Guideline Summary NGC-8455

Guideline Title

ACR Appropriateness Criteria® dementia and movement disorders.

Bibliographic Source(s)


Guideline Status

This is the current release of the guideline.


The appropriateness criteria are reviewed biennially and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

Scope

Disease/Condition(s)

Dementia and movement disorders, including:

- Alzheimer's disease (AD)
- Frontotemporal dementia (FTD)
- Dementia with Lewy bodies (DLB)
- Vascular dementia (VaD)
- Creutzfeldt-Jakob disease (CJD)
- Normal-pressure hydrocephalus (NPH)
- Huntington's disease (HD)
- Neurodegeneration with brain iron accumulation (NBIA)
- Parkinson's disease (PD)
- Multiple system atrophy (MSA)
- Progressive supranuclear palsy (PSP)
- Amyotrophic lateral disease (ALS)
- Other Parkinsonian syndromes

Guideline Category

Diagnosis
Evaluation

Clinical Specialty

Family Practice
Geriatrics
Internal Medicine
Neurology
Nuclear Medicine
Psychiatry
Guideline Objective(s)
To evaluate the appropriateness of initial radiologic examinations for dementia and movement disorders

Target Population
Patients with dementia and movement disorders

Interventions and Practices Considered
1. Magnetic resonance imaging (MRI)
   - Head without contrast
   - Head without and with contrast
   - Spectroscopy, head
   - Functional MRI (fMRI), head
   - Spine without contrast
   - Spine without and with contrast
2. Magnetic resonance angiography (MRA) head and/or neck
3. Computed tomography (CT), head
   - Without contrast
   - Without and with contrast
4. Computed tomography angiography (CTA), head and/or neck with contrast
5. 18-Fluorine-fluorodeoxyglucose positron emission tomography (FDG-PET), head
6. Technetium (Tc)-99m hexamethylpropyleneamine-oxide (HMPAO) single-photon-emission computed tomography (SPECT), head
7. Cisternography
8. Ultrasound (US), carotid with Doppler

Major Outcomes Considered
Utility of radiologic procedures in differential diagnosis of dementia and movement disorders

Methodology

Methods Used to Collect/Select the Evidence
Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure
The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Expanding the term “diagnostic imaging” captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.
1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Radiology only.
3. May restrict the search to adults only or pediatrics only.
   The search strategy may be revised to improve the output as needed.

Number of Source Documents
The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence
Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key
Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence
Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence
The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More Information about the evidence table development process can be found in the American College of Radiology (ACR) Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations
Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique
The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist’s expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as “usually not appropriate”; 4, 5, or 6 is defined as “may be appropriate”; and 7, 8, or 9 is defined as “usually appropriate.” Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel’s consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, “No consensus” appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations
Not applicable

Cost Analysis
A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation
Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Dementia and Movement Disorders

Variant 1: Probable Alzheimer’s disease.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>5</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>Tc-99m HMPAO SPECT head</td>
<td>4</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>4</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td>For research purposes.</td>
<td></td>
</tr>
</tbody>
</table>

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Possible Alzheimer’s disease.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>5</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>Tc-99m HMPAO SPECT head</td>
<td>5</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>4</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Suspected vascular dementia or mixed vascular dementia and Alzheimer’s disease.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without and with contrast</td>
<td>8</td>
<td>See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>6</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>5</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>MRA and/or neck</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRA head and/or neck</td>
<td>5</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>CTA head and/or neck with contrast</td>
<td>6</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td>For problem solving.</td>
<td>O</td>
</tr>
<tr>
<td>Tc-99m HMPAO SPECT head</td>
<td>5</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Suspected frontotemporal dementia.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
</tbody>
</table>
## Variant 5: Suspected dementia with Lewy bodies.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>Relative Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>Te-99m HMPAO SPECT head</td>
<td>4</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>4</td>
<td>See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

## Variant 6: Suspected prion disease (Creutzfeldt-Jakob, iatrogenic or variant).

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>Relative Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

## Variant 7: Suspected normal pressure hydrocephalus.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>Relative Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

## Variant 8: Suspected Huntington disease.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>Relative Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>6</td>
<td>For problem solving.</td>
<td></td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.
### Variant 9: Clinical features suggestive of neurodegeneration with brain iron accumulation (NBIA).

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Tc-99m HMIPAO SPECT head</td>
<td>3</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>3</td>
<td>For problem solving.</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

### Variant 10: Parkinson's disease: typical clinical features and responsive to levodopa.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>7</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>For problem solving. See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Tc-99m HMIPAO SPECT head</td>
<td>6</td>
<td>For problem solving. Specific ligand.</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>6</td>
<td>For problem solving. Dopa PET.</td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

### Variant 11: Parkinsonian syndrome: atypical clinical features not responsive to levodopa.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See comments regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
</tr>
<tr>
<td>Tc-99m HMIPAO SPECT head</td>
<td>6</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>6</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

### Variant 12: Motor neuron disease.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI spine without contrast</td>
<td>8</td>
<td>May need multilevel imaging.</td>
</tr>
<tr>
<td>MRI head without contrast</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>MRI spine without and with contrast</td>
<td>7</td>
<td>May need multilevel imaging. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MR spectroscopy head</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Tc-99m HMIPAO SPECT head</td>
<td>3</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>FDG-PET head</td>
<td>3</td>
<td>For problem solving.</td>
</tr>
<tr>
<td>MRI functional (MRI) head</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

**Summary of Literature Review**

**Introduction/Background**
Degenerative disease of the central nervous system (CNS) is a growing public health concern. The prevalence of dementia, one of the leading degenerative conditions, is expected to quadruple by 2050. Other degenerative diseases may affect the extrapyramidal system and the motor system.

Dementia is characterized by a significant loss of function in multiple cognitive domains without affecting the general level of arousal. Several forms are now recognized, including Alzheimer disease (AD), frontotemporal dementia (FTD), Lewy body, and the various vascular dementias. Although the causes of most dementias remain elusive, genetic research has opened many frontiers in understanding the pathophysiology of heretofore enigmatic such as AD. Additionally, infectious, vascular, and toxic etiologies have become increasingly appreciated as causes of cognitive decline.

The extrapyramidal centers are large subcortical nuclear structures from which output systems emerge at several points. Since mediation and control of the corticospinal tract are the most prominent functions of these output systems, lesions of the extrapyramidal nuclei typically result in motor dysfunction and movement disorders of various types. Examples of extrapyramidal diseases include Huntington disease (HD), neurodegeneration with brain iron accumulation (NBIA), and Parkinsonism and its variants.

Finally, motor neuron diseases are a heterogeneous group of syndromes in which the upper and/or lower motor neurons degenerate. Amyotrophic lateral sclerosis (ALS) is the most frequent type of motor neuron disease, although an increasing number of variants are being recognized.

Imaging Modalities

Neuroimaging has played an increasing role in the understanding, diagnosis, and management of degenerative diseases of the CNS by supplementing and complementing current clinical tests. Neuroimaging may be divided into structural neuroimaging, which evaluates anatomic changes that occur in neurodegenerative conditions, and functional neuroimaging, which evaluates CNS activities such as blood flow and metabolism in neurodegenerative conditions. For example, structural neuroimaging with computed tomography (CT) and magnetic resonance imaging (MRI) has defined patterns and rates of brain volume loss in AD. Moreover, structural neuroimaging may exclude treatable conditions that may present with dementia-like symptoms. Functional neuroimaging with MRI (fMRI), single photon emission computed tomography (SPECT), and positron emission tomography (PET) have greatly assisted in the understanding of blood flow, metabolism, and amyloid deposition in demented patients. Application of MR spectroscopy (MRS) has also yielded promising information about degenerative processes.

These determinations have become increasingly important given the current availability of therapies such as cholinesterase inhibitors for AD that can delay institutionalization. Moreover, a confident diagnosis supported by clinical and imaging evidence provides the clinician with prognostic information with which to guide patients and families regarding future course, to facilitate legal and financial planning, and to assist with providing access to community resources.

Application of imaging does have certain limitations in patients with neurodegenerative disorders. First of all, frequently observed imaging findings of white matter disease and general atrophy are nonspecific and may not necessarily refine the differential diagnosis of dementia or neurodegeneration. Although many of the newer imaging techniques have penetrated the American markets, some of the advanced modalities are still not widely available in some communities. Additionally, many patients are frail and confused and may not tolerate long scanning times. Also, older patients may have significant comorbidities, such as cardiac pacemakers or renal insufficiency, which may limit the choice of available modalities and administration of intravenous contrast agents. Moreover, the cost of imaging must be weighed against its potential benefits. One older study determined that CT might detect from 1,400 to 15,000 potentially treatable lesions per 100,000 demented patients scanned at an estimated cost of $49 million in 1995, a cost that is certainly much higher. The addition of MRI might add 70 to 150 additional treatable cases but would almost double the cost according to these authors. Also, treating selected lesions detected on these scans would not necessarily guarantee return to pre-presentation functional status, assuming patients were appropriate candidates for the proposed treatment.

Dementia

Alzheimer Disease

The National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) and the Alzheimer’s Disease and Related Disorders Association (ADRA) have established the criteria for the definite, probable, and possible diagnosis of AD, the most frequent type of dementia in the U.S. and most European countries. Another related condition, mild cognitive impairment (MCI), is defined as a cognitive decline greater than expected for an individual’s age and education level without significantly interfering with activities of daily life. More than half of the patients with MCI progress to dementia within 5 years. The amnestic subtype of MCI may constitute a prodromal stage of AD.

Patients with suspected dementia should undergo clinical testing aimed at confirming the diagnosis, identifying the form or variant, and establishing the etiology.

The primary role of neuroimaging in the workup of patients with probable or possible AD is to exclude other significant intracranial abnormalities, primarily because clinical diagnosis is inexact and the cost of a false positive clinical diagnosis of AD, especially in cases of MCI, is very high. Moreover, diagnostic neuroimaging signs may allow differentiation of AD from other forms of dementia. Patients with possible AD have a greater incidence of other significant intracranial pathologies detected on neuroimaging studies than patients with probable AD. The American Academy of Neurology (AAN) has recommended that the routine use of structural neuroimaging such as a noncontrast CT or MRI may assist with the diagnosis of dementia.

Positron Emission Tomography

Recently, PET imaging has been shown to provide greater diagnostic accuracy when compared with clinical evaluations without functional neuroimaging. PET studies with fluorine-18-fluorodeoxyglucose (FDG) show characteristic reductions of regional glucose metabolic rates in patients with probable and definite AD in the parietal, temporal, and posterior cingulate regions. PET accurately discriminates AD patients from normal subjects with a sensitivity of 90% and specificity of 100%. Quantitative FDG-PET measures may improve prediction of the progression to AD in patients with MCI. A new promising technique for diagnosing AD is the use of molecular imaging with PET to detect in vivo Aβ amyloid in the brains of patients with AD. This has been achieved using the carbon-11 Pittsburgh compound-B (PiB). This method, however, is not currently available in clinical practice because the very short half-life of this compound. Also under investigation is F-18 amyloid imaging (18F-AV-45) for early detection of amyloid accumulation. The AAN consensus group did not recommend routine PET for diagnosing AD. The Centers for Medicare and Medicaid Services have made the modality available to Medicare recipients to assist with the diagnosis of dementia in the appropriate clinical setting in recognition of this usefulness.
Volumetric Structural Imaging

CT and MRI-based volumetric measurements of the hippocampal formation are significantly smaller in patients with mild AD compared with controls and compared to patients with other forms of dementia. This finding correlates with a neuropathologic hallmark of AD, which is focal atrophy of the hippocampal formation. MRI volumetric calculations permit accurate differentiation of controls from patients with AD in 85% to 100% of cases. Although it is not as accurate as MRI, CT also permits detection of hippocampal atrophy in AD patients. Medial temporal lobe atrophy has also been observed in patients with MCI compared to cognitively normal individuals. The presence of this sign has a high predictive value for the progression to dementia. The AAN did not recommend quantitative volumetry of the hippocampus.

Single Photon Emission Computed Tomography

Regional cerebral blood flow determined using SPECT imaging with 11C-99m hexamethyl propylene amine oxime (HMPAO) shows bilateral temporoparietal or hippocampal hyperfusion in patients with AD. Whether brain SPECT contributes substantially to diagnostic accuracy after a careful clinical examination using current diagnostic criteria is controversial. Although perfusion MRI is promising, SPECT remains superior in identifying pathologic perfusion. Application of fMRI in dementia is also an emerging technique, but remains an investigational tool. An evidence-based review performed by the AAN concluded that SPECT imaging cannot be recommended for either the initial or the differential diagnosis of suspected dementia because it has not demonstrated superiority to clinical criteria. Also, compared with PET, SPECT has a lower diagnostic accuracy and is inferior in its ability to separate healthy controls from patients with true dementia.

MR Spectroscopy

Hydrogen-1 MRS may permit identification of mild to moderate AD with a specificity and sensitivity that suggest the potential for clinical usefulness and may predict the conversion of MCI to dementia. Studies of automated MRS for AD diagnosis have reported high sensitivity and moderate specificity. Findings in reported studies have varied, but decreased N-acetylaspartate (NAA) and increased myoinositol (ml) with the use of the NAA:ml ratio shows the greatest promise. Prospective studies are still lacking to validate this method for diagnosing AD. Functional MRI, diffusion tensor MRI, and perfusion imaging have been used in the diagnosis of AD and MCI patients. These tests are still investigational tools and are not widely used at this time.

Of these neuroimaging tests, MR volumetric analysis of the hippocampal formation and PET assessment of regional glucose metabolism are the most diagnostic of AD. Determining the specific clinical applications of either of these studies will be crucial in patients with probable or possible AD, MCI, or atypical dementias awaits additional investigation.

Summary

In patients with a diagnosis of probable AD, any of these neuroimaging studies may permit the accuracy to increase from the 80% to 85% range to the 90% to 100% range, depending on the prevalence of the disorder in the subject population. In patients with possible AD or other atypical dementias, these neuroimaging studies may also permit a more accurate diagnosis. Volumetric MRI studies, PET studies, and possibly fMRI likely will play an important investigational role in the evaluation of new therapeutic drug strategies for treating AD. Information derived from the Alzheimer's Disease Neuroimaging Initiative is likely to greatly impact the evaluation and management of this dementia.

Frontotemporal Dementia

FTD is a neurodegenerative disorder commonly mistaken for AD. Pathologically, it includes a heterogeneous group of sporadic and familial neuropsychiatric disorders. Pick's disease is one of the neuropathological entities of FTD. Unlike AD, which increases in frequency with age, FTD is rare after the age of 75.

MRI may show atrophy of the anterior temporal and frontal lobes. PET studies assessing regional glucose metabolism with FDG show the metabolic disturbance most prominent in the frontal and temporal lobes. SPECT studies assessing regional cerebral perfusion with HMPAO show frontal hypoperfusion. Although PET and SPECT could help to make the differential diagnosis between AD and FTD, they are not recommended for routine use at the present time.

Dementia with Lewy Bodies

Dementia with Lewy bodies (DLB) has been identified in a subgroup of demented patients demonstrating Lewy bodies in their brainstem and cortex on autopsy.

Functional imaging of the dopamine transporter (DAT) using SPECT can help to distinguish DLB from AD. DAT striatal activity in AD is normal in AD and low in DLB. Occipital hypoperfusion has been demonstrated using SPECT and occipital hypometabolism using PET. In patients with DLB, MRI shows a preservation of hippocampal and medial temporal lobe volume, no occipital lobe atrophy despite abnormality on functional imaging, and atrophy of the putamen.

Vascular Dementia

Vascular dementia (VaD) is the second most common type of dementia. The main clinicopathological subtypes are large-vessel VaD and small-vessel VaD. Most patients with a diagnosis of VaD have small-vessel disease. Clinical and imaging tests that aid in distinguishing VaD from less treatable forms of dementia may be beneficial. One of the roles of neuroimaging, therefore, is to document the presence or absence of strokes. Although CT can detect the presence or absence of infarctions in patients with dementia, histopathologically verified cases of VaD with normal CT studies have been reported. Thus MRI is preferable to CT for detecting vascular lesions in patients with dementia.

Differentiation between AD and VaD from either AD with superimposed cerebrovascular disease or mixed AD and VaD is especially difficult. When VaD is diagnosed, this pathologic diagnosis alone is confirmed in about 25% of cases; more commonly, a mixed disorder with neuropathologic changes of both AD and VaD is found. On neuroimaging studies, extensive infarctions (cortical or lacunar or both) and white-matter changes (hyperintense on T2-weighted MRI or hypodense on CT) in a patient with dementia favor a clinical diagnosis of VaD or mixed VaD and AD over AD. The absence or mild extent of these changes in a patient with dementia argues against a diagnosis of VaD.

FDG-PET in VaD shows multiple focal metabolic defects. Differentiation between AD and VaD is much better achieved by PET than by SPECT. SPECT is of little value in differentiating AD from VaD. MRS and fMRI are investigational and, to date, do not appear to clinically help establish a diagnosis of VaD or mixed VaD and AD.

Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) is an autosomal dominant hereditary small-artery vasculopathy caused by mutations in the notch3 gene on chromosome 19. Clinically, the disease is characterized by migraine with aura, strokes and progressive subcortical dementia, and mood disturbances. MRI in these patients shows focal lacunar infarcts and leukoaraiosis. Lesion load increases with age. Besides familial amnesia and clinical history, structural MRI changes in these patients help to suggest the diagnosis by showing characteristic hyperintense T2 fluid-attenuated inversion recovery (FLAIR) lesions which predominate in the frontal,
parietal, and anterior temporal cortexes, and in the external capsule. Diagnosis is confirmed by skin biopsy or detection of a pathogenic notch3 mutation on direct sequencing.

**Creutzfeldt-Jakob Disease**

Creutzfeldt-Jakob disease (CJD) is a fatal neurodegenerative disorder due to the accumulation of an abnormal form of the human prion protein PrPSc in the brain. Although some variability exists, the most common MRI abnormality, other than plaques, is hypointensity on fluid-attenuated inversion recovery (FLAIR) images in high signal intensities, usually in the basal ganglia or thalamus, and less commonly in the cortical gray matter. More recent MRI studies have demonstrated the value of diffusion-weighted imaging (DWI) in diagnosing CJD. Cortical diffusion abnormalities were present in 70 of 157 patients (45%) but were visible in 35 of 44 patients (80%) of the available DWI examinations. Basal ganglia were affected in 94 patients (60%), in particular in the caudate nucleus. The most sensitive sequences were DWI (64%) and proton-density (PD)-weighted (63%). MRI may aid the diagnosis of CJD, and incorporation of MRI in the diagnostic criteria has been proposed for sporadic CJD (sCJD).

Marked cerebral hypometabolism on FDG-PET in the early stages of CJD, when no parenchymal abnormalities are present on MRI, has been described. Similarly, focal hypoperfusion was detected with SPECT using N-isopropyl-i-iodoamphetamine (123I-IMP) before CT or MRI showed any abnormalities. Changes in cerebral metabolites using proton MRs have also been described in patients with CJD.

Variant CJD (vCJD) was described in humans for the first time in 1996. Strong evidence indicates transmission to humans of bovine spongiform encephalopathy (BSE) via ingestion of contaminated beef products. As of August 2006 there have been only two human cases in the United States, but 102 cases have been observed in the United Kingdom and 20 in France. In contrast to sCJD, vCJD affects younger patients and has a relatively longer duration of illness (median of 14 months as opposed to 4.5 months). In the appropriate clinical context, bilateral hyperintensity on a T2-weighted MRI sequence at the level of the pulvinar (pulvinar sign) relative to the signal intensity of the anterior putamen has been described as a useful noninvasive test for diagnosing vCJD. Histological confirmation of a diagnosis of vCJD can be obtained using tonsil biopsy.

**Normal-Pressure Hydrocephalus**

Normal-pressure hydrocephalus (NPH) is characterized by the clinical triad of dementia, gait disturbance, and urinary incontinence. Other diagnostic features include normal cerebrospinal fluid (CSF) pressure at lumbar puncture, contributory ventriculomegaly documented on MRI or CT, and ventricular influx but no passage of isotope over the convexities on radionuclide cisternography (RC).

Because the dementia and other symptoms can be reversible with shunting, and because patients with NPH who are not shunted may progress symptomatically, distinguishing responders from nonresponders is important. Several clinical, laboratory, and imaging signs may improve distinction between responders and nonresponders to shunting. Clinical features that favor shunt responsiveness include predominance of gait disturbance, mild to moderate degree of dementia, and rapid clinical progression of urinary incontinence. MRI or CT findings include at least moderate ventriculomegaly (with rounded, smooth contours and marked enlargement of the temporal horns and third ventricle), and absence of or only mild cortical atrophy. Increased CSF flow void through the cerebral aqueduct on MRI appears to correlate with a good response to shunt surgery. Cine MRI with inflow technique showing hyperdynamic aqueductal CSF may also help in identifying shunt-responsive NPH patients. SPECT cisternography permits more accurate localization of radionuclide activity than planar cisternography, which partially superimposes different CSF compartments. One study using quantitative RC with SPECT found that a higher relative count value in the lateral and third ventricles was predictive for the patient responding to shunt surgery.

Evidence-based guidelines have been developed for diagnosing idiopathic normal pressure hydrocephalus (iNPH). In these guidelines, the patients are divided into probable iNPH, possible iNPH, or unlikely iNPH. Brain imaging features for diagnosing probable iNPH include: ventricular enlargement not entirely attributable to cerebral atrophy or congenital enlargement (Evans index = maximal width of frontal horns/maximal width of inner skull >0.3); no macroscopic obstruction of CSF flow; and at least one of the following features: enlargement of the temporal horns, callosal angle of ≥ 240 degrees, evidence of altered brain water content, and aqueductal or fourth ventricle flow void on MRI. Other brain imaging findings considered as supportive of the diagnosis but not necessary for probable iNPH are: brain imaging performed before onset of symptoms showing smaller ventricular size; radionuclide cisternography showing delayed clearance of radionuclide over the cerebral convexities; cine MRI study showing increased ventricular flow rate; and a SPECT acetazolamide challenge showing decreased periventricular perfusion that is not altered by acetazolamide.

**Degenerative Diseases of the Extrapyramidal System**

**Huntington Disease**

HD is inherited in an autosomal dominant fashion with complete penetrance. Clinical manifestations are choreoathetosis, rigidity, dementia, and emotional disturbance. Neuroimaging and pathology studies both show characteristic atrophy of the caudate and/or putamen. MRI also shows signal changes of the striatum, either hyperintensity or hypointensity on T2-weighted images. Neuronal loss accompanied by loss of myelin and gliosis likely results in the hypointense signal, while iron accumulation likely accounts for the hypointense signal. Using voxel-based morphometry, it has been shown that patients with HD have significant volume reductions in almost all brain structures, including total cerebellum, total white matter, cerebral cortex, caudate, putamen, globus pallidus, amygdala, hippocampus, brainstem, and cerebellum when compared with healthy age-matched controls.

Localized MR spectroscopic studies have found increased lactate concentrations in the occipital cortex of symptomatic HD patients compared with normal controls. Modification of activation pattern has been demonstrated using RC during a time-discrimination task in presymptomatic HD compared to control subjects. SPECT studies show hypometabolism of the striatum in HD and in other types of chorea. Progressive striatal and cortical dopamine receptor dysfunction in HD has been shown using (11) C-raclopride PET scans.

**Neurodegeneration with Brain Iron Accumulation (NBIA)**

NBIA is a heterogeneous group of disorders characterized by neurodegeneration and excessive iron deposition in the basal ganglia, also known as Hallervorden-Spatz disease (HSD). Most patients with NBIA and all of those with the early-onset, rapidly progressive type have mutations in the gene encoding pantothenate kinase 2 (PANK2). MRI findings in NBIA correlate with the presence or absence of PANK2 mutations. All patients with the PANK2 mutation show bilateral areas of hypointensity within a hypointense zone in the medial globus pallidus on T2-weighted images. This pattern has been described as the “eye of tiger.”

**Parkinsonism Syndromes**
Parkinson’s Disease

Primary Parkinsonism syndromes include Parkinson’s disease (PD), progressive supranuclear palsy (PSP), and multiple system atrophy (MSA). They include the disorders previously called striatonigral degeneration (SND), sporadic olivopontocerebellar atrophy (OPCA), and the Shy-Drager syndrome. A diagnosis of idiopathic PD is usually based on patient history and physical examination alone. When clinical signs and symptoms and response to medication are typical of PD, no imaging is required. In patients with unusual clinical features, incomplete or uncertain medication responsiveness, or clinical diagnostic uncertainty, imaging to exclude alternative pathologies may be indicated. MRI findings in PD are nonspecific, but imaging may reveal signs of atypical Parkinsonian variants or secondary Parkinsonism.

A diminution of the width of the pars compacta on MRI has been described in PD patients compared to controls, with overlap between groups. This diminished width probably reflects selective neuronal loss of the pars compacta. Other authors have found a normal appearance of the substantia nigra on T2-weighted images in a majority of PD patients. MRI can be used in PET and SPECT tracer studies exploring the presynaptic nigrostriatal terminal function and the postsynaptic dopamine receptors have attempted to classify the various Parkinsonism syndromes although this work remains investigational.

Proton MR spectroscopic studies found an increase in lactate in the occipital lobe in patients with PD compared to controls. Fluorine-18-L-dihydroxyphenylalanine (18F-dopa) PET can detect frontal changes in PD and preclinical disease in 30% of asymptomatic adult relatives of familial cases. SPECT with 123Iodobenzamide predicts dopaminergic responsiveness in patients with Parkinsonism. More recently, it has been demonstrated that FDG-PET performed at the time of initial referral for Parkinsonism accurately predicted the clinical diagnosis of individual patients made at subsequent follow-up.

Other Parkinsonian Syndromes

Glial cytoplasmic inclusions (GCI) in the brain of patients with MSA provide a pathological marker for the disorder and confirm that SND, OPCA, and Shy-Drager syndrome are the same disease with different clinical expression. Neuroimaging and gross pathology show atrophy of the striatum due to neuronal loss, with the putamen more involved than the caudate. At 1.5 T, T2-weighted images show putaminal hypointensity, particularly along its posterolateral margin, equal to or more evident than pallidal hypointensity. The degree of hypointense signal correlates significantly with the severity of rigidity. The hypointense signal is due to the paramagnetic effect of iron. PET with 18F-dopa is useful in differentiating between PD and atypical parkinsonism in MSA.

More recently, hypointense putaminal signal changes on T2* sequences have been described in MSA more often than in PD but not on T2-weighted images. These discrepancies between the results of recent studies and previous results are probably due to the evolution of MRI sequences currently used. Fast spin-echo (SE) sequences are far less sensitive to magnetic susceptibility than SE T2-weighted sequences used in 1986. In a recent study of 230 Japanese patients with MSA, a hypointense rim at the lateral edge of the dorsolateral putamen was seen on MRI in 34.5% of cases, and a “hot cross bun” sign in the pontine basis (PB) in 63.3%. These putaminal and pontine abnormalities become more prominent as predominant Parkinsonism (MSA-P) and predominant cerebellar ataxia (MSA-C) features advanced.

PSP, also called Steele-Richardson-Olszewski syndrome, is one of the most common atypical Parkinsonian syndromes. Putaminal hypointensity has been described in PSP patients at 1.5 T, using T2-weighted sequences. The periaqueductal region of the midbrain is also implicated in the pathology of PSP. Some patients show slight hyperintense signal on the T2-weighted sequences of the periaqueductal gray matter. The anteroposterior diameters of the suprapontine midbrain measured on axial T2-weighted MRI in patients with PSP are significantly lower than those of patients with PD and in control subjects without any overlap between these two groups. Other authors have demonstrated that the average midbrain area of patients with PSP measured on midsagittal MRI was significantly smaller than that of the patients with PD and MSA-P and that of an age-matched control group.

Degenerative Diseases of the Motor System

ALS is characterized predominantly by degeneration of the corticospinal tract and lower motor neurons. Neuroimaging abnormalities can often be traced from the lower spinal cord to the motor cortex. On MRI, corticospinal tract atrophy and hyperintensity may be seen on T2-weighted sequences. This high signal likely reflects characteristic histologic changes of myelin loss and gliosis. Hypointense signal on T2-weighted sequences may also be found in ALS, due to iron deposition. The anterior and lateral portions of the cord may be atrophic and flattened due to loss of motor neurons in the anterior horn cells and corticospinal tracts. Magnetic resonance transfer measurements are useful for detecting abnormalities associated with degeneration of the pyramidal tract in patients with ALS.

Proton MRS reveals decreased NAA values in the sensorimotor cortex and brainstem of patients with ALS, consistent with neuronal dysfunction or loss. Involvement of the corticospinal tract in patients with ALS has been demonstrated using diffusion tensor imaging, even at an early stage.

Summary

- Neuroimaging plays an increasing role in the evaluation of neurodegenerative conditions such as dementia and movement disorders by supplementing and complementing current clinical tests.
- The primary function of neuroimaging studies is to rule out structural causes that may be reversible.
- Neuroimaging may also contribute to improving the specificity of the diagnosis and to the monitoring of therapy.
- Advanced imaging techniques such as fMRI and MRS hold exciting investigative potential for better understanding neurodegenerative disorders, but are not considered routine clinical practice at this time.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 ml/min/1.73 m²), and almost never in other patients. There is growing literature regarding NSF, although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 ml/min/1.73 m². For more information, please see the ACR Manual on Contrast Media (see the “Availability of Companion Documents” field).

Abbreviations

- ACR: American College of Radiology
- NSF: Nephrogenic systemic fibrosis
Relative Radiation Level Designations

<table>
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<tr>
<th>Relative Radiation Level*</th>
<th>Adult Effective Dose Estimate Range</th>
<th>Pediatric Effective Dose Estimate Range</th>
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<td>30-100 mSv</td>
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*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for dementia and movement disorders

Potential Harms

Relative Radiation Level (RRL) Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 ml/min/1.73 m²), and almost never in other gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 ml/min/1.73 m². For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Qualifying Statements
Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

- Getting Better
- Living with Illness

IOM Domain

- Effectiveness

Identifying Information and Availability

Bibliographic Source(s)


Adaptation

Not applicable: The guideline was not adapted from another source.

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Guideline Committee

- Committee on Appropriateness Criteria, Expert Panel on Neurologic Imaging

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- Not stated

Guideline Status
This is the current release of the guideline.


The appropriateness criteria are reviewed biennially and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

**Guideline Availability**


**Availability of Companion Documents**

The following are available:


**Patient Resources**

None available

**NGC Status**

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