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Clinical Consensus Statement: Pediatric Chronic Rhinosinusitis

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Abstract

Objective. To develop a clinical consensus statement on the optimal diagnosis and management of pediatric chronic rhinosinusitis (PCRS).

Methods. A representative 9-member panel of otolaryngologists with no relevant conflicts of interest was assembled to consider opportunities to optimize the diagnosis and management of PCRS. A working definition of PCRS and the scope of pertinent otolaryngologic practice were first established. Patients of ages 6 months to 18 years without craniofacial syndromes or immunodeficiency were defined as the targeted population of interest. A modified Delphi method was then used to distill expert opinion into clinical statements that met a standardized definition of consensus.

Results. After 2 iterative Delphi method surveys, 22 statements met the standardized definition of consensus while 12 statements did not. Four statements were omitted due to redundancy. The clinical statements were grouped into 4 categories for presentation and discussion: (1) definition and diagnosis of PCRS, (2) medical treatment of PCRS, (3) adenoiditis/adenoidectomy, and (4) endoscopic sinus surgery (ESS)/turbinoplasty.

Conclusion. Expert panel consensus may provide helpful information for the otolaryngologist in the diagnosis and management of PCRS in uncomplicated pediatric patients.

Keywords

pediatric otolaryngology, rhinosinusitis, chronic rhinosinusitis, evidence-based medicine, review, Delphi method

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Introduction

Pediatric chronic rhinosinusitis (PCRS) is a commonly encountered condition in otolaryngological practice. Five percent to 13% of childhood viral upper respiratory tract infections may progress to acute rhinosinusitis,[1-4] with a proportion of these progressing to a chronic condition. PCRS may also coexist and/or be exacerbated by other widespread conditions such as allergic rhinitis and adenoid disease,[5-9] and some suggest the incidence of PCRS may be rising.[10] In addition, PCRS has a meaningful impact on quality of life,[11] with its related adverse effects potentially exceeding that of chronic respiratory and arthritic disease.[12] PRCS also has the potential to exacerbate asthma,[13,14] a condition that negatively affects 2% to 20% of children.[15-17]

In spite of its prevalence and impact on affected families, many aspects of PCRS remain ill-defined. At the most basic level, even the diagnostic definition of PCRS has not been concretely elucidated among our specialty societies, creating challenges in discussing clinical presentations or establishing human study protocols. Similarly, while performing nasal endoscopy and obtaining site-specific cultures may be routine in the cooperative adult population, their role in the evaluation of children has not been clearly established. Likewise, the concept of maximal medical therapy has yet to be specifically delineated, although there is a broad spectrum

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of options, ranging from topical irrigations to longstanding intravenous antibiotic therapy. Both adenoidectomy and endoscopic sinus surgery (ESS) have been reported to produce associated improvements,[18,19] thus raising practical questions regarding whether these procedures are best done in tandem or concomitantly and whether that choice should depend on age, comorbidities, or additional patient factors. In addition, other related aspects of PCRS remain controversial, such as the potential impact of gastroesophageal reflux (GER), the effect of ESS on facial growth, the role of postoperative debridement, and emerging techniques such as balloon sinuplasty in children.

Nonetheless, PCRS occurs with sufficient frequency that otolaryngologists regularly encounter it in their practice, creating opportunities for optimizing practice patterns. While experience regarding the epidemiology, diagnosis, and management of PCRS is burgeoning, the associated evidence regarding optimal medical and surgical management has clear limits. Thus, the American Academy of Otolaryngology—Head and Neck Surgery Foundation (AAO-HNSF) Guidelines Task Force selected this topic for clinical consensus statement (CCS) development. The expert panel convened with the objectives of addressing opportunities to promote appropriate care, reduce inappropriate variations in care, and educate and empower clinicians and patients toward the optimal management of PCRS. This document describes the result of this process and focuses on diagnosis, medical therapy, and surgical interventions.

Methods

This clinical consensus statement was developed in discrete, predetermined steps: (1) evaluation of the suitability of PCRS as the subject of a clinical consensus statement; (2) panel recruitment; (3) vetting potential conflict of interests among proposed panel members; (4) systematic literature review; (5) determination of working definition of PCRS, intended scope of practice, and population of interest for the consensus statement; (6) modified Delphi survey development and completion; (7) iterative revision of clinical statements based on survey results; and (8) data aggregation, analysis, and presentation. The pertinent details of each of these steps will be briefly described.

Determination of PCRS as the Topic of a Consensus Statement, Panel Recruitment, and Vetting

PCRS was first considered as the subject of a clinical consensus statement based on suggestion from an American Academy of Otolaryngology—Head and Neck Surgery member. After deliberation, the Guidelines Task Force supported the suggestion, and consensus panel leadership was selected and administrative support allocated. Panel membership was strategically developed to ensure appropriate representation of all relevant subgroups within the specialty of otolaryngology. The various subgroups were contacted about the consensus statement project with the requirements and desired qualifications for panel membership,s and each subgroup then selected their own representative expert to participate. Participating subgroups include the American Society of Pediatric Otolaryngology (JJS), the American Academy of Otolaryngic Allergy (MV), the American Rhinologic Society (HHR), the Triologic Society (SC), and the appropriate committees within the American Academy of Otolaryngology—Head and Neck Surgery including the Board of Governors (SP), the Outcomes Research and Evidence Based Medicine Subcommittee (SEB), the Rhinology and Paranasal Sinus Committee (JL), the Pediatric Otolaryngology Committee (MP), and the Young Physicians Section (JP). Each member of the panel is either a fellowship-trained pediatric otolaryngologist or rhinologist in active clinical practice. Once the panel was assembled, complete disclosure of potential conflicts of interest were reported and vetted within the group. A panel vote was used to determine whether a disclosed conflict of interest necessitated disqualification from panel participation. The panel chair (SEB) and panel co-chair (JJS) led the development of the clinical statements and the Delphi process with input from a senior consultant/methodologist from the Academy leadership in the Guidelines Task Force (RMR) and administrative support from an Academy staff liaison (MC).

Literature Review and Determination of the Scope of the Consensus Statement

A systematic biomedical literature review was performed to identify current high-level evidence regarding the diagnosis and medical and surgical management of PCRS. The purpose of this literature search was to guide the CCS panel in developing clinical statements for standardized consensus evaluation that could help fill evidence gaps and assist otolaryngologists in the diagnosis and management of PCRS. The literature search was conducted in January 2014 with the assistance of a professional database search consultant. The systematic search included systematic reviews (including meta-analyses), clinical practice guidelines, and other relevant clinical consensus statements in English from Medline; National Guidelines Clearinghouse; CMA Infobase; National Library of Guidelines; National Institute for Health and Clinical Excellence (NICE); Scottish Intercollegiate Guidelines Network (SIGN); New Zealand Guidelines Group; Australian National Health and Medical Research Council; Trip Database; Guidelines International Network (G-I-N); Cochrane Database of Systematic Reviews; Excerpta Medica database (EMBASE); Cumulative Index to Nursing and Allied Health (CINAHL); Allied and Complementary Medicine Database (AMED); BIOSIS Citation Index; Web of Science; Agency for Healthcare Research and Quality (AHRQ) Research Summaries, Reviews, and Reports; and Health Services/Technology Assessment Texts (HSTAT) from 2003 using the search string: ''(chronic disease OR chronic) AND (sinusitis OR rhinosinusitis) AND (child OR adolescent OR teen).'' The gaps in literature were used as a framework for the qualitative survey.

The panel evaluated the recent AAO-HNSF CCS regarding the Appropriate Use of Computed Tomography for Paranasal Sinus Disease[20] and made an early decision to

accept the statements within this document regarding use of CT for the diagnosis of PCRS in children rather than readdress this topic within the current consensus statement.

The panel made several decisions regarding the scope of this clinical consensus statement before formally beginning the Delphi process. It was decided that the target audience of the statement would be specifically otolaryngologists. A working definition of PCRS was determined and consensus on this definition was confirmed using the Delphi process (see statement 1). The target population was defined as children ages 6 months to 18 years old with PCRS, although it was acknowledged that children of different ages have different factors in regards to the diagnosis and management of PCRS (statement 3). Children with craniofacial syndromes (eg, Trisomy 21) or relative immunodeficiency (eg, cystic fibrosis) were excluded as it was felt the treatment of this subgroup is very different from the typical PCRS patient. Once the target population and scope of practice were determined, the panel used the results of the literature review to prioritize the clinical areas that could most benefit from potential consensus from an expert panel. These areas were then used as the basis for the formulation of the initial statements that were then evaluated through the Delphi survey method.

Delphi Survey Method Process and Administration

A modified Delphi survey method was utilized to distill expert opinion into concise clinical consensus statements. The Delphi method involves using multiple anonymous surveys to assess for objective consensus within an expert panel.[21] This rigorous and standardized approach minimizes bias and facilitates expert consensus.

Web-based software (www.surveymonkey.com) was used to administer confidential surveys to panel members. The survey period was broken down into 3 iterations: 1 qualitative survey with free text boxes for responses and 2 subsequent Delphi rounds. All answers were de-identified and remained confidential; however, names were collected to ensure proper follow-up if needed. The qualitative survey included 54 questions on the definition and clinical areas of chronic pediatric sinusitis. The purpose of the qualitative survey was to narrow the scope and provide a framework for the subsequent Delphi rounds.

Based on the outcomes of the qualitative survey and resulting discussion, the panel chair developed the first Delphi survey, which consisted of 37 statements. Prior to dissemination to the panel, the Delphi surveys were reviewed by the consultant for content and clarity. Questions in the survey were answered using a 9-point Likert scale where 1 = strongly disagree, 3 = disagree, 5 = neutral, 7 = agree, and 9 = strongly agree. The surveys were distributed, and responses were aggregated, distributed back to the panel, discussed via teleconference, and revised if warranted. The purpose of the teleconference was to provide an opportunity to clarify any ambiguity, propose revisions, or drop any statements recommended by the panel.

The criterion for consensus was established a priori with reference to previous consensus statements[20,22] and followed the following criteria (outliers are defined as any rating at least 2 Likert points away from the mean):

- **consensus**: statements achieving a mean score of 7.00 or higher and have no more than 1 outlier,
- **near consensus**: statements achieving a mean score of 6.50 or higher and have no more than 2 outliers,
- **no consensus**: statements that did not meet the criteria of consensus or near consensus.

Additionally for the purposes of emphasis within the discussion, strong consensus was subsequently defined as a mean Likert score of 8.00 or higher with no outliers.

Two iterations of the Delphi survey were performed. The panel extensively discussed (via teleconference) the results of each item after the first Delphi survey. Items that reached consensus were accepted, and items that did not meet consensus were discussed to determine if wording or specific language was pivotal in the item not reaching consensus. Four items were found to be essentially redundant to other items and were omitted at this point. The second iteration of the survey was used to reassess items for which there was near consensus or for items for which there was suggestion of significant alterations in wording that could have affected survey results. The entire panel also extensively discussed the results of the second Delphi survey. All items reaching consensus were accepted. A third iteration of the Delphi process was considered but was not felt to be necessary. The factors leading to the remaining items not reaching consensus were not attributed to wording or other modifiable factors but rather a true lack of consensus.

The final version of the clinical consensus statements were grouped into 4 specific areas: (1) definition and diagnosis of PCRS, (2) medical treatment of PCRS, (3) adenoiditis/adenoidectomy, and (4) ESS/turbinoplasty. The final manuscript was drafted with participation and final review from each panel member.

Results

Thirty-eight clinical statements were developed for assessment with the Delphi survey method. All panelists completed all survey items. After 2 iterations of the Delphi survey, 22 statements (58%) met the standardized definition for consensus. Twelve clinical statements (31%) did not meet the criteria for consensus. Four clinical statements (11%) were omitted due to redundancy. The clinical statements were organized into 4 specific subject areas, and the results of each will be individually considered in the following.

Definition and Diagnosis of Pediatric Chronic Rhinosinusitis

In the area of definition and diagnosis of PCRS, 7 statements reached objective clinical consensus (see **Table 1**). The panel reached consensus on a working definition of PCRS that included both subjective symptoms and objective features. PCRS is defined as at least 90 continuous days of

Table 1. Definition and Diagnosis of Pediatric Chronic Rhinosinusitis Statements Reaching Consensus.

Number	Statement	Mean	Outliers	Quality Improvement Opportunity
1	Chronic rhinosinusitis (PCRS) is defined as at least 90 continuous days of 2 or more symptoms of purulent rhinorrhea, nasal obstruction, facial pressure/pain, or cough *and* either endoscopic signs of mucosal edema, purulent drainage, or nasal polyposis and/or CT scan changes showing mucosal changes within the ostiomeatal complex and/or sinuses in a pediatric patient aged 18 years or younger (Adapted from European Position Paper on Rhinosinusitis and Nasal Polyps 2012[23]).	7.56	0	Promoting appropriate care
2	Management of children aged 12 years and younger with CRS is distinctly different than management of children aged 13 to 18 years old with CRS.	7	0	Promoting appropriate care
3	Nasal endoscopy (flexible or rigid) is appropriate in evaluating a child with CRS to document purulent drainage, mucosal edema, nasal polyps, and/or adenoid pathology (hyperplasia, infection).	7.67	1	Promoting appropriate care
4	Management of the children with nasal polyps and CRS is distinctly different than management of children with CRS unaccompanied by nasal polyps.	8.22	0	Reducing inappropriate or harmful care
5	Allergic rhinitis is an important contributing factor to PCRS, especially in older children.	7.56	0	Promoting appropriate care
6	Adenoiditis is an important contributing factor to PCRS, especially in younger children.	7.67	1	Promoting appropriate care
7	The ability of adenoids to serve as a bacterial reservoir for PCRS is independent of adenoid size.	7.67	1	Reducing inappropriate or harmful care

symptoms of purulent rhinorrhea, nasal obstruction, facial pressure/pain, or cough with corresponding endoscopic and/or CT findings in a patient who is 18 years of age or younger (statement 1). Strong consensus (mean Likert score above 8.00) was achieved for the statement that pediatric patients with nasal polyps should be managed differently than those without polyps (statement 4). The panel reached consensus that age was an important distinguishing factor in the diagnosis of PCRS, with adenoid disease (independent of adenoid size) being a prominent factor in younger children and allergic rhinitis being a more important contributing factor in older children (statements 2, 5-7). Lastly, consensus was also reached that nasal endoscopic (flexible or rigid) is appropriate and useful in the diagnosis of PCRS (statement 3). There was no consensus regarding the contribution of gastroesophageal reflux disease (GERD) to PCRS (**Table 2**, statement 8).

Medical Treatment of PCRS

For medical management of PCRS, 5 statements reached consensus by the panel and 4 statements failed to reach consensus (see **Table 3**). Consensus was reached that daily, topical nasal steroid spray as well as daily, topical nasal irrigations are beneficial adjunctive medical therapies for PCRS (statements 11 and 12). Regarding antibiotic therapy, the panel failed to reach consensus on the statement that appropriate antibiotic therapy for PCRS includes a minimum of 10 consecutive days of an antimicrobial medication that is effective against typical rhinosinusitis pathogens (statement 14). However, the panel did reach consensus that 20 consecutive days of antibiotic therapy may produce a superior clinical response in PCRS patients compared to 10 days of antibiotic therapy (**Table 2**, statement 9). The panel also reached consensus that culture-directed antibiotic therapy may improve outcomes for PCRS patients who have not responded to empiric antibiotic therapy (statement 10).

The panel did not agree that medical therapy for PCRS should include treatment for GERD when signs or symptoms of GERD are present (**Table 2**, statement 15), instead agreeing that empiric treatment for GERD is not a beneficial adjunctive medical therapy for PCRS (statement 13). Additionally, the panel did not reach consensus that the current evidence supports a role for topical antibiotic therapy or antral irrigation in managing children with PCRS (**Table 2**, statements 16, 17).

Adenoiditis/Adenoidectomy

For adenoiditis/adenoidectomy, 4 statements reached consensus by the panel and 1 did not (see **Table 4**). Strong consensus was reached regarding the effectiveness of adenoidectomy as the initial surgical therapy for patients aged up to 6 years, and measurably less consensus was obtained for patients age 6 to 12 years (statements 18, 19). However, the panel could not reach consensus on whether adenoidectomy was an effective first-line procedure for patients aged 13 years and older with CRS (**Table 2**, statement 22). The panel agreed that adenoidectomy can have a beneficial effect in pediatric patients with PCRS that is independent of ESS (statement 20). There was strong consensus, in fact the highest Likert score of any statement in

Table 2. Clinical Statements that Did Not Meet the Criteria for Consensus.

Number	Statement	Subgroup	Status	Mean	Outliers
8	Gastroesophageal reflux disease (GERD) can contribute to pediatric chronic rhinosinusitis (PCRS).	Definition and Diagnosis of PCRS	No consensus	6.11	1
14	Appropriate antibiotic therapy for PCRS includes a minimum of 10 consecutive days of an antimicrobial medication that is effective against typical rhinosinusitis pathogens.	Medical Management of PCRS	No consensus	6.22	3
15	Medical therapy for PCRS should include treatment for GERD when signs or symptoms of GERD are present.	Medical Management of PCRS	No consensus	6.22	2
16	Current evidence supports a role for topical antibiotic therapy in managing selected children with CRS.	Medical Management of PCRS	No consensus	4.67	2
17	Current evidence supports a role for antral irrigation in managing selected children with CRS.	Medical Management of PCRS	No consensus	4.56	2
22	Adenoidectomy is an effective first-line surgical procedure for children aged 13 years and older with CRS.	Adenoidectomy/ Adenoiditis	No consensus	3.89	3
29	Balloon sinuplasty is safe for treating children with PCRS.	Endoscopic Sinus Surgery/ Turbinoplasty	Near consensus	6.56	2
30	Balloon sinuplasty is effective for treating patients with PCRS.	Endoscopic Sinus Surgery/ Turbinoplasty	No consensus	5.33	0
31	Inferior turbinate reduction can benefit children with CRS by reducing nasal congestion and improving penetration of topical medications.	Endoscopic Sinus Surgery/ Turbinoplasty	No consensus	6.22	1
32	Inferior turbinate reduction is a safe and minimally invasive adjunctive procedure for treating PCRS.	Endoscopic Sinus Surgery/ Turbinoplasty	No consensus	6.11	1
33	Children with swollen, enlarged inferior turbinates on preoperative assessment that have not responded to medical therapy are most likely to benefit from bilateral inferior turbinate reduction.	Endoscopic Sinus Surgery/ Turbinoplasty	No consensus	6.33	1
34	Reduction or removal of an obstructive middle turbinate concha bullosa when present is a valuable component of the surgical management of PCRS.	Endoscopic Sinus Surgery/ Turbinoplasty	Near consensus	6.78	0

Table 3. Medical Management of Pediatric Chronic Rhinosinusitis (PCRS) Statements Reaching Consensus.

Number	Statement	Mean	Outliers	Quality Improvement Opportunity
9	Twenty consecutive days of antibiotic therapy may produce a superior clinical response in PCRS patients compared to 10 days of antibiotic therapy.	7.44	0	Promoting appropriate care
10	Culture-directed antibiotic therapy may improve outcomes for PCRS patients who have not responded to empiric antibiotic therapy.	8	0	Promoting appropriate care
11	Daily, topical nasal steroids are a beneficial adjunctive medical therapy for PCRS.	7.44	0	Promoting appropriate care
12	Daily, topical nasal saline irrigations are a beneficial adjunctive medical therapy for PCRS.	7.78	0	Promoting appropriate care
13	Empiric treatment for gastroesophageal reflux disease (GERD) is not a beneficial adjunctive medical therapy for PCRS.	7	0	Reducing inappropriate or harmful care

Table 4. Adenoidectomy/Adenoiditis Statements Reaching Consensus.

Number	Statement	Mean	Outliers	Quality Improvement Opportunity
18	Adenoidectomy is an effective first line surgical procedure for children up to 6 years of age with chronic rhinosinusitis (CRS).	8.33	0	Promoting appropriate care
19	Adenoidectomy is an effective first-line surgical procedure for children aged 6 to 12 years with CRS.	7.11	1	Promoting appropriate care
20	Adenoidectomy can have a beneficial effect in patients with pediatric CRS that is independent of endoscopic sinus surgery (ESS).	7.33	1	Educating and empowering clinicians and patients
21	Tonsillectomy (without adenoidectomy) is ineffective treatment for PCRS.	8.56	0	Reducing inappropriate or harmful care

Table 5. Endoscopic Sinus Surgery/Turbinoplasty Statements Reaching Consensus.

	Statement	Mean	Outliers	Quality Improvement Opportunity
23	Endoscopic sinus surgery (ESS) is an effective procedure for treating pediatric chronic rhinosinusitis (PCRS) that is best performed after medical therapy, adenoidectomy, or both have failed.	7.89	0	Promoting appropriate care
24	A CT scan of the paranasal sinuses is indicated prior to ESS to assess structure, development, and extent of disease.	8.56	0	Promoting appropriate care
25	Image-guided ESS is useful for revision ESS cases and/or for patients with extensive nasal polyposis that can distort anatomical landmarks.	8.22	1	Promoting appropriate care
26	There is a lack of convincing evidence that ESS causes a clinically significant impairment of facial growth when performed in children with CRS.	7	0	Educating and empowering clinicians and patients
27	Postoperative debridement after ESS for PCRS is not essential for treatment success.	7	1	Reducing inappropriate or harmful care
28	The effectiveness of balloon sinuplasty compared to traditional ESS for PCRS cannot be determined based on current evidence	7.89	0	Reducing inappropriate or harmful care

the entire clinical consensus statement, that tonsillectomy (without adenoidectomy) is an ineffective treatment for PCRS (statement 21).

Endoscopic Sinus Surgery/Turbinoplasty

For the specific area of ESS/turbinoplasty, 6 statements reached consensus and 6 did not (see **Table 5**). Consensus was reached that ESS is an effective procedure for treating PCRS and that it is best performed when medical management, adenoidectomy, or both have failed to control the symptoms of PCRS (statement 23). Strong consensus was reached that a CT scan of the paranasal sinuses is indicated prior to ESS to assess the anatomy of the sinuses and development, extent, and severity of sinus disease and also that image-guided surgery is useful in revision cases and in patients with extensive nasal polyposis that can distort anatomical landmarks (statements 24, 25). There was consensus by the panel about the lack of convincing evidence that ESS causes a clinically significant impairment of facial growth when performed in children with CRS (statement 26). There was also consensus that postoperative debridement after ESS for PCRS is not an essential component for treatment success (statement 27).

The panel considered balloon sinuplasty for PCRS at length as it is a topic that receives a great deal of attention. The panel decided to assess an initial statement regarding the comparative effectiveness of balloon sinuplasty versus ESS in pediatric patients. Consensus was reached that there was insufficient current evidence to compare balloon sinuplasty to ESS for PCRS (statement 28). Not unexpectedly, the panel subsequently could not reach consensus regarding the effectiveness of balloon sinuplasty in treating PCRS although there was near consensus (mean Likert score = 6.56) regarding the safety of balloon sinuplasty (**Table 2**, statements 29, 30).

Turbinoplasty was extensively deliberated by the panel as consensus was actively sought for the appropriate role for this commonly performed, simple, noninvasive procedure. Unfortunately, the panel could not reach any consensus regarding the indications, potential benefits, or optimal candidates for inferior turbinoplasty (**Table 2**, statements 31-33). The primary reason noted in the panel discussion for this result was lack of pediatric-specific data. Near consensus (mean Likert score 6.78) was reached regarding the potential benefits of reducing an obstructive concha bullosa in PCRS patients (**Table 2**, statement 34).

Discussion

The purpose of this clinical consensus statement is to formulate evidence-enriched expert opinion into distinct clinical statements to promote high-quality care, reduce variations in care, and educate and empower clinicians and patients toward the goal of optimal management of PCRS. Specific discussion of the key elements in each of the 4 distinct clinical areas follows.

Definition and Diagnosis of PCRS

The definition of CRS that reached expert panel consensus for the pediatric population is similar to what has been accepted in adults.[23] Like the definition of CRS in adults, the panel agreed that an ideal definition of PCRS should include both subjective symptoms and objective signs. Specifically, the consensus definition specifies 2 or more symptoms of nasal congestion, nasal discharge, facial pressure/pain, or cough accompanied either by clinical signs on endoscopy such as nasal polyps, mucosal edema, or mucopurulent discharge or relevant findings on sinus CT scan over a 90-day continuous time span (statement 1). The chronicity requirement of 90 days is somewhat arbitrary but was felt to clearly represent a benchmark that distinguished PCRS from acute and subacute presentations of rhinosinusitis and is aligned with parallel adult definitions.[23-25]

The panel considered various pediatric age ranges to use as the target of this consensus statement. Clearly the typical medical-legal division between the pediatric and adult realms of 18 years old is not necessarily a physiologic threshold. Yet, since adult-based literature targets age 18 years and greater, the panel felt this was likely the appropriate limit to use for practical reasons. It is well known that sinus anatomic development continues throughout childhood and into adulthood.[26] Likewise, it would be expected that the pathophysiology of PCRS also evolves throughout childhood into adulthood. The age at which the frontal sinuses (the last to fully develop) reach an adult size is approximately age 19.[27] Similarly, the management CRS in children 13 to 18 may more closely approximate that of adults compared to children 12 years or younger, as the anatomic space and physiologic mechanisms incrementally approach that of adults. The panel's actions highlighted this concept of an age continuum by reaching consensus on a statement indicating patients 12 and under are typically managed differently than patients 13 to 18 years old (statement 2).

Although it may not always be feasible in the uncooperative pediatric patient, the use of nasal endoscopy to evaluate CRS is ideal and should be attempted. The panel reached consensus that either flexible or rigid nasal endoscopy is advantageous as it allows for direct assessment for the presence of purulence, mucosal edema, nasal polyps, and adenoid hypertrophy/adenoiditis (statement 3). Alternatively, lateral plain film x-ray or CT is less invasive but can only indirectly assess for some of these same vital factors, albeit with the requisite radiation exposure to the skull and brain, which carries a postulated risk of malignancy. Radiologic imaging studies (eg, lateral plain films) are not recommended to assess the adenoid in children with CRS because they provide limited information on adenoid size alone, which does not necessarily correlate with ability to serve as a bacterial reservoir for infection (statement 7). Moreover, imaging studies involve radiation of the skull and brain, which carries a postulated risk of malignancy. Although the relative risk ratios of cancer from childhood radiation exposure can be eye-catching, the absolute risk of malignancy from radiation exposure is extremely small. Specifically, the estimated absolute risk difference is approximately 1 resultant case of leukemia or brain tumor per 10,000 head CT scans obtained in childhood although this carries an imposing relative risk ratio of approximately 3.18 (95% CI, 1.46-6.94) for leukemia and 2.82 (95% CI, 1.33-6.03) for brain tumors.[28]

The panel reached strong consensus (mean Likert score = 8.22) that children who present with polyps as a component of PCRS represent a distinct patient subgroup (statement 4). Similar to adults, the presence of polyps in children constitutes a different subtype of CRS with differing pathophysiology and distinct optimal management.[23-25,29] Specifically, children presenting with nasal polyps carry a substantially increased risk of underlying cystic fibrosis and should be specifically assessed for this and other serious comorbid disorders such as allergic fungal sinusitis or antrochoanal polyps.[30]

Although some studies have shown possible association of allergic rhinitis (AR) to the development of PCRS, other studies suggest that allergy is not a significant factor in pediatric sinus disease. A study by Sedaghat et al[31] reported on a large series of 4044 pediatric patients with PCRS and found that AR was the most common comorbidity with 26.9% of patients carrying a diagnosis of AR. The authors concluded, ''formal allergy testing, guided by clinical history and regional allergen sensitivity prevalence, should be strongly considered in all children with CRS.''[31]

Interestingly, a later study from the same author group reported on a cohort of patients with allergic rhinitis with or without development of subsequent PCRS. They found that patients who developed subsequent PCRS did not have more severe subjective AR or more severe objective quantitative atopy measurements.[32] The only factor associated with development of PCRS was exposure to tobacco smoke (OR = 3.96, 95% CI, 1.50-10.48), and the authors concluded ''the degree of atopy, as reflected by the number of aeroallergen sensitivities or the presence of atopic comorbidities, is not associated with progression to CRS in the pediatric age group.''[32] Although this study does not directly contradict a possible causal relationship between AR and PCRS, it does suggest there is a not a measurable dose-dependent relationship between them. Clearly the association between AR and PCRS is complex and multifarious, and further study into this important question is required. The panel weighed this issue and the available evidence along with their own experience, and ultimately the majority felt that there was indeed a clinically relevant association between

AR and PCRS. This led to consensus being achieved for a statement supporting the association of AR as a contributing factor for PCRS, particularly in older children (statement 5).

Medical Treatment of PCRS

Published recommendations advocate the use of antibiotic therapy in PCRS as an essential element in the treatment of this disease.[23] Although no specific high-level evidence supports the effectiveness of broad-spectrum antibiotics in chronic rhinosinusitis in children, their use is understandably widespread. The optimal duration of antimicrobial therapy or duration that would constitute ''maximal medical therapy'' remains unclear. The panel struggled with the question of antibiotic duration in PCRS to be highly nuanced, as demonstrated by statement 9 achieving consensus while statement 14 did not (see **Table 3**). While guidelines from professional organizations have recommended 10 to 14 days of therapy for acute uncomplicated rhinosinusitis in children,[33,34] longer courses have generally been recommended for chronic rhinosinusitis with the inference that PCRS is a more advanced infection requiring more extended therapy.[23] As an extension of this concept, topical antibiotic therapy has been purported as a direct therapy that might be utilized over extended periods for the treatment of chronic rhinosinusitis.[35] However, based on the current limited body of related evidence, the panel did not reach consensus regarding a role for topical antimicrobials.

CRS is increasingly understood as a multifactorial process in which bacteria may play only 1 role of many.[36] Accordingly, therapies beyond antimicrobials have been utilized in PCRS, and there was more agreement among the panel regarding other topical adjuvant medical therapies. Intranasal topical corticosteroids suppress mucosal inflammation and have been widely prescribed. These anti-inflammatory agents have demonstrated efficacy in the adult population for chronic rhinosinusitis and are included in the consensus statement addressing adult sinusitis.[37] Evidence is more limited in the pediatric literature but supports topical steroid use in PCRS either alone or in combination with antibiotic therapy.[38] Nasal saline irrigations are thought to help primarily in the clearance of secretions, pathogens, and debris. Wei and colleagues demonstrated significant improvement in both quality of life and CT scan Lund-Mackay scores after 6 weeks of once-daily nasal saline irrigation[39] as well as long-term efficacy as a first-line treatment in PCRS and subsequent nasal symptoms.[40]

The panel directed special attention on the topic of gastroesophageal reflux disease and PCRS due to persistent controversy and uncertainty on this topic. An association between GERD and sinusitis has been repeatedly suggested in the pediatric population. However, no definitive causal relationship has been demonstrated in randomized, controlled studies in the PCRS patient.[41] The question has not been answered conclusively, but there is a lack of evidence to support a strong relationship between GERD and PCRS. This fact was reflected in the panel reaching consensus that empiric therapy for GERD in the context of PCRS is not indicated (statement 13). Similarly, consensus was not reached regarding a contribution of GERD in the pathogenesis of PCRS (**Table 2**, statement 8) and in the routine treatment of GERD as part of the comprehensive therapy of PCRS (**Table 2**, statement 15).

Adenoidectomy/Adenoiditis

Adenoidectomy is a simple, well-tolerated procedure that has always been an attractive surgical option to consider for the treatment of PCRS. Yet, the ideal role of adenoidectomy in the treatment of PCRS has been somewhat elusive. The panel desired to address this issue as part of the consensus statement. Although high-level, randomized sham surgery controlled studies are not available or even feasible, solid evidence supports the benefit of adenoidectomy in managing PCRS. From the microbiologic viewpoint, adenoidectomy (regardless of adenoid hypertrophy) has been shown to produce a dramatic decrease in nasopharyngeal pathogens that have been implicated in pediatric CRS.[8,42] From a clinical outcomes standpoint, a meta-analysis of 8 studies investigating the efficacy of adenoidectomy alone in pediatric CRS patients (mean age 5.8 years; range, 4.4-6.9 years) that failed medical management demonstrated that the majority of patients significantly improved sinusitis symptoms after adenoidectomy (subjective success rate = 69.3%, 95% CI, 56.8%-81.7%, $P < .001$).[43] The data from these studies helped the panel reach consensus that adenoidectomy is an effective first-line surgical procedure for younger children (statements 18, 19). The panel was unable to reach consensus on the utility of adenoidectomy in patients age 13 years and older due to the absence of supporting data for adolescent patients (**Table 2**, statement 23).

The panel reached agreement that adenoidectomy can have a beneficial effect on pediatric CRS independent of ESS (statement 24). This consensus was based in part on the highly published success rate of adenoidectomy in managing pediatric CRS[44] and the data from one prospective investigation that recommended adenoidectomy prior to ESS as part of a stepped treatment algorithm for the management of pediatric CRS.[45] It is recognized that adenoidectomy is frequently coupled with other minimally invasive procedures such as sinus irrigation. However, due to the practical limitations of the clinical consensus statement process, the panel chose to consider procedures on their own individual merit as opposed to in combination with other procedures. Panel consensus was achieved regarding the value of adenoidectomy by itself (statements 18, 19, 20) but not for antral irrigation by itself (statement 17).

Despite the general belief that infection in 1 part of the pharyngeal lymphoid tissue can spread to another part of Waldeyer's ring and that the bacteriology in the adenoid and palatine tonsils are similar,[46] the consensus panel strongly agreed that tonsillectomy is an ineffective treatment for pediatric CRS (statement 25). This was due to the lack

of any direct evidence supporting tonsillectomy for the management pediatric CRS.

Endoscopic Sinus Surgery and Turbinoplasty

ESS has been shown to be an effective mode of therapy in children with PCRS who have failed maximal medical management.[18,19] In a Cochrane/PubMed database review (1990-2012) conducted by Makary and Ramadan, success rates of 82% to 100% were reported for pediatric ESS with an overall complication rate of only 1.4%.[18] Similarly, in a meta-analysis of 15 interventional studies (levels II-IV, n = 1301), Vlastarakos et al[19] concluded that ESS improved sinus-related symptoms and quality of life in PCRS patients, giving the procedure a grade B strength of recommendation. PCRS patients undergoing ESS have also been found to harbor more severe disease than those treated with adenoidectomy or medical therapy.[18] Given such evidence, the panel reached consensus that ESS is an effective procedure for treating PCRS and is best performed when medical therapy, adenoidectomy, or both have proven unsuccessful (statement 23).

A comprehensive clinical consensus statement regarding the appropriate use of computed tomography in the context of PCRS has been published previously[20] and was not further addressed by the current panel. However, the panel did agree that CT scan of the paranasal sinuses is indicated prior to ESS to assess structure, development, and extent of disease (statement 24). Image guidance was also deemed particularly useful for revision ESS cases and in children with extensive nasal polyposis that could obscure typical anatomical landmarks (statement 25). Data regarding post-ESS debridement in pediatric patients differ from the related data in adults. Multiple level 1b studies have shown that sinus cavity debridement significantly improved symptoms and endoscopic outcomes in adult CRS patients following ESS.[47-50] Based on the available evidence, debridement has been recommended in the early postoperative care of adult ESS patients.[51] However, no corresponding studies have been published investigating the impact of postoperative debridement on PCRS patients. In fact, several studies have shown that postoperative debridement was not necessary in children.[52,53] Consequently, the panel agreed that debridement is not essential for the successful outcome of pediatric ESS (statement 27).

Based on findings primarily from animal studies, there has been concern that pediatric ESS may lead to adverse sequelae on pediatric facial skeletal development. Both Mair et al[54] and Carpenter et al[55] reported significant alterations in midface and sinus growth following ESS in a piglet model. In humans, Kosko et al[56] presented a series of 5 patients who developed maxillary sinus hypoplasia after ESS but no clinically apparent facial asymmetry or midface hypoplasia. Three longitudinal studies of human children with follow-up times ranging from 6.9 to 13.2 years reported no deleterious effects on facial growth after pediatric ESS using both volumetric and anthropomorphic measurements.[57-59] Therefore, after reviewing the evidence, the panel reached consensus that there is a lack of convincing evidence that ESS causes clinically significant impairment of facial growth when performed in children with CRS (statement 26).

Balloon catheter sinuplasty (BCS) has recently emerged as another therapeutic option in the surgical management of PCRS, having been more extensively studied in adult patients to this point. In a nonrandomized prospective review of 30 PCRS patients who failed medical therapy, 80% treated with BCS showed symptomatic improvement.[60] Likewise, in a follow-up study by the same author, a success rate of 81% was reported in children with CRS who underwent BCS after adenoidectomy failure.[61] However, no studies have directly compared the efficacy of BCS to ESS in the treatment of PCRS. Therefore, the panel reached consensus that the effectiveness of BCS versus traditional ESS for PCRS cannot be determined with the current evidence (statement 28). The further evaluation of BCS in children as a simple, potentially less traumatic procedure in the management of PCRS would be an appropriate research priority for the near future.

With respect to inferior turbinoplasty, no consensus could be reached regarding its role in the treatment of PCRS. The panel explored this issue extensively as turbinoplasty is a commonly performed procedure whose precise clinical role remains ill defined. Although some panelists agreed that inferior turbinate reduction is a safe, minimally invasive procedure that could potentially benefit children with PCRS, others disagreed due to the lack of supportive evidence in the literature. To date, no clinical studies specifically investigating the efficacy of inferior turbinoplasty in the context of PCRS have been reported. Moreover, there is also no data to determine that PCRS patients would derive the most benefit from inferior turbinate reduction or what the potential mechanisms of improvement might be. Thus, no consensus statements pertaining to inferior turbinoplasty in the management of PCRS could be made by the panel (**Table 2**, statements 31-33). Given the attractiveness of turbinoplasty as an adjunctive procedure to adenoidectomy and/or ESS, further investigation into potential role of inferior turbinoplasty in the management of PCRS should be a research priority.

Similar to inferior turbinoplasty, there were no studies found in children examining whether reduction of a concha bullosa has any positive impact on the treatment of PCRS. Again similar to inferior turbinoplasty, reduction of a concha bullosa is also an attractive, simple, minimally invasive procedure that could be plausibly expected to improve nasal airflow and mucociliary clearance and potentially increase the permeation of topical medications. However, there is a dearth of evidence on the topic, so the panel only reached a near consensus that reduction of concha bullosa, when present, is a valuable component of the surgical management of PCRS (**Table 2**, statement 34).

Conclusion

This clinical consensus statement was developed by and for otolaryngologists and is intended to promote appropriate, and when possible, evidence-based care for pediatric patients with chronic rhinosinusitis. A series of clinical statements were developed by an expert panel using an objective survey method. A complete definition of PCRS was first developed, and additional statements addressing the diagnosis of PCRS, the medical management of PCRS, the appropriate role of adenoidectomy in the management of PCRS, and the appropriate role of endoscopic sinus surgery in the management of PCRS were subsequently produced and evaluated. It is anticipated that the application of these principles will result in decreased variations in the care of PCRS patients and an increase in the quality of care.

Disclaimers

The views herein are the private views of the authors and do not reflect the official views of the Department of the Army or the Department of Defense.

Clinical consensus statements are based on the opinions of carefully chosen expert panels and provided for informational and educational purposes only. The purpose of the expert panel is to synthesize information, along with possible conflicting interpretations of the data, into clear and accurate answers to the question of interest. Clinical consensus statements may reflect uncertainties, gaps in knowledge, opinions, or minority view points, but through a consensus development process, many of the uncertainties are overcome, a consensual opinion is reached, and statements are formed. Clinical consensus statements are not clinical practice guidelines and do not follow the same procedures as clinical practice guidelines. Clinical consensus statements do not purport to be a legal standard of care. The responsible physician, in light of all the circumstances presented by the individual patient, must determine the appropriate treatment, diagnosis, and management. Consideration of clinical consensus statements will not ensure successful patient outcomes in every situation. The AAO-HNSF emphasizes that these clinical consensus statements should not be deemed to include all proper diagnosis/management/treatment decisions or methods of care or to exclude other treatment decisions or methods of care reasonably directed to obtaining the same results.

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