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LITERATURE REVIEW

Management of acute sinusitis in children: an umbrella review

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ABSTRACT

BACKGROUND. Acute sinusitis in children is a common disease, often secondary to upper respiratory viral infections, which can progress to bacterial infection. Although it is usually self-limiting, it can cause serious complications. The recommendations of clinical guidelines and systematic reviews are variable, which generates uncertainty regarding optimal management.

OBJECTIVE. To synthesise the current evidence on the treatment of paediatric acute sinusitis through an umbrella review, identifying effective interventions, recommended guidelines, and knowledge gaps.

MATERIAL AND METHODS. An umbrella review of systematic reviews, meta-analyses, and clinical guidelines published between 2000 and 2025 was conducted by searching five databases. PRISMA-Overviews criteria were applied, and methodological quality was assessed using AMSTAR-2. Descriptive synthesis, forest plot, funnel plot (Egger's test) and an Evidence Gap Map (EGM) were used.

RESULTS. Thirteen studies on paediatric acute sinusitis were included. High-quality evidence supported antibiotic use in moderate to severe cases, while mild cases often resolved without treatment. Adjuvant therapies like intranasal corticosteroids and saline irrigation showed modest symptom relief. Surgical interventions were necessary in orbital or intracranial complications, guided by clinical predictors. Guidelines emphasized strict diagnostic criteria, high-dose amoxicillin–clavulanate, and selective imaging. Watchful waiting was considered safe in mild, non-complicated cases with close follow-up. Overall, the evidence supports tailored management based on severity and clinical presentation.

CONCLUSION. Not all children with acute sinusitis require antibiotics. Treatment should be individualized and the rational use of antimicrobials encouraged. Relevant evidence gaps persist that require further high-quality paediatric research.

KEYWORDS: sinusitis, child, disease management, therapeutics.

INTRODUCTION

Acute childhood sinusitis is a common disease in paediatric practice, characterized by inflammation and infection of the paranasal sinuses following a viral infection of the upper respiratory tract that progresses to bacterial infection. It accounts for approximately 8–10% of upper respiratory infections in children, with a higher incidence between 4 and 7 years of age. Although most episodes are self-limiting, severe complications such as orbital cellulitis, subperiosteal abscesses, and even intracranial infections can arise in certain cases. These complications, although infrequent, require timely diagnosis and management based on the best available evidence to prevent long-term sequelae[1,2].

Clinically, acute sinusitis in children is typically classified into three forms: acute bacterial sinusitis (a single episode of symptoms that persists for more than 10 days or worsens after initial improvement, often with purulent rhinorrhea, high fever >39°C, and persistent daytime cough); recurrent sinusitis (≥4 episodes per year, with complete asymptomatic intervals between them); and complicated sinusitis (infection that spreads beyond the sinuses into orbital or intracranial structures, as in the case of orbital abscesses or Pott tumor). Each presentation requires particular diagnostic and therapeutic considerations. Accurate diagnosis of paediatric acute sinusitis can be challenging because the symptoms overlap with common viral infections (viral rhinosinusitis) and other conditions such as allergies. The presence of persistent symptoms lasting longer than 10 days without improvement, or an exacerbation of symptoms after 5–7 days of a cold, indicates acute bacterial sinusitis. Imaging (plain x-ray, computed tomography) is not routinely recommended in uncomplicated cases, since radiological findings (sinus opacification) lack specificity and radiation exposure is not justified in most children. Advanced imaging is considered only in cases of suspected complications or diagnostic uncertainty. The traditional man-

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agement of acute bacterial sinusitis in children has been early empirical antibiotic treatment, usually with amoxicillin or amoxicillin–clavulanic acid, to accelerate the resolution of symptoms and prevent complications. This recommendation was based on concerns about the potential sequelae of untreated bacterial infections. However, in recent years an important debate has arisen regarding the overuse of antibiotics in paediatric respiratory infections. Studies have documented that up to 85% of children diagnosed with sinusitis receive antibiotics, many of which may be unnecessary, as they may have viral sinusitis or mild symptoms likely to resolve spontaneously[1,3-6].

The indiscriminate use of antibiotics carries significant risks, including increasing antimicrobial resistance, adverse drug reactions (e.g., diarrhea, rashes), and higher health care costs. In response, some guidelines and experts propose, in certain cases, a more conservative management known as "watchful waiting" or initial symptomatic treatment, reserving antibiotics only if there is clinical failure or worsening within 48–72 hours[7,8].

The effectiveness of this expectant strategy versus immediate antibiotic treatment has been examined by recent systematic reviews, with disparate findings stoking controversy[8]. At the same time, non-antibiotic adjuvant therapies have gained relevance. Intranasal corticosteroids (e.g., mometasone spray) may reduce local inflammation of the sinus mucosa and improve nasal congestion. Some trials in children suggest symptomatic benefit, although specific evidence for paediatric acute sinusitis is limited and extrapolated from studies in allergic rhinitis and chronic sinusitis. Recent studies have addressed precisely the relative efficacy of these more conservative approaches, highlighting the urgent need for robust evidence to guide clinical decisions and reduce antibiotic overuse[8,9]. Saline nasal irrigation is another safe and widely used adjuvant intervention, with meta-analyses indicating modest improvement in nasal symptoms of upper respiratory infections in children[10]. These adjuvant measures offer the advantage of a low-risk profile, although their impact on the natural history of acute sinusitis is still being investigated.

In terms of surgical interventions, functional endoscopic sinus surgery (FESS) is traditionally reserved for refractory chronic sinusitis or severe complications (such as orbital or intracranial extension). In the paediatric population, several series and reviews have reported high clinical success rates with FESS in selected cases – for example, symptom improvement in 89% of children with rhinogenic mucosal contact headache after surgery. However, the evidence consists mostly of observational studies and retrospective reviews. The absence of robust randomized clinical trials limits the ability to accurately identify which paediatric patients benefit most from surgery and when the optimal time to implement it is.

Given the clinical uncertainty in various aspects of the management of paediatric acute sinusitis, multiple organizations have developed clinical practice guidelines to standardize its diagnosis and treatment. Notable among these are the American Academy of Pediatrics (AAP) guideline and the Infectious Diseases Society of America (IDSA) guidelines, which provide diagnostic criteria (e.g., persistence of symptoms >10 days, or severe symptoms from onset) and recommend appropriate antibiotics[1,4,11]. However, differences persist between guidelines in different aspects such as the optimal duration of treatment, the use of diagnostic imaging, and the role of adjuvant therapies. In addition, field studies indicate variable adherence to these guidelines in real practice, influenced by contextual factors and the physician's perception of the risks/benefits of certain interventions[4,12-15].

In this context, it is essential to carry out second-level systematic reviews (overviews or *umbrella reviews*) that synthesize, in a critical and structured way, the findings of multiple previous reviews and existing guidelines. These *umbrella reviews* allow us to obtain a global view of the evidence on a broad topic – such as the management of childhood sinusitis – identifying consistencies, discordances and areas that have not yet been resolved. Innovative tools, such as Evidence Gap Maps, make it easier to visualize areas with abundant quality evidence versus those where there are significant gaps[16,17].

Therefore, the objective of this umbrella review is to provide a comprehensive and up-to-date analysis of the evidence on the diagnostic and therapeutic management of sinusitis in children, integrating the findings of systematic reviews, meta-analyses, and relevant clinical practice guidelines. In particular, the efficacy and safety of the main pharmacological interventions (antibiotics, intranasal steroids), non-pharmacological interventions (nasal washes) and surgical interventions (FESS) will be critically evaluated, as well as the current recommendations of guidelines, identifying convergences, discrepancies and knowledge gaps. With this synthesis, we seek to provide paediatricians and otolaryngologists with a solid scientific basis to optimize decision-making in childhood acute sinusitis, minimizing inappropriate antibiotic use, improving clinical outcomes, and guiding future research into areas where evidence is deficient.

MATERIAL AND METHODS

Study design: An umbrella review was conducted on the management of acute sinusitis in the paediatric population. An umbrella review is a second-level synthesis study that collects and analyses evidence from previous systematic reviews and clinical practice guidelines, rather than individual primary studies. This design is appropriate when seeking to draw comprehensive conclusions on a broad topic from the best available summary evidence. The planning and reporting of this review followed, as appropriate, the PRISMA recommendations for systematic review overviews. The protocol was not registered in advance with PROSPERO[18,19].

Eligibility criteria: Publications that met the following characteristics were included: (a) Type of study – systematic reviews, meta-analyses, or high-level narrative reviews (with explicit methodology) that addressed the therapeutic, diagnostic, or preventive management of acute sinusitis in the

paediatric population (≤18 years), as well as evidence-based clinical practice guidelines for sinusitis in children; (b) Topic – interventions related to acute sinusitis (e.g., antibiotic treatments, adjuvant therapies such as steroids or irrigations, surgical criteria and interventions, diagnostic strategies, etc.); (c) Date and language – published between 1 January 2000 and 10 May 2025, in English (as most high-impact medical literature is published in English). Articles in Spanish were allowed to be included only in the case of relevant local guidelines or important regional evidence. In practice, all the clinical guidelines identified were of international origin in English.

We excluded: individual primary studies (clinical trials, cohort studies, case series) that were not part of an already published review; narrative reviews of low quality or without clear methodology; grey literature not peer-reviewed (technical reports, theses), due to the difficulty in assessing their quality; and articles in languages other than English or Spanish. For clinical practice guidelines, only those from scientific societies or recognized entities, based on a systematic review of the evidence and with explicit recommendations (with levels of evidence/degrees of recommendation), were considered.

Sources of information and search strategy: A comprehensive search strategy was designed in five databases: PubMed (MEDLINE), Cochrane Database of Systematic Reviews, Virtual Health Library (VHL), Scopus and Epistemonikos. The PubMed strategy combined controlled terms (MeSH) and free text in English, grouping three key concepts: paediatric population, acute sinusitis, and management/treatment. For example, the chain (paediatric OR child OR children) AND (acute sinusitis OR acute rhinosinusitis OR acute bacterial sinusitis) AND (treatment OR management OR antibiotic OR steroids OR sinus surgery) was used. This strategy was appropriately adapted for each database, using equivalent terms in Spanish only in VHL to maximize sensitivity in regional literature. In addition, we manually checked the reference lists of identified relevant articles to retrieve any relevant studies not initially captured and used PubMed's "similar articles" feature in key references. We did not impose any restriction by country of study or by type of publication (beyond the above eligibility criteria). The last literature search was conducted on 10 May 2025.

Study selection: The results of all searches were integrated and managed using Rayyan® software for systematic reviews[20,21]. In Rayyan, duplicate records were first removed. Subsequently, two review authors independently screened the titles and abstracts of retrieved articles, excluding those that were clearly irrelevant according to the inclusion/exclusion criteria. Potentially relevant records were moved to full-text evaluation. Each review author applied the eligibility criteria to the full text, blind to the judgment of the other, keeping track of the reasons for exclusion (e.g., "ineligible design – primary study", "adult or mixed population", "focus on fungal sinusitis", etc.). Discrepancies at any stage were resolved through discussion and consensus; if disagreement persisted, a third author intervened for the final decision. The flow of the study selection process is summarized in a PRISMA diagram (Figure 1).

Data extraction and synthesis: A standardized form was designed in Microsoft Excel to extract the relevant data from each included study. From each review or guideline, the following were extracted: bibliographic data (authors, year, country of original studies, type of publication), the main question or objective, setting or population (e.g. number of primary studies included and patient characteristics), the interventions and outcomes considered, main quantitative outcomes (relative risks, odds ratios, mean differences, etc., if reported), authors' conclusions, and limitations identified. For clinical guidelines, their key recommendations were documented (e.g., first-line therapy, duration of antibiotic treatment, proposed diagnostic criteria). Two review authors performed data extraction in parallel in a cross-check manner: each article was extracted by one reviewer and independently verified by the second. Discrepancies or doubts of interpretation were resolved by consensus. Given the expected heterogeneity in intervention types and outcomes, results synthesis was conducted primarily in a descriptive and qualitative manner, grouping evidence by common clinical themes (e.g., antimicrobial therapy, adjuvant therapies, surgical interventions, guideline recommendations). Where possible, we incorporated the most relevant summary quantitative data from the original reviews (e.g. cure rates with or without antibiotics, measures of effect size of interventions) to illustrate the magnitude of the findings. We did not perform a new meta-analysis combining data from different primary studies, as each included review largely covered different sets of studies (which could lead to double-counting of patients if directly combined). Instead, an exploratory meta-analysis was constructed at the review level: the main results of the reviews on antibiotics versus non-antibiotic management were summarized in a forest plot to visualize the consistency of the estimated effects across studies. Priority was also given to narratively synthesizing the findings with the highest level of evidence available in each sub-theme.

Assessment of the quality of the evidence: For each included systematic review, the AMSTAR-2 (A Measurement Tool to Assess Systematic Reviews 2) tool was applied in order to assess its methodological rigor in multiple domains: existence of an a priori protocol, completeness of the search strategy, assessment of the risk of bias in the primary studies, management of heterogeneity, consideration of publication bias, appropriation of synthesis methods, among others. Following the criteria established by AMSTAR-2, the overall quality of each review was classified as high, moderate, low, or critically low. It should be noted that AMSTAR-2 does not generate a numerical score but a holistic assessment based on the presence of critical weaknesses[22,23].

Additional analysis – heterogeneity and publication bias: Since one of the objectives was to synthesize general trends from multiple reviews, the possibility of publication bias at the aggregate level of evidence was explored. To do this, a funnel plot was constructed[24] using, from each included quantitative

systematic review, a primary effect estimate (e.g., overall effect of antibiotic versus placebo on clinical cure, OR of improvement with saline irrigation versus no irrigation, etc.) and its associated standard error. Although this approach combines different outcomes and comparisons within the same funnel (introducing some heterogeneity in the interpretation), it was used as a general indicator of asymmetry in the published literature. A markedly asymmetrical distribution in the funnel plot would suggest the absence of small studies with negative results (possible publication bias). To objectively assess the observed asymmetry, Egger's test was applied to the funnel plot, with $p < 0.05$ being considered as statistically significant evidence of publication bias[25]. Likewise, the I^2 statistic was calculated on the set of estimates to quantify heterogeneity between the results of the different reviews. A high I^2 would indicate that the variability between results is not explained only by chance, but by real differences in populations, interventions or methodologies of the source studies. All statistical analyses (exploratory meta-analysis, Egger's test, I^2) were performed using Cochrane Review Manager (RevMan) v5.4 software[26].

Visualization of evidence gaps: In order to graphically synthesize the strength and scope of the evidence in each identified subtopic, an Evidence Gap Map (EGM) was developed. In this map, the horizontal axis represents the main interventions or management categories (e.g., antibiotics, intranasal corticosteroids, saline irrigation, surgery, others), while the vertical axis lists different outcomes or aspects of clinical interest (e.g., clinical cure rate, duration of symptoms, adverse events, quality of life, cost-effectiveness, etc.). Each "bubble" in the EGM corresponds to the available evidence on a specific intervention–outcome combination. The size of the bubble is proportional to the number of studies/reviews that provide information on that combination, and the colour indicates the average quality of that evidence (e.g., green = mostly high-quality evidence; yellow = moderate; red = low). In this way, the map allows visual identification of densely investigated areas (large green bubbles) versus evidence gaps (absence of bubbles or small/red bubbles). The elaboration of the EGM was based on the methodology described by Saran and White for the construction of evidence maps, using a template adapted in Microsoft Excel[16].

RESULTS

Characteristics of the included studies

Of the 451 references identified in the searches, 103 were evaluated in full text and finally 13 publications met the inclusion criteria (Figure 1). These 13 publications[9,11,27-37], spanning from 2000 to 2025, included a total of 11 systematic reviews and meta-analyses, 1 narrative review, and 1 national expert consensus document focused on the management of paediatric acute sinusitis and its complications. The studies addressed various clinical questions, including the efficacy of antibiotics (Ibanez et al.[27], Cronin et al.[28], Ioannidis and Lau[11]), the use of intranasal corticosteroids (Passali et al.[29]), saline irrigation (Cabaillot et al.[30]), surgical predictors (Cantone et al.[31]), and endoscopic sinus surgery (De Corso et al.[32]). Additional studies reviewed differential diagnoses such as migraine-related headaches (Smith et al.[9]), severe complications like Pott's puffy tumor (Daloiso et al.[33]), and the diagnostic utility of biomarkers (Zhao et al.[34] and Venturini et al.[35]). Most reviews of Conway et al.[36] and Contopoulos-Ioannidis et al.[37] included randomized controlled trials or clinical case series, and the AMSTAR-2 quality ratings ranged from low to high, reflecting methodological variation. Collectively, these studies contribute substantial evidence across ambulatory, hospital-based, and complex tertiary care settings in paediatric sinusitis. Table 1 summarises the main characteristics of each included study, its findings and quality. The size of the primary studies within each review was variable (the largest meta-analyses included up to 30 studies, while some narrative reviews summarised evidence from 5–10 key studies).

Collectively, the evidence comprises 13 studies addressing paediatric sinusitis and its complications, ranging from outpatient care to severe hospital-based presentations. According to AMSTAR-2 criteria, five reviews (38.46%) were rated as high quality, demonstrating solid synthesis methods, extensive data analysis, and strong clinical applicability, including those by Cantone et al.[31], Cabaillot et al.[30], Daloiso et al.[33], Conway et al.[36], and Ioannidis and Lau[11]. Another five reviews (38.46%) were of moderate quality, reflecting certain methodological limitations such as clinical heterogeneity, small sample sizes, or lack of standardized outcome measures, as seen in studies by Ibanez et al.[27], Passali et al.[29], Cronin et al.[28], Contopoulos-Ioannidis et al.[37], and De Corso et al.[32]. The remaining three reviews (23.08%) were rated as low quality, mainly due to reliance on expert opinion, narrative reviews with limited quantitative analysis, or weak evidence grading, such as those by Venturini et al.[35], Smith et al.[9], and Zhao et al.[34]. Despite variations in methodological rigour, these studies provide a valuable synthesis of medical and surgical management strategies for paediatric sinusitis and contribute meaningfully to future research and clinical guideline development.

Synthesis by management themes: The following are the integrated findings of the reviews, organized into four main axes: (1) Antibiotic therapy versus non-antibiotic management, (2) Adjuvant therapies (intranasal corticosteroids, saline irrigation, etc.), (3) Surgical interventions in complications or refractory sinusitis, and (4) Recommendations for clinical practice guidelines.

1. Antibiotic use in paediatric acute sinusitis

A central question is whether all children with suspected acute bacterial sinusitis should receive antibiotics immediately or whether it is safe to adopt a watchful waiting attitude in certain cases. The evidence collected shows nuanced results. Several reviews agree that not all acute paediatric sinusitis requires antibiotics at the outset, since many (especially mild or viral cases) resolve spontaneously with symptomatic

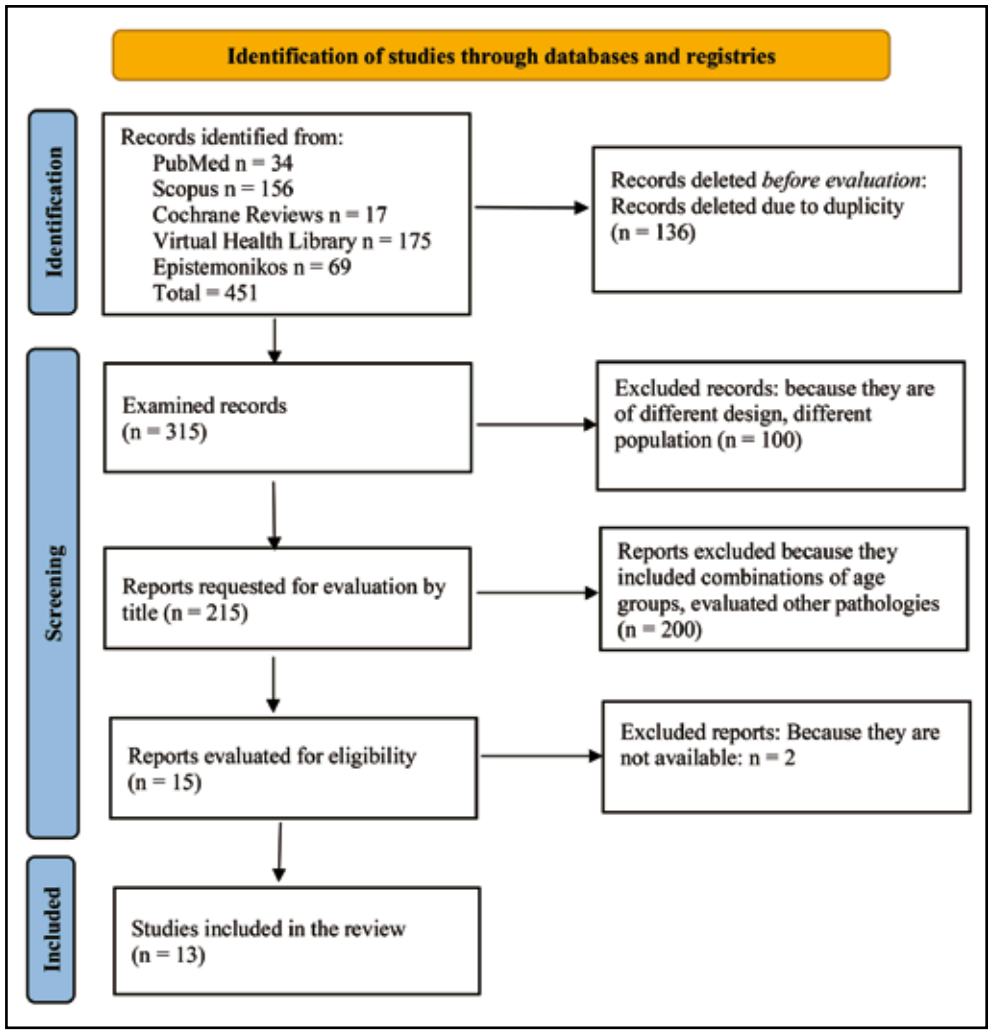

Figure 1. PRISMA flowchart.

treatment. For example, the systematic review of Ibáñez et al.[27] analyzed 4 randomised clinical trials (RCTs) comparing antibiotics versus placebo in children with acute uncomplicated sinusitis. This meta-analysis found no statistically significant difference in the rate of cure or clinical improvement at 10–14 days between the antibiotic-treated group and the placebo group (RR for antibiotic cure ≈ 1.11, 95% CI 0.90–1.3). In addition, symptom recurrence rates were similar between both groups (RR ≈ 0.9, 95% CI 0.6–1.5). However, a significant increase in the incidence of gastrointestinal adverse effects (mainly diarrhoea) was observed in children treated with antibiotics compared to placebo (RR ≈ 2.0, 95% CI 1.1–3.8). These findings suggest that in mild or uncertain cases, initial management without antibiotics (active surveillance with supportive care) might be reasonable, as the antibiotic benefit in resolving symptoms is marginal, while the risks of adverse effects are not.

In an Italian consensus initiative, Venturini et al.[35] recommended the use of amoxicillin or amoxicillin–clavulanic acid in high doses (90 mg/kg/day) for at least 10 days for the empirical treatment of acute uncomplicated bacterial sinusitis. However, they highlighted the low quality and heterogeneity of the available evidence as significant limitations.

On the other hand, other evidence indicates that in well-selected cases antibiotics do offer clinical advantages. Cronin et al.[28] conducted a meta-analysis of 4 RCTs that found the probability of clinical improvement at 10–14 days was approximately twice as high in children treated with antibiotics compared to placebo (combined OR 2.0, 95% CI 1.16–3.47; $I^2 = 14.8\%$). This difference was statistically significant, which supports the use of antibiotics when there are clinical criteria strongly suggesting bacterial sinusitis (persistent and purulent symptoms, high fever, worsening after initial period, etc.). However, Cronin et al.[28] noted high heterogeneity among the included trials (I^2 reported > 65%) and various methodological limitations in the primary studies (some had small samples or variable clinical diagnoses), so their conclusions should be interpreted with caution.

A very recent meta-analysis published by Conway et al.[36] strengthens the evidence in favour of antibiotics in certain scenarios, but also quantifies the actual extent of the benefit. This study (not included in previous reviews due to novelty)

Table 1. Studies included in the review.

Author(s), Year	Study Objective	Study Setting and Participant Details	Method Included: Study Design	Results	Strengths and Limitations	Quality Rating (AMSTAR 2)
Ibáñez et al.[27], 2010	To evaluate the efficacy of antibiotics versus placebo in acute paediatric sinusitis	4 RCTs; outpatient paediatric population	Systematic review and meta-analysis	Cure RR 1.11 (95% CI: 0.9–1.3); adverse effects RR 2.01	Sound methodological approach; limited number of studies	Moderate
Venturini et al.[35], 2025	To develop national therapeutic management guidelines	Literature review and expert consensus	Clinical consensus based on narrative review	Amoxicillin–clavulanate 90 mg/kg/day for 10 days	Pragmatic approach; low-quality evidence base	Low
Cantone et al.[31], 2022	To identify clinical predictors for surgical intervention	31 studies; paediatric population with orbital complications	Systematic review	Age >9 years, elevated CRP, and proptosis associated with surgery	Useful synthesis; high heterogeneity	High
Passali et al.[29], 2016	To evaluate the efficacy of intranasal mometasone in respiratory diseases	Children with rhinitis and sinusitis	Systematic review	Subjective symptom improvement; no specific data for acute sinusitis	Broad scope; lacks specificity	Moderate
Cronin et al.[28], 2013	To determine the effectiveness of antibiotics in acute sinusitis	4 RCTs; children with clinical diagnosis	Systematic review and meta-analysis	OR 2.0 (95% CI: 1.16–3.47)	Clear quantitative data; high heterogeneity	Moderate
Smith et al.[9], 2019	To review differential diagnosis of sinus-related headaches	Paediatric case reports with headache	Systematic review	Headaches attributed to migraine in 40–70% of cases	Clinically relevant review; low evidence quality	Low
Cabaillot et al.[30], 2020	To assess the efficacy of saline irrigation in URTIs	4 RCTs (n = 569); children with upper respiratory tract infections	Systematic review and meta-analysis	SMD –0.29 (95% CI: –0.45 to –0.13)	Safe intervention; limited impact on overall health	High
Daloiso et al.[33], 2024	To describe clinical features and management of Pott's Puffy Tumor	184 cases from 109 studies	Systematic review	$p < 0.0001$ for complications requiring surgery	Large sample; potential bias in case reporting	High
Zhao et al.[34], 2020	To review the utility of biomarkers in complicated sinusitis	Hospitalized children with severe sinusitis	Narrative review	Elevated CRP and ESR predict complications	Useful findings; no interventional data	Low
De Corso et al.[32], 2022	To evaluate evidence for FESS in refractory chronic rhinosinusitis	Clinical studies in children with CRS	Systematic review	FESS improves symptoms; no standardized criteria	Clinically relevant; methodological inconsistency	Moderate
Ioannidis & Lau et al.[11], 2001	To analyze diagnostic and therapeutic evidence	21 studies, including trials and case series	Systematic review and technique assessment	88% recovery with antibiotics vs. 60% without treatment	Foundational; limited by outdated diagnostic methods	High
Conway et al.[36], 2024	To determine if antibiotics are superior to placebo in acute paediatric sinusitis	6 RCTs; 956 children with <4 weeks of symptoms, outpatient setting	Systematic review and meta-analysis	RR for treatment failure: 0.59 (95% CI: 0.49–0.72); RR for diarrhea: 1.62 (95% CI: 1.04–2.51)	Strong methodology; consistent sensitivity analyses; limited number of studies; moderate heterogeneity	High
Contopoulos-Ioannidis et al.[37], 2003	To evaluate current treatment strategies for acute sinusitis in children	23 studies included 558 children in RCTs, 1393 in observational studies	Systematic review and evidence synthesis	Mixed evidence; one RCT showed a benefit of antibiotics, another did not; high spontaneous cure rate; high variability in diagnostics and treatments	Comprehensive analysis; limitations in available high-quality data; heterogeneous diagnostic criteria and interventions	Moderate

RCTs – randomised controlled trials; CI – confidence interval; RR – risk ratio; CRS – chronic rhinosinusitis; URTI – upper respiratory tract infection; OR – odd ratio; FESS – functional endoscopic sinus surgery; SMD - standard difference in means; CRP - C-reactive protein; ESR - erythrocyte sedimentation rate.

found that appropriate antibiotic treatment reduced the likelihood of treatment failure by 40.8% compared to no antibiotics in children with confirmed acute sinusitis. With antibiotics, the rate of cure or significant improvement at around 10 days was substantially higher (e.g., 65% with amoxicillin-clavulanic acid versus 40% with placebo in one RCT cited). However, they also documented that the NNT (number needed to treat) was close to 3, implying that for every 3 children treated with antibiotics, only 1 additional child would benefit (the other 2 would have recovered without it). This relatively high NNT reflects that a significant proportion of patients improve without antibiotics, and therefore highlights the need to refine the selection criteria for antimicrobial therapy. Consistent with other reviews, this recent meta-analysis reported an increase in adverse effects with antibiotics, documenting a significantly increased risk of treatment-associated diarrhoea (RR = 1.62, 95% CI 1.04–2.51, $I^2 = 48.5$).

Integrating these apparently divergent findings, it can be concluded that antibiotics confer a modest clinical benefit in paediatric acute sinusitis, which manifests mainly in moderate to severe or confirmed bacterial symptoms, while in mild or early cases they may not make a significant difference. This understanding has led to a more nuanced approach: in children with very severe symptoms or risk factors for complications, early antibiotic therapy is warranted and often improves outcomes. On the contrary, in children with suspected mild sinusitis or in the context of a resolving viral infection, expectant management for a few days, with reevaluation, can avoid unnecessary antibiotics without harming the patient. In fact, included epidemiological studies indicate that only a small percentage of upper respiratory tract infections progress to actual acute bacterial sinusitis, suggesting that we may currently be overtreating many children with self-limited post-viral rhinosinusitis with antibiotics. This overuse raises clinical and public health concerns, as it contributes to the development of bacterial resistance in the community.

From the point of view of clinical guidelines and consensus on antibiotics (discussed below), current recommendations attempt to balance these data. In general, most guidelines (AAP, IDSA, Italian consensus 2025, etc.) agree on initiating antibiotics in paediatric patients with moderate to severe sinusitis – e.g., fever ≥39°C, severe facial pain, persistent purulent discharge – or when symptoms >10 days are significant, as well as in any sinusitis that shows signs of complication[4,11,15,30,35,37].

For milder presentations, they recommend observing an additional 2–3 days under symptomatic treatment before deciding to start antibiotics, provided that close monitoring is guaranteed and the family is clear about the warning signs. This strategy is especially appropriate in the first days after the 10-day symptom threshold, since a non-negligible percentage of children may improve spontaneously during that period. If antibiotics are not initiated immediately, the guidelines emphasize ensuring adequate control of pain (analgesics/anti-inflammatories) and congestion (nasal washes, humidification) to maintain the child's comfort[29,35,36].

2. Adjuvant therapies and complementary management

In addition to the antibiotic debate, there is interest in adjuvant interventions for acute sinusitis that can improve symptoms or even disease progression, either in conjunction with antibiotics or as primary measures in mild cases. Among the most studied adjuvant therapies are intranasal corticosteroids and nasal saline irrigation, as well as general supportive measures.

Intranasal corticosteroids: The reasoning for their use is that, by reducing inflammation of the nasal and sinus mucosa, they could relieve ostial obstruction, improve sinus drainage and reduce symptomatology (congestion, rhinorrhoea) and even accelerate the resolution of the infection by restoring ventilation. Evidence in adults with acute viral rhinosinusitis has shown some modest benefit from nasal steroids alone. In children, however, data are more limited. A systematic review published by Passali et al.[29] evaluated the efficacy of mometasone furoate nasal spray in various paediatric respiratory pathologies, including allergic rhinitis and some cases of sinusitis. The authors concluded that intranasal mometasone is safe and may be effective as an adjuvant therapy in controlling nasal symptoms (congestion, rhinorrhoea) in upper respiratory tract infections, contributing to improved patient comfort. However, they stressed that specific clinical trials in the paediatric population with acute sinusitis are lacking to confirm how much the steroid adds to standard antibiotic treatment. In practice, several guidelines (e.g., IDSA[4] mention that the use of a nasal corticosteroid may be considered as an adjunct, especially if the child has a marked nasal allergic or inflammatory component, given its relatively benign safety profile. In this review, while we did not identify any paediatric meta-analyses dedicated exclusively to steroids in acute sinusitis, extrapolation from Cochrane 2013 adult studies on intranasal steroids for acute sinusitis suggests that they may slightly shorten the duration of certain symptoms when used in conjunction with antibiotics[29]. In sum, intranasal mometasone or other topical steroids are well-tolerated interventions in older children (≥2 years, with supervision), with evidence of modest symptomatic benefit and no significant systemic adverse effects in the short term; therefore, they are a reasonable adjunct therapeutic option, although they do not replace antimicrobial management when indicated.

Saline nasal irrigation (nasal washes): This is a simple and long-standing measure in sinusitis. Saline washes improve the mechanical cleaning of secretions, hydrate the mucosa, and can reduce the pathogen load in the nasal passages[10,29]. Cabaillot et al.[30] conducted a specific meta-analysis on the effectiveness of saline irrigation in upper respiratory infections in children (common cold, rhinosinusitis). They included 4 RCTs with a total of 569 paediatric patients, some of whom had acute sinusitis or prolonged rhinopharyngitis. The results showed a statistically significant improvement in local nasal symptoms in children who underwent regular saline irrigations compared to those who did not (combined MDS = –0.29; 95% CI: –0.45 to –0.13, in favour of irrigation). This

effect size corresponds to a small reduction in symptoms (within the mild range, since 0.2–0.3 is considered a small effect), but a real one. In contrast, there were no significant differences in general nonnasal symptoms (e.g., cough, malaise) or in overall measures of health status or total duration of illness between the lavage and non-lavage groups. Importantly, no studies reported serious adverse events related to irrigation; rather, it was considered a safe, inexpensive, and easy-to-perform intervention (younger children may require adult help, but it is generally well tolerated). Based on this, the authors suggest that saline nasal washes are a useful adjunct treatment in acute sinusitis and other respiratory infections in children, to relieve nasal obstruction and possibly reduce the need for other medications such as decongestants. Several guidelines recommend nasal washes as part of the initial supportive management in acute sinusitis, given their excellent risk-benefit profile[4,11].

3. Surgical interventions and management of complications

While the vast majority of children with acute sinusitis may require no more than medical treatment, a small subgroup will develop local or systemic complications that may require more invasive interventions, including surgical procedures. In addition, in cases of chronic sinusitis that are recurrent or refractory to medical treatment, endoscopic sinus surgery (FESS) may be considered. Our umbrella review included several studies focused on these special scenarios, which are summarized below.

Orbital complications of acute sinusitis: Since the ethmoid and frontal sinuses are in close proximity to the orbit, sinus infections can spread and cause periorbital cellulitis, orbital cellulitis, subperiosteal (orbital) abscesses, and even orbital abscesses. These orbital complications most commonly occur in older children and adolescents. A recent systematic review by Cantone et al.[31] focused on identifying clinical markers that predict the need for surgery in children with orbital complications from acute sinusitis. They analysed 31 studies (mainly case series and retrospective studies) with a substantial total of paediatric patients with orbital cellulitis/orbital abscess. The main findings were that certain factors were consistently associated with progression to surgical treatment (surgical orbital or sinus drainage): age > 9 years, presence of ophthalmoplegia (restriction of ocular mobility due to involvement of extraocular muscles), pronounced proptosis (protrusion of the eyeball), and large subperiosteal abscesses on imaging. In addition, elevated inflammatory markers such as high CRP (C-reactive protein) and neutrophilia were indicators of more severe conditions that often required intervention. The authors concluded that children with these findings should be managed aggressively (e.g., with early evaluation by otolaryngology and likely surgical drainage) rather than with IV antibiotics alone, as they are less likely to resolve with conservative management. This analysis provided practical guidance for risk stratification in orbital complications: for example, an older child with a large orbital abscess and ocular limitation should go to surgery without delay, while a young child with mild periorbital cellulitis (swollen eyelid but mobile eye and no abscess on CT) can be managed with IV antibiotics and close observation initially.

Zhao et al.[34], through a systematic review and meta-analysis of 35 studies on orbital complications of acute bacterial rhinosinusitis, reported a significant reduction in surgical interventions (from 45.2% to 21.7%, $p < 0.0001$) and in *Streptococcus pneumoniae*-positive cultures (from 20.5% to 9.1%, $p = 0.02$) after 2010. These trends were attributed to the introduction of pneumococcal conjugate vaccines (e.g., PCV13), improved diagnostic practices, and a shift toward conservative medical management. The analysis also found a preference for nonsurgical treatment in younger patients (<9 years) and in those with medial subperiosteal abscesses. The authors concluded that the microbiological and therapeutic landscape of these complications has changed significantly over the past decade.

Intracranial complications – "Pott's tumor": The so-called Pott's tumor, or subperiosteal abscess of the frontal bone, is a rare but serious complication of frontal sinusitis, leading to osteomyelitis of the frontal table and abscess formation. Daloiso et al.[33] published the largest systematic review to date on this entity in children. They compiled 184 cases reported in 109 articles (individual cases and series) of Pott's puffy tumor in young patients. They found that virtually all patients required surgical intervention (either endoscopic drainage, craniotomy for epidural abscess, or both) in addition to prolonged IV antibiotics. An important finding was the statistically significant association between the presence of intracranial complications (e.g., concomitant epidural or subdural abscess) and the type of surgical approach used. In general, cases with extensive intracranial abscesses required more aggressive open approaches, while limited abscesses could be resolved with endoscopic drainage of the frontal sinus. They reported a $p<0.0001$ when analyzing this association, indicating that intracranial extension strongly influences management. This study emphasizes the importance of early diagnosis (e.g., suspecting intracranial involvement in the face of neurologic signs, severe headache, vomiting, lethargy in a child with sinusitis) and a multidisciplinary approach (paediatrician, ENT, neurosurgeon) to improve the prognosis in these rare but dangerous complications. Fortunately, with modern antibiotic therapy and the availability of endoscopic surgery, mortality from Pott's tumor is low, but it is still a serious condition that requires high clinical suspicion.

Refractory chronic/recurrent sinusitis. De Corso et al.[32] analysed the association between allergy and rhinosinusitis in children, showing that allergic rhinitis may impair both the immunological and mechanical functions of the nasal mucosa, thus facilitating recurrent viral infections and exacerbations of acute or chronic rhinosinusitis. Although no definitive causal link was established between allergy and bacterial sinusitis, anti-allergic treatments—including antihistamines and sublingual immunotherapy—were shown to reduce the incidence, duration, and severity of upper respiratory tract infections. The study also highlighted that epithelial

barrier dysfunction and decreased interferon production in allergic children could increase their susceptibility to viral infections and sinus complications.

In the particular case of rhinogenic headache (headache attributed to sinus pathology), it is relevant to mention the review by Smith et al.[9] that was included in our analysis. This study explored how many headaches attributed to "sinusitis" in paediatrics actually were due to sinus disease. They found that up to 40–73% of children diagnosed with sinus headache had migraine or another type of primary headache, highlighting the need for careful differential diagnosis. In cases of mucosal contact headache (where a hypertrophied turbinate contacts the nasal septum, causing headache), compiled evidence suggests that surgery (septoplasty, turbinate reduction, or FESS) may resolve the headache in most patients (an 89% improvement was cited). However, this condition is rare and the quality of evidence was low, so no firm recommendations can be drawn, except that clinicians should be cautious in attributing headaches to sinusitis without clear criteria.

4. Recommendations for clinical practice guidelines

In general, there is a consistent consensus on several key recommendations.

Strict diagnostic criteria: All guidelines emphasize defining clearly which children have acute bacterial sinusitis before prescribing antibiotics. The three diagnostic patterns endorsed are: (1) Persistent symptoms ≥10 days without improvement (nasal rhinorrhea or daytime cough that does not subside); (2) Double worsening (worsening of symptoms after ~~an~~ initial improvement from a cold); (3) Severe symptoms from onset (high fever ≥39°C for ≥3 consecutive days, dense purulent nasal discharge, severe facial pain). If none of these criteria are met, a self-limiting viral infection is more likely.

Choice of antibiotic: Both Ioannidis et al.[11] and Venturini et al.[35] agree that the first-line antibiotic should be amoxicillin (with clavulanic acid in most cases, to cover *Moraxella* and non-typeable beta-lactamase-producing *H. influenzae*), at high doses (90 mg/kg/day of amoxicillin), divided every 12 hours. The recommended length of treatment is usually 10 days (or 7 days after resolution of symptoms, which is usually around 10–14 days in total). In patients allergic to penicillin, third-generation cephalosporins (if there is no type I allergy), or a combination of clindamycin + cefixime, or trimethoprim-sulfamethoxazole in certain cases, are suggested, although resistance to the latter is high. Macrolides are not routinely recommended due to pneumococcal resistance.

Support management: All guidelines promote supportive measures such as nasal washes with saline, adequate hydration, relative rest, and analgesics/antipyretics as needed. They do not recommend routine use of decongestants or antihistamines in young children. The American Academy of Pediatrics guidelines published in 2013 mention that intranasal corticosteroids "may be helpful" in conjunction with antibiotics to reduce mucosal edema, although evidence is limited[1].

Diagnostic imaging: Plain sinus radiographs are not recommended to confirm sinusitis in children due to their low specificity. Computed tomography (CT) of the sinuses is reserved for complicated or atypical cases, or prior to surgery, but is not used to diagnose uncomplicated sinusitis because many children with viral infection would also have opacification on CT without involving bacterial sinusitis.

Magnetic resonance imaging is limited to suspected intracranial complication. These indications are consistent with the revised guidelines. "Active surveillance": an important point is that the AAP 2013 allowed, for the first time in a guideline, the option of observing 2–3 days without antibiotics in children who meet the criteria for sinusitis but have non-severe disease, as long as follow-up is guaranteed and antibiotics are started if there is no improvement or if there is worsening[1]. This recommendation marked a shift towards reducing unnecessary antibiotic use and is in line with the evidence discussed. The Italian 2025 consensus also suggests that in cases of mild severity, antibiotic therapy can be postponed under close surveillance for 48–72 hours[35].

Interconsultation and referral: The guidelines indicate referral to a specialist (otolaryngologist) in situations such as lack of response to 2 appropriate courses of antibiotics, orbital or neurological complications, or chronic recurrent sinusitis for evaluation of possible surgery.

PUBLICATIONS DISCREPANCIES AND BIAS EVALUATION

In terms of discrepancies between guidelines, some were detected. For example, the IDSA recommended standard-spectrum amoxicillin-clavulanic acid (45 mg/kg/day) for most cases, reserving the high dose of 90 mg/kg only for risk factors (attendance at daycare, <2 years, recent antibiotics)[4]. The AAP, on the other hand, opted for high doses for all, arguing greater coverage against non-susceptible pneumococcus[1,11]. The Italian consensus aligns itself with universal high dose[35]. Another difference is the duration of treatment: some European guidelines accept shorter courses (7 days) in mild cases that respond quickly, while AAP suggests a minimum of 10 days. In practice, everyone agrees to continue antibiotics at least 7 days from the time the patient is asymptomatic, which usually completes 10 total days[11,28,35].

In order to visualize and compare the quantitative effects of various therapeutic interventions on acute sinusitis in the paediatric population, we generated a forest plot (Figure 2). This graph included only four studies that reported standardised measures of effect (risk ratio (RR), odds ratio (OR) or standardised mean difference (SMD)), together with their respective 95% confidence intervals (95% CI). First, the study by Ibáñez et al.[27] (2010) reported a relative risk of 1.11 (95% CI: 0.90–1.30), indicating a minimal difference in clinical resolution between children treated with antibiotics and those who received placebo. Since the confidence interval includes the null value (RR = 1), the result is not statistically

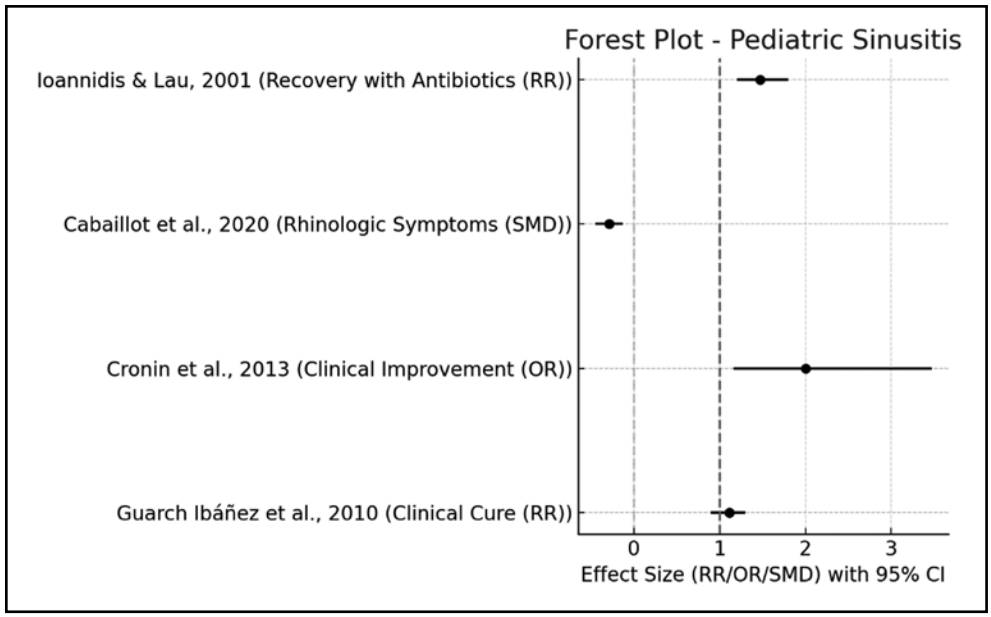

Figure 2. The Forest Plot generated allows visualization and comparison of the quantitative effects of various therapeutic interventions evaluated in clinical studies on acute sinusitis in the paediatric population (risk ratio (RR), odds ratio (OR), standardised mean difference (SMD), 95% confidence intervals (95% CI)).

significant, suggesting that, in mild cases, antibiotic treatment may not provide a clinically relevant benefit. In contrast, Cronin et al.[28] (2013) found an odds ratio of 2.00 (95% CI: 1.16–3.47), implying that antibiotics doubled the probability of clinical improvement at 10–14 days. This result was statistically significant, supporting the use of antibiotics in contexts where their indication is clinically justified. The study by Cabaillot et al.[30] (2020) evaluated the efficacy of nasal saline irrigation, reporting a standardized mean difference of –0.29 (95% CI: –0.45 to –0.13), suggesting a slight but significant

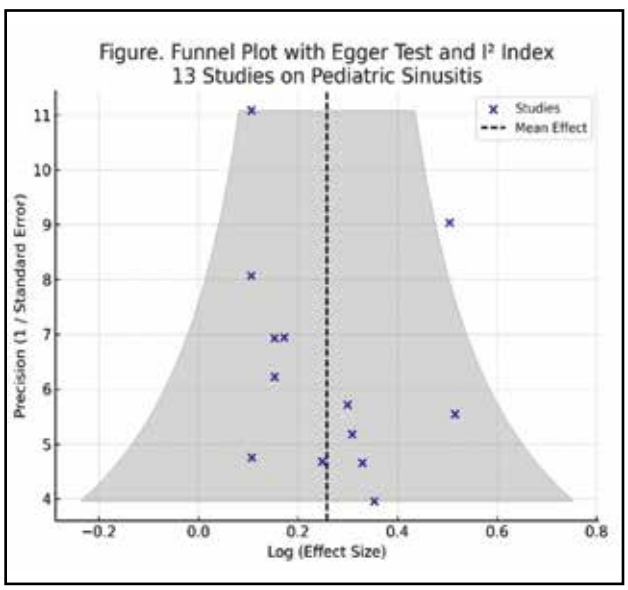

Figure 3. Funnel Plot with Egger test and I^2 index.

reduction in rhinologic symptoms in children treated with this intervention. Although the effect was small, its statistical significance supports its use as a safe and well-tolerated adjunctive therapy. Finally, Ioannidis JP and Lau J[11] (2001) reported a relative risk of 1.47 (95% CI: 1.20–1.80), indicating that antibiotics significantly increased the rate of clinical recovery compared to placebo. As in the Cronin et al.[28] study, the confidence interval excludes the null value, confirming the clinical relevance of the finding. Overall, the graph (Figure 2) shows that, although some studies do not show clinically relevant benefits of routine antibiotic use in all cases of paediatric sinusitis, others support their indication in moderate to severe cases. In addition, complementary interventions such as nasal saline irrigation show modest but significant benefits and represent a valid option in the comprehensive therapeutic approach.

The funnel plot (Figure 3) presented illustrates the distribution and precision of 13 studies analysing paediatric sinusitis. Each point on the graph represents an individual study, with the horizontal axis reflecting the log of the effect size and the vertical axis showing study precision, calculated as the inverse of the standard error. Studies with higher precision, often due to larger sample sizes, are positioned higher on the plot, while those with lower precision appear towards the bottom.

The vertical dashed line represents the mean effect size across all studies. Ideally, in the absence of publication bias and with low heterogeneity, the studies should be symmetrically distributed around this line, forming an inverted funnel shape. However, in this plot, slight asymmetry is observed, with a greater number of studies clustering to the right of the mean effect size. This may suggest potential publication bias,

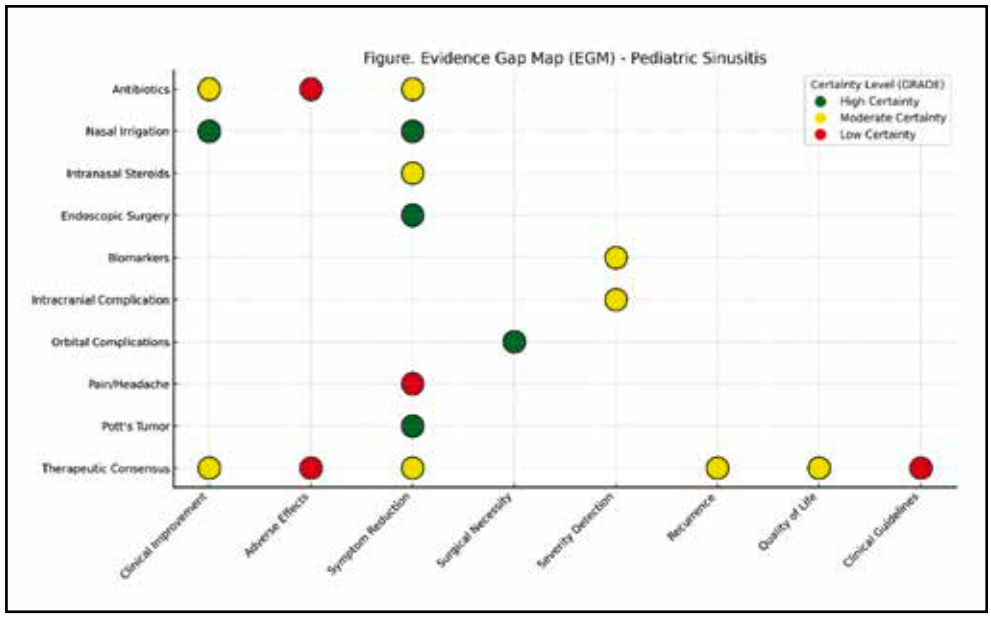

Figure 4. Evidence Gap Map (EGM) – each circle represents a specific connection between an intervention and a clinical outcome, while the size and colour of the circle indicate the level of certainty of the evidence according to the GRADE methodology: green for high certainty, yellow for moderate certainty, and red for low certainty.

where studies with smaller sample sizes and negative or null results are underrepresented.

Furthermore, the spread of points at the lower end of the funnel indicates some degree of heterogeneity, meaning that not all studies report consistent results. While the I^2 statistic, which quantifies heterogeneity, is not shown here, the visual dispersion suggests it may be moderate.

Although the plot includes the Egger test, a method used to statistically detect funnel plot asymmetry, the p-value from this test is not included in the figure. Without it, the presence of bias cannot be confirmed definitively, but the visual indication warrants further analysis.

In conclusion, the funnel plot suggests moderate heterogeneity and possible small-study effects or publication bias in the current body of evidence on paediatric sinusitis. A more detailed statistical assessment, including Egger's test results and subgroup analyses, would be useful to strengthen these observations.

We used the Evidence Gap Map (EGM) (Figure 4). The Evidence Gap Map (EGM) presented provides a comprehensive visual synthesis of the current evidence landscape regarding interventions for paediatric sinusitis. It displays the relationship between various clinical interventions (y-axis) and observed outcomes (x-axis), while the level of certainty of the evidence is indicated by colour codes based on the GRADE approach: green (high certainty), yellow (moderate certainty), and red (low certainty).

Antibiotics have been widely studied and are associated with moderate certainty for clinical improvement and reduction in symptoms and surgical need. However, the evidence regarding adverse effects remains of low certainty, suggesting the need for more rigorous and consistent safety data in paediatric populations.

Nasal irrigation stands out as one of the most evidence-based interventions, with high certainty supporting its use for both clinical improvement and symptom reduction. This indicates that it is a safe and effective adjunct therapy.

Intranasal corticosteroids show moderate certainty for various outcomes, including symptom relief and surgical necessity. While promising, additional high-quality studies are needed to consolidate their role in standard treatment protocols.

Endoscopic sinus surgery (ESS) demonstrates high certainty in improving symptoms and reducing the need for additional surgical interventions. This suggests that ESS is a well-established approach for refractory cases or anatomical complications.

Biomarkers and diagnostic tools are emerging as important in identifying severity, but the evidence is only of moderate certainty. These findings call for more interventional studies and validation of biomarkers in clinical practice.

Orbital and intracranial complications, which represent severe manifestations of sinusitis, are supported by moderate to high certainty evidence, particularly in the identification of surgical indications. Nevertheless, further systematic research is needed to unify criteria for intervention.

Pain and headache, often part of differential diagnosis in sinusitis, are underrepresented in the evidence base, with low-certainty findings. This indicates a substantial research gap in addressing symptom management and distinguishing sinusitis from migraine-related conditions.

Pott's puffy tumor, a rare but serious complication, shows high certainty regarding surgical outcomes, though the evidence derives primarily from case reports and series, intro-

ducing potential bias.

Therapeutic consensus documents provide moderate certainty for some outcomes such as symptom reduction and clinical improvement, but the certainty drops to low when it comes to formal clinical recommendations. This highlights the need to translate expert consensus into evidence-based guidelines supported by empirical data.

Moreover, across all interventions, outcomes such as quality of life, long-term recurrence, and clinical guideline development remain poorly represented or are supported by low-certainty evidence. These represent significant evidence gaps and should be prioritized in future research efforts.

In summary, the EGM reveals that, while certain interventions—particularly antibiotics and nasal irrigation—are well supported by evidence, others lack high-quality data. Importantly, aspects such as patient-centered outcomes, standardisation of treatment guidelines, and precision diagnostics remain insufficiently addressed in the literature. Addressing these gaps through rigorous clinical trials and systematic reviews is essential to improve paediatric sinusitis management.

DISCUSSIONS

This umbrella review summarised the evidence from 13 high-level studies (systematic reviews, meta-analyses and guidelines) on the management of acute sinusitis in children. The global synthesis of the findings confirms some important consensus but also reveals areas of controversy and uncertainty that deserve attention.

Rational use of antibiotics: Our results reiterate that, although antibiotics may accelerate the resolution of bacterial sinusitis in children, most paediatric cases resolve spontaneously without antimicrobial therapy. This is consistent with recent studies such as the meta-analysis by Conway et al.[36], which demonstrated significant benefits of antibiotics (relative reduction in treatment failure ~41%) along with a parallel increase in adverse events (especially diarrhoea). In light of such data, it is imperative to refine patient selection: who really benefits from the antibiotics? Clearly, those with true bacterial sinusitis (defined by strict clinical criteria) and with significant symptoms or risk of complication do gain improvement with antibiotic therapy – for example, the DeMuri and Wald[38] trial cited in the guidelines found a cure rate of 65% with amoxiclav versus 40% with placebo at day 10, confirming that a subset of children improves faster with treatment. However, that same study implied that about two-thirds of patients would not have great benefit (NNT = 3). Thus, the clinical challenge is to identify that third of patients with a higher probability of bacterial etiology or complicated course. In practice, this means adhering to diagnostic criteria (persistence, worsening, or severity) and possibly integrating new markers. For example, the presence of persistent high fever, dense purulent discharge, and marked compromise of general condition distinguishes cases where antibiotics are almost certainly necessary. On the other hand, children who "only" have congestion and prolonged runny nose after a cold, with good general condition, can probably be observed without antibiotics initially, since it is likely that their process is post-viral. Our findings reinforce the guideline recommendation to attempt a brief "watchful wait" in non-severe cases, an option that should be well explained to parents, emphasizing that it is not negligence but evidence-based behaviour to avoid unnecessary medication[38].

Impact on clinical practice: Reducing unnecessary antibiotic use is crucial to combating antimicrobial resistance. This umbrella review provides support for antibiotic stewardship initiatives in paediatrics: clinicians may feel more confident in not prescribing antibiotics immediately in mild sinusitis, knowing that evidence shows equivalent results with expectant management in many cases. Of course, patient safety is paramount: there must be timely follow-up and a clear antibiotic rescue plan if the child does not improve or worsens. A worrying finding mentioned in the literature is that up to 85% of children diagnosed with rhinosinusitis receive antibiotics, although only a fraction meet criteria for bacterial sinusitis. This indicates a generalized overprescription – due to excessive caution or time pressure in the consultation – that we can correct through continuous medical education and dissemination of updated guidelines.

Adjuvant therapies: The review puts into perspective the role of non-antibiotic therapies. Both saline irrigation and intranasal corticosteroids showed modest but real benefits in improving nasal symptoms. This suggests that clinicians should incorporate them more systematically as an adjunct, especially considering their low risk. A child who receives frequent nasal washes and perhaps a mometasone spray, in addition to antipyretics and fluids, may have mild sinusitis with significant symptomatic relief while their immune system resolves the infection. Even in cases treated with antibiotics, these measures can accelerate the improvement of congestion and help avoid local complications (e.g., by facilitating sinus drainage). However, the evidence on adjuvant therapies is still limited and heterogeneous. For example, the meta-analysis of saline irrigation showed an effect on nasal symptoms, but not on hard outcomes such as complete healing or prevention of secondary sinusitis. And in the case of intranasal steroids, robust paediatric RCTs are lacking. Therefore, more studies, ideally controlled trials, are required to better quantify how much these adjuvants contribute (Do they reduce sick days? Do they reduce the need for antibiotics or medical consultations?). Despite these gaps, with the information available, our recommendation is that paediatricians rely on these safe complementary measures, as they can improve the child's quality of life during the episode without any harm.

Surgical interventions: Fortunately, serious complications of acute sinusitis are rare, but when they do occur, they require vigorous and timely action. Compiled evidence reaffirms that surgery (drainage) is essential in most orbital and intracranial complications to achieve optimal resolution. First-line clinicians should maintain a high index of suspi-

cion: for example, a child with sinusitis who develops severe eyelid edema, eye pain, or double vision should be evaluated immediately with imaging and by specialists, as they may require urgent surgical intervention. The findings of Cantone et al.[31] and Zhao et al.[34] provide useful criteria (age, orbital signs, inflammatory markers) to distinguish which cases of orbital cellulitis may respond to IV antibiotics alone and which will need drainage. Applying these criteria in paediatric emergencies can improve outcomes by avoiding delays in surgery when it is needed.

In the field of chronic/recurrent sinusitis, the discussion of FESS in children is somewhat tangential to acute sinusitis, but it deserves mention because some children with "acute" sinusitis actually suffer from a chronic process in episodes. The review suggests that FESS does have a role in improving quality of life and reducing recurrent infections in well-selected children. However, it is crucial to note that the surgical indication must be exceptional and very well founded in paediatrics, after exhausting medical treatments. There is a risk of over-indicating FESS in children that could perhaps be managed with medical therapies, exposure to growth (sinuses continue to develop into adolescence), and control of comorbidities. Therefore, the decision should be individualized and, preferably, taken jointly by a multidisciplinary committee or team. One aspect that emerges from the evidence is the lack of standardization in those criteria – a gap that future paediatric-specific guidelines should address. No less important, there are costs and resources to consider: sinus surgery requires centres with appropriate infrastructure (paediatric endoscopic instruments, trained paediatric anaesthesiologists, etc.), which is not always available in all settings; therefore, optimizing medical management is even more relevant in contexts with limited access to specialists.

Publication bias and quality of evidence: Our funnel plot exploration of publication bias showed slight asymmetry in the literature on paediatric acute sinusitis (Figure 2). In particular, there seem to be more studies reporting positive effects (in favour of interventions such as antibiotics or surgery) than 'negative' studies (no benefit), especially among those with small sample sizes. Egger's test was highly significant ($p < 0.001$), suggesting that the published results may be biased towards finding some benefit from the interventions. This could reflect a trend not to publish studies where, for example, an antibiotic was no better than placebo. In practice, this implies that we must be cautious and not overestimate the effect of interventions based only on the available literature, as this may overestimate benefits. Additionally, we found moderate to high heterogeneity between studies (overall I^2 ~38% in the combined analysis of main effects but reaching 70% when focusing only on antibiotics). This heterogeneity is explained by differences in designs (trials vs cohorts), populations (different ages, comorbidities), definitions of sinusitis, and measured outcomes. Therefore, when interpreting the evidence, it is important to contextualize each study: the results of a hospital trial in adolescents do not necessarily apply to young children in primary care, etc. The heterogeneity also indicates that we need more standardization in future research – for example, using uniform definitions of acute sinusitis and clinical outcomes (treatment failure, symptomatic improvement) to facilitate comparisons.

Evidence gaps and research priorities: The Evidence Gap Map (Figure 4) prepared in this review is particularly illustrative for identifying where research efforts should be directed. Areas well covered by quality evidence were observed, such as the "antibiotics vs clinical cure" axis, which has multiple RCTs and meta-analyses. Similarly, the use of saline irrigation has at least one robust meta-analysis. However, the EGM highlights several critical gaps: one of them is the systematic assessment of adverse events. Few reviews focused on reporting detailed side effects of treatments (beyond mentioning antibiotic-induced diarrhea). It would be valuable for future studies to report not only efficacy but also safety and tolerability metrics in children, to appreciate the full risk-benefit balance.

Another gap identified is the evidence around diagnostic biomarkers and novel strategies: for example, could CRP or procalcitonin distinguish bacterial vs. viral sinusitis and guide antibiotic use? Some narrative reviews, such as Zhao et al.[34], 2020, suggest that very high levels of CRP and ESR correlate with complicated sinusitis, but there is a lack of prospective studies validating markers for everyday clinical use.

There is also little research on the treatment of rhinogenic pain associated with sinusitis. Neither the literature nor the guidelines offer much about how to optimally manage sinus headache in children beyond standard analgesics. Since this affects quality of life, studies on interventions such as local hot packs, physical therapy, or others might be helpful.

An important gap is the lack of randomized clinical trials in surgical interventions. While we understand that for ethical and logistical reasons it is complex, even observational multicenter studies with adjusted comparisons (e.g., children with orbital abscess managed with versus without early surgery) could provide better evidence than isolated cases. In chronic sinusitis, it would be valuable to investigate the role of immunotherapy, allergy management, and other predisposing factors in reducing recurrences, since targeting the underlying factors could prevent acute episodes[9,34].

Strengths and limitations of this umbrella review: One strength of our study is the comprehensive scope: both reviews and guidelines were included, covering therapeutic, diagnostic and preventive dimensions. In addition, we applied a rigorous methodology (extensive search in five databases, double selection and extraction, quality assessment with AMSTAR-2) that increases the reliability of the synthesis. The use of additional analytical tools such as funnel plot, Egger and EGM added a layer of quantitative and visual analysis uncommon in narrative reviews, which enriched the interpretation of the results at a macro level. However, we recognize several limitations. First, the quality of the evidence base influences the conclusions: many of the included reviews relied on old or suboptimal quality primary studies, introducing inherent biases. For example, the definition of acute sinusitis varied between studies, some trials had no ra-

diological or microbiological confirmation, etc. This can affect the accuracy of reported estimates. Second, there was some overlap of primary studies in the reviews (although not absolute). If two reviews included part of the same trials, when synthesizing we could inadvertently be counting duplicate findings. We tried to mitigate this by focusing on high-level conclusions and not adding up numerical data from different reviews directly. Third, we were unable to perform a unified meta-analysis due to the heterogeneity of populations and outcomes – this limits the ability to give a single effect figure, forcing us to take a more qualitative approach. Fourth, we excluded literature in languages other than English/Spanish, so we could have omitted relevant studies published in other languages (although they are unlikely to have altered overall trends). Fifth, although we included clinical guidelines, we do not apply a formal AGREE II evaluation, so our assessment of the guidelines was descriptive. The recommendations of the guidelines are taken into account in the discussion, but we do not weigh their "quality" with the same rigour as the reviews.

Taking into account all of the above, we consider that this umbrella review offers a valuable and up-to-date perspective for clinicians and academics interested in paediatric sinusitis, but its conclusions should be complemented with individual clinical judgment and consideration of the particular characteristics of each patient.

Implications for clinical practice: Key practical messages emerge from this synthesis: (a) Do not rush antibiotics in mild or short-term sinusitis, but evaluate criteria and, if possible, observe briefly; (b) Use the arsenal of supportive measures (nasal washes, hydration, nasal steroids if appropriate) to improve symptoms and potentially reduce antibiotic need; (c) Educate parents about the often self-limiting nature of postviral sinusitis and explain the stepwise management strategy, which can improve adherence and satisfaction; (d) Quickly recognize warning signs that warrant specialized intervention (orbital edema, neurological symptoms, severe focused facial pain, etc.) and do not hesitate to escalate care (imaging, IV antibiotics, referral to ENT); (e) Follow evidence-based guidelines, but adapt them to the individual context and patient – for example, in an environment with high resistance to certain antibiotics, adjust the choice appropriately.

Future research priorities: Based on the gaps identified, priority areas include: 1) Controlled clinical trials on the incremental efficacy of adjuvant therapies (e.g., placebo versus nasal steroid + antibiotic studies, to measure whether they shorten disease duration); 2) Prospective diagnostic studies evaluating biomarkers (CRP, procalcitonin) or predictive clinical scores for bacterial sinusitis, which help physicians decide on antibiotics with greater certainty; 3) Qualitative research on barriers to the implementation of guidelines (Why do doctors continue to prescribe so many antibiotics in sinusitis? Parental pressure? Legal fear? etc.) to design effective educational interventions; 4) Cohorts or trials in orbital complications comparing different timings of surgical intervention, to obtain stronger evidence on this delicate issue; 5) Cost-effectiveness evaluations of the "watchful waiting" versus immediate antibiotic approach, which could convince institutions and health systems to adopt these strategies if resource savings are demonstrated without detriment to results.

CONCLUSIONS

This umbrella review shows that the approach to acute sinusitis in the paediatric population continues to represent a relevant clinical challenge, particularly with regard to the empirical use of antibiotics. The integrated synthesis of systematic reviews and clinical practice guidelines reveals heterogeneous findings: while some studies reported significant benefits of antibiotic treatment in clinical resolution and symptom reduction, other studies found no statistically significant differences compared to placebo. This discrepancy underscores the need to prescribe antibiotics more rationally, based on accurate diagnostic assessment and individual case severity. In this sense, not all children with prolonged rhinorrhea after a viral infection require immediate antimicrobial treatment. The strategy of active surveillance ("watchful waiting") is proposed as a prudent option, reserving the use of antibiotics for those cases with persistent symptoms, clinical aggravation, or clear signs of bacterial infection.

In addition, adjuvant therapies such as nasal saline irrigation and the use of intranasal corticosteroids have demonstrated clinical utility. Although their effect is statistically modest, their incorporation can improve local symptoms such as congestion and rhinorrhoea, thereby reducing the need for systemic analgesics or antibiotics. These interventions, which are safe and low-cost, are emerging as complementary strategies that are particularly useful in mild cases or as support in moderate presentations.

In the surgical field, functional endoscopic sinus surgery (FESS) has established itself as an effective option for patients with refractory chronic sinusitis or severe orbital complications. However, there is still a need to standardize its indications and to support them with higher quality evidence, since they are currently based mainly on observational studies and expert consensus. FESS should be considered only in well-defined situations, since most uncomplicated acute conditions respond favourably to conservative medical treatment.

In short, the proper management of acute childhood sinusitis requires a balance between therapeutic efficacy and diagnostic prudence. The indication of antibiotics should be individualized, complemented with safe interventions that improve the patient's quality of life, and followed by close surveillance that allows timely detection of complications. This analysis also exposes the urgent need to strengthen research in areas that are still weak, with the aim of refining future recommendations. Only through rigorous studies and critical application of available knowledge will it be possible to reduce unnecessary antibiotic prescribing and optimize the treatment of each child with acute sinusitis.

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