# Guideline Summary NGC-9225

## Guideline Title

**ACR Appropriateness Criteria® neuroendocrine imaging.**

## Bibliographic Source(s)

Seidenwurm DJ, Wippold FJ II, Cornelius RS, Berger KL, Broderick DF, Davis PC, Douglas AC, Frey KA, Germano IM, Mechtler LL, Smirniotopoulos JG, Vogelbaum M, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria® neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 12 p. [79 references]

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Seidenwurm DJ, Wippold FJ II, Cornelius RS, Brunberg JA, Davis PC, De La Paz RL, Dormont D, Gray L, Jordan JE, Mukherji SK, Turski PA, Zimmerman RD, Sloan MA, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria® neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 11 p.

# Scope

## Disease/Condition(s)

Endocrine disorders, including the following:

- Hypopituitarism
- Obesity/eating disorder
- Hyperthyroidism (high thyroid stimulating hormone [TSH])
- Cushing's syndrome (high adrenal corticotropic hormone [ACTH])
- Hyperprolactinemia
- Acromegaly/gigantism
- Growth hormone deficiency, growth deceleration, panhypopituitarism
- Diabetes insipidus
- Pituitary apoplexy
- Postoperative sella
- Precocious puberty

## Guideline Category

Diagnosis

Evaluation

## Clinical Specialty

Endocrinology

Family Practice

Internal Medicine

Neurological Surgery

Neurology

Pediatrics

Radiology

Surgery

### Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

### Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for patients with endocrine disorders

### Target Population

Patients with endocrine disorders

### Interventions and Practices Considered

1. Magnetic resonance imaging (MRI) head
   - Without contrast
   - Without and with contrast
2. Magnetic resonance angiography (MRA) head
   - Without contrast
   - Without and with contrast
3. Computed tomography (CT) head
   - Without contrast
   - Without and with contrast
   - With contrast
4. CT angiography (CTA) head with contrast
5. X-ray
   - Sella
   - Tomography head
6. Cerebral arteriography
7. Venous sampling petrosal sinus

### Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

## 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. Exploding 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 Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

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 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: Neuroendocrine Imaging**

**Variant 1: Hypopituitarism.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA are contraindicated. | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 2: Obesity / eating disorder.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. In selected patients with high clinical likelihood of structural abnormality. | ☢☢☢ |
| MRI head without contrast | 4 | In carefully selected patients with high clinical likelihood of structural abnormality. Multiplanar thin sellar imaging. | O |
| MRI head without and with contrast | 4 | In carefully selected patients with high clinical likelihood of structural abnormality. Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| CT head without contrast | 3 | Indicated if MRI is not available or contraindicated. In selected patients with high clinical likelihood of structural abnormality. | ☢☢☢ |
| CT head without and with contrast | 3 | Indicated if MRI is not available or contraindicated. In selected patients with high clinical likelihood of structural abnormality. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| CTA head with contrast | 1 | | ☢☢☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 3: Hyperthyroidism (high TSH).**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 3 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 3 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA are | ☢☢☢ |

| | | | |
|---|---|---|---|
| | | contraindicated. | |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 4: Cushing's syndrome (high ACTH).**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| Venous sampling petrosal sinus | 4 | Indicated if MRI is negative or equivocal. | Varies |
| CT head without contrast | 4 | Indicated if MRI not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 5: Hyperprolactinemia.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA are contraindicated. | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | Indicated in unusual cases in which lateralization is indeterminate. | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 6: Acromegaly/gigantism.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| Venous sampling petrosal sinus | 3 | Indicated in unusual cases in which lateralization is indeterminate. | Varies |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA contraindicated | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation** |

| | Level |
|---|---|

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

**Variant 7: Growth hormone deficiency, growth deceleration, panhypopituitarism.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| MRI head without and with contrast | 5 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA contraindicated. | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 8: Diabetes insipidus.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| MRI head without and with contrast | 6 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CTA head with contrast | 2 | For surgical planning or vascular detail if MRI and MRA contraindicated. | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 9: Pituitary apoplexy.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head without contrast | 6 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head with contrast | 5 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without and with contrast | 4 | Indicated if MRI is not available or contraindicated. | ☢☢☢ |
| CTA with contrast | 4 | | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 10: Postoperative sella.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| CT head with contrast | 5 | CT may be indicated to assess bony anatomy and if MRI is | ☢☢☢ |

| | | | |
|---|---|---|---|
| | | not available or contraindicated. | |
| CT head without and with contrast | 4 | CT may be indicated to assess bony anatomy and if MRI is not available or contraindicated. | ☢☢☢ |
| CT head without contrast | 4 | CT may be indicated to assess bony anatomy and if MRI is not available or contraindicated. | ☢☢☢ |
| CTA head with contrast | 4 | | ☢☢☢ |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Variant 11: Precocious puberty.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with contrast | 8 | Multiplanar thin sellar imaging. See statement regarding contrast in the text below under "Anticipated Exceptions." | O |
| MRI head without contrast | 7 | Multiplanar thin sellar imaging. | O |
| MRA head without contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| MRA head without and with contrast | 3 | May be useful if vascular pathology is known or suspected. | O |
| CT head without contrast | 2 | | ☢☢☢ |
| CT head with contrast | 2 | | ☢☢☢ |
| CT head without and with contrast | 2 | | ☢☢☢ |
| CTA head with contrast | 2 | | ☢☢☢ |
| X-ray tomography head | 1 | | ☢ |
| X-ray sella | 1 | | ☢ |
| Arteriography cerebral | 1 | | ☢☢☢ |
| Venous sampling petrosal sinus | 1 | | Varies |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

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

**Summary of Literature Review**

**Introduction/Background**

The imaging approach to the hypothalamic pituitary axis is based on specific endocrine testing suggested by clinical signs and symptoms. Endocrine disorders are generally characterized by excess or deficiency of specific hormones. Hormone excess is diagnosed under conditions that would ordinarily suppress hormone secretion. Endocrine deficiencies are diagnosed on the basis of hormone measurements under conditions of stimulation. Specific clinical syndromes of hormonal disorders are determined by the physiologic role of that particular hormone.

The hypothalamic pituitary axis consists of two separate neuroendocrine organs: the anterior pituitary system and the posterior pituitary system. The hormones of the anterior pituitary are thyroid-stimulating hormone (TSH), adrenal corticotropic hormone (ACTH), prolactin (PRL), growth hormone (GH), and the gonadotropins (follicle stimulating hormone [FSH] and luteinizing hormone [LH]). These are secreted under the influence of hypothalamic trophic factors, corticotrophin releasing factor (CRF), thyrotropin releasing factor (TRF) and somatostatin- and gonadotropin-releasing hormone (GnRH). Prolactin release is under the control of a dopaminergic circuit. The hypothalamic-releasing hormones are transported to the pituitary gland by the hypophyseal portal system.

The posterior pituitary gland consists of axonal terminations of neurons whose cell bodies are located in the hypothalamus. The principal hormones secreted by these cells are oxytocin and vasopressin or antidiuretic hormone (ADH). The hypothalamus also participates in complex mediation of food intake, temperature regulation, sleep and arousal, memory, thirst, and other autonomic functions.

Structural causes of obesity, anorexia, central hypothermia and hyperthermia, insomnia and hypersomnia are only very rarely demonstrated in the hypothalamus and pituitary gland. Imaging in patients who present with these symptoms absent other specific neurological or endocrine abnormality is almost always unrewarding. An exception is in children in whom the "diencephalic syndrome" of hypothalamic lesions is relatively common. Also precocious puberty in children can result from hypothalamic lesions.

Pituitary adenomas are the most common lesions of the pituitary gland. These may secrete prolactin, TSH, GH, ACTH, or gonadotropins. Prolactinomas are the most common and are generally present as microadenomas in premenopausal females with amenorrhea and galactorrhea. PRL elevation by itself is nonspecific and may be due to a variety of medical, neurological, or pharmacological causes as well as pituitary adenoma, depending on serum hormone level. In males, prolactinomas may be entirely asymptomatic until visual symptoms occur, due to compression of the chiasm, or they may result in hypogonadotropic hypogonadism with loss of libido and impotence. GH-secreting tumors generally present as larger lesions manifesting clinical acromegaly. Because of the gradual onset of deformity, these tumors may be present for many years and grow to substantial size prior to their detection. In a prepubertal individual the GH-secreting tumor may result in gigantism. TSH- and ACTH-secreting tumors may present at very small size because the impact of their hormone product is usually apparent more rapidly. Gonadotropin-secreting tumors are rare. Nonfunctioning tumors are common, presenting as incidental findings or, if large enough, as compressive lesions.

Precocious puberty and other neurological symptoms can be produced by hypothalamic lesions such as hamartomas. Magnetic resonance imaging (MRI) is generally indicated in all patients with endocrinologically confirmed precocious

puberty, especially when rapid progression of development and neurological symptoms are present.

Posterior pituitary dysfunction with loss of ADH results in the clinical syndrome of diabetes insipidus. This may occur as a transient phenomenon after trauma or neurosurgical procedures. The etiology is usually evident, and the phenomenon is frequently transient. Imaging is performed to search for the cause of stalk transsection, which can be a manifestation of numerous sellar or parasellar pathologies or of trauma, or can be congenital. Rarely, the hormone is absent developmentally. The syndrome of inappropriate ADH (SIADH) is usually due to an extracranial source. Frequently this is a paraneoplastic phenomenon related to small-cell lung carcinoma, though a variety of pulmonary diseases and pharmacological disturbances can result in SIADH.

Other common mass lesions that may affect the neuroendocrine system are germ-line tumors, meningioma, craniopharyngioma, and Rathke's cleft cyst among others. Metastatic lesions may affect the sella. Sarcoid and other inflammatory processes occur in the sellar and suprasellar regions as well. Pituitary apoplexy is a syndrome of headache ophthalmoplegia and visual loss that results from pituitary hemorrhage. In the postpartum period, pituitary infarcts may occur, and hypophysitis is an uncommon disorder resulting in endocrine disturbance and other symptoms.

**Overview of Imaging Modalities**

Classically, radiography and pluridirectional x-ray tomography were the mainstays of sellar imaging. Computed tomography (CT) largely replaced these modalities through the seventies and eighties. More recently, MRI has largely supplanted CT. MRI for sellar pathology includes thin-section multiplanar imaging with slice thickness of 3 mm or less, often before and after contrast administration. Other techniques that are used for evaluation of this anatomical region are computed tomography angiography (CTA), magnetic resonance angiography (MRA), direct catheter angiography, and petrosal sinus sampling.

Radiography and pluridirectional tomography are insensitive and nonspecific imaging modalities for evaluating sellar pathology. Pituitary microadenoma and even small pituitary macroadenomas are frequently associated with a normal sella size. The sella turcica can be enlarged when no neoplasm or mass is present. This is due to pulsations of cerebral spinal fluid (CSF) transmitted through a developmental or acquired dehiscence of the diaphragm sella in the empty sella syndrome. Therefore, these imaging modalities are rarely, if ever, used productively in the evaluation of endocrine disease.

**Computed Tomography**

CT detects pituitary microadenomas and macroadenomas. It is, however, difficult to distinguish tumor from the optic chiasm and to diagnose cavernous invasion. Also, cystic lesions of the suprasellar region may be confused with normal CSF. Additionally, artifact due to dental amalgam, difficulty in obtaining reliable contrast enhancement, and awkward positioning for direct coronal scanning limit the utility of this imaging modality. In the hands of experienced radiologists this technique can result in acceptable diagnostic accuracy, though the examinations are sometimes hard to interpret despite excellent technique.

**Magnetic Resonance Imaging**

MRI provides excellent noninvasive evaluation of the hypothalamus and pituitary gland. It is the only imaging modality that reliably depicts the hypothalamus in a useful fashion. It depicts the anatomy of the pituitary gland, infundibulum, optic chiasm, cavernous sinuses, and neighboring vascular structures accurately and noninvasively. It is technically reproducible and is considered the study of choice for virtually all patients with suspected neuroendocrine pathology.

The addition of gadolinium facilitates diagnosis of microadenoma and increases the confidence with which cavernous sinus invasion can be diagnosed or excluded. The specific bony landmarks may be difficult to demonstrate but the signal pattern of sphenoid sinus mucosa permits assessment of septa for operative planning. Visualization of vascular structures in the parasellar region or even intrasellar carotid artery loop or aneurysm is crucial in some cases. Dynamic contrast-enhanced imaging of the pituitary is advocated by some authors, but its value is not confirmed by systematically collected data.

**Angiography**

Angiography is reserved for those patients in whom vascular pathology is known or suspected on the basis of clinical or radiological findings. Aneurysm is the most important vascular lesion in the parasellar region, but these lesions rarely present as endocrine disorders. Knowledge of vascular anatomy guides surgery. Occasionally, a sellar lesion may grow to displace or encase the carotid arteries or other major intracranial vessels. Interventional neuroradiology procedures can be planned on the basis of CTA, MRA, or catheter angiography. Vascular lesions are depicted reliably by MRA.

**Petrosal Sinus Venous Sampling**

Petrosal sinus venous sampling is reserved for those cases in which a definite excess of pituitary hormone is present, medical management has failed, sectional imaging is negative or equivocal and surgery is planned. When a significant discrepancy in hormone level, usually ACTH, exists between the vessels studied, tumor localization is very accurate. Complications are rare in experienced hands.

**Problems Imaging the Pituitary**

A significant problem encountered in CT and MRI of the pituitary, particularly when endocrine findings suggest microadenoma, is the false-positive examination. Since the endocrine studies confirm the presence of a lesion, and first-line therapy is usually medical, false-negative examinations are less problematic once chiasmatic compression has been excluded. Approximately 20% of the population may harbor small incidental nonfunctioning adenomas or cysts. It is important, therefore, that the probability of disease be high in the target population if a positive MRI is to be relied upon for surgical planning. Additional problems are created by variations in size of the pituitary gland, which occur normally in response to physiological hormonal changes. The gland may enlarge in puberty, pregnancy, and menopause. Pituitary hyperplasia in hypothyroidism may simulate a pituitary adenoma in some patients. Also, in patients with intracranial hypotension the gland may appear more prominent than normal. Similar problems arise in imaging the posterior pituitary, since up to 29% of normal subjects do not demonstrate a bright posterior pituitary.

**Summary**

- MRI dedicated to the sella is the investigation of choice for disorders of the hypothalamic pituitary axis.
- Neuroradiological evaluation is usually not indicated in the evaluation of obesity.
- Pituitary apoplexy is an acute event in which urgent imaging is indicated.

- Rigorous correlation with endocrine findings is required, since normal subjects often exhibit imaging abnormalities of the pituitary gland.

**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 $m^2$), 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 $m^2$.For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

**Abbreviations**

- ACTH, adrenal corticotropic hormone
- CT, computed tomography
- CTA, computed tomography angiography
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- TSH, thyroid stimulating hormone

**Relative Radiation Level Designations**

| Relative Radiation Level* | Adult Effective Dose Estimate Range | Pediatric Effective Dose Estimate Range |
|---|---|---|
| O | 0 mSv | 0 mSv |
| ☢ | <0.1 mSv | <0.03 mSv |
| ☢☢ | 0.1-1 mSv | 0.03-0.3 mSv |
| ☢☢☢ | 1-10 mSv | 0.3-3 mSv |
| ☢☢☢☢ | 10-30 mSv | 3-10 mSv |
| ☢☢☢☢☢ | 30-100 mSv | 10-30 mSv |

*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 "Varies."

### 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 evaluation of patients with endocrine disorders

### Potential Harms

- A significant problem encountered in computed tomography (CT) and magnetic resonance imaging (MRI) of the pituitary, particularly when endocrine findings suggest microadenoma, is the false-positive examination. Since the endocrine studies confirm the presence of a lesion, and first-line therapy is usually medical, false-negative examinations are less problematic once optic chiasmatic compression has been excluded.
- Complications from petrosal sinus venous sampling are rare in experienced hands.

**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 $m^2$), and almost never in other patients. 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 $m^2$. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

**Relative Radiation Level (RRL)**

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 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 ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (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)**

Seidenwurm DJ, Wippold FJ II, Cornelius RS, Berger KL, Broderick DF, Davis PC, Douglas AC, Frey KA, Germano IM, Mechtler LL, Smirniotopoulos JG, Vogelbaum M, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria® neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 12 p. [79 references]

**Adaptation**

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

**Date Released**

1999 (revised 2012)

**Guideline Developer(s)**

American College of Radiology - Medical Specialty Society

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The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

**Guideline Committee**

Committee on Appropriateness Criteria, Expert Panel on Neurologic Imaging

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### Financial Disclosures/Conflicts of Interest

Not stated

### Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Seidenwurm DJ, Wippold FJ II, Cornelius RS, Brunberg JA, Davis PC, De La Paz RL, Dormont D, Gray L, Jordan JE, Mukherji SK, Turski PA, Zimmerman RD, Sloan MA, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria® neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 11 p.

### Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

### Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 4 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria® neuroendocrine imaging. Evidence table. Reston (VA): American College of Radiology; 2012. 33 p. Electronic copies: Available in PDF from the ACR Web site.

### Patient Resources

None available

### NGC Status

This summary was completed by ECRI on July 31, 2001. The information was verified by the guideline developer as of August 24, 2001. This summary was updated by ECRI on August 17, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on July 2, 2009. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on August 31, 2012.

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