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Rhinosinusitis AUC

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Appropriateness of advanced imaging procedures* in patients with rhinosinusitis and the following clinical presentations or diagnoses:

*Including MRI, MR angiography, MR venography, MR perfusion, CT, CT angiography, CT venography, CT perfusion, nuclear medicine, SPECT, PET, PET/CT

Abbreviation list:

AAAAI	American Academy of Allergy, Asthma and Immunology
AAO-HNSF	American Academy of Otolaryngology-Head and Neck Surgery Foundation
ABRS	Acute bacterial rhinosinusitis
ACAAI	American College of Allergy, Asthma and Immunology
ACR	American College of Radiology
AFIFS	Acute fulminant invasive fungal sinusitis
ARS	Acute rhinosinusitis
CRS	Chronic rhinosinusitis
CT	Computed tomography
CTA	Computed tomography angiography
CTV	Computed tomography venography
ESS	Endoscopic sinus surgery
ICSI	Institute for Clinical Systems Improvement
IDSA	Infectious Diseases Society of America
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MRV	Magnetic resonance venography
RARS	Recurrent acute rhinosinusitis
SNOT-22	22-item Sino-Nasal Outcome Test
SPECT	Single-photon emission computed tomography

Acute uncomplicated rhinosinusitis (< 4 weeks duration):

- **Green** –
- **Yellow** –
- **Orange** –
- **Red** – MRI; CT; MRA; MRV; CTA; CTV; scintigraphy; SPECT

Level of Evidence: CT, MRI: moderate for not performing imaging, insufficient for contrast

Notes concerning applicability and/or patient preferences:

Guideline and PLE expert panel consensus summary:
In uncomplicated cases, acute rhinosinusitis is diagnosed on clinical criteria and supplementary investigations are not required (Fokkens et al. 2012).

Sinus x-rays and other imaging tests are not recommended in making the diagnosis of acute sinusitis (Short et al. [*ICSI*] 2017).

Most cases of acute bacterial rhinosinusitis (ABRS) do not require radiographic evaluation because findings on radiographs or CT are nonspecific and do not distinguish bacterial from viral infection (Chow et al. [*IDSA*] 2012).

Clinicians should not obtain radiographic imaging for patients who meet diagnostic criteria for acute rhinosinusitis, unless a complication or alternative diagnosis is suspected (Rosenfeld et al. [*AAO-HNSF*] 2015, recommendation against imaging).

The diagnosis of ABRS is generally made based on history and physical examination. Imaging is useful when acute complications are suspected, the response to initial management is poor, or when the diagnosis is in question (Peters et al. [*AAAAI & ACAAI*] 2014).

MRI is not currently used in the workup of patients with uncomplicated rhinosinusitis (Kirsch et al. [*ACR*] 2017).

In patients with *sinonasal disease, acute (< 4 weeks) uncomplicated rhinosinusitis*, the *American College of Radiology* does not recommend any advanced imaging (Kirsch et al. [*ACR*] 2017).

Clinical notes:

- Acute rhinosinusitis in adults may be defined as sinonasal inflammation lasting less than 4 weeks associated with the sudden onset of symptoms. This definition is largely based on expert opinion and consensus (Orlandi et al. 2016).
- Diagnosis of most cases of uncomplicated acute and subacute rhinosinusitis is based on clinical findings (Seidman et al. [*AAO-HNSF*] 2015). Symptoms may include congestion, stuffiness, facial or periorbital pain, fullness and pressure, and progression from serous to mucopurulent drainage (Kirsch et al. [*ACR*] 2017; Short et al. [*ICSI*] 2017).
- By definition, uncomplicated rhinosinusitis is symptomatic inflammatory change involving the nasal cavity and paranasal sinuses without extension beyond the paranasal sinuses or nasal cavity at time of diagnosis (Kirsch et al. [ACR] 2017; Rosenfeld et al. [*AAO-HNSF*] 2015).

- Acute rhinosinusitis (ARS) of < 4 weeks is subdivided into acute bacterial rhinosinusitis (ABRS; 2-10% of cases) or viral rhinosinusitis (90-98% of cases). The distinction is a clinical one determined by illness pattern and length of occurrence (Kirsch et al. [*ACR*] 2017; Chow et al. [*IDSA*] 2012).
    - In acute viral rhinosinusitis, symptoms last < 10 days without worsening (Kirsch et al. [*ACR*] 2017; Rosenfeld et al. [*AAO-HNSF*] 2015).
    - ABRS diagnosis is made when symptoms of ARS are present without evidence of improvement for at least 10 days after the onset of upper respiratory symptoms, or when symptoms recur or worsen within 10 days after initial improvement (Kirsch et al. [*ACR*] 2017; Short et al. [*ICSI*] 2017; Rosenfeld et al. [*AAO-HNSF*] 2015; Chow et al. [*IDSA*] 2012).
    - Acute bacterial rhinosinusitis may also have onset of severe symptoms, characterized by high fever (≥ 39°C [102°F]) and purulent nasal drainage or facial pain lasting for at least 3-4 consecutive days at the beginning of illness or following a typical viral upper respiratory infection (Chow et al. [*IDSA*] 2012). *The PLE expert panel consensus opinion was that fever was not an efficient discriminator between acute viral and bacterial sinusitis.* Fever has a reported sensitivity and specificity of only 50% for ABRS (Rosenfeld et al. [*AAO-HNSF*] 2015).

Imaging Notes:

- Radiographic confirmation of sinus disease for patients with uncomplicated ABRS is not necessary and is not advised (Chow et al. [*IDSA*] 2012; Kirsch et al. [*ACR*] 2017; Desrosiers et al. 2011, strength of evidence: moderate/strength of recommendation: strong).

Evidence update (2017-present): There were no new studies significantly affecting the evidence and recommendations included in the guidelines cited above.

Recurrent acute rhinosinusitis (RARS):

- **Green** – CT paranasal sinuses without contrast; CT cone beam paranasal sinuses without contrast
- **Yellow** –
- **Orange** -
- **Red** – CT with IV contrast; MRI; MRA; MRV; CTA; CTV; scintigraphy; SPECT

Level of Evidence: CT: very low (insufficient for contrast); MRI: insufficient

Notes concerning applicability and/or patient preferences:

Guideline and PLE expert panel consensus summary:
Noncontrast sinus CT is indicated for evaluation of recurrent acute rhinosinusitis before surgical intervention … (Kirsch et al. [*ACR*] 2017).

Sinonasal imaging, specifically CT scans without contrast, may be indicated in patients who demonstrate signs and symptoms of recurrent acute rhinosinusitis, nasal polyposis, chronic rhinosinusitis, or complicated rhinosinusitis or to define sinus anatomy prior to surgery (Seidman et al. [*AAO-HNSF*] 2015).

Although the diagnostic evaluation of patients with recurrent acute rhinosinusitis is clinical, it is important to assess for allergy that may be an instigating factor and to evaluate for anatomic obstruction using CT (Orlandi et al. 2016).

MRI is not considered the first-line study for routine sinus imaging because of lack of bone detail and length of imaging time (Kirsch et al. [*ACR*] 2017).

In patients with *rhinosinusitis, possible surgical candidate, recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polyposis, or noninvasive fungal sinusitis,* the *American College of Radiology* recommends CT paranasal sinuses without IV contrast (9), CT cone beam paranasal sinuses without contrast (7), and CT paranasal sinuses with IV contrast (5) (Kirsch et al. [*ACR*] 2017). *The PLE expert panel thought that CT with IV contrast does not have a role in the evaluation of patients with uncomplicated recurrent acute rhinosinusitis.*

Clinical notes:

- If four or more episodes of acute bacterial rhinosinusitis (ABRS) occur annually, without signs or symptoms between the episodes, the term *recurrent acute rhinosinusitis* (RARS) is used (Kirsch et al. [*ACR*] 2017; Orlandi et al. 2016; Rosenfeld et al. [*AAO-HNSF*] 2015; Desrosiers et al. 2011).

Imaging notes:

- CT examinations of the paranasal sinuses should utilize thin sections (≤1.25 mm) with sagittal reformations, coronal reformations and thick (2-3 mm) soft tissue axial reformations (PLE expert panel consensus opinion).
- CT images can also be imported into computer navigation systems for image-based guidance surgery during endoscopic sinus surgery. Imaging protocols should be aligned with any image-

guided procedure requirements to eliminate redundant imaging for surgical guidance (Kirsch et al. [*ACR*] 2017).

- Image-based guidance surgery provides real-time information of instrument location relative to critical structures (PLE expert panel consensus opinion).
- The CT Lund-Mackay score is a method for the staging of chronic rhinosinusitis on CT (Lund & Mackay, 1993). The reader assigns each sinus a score of:
    - 0 (no abnormality)
    - 1 (partial opacification) or
    - 2 (complete opacification)

  The sinuses are grouped into:
    - frontal sinus
    - anterior ethmoidal cells
    - posterior ethmoidal cells
    - maxillary sinus
    - sphenoid sinus
    - ostiomeatal complex

  The ostiomeatal complex is assigned a score of either 0 (not obstructed) or 2 (obstructed). Each side is graded separately. A combined score of up to 24 is possible. Of note, an aplastic (absent) frontal sinus receives a score of 0.

<u>Evidence update (2017-present):</u>
Fraczek et al. (2017) conducted a cross-sectional single-blind study to assess the extent to which the use of a low-dose multidetector CT protocol affects the identification of surgically relevant anatomical structures in patients with chronic rhinosinusitis (CRS). A total of 135 CRS patients were divided into standard-dose or low-dose CT groups. The authors found that the low-dose technique has a reasonable diagnostic value for screening CRS. However, in the context of planned surgical interventions, when knowledge of the individual anatomy becomes particularly important, its application should be well thought out. Higher mAs settings enable a more accurate evaluation of surgically relevant anatomical structures and should be considered, especially among those subjects with an initially higher chance of intraoperative difficulties (low level of evidence). *This statement may not apply to all or newer dose reduction or iterative reduction techniques* (PLE expert panel consensus opinion).

Sohn et al. (2018) conducted a retrospective study to assess clinical presentations and anatomic variants among 304 patients with recurrent acute rhinosinusitis (RARS) and chronic rhinosinusitis (CRS) - either with nasal polyps (CRSsNP) or without nasal polyps (CRSwNP). All patients completed the Sino-Nasal Outcome Test (SNOT-20) one day before and six months after endoscopic sinus surgery. No significant differences were found among the average preoperative SNOT-20 scores of the 3 groups. Patients with RARS were significantly more likely to show agger nasi cells, Haller cells, and septal deviation on CT. Those with CRSwNP had significantly smaller mean infundibular widths. All groups showed significantly improved SNOT-20 scores postoperatively (low level of evidence).

Chronic uncomplicated rhinosinusitis (CRS):

- **Green** – CT paranasal sinuses without contrast; CT cone beam paranasal sinuses without contrast
- **Yellow** – MRI maxillofacial with and without IV contrast
- **Yellow** – MRI maxillofacial without IV contrast in patients who are unable to receive or refuse IV contrast
- **Yellow** – MRI maxillofacial with IV contrast in patients with recent MR maxillofacial without IV contrast
- **Yellow** – CT paranasal sinuses with IV contrast in patients who cannot undergo MRI
- **Red** – MRA; MRV; CTA; CTV; scintigraphy; SPECT

Level of Evidence: CT: moderate (insufficient for contrast); MRI: insufficient

Notes concerning applicability and/or patient preferences: A patient's history of radiation exposure and preferences should be taken into account when deciding to confirm CRS with CT. Nasal endoscopy is another method of confirming CRS but is less sensitive and cannot delineate anatomy for surgical planning (Orlandi et al. 2016). MRI is not considered the first-line study for routine sinus imaging (Kirsch et al. [*ACR*] 2017).

Guideline and PLE expert panel consensus summary:
Noncontrast sinus CT is indicated in patients with chronic rhinosinusitis for the objective confirmation of the diagnosis or for evaluation prior to surgical intervention (Kirsch et al. [*ACR*] 2017).

CT scanning is recommended for all patients meeting symptom-based criteria for CRS with a lack of objective clinical findings on anterior rhinoscopy or nasal endoscopy, or for preoperative planning. It is an option for confirming CRS instead of nasal endoscopy (Orlandi et al. 2016, grade of evidence: B).

Sinonasal imaging, specifically CT scans without contrast, may be indicated in patients who demonstrate signs and symptoms of recurrent acute rhinosinusitis, nasal polyposis, chronic rhinosinusitis, or complicated rhinosinusitis or to define sinus anatomy prior to surgery (Seidman et al. [*AAO-HNSF*] 2015).

CT imaging of the sinuses is often useful in evaluating chronic rhinosinusitis with nasal polyps, especially for unilateral polyps, concern for polyps extending outside of the nasal cavity, or other atypical presentations (Rosenfeld et al. [*AAO-HNSF*] 2015).

Although there is no standard diagnostic test for osteitis, CT is currently the modality of choice. CT imaging offers availability, good bony detail, and excellent sensitivity and specificity for detecting mucosal abnormalities and thickening (Orlandi et al. 2016).

MRI is not considered the first-line study for routine sinus imaging because of lack of bone detail and length of imaging time (Kirsch et al. [*ACR*] 2017).

Rarely, in selected cases, MRI or contrast-enhanced sinus CT may be needed to help differentiate polypoid mucosal hypertrophy from superimposed sinus fluid and also help to exclude a true underlying soft-tissue mass causing sinus obstruction. (Kirsch et al. [*ACR*] 2017).

The utility of MRI for diagnosis of CRS is limited. MRI is generally useful only in specific instances such as delineation of mucoceles, allergic fungal rhinosinusitis, concerns over skull-base integrity, or tumor-associated sinonasal inflammation (Orlandi et al. 2016; Kirsch et al. [*ACR*] 2017).

The use of single-photon emission computed tomography (SPECT) is limited in the evaluation of chronic rhinosinusitis. Even though positive SPECT in patients with chronic rhinosinusitis correlates with poor subjective response to medical treatment, this technique is generally not used in clinical practice (Kirsch et al. [*ACR*] 2017). It is not readily available and exposes the patient to larger doses of radiation (Orlandi et al. 2016).

In patients with *rhinosinusitis, possible surgical candidate, recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polyposis, or noninvasive fungal sinusitis,* the *American College of Radiology* recommends CT paranasal sinuses without IV contrast (9), CT cone beam paranasal sinuses without contrast (7), and CT paranasal sinuses with IV contrast (5) (Kirsch et al. [*ACR*] 2017).

<u>Clinical notes:</u>

- Chronic rhinosinusitis (CRS) is defined when signs and symptoms of rhinosinusitis occur for 12 weeks or longer and include mucopurulent drainage, nasal obstruction and congestion, facial pain, pressure and fullness, or a decreased or absent sense of smell (Kirsch et al. [*ACR*] 2017; Orlandi et al. 2016; Desrosiers et al. 2011; Peters et al. [*AAAAI & ACAAI*] 2014).
- Chronic rhinosinusitis (CRS) is diagnosed on clinical grounds but must be confirmed by objective findings on endoscopy and/or computed tomography (CT) scan (Desrosiers et al. 2011, strength of evidence: weak, strength of recommendation: strong; Cottrell et al. 2018).
- Symptoms alone have a high sensitivity but an unacceptably low specificity, which is why the symptoms must be accompanied by objective findings including positive nasal endoscopy (purulence, polyps, or edema) or positive imaging findings consisting of inflammation or mucosal changes within the sinuses (Orlandi et al. 2016; Cottrell et al. 2018).
- Conversely, in the absence of symptoms, diagnosis of CRS based on radiology alone is not appropriate because [it is a clinical diagnosis] and there is a high incidence of radiological anomalies on CT scans in normal individuals (Desrosiers et al. 2011).
- Subacute rhinosinusitis has been a term used to describe clinical presentations that fall between the time frames of acute rhinosinusitis and chronic rhinosinusitis. It is likely that patients who fall into this group either have slow-to-resolve acute rhinosinusitis or an early presentation of evolving chronic rhinosinusitis (Orlandi et al. 2016).
- Rhinosinusitis lasting between 4 and 12 weeks should be assessed on an individual clinical basis to determine if the pattern is acute or chronic, because timeline definitions are consensus- rather than evidence-based (Kirsch et al. [*ACR*] 2017).
- Noninvasive fungal sinus disease may manifest as a fungus ball (mycetoma) or allergic fungal sinusitis. Fungus balls are a collection of fungal hyphae without allergic mucin, often occurring in maxillary and sphenoid sinuses, with etiologies postulated to occur from poor mucociliary clearance (Kirsch et al. [*ACR*] 2017).
- Noninvasive fungal sinusitis may be associated with allergic rhinitis, nasal polyps, and asthma (Kirsch et al. [*ACR*] 2017).
- Office endoscopy is the preferred initial method of evaluating medical problems such as nasal stuffiness and obstruction, sinusitis, nasal polyps, nasal tumors, and epistaxis (nose bleeds). During endoscopy, the presence of purulent secretions draining from the sinus openings can be

observed. If pus is observed, it can be sampled with a small swab and cultured to determine what organism is causing the infection (*American Rhinologic Society* 2014). Overall, nasal endoscopy is a safe and low risk procedure (Rosenfeld et al. [*AAO-HNSF*] 2015; Fraczek et al. 2017).

- Despite the high specificity and positive predictive value of nasal endoscopy in confirming a chronic rhinosinusitis diagnosis, endoscopy is notably less sensitive and thus has a high false-negative rate compared to CT. Published estimates of sensitivity and false-negative rates are 30% to 46% and 35% to 70%, respectively, when compared to CT (Orlandi et al. 2016).

Imaging notes:

- Radiographic imaging may be useful in unilateral chronic recurrent rhinosinusitis to exclude a tumor, anatomic variants or foreign body (Kirsch et al. [*ACR*] 2017; Peters et al. 2014 [*AAAAI & ACAAI*], strength of recommendation: C).
- CT examinations of the paranasal sinuses should utilize thin sections (≤1.25 mm) with sagittal reformations, coronal reformations and thick (2-3 mm) soft tissue axial reformations (PLE expert panel consensus opinion).
- CT images can also be imported into computer navigation systems for image-based guidance surgery during endoscopic sinus surgery. Imaging protocols should be aligned with any image-guided procedure requirements to eliminate redundant imaging for surgical guidance (Kirsch et al. [*ACR*] 2017).
- Image-based guidance surgery provides real-time information of instrument location relative to critical structures (PLE expert panel consensus opinion).
- The CT Lund-Mackay score is a method for the staging of chronic rhinosinusitis on CT (Lund & Mackay, 1993). The reader assigns each sinus a score of:
    - 0 (no abnormality)
    - 1 (partial opacification) or
    - 2 (complete opacification)

  The sinuses are grouped into:
    - frontal sinus
    - anterior ethmoidal cells
    - posterior ethmoidal cells
    - maxillary sinus
    - sphenoid sinus
    - ostiomeatal complex

  The ostiomeatal complex is assigned a score of either 0 (not obstructed) or 2 (obstructed). Each side is graded separately. A combined score of up to 24 is possible. Of note, an aplastic (absent) frontal sinus receives a score of 0.

Evidence update (2017-present):

Fraczek et al. (2017) conducted a cross-sectional single-blind study to assess the extent to which the use of a low-dose multidetector CT protocol affects the identification of surgically relevant anatomical structures in patients with chronic rhinosinusitis (CRS). A total of 135 CRS patients were divided into standard-dose or low-dose CT groups. The authors found that the low-dose technique has a reasonable diagnostic value for screening CRS. However, in the context of planned surgical interventions, when knowledge of the individual anatomy becomes particularly important, its application should be well thought out. Higher mAs settings enable a more accurate evaluation of surgically relevant anatomical structures and should be considered, especially among those subjects with an initially higher chance of intraoperative difficulties (low level of evidence). *This statement may not apply to all or newer dose*

reduction or iterative reduction techniques (PLE expert panel consensus opinion).

Hirsch et al. (2017) conducted a retrospective cohort study to determine whether elimination of pain improves accuracy of clinical diagnostic criteria for adult chronic rhinosinusitis (CRS). History, symptoms, nasal endoscopy, and CT results were analyzed for 1,186 adults referred to an academic otolaryngology clinic with presumptive diagnosis of CRS. Clinical diagnosis was rendered using the 1997 Rhinosinusitis Taskforce (RSTF) Guidelines and a modified version eliminating facial pain, ear pain, dental pain, and headache. Applying modified RSTF diagnostic criteria, 39% lacked sinonasal inflammation by CT, 38% by endoscopy, and 24% by either modality. Using either abnormal CT or endoscopy as reference standard, modified diagnostic criteria yielded a statistically significant increase in specificity from 37.1% to 65.1%, with a nonsignificant decrease in sensitivity from 79.2% to 70.3%. The authors conclude that clinical diagnostic criteria overestimate the prevalence of CRS, and removing facial pain, ear pain, dental pain, and headache increased specificity without a concordant loss in sensitivity (low level of evidence).

Racette et al. (2017) conducted a prospective multicenter study to evaluate symptoms described by patients with chronic rhinosinusitis (CRS) with polypoid changes/nasal polyps and their correlation with CT, nasal endoscopy, and intranasal biomarkers. Using logistic regression analysis, participant-rated 16-question surveys from 258 participants were assessed for correlation with nasal endoscopy scores, CT percentage of sinus occlusion, and intranasal biomarkers of fungal antigens, eosinophilic inflammation, and inflammatory cytokines. The authors found that while both nasal endoscopy and CT imaging are valid objective tools in the evaluation of CRS patients, nasal endoscopy has a stronger correlation with the two cardinal symptoms of congestion and anterior rhinorrhea in CRS patients; these correlate with biomarkers of eosinophilic inflammation (moderate level of evidence).

Yoon et al. (2017) conducted a retrospective analysis of clinical records (including clinical presentations, radiological findings, management, and outcomes) of sinonasal fungus ball (FB) patients who have undergone surgery for treatment. A total of 538 cases were reviewed (mean age 58 years; approximately 2:1 female). The authors found while the most common presenting symptoms of maxillary sinus FB patients were nasal symptoms, such as postnasal drip and nasal obstruction, sphenoid sinus FB patients presented with headache mostly. On CT scans, the most common finding was intralesional hyperdensity (77.3%).There was no significant correlation between presence of FB and structural variations. The authors conclude that a preoperative CT scan is an essential tool in making diagnosis easier and faster, and that endoscopic surgery is the treatment of choice (low level of evidence).

Pre-operative evaluation for routine functional endoscopic sinus surgery (ESS):

- **Green** – CT paranasal sinuses without contrast; CT cone beam paranasal sinuses without contrast
- **Yellow** –
- **Red** – MRI; CT with IV contrast; MRA; MRV; CTA; CTV; scintigraphy; SPECT

Level of Evidence: CT: low (insufficient for contrast); MRI: insufficient

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus summary:
Noncontrast sinus CT is indicated for evaluation of recurrent acute rhinosinusitis and chronic rhinosinusitis before surgical intervention … (Kirsch et al. [*ACR*] 2017).

Sinonasal imaging, specifically CT scans without contrast, may be indicated in patients who demonstrate signs and symptoms of recurrent acute rhinosinusitis, nasal polyposis, chronic rhinosinusitis, or complicated rhinosinusitis or to define sinus anatomy prior to surgery (Seidman et al. [*AAO-HNSF*] 2015).

Perform a CT scan when imaging of the sinuses is indicated. It is required before surgical intervention or when complications of rhinosinusitis are suspected (Peters et al. 2014 [*AAAAI & ACAAI*], strength of recommendation: A).

CT of the paranasal sinuses should be obtained when endoscopic sinus surgery is considered or planned in patients with chronic rhinosinusitis or recurrent acute rhinosinusitis. In addition to demonstrating abnormal mucosa and opacified sinuses, the study will provide the anatomic detail necessary to guide the surgery (Rosenfeld et al. [*AAO-HNSF*] 2015).

CT scanning provides the best preoperative information for endoscopic surgery, with excellent delineation of the complex ethmoidal anatomy, ostiomeatal unit, and anatomic variations, including the presence of sphenoethmoidal (Onodi) air cells, which increase the risk of injury to the optic nerves or carotid arteries (Kirsch et al. [*ACR*] 2017).

CT should not be used as the sole criteria for determining the need for surgical intervention, but rather should be used as an objective tool for confirming the diagnosis of chronic rhinosinusitis and for surgical planning (Desrosiers et al. 2011).

MRI is not considered the first-line study for routine sinus imaging because of lack of bone detail and length of imaging time (Kirsch et al. [*ACR*] 2017).

In patients with *rhinosinusitis, possible surgical candidate, recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polyposis, or noninvasive fungal sinusitis,* the *American College of Radiology* recommends CT paranasal sinuses without IV contrast (9), CT cone beam paranasal sinuses without contrast (7), and CT paranasal sinuses with IV contrast (5) (Kirsch et al. [*ACR*] 2017).

Clinical notes:

- In chronic rhinosinusitis, the goal of surgery is to re-establish sinus drainage by removing excess tissue responsible for obstruction and bony areas in narrow areas. The extent of surgery is guided by the degree of sinus involvement (Desrosiers et al. 2011).

Technical notes:

- CT examinations of the paranasal sinuses should utilize thin sections (≤1.25 mm) with sagittal reformations, coronal reformations and thick (2-3 mm) soft tissue axial reformations (PLE expert panel consensus opinion).
- CT images can also be imported into computer navigation systems for image-based guidance surgery during endoscopic sinus surgery. Imaging protocols should be aligned with any image-guided procedure requirements to eliminate redundant imaging for surgical guidance (Kirsch et al. [*ACR*] 2017).
- Image-based guidance surgery provides real-time information of instrument location relative to critical structures (PLE expert panel consensus opinion).
- The CT Lund-Mackay score is a method for the staging of chronic rhinosinusitis on CT (Lund & Mackay, 1993). The reader assigns each sinus a score of:
    - 0 (no abnormality)
    - 1 (partial opacification) or
    - 2 (complete opacification)

  The sinuses are grouped into:
    - frontal sinus
    - anterior ethmoidal cells
    - posterior ethmoidal cells
    - maxillary sinus
    - sphenoid sinus
    - ostiomeatal complex

  The ostiomeatal complex is assigned a score of either 0 (not obstructed) or 2 (obstructed). Each side is graded separately. A combined score of up to 24 is possible. Of note, an aplastic (absent) frontal sinus receives a score of 0.

Evidence update (2017-present):

Fraczek et al. (2017) conducted a cross-sectional single-blind study to assess the extent to which the use of a low-dose multidetector CT protocol affects the identification of surgically relevant anatomical structures in patients with chronic rhinosinusitis (CRS). A total of 135 CRS patients were divided into standard-dose or low-dose CT groups. The authors found that the low-dose technique has a reasonable diagnostic value for screening CRS. However, in the context of planned surgical interventions, when knowledge of the individual anatomy becomes particularly important, its application should be well thought out. Higher mAs settings enable a more accurate evaluation of surgically relevant anatomical structures and should be considered, especially among those subjects with an initially higher chance of intraoperative difficulties (low level of evidence). *This statement may not apply to all or newer dose reduction or iterative reduction techniques* (PLE expert panel consensus opinion).

Julkunen et al. (2017) conducted a cross-sectional study to evaluate the inter-observer agreement of structures of sinus CT scans. A total of 57 patients (mean age 43 years) with chronic rhinosinusitis (CRS) were evaluated. Lund-Mackay (LM) scores and 43 other structural parameters were analyzed, and reproducibility of findings between three blinded observers (radiologist, ENT surgeon, ENT resident) were compared. The authors found that, in general, there was moderate inter-observer agreement of the structures by Cohen's kappa coefficient. Poor reproducibility was observed in the following

structures: optic nerve, insertion of the uncinated process, anterior ethmoidal artery, and Keros class (low level of evidence).

Diagnosis of complications of rhinosinusitis:

- **Green** – CT paranasal sinuses or orbits without contrast
- **Yellow** – CT paranasal sinuses or orbits with IV contrast in patients who are unable to undergo MRI

- **Green** – MRI maxillofacial, orbit or brain with and without IV contrast
- **Yellow** – MRI maxillofacial, orbit or brain without IV contrast in patients who are unable to receive or refuse IV contrast
- **Yellow –** MRI maxillofacial, orbit or brain with IV contrast in patients with a recent corresponding MRI without IV contrast

- **Yellow** – CT head with and without IV contrast, CT head with IV contrast, or CT head without IV contrast in patients who cannot undergo MRI
- **Yellow** – MRA head, CTA head, to evaluate for suspected vascular complications
- **Orange** – CT with and without IV contrast
- **Red** – Scintigraphy; SPECT; CT cone beam; MRV; CTV

Level of Evidence: CT: moderate (low for contrast); MRI: moderate (very low for MRI vs CT; low for contrast)

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus summary:
CT paranasal sinuses without IV contrast –
If a complication or alternative diagnosis [of acute rhinosinusitis] is suspected, then CT of the sinuses should be obtained (Short et al. [*ICSI*] 2017).

Sinonasal imaging, specifically CT scans without contrast, may be indicated in patients who demonstrate signs and symptoms of recurrent acute rhinosinusitis, nasal polyposis, chronic rhinosinusitis, or complicated rhinosinusitis or to define sinus anatomy prior to surgery (Seidman et al. [*AAO-HNSF*] 2015).

Perform a CT scan when imaging of the sinuses is indicated. It is required before surgical intervention or when complications of rhinosinusitis are suspected (Peters et al. 2014 [*AAAAI & ACAAI*], strength of recommendation: A).

In patients with acute bacterial rhinosinusitis suspected to have suppurative complications, axial and coronal views of contrast-enhanced computed tomography (CT) rather than magnetic resonance imaging (MRI) is recommended to localize the infection and to guide further treatment (Chow et al. [*IDSA*] 2012, weak strength of recommendation, low quality of evidence).

Sinus CT imaging may be appropriate as per clinical judgment when acute bacterial rhinosinusitis (ABRS) has associated complications including headache, facial swelling, orbital proptosis, and cranial nerve palsies (Kirsch et al. [*ACR*] 2017; Rosenfeld et al. [*AAO-HNSF*] 2015).

Cone beam CT is not recommended for the detection and evaluation of complications of rhinosinusitis, as it is unable to detect soft tissue abnormalities (PLE Multidisciplinary Committee consensus statement).

CT with IV contrast -
CT scanning provides the best delineation of bone integrity or erosion. A contrast-enhanced CT may be an alternative in the setting of MRI contraindications to evaluate for intraorbital or intracranial complications. Imaging without and with contrast is not necessary (Kirsch et al. [*ACR*] 2017).

There is a limited role for contrast-enhanced sinus CT imaging. The vast majority of cases of inflammatory sinus disease should be imaged without intravenous contrast. Most complications related to sinus disease can be observed with unenhanced CT imaging. However, MRI with contrast is preferred over contrast-enhanced sinus CT to evaluate for inflammatory sinus disease complications, particularly if intracranial spread of infection is suspected (Peters et al. [*AAAAI & ACAAI*] 2014).

Orbital, maxillofacial and olfactory imaging -
CT of the orbits with contrast is often the initial imaging modality in the emergent setting for suspected infection. CT is superior to MRI for foreign body assessment, calcification detection, and osseous evaluation. In patients who cannot receive contrast, a noncontrast orbit CT may still add useful information (Kennedy et al. [*ACR*] 2017).

Orbital MRI is complementary to CT in evaluating intraorbital spread of infection. An MRI of the orbits without and with contrast should be considered if a more detailed assessment of intraorbital spread of infection is clinically warranted (Kennedy et al. [*ACR*] 2017).

If there is clinical concern for orbital or intracranial complications, both CT and MRI may be necessary to better define the soft-tissue structures, orbital contents, and brain to guide appropriate treatment, with radiation exposure as low as reasonably achievable (Kirsch et al. [*ACR*] 2017).

MRI is the mainstay for examining the olfactory apparatus, although CT remains useful when evaluating fractures, paranasal sinus inflammatory disease, and bony anatomy (Policeni et al. [*ACR*] 2017).

In patients with suspected invasive fungal sinusitis, CT with contrast may be used to help define orbital … complications and can be used in cases when a patient is unable or unwilling to have an MRI (Kirsch et al. [*ACR*] 2017).

In patients with *suspected orbital cellulitis, uveitis, or scleritis, initial imaging*, the *American College of Radiology* recommends CT orbits with IV contrast and MRI orbits without and with IV contrast (usually appropriate). CT orbits without IV contrast, MRI head without and with IV contrast, MRI orbits without IV contrast, CTA head and neck with IV contrast, MRA head and neck without and with IV contrast, MRI head without IV contrast, CT head with IV contrast, and MRA head and neck without IV contrast may also be indicated in specific scenarios (may be appropriate) (Kennedy et al. [*ACR*] 2017). *MRA and CTA are only indicated for the evaluation of cavernous or sagittal sinus thrombosis or for suspected invasion of the intracranial carotid artery* (PLE expert panel consensus opinion).

In patients with *cranial neuropathy*, *anosmia and abnormalities of the sense of smell (olfactory nerve, CN I)*, the *American College of Radiology* recommends MRI head without and with IV contrast (8), MRI orbit face neck without and with IV contrast (8), MRI head without IV contrast (6), MRI orbit face neck

without IV contrast (6), CT maxillofacial with IV contrast (6), CT head with IV contrast (5), CT head without IV contrast (5), CT head without and with IV contrast (5), and CT maxillofacial without IV contrast (5) (Policeni et al. [*ACR*] 2017).

In patients with *suspected invasive fungal sinusitis,* the *American College of Radiology* recommends MRI maxillofacial without and with IV contrast (9), CT paranasal sinuses without IV contrast (8), CT paranasal sinuses with IV contrast (8), MRI maxillofacial without IV contrast (6), and MRA head without IV contrast (5) (Kirsch et al. [*ACR*] 2017).

Intracranial imaging -
If there is a suspicion for intracranial complications from sinus disease, then MRI of the brain with and without contrast is indicated. However, if MRI is contraindicated, then CT of the head with and/or without contrast may be indicated (Douglas et al. [*ACR*] 2013).

MRI appears more sensitive than CT for detecting soft tissue involvement in patients with suspected intracranial complications and is not associated with ionizing radiation (Chow et al. [IDSA] 2012).

MRI may better depict intraorbital and intracranial complications in cases of aggressive sinus infection as well as differentiating soft-tissue masses from adjacent T2-hyperintense inflammatory mucosal disease (Kirsch et al. [*ACR*] 2017).

MRI of the face or sinuses without and with contrast provides a more accurate evaluation of complex sinus secretions and extension of disease into adjacent soft tissues. Brain MRI with and without contrast may be complementary to help characterize any intracranial spread beyond the field of view of the sinus examination (Kirsch et al. [*ACR*] 2017).

Contrast-enhanced MRI with coverage through the cavernous sinuses is the test of choice for suspected cavernous sinus thrombosis and suspected orbital complications including both the maxillofacial and intracranial structures (Kirsch et al. [*ACR*] 2017).

In patients with suspected invasive fungal sinusitis, CT with contrast may be used to help define … intracranial complications and can be used in cases when a patient is unable or unwilling to have an MRI (Kirsch et al. [*ACR*] 2017).

In patients with *headache, suspected intracranial complication of sinusitis and/or mastoiditis*, the *American College of Radiology* recommends MRI head without and with IV contrast (8), MRI head without IV contrast (6), CT head without IV contrast (6), CT head without and with IV contrast (6), and CT head with IV contrast (5) (Douglas et al. [*ACR*] 2013).

In patients with *acute rhinosinusitis, suspected orbital or intracranial complication,* the *American College of Radiology* recommends MRI maxillofacial without and with IV contrast (9), MRI head without and with IV contrast (8), CT paranasal sinuses with IV contrast (8), CT paranasal sinuses without IV contrast (7), CT head with IV contrast (6), MRI maxillofacial without IV contrast (6), and MRI head without IV contrast (6) (Kirsch et al. [*ACR*] 2017).

Vascular imaging -
CTA or MRA may be added to routine CT or MRI scans if there is a suspicion for vascular invasion including cavernous sinus thrombosis, particularly in the setting of fungal disease. MRA may be

performed without and/or with contrast (Kennedy et al. [*ACR*] 2017).

Because fungal sinusitis in the sphenoid can result in cavernous sinus invasion and involvement of the cavernous carotid artery, additional imaging via CTA, MRA, or catheter angiography may be needed if there is concern for [carotid invasion and] pseudoaneurysm formation; however, they are not first-line examinations (Kirsch et al. [*ACR*] 2017).

Clinical notes:

- Orbital, intracranial, and osseous complications of acute rhinosinusitis represent rare, but potentially serious clinical events (Fokkens et al. 2012):
    - Periorbital complications (60-75% of cases) include preseptal cellulitis, orbital cellulitis, and subperiosteal or intraorbital abscess. Prompt recognition is vital in order to avoid long-term sequelae (Fokkens et al. 2012).
    - Intracranial complications (15-20% of cases) include epidural or subdural abscesses, brain abscess, meningitis, encephalitis, and superior sagittal and cavernous sinus thrombosis. They may present with non-specific signs and symptoms such as high fever or severe headache (Fokkens et al. 2012).
    - Osseous complications (5-10% of cases) result from osteomyelitis of the facial skeleton associated with the progress of inflammation and may present as Pott's puffy tumor or frontocutaneous fistula (Fokkens et al. 2012).
- Infection from the ethmoid sinus can spread through the perforations of the lamina papyracea and cribriform plate; through the valveless veins, which extend to the cavernous sinus; and via direct extension in osteomyelitis (Kirsch et al. [*ACR*] 2017).
- Symptoms such as periorbital edema, displaced globe, diplopia, ophthalmoplegia, reduced visual acuity, severe unilateral or bilateral frontal headache, frontal headache, focal neurological signs, or meningism point to complications such as intracranial sepsis, or an alternative diagnosis and require urgent diagnosis and appropriate management (Fokkens et al. 2012).
- Immunosuppressed patients are much more vulnerable to complications of acute rhinosinusitis, and a more aggressive diagnostic approach is required (Fokkens et al. 2012).
- Invasive fungal sinusitis occurs when fungal hyphae involve the paranasal sinus mucosa, submucosa, blood vessels, or bones and may be further subdivided into acute fulminant invasive fungal sinusitis (AFIFS) and chronic invasive fungal sinusitis (Kirsch et al. [*ACR*] 2017).
    - Acute fulminant invasive fungal sinusitis (AFIFS) is rapidly progressive, with a time course of < 4 weeks, and is associated with a high morbidity and mortality of 50% to 80%. Because of this high morbidity and mortality in patients who are immunosuppressed or leukemic, have poorly controlled diabetes, or are transplant patients on high-dose steroid treatment, a high index of suspicion should be maintained when these patients present with a fever and symptoms of sinonasal inflammation (Kirsch et al. [*ACR*] 2017).
    - Chronic invasive fungal sinusitis is progression of fungal deposition over months to years, with invasion of the paranasal sinus mucosa, submucosa, vessels, and bones, and may also result in significant mortality and morbidity (Kirsch et al. [*ACR*] 2017).

Imaging notes:

- Orbital radiographs are insufficient to detect orbital cellulitis. Radiographs have largely been supplanted by CT when imaging is necessary (Kennedy et al. [*ACR*] 2017).

- CT examinations of the paranasal sinuses should utilize thin sections (≤1.25 mm) with sagittal reformations, coronal reformations and thick (2-3 mm) soft tissue axial reformations (PLE expert panel consensus opinion).
- CT images can also be imported into computer navigation systems for image-based guidance surgery during endoscopic sinus surgery. Imaging protocols should be aligned with any image-guided procedure requirements to eliminate redundant imaging for surgical guidance (Kirsch et al. [*ACR*] 2017).
- Image-based guidance surgery provides real-time information of instrument location relative to critical structures (PLE expert panel consensus opinion).
- The CT Lund-Mackay score is a method for the staging of chronic rhinosinusitis on CT (Lund & Mackay, 1993). The reader assigns each sinus a score of:
    - 0 (no abnormality)
    - 1 (partial opacification) or
    - 2 (complete opacification)

  The sinuses are grouped into:
    - frontal sinus
    - anterior ethmoidal cells
    - posterior ethmoidal cells
    - maxillary sinus
    - sphenoid sinus
    - ostiomeatal complex

  The ostiomeatal complex is assigned a score of either 0 (not obstructed) or 2 (obstructed). Each side is graded separately. A combined score of up to 24 is possible. Of note, an aplastic (absent) frontal sinus receives a score of 0.
- Postcontrast T1-weighted fat-saturation [MRI] sequences should be included if there is concern for abscess formation or extrasinus extension (Kirsch et al. [*ACR*] 2017).
- In the setting of cavernous sinus thrombosis, a contrast-enhanced MRA may provide additional information not provided by a traditional noncontrast MRA examination (Kennedy et al. [*ACR*] 2017).

<u>Evidence update (2017-present):</u> There were no new studies significantly affecting the evidence and recommendations included in the guidelines cited above.

Exclusions:

- Acute trauma;
- Pediatric patients;
- Pregnant patients;
- Suspected neoplasm;
- Chronic sinus disease associated with systemic illness (cystic fibrosis, immotile cilia syndrome, granulomatosis with polyangiitis (Wegener's granulomatosis), Churg-Strauss vasculitis etc.).