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Neuroimaging in dementia and Alzheimer's disease: Current protocols and practice in the Republic of Ireland

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ABSTRACT

Introduction: Neuroimaging plays an essential supportive role in the diagnosis of dementia, assisting in establishing the dementia subtype(s). This has significant value in both treatment and care decisions and has important implications for prognosis. This study aims to explore the development and nature of neuroimaging protocols currently used in the assessment of dementia and Alzheimer's disease (AD).
Methods: An online questionnaire was designed and distributed to lead radiography personnel working in computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) departments (n = 94) in both hospital-based and out-patient imaging centres in the Republic of Ireland.
Results: Response rates for each modality ranged from 42 to 44%. CT, MRI, and PET were used to specifically diagnose dementia or AD by 43%, 40% and 50% of responding centres respectively. Of these, dementia-specific neuroimaging protocols were utilised in 33%, 50% and 100% of CT, MRI and PET centres respectively, with the remainder using either standard or other non-specific protocols. Both radiologists and clinical specialist radiographers participated in the development of the majority of protocols. The Royal College of Radiologists (RCR) guidelines were most commonly referenced as informing protocol development, however, none of the MRI respondents were able to identify any guidelines used to inform MR protocol development.
Conclusion: Currently there is no consensus in Ireland on optimal dementia/AD neuroimaging protocols, particularly for PET and MRI. Similarly the use of validated and published guidelines to inform protocols is not universal.

Introduction

Dementia is defined as a syndrome, usually chronic, due to disease of the brain and is characterised by progressive, global deterioration of cognitive function beyond what would be expected in normal ageing.[1] Although a condition primarily associated with increasing age, current estimates show that 2–10% of cases are diagnosed before the age of 65 years with Alzheimer's disease (AD), one subtype of dementia, accounting for 50–75% of all cases.[2] The World Alzheimer Report 2009 has estimated that over 35 million people worldwide are currently living with dementia, with this number expected to double every 20 years to a projected figure of over 115 million people by 2050.[2] Currently, the majority of people living with dementia do not receive a formal diagnosis.[3–5] A large number of factors contributing to the underdiagnosis of dementia and AD have been identified, which include: a lack of international consensus as to which speciality within medicine should take the lead in the diagnosis and treatment of dementia and AD[5]; reticence among many primary care physicians,[6] who may have limited specialist training in the area of dementia/AD,[7] or who may perceive that there is little to offer until later on in the course of the condition[8,9]; the well-documented and ongoing stigma surrounding the diagnosis of dementia and AD perceived by many healthcare professionals worldwide[6,10–13]; the challenges encountered when diagnosing dementia and AD, especially when earlier, more subtle signs are present, which may go undetected for years.[14] In the UK, it is estimated that 48% of people with dementia are formally diagnosed, with similar figures in the Republic of Ireland.[15,16] This can be of significant consequence, as early diagnosis is essential due to the improved effectiveness of certain

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interventions when commenced at an early stage in addition to allowing access to organised care and support.[3] Timely intervention also results in significant health, financial and social benefits.[3]

Neuroimaging plays an important diagnostic role in the assessment of dementia and AD as it facilitates the identification of brain changes as part of the clinical diagnosis and can help establish dementia subtypes.[17] Over the last few decades, significant advances have been made both in the understanding of dementia and AD pathogenesis and in neuroimaging technology, leading to the discovery of novel biomarkers,[18,19] however, conventional diagnostic criteria for dementia and AD[20,21] support a clinical diagnosis based on probability and with no definitive biomarkers.[9] Furthermore, the specificity of conventional diagnostic criteria for dementia subtypes is widely variable, and often suboptimal.[18,22,23] With the advent of novel biomarkers, new diagnostic criteria for dementia and AD which include these biomarkers have been proposed.[18,24–28] For neuroimaging, a specific set of biomarker protocols most effective for dementia or AD assessment has yet to be elucidated, as uncertainty still exists regarding optimum neuroimaging protocol.[18] The protocols used to formally assess neuroimaging biomarkers have been shown to be as important as the selected biomarkers themselves for diagnostic and prognostic accuracy.[29] Standard operating procedures (SOPs) for neuroimaging protocols are therefore a key component for the validation of any study design.[29] Validation studies may eventually help to optimise dementia and AD assessment.[29–31]

The aim of this study was to acquire information on current approaches to the assessment of dementia and AD in imaging centres across the Republic of Ireland through the collection of details on neuroimaging use and protocols.

Methods

Study design

The research employed a questionnaire-based study. An online questionnaire was developed which included both closed (multiple-choice) and open questions. Questions were included to allow the collection of key information pertaining to neuroimaging protocols for dementia and AD; including: the frequency of neuroimaging for particular clinical indications; the use of imaging to specifically diagnose dementia or AD; whether specific protocols were used; protocol development and review including use of international imaging guidelines; and additional or alternative imaging studies performed. Three variants of the questionnaire were developed for completion by staff working in CT, MRI and PET departments to account for each modality separately.

Participants

For questionnaire distribution purposes, a database of all imaging centres, both public and private, in the Republic of Ireland was first created. Information on whether each centre had CT, MRI or PET imaging available was also added. The development of this comprehensive database involved: the review of data from the Irish Health Service Executive (HSE); documentation from each of the Irish private health insurance providers; and obtaining information through the websites of individual centres and by directly contacting each imaging centre by telephone. The radiography services manager (RSM) in each imaging centre was sent information about the study, together with links to the online questionnaires, by email. The RSMs were then asked to distribute the information and links to the clinical specialist radiographers in each of the relevant modalities.

This study received an exemption from full ethical approval from the University College Dublin Human Research Ethics Committee (Reference Number: LS-E-14-30-Butler).

Results

Participants and population

A total of 94 departments in the Republic of Ireland were included: CT (n = 50), MRI (n = 35), and PET (n = 9). The response rates were 42% for CT (n = 21), 43% for MRI (n = 15) and 44% for PET (n = 4). Additional details on the types of centres are outlined in Table 1.

Clinical indications

Regarding the clinical indications for neuroimaging, the reported frequency of examinations for specific clinical indications across each imaging modality is illustrated in Figs. 1–3.

Presence of protocol

Respondents were initially asked if their imaging modality was currently used to specifically diagnose dementia or AD. In response,

Table 1
Demographic data of imaging centres/respondents.

Type of centre	CT *(% respondents)*	MRI *(% respondents)*	PET *(% respondents)*
University Teaching Hospital[a]	19	34	50
Regional Hospital[b]	10	0	0
General Hospital[c]	33	40	50
Out-patient imaging service[d]	24	13	0
Other[e]	14	13	0
Type of Service			
Public[f]	67	40	25
Private[g]	33	47	50
Other[h]	0	13	25

[a] University Teaching Hospital: hospital with dedicated teaching facilities and staff; with university affiliation. Largest range of specialities and facilities.
[b] Regional Hospital: hospital with catchment area of a medium to large region. Large range of specialities and facilities.
[c] General Hospital: hospital with small catchment area. Smaller range of specialities and facilities.
[d] Out-patient imaging service: dedicated imaging services only. No other facilities or in-patient services.
[e] Other: including private hospitals.
[f] Public: public health service or under the Irish General Medical Scheme (GMS) which entitles patients with an income below a particular threshold to receive certain health services at no cost or at a reduced cost.
[g] Private: private health service.
[h] Other: centres providing imaging services for both public and private patients.