Neuroimaging in psychiatry: Potentials and pitfalls

Robyn Thom, MD, and Helen M. Farrell, MD

Advances in neuroimaging over the past 25 years have allowed for an increasingly sophisticated understanding of the structural and functional brain abnormalities associated with psychiatric disease.[1] It has been postulated that a better understanding of aberrant brain circuitry in psychiatric illness will be critical for transforming the diagnosis and treatment of these illnesses.[2] In fact, in 2008, the National Institute of Mental Health launched the Research Domain Criteria project to reformulate psychiatric diagnosis based on biologic underpinnings.[3]

In the midst of these scientific advances and the increased availability of neuroimaging, some private clinics have begun to offer routine brain scans as part of a comprehensive psychiatric evaluation.[4-7] These clinics suggest that single-photon emission computed tomography (SPECT) of the brain can provide objective, reliable psychiatric diagnoses. Unfortunately, using SPECT for psychiatric diagnosis lacks empirical support and carries risks, including exposing patients to radioisotopes and detracting from empirically validated treatments.[8] Nonetheless, given the current diagnostic challenges in psychiatry, it is understandable that patients, parents, and clinicians alike have reported high receptivity to the use of neuroimaging for psychiatric diagnosis and treatment planning.[9]

While neuroimaging is central to the search for improved understanding of the biologic foundations of mental illness, progress in identifying biomarkers has been disappointing. There are currently no neuroimaging biomarkers that can reliably distinguish patients from controls, and no empirical evidence supports the use of neuroimaging in diagnosing psychiatric conditions.[10] The current standard of clinical care is to use neuroimaging to diagnose neurologic diseases that are masquerading as psychiatric disorders. However, given the rapid advances and availability of this technology, determining if and when neuroimaging is clinically indicated will likely soon become increasingly complex. Prior to the widespread availability of this technology, it is worth considering the potential advantages and pitfalls to the adoption of neuroimaging in psychiatry. In this article, we:

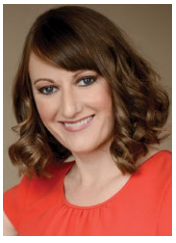
- outline arguments that support the use of neuroimaging in psychiatry, and some of the limitations
- discuss special considerations for patients with first-episode psychosis (FEP) and forensic psychiatry
- suggest guidelines for best-practice models based on the current evidence.

Advantages of widespread use of neuroimaging in psychiatry

Currently, neuroimaging is used in psychiatry to rule out neurologic disorders such as

Dr. Thom is a Child and Adolescent Psychiatry Fellow, Massachusetts General Hospital/McLean Hospital, Boston, Massachusetts. Dr. Farrell is Lecturer, Harvard Medical School, and Psychiatrist, Beth Israel Deaconess Medical Center, Boston, Massachusetts.

Disclosures
The authors report no financial relationships with any companies whose products are mentioned in this article, or with manufacturers of competing products.



Helen M. Farrell, MD
Department Editor

DO YOU HAVE A QUESTION OR CONCERN ABOUT THE FUTURE OF PSYCHIATRY?

▶ **Contact Dr. Farrell at hfarrell@mdedge.com**

▶ **Include your name, address, and practice location**

seizures, tumors, or infectious illness that might be causing psychiatric symptoms. If neuroimaging were routinely used for this purpose, one theoretical advantage would be increased neurologic diagnostic accuracy. Furthermore, increased adoption of neuroimaging may eventually help broaden the phenotype of neurologic disorders. In other words, psychiatric symptoms may be more common in neurologic disorders than we currently recognize. A second advantage might be that early and definitive exclusion of a structural neurologic disorder may help patients and families more readily accept a psychiatric diagnosis and appropriate treatment.

In the future, if biomarkers of psychiatric illness are discerned, using neuroimaging for diagnosis, assessment, and treatment planning may help increase objectivity and reduce the stigma associated with mental illness. Currently, psychiatric diagnoses are based on emotional and behavioral self-report and clinical observations. It is not uncommon for patients to receive different diagnoses and even conflicting recommendations from different clinicians. Tools that aid objective diagnosis will likely improve the reliability of the diagnosis and help in assessing treatment response. Also, concrete biomarkers that respond to treatment may help align psychiatric disorders with other medical illnesses, thereby decreasing stigma.

Clinical Point

Using neuroimaging for diagnosis, assessment, and treatment planning may help increase objectivity and reduce stigma

Cautions against routine neuroimaging

There are several potential pitfalls to the routine use of neuroimaging in psychiatry. First, clinical psychiatry is centered on clinical acumen and the doctor–patient relationship. Many psychiatric clinicians are not accustomed to using lab measures or tests to support the diagnostic process or treatment planning. Psychiatrists may be resistant to technologies that threaten clinical acumen, the power of the therapeutic relationship, and the value of getting to know patients over time.[11] Overreliance on neuroimaging for psychiatric diagnosis also carries the risk of becoming overly reductionistic. This approach may overemphasize the biologic aspects of mental illness, while excluding social and psychological factors that may be responsive to treatment.

Second, the widespread use of neuroimaging is likely to result in many incidental findings. This is especially relevant because abnormality does not establish causality. Incidental findings may cause unnecessary anxiety for patients and families, particularly if there are minimal treatment options.

Third, it remains unclear whether widespread neuroimaging in psychiatry will be cost-effective. Unless imaging results are tied to effective treatments, neuroimaging is unlikely to result in cost savings. Presently, patients who can afford out-of-pocket care might be able to access neuroimaging. If neuroimaging were shown to improve clinical outcomes but remains costly, this unequal distribution of resources would create an ethical quandary.

Finally, neuroimaging is complex and almost certainly not as objective as one might hope. Interpreting images will require specialized knowledge and skills that are beyond those of currently certified general psychiatrists.[12] Because there is a great deal of overlap in brain anomalies across psychiatric illnesses, it is unclear whether using neuroimaging for diagnostic purposes will eclipse a thorough clinical assessment. For example, the amygdala and insula show activation across a range of anxiety disorders. Abnormal amygdala activation has also been reported in depression, bipolar disorder, schizophrenia, and psychopathy.[13]

In addition, psychiatric comorbidity is common. It is unclear how much

continued on page 33

continued from page 28

neuroimaging will add diagnostically when a patient presents with multiple psychiatric disorders. Comorbidity of psychiatric and neurologic disorders also is common. A neurologic illness that is detectable by structural neuroimaging does not necessarily exclude the presence of a psychiatric disorder. This poses yet another challenge to developing reliable, valid neuroimaging techniques for clinical use.

Areas of controversy

First-episode psychosis. Current practice guidelines for neuroimaging in patients with FEP are inconsistent. The Canadian Choosing Wisely Guidelines recommend against routinely ordering neuroimaging in first-episode psychoses in the absence of signs or symptoms that suggest intracranial pathology.[14] Similarly, the American Psychiatric Association's Practice Guideline for the Treatment of Patients with Schizophrenia recommends ordering neuroimaging in patients for whom the clinical picture is unclear or when examination reveals abnormal findings.[15] In contrast, the Australian Clinical Guidelines for Early Psychosis recommend that all patients with FEP receive brain MRI.[16] Freudenreich et al[17] describe 2 philosophies regarding the initial medical workup of FEP: (1) a comprehensive medical workup requires extensive testing, and (2) in their natural histories, most illnesses eventually declare themselves.

Despite this inconsistency, the overall evidence does not seem to support routine brain imaging for patients with FEP in the absence of neurologic or cognitive impairment. A systematic review of 16 studies assessing the clinical utility of structural neuroimaging in FEP found that there was "insufficient evidence to suggest that brain imaging should be routinely ordered for patients presenting with first-episode psychosis without associated neurological or cognitive impairment."[18]

Forensic psychiatry. Two academic disciplines—neuroethics and neurolaw—attempt to study how medications and neuroimaging could impact forensic psychiatry.[19] And in this golden age of neuroscience, psychiatrists specializing in forensics may be increasingly asked to opine on brain scans. This requires specific thoughtfulness and attention because forensic psychiatrists must "distinguish neuroscience from neuro-nonsense."[20] These specialists will need to consider the Daubert standard, which resulted from the 1993 case *Daubert v Merrell Dow Pharmaceuticals, Inc.*[21] In this case, the US Supreme Court ruled that evidence must be "'generally accepted' as reliable in the relevant scientific community" to be admissible. According to the Daubert standard, "evidentiary reliability" is based on scientific validity.[21]

How should we use neuroimaging?

While neuroimaging is a quickly evolving research tool, empirical support for its clinical use remains limited. The hope is that future neuroimaging research will yield biomarker profiles for mental illness, identification of risk factors, and predictors of vulnerability and treatment response, which will allow for more targeted treatments.[1]

The current standard of clinical care for using neuroimaging in psychiatry is to diagnose neurologic diseases. Although there are no consensus guidelines for when to order imaging, it is reasonable to consider imaging when a patient has[22]:

- abrupt onset of symptoms
- change in level of consciousness
- deficits in neurologic or cognitive examination
- a history of head trauma (with loss of consciousness), whole-brain radiation, neurologic comorbidities, or cancer
- late onset of symptoms (age >50)
- atypical presentation of psychiatric illness.

continued

Clinical Point

Neuroimaging may overemphasize the biologic aspects of mental illness and exclude social and psychological factors

Clinical Point

Evidence does not seem to support routine brain imaging for patients with first-episode psychosis

References

1. Silbersweig DA, Rauch SL. Neuroimaging in psychiatry: a quarter century of progress. Harv Rev Psychiatry. 2017; 25(5):195-197.
2. Insel TR, Wang PS. Rethinking mental illness. JAMA. 2010;303(19):1970-1971.
3. Insel TR, Cuthbert BN. Endophenotypes: bridging genomic complexity and disorder heterogeneity. Biol Psychiatry. 2009;66(11):988-989.
4. Cyranoski D. Neuroscience: thought experiment. Nature. 2011;469:148-149.
5. Amen Clinics. https://www.amenclinics.com/. Accessed October 22, 2019.
6. Pathfinder Brain SPECT Imaging. https://pathfinder.md/. Accessed October 22, 2019.
7. DrSpectScan. http://www.drspectscan.org/. Accessed October 22, 2019.
8. Adinoff B, Devous M. Scientifically unfounded claims in diagnosing and treating patients. Am J Psychiatry. 2010;167(5):598.
9. Borgelt EL, Buchman DZ, Illes J. Neuroimaging in mental health care: voices in translation. Front Hum Neurosci. 2012;6:293.
10. Linden DEJ. The challenges and promise of neuroimaging in psychiatry. Neuron. 2012;73(1):8-22.
11. Macqueen GM. Will there be a role for neuroimaging in clinical psychiatry? J Psychiatry Neurosci. 2010;35(5):291-293.
12. Boyce AC. Neuroimaging in psychiatry: evaluating the ethical consequences for patient care. Bioethics. 2009; 23(6):349-359.
13. Farah MJ, Gillihan SJ. Diagnostic brain imaging in psychiatry: current uses and future prospects. Virtual Mentor. 2012;14(6):464-471.
14. Canadian Academy of Child and Adolescent Psychiatry, et al. Thirteen things physicians and patients should question. Choosing Wisely Canada. https://choosingwiselycanada.org/wp-content/uploads/2017/02/Psychiatry.pdf. Updated June 2017. Accessed October 22, 2019.
15. Lehman AF, Lieberman JA, Dixon LB, et al; Work Group on Schizophrenia. Practice guideline for the treatment of patients with schizophrenia, second edition. Am J Psychiatry. 2004;161(suppl 2):1-56.
16. Australian Clinical Guidelines for Early Psychosis. 2nd edition. The National Centre of Excellence in Youth Mental Health. https://www.orygen.org.au/Campus/Expert-Network/Resources/Free/Clinical-Practice/Australian-Clinical-Guidelines-for-Early-Psychosis/Australian-Clinical-Guidelines-for-Early-Psychosis.aspx?ext=. Updated 2016. Accessed October 22, 2019.
17. Freudenreich O, Schulz SC, Goff DC. Initial medical work-up of first-episode psychosis: a conceptual review. Early Interv Psychiatry. 2009;3(1):10-18.
18. Forbes M, Stefler D, Velakoulis D, et al. The clinical utility of structural neuroimaging in first-episode psychosis: a systematic review. Aust N Z J Psychiatry. 2019:000486741984803. doi: 10.1177/0004867419848035.
19. Aggarwal N. Neuroimaging, culture, and forensic psychiatry. J Am Acad Psychiatry Law. 2009;37(2): 239-244
20. Choi O. What neuroscience can and cannot answer. J Am Acad Psychiatry Law. 2017;45(3):278-285.
21. Daubert v Merrell Dow Pharmaceuticals, Inc. 509 US 579 (1993).
22. Camprodon JA, Stern TA. Selecting neuroimaging techniques: a review for the clinician. Prim Care Companion CNS Disord. 2013;15(4):PCC.12f01490. doi: 10.4088/PCC.12f01490.