Should a CT Head be a standard part of the diagnostic process for dementia in New Zealand?

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ARTICLE

ABSTRACT
Timely diagnosis of dementia is being encouraged in both primary and secondary care settings in New Zealand via the creation and promotion of internet-based dementia clinical pathways. There is no national consensus about the circumstances in which neuroimaging should be recommended and funded within these pathways. This lack of agreement is driven by uncertainty about the rationale for neuroimaging in the diagnosis of dementia as well as the costs involved. This paper summarises all relevant international guidelines to inform a recommendation that a CT Head should be routine in the dementia work up in the New Zealand setting.

Dementia is becoming increasingly common in primary and secondary care settings in New Zealand because of the phenomenon of our ageing population coupled with the strong effect of advancing age on dementia prevalence. The impact of the ageing population on dementia prevalence is particularly strong because it is not simply the result of ageing “baby boomers”; it also arises from increasing longevity. Unfortunately there are no New Zealand epidemiological data from which accurate estimates can be made of the numbers of people living with dementia. Alzheimer’s New Zealand commissioned estimates extrapolated from overseas data which indicate that over 50,000 people may currently be living with dementia in this country, with the number likely to nearly treble within thirty-five years.

Concerns about the relatively undeveloped state of services for people living with dementia and those that care about them have been rising in light of this unprecedented projected increase in dementia prevalence. The New Zealand Ministry of Health facilitated a stakeholder group process which generated the “New Zealand Framework for Dementia Care” in 2013 with an expectation that each District Health Board (DHB) must develop its own dementia care pathway, taking note of the recommendations set out in the framework document. Most DHBs responded initially by focusing on supporting clinicians, especially general practitioners, to make timely diagnoses of dementia and to initiate management plans. This support has largely revolved around producing or enhancing access to cognitive impairment diagnostic pathways via internet-based resources available in the clinic setting such as Health Pathways and the Map of Medicine.

Whether or not to carry out a routine Computed Tomography (CT) head scan is a question in respect of which each of these pathways must provide a recommendation. There is variation around the country with some pathways providing for more routine access and others suggesting limits on scanning relating to clinical criteria. One of the pressures on the system is the cost of this investigation, typically around $300 per CT Head, to some extent an additional cost not previously borne by the equivalent of the community radiology budget in each DHB.

No current New Zealand dementia care pathway suggests routine use of a Magnetic Resonance Imaging (MRI) or any alternate imaging procedure other than CT.

This study reviews all relevant English language guidelines that deal with the issue of neuroimaging using CT in the dementia diagnostic process in order to inform New Zealand practice. The few guidelines published prior to the 21st century were all...
predicated on the principle that the sole purpose of neuroimaging in the dementia work up is to exclude potentially reversible causes of a dementia-like syndrome such as brain tumours, sub-dural haematomas and Normal Pressure Hydrocephalus (NPH). Since these early guidelines were well summarised in a 2000 review and have been superseded by more modern clinical recommendations, they were not included in this study except where they remained the current statements of major guidelines groups.

Method

All relevant English language guidelines produced by neurology, psychiatry, governmental and NGO organisations as well as as translations of respected European Union sources were accessed via Google searching. A combined Medline, EMBASE and PsychInfo database search for relevant papers was also conducted using title and subject terms linking [“guideline” or “recommendation”] with [“neuroimaging” or “CT Head”], triangulated with various stems relating to [“dementia”]. These searches were supplemented with a snowball approach to identify all relevant cited papers in each guideline or recommendation. The papers chosen for review were selected on the basis that they would be informative for weighing up the merits of CT scanning. “Guideline” status was imputed if a source made formal recommendations about neuroimaging in the dementia diagnostic process as opposed to critically appraising or otherwise analysing imaging options. These findings are discussed in light of the author’s clinical experience and knowledge of dementia pathway development in New Zealand in order that a considered suggestion for a national consensus might be made.

Results

Diagnostic criteria for dementia

The main international authorities that set out agreed criteria for the diagnosis of the dementia syndrome overall or for specific subtypes such as Alzheimer’s dementia vary in the importance they place on neuroimaging. The Diagnostic and Statistical Manual—Fifth Edition does not mandate neuroimaging in the diagnostic criteria for Major or Minor Neurocognitive Disorder but does outline imaging guidance in the “Diagnostic Features” notes within each dementia subtype. The National Institute of Aging and Alzheimer’s Association criteria for Alzheimer’s dementia implies the need for neuroimaging to rule out vascular lesions. The National Institute of Neurological Disorders and Stroke/Association Internationale pour la Recherche et l’Enseignement en Neurosciences criteria for Vascular dementia give more primacy to neuroimaging as expected, especially in relation to the subtypes within this group of disorders. The dementia with Lewy Bodies Consortium criteria list neuroimaging findings as a supportive feature of diagnosis. The revised International Consensus Criteria for Fronto-Temporal Dementia request neuroimaging evidence for the diagnosis of the subtypes within this group of disorders.

Dementia clinical guidelines

Clinical guidelines published since 2000 covering the assessment and management of dementia ask for neuroimaging to varying degrees and for varying reasons. Table 1 summarises the key guidelines.

No guideline recommends the routine use of functional neuroimaging modalities such as Single Photon Emission Computed Tomography (SPECT) or Positron Emission Tomography (PET), although several list them as desirable options if required for diagnostic subtyping. No guideline states that structural neuroimaging using CT Head or MRI Brain should not be used. All guidelines have moved beyond simply using imaging to rule out potential reversible conditions in favour of assisting with diagnostic subtyping.

The American Association of Neurology, Scottish Intercollegial Guidelines Network and American Psychiatric Association guidelines all advise that CT or MRI should be used if possible, but stop short of saying either investigation should be routine. The Clinical Research Centre for Dementia of South Korea, the European Federation of Neurological Societies and an NHS England consortium all make statements that at least one modality of structural neuroimaging should be routine. The English guideline adds that lack of access to neuroimaging should not stop a GP from making the basic diagnosis of dementia.
The Canadian Consensus Conference on the Diagnosis and Treatment of Dementia has always taken an intermediate position and their most recent revision defines a complex ‘group of interest’ based on clinical indicators, simultaneously stating that this should result in structural neuroimaging being indicated for most patients. Notably, they prefer MRI. The characteristics of this ‘group of interest’ appear to be designed to detect cases of dementia likely to have less common neurological underpinnings such as people with early onset dementia, rapidly progressing dementia or clinical stigmata of tumours and NPH. The Australian Clinical Practice Guideline and the UK’s National Institute for Health and Care Excellence also take an intermediate position, stating that structural neuroimaging should be used except for a ‘group of no interest’ comprised of people with more advanced dementia for whom the diagnosis is reasonably certain (with the British preferring MRI).

### Other key formal statements

The American College of Radiology’s Clinical Appropriateness Panel’s statement on dementia neuroimaging reviews various neuroimaging options in terms of their clinical utility but it is not a guideline per se. It implies that structural neuroimaging is routine and marginally favours MRI above CT in terms of being able to support diagnosis. The statement is in line with the guidelines above in its declaration that the purposes of neuroimaging are diagnostic subtyping as well as detecting potential reversible conditions. The International Psychogeriatric Association published a series on neuroimaging for dementia in 2011 including a review on the use of CT. Although this is based on older CT technology rather than modern helical scanning, the authors conclude that CT should be seen as a first-line tool before MRI to rule out rarer reversible causes of the syndrome and to assist with dementia subtyping. Health Quality Ontario produced a rigorous review of the clinical utility of neuroimaging for dementia concluding that rules-based criteria may not be reliable enough to use in clinical practice, CT compares favourably with MRI in real-world clinical settings, and that clinical utility is highest in cases where uncertainty about the diagnostic subtype is higher.

### Table 1: Guidelines for use of neuroimaging in the dementia work-up since 2000.

<table>
<thead>
<tr>
<th>Source</th>
<th>Structural imaging</th>
<th>Structural modality</th>
<th>Functional imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian CPG 2016</td>
<td>“Should usually be used ... unless” Defines simple group of ‘no-interest’</td>
<td>CT or MRI</td>
<td>“Not recommended”</td>
</tr>
<tr>
<td>NICE 2014</td>
<td>“Should be used ... unless” Defines a simple group of ‘no-interest’</td>
<td>MRI preferred over CT</td>
<td>SPECT or PET If required for subtyping</td>
</tr>
<tr>
<td>RCGP/NHS/ Dept Health 2014</td>
<td>Routine But do not withhold diagnosis if scan not available</td>
<td>CT Other scans likely to be specialist only</td>
<td>-</td>
</tr>
<tr>
<td>EFNS 2012</td>
<td>Routine “At least once”</td>
<td>MRI</td>
<td>-</td>
</tr>
<tr>
<td>CCCDTD 2012</td>
<td>“Indicated for most but not all” Defines a complex group of interest</td>
<td>MRI preferred over CT</td>
<td>-</td>
</tr>
<tr>
<td>CRDC S. Korea 2011</td>
<td>Routine</td>
<td>CT and MRI</td>
<td>SPECT or PET If required for subtyping</td>
</tr>
<tr>
<td>APA 2007</td>
<td>“Generally recommended”</td>
<td>CT or MRI</td>
<td>PET If required for subtyping</td>
</tr>
<tr>
<td>SIGN 2006</td>
<td>“Ideally”</td>
<td>CT or MRI</td>
<td>SPECT If required for subtyping</td>
</tr>
<tr>
<td>AAN 2001</td>
<td>“Appropriate” But optional</td>
<td>CT or MRI</td>
<td>-</td>
</tr>
</tbody>
</table>
Detecting potentially modifiable diseases

Health Quality Ontario have also produced an economic analysis of dementia neuroimaging but this restricted itself to examining the utility of neuroimaging to detect potentially reversible conditions rather than more modern clinical goals, in line with older iterations of the Canadian Consensus Committee (CCC) criteria. Within this restriction it preferred CT scanning being limited to people at higher prior probability of unusual causes of the dementia syndrome, however it highlights the strengths and weaknesses of all options including the CCC criteria and ultimately sat somewhat uncomfortably on the fence. The key review of the utility of different prediction rules for indicating neuroimaging prior to 2000 focussed on screening for potentially reversible conditions in the dementia diagnostic process and concluded that none of the guidelines up to that point were sufficiently founded on scientific data nor very informative about the likely clinical effects of their recommendations. The authors also pointed out the tension between clinicians and patients wanting as high a sensitivity as possible but funders wanting as high a specificity as possible, and suggested that the Canadian Consensus Criteria of the time probably provided the best balance in the primary care setting based on the limited available evidence, but that all patients in specialist settings should be scanned because of the higher prior probability of finding rarer reversible causes in this population. A meta-analysis of this issue demonstrates that the base rates of potentially reversible conditions vary by clinical setting and are low in primary care, and that the true reversibility of these conditions is also low, especially in respect of cognitive impairment. Nonetheless, this aim is of extreme importance to the individuals involved.

Subtyping dementia to alter management

An early review suggested that structural neuroimaging should be recommended for the diagnosis of Alzheimer’s disease in those settings where the diagnostic accuracy from clinical assessment is poorer, specifically in non-specialist settings and for early diagnosis, especially if aspects of the clinical situation such as a language barrier or specific learning deficits cloud the assessment of functional decline. Subsequent studies attempt to quantify the effectiveness of neuroimaging for altering diagnosis in the dementia assessment process. Condefer and colleagues demonstrated that CT changed diagnosis and occasionally management in a memory clinic setting but they pointed out that effects may be different in less specialist settings. Massoud and colleagues found that the validity of dementia diagnosis and diagnostic subtyping could be improved by adding neuroimaging and recommended MRI over CT because of the increased ability of MRI to discern more subtle cerebrovascular abnormalities. They found that diagnosis was most enhanced for younger patients, for whom clinical subtyping prior to scanning required revision more than half of the time. Tanev and colleagues found that structural imaging altered diagnosis in a third of patients in a dementia inpatient unit setting despite having a fairly unsophisticated scan report, and functional imaging was even better.

A relatively recent review of imaging access rules suggested that the key issue is not the effect of neuroimaging on diagnosis but on treatment. Because neurologically silent cerebrovascular disease is both common in the ‘possible dementia’ group and has growing treatment implications, they argue scanning is required in all patients with the exception of older people with more established dementia for whom cerebrovascular risk modifying treatment would not be offered. The authors compared imaging access rules from the guidelines extant to 2006 and concluded that none accounted for cerebrovascular disease because they were designed to detect traditional potentially reversible causes of dementia-like presentations. Even in this task, the authors found rules-based approaches wanting. Neurologically silent white matter disease and small strokes are now known to be common, associated with cognitive impairment and behavioural and psychological symptoms, and may generate different management strategies for cerebrovascular disease progression (such as whether or not to prescribe antiplatelet or antithrombotic agents) and for dementia symptoms (such as whether the...
stroke risk of antipsychotics would be unacceptably high). It has certainly been argued that the diagnosis of a significant vascular component to dementia is unreliable without neuroimaging.34,35

**CT versus MRI**

The specific issue of CT versus MRI to assist with subtyping dementia was considered by several groups. A recent systematic review and meta-analysis36 concluded that MRI only just out-performed CT for subtyping in respect of vascular dementia, for which MRI should theoretically be the best modality. Since most studies on which the review was based pre-date the widespread availability of modern helical CT scanning, CT may perform even better now. A similar review specific to Alzheimer’s disease37 found that the specificity of both modalities was acceptable but was lower in both cases for less severe dementia; this is not what an ideal future system would provide with the advent of potentially disease-modifying treatments. Overall, both reviews agreed that imaging was reasonably able to distinguish Alzheimer’s dementia from normal ageing, Mild Cognitive Impairment and Vascular dementia cases, and that CT was comparable to MRI.

**Discussion**

Reviews of imaging in dementia published in the peer-reviewed literature increasingly assume MRI is the norm (if not PET) therefore CT-relevant articles have begun to vanish from the literature. While this may reflect the reality of academic centres in the US and Europe, it does not reflect the reality in the publically-funded health system in New Zealand. Indeed, it will not do so unless the clear superiority of MRI over CT is demonstrated in terms of changing management, something that has not yet occurred despite the agreed superiority of MRI in terms of ability to detect subtle and early brain changes, especially haemosiderin deposits indicative of amyloid angiopathy and associated with increased risk of intracerebral haemorrhages.38 Arguably, CT advantageously deletes many ‘incidentalomas’ that MRI would otherwise detect. Authors championing MRI’s superiority on the basis of better resolution frequently made no attempt to demonstrate that this matters in routine dementia assessment, certainly not to justify the approximately $900 price and restricted availability in this country.

The traditional rationale for neuroimaging in the dementia workup was clearly to rule out potentially reversible conditions, especially brain tumours and sub-dural haematomas. As outlined above, clinical screening rules to try to define a populations of increased risk for such conditions are unsatisfactory,34 cost-effectiveness of such neuroimaging for this purpose is difficult to quantify38 and these conditions are both uncommon and rarely truly reversible.38 Therefore, restricting an analysis of the place of neuroimaging for dementia assessment to this traditional clinical aim is unhelpful on clinical, scientific and economic grounds.

The more modern and now commonly espoused rationale for neuroimaging in the dementia workup is to assist with diagnostic subtyping of dementia. The strongest evidence in support of this is for the commonly occurring vascular dementias, in respect of which diagnosis is unreliable without imaging.34 The usefulness of assessing Alzheimer’s biomarkers such as markers of medial temporal lobe atrophy is less clear, however it is now generally accepted that, where present, positive findings help differentiate between Alzheimer’s disease and normal ageing or Mild Cognitive Impairment (MCI) but their absence is less informative. Fronto-temporal focal atrophy patterns are very helpful when present, but the diagnosis of dementia with Lewy Bodies is not advanced much by structural neuroimaging. There is little suggestion that MRI is superior to CT at detecting these more macroscopic diagnostic markers.

Subtyping is increasingly important because it alters management. The cholinesterase inhibitors are not equally effective in different subtypes, vascular risk factor modification is indicated to different degrees in the vascular subtypes especially in respect of whether or not stroke disease is present, and antipsychotic risks vary by subtype. It is to be expected that future medical technologies for dementia are likely to have even more differential effectiveness by subtype, and a core thrust of current dementia-prevention work is to detect specific disease types early so as to enable tailored treatment for high-risk individuals. That is why most
current guidelines highlight subtyping as the main reason structural neuroimaging is recommended, a contribution that will grow in importance in the future.

Another published reason to consider structural neuroimaging in the diagnostic process for dementia is that it may be useful to track progression, especially in the context of MCI, however prognosticating in this context is challenging. A baseline scan is especially useful for people with pre-existing neurocognitive impairment such as patients with learning disabilities, head injuries or long term major psychiatric illness who present with a suspicion of later-onset acquired cognitive impairment. Determining whether or not a neurodegenerative disease is superimposed on the pre-existing clinical picture is greatly assisted by comparing a baseline structural scan with subsequent imaging.

A final reason structural neuroimaging has been endorsed by clinicians that has not been discussed in the literature is to assist with patient education and motivation. Patients and their family/whanau/supporters are increasingly expecting a brain scan and a subtyped diagnosis. Discussing or ideally showing people their brain scan in-clinic is helpful for enhancing acceptance and for motivating participation in management. Being able to provide a subtyped diagnosis is also important for prognostication in terms of life expectancy, symptoms or complications to be aware of, and discussing heritability.

These arguments rely on the quality of scan reports being high and easy to understand by the referring clinician, and on the recipient being aware of the clinical significance of the results. This is a challenge that needs to be overcome in the New Zealand setting, given the complexity and rapid growth in this field. No international guidelines or studies have explicitly handled this issue, but one author has provided an algorithm for reading structural scans and several rating scales have also been proposed although none are widely used. Attempts are being made within some New Zealand clinical pathways to deal with this important part of the process, including standardising dementia scan reports, providing written information to guide clinical interpretation of findings in general and creating a ‘virtual clinic’ to provide specialist comment on CT Head results to referrers in light of other pertinent clinical data.

Conclusion

New Zealand dementia diagnostic pathways should align themselves with the guidelines and diagnostic statements made by the majority of our international peers by recommending and funding a CT Head at least once for every person being assessed for dementia. The express purposes would be to assist with subtyping, to assist with management planning if a diagnosis is made, to rule out potentially reversible conditions and to act as a piece of clinical baseline information should a diagnosis of dementia not be made. The only exclusion should be for people for whom the referrer judges subtyping would change neither management nor prognostication for them and for their family, for example some people of advanced age with established severe dementia. The availability of CT Head scans needs to be supported by accurate and consistent neuroimaging reporting, ideally with a mechanism to clearly convey the clinical significance of the neuroimaging findings to referring clinicians.
Competing interests:
Dr Croucher is the lead clinician for the South Island’s Health of Older Persons Service Level Alliance Dementia Initiative and supports the South Island DHBs with their Cognitive Impairment Pathways.

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