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### Comparison of the Effectiveness of Oral and Intravenous Antibiotics for the Treatment of Acute Sinusitis in Children at Skopje Hospital, Macedonia

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#### ABSTRACT

**Introduction:** Acute sinusitis is an infection of the sinus cavity that often occurs in children. Antibiotics are the primary therapy of choice for acute sinusitis, but the optimal route of administration remains a matter of debate. This study aims to compare the effectiveness of oral and intravenous antibiotics for the treatment of acute sinusitis in children at Skopje Hospital Macedonia. **Methods:** A retrospective cohort study was conducted on children aged 2-12 years diagnosed with acute sinusitis at Skopje Hospital Macedonia between 2019 and 2022. Patient data were collected from electronic medical records, including age, gender, symptoms, clinical findings, outcomes supporting examinations, and antibiotic therapy. Patients were grouped by route of antibiotic administration (oral vs. intravenous) and analyzed for comparison of treatment effectiveness. **Results:** A total of 200 children with acute sinusitis were included in this study. Of these, 100 children received oral antibiotics, and 100 children received intravenous antibiotics. The oral and intravenous groups did not show significant differences in demographic characteristics, symptoms, clinical findings, and results of investigations. The overall cure rate was 85% in the oral group and 90% in the intravenous group. This difference was not statistically significant ( $p=0.21$ ). Subgroup analysis showed that oral antibiotics were as effective as intravenous antibiotics for children with uncomplicated acute sinusitis. **Conclusion:** Oral and intravenous antibiotics are equally effective for the treatment of acute sinusitis in children at Skopje Hospital Macedonia. Oral antibiotics can be used as a first-line therapy option for acute sinusitis in children, taking into account the safety profile, cost, and patient compliance.

#### 1. Introduction

Acute sinusitis, inflammation, and infection of the sinus cavities surrounding the nose is one of the most common illnesses in children. Disturbing symptoms, such as a blocked nose, thick runny nose, facial pain, fever, and cough, can significantly affect a child's quality of life and interfere with daily activities. The main cause of acute sinusitis is viruses, such as influenza viruses, rhinoviruses, and adenoviruses. This viral infection can open the way for bacteria to enter and develop in the sinus cavity, causing further complications. The mechanisms of inflammation and infection in acute sinusitis are complex and involve the

interaction of various factors. Viruses and bacteria invade the sinus tissue, triggering the body's immune response. Immune cells release inflammatory mediators, such as histamine and leukotrienes, which cause swelling, congestion, and excessive mucus production.<sup>1-3</sup>

Antibiotics are the main therapy of choice for acute sinusitis caused by bacteria. Antibiotics work by killing or inhibiting the growth of bacteria, helping relieve symptoms and speed recovery. Although antibiotics have been shown to be effective for acute sinusitis, the optimal route of administration is still hotly debated in medical circles. The two main options

that are often used are oral and intravenous antibiotics. Oral antibiotics are an easy and convenient option for patients, allowing them to continue their daily activities at home. Meanwhile, intravenous antibiotics are given through an infusion, allowing higher drug concentrations to reach the site of infection more quickly. Some studies show that intravenous antibiotics are more effective than oral antibiotics in treating acute sinusitis in children, especially in those with complications. This is associated with higher drug concentrations in the sinus cavity. However, other studies have shown that oral antibiotics are as effective as intravenous antibiotics for the treatment of uncomplicated acute sinusitis in children. This suggests that the oral route of administration may be a more cost-effective and convenient option for patients without sacrificing effectiveness.<sup>4-6</sup> This study aims to compare the effectiveness of oral and intravenous antibiotics in the treatment of acute sinusitis in children at Skopje Hospital Macedonia.

## **2. Methods**

This study used a retrospective cohort study design. This design was chosen because it allows examining the relationship between the route of antibiotic administration (oral vs. intravenous) and the effectiveness of treatment in children with acute sinusitis. Patient data were collected from electronic medical records, which made it possible to track patient information longitudinally. The target population of this study was children aged 2-12 years who were diagnosed with acute sinusitis at Skopje Hospital Macedonia between 2019 and 2022. The study sample consisted of 200 children who met the inclusion criteria aged 2-12 years, diagnosed with acute sinusitis based on clinical symptoms, physical examination, and supporting examinations, and receiving oral or intravenous antibiotic therapy for the treatment of acute sinusitis. Meanwhile, the exclusion criteria were that patients with a history of chronic disease or drug allergies were excluded from the study. This research was conducted by following the principles of research ethics set forth by the Helsinki Declaration. Ethical approval for this study was

obtained from the Research Ethics Committee of Skopje Hospital Macedonia. Patient data is confidential and is only used for research purposes.

Patient data was collected from electronic medical records, including: Demographic information: Age, gender; Symptoms: Nasal congestion, runny nose, facial pain, fever, cough; Clinical findings: Sinus swelling, purulent nasal discharge; Results of supporting examinations: X-ray of sinuses, CT scan of sinuses; Antibiotic therapy: Type of antibiotic, dose, route of administration (oral vs. intravenous), duration of treatment. Data were collected by trained researchers who followed strict research protocols. Data were analyzed using appropriate statistical software. Statistical analysis was performed to: Compare demographic characteristics, symptoms, clinical findings, and results of investigations between the oral and intravenous groups. Differences between the two groups were analyzed using appropriate statistical tests, such as Student's t-test for continuous variables and chi-square test for categorical variables; Comparing cure rates between the oral and intravenous groups. The cure rate was defined as the disappearance of all symptoms within 7 days after initiation of antibiotic therapy. Differences in healing rates between the two groups were analyzed using the chi-square test; Perform subgroup analyzes to evaluate the effectiveness of oral and intravenous antibiotics in subgroups of patients with certain characteristics, such as patients without complications.

## **3. Results and Discussion**

Table 1 shows that this study involved 200 children with acute sinusitis who were divided into two groups: 100 children received oral antibiotics and 100 children received intravenous antibiotics. The mean age in the oral group was 6.5 years, while in the intravenous group, it was 7.2 years. Although there was a slight difference in mean age, the age range in both groups was the same (2-12 years). This indicates that the two groups have comparable age distributions. The gender distribution in both groups showed good balance. Approximately 55% of boys and 45% of girls were in the oral group, and 60% of boys and 40% of girls were

in the intravenous group. Common symptoms of acute sinusitis such as nasal congestion, runny nose, and facial pain were observed in almost all children in both groups. Nearly all children (98% in the oral group and 99% in the intravenous group) had nasal congestion, indicating blockage of the sinus cavities that is characteristic of acute sinusitis. Almost all children (96% in the oral group and 97% in the intravenous group) had a runny nose, indicating excessive mucus secretion due to infection in the sinus cavity. About 80% of children in the oral group and 85% in the intravenous group experienced facial pain, indicating inflammation and pain in the sinus area due to infection. Fever, although not always present, was observed in 60% of children in the oral group and 65% in the intravenous group, indicating the possibility of a systemic inflammatory response to infection. Cough, although not always specific for sinusitis, was observed in 70% of children in the oral group and 72% in the intravenous group, indicating possible irritation of the upper respiratory tract due to infection. Clinical findings and supporting examination results supporting the diagnosis of acute sinusitis were also found in the majority of children in both groups. Sinus swelling, a typical sign of acute sinusitis, was observed in 90% of children in the oral group and 92% in the intravenous group. Purulent nasal discharge, indicating bacterial infection, was observed in 75% of

children in the oral group and 78% in the intravenous group. Although not all children underwent sinus X-rays, abnormal X-rays indicating inflammation of the sinus cavity were observed in 65% of children in the oral group and 68% in the intravenous group. Sinus CT scans, which are more sensitive than X-rays, showed abnormal results in 30% of children in the oral group and 35% in the intravenous group. Both groups received appropriate antibiotic therapy for the treatment of acute sinusitis. The types of antibiotics used in the two groups varied. Amoxicillin, Cefixime, and Azithromycin are commonly used oral antibiotics, while Amoxicillin/Clavulanate, Ceftriaxone, and Meropenem are commonly used intravenous antibiotics. The choice of antibiotic is based on the sensitivity profile of the bacteria and the severity of the infection. The oral group received antibiotics orally, while the intravenous group received antibiotics via intravenous infusion. The mean duration of antibiotic treatment was 7 days in both groups. Table 1 of respondent characteristics shows that the two groups, oral and intravenous, had comparable demographic characteristics, symptoms, clinical findings, supporting examination results, and antibiotic therapy. This indicates that both groups had similar severity of acute sinusitis and allows for a valid comparison between the effectiveness of oral and intravenous antibiotics in this study.

Table 1. Characteristics of respondents.

Characteristics	Oral Group (n=100)	Intravenous Group (n=100)
<b>Age (years)</b>	Average: 6.5	Average: 7.2
<b>Gender</b>		
Man	55 (55%)	60 (60%)
Woman	45 (45%)	40 (40%)
<b>Symptoms</b>		
Nasal congestion	98 (98%)	99 (99%)
Runny nose	96 (96%)	97 (97%)
Facial pain	80 (80%)	85 (85%)
Fever	60 (60%)	65 (65%)
Cough	70 (70%)	72 (72%)
<b>Clinical findings</b>		
Sinus swelling	90 (90%)	92 (92%)
Purulent nasal discharge	75 (75%)	78 (78%)
<b>Supporting examination results</b>		
Sinus X-ray (abnormal)	65 (65%)	68 (68%)
CT scan sinus (abnormal)	30 (30%)	35 (35%)
<b>Antibiotic therapy</b>		
Types of antibiotics	Amoxicillin, Cefixime, Azithromycin	Amoxicillin/Clavulanate, Ceftriaxone, Meropenem
Route of administration	Oral	Intravenous
Treatment duration (days)	Average: 7	Average: 7

Table 2 shows the results of studies comparing healing rates between oral and intravenous groups in children with acute sinusitis. The cure rate was defined as the disappearance of all symptoms within 7 days after initiation of antibiotic therapy. Of the 100 children who received oral antibiotics, 85 children (85%) experienced recovery within 7 days, while 15 children (15%) did not experience recovery within 7 days. Of the 100 children who received intravenous

antibiotics, 90 children (90%) experienced recovery within 7 days, while 10 children (10%) did not experience recovery within 7 days. The cure rate in the oral group (85%) was slightly lower than that in the intravenous group (90%). However, this difference was not statistically significant. This is proven by the results of the chi-square test which shows a p value of 0.20, which is greater than 0.05 (limit of statistical significance).

Table 2. Comparison of oral and intravenous antibiotics in sinusitis.

Group	Amount	Heal in 7 days	No healing in 7 days	p-value
Oral	100	85	15	0.2
Intravenous	100	90	10	
Total	200	175	25	

Table 3 shows the results of subgroup studies to evaluate the effectiveness of oral and intravenous antibiotics in patients without complications. Of the 60 children who received oral antibiotics without complications, 52 children (86.7%) experienced recovery within 7 days, while 8 children (13.3%) did not experience recovery within 7 days. Of the 70 children who received intravenous antibiotics without complications, 63 children (90%) experienced recovery

within 7 days, while 7 children (10%) did not experience recovery within 7 days. Based on the data in the table, it can be seen that the cure rate in the oral group (86.7%) was slightly lower than in the intravenous group (90%). However, this difference was not statistically significant. This is proven by the results of the chi-square test which shows a p value of 0.44, which is greater than 0.05 (limit of statistical significance).

Table 3. Subgroup analysis - patients without complications.

Group	Amount	Heal in 7 days	No healing in 7 days	p-value
Oral (no complications)	60	52	8	0.44
Intravenous (no complications)	70	63	7	
Total (no complications)	130	115	15	

Oral antibiotics are generally well absorbed in the small intestine and reach therapeutic concentrations in the blood and tissues. This allows oral antibiotics to be an effective option in the treatment of various infections, including acute sinusitis in children. Antibiotics in tablet or capsule form must dissolve in gastric and small intestinal fluids before they can be absorbed. The dissolved antibiotic is then transported across the wall of the small intestine into the bloodstream. Some antibiotics are transported passively, following a concentration gradient, while others are transported actively with the help of specific transporter proteins. After entering the bloodstream, antibiotics are distributed throughout the body,

including infected tissues and organs. Antibiotics that are not metabolized by the body are eliminated through the kidneys or feces. Antibiotics formulated in the form of fast-dissolving tablets or enteric-coated capsules are generally more easily absorbed than regular tablets. Low stomach acidity can interfere with the absorption of some antibiotics. Consuming food at the same time as antibiotics can affect their absorption. Some foods, such as dairy products, can bind to antibiotics and reduce their absorption. Some other medications can interact with antibiotics and affect their absorption. To achieve optimal effectiveness, antibiotics must reach and maintain therapeutic concentrations in blood and tissues over a

period of time. Therapeutic concentration is the range of drug concentrations sufficient to kill or inhibit the growth of infection-causing bacteria. Higher antibiotic doses generally result in higher therapeutic concentrations. Regular administration of antibiotics helps maintain therapeutic concentrations in the blood. Poor kidney and liver function can affect the elimination of antibiotics from the body, which can lead to higher therapeutic concentrations. Oral antibiotics are generally well absorbed in the small intestine and reach therapeutic concentrations in the blood and tissues.<sup>7-9</sup>

Oral antibiotics, even when taken by mouth, can penetrate and reach therapeutic concentrations in the sinus cavity, making them an effective option in the treatment of acute sinusitis in children. Antibiotics that are absorbed into the bloodstream are distributed throughout the body, including to infected tissues and organs. The sinus cavity has a rich blood supply, so oral antibiotics can reach therapeutic concentrations in the sinus cavity. Antibiotics that are not bound to proteins in the blood can diffuse through the sinus mucosa, which is a thin layer of tissue lining the sinus cavity. This diffusion occurs because the antibiotic moves from an area of high concentration to an area of low concentration. Antibiotics that have lipophilic properties (easily dissolve in fat) generally penetrate the sinus mucosa more easily than antibiotics that are hydrophilic (easily soluble in water). Inflammation of the sinus mucosa can increase its permeability, thereby facilitating antibiotic penetration. High sinus pressure can help push antibiotics through the sinus mucosa. Several studies have shown that oral antibiotics can achieve therapeutic concentrations in the sinus cavity. A study involving 20 patients with acute sinusitis found that the concentration of oral amoxicillin in the sinus cavity was equivalent to the concentration in the blood. A study involving 50 children with acute sinusitis found that oral azithromycin concentrations in the sinus cavity were higher than blood concentrations. A study involving 30 patients with acute sinusitis found that oral concentrations of levofloxacin in the sinus cavity were equivalent to concentrations in the blood. Oral antibiotics can penetrate into the sinus cavity through

blood flow and diffusion through the sinus mucosa, making them an effective option in the treatment of acute sinusitis in children.<sup>10-15</sup>

Several other studies have shown results similar to this study. A study involving 421 children with acute sinusitis found that there was no significant difference in recovery rates between the oral and intravenous groups. A study involving 500 children with acute sinusitis found that oral antibiotics were as effective as intravenous antibiotics for the treatment of uncomplicated acute sinusitis. A study involving 300 children with acute sinusitis found that oral antibiotics were as effective as intravenous antibiotics for the treatment of acute sinusitis in children younger than 2 years of age. This and other studies suggest that oral antibiotics are as effective as intravenous antibiotics for the treatment of acute sinusitis in children. These findings support the use of oral antibiotics as a first-line therapeutic option for acute sinusitis in children, taking into account several factors such as safety profile, cost, and patient compliance.<sup>16-20</sup>

#### **4. Conclusion**

This study provides preliminary evidence that oral antibiotics are as effective as intravenous antibiotics for the treatment of acute sinusitis in children at Skopje Hospital Macedonia.

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