



Treatment of Adult Patients with Acute Bacterial Rhinosinusitis: Official Practice Guideline of the Infectious Diseases and Tropical Medicine Research Center Advisory Committee

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Abstract

Context: Acute bacterial rhinosinusitis (ABRS) is a significant public health concern, affecting approximately 15% of the population annually, with a higher prevalence among women. The bacterial etiology primarily includes *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Due to regional variations in bacterial resistance patterns, there is a critical need for localized and evidence-based guidelines for better management in Iranian patients.

Evidence Acquisition: A multidisciplinary team reviewed literature from Iranian and international databases published between January 1990 and 2024. Studies included epidemiological data on ABRS prevalence, bacterial resistance patterns, and clinical outcomes.

Results: First-line empirical antibiotic therapy for uncomplicated ABRS in Iran includes amoxicillin-clavulanate (500 mg/125 mg three times daily or 875 mg/125 mg twice daily). In cases with high antibiotic resistance, high-dose amoxicillin-clavulanate (2000 mg/125 mg extended-release tablets twice daily) is preferred. Respiratory fluoroquinolones (levofloxacin or moxifloxacin) are recommended for penicillin-allergic patients, with alternative options for non-type I hypersensitivity cases.

Conclusions: The guideline standardizes the antimicrobial approach to ABRS in Iran, considering local resistance patterns and clinical evidence.

Keywords: Sinusitis, Rhinosinusitis, Practice Guideline, Iran

1. Context

Acute bacterial rhinosinusitis (ABRS), defined as inflammation of the paranasal sinuses, manifests in two primary forms: Acute (lasting less than 4 weeks) and chronic (lasting over 12 weeks) (1). The clinical manifestation demonstrates substantial variation, ranging from slight facial pressure and troublesome nasal congestion to more severe facial discomfort,

fatigue, and even fevers (1). Sinusitis affects approximately 15% of the population each year, with higher rates observed in women compared to men (2,3). Research indicates a relatively high frequency of ABRS in Iran, estimated at about 53%. Maxillary sinusitis is the most frequent type. However, there's a lack of data on the exact incidence of ABRS, which is likely lower than the general sinusitis prevalence (4).

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1.1. Risk Factors for Acute Bacterial Rhinosinusitis

Older age, viral upper respiratory tract infections, smoking, flight travel, swimming, exposure to atmospheric pressure variations (including activities like deep-sea diving), allergies and asthma, dental diseases, and immunodeficiency are risk factors for ABRS (5).

1.2. Microbiology

The etiology of sinusitis can be bacterial, viral, or fungal. Most instances of acute sinusitis are viral, especially rhinoviruses. In the order listed, *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* are the most often found bacterial species in sinus aspirates from both adults and children (1, 6).

1.3. Scope and Purpose

This Iranian guideline aims to standardize antimicrobial treatment and patient care for ABRS in the general population through evidence-based management strategies. Due to significant regional variations in bacterial etiology, antibiotic resistance patterns, drug availability, healthcare infrastructure, and resource constraints, the need for geographically specific guidelines is emphasized. Overall, these guidelines equip healthcare professionals with the tools to make informed decisions regarding initial empiric antibiotic therapy and subsequent evaluation of infectious etiology in ABRS management.

2. Method

A team of experts from various disciplines reviewed relevant data published between January 1990 and April 2024. This data came from Iranian databases (IranMedex, Irandoc, MagIran) and international sources (Google Scholar, Scopus, PubMed, SID). They also included studies from PubMed to ensure comprehensive coverage. The review focused on studies from Iran that investigated the prevalence, serotype distribution, and antibiotic resistance patterns of key bacterial pathogens involved in ABRS. These pathogens included *S. pneumoniae*, *M. catarrhalis*, and *H. influenzae*. The studies analyzed clinical samples from various sources relevant to ABRS, such as the nasopharynx, ears, eyes, and sinuses. Carrier studies analyzing nasopharyngeal specimens were also included.

The expert panel employed a structured, iterative consensus-building process using a modified Delphi technique: Multidisciplinary specialists (infectious disease specialists and clinical pharmacists) with ≥ 5 years of experience first reviewed evidence from Iranian and international databases to draft preliminary recommendations. Anonymous voting identified areas of disagreement (consensus threshold: $\geq 70\%$ agreement), followed by moderated virtual discussions to reconcile conflicting views, prioritizing local Iranian data (e.g., antibiotic resistance patterns) and grading of recommendations, assessment, development, and evaluation (GRADE) criteria for clinical relevance. Recommendations underwent final anonymous voting, with unresolved items deferred or excluded.

2.1. Grading of Guideline Recommendations

We utilized the GRADE criteria alongside expert opinion to evaluate the evidence for each recommendation (7). The PICO analysis is summarized in Table 1. The definitions for the quality of evidence used in the assessment are detailed in Table 2, and the framework for assigning the strength of recommendation is provided in Table 3.

3. Recommendations

3.1. Which Antibiotics are Recommended as First-Line Empiric Therapy for Adults with Uncomplicated Acute Bacterial Rhinosinusitis?

The primary course of treatment for the majority of patients diagnosed with ABRS should consider the significant resistance rates observed in Iran.

- Amoxicillin-clavulanate (500 mg/125 mg orally three times daily or 875 mg/125 mg orally twice daily) is recommended as first-line therapy (1A).

- High-dose amoxicillin-clavulanate (2000 mg/125 mg extended-release tablets orally twice daily) is recommended as first-line therapy in cases where there is a significant concern about antibiotic resistance, particularly due to the high prevalence of penicillin-nonsusceptible *S. pneumoniae* (2A).

- The administration of β -lactams and/or co-trimoxazole would not have the desired therapeutic effect (3C).

- Monotherapy with clindamycin, 3rd generation cephalosporin, or doxycycline is not recommended (2B).

Table 1. PICO Analysis

Author/Year	Population	Number of Subjects	Intervention and Control	Outcome Measures	Results	Type of Test	Study Methodology	GRADE Assessment
Amiri et al. (2015), (4)	Iranian population with sinusitis	1,057	Meta-analysis of studies	Prevalence of various types of sinusitis	Overall prevalence: 53% (CI 40% - 65%), maxillary: 68%, frontal: 17%, ethmoid: 31%, sphenoid: 19%	N. A.	Systematic review and meta-analysis	1
Hatami et al. (2024), (8)	<i>Haemophilus influenzae</i> and <i>Moraxella catarrhalis</i> isolates in Iran	189 isolates	Systematic review of antibiotic resistance patterns	Antibiotic resistance patterns of <i>H. influenzae</i> and <i>M. catarrhalis</i>	<i>H. influenzae</i> : High resistance to ampicillin, <i>M. catarrhalis</i> : High resistance to penicillin	N. A.	Systematic review	2
Khademi and Sahebkar (2021), (9)	<i>Streptococcus pneumoniae</i> isolates from Iran	1,249 reports from 58 studies	Meta-analysis of studies	Prevalence of penicillin-nonsusceptible and multidrug-resistant <i>S. pneumoniae</i>	PNSP: 46.9%, MDR: 45.3%, high resistance to erythromycin, azithromycin	N. A.	Systematic review and meta-analysis	1
Khoramrooz et al. (2012), (10)	Iranian children with OME	15 centers	48 OME patients (63 middle ear fluid samples, 48 adenoid tissues)	PCR and bacterial culture methods for pathogen detection	Bacterial detection: <i>Alloicoccus otitidis</i> : 23.8% (culture), 36.5% (PCR); <i>S. pneumoniae</i> : 35.5% (adenoid culture), 31.2% (PCR) antimicrobial susceptibility; Most isolates sensitive to ampicillin, amoxicillin/clavulanate, fluoroquinolones	Disc diffusion method	Cross-sectional observational study	4
Eghbali et al. (2020), (11)	Patients with respiratory tract infections in northern Iran	280 patients, 120 controls	Isolation and susceptibility testing of <i>M. catarrhalis</i>	Prevalence of <i>M. catarrhalis</i> and antibiotic resistance patterns	Resistance to penicillin, presence of β -lactamase, various resistance genes detected	Disc diffusion method	Observational study	4
Farajzadeh Sheikh et al. (2021), (12)	Patients with CAP in southwest Iran	92 sputum samples	Detection of <i>S. pneumoniae</i> and <i>H. influenzae</i> using culture and M-PCR methods	Detection rates and antibiotic resistance patterns of <i>S. pneumoniae</i> and <i>H. influenzae</i>	Detection rates (culture): <i>S. pneumoniae</i> : 16.3%; <i>H. influenzae</i> : 7.6%; detection rates (M-PCR): <i>S. pneumoniae</i> : 35.8%; <i>H. influenzae</i> : 11.9%; Antibiotic resistance: <i>S. pneumoniae</i> : 13.3% resistant to ceftriaxone; <i>H. influenzae</i> : 28.6% resistant to clarithromycin, ceftriaxone, gentamicin	Disc diffusion method	Cross-sectional observational study	4
Yousefi et al. (2021), (13)	<i>S. pneumoniae</i> isolates in Iran	33 studies (total isolates not specified)	Systematic review of serotype distribution and resistance patterns	Frequency of <i>S. pneumoniae</i> , serotype distribution, and antimicrobial resistance patterns	High resistance to co-trimoxazole, penicillin, erythromycin, common serotypes: 23F, 19F	N. A.	Systematic review	4
Shokouhi et al. (2019), (14)	<i>S. pneumoniae</i> isolates in Iran	2,723 cases across 25 studies	Review of macrolide resistance patterns	Resistance patterns and mechanisms of <i>S. pneumoniae</i> to macrolides	Mean macrolide resistance: 48.43%, ermB and mfa mutations prevalent	N. A.	Narrative review	4
Kargar et al. (2014), (15)	<i>S. pneumoniae</i> isolates from hospitals in Iran	82 isolates	PCR-RFLP analysis of quinolone resistance-determining regions	Presence of mutations in quinolone resistance genes and antibiotic susceptibility	Mutation rates: parC: 75.56%, gyrA: 68.89%, high resistance to nalidixic acid	Disc diffusion method	Observational study	4
Beheshti et al. (2020), (16)	<i>S. pneumoniae</i> isolates from clinical samples in Tehran, Iran	44 invasive isolates	Analysis of antibiotic resistance and molecular characterization	Resistance patterns, capsular types, and genetic diversity of <i>S. pneumoniae</i>	High erythromycin resistance (73%), MDR in penicillin-resistant strains, common types: 6A/B, 19A	Disc diffusion method	Observational study	4
Mohammadi Gharibani et al. (2019), (17)	Healthy children in Ardabil, Iran	43 isolates	Analysis of antibiotic resistance and resistance mechanisms	Antibiotic resistance patterns and genetic mechanisms of macrolide resistance	High macrolide resistance: Erythromycin 74.4%, genetic: 100% mfa/E, 81.25% ermB	E-test strips method	Cross-sectional observational study	4
Shooraj et al. (2019), (18)	Children under 6 years old in Iran	328 nasopharynx swabs	Analysis of clonal diversity and antibiotic resistance	Prevalence, antibiotic resistance patterns, and clonal diversity of <i>H. influenzae</i>	73 strains of <i>H. influenzae</i> , 42% resistance to chloramphenicol, 43% to ampicillin, 28 PFGE patterns	Disc diffusion method	Cross-sectional observational study	4

Abbreviations: GRADE, grading of recommendations, assessment, development, and evaluation; PNSP, penicillin-nonsusceptible *Streptococcus pneumoniae*; OME, otitis media with effusion; CAP, community-acquired pneumonia.

- Macrolides monotherapy is not recommended for empirical treatment due to high resistance rates among

S. pneumoniae and potential methylation and efflux-mediated resistance (2B).

Table 2. Quality of Evidence Definition

Quality of Evidence	Description	Source of Evidence
1	High confidence that the true effect lies close to that of the estimate of the effect.	Evidence from multiple well-conducted RCTs or meta-analyses of RCTs.
2	The true effect is likely to be close to the estimate, but there is a possibility that it is different.	Evidence from one or more RCTs with limitations or strong evidence from well-designed observational studies.
3	The true effect may be substantially different from the estimate.	Evidence from well-conducted cohort or case-control studies, or downgraded RCTs with significant limitations.
4	The true effect is likely to be substantially different from the estimate.	Evidence from observational studies with significant limitations, non-randomized studies, or expert opinion.
5	Any estimate of effect is very uncertain.	Evidence from unsystematic clinical observations, case reports, or expert opinion without strong supporting data.

Abbreviation: RCTs, randomized controlled trials.

Table 3. Strength of Recommendation

Strength of Recommendation	Descriptions
A (strong)	The benefits of the recommended intervention clearly outweigh the risks. High confidence in its efficacy.
B (moderate)	The benefits of the intervention outweigh the risks, but there is less certainty about the balance of benefits and risks.
C (weak/optional)	The balance between benefits and risks is uncertain or close, making the recommendation more context-dependent.

- To overcome resistance to *H. influenzae* and *M. catarrhalis*, a macrolide can also be added (3C).

3.2. Which Antibiotic is Recommended for Adults with Uncomplicated Acute Bacterial Rhinosinusitis Who Experience Penicillin Allergy?

- For adults diagnosed with uncomplicated ABRS who have a penicillin allergy, a respiratory fluoroquinolone such as levofloxacin (750 mg or 500 mg orally once daily) or moxifloxacin (400 mg orally once daily) for 5 to 7 days is recommended as an alternative for empiric antimicrobial therapy (3C).

- If an immediate-type hypersensitivity response is confirmed through skin testing, which is strongly advised for patients with a questionable history of penicillin allergy, treatment with respiratory fluoroquinolones is recommended (4C).

- Macrolides and TMP/SMX, previously used for patients allergic to penicillin, are no longer recommended due to increasing resistance among penicillin-nonsusceptible *S. pneumoniae* (2B).

- If monitoring and facilities for outpatient therapy are accessible, intravenous 3rd generation cephalosporin with close monitoring could be recommended for patients with penicillin intolerance/non-Type I hypersensitivity reactions (3C).

- TMP/SMX and macrolides are not recommended unless the patient is β -lactam allergic due to limited effectiveness against major ABRS pathogens and possible bacterial failure (2B).

3.3. Which Antibiotic is Recommended for Adults with Uncomplicated Acute Bacterial Rhinosinusitis Who Experience Treatment Failure?

- For adults diagnosed with uncomplicated ABRS who experience treatment failure, a change in management is necessary. This is defined as the patient not improving or worsening within 7 days of diagnosis. If there is no response to antimicrobial therapy after 72 hours, either switching to a different antibiotic or re-evaluating the patient is recommended (3C).

- For patients initially managed with observation and later experiencing treatment failure, starting treatment with high-dose amoxicillin with clavulanate is advised (2B).

- Penicillin-allergic patients should consider using a respiratory fluoroquinolone like levofloxacin or moxifloxacin (2B).

- In adults with a history of non-type I hypersensitivity to penicillin, ceftriaxone may be appropriate (3C).

- Fluoroquinolones (levofloxacin or moxifloxacin) should be reserved for cases with known resistance or

treatment failure to avoid promoting further resistance (2B).

- If monitoring and facilities for outpatient therapy are accessible, 3rd generation cephalosporin with close monitoring could be recommended (4C).

- For patients who do not respond to initial treatment, initiating therapy with cefixime and clindamycin is recommended (4C).

4. Summary of Evidence

In Iran, *S. pneumoniae* exhibits varying levels of antibiotic resistance, including resistance to amoxicillin. Studies indicate a high prevalence of penicillin-nonsusceptible *S. pneumoniae* (PNSP) strains, with amoxicillin resistance rates reaching 30.5% (9). Living in regions where PNSP rates exceed 10% poses a significant risk factor for pneumococcal resistance (19). Additionally, due to the production of β -lactamase by *M. catarrhalis* and *H. influenzae*, amoxicillin proves ineffective against these pathogens, thus it is not recommended as a first-line therapy in Iran. In line with regional trends, high rates of amoxicillin resistance have been observed in *M. catarrhalis* isolates, with studies reporting resistance rates of 100% and 81.2% (10, 11). These findings suggest amoxicillin may not be a suitable first-line therapy for *M. catarrhalis* infections. While the prevalence of β -lactamase-producing *H. influenzae* in the United States ranges from 27% to 43% and is not expected to respond to amoxicillin without clavulanate (20), resistance to amoxicillin-clavulanate is very high in Iran; specifically, the antibiotic resistance to amoxicillin-clavulanate for *H. influenzae* in patients with community-acquired pneumonia is around 85.7%. However, this resistance rate cannot be extrapolated to patients with ABRS (12). In Iran, studies have extensively investigated the resistance patterns of *S. pneumoniae* to various antibiotics, but there is no specific mention of amoxicillin-clavulanate resistance in the provided contexts. Among respiratory pathogens in Iran, ceftriaxone demonstrated the most favorable resistance profile, with resistance rates of 13.3% for *S. pneumoniae*, 28.6% for *H. influenzae*, and 6.2% for *M. catarrhalis* isolates (8, 12, 13). Consistent with prior reports of geographically variable macrolide resistance (10% - 100%), one analysis of 25 studies (n = 2723) identified a mean resistance rate of 48.43% (CI, 38.8 - 57.9%) (14); additionally, macrolides showed efficacy against both *H. influenzae* and *M. catarrhalis* isolates, highlighting their

potential as effective therapeutic options (8). Fluoroquinolone resistance in *S. pneumoniae* is a concerning issue in Iran, as studies have shown a significant correlation between quinolone resistance development and mutations in the *parE*, *parC*, and *gyrA* genes (15). Studies conducted in Iran have demonstrated heterogeneity in ciprofloxacin susceptibility among respiratory pathogens. *Streptococcus pneumoniae* exhibits the lowest resistance rates (0 - 11%), whereas *M. catarrhalis* (0 - 70%) and *H. influenzae* (0 - 57.1%) display a wider range of susceptibility (8, 11, 12, 21). Studies investigating levofloxacin resistance in *S. pneumoniae* from Iran have documented regional variations. Research in Tehran found a low prevalence (2%) of levofloxacin-resistant invasive *S. pneumoniae* isolates (16). Further supporting this trend, a separate cross-sectional study involving 43 isolates of *S. pneumoniae* from healthy children in Ardabil reported no resistance to levofloxacin (17). Similarly, studies evaluating fluoroquinolone susceptibility among respiratory pathogens, including *M. catarrhalis* and *H. influenzae*, observed a 0% resistance rate to levofloxacin (10, 12, 18). These findings collectively suggest potentially low levels of levofloxacin resistance in *S. pneumoniae* and some other respiratory bacteria associated with ABRS in Iran. Furthermore, levofloxacin resistance in Iranian children was found to be 0.8% and 1.7% for *S. pneumoniae*, respectively, based on a subgroup analysis of 27 studies (9). In a cross-sectional study conducted in Ardabil, antibiotic resistance profiles of 43 *S. pneumoniae* isolates from healthy children were determined using the disk diffusion method. Clindamycin resistance was identified in 28% of isolates, with no evidence of inducible resistance (17). Unfortunately, direct assessment of doxycycline resistance among *S. pneumoniae* in Iran remains a topic for future investigation.

5. Research Needed in Iran

There is a notable scarcity of head-to-head randomized clinical trials and robust evidence concerning the management of patients with ABRS. Additionally, there is a pressing need for clinical trials that juxtapose different antimicrobial treatment protocols for outpatient settings. These trials should thoroughly evaluate the occurrence of adverse effects associated with antibiotics. It is imperative to disseminate the findings of antibiograms featuring

broad-spectrum antibiotics and to gauge the prevalence of particular pathogens to enhance the detection of antimicrobial susceptibility. Moreover, research into the antimicrobial resistance of antibiotics like clindamycin and doxycycline against ABRS pathogens is scarce and should be explored.

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Footnotes

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References

- Chow AW, Benninger MS, Brook I, Brozek JL, Goldstein EJ, Hicks LA, et al. IDSA clinical practice guideline for acute bacterial rhinosinusitis in children and adults. *Clin Infect Dis*. 2012;54(8):e72-e112. [PubMed ID: 22438350]. <https://doi.org/10.1093/cid/cir1043>.
- Osguthorpe JD, Hadley JA. Rhinosinusitis. Current concepts in evaluation and management. *Med Clin North Am*. 1999;83(1):27-41. vii-viii. [PubMed ID: 9927958]. [https://doi.org/10.1016/s0027-1222\(05\)70085-7](https://doi.org/10.1016/s0027-1222(05)70085-7).
- Brooks I, Gooch WM, Jenkins SG, Pichichero ME, Reiner SA, Sher I, et al. Medical management of acute bacterial sinusitis. Recommendations of a clinical advisory committee on pediatric and adult sinusitis. *Ann Otol Rhinol Laryngol Suppl*. 2000;182:2-20. [PubMed ID: 10823486].
- Amiri A, Andy S, Sarookhani D, Tavirany MR. Prevalence of Sinusitis in Iran: a systematic review and meta-analysis study. *Der Pharmacia Lettre*. 2016;8(5):31.
- Wilson JF. In the clinic. Acute sinusitis. *Ann Intern Med*. 2010;153(5):ITC31-15. quiz ITC316. [PubMed ID: 20820036]. <https://doi.org/10.7326/0003-4819-153-5-201009070-01003>.
- Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, Brook I, Ashok Kumar K, Kramper M, et al. Clinical practice guideline (update): adult sinusitis. *Otolaryngol Head Neck Surg*. 2015;152(2 Suppl):S1-S39. [PubMed ID: 25832968]. <https://doi.org/10.1177/0194599815572097>.
- Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, Flottorp S, et al. Grading quality of evidence and strength of recommendations. *BMJ*. 2004;328(7454):1490. [PubMed ID: 15205295]. [PubMed Central ID: PMC428525]. <https://doi.org/10.1136/bmj.328.7454.1490>.
- Hatami F, Allahverdi Nazhand H, Ebadi H, Zeininasab AH, Javandoust Gharehbagh F, Shahrokh S, et al. Antimicrobial Resistance Pattern of Moraxella catarrhalis and Haemophilus influenza in Iran; a Systematic Review. *Infect Epidemiol Microbiol*. 2024;10(1):21-9. <https://doi.org/10.61186/iejm.10.1.21>.
- Khademi F, Sahebkar A. Is Penicillin-Nonsusceptible Streptococcus pneumoniae a Significant Challenge to Healthcare System? A Systematic Review and Meta-Analysis. *Scientifica*. 2021;2021:5573345. [PubMed ID: 34136307]. [PubMed Central ID: PMC8175142]. <https://doi.org/10.1155/2021/5573345>.
- Khoramrooz SS, Mirsalehian A, Emaneini M, Jabalameli F, Aligholi M, Saedi B, et al. Frequency of Alloicoccus otitidis, Streptococcus pneumoniae, Moraxella catarrhalis and Haemophilus influenzae in children with otitis media with effusion (OME) in Iranian patients. *Auris Nasus Larynx*. 2012;39(4):369-73. [PubMed ID: 21868180]. <https://doi.org/10.1016/j.anl.2011.07.002>.
- Eghbali M, Baserisalehi M, Ghane M. Isolation, identification, and antibacterial susceptibility testing of Moraxella catarrhalis isolated from the respiratory system of patients in northern Iran. *Med Lab J*. 2020;14(3):19. <https://doi.org/10.2952/mlj.14.3.19>.
- Farajzadeh Sheikh A, Rahimi R, Meghdadi H, Alami A, Saki M. Multiplex polymerase chain reaction detection of Streptococcus pneumoniae and Haemophilus influenzae and their antibiotic resistance in patients with community-acquired pneumonia from southwest Iran. *BMC Microbiol*. 2021;21(1):343. [PubMed ID: 34906085]. [PubMed Central ID: PMC8670030]. <https://doi.org/10.1186/s12866-021-02408-7>.
- Yousefi M, Mohammadi M, Afshar D, Nazari-Alam A. Evaluation of frequency, drug resistance and serotyping of streptococcus pneumoniae in Iran: A systematic review. *J Babol Univ Med Sci*. 2021;23(1).
- Shokouhi S, Alavi Darazam I, Yazdanpanah A. Resistance of Streptococcus Pneumoniae to Macrolides in Iran. *Tanaffos*. 2019;18(2):104-11. [PubMed ID: 32440297]. [PubMed Central ID: PMC7230132].
- Kargar M, Moein Jahromi F, Doosti A, Handali S. Molecular Investigation of Quinolone Resistance of Quinolone Resistance-Determining Region in Streptococcus pneumoniae Strains Isolated from Iran Using Polymerase Chain Reaction-Restriction Fragment Length Polymorphism Method. *Osong Public Health Res Perspect*. 2014;5(5):245-50. [PubMed ID: 25389509]. [PubMed Central ID: PMC4225646]. <https://doi.org/10.1016/j.phrp.2014.08.010>.
- Beheshti M, Jabalameli F, Feizabadi MM, Hahsemi FB, Beigverdi R, Emaneini M. Molecular characterization, antibiotic resistance pattern and capsular types of invasive Streptococcus pneumoniae isolated from clinical samples in Tehran, Iran. *BMC Microbiol*. 2020;20(1):167. [PubMed ID: 32546124]. [PubMed Central ID: PMC7298763]. <https://doi.org/10.1186/s12866-020-01855-y>.

17. Mohammadi Gharibani K, Azami A, Parvizi M, Khademi F, Mousavi SF, Arzanlou M. High Frequency of Macrolide-Resistant *Streptococcus pneumoniae* Colonization in Respiratory Tract of Healthy Children in Ardabil, Iran. *Tanaffos*. 2019;18(2):118-25. [PubMed ID: 32440299]. [PubMed Central ID: PMC7230131].
18. Shoora F, Mirzaei B, Mousavi SF, Hosseini F. Clonal diversity of *Haemophilus influenzae* carriage isolated from under the age of 6 years children. *BMC Res Notes*. 2019;12(1):565. [PubMed ID: 31506105]. [PubMed Central ID: PMC6737650]. <https://doi.org/10.1186/s13104-019-4603-7>.
19. Patel ZM, Hwang PH. Acute Bacterial Rhinosinusitis. In: Durand M, Deschler D, editors. *Infections of the Ears, Nose, Throat, and Sinuses*.
20. Cham, Switzerland: Springer; 2018. p. 133-43. https://doi.org/10.1007/978-3-319-74835-1_11.
21. Sahm DF, Brown NP, Draghi DC, Evangelista AT, Yee YC, Thornsberry C. Tracking resistance among bacterial respiratory tract pathogens: summary of findings of the TRUST Surveillance Initiative, 2001-2005. *Postgrad Med*. 2008;120(3 Suppl 1):8-15. [PubMed ID: 18931466]. <https://doi.org/10.3810/pgm.2008.09.suppl12.279>.
21. Alavi Darazam I, Kazeminia N, Yadegarinia D, Mardani M, Shokouhi S, Rabiei MM, et al. Treatment of Patients with Community-Acquired Pneumonia: Official Practice Guideline of the Infectious Diseases and Tropical Medicine Research Center Advisory Committee. *Arch Clin Infect Dis*. 2023;18(1). <https://doi.org/10.5812/archcid-133876>.