolar disorders
    - Major depressive disorders

- Psychotic disorders
    - Schizophrenia

- Anxiety disorders
    - Obsessive-compulsive disorders

- Neurodevelopmental disorders
    - Autism

- Substance use disorders
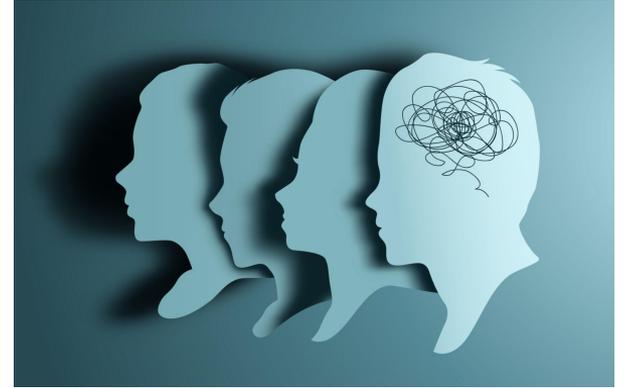
> " Depression will affect 15-20% of the population in their lifetime, schizophrenia 0.7-1%, and bipolar disorder 1-2.5% "

- Brossollet, Gallet, Favre, & Houenou, 2023

Major Depressive Disorder

- Defined by the occurrence of one or more major depressive episodes without any mania or hypomanic episodes in the lifetime.

- Its prevalence can vary significantly according to the studies, but exceeds 15% of the population during their lifetime.

- Most common mental health disorder in the United States.

Bipolar Disorder

- Defined as a chronic mood disorder characterized by episodes of depression and episodes of abnormal excitation (mania, hypomania), separated by periods of "euthymia" (without any symptoms of major mood episode).

Schizophrenia

- Mental disorder characterized by disruptions in thought processes, perceptions, emotional responsiveness, and social interactions.

- Although the course of schizophrenia varies among individuals, schizophrenia is typically persistent and can be both severe and disabling.

- Common symptoms: delusions, hallucinations, and cognitive impairment

Current Studies

Changes in the structure and function of the brain can be seen in many common mental health disorders, so utilizing both types of imaging is necessary.
- Structural imaging shows a detailed anatomy of the brain
- Functional imaging shows brain activity
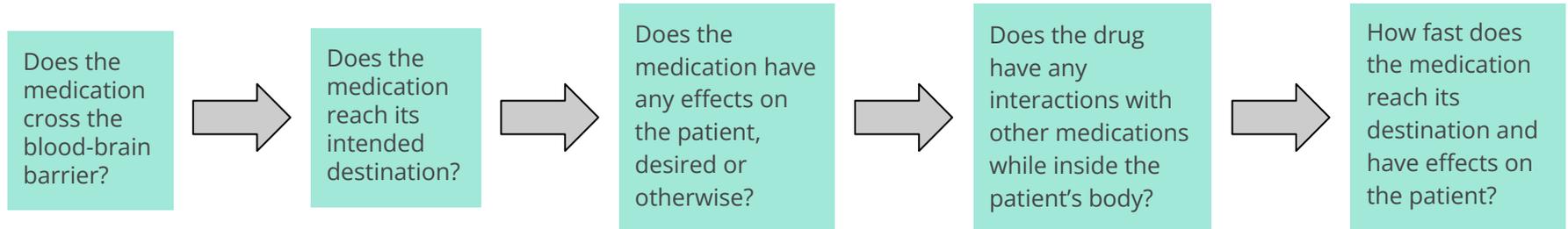 - MRI, PET, SPECT
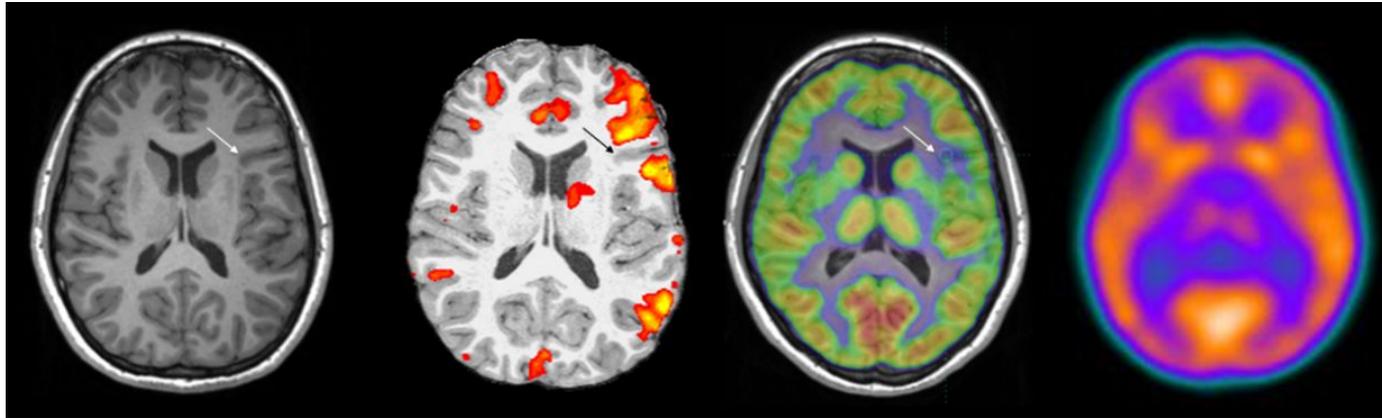
structural MRI   functional MRI   PET   SPECT

Current Studies - medication development and research trials

- Medical imaging is currently being used in medication development and research trials.

- Neuroimaging can be utilized to study drugs during every stage in the medication pathway.

| Does the medication cross the blood-brain barrier? | → | Does the medication reach its intended destination? | → | Does the medication have any effects on the patient, desired or otherwise? | → | Does the drug have any interactions with other medications while inside the patient's body? | → | How fast does the medication reach its destination and have effects on the patient? |

Current Studies continued...

"
fMRI [functional MRI] has the potential to show the mending of abnormal brain function with effective new medications. For example, fMRI has been used as a pre-biomarker in the study of depression. The SSRI antidepressant citalopram reduced amygdala activation in response to fearful faces in normal volunteers. The amygdala response to fearful stimuli could develop into a pre-biomarker for antidepressant effects.
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- Masdeu (2011)
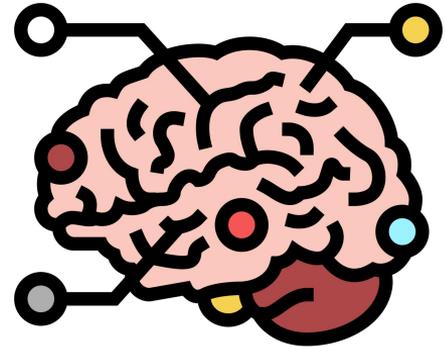
Limitations

- Costs of tests and clinical trials

- Large amount of data that needs interpretation on each scan

- Overlap and variability of biomarkers and symptom presentation between different psychiatric conditions

" Even when for clinical and research purposes entities such as schizophrenia and depression are used as if they were a single disease, these disorders are more likely to be syndromic groupings of an array of different diseases. No surprise then that the neuroimaging findings in psychiatric disease may lack specificity and often fail to reveal a clear connection to a single neurobiological disturbance. Currently, the neuroimaging pattern determined in the study of a single psychiatric patient does not allow for an accurate diagnosis. Some characteristic findings, however, have been derived from samples of patients with each of the psychiatric diagnostic groupings. "

- Masdeu (2011)

Future Goals and Applications - discovering biomarkers

- The next step would be searching for early biomarkers of various disorders.

- If early biomarkers are found, scans could be performed on patients who are high risk but not yet exhibiting any symptoms.

- If neuroimaging could detect a disorder before the patient exhibits symptoms, this would lead to quicker care and more positive outcomes.

- Interventions such as medication and therapies could be implemented to stop the disorder in its tracks, or at least delay the onset and decrease the symptoms.

" Even if we know from other testing or family history that someone is at risk of a disorder… we are still unable to predict when exactly it will occur… Brain imaging could narrow down that time window, by catching the relevant patterns when they do show up before clinical disease is apparent. "

- Reetz, 2022

Future Goals and Applications - collaboration with other research modalities

> Psychiatric neuroimaging has benefitted from its interaction with genetics ("imaging genetics"). In such studies, neuroimaging findings in two or more genetic variants of the population are compared in order to discover imaging endophenotypes that may be amenable to measurement, and, therefore, useful as biomarkers in therapeutic discovery. By relating neural structures to specific genes, imaging genetics is also likely to reveal the molecular underpinning of the organization and function of the various brain structures.

- Masdeu (2011)

By identifying a correlation between specific genes and the functional and structural differences characteristic of a specific disorder, additional biomarkers may be identified.

Conclusion

- While medical imaging is not currently able to definitively diagnose mental health disorders, advancements in imaging and other research modalities show promise for the future.

- These advancements include not only diagnostic improvements, but also improvements in treatment through medicinal study.

- By diagnosing and treating psychiatric disorders more effectively, the quality of life for patients suffering with debilitating symptoms may be greatly improved.

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