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Neuroimaging: a new training issue in psychiatry?

Many studies recently have highlighted the role of neuroimaging in the diagnosis and management of patients with psychiatric disorders (Lewis, 1996; Costa *et al*, 1999; Longworth *et al*, 1999). In old age psychiatry, a diagnosis of dementia is facilitated by structural and functional imaging, both of which have been shown to increase the accuracy with which a diagnosis of Alzheimer's disease can be made (Zakzanis *et al*, 2003). There is also a role for neuroimaging in the differential diagnosis of organic brain syndromes, which are often referred to the old age and liaison psychiatric services. The usefulness of neuroimaging has extended further into the area of the major functional psychiatric disorders by contributing to our understanding of the aetiology and pathophysiology of these illnesses. Despite this, image interpretation has not yet been incorporated into the training of psychiatrists, at junior or senior level. In this, we differ from other specialist areas of medicine where the ability to interpret images is an integral part of training. At present, the Royal College of Psychiatrists is developing a competency-based curriculum for senior trainees that will lead to the certificate of completion of training (CCT). This will replace the existing CCST (certificate of completion of specialist training; http://www.rcpsych.ac.uk/traindev/postgrad/ccst.htm). In order to obtain the CCT, a series of 'general competencies' will be recommended for all senior trainees, which will involve the trainee developing expertise in a number of roles identified by the College. These include the roles of clinician, researcher and educator, among others. Specific key competencies will be further recommended in the development of these general competencies, with variations in some key competencies according to the sub-specialty.

We propose that an understanding of the neuroimaging modalities and interpretation of brain scans should become a vital part of acquiring the key competencies of using appropriate investigations and making accurate diagnoses of mental disorder in older people and for those pursuing careers in neuropsychiatry, liaison psychiatry and for those with specific research interests.

Background

Neuroimaging may be structural or functional and both are well-recognised useful tools for research and clinical purposes in psychiatry. Structural imaging examines the anatomical structures of the brain and surrounding bone and includes computed tomography (CT scan) and magnetic resonance imaging (MRI). Functional imaging can measure cerebral blood flow and receptor activity and includes single photon emission computed tomography (SPECT), positron emission tomography (PET) and functional MRI (fMRI). Neuroimaging has provided a significant insight into our understanding of the aetiology and pathophysiology of the major psychiatric disorders through imaging of structure, blood flow and receptor activity. In the area of dementia and organic brain syndromes, individual patient management can actually be changed as a direct result of scanning, e.g. detecting normal pressure hydrocephalus in a patient with dementia.

In the case of schizophrenia, neuroimaging has provided a wealth of data contributing to the view that schizophrenia has a strong neurobiological basis by demonstrating ventricular enlargement and cerebral atrophy (Johnstone *et al*, 1976; Sanfilipo *et al*, 2000; Wright *et al*, 2000), reduced cortical volume (Ward *et al*, 1996), particularly in the hippocampus (Nelson *et al*, 1998) and hypofrontality (Parellada, 1998; Riehemann, 2001). It has also substantially added to our knowledge of the underlying neurochemical abnormalities by demonstrating involvement of the dopaminergic (DA), serotonergic (5-hydroxytryptamine, 5-HT) and glutamatergic systems. Imaging studies have consistently demonstrated a presynaptic dopamine abnormality, with abnormal responsiveness of dopaminergic neurones shown in studies on both medicated (McGowan *et al*, 2004) and drug naive patients (Abi-Dargham *et al*, 1998; Laakso *et al*, 2000). Further complexity was added with the discovery that atypical antipsychotic agents have a high affinity for 5-HT2a receptors (Farde *et al*, 1995) and clozapine also has a relatively low D2 receptor occupancy (Nordstrom *et al*, 1995). Thus interest in the role of 5-HT was rekindled, although originally interest arose because the hallucinogenic lysergic acid diethylamide (LSD) is a 5-HT agonist. The glutamatergic dysfunction hypothesis of schizophrenia suggests that there is reduced glutamate output from the hippocampus and defective afferent activation of the anterior cingulate gyrus resulting in psychotic symptoms (Tsai *et al*, 1995; Tamminga, 1998). Radioligands for the *N*-methyl-D-aspartate (NMDA)

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subtype of the glutamate receptor have been developed and are now being used to characterise the NMDA receptor in patients with schizophrenia (Bressan *et al*, 2003) and may facilitate further neuroimaging of the glutamatergic system, particularly with regard to therapeutic intervention. Although a single cohesive model of the illness clearly has not yet emerged, the strength of evidence is such that a biological explanation should go a long way towards reducing the stigma suffered by both family and patients and ultimately contributing to our ability to diagnose, treat and prognosticate.

In depressive disorders, studies over time have demonstrated a reduction in pre-frontal brain activity (Bench *et al*, 1993; Goodwin, 1996; Galynker II *et al*, 1998) with more recent studies suggesting that activity in the anterior cingulate cortex may predict response to treatment (Wu *et al*, 1992; Mayberg *et al*, 1997). To date, studies on the 5-HT system have been limited, but work is ongoing in the development of specific radiotracers for 5-HT1a and 5-HT2a receptor groups, with the aim of specifically characterising the 5-HT abnormalities that occur in depression and ultimately refining treatment targets.

Despite all this, neuroimaging remains the preserve of radiologists, nuclear medicine physicians and a small number of psychiatrists with particular research interests.

In many areas of medicine, by contrast, the use of a relevant imaging modality has become chiefly the preserve of the investigating physician. The use of echocardiography by cardiologists is a good example of this. Echocardiography, an imaging tool used in the investigation of cardiac murmurs, ventricular function and other cardiac defects, has largely superseded auscultation. Two recent studies have shown that 61.5% of echocardiography is performed and interpreted by cardiologists (Levin *et al*, 2002), and that this results in altered management as compared with echocardiography performed by internists (Calenda *et al*, 1996).

Current uses and recommendations

Imaging has particular uses in excluding underlying physical causes of psychiatric disability such as stroke, brain tumours and normal pressure hydrocephalus. However, imaging does more than outrule such lesions, it can also contribute to the accuracy with which a diagnosis of dementia is made. Recent recommendations from the American Association of Neurologists advise that a CT or MRI scan is an essential investigation in dementia (Knopman *et al*, 2001).

Imaging tools are increasingly available in hospitals throughout Britain and Ireland but their use in psychiatry varies according to local expertise.

In our experience of running a memory clinic, where a diagnosis is made using medical, psychiatric and neuropsychological expertise, differentiating between the dementias has been enhanced by having a psychiatrist trained in image interpretation at case conference meetings.

Current training requirements

Currently, the clinical curriculum for MRCPsych requires that all trainees should be able to deal with the medical aspects of psychiatric disorders and physical disease in psychiatric practice (Royal College of Psychiatrists, 2001) and the skill to do physical examinations and manage physical illness at a basic level is a key competency for old age psychiatry. This is particularly important in psychiatry of the elderly where a physical problem may well underlie a psychiatric presentation. The new format for the first part of the membership examination aims to test these skills in a practical way by using an objective structured clinical examination (OSCE). The *Basic Specialist Training Handbook* suggests that the trainee should be able to demonstrate familiarity with the techniques used in brain imaging as well as having a good understanding of normal neuroanatomy and physiology (Royal College of Psychiatrists, 2001). This adds weight to the assumption that there is a biological basis for many of the major psychiatric illnesses, both functional and organic. Nonetheless, there is no formal testing of imaging skills in the examination, either in the form of image interpretation or logbook evidence of attendance at radiology conferences. For senior trainees, the College is in the process of identifying specific roles or 'general competences' necessary for the acquisition of the CCT. These roles will include that of clinician, professional, educator, leader and researcher among others. The College thinking further elaborates on these themes and will suggest a series of 'key competencies' and methods by which these could be attained for the varying sub-specialties. Key competencies applying to old age psychiatry, for example, may include appropriate use of investigations in old age psychiatry and making accurate diagnosis of mental disorder in the elderly. However, as yet there is no specific mention of neuroimaging at senior training level in relation to these particular competencies.

The situation in medicine is somewhat different. At general professional training level in medicine, both the Irish and British Royal Colleges of Physicians require a logbook of clinical and procedural skills. Attendance at radiology conferences is also part of general professional training. Interpretation of imaging data is an integral part of the membership examination for both Colleges and the emphasis on image interpretation partly stems from the need to diagnose and treat patients who present as emergencies. However, the ability to interpret images by the physician has now extended well beyond basic interpretation of chest X-rays while on call, and certain imaging modalities have become the preserve of the specialised physician.

This has led to even more specific training at specialist registrar level. Training in cardiology, for example, requires considerable experience of echocardiography. At basic sub-specialty level, cardiology trainees are required to understand the principles behind echocardiography and to have performed at least 500 such examinations under experienced direction. At senior training level, these skills are extended to include

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transthoracic and transoesophageal echocardiograms, the view of the College and Special Advisory Committee being that recording and interpretation skills improve with experience (Joint Committee on Higher Medical Training, 2003).

In psychiatry there are very specific requirements for training in different areas of sub-specialist interest. Psychotherapy training, for example, at basic specialist training level involves five basic requirements that include development of interview skills and psychotherapeutic formulation of a psychiatric disorder. The clinical exposure required includes a minimum of three short-term cases, each using a different psychotherapeutic model and one long-term individual case. Experience of group psychotherapy or couple, family and systemic therapy is also required (Royal College of Psychiatrists, 2003). The implementation of this training requires a coordinator for psychotherapy, normally a consultant psychotherapist and the use of logbooks. The objectives must be fulfilled to enter for the MRCPsych Part 2 examination.

Recommended training requirements for neuroimaging

We suggest that neuroimaging and image interpretation should be incorporated into psychiatry training in a number of ways, with clear recommendations for training, implementation and assessment. We consider that training in neuroradiology would be of particular benefit to those with specific interests in psychiatry of the elderly, liaison psychiatry, neuropsychiatry and those with specific research interests. Developing these skills would enhance many of the roles set out by the college in its competency-based curriculum.

Recommendations for training

Goals of basic specialist training should include the following:

1. A basic understanding of each imaging modality and the degree of radiation exposure associated with each one.
2. Familiarity with structural and functional imaging findings in dementia, schizophrenia, affective disorders, autism, stroke and cerebral haemorrhage.
3. Understanding the indications and contraindications for each imaging modality.

Two other issues which strongly influence the choice of imaging modality are the patient's subjective experience and the relative cost of the procedure. For example, performing a 40-min MRI scan in a claustrophobic patient with suspected vascular disease may not be as useful as a 10-min CT scan. Although the degree of image resolution is better with MRI, patient cooperation for the CT is likely to be much greater. MRI is considerably more expensive than CT; a fact which would also make CT a much better choice in the above example.

At a senior training level, training for those with a special interest in neuroradiology should be much more specific with a focus on the following:

1. Image interpretation and image analysis techniques.
2. Ability to interpret at least one modality of structural brain scans and one modality of functional imaging.
3. Knowledge of the types of ligand commercially available.

Recommendations for implementation

In order to implement the training recommendations, learning methods should be along the lines suggested by the College and should include such methods as observation, attendance at multidisciplinary case conferences, supervision by specialists in neuroradiology and the keeping of logbooks.

Particular emphasis for the senior trainee needs to be placed on attendance at specific workshops and courses and professional conferences. Both poster and paper presentations would further enhance senior training.

Recommendations for assessment

Assessment should be performed at both basic specialist and senior training levels. The OSCE provides the opportunity for examining the trainee's ability to identify the imaging modality used, the basic neuroanatomical structures and identification of gross pathology.

At senior level, the trainee assessment should again follow the College guidelines and include validated self-assessment, in-training assessment and papers accepted by peer-reviewed journals. Particular emphasis should be placed on clinical supervision, direct observation, peer review and the keeping of logbooks.

Conclusion

Neuroimaging has a well-recognised role in the diagnosis and management of various psychiatric disorders and a further role in elucidating the underlying neurobiological components of the major functional illnesses. We recommend that a working knowledge of the various neuroimaging modalities should be an essential part of basic specialist training in psychiatry and that an ability to interpret brain images should be part of the remit of psychiatrists at higher professional training level, particularly those training in psychiatry of the elderly, liaison psychiatry, neuropsychiatry and those with specific research interests. This would enable psychiatrists to make appropriate referrals, enhance diagnostic accuracy and hopefully increase the contribution of psychiatrists to the large body of work examining the neurobiological models of the major psychiatric disorders.

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