



Contents lists available at [SciVerse ScienceDirect](#)

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl



Clinical spectrum of acute rhinosinusitis among atopic and nonatopic children in Taiwan

Shi-Wei Lin^a, Yun-Hu Wang^b, Ming-Yung Lee^c, Min-Sho Ku^{a,d}, Hai-Lun Sun^a,
Ko-Hsiu Lu^e, Ko-Huang Lue^{*,a,e}

^a Division of Allergy, Asthma and Rheumatology, Department of Pediatrics, Chung Shan Medical University Hospital, Taichung, Taiwan

^b Department of Pediatrics, Fooyin University Hospital, Pingtung, Taiwan

^c Department of Statistics and Informatics Science, Providence University, Taichung, Taiwan

^d Institute of Medicine, Chung Shan Medical University, Taichung, Taiwan

^e School of Medicine, Chung Shan Medical University, Taichung, Taiwan

ARTICLE INFO

Article history:

Received 29 July 2011

Received in revised form 30 September 2011

Accepted 2 October 2011

Available online xxx

Keywords:

Acute rhinosinusitis

Atopy

Children

Taiwan

Nasal peak expiratory flow rate

Pediatric Rhinoconjunctivitis Quality of Life

Questionnaire

Bacteriology

ABSTRACT

Background: Rhinitis and sinusitis are very common medical conditions and have been shown to be frequently associated. The role of allergies in the pathogenesis of chronic rhinosinusitis has been confirmed; however, the role of allergies in acute rhinosinusitis is debatable. Nonetheless, allergies are an important factor in the development of rhinosinusitis.

Objective: To evaluate the incidence of allergic rhinitis in patients with acute rhinosinusitis and identify the clinical spectrum in Taiwan.

Methods: This study randomly recruited 69 participants between 3 and 12 years of age with acute rhinosinusitis over the period of one and a half years. All participants underwent a nasal peak expiratory flow rate (nPEFR) test, skin-Prick test (SPT), nasal smear examination, nasal culture, radiography (Water's projection) and were requested to complete the Pediatric Rhinoconjunctivitis Quality of Life Questionnaire (PRQLQ) as well as provide their allergic history.

Results: Among the 69 participants in the study, 27 (39.1%) participants were shown to have allergic rhinitis. The most troublesome symptoms among the 69 participants with acute rhinosinusitis were postnasal drip (3.00 ± 1.29), nasal obstruction (2.94 ± 1.39) and cough (2.67 ± 1.42). The most troublesome symptoms among the 27 participants with acute rhinosinusitis combined with allergic rhinitis were nasal obstruction (3.33 ± 1.24), postnasal drip (3.22 ± 1.09) and itchy eyes (2.74 ± 1.43) and with the higher values. In addition, the participants (≥ 6 yo) with acute rhinosinusitis combined with allergic rhinitis had significantly lower nPEFR values compared with the nonatopic children (75.2 ± 18.2 vs 96.6 ± 21.4 , $p < 0.05$). If nPEFR is below 75 mL/min, the positive predict value in the patients of acute rhinosinusitis is 75.0% combined with allergic rhinitis (sensitivity 63.2%; specificity 85.7%). *Streptococcus pneumoniae* (29.0%), *Haemophilus influenzae* (20.3%), and *Moraxella catarrhalis* (17.4%) were the major isolated pathogens in this study. The prevalence of colonization with *Staphylococcus aureus* in the 69 participants with acute rhinosinusitis was 23.2%, and 15.9% for methicillin-resistant *S. aureus* (MRSA).

Conclusion: This study demonstrated that the bacteriological properties of acute rhinosinusitis among children in Taiwan are the same as those in other parts of the world; however, the prevalence of colonization by MRSA was higher than among healthy children. Second, atopic children were more likely to develop acute rhinosinusitis than nonatopic children. Third, most Taiwanese children with acute rhinosinusitis complained of postnasal drip, nasal obstruction and cough. If a child suffering from acute rhinosinusitis complained of severe nasal obstruction (nPEFR ≤ 75 mL/min), the doctor should be alerted to atopic conditions requiring further treatment. The issues dealt with in this study may require further research with a larger sample population over an extended period of time to verify these conclusions.

© 2011 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Allergic rhinitis and rhinosinusitis are common diseases among children and adults consuming considerable health care resources and have been shown to be frequently associated [1,2]. Although allergic rhinitis and rhinosinusitis have conventionally been

* Corresponding author at: Division of Allergy, Asthma and Rheumatology, Department of Pediatrics, Chung Shan Medical University Hospital, No. 110, Sec. 1, Chien-Kuo N. Road, Taichung 402, Taiwan. Tel.: +886 4 2473 9595x34816; fax: +886 4 2471 0934.

E-mail address: periactinkimo@yahoo.com.tw (S.-W. Lin).

considered as distinct clinical entities, they are increasingly being regarded as interrelated and part of a spectrum of upper airway inflammatory disease [3]. Children contract an average of six to eight colds per year with 0.5–5% developing rhinosinusitis [4]. The primary symptoms associated with rhinosinusitis in children are cough, rhinorrhea, nasal obstruction, snoring, postnasal drip, and facial pain [5]. This study focused on whether the symptoms differ among atopic and nonatopic children with acute rhinosinusitis. According to the clinical practice guidelines of the American Academy of Pediatrics (AAP), acute rhinosinusitis is defined as an infection of the paranasal sinuses lasting less than 30 days and often presenting as an upper respiratory infection with symptoms worsening 7–10 days after onset. A severe upper respiratory infection with fever and concurrent purulent rhinorrhea for 3–4 consecutive days also meets the criteria for the diagnosis of acute rhinosinusitis [6]. Early, effective antibacterial therapy is essential to shorten the duration of infection and illness, to diminish mucosal damage, and to prevent contiguous infectious involvement of the orbit or central nervous system [7]. Unfortunately, little data is available concerning the bacteriological properties of acute rhinosinusitis among Taiwanese children [8,9]. Therefore, this study investigated the bacterial isolates from Taiwanese children with acute rhinosinusitis.

The prevalence of allergic rhinitis is increasing, estimated to affect 27.6% (2002) of the children in Taiwan [10]. Allergic rhinitis presents as an inflammation of the nasal mucosa in which eosinophils and the damaged epithelium of the airway play a key role by releasing cytokines and other proinflammatory proteins. This mucosal inflammatory reaction has been shown in mice models to directly obstruct sinus drainage and enhance rhinosinusitis [11]. Subjects with allergic rhinitis show signs of more severely impaired paranasal sinus functioning during viral colds than nonallergic subjects and may face an increased risk of bacterial sinusitis [12]. The role played by allergies in the pathogenesis of chronic rhinosinusitis has been confirmed [13]. However, the link between allergies and acute rhinosinusitis remains an issue of debate. Nonetheless, allergies are an important factor in the development of rhinosinusitis. For this reason, this study evaluated the incidence of allergic rhinitis among children with acute rhinosinusitis.

2. Materials and methods

2.1. Participants

This study was conducted in the Division of Allergy, Asthma and Rheumatology in the Department of Pediatrics of Chung Shan Medical University Hospital in Taichung, Taiwan, between December 2006 and June 2008. Approval for the study was granted by the Chung Shan Medical University Hospital Institutional Review Board and written parental informed consent was obtained prior to commencing the study. The inclusion criteria for this study were as follows: (1) a history of recent upper respiratory infection and purulent nasal discharge for more than 7 days; (2) abnormal findings in one or both maxillary sinuses (mucosal swelling, a horizontal fluid meniscus in the sinus or complete opacity) using Water's projection. Patients with severe symptoms, a history of any nasal or adenoid surgery and those with probable complications (e.g., periorbital swelling) were excluded. Sixty-nine children with acute rhinosinusitis aged 3–12 years of age met the inclusion criteria for the study. In addition, twenty-seven children were atopic group who had positive findings of skin-Prick tests and higher eosinophil counts (>4%) in their nasal smear [14,15].

2.2. Study design

All participants underwent a physical examination, nasal peak expiratory flow rate (nPEFR) test, skin-Prick test (SPT), nasal smear

examination, nasal culture, radiography (Water's projection) and were requested to complete the Pediatric Rhinoconjunctivitis Quality of Life Questionnaires (PRQLQ) and their atopic history by their care giver. This was a randomized, prospective cross sectional study.

2.3. Pediatric Rhinoconjunctivitis Quality of Life Questionnaire (PRQLQ)

The PRQLQ includes 20 items in the five areas of nasal symptoms, ocular symptoms, practical problems, other symptoms, and activity limitations. Each item is scored using a 7-point scale from 0 to 6 [16]. The questionnaire can be completed within 5 min by children, although younger aged children may require the help of their parents.

2.4. Nasal peak expiratory flow rate (nPEFR)

nPEFR was assessed using a Mini-Wright peak expiratory flow meter equipped with a purpose-built face mask for patients over 6 years of age. The face mask was specifically designed to provide a good seal with the face during testing. Patients were instructed to blow their noses forcefully after inhaling deeply while sitting with their mouths firmly closed. The test was performed three times and the highest value was recorded. nPEFR was assessed using a Micro Medical MicroRint airways resistance meter for patients under 6 years of age. The resistance meter which employed the interrupter method requiring minimal cooperation from the subject, making it useful for measuring nPEFR in very young children [17].

2.5. Nasal smear

The underside of the patient's inferior turbinate was rubbed with a cotton wool bud and then smeared on a glass slide. The slides were stained with Leu stain and examined using a light microscope. An experienced cytologist blinded to the clinical status of the subjects performed the assay. The nasal smear was recorded by counting a minimum of 100 leukocytes, and the eosinophil and neutrophil counts were expressed as a proportion of the total number of leukocytes.

2.6. Nasal culture

Nasal secretion was collected from the nasal cavity following disinfection with aqueous hibitane. First, remove sterile nasal swabs from the packaging and insert it into the nostril presenting sinus opacification in the Water's projection. The swab was swept upwards toward to the top of the nostril and without contaminating the nasal swab, before being placed in the culture medium provided. The swabs were inoculated on trypticase soy agar base with 5% sheep blood, chocolate agar, and eosin methylene blue agar for aerobic cultures. The agar plates were incubated at 35 °C in 5% CO₂ and read at 24 h and 48 h. Antimicrobial sensitivity was evaluated by agar diffusion methods according to the National Committee for Clinical Laboratory Standards guidelines [18]. The susceptibility of *Streptococcus pneumoniae* to penicillin was determined using an oxacillin disk. If the size of oxacillin zones was ≥ 20 mm, the isolate was defined as penicillin-susceptible. If the size of oxacillin zones was ≤ 19 mm, the isolate was defined as penicillin-nonsusceptible. The definition of "normal nasal flora" in aerobes was in accordance with the Manual of Clinical Microbiology by the American Society of Microbiology, including coagulase-negative Staphylococci, Corynebacteria, Neisseria stomatococcus, Micrococcus, Lactobacillus, Mycoplasma, and enteric organisms [19]. No pathogen meant normal nasal flora or no growth.

Table 1

Characteristics and baseline data of the patients with acute rhinosinusitis.

	Allergic rhinitis	Non-allergic rhinitis	P-value
Number	27 (39.1%)	42 (60.9%)	
Sex			
Male	20 (74.1%)	19 (45.2%)	0.025 ^a
Female	7 (25.9%)	23 (54.8%)	
Age (year)	6.35 ± 1.97	5.83 ± 1.64	0.278
Height (cm)	116.30 ± 10.50	115.51 ± 11.45	0.782
Weight (kg)	21.81 ± 5.22	22.31 ± 7.29	0.655
Personal history			
AD	5 (18.59%)	3 (7.1%)	0.247
AS	1 (3.7%)	0 (0%)	0.391
Family history			
Father			
AR	12 (44.4%)	12 (28.6%)	0.203
AD	1 (3.7%)	1 (2.4%)	1.000
AS	1 (3.7%)	0 (0%)	0.391
Mother			
AR	11 (40.7%)	12 (28.6%)	0.433
AD	1 (3.7%)	0 (0%)	0.391
AS	1 (3.7%)	0 (0%)	0.391
Siblings			
AR	9 (33.3%)	6 (14.3%)	0.391
AD	1 (3.7%)	0 (0%)	0.391
AS	3 (11.1%)	0 (0%)	0.056

Values are number (percentage). AR, Allergic rhinitis; AD, atopic dermatitis; AS, asthma.

^a Significant difference between two groups ($P < 0.05$, Chi-square test).

2.7. Skin-Prick test (SPT)

SPT for a standard battery of predefined aeroallergens (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*) was placed on the forearm in a standardized manner. Two nurses with experience in allergies performed all of the tests using the same standardized procedure. The weal perimeter was transferred to paper from the skin by using translucent tape. The results were classified as positive if the mean diameter was 3 mm or more.

2.8. Statistical analysis

Analyses were performed using SPSS/PC 12.0 software (SPSS Inc., Chicago, IL). All collected data were expressed as a mean

± standard deviation. Independent-samples *t* test was selected to compare the nPEFR between the atopic and nonatopic groups. The Mann–Whitney *U*-test was used to compare the mean symptom scores between the two groups. A *p* value of less than 0.05 was considered significant.

3. Results

A total of 69 patients were enrolled in this study, including 39 males and 30 females. The mean age of the patients was 6 (range 3–12) years. It was proved that 27 (39.1%) participants also suffered from allergic rhinitis. No significant differences except gender were observed in the baseline demographic or health characteristics among the patients of the two groups, including: age, height, body weight and personal and family allergic history. Patients with acute rhinosinusitis combined with allergic rhinitis had a higher incidence of allergic history of siblings (allergic rhinitis, $P = 0.061$; asthma, $P = 0.056$) (Table 1).

The most troublesome symptoms among the 69 patients with acute rhinosinusitis were postnasal drip (3.00 ± 1.29), nasal obstruction (2.94 ± 1.39) and cough (2.67 ± 1.42) in that order. But the most troublesome symptoms among the 27 patients with acute rhinosinusitis combined with allergic rhinitis were nasal obstruction (3.33 ± 1.24), postnasal drip (3.22 ± 1.09) and itchy eyes (2.74 ± 1.43) in that order and with the higher values. The most troublesome symptoms among the 42 patients with acute rhinosinusitis without allergic rhinitis were postnasal drip (2.86 ± 1.24), nasal obstruction (2.67 ± 1.42) and cough (2.62 ± 1.40) in that order but with the lower values. In addition, the two groups showed significant differences in symptoms, including anxiety, dizziness, sneeze, snore, itchy eyes, eye congestion, tearing, burning eyes, dyspnea and chest tightness ($P < 0.05$) (Table 2).

Patients ($\geq 6y/o$) with acute rhinosinusitis combined with allergic rhinitis had significantly lower nPEFR values compared with the nonatopic children (75.2 ± 18.2 vs 96.6 ± 21.4 , $P < 0.05$) (Fig. 1). A potent cut point of 75 mL/min (nPEFR) was selected, because it demonstrated a high degree of specificity (85.7%) and moderate sensitivity (63.2%), positive predictability (75.0%) and negative predictability (77.4%) (Table 3). However, no difference was observed in nPEFR between the patients ($< 6y/o$) with acute rhinosinusitis combined with or without allergic rhinitis (0.70 ± 0.22 Vs 0.68 ± 0.37 , $P = 0.897$) (Fig. 2).

Table 2

Compare the symptom scores of the patients with acute rhinosinusitis.

Symptoms	Acute rhinosinusitis	^a Allergic rhinitis	^a Non-allergic rhinitis	Z
Fatigue	0.9 ± 1.20	1.30 ± 1.33	0.95 ± 1.08	0.122
Insomnia	1.41 ± 1.43	1.78 ± 1.55	1.17 ± 1.29	0.086
Muscle weakness	0.62 ± 1.03	0.70 ± 1.27	0.57 ± 0.84	0.487
Anxiety	0.93 ± 1.32	1.33 ± 1.52	0.67 ± 1.11	0.038*
Dizziness	0.78 ± 1.22	0.96 ± 1.13	0.67 ± 1.26	0.035*
Postnasal drip	3.00 ± 1.29	3.22 ± 1.09	2.86 ± 1.24	0.990
Headache	0.97 ± 1.16	1.11 ± 1.19	0.88 ± 1.12	0.071
Sneeze	2.01 ± 1.40	2.52 ± 1.58	1.69 ± 1.16	0.021*
Nasal obstruction	2.94 ± 1.39	3.33 ± 1.24	2.67 ± 1.42	0.095
Alteration in the sense of smell	0.43 ± 0.77	0.59 ± 0.93	0.33 ± 0.61	0.065
Snore	1.26 ± 1.25	1.70 ± 1.38	0.97 ± 1.08	0.026*
Otologic pain	0.61 ± 1.13	0.63 ± 1.18	0.59 ± 1.09	0.116
Itchy eyes	1.81 ± 1.50	2.74 ± 1.43	1.21 ± 1.21	<0.001*
Eye congestion	0.97 ± 1.30	1.44 ± 1.57	0.67 ± 0.92	0.003*
Tearing	0.88 ± 1.22	1.29 ± 1.48	0.62 ± 0.89	0.006*
Burning eyes	0.58 ± 1.01	0.92 ± 1.36	0.36 ± 0.54	0.004*
Dyspnea	0.67 ± 1.33	1.22 ± 1.65	0.31 ± 0.94	0.009*
Cough	2.64 ± 1.42	2.67 ± 1.64	2.62 ± 1.40	0.833
Chest tightness	0.49 ± 0.83	0.78 ± 1.08	0.31 ± 0.49	0.001*

Mann–Whitney *U*-test (Z).

* Significant difference between two groups ($P < 0.05$).

^a Combined with.

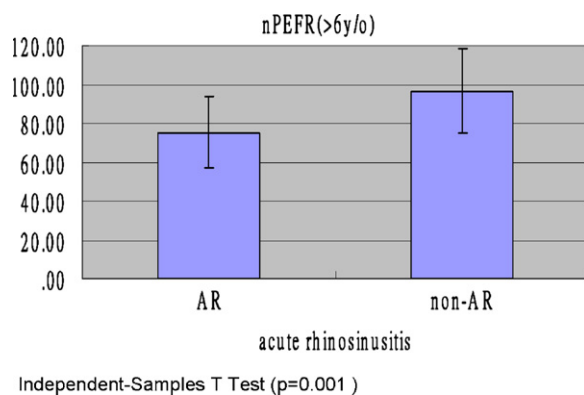


Fig. 1. nPEFR of the patients ($\geq 6y/o$) with acute rhinosinusitis.

Table 3

Predict values of acute rhinosinusitis combined with AR according to nPEFR.

Nasal flow	Sensitivity	Specificity	PPV	NPV
≤ 60	47.4%	100.0%	100.0%	73.7%
≤ 70	63.2%	85.7%	75.0%	77.4%
≤ 75	63.2%	85.7%	75.0%	77.4%
≤ 80	73.7%	60.7%	56.0%	77.3%
≤ 85	73.7%	60.7%	56.0%	77.3%
≤ 90	89.5%	53.6%	56.7%	88.2%
≤ 95	89.5%	50.0%	54.8%	87.5%
≤ 100	94.7%	28.6%	47.4%	88.9%

PPV, positive predict value; NPV, negative predict value.

Among the 69 patients, 16 (23.2%) patients had no pathogens in their nasal cultures and 9 (13.0%) patients had multiple pathogens in their nasal cultures. *S. pneumoniae* (29.0%), *Haemophilus influenzae* (20.3%), *Moraxella catarrhalis* (17.4%), *Group A streptococcus* (8.7%), and *Diphtheroid* (4.4%) were the major isolates of pathogens in this study. Only 6 (30.0%) of the 20 isolates of *S. pneumoniae* were sensitive to penicillin. Among the 14 isolates of *H. influenzae*, 4 were sensitive to ampicillin (28.6%) (Fig. 3). The incidence of colonization with *Staphylococcus aureus* in the 69 participants with acute rhinosinusitis is 23.2% (16 of 69), where methicillin-resistant *S. aureus* (MRSA) is accounted for 68.8% (11 of 16) (Fig. 4).

4. Discussion

In present study, the 69 patients with acute rhinosinusitis were randomly enrolled in the study. The incidence of allergic rhinitis (39.1%) was higher than the prevalence in the normal population (27.6%) [10]. Ramadan et al. pointed out that allergies are a

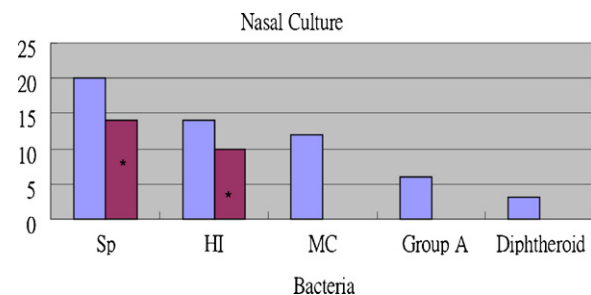


Fig. 3. Bacterial isolates in 69 children with acute rhinosinusitis. Sp, *Streptococcus*; HI, *Haemophilus influenzae*; MC, *Moraxella catarrhalis*. Group A, *Group A streptococcus*. *Red bar showed penicillin non-sensitive Sp (PNSSP) and ampicillin non-sensitive HI. # Including no growth (16 cases) and multiple pathogens (9 cases). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

significant factor in the development of rhinosinusitis [20]. Naclerio et al. presented several hypotheses to explain the link between allergies and rhinosinusitis. These include tissue edema and vascular congestion causing obstruction of sinus drainage, direct entry of allergens into the sinuses, an exaggerated response in allergic patients, allergic inflammation inducing systemic host responses, and finally allergic nasal inflammation inducing neurogenic responses within the sinuses [21]. A number of differences in baseline demographic were observed between the atopic and nonatopic groups including gender and the allergic history of siblings. In this study, the atopic group had higher incidence of boys than girls and the nonatopic group did not show the differences in gender. It was proved that boys had a significant higher incidence of atopic disease when compared to girls especially before the age of 8 years [22]. The incidence of allergies among siblings was higher for patients with acute rhinosinusitis combined with allergic rhinitis. However, the incidence of allergies among parents of patients in the atopic group was not elevated, and this may be due to the limited number of enrolled patients or a reduced parent-of-origin effect [23].

This study determined that the most troublesome symptoms among the 27 patients with acute rhinosinusitis combined with allergic rhinitis was nasal obstruction. Also confirmed that abnormal nasal airflow is significantly associated with elevated computed tomography scores of the ipsilateral paranasal sinus, further indicating that the impairment in ventilation and drainage in the nasal passages extended into the paranasal sinuses as well [24]. Impairment of sinus function has been considered a key factor in the development of bacterial sinusitis [25]. Furthermore, patients ($\geq 6y/o$) with acute rhinosinusitis combined with allergic rhinitis showed significantly lower nPEFR values than nonatopic

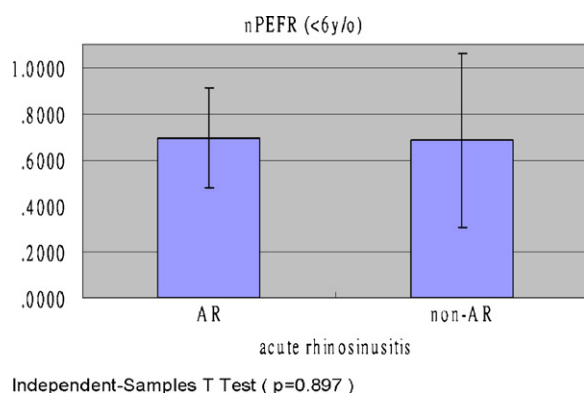


Fig. 2. nPEFR of the patients (<6y/o) with acute rhinosinusitis.

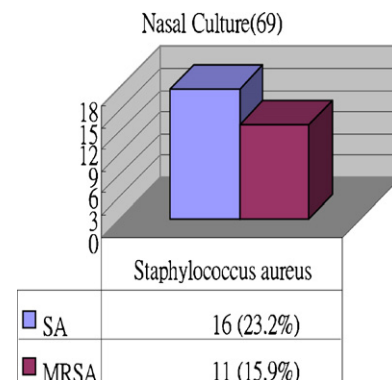


Fig. 4. Incidence of methicillin-resistant *Staphylococcus aureus* among 69 children with acute rhinosinusitis.

children ($P < 0.05$); however, this was not observed in patients (<6 yo). The reason may be the operation in coordination with so younger children. In practice, most patients visit our clinic for severe symptoms of acute rhinosinusitis, rather than the symptoms of allergic rhinitis, which are not even noticed. Therefore, it is important to determine whether the nasal obstruction is the most troublesome symptom of patients with acute rhinosinusitis. If a patient 6 years old or above presented with acute rhinosinusitis and were suffering from the nasal obstruction, checking the nPEFR would be essential. If nasal airflow was below 75 mL/min, it would be advisable to alert the patient of the likelihood of allergic rhinitis, which may require further management.

The symptoms of anxiety, dizziness, sneeze, snore, itchy eyes, eye congestion, tearing, burning eyes, dyspnea and chest tightness did not differ from the patients with acute rhinosinusitis combined with allergic rhinitis. The former symptoms (anxiety, dizziness, sneeze, snore, itching eyes, eye congestion, tearing, burning eyes) were highly associated with allergic rhinitis [26]. Krouse et al. illustrated the concept of a “unified airway” with inflammatory processes coexisting in the upper and lower airways [27]. Chawes et al. further confirmed that children with allergic rhinitis had increased bronchial responsiveness and elevated FeNO [28]. We believe that patients with acute rhinosinusitis combined with allergic rhinitis suffered from dyspnea and chest tightness because of these results.

Huang et al. showed that polymicrobial infection (12 of 58 patients) and positive cultures (13 of 58) from the middle meatus occurred more frequently in pediatric patients [9]. These results were confirmed in the present study. Second, the major isolates of pathogens in their study were *H. influenzae* (37.9%), *S. pneumoniae* (34.5%) and *M. catarrhalis* (17.2%). Hsin et al. presented bacteriological findings obtained by maxillary sinus taps from 31 patients, including *S. pneumoniae* (30.3%), *H. influenzae* (21.1%) and *M. catarrhalis* (6.6%) [29]. We did not use a maxillary antral puncture for cultures because of the discomfort caused to patients and the difficulty performing this technique on children. Nonetheless, our data was similar to the gold standard, despite a poor correlation between the bacteria isolated from the nasopharynx and bacteria from the sinus aspirate [30]. Third, Huang et al. showed a high prevalence of antibiotic resistance to first-line antibiotics in *S. pneumoniae* (72.4%), *H. influenzae* (60.5%) and *M. catarrhalis* (58.3%). These were confirmed in present study which showed 70.0% in *S. pneumoniae* and 71.4% in *H. influenzae*; however, we did not check the antibiotic resistance of *M. catarrhalis*. We recommended amoxicillin–clavulanate (90 mg/6.4 mg/kg per day) as treatment for most cases of acute rhinosinusitis in Taiwanese children [6]. Adjunct treatment with saline irrigations may provide a more rapid clinical cure. In this study, fewer children required surgical intervention due to the success of medical treatment [31].

The prevalences of *S. aureus* and MRSA nasal carriage among the healthy Taiwanese children were 23% and 7.3%, respectively. Most MRSA isolates belonged to one of two major clones, characterized as sequence type 59 (ST59)/PFGE C/SCCmec IV/absence of PVL genes (59%) and ST59/PFGE D/SCCmec V(T)/presence of PVL genes (25%) [32]. Our data reported the incidence of *S. aureus* and MRSA nasal carriage among the Taiwanese children with acute rhinosinusitis at 23.2% and 15.9%, respectively. MRSA colonization was higher among the Taiwanese children with acute rhinosinusitis. The reason may be the previous use of antibiotics by these children [33].

To our knowledge, this is the first study evaluating the symptoms of acute rhinosinusitis in atopic and nonatopic younger children. In addition, this is the first study to perform a bacteriological evaluating and MRSA colonization of such a large number of children with acute rhinosinusitis in Taiwan. Our study was limited by the relatively small sample size and a failure to

obtain data related to immunoglobulin E, eosinophil count and eosinophil cationic protein in the blood. In addition, all of our patients were Taiwanese and of a young mean age. These limitations diminish the generalizability of the results in this study.

In conclusion, this study showed that the bacteriological properties of acute rhinosinusitis among children in Taiwan are the same as those found in other parts of the world; however, the incidence of MRSA colonization was higher than among healthy children. Second, atopic children were more likely to develop acute rhinosinusitis than nonatopic children. Third, children with acute rhinosinusitis in Taiwan primarily complained of postnasal drip, nasal obstruction and cough. If a child suffering from acute rhinosinusitis complained of severe nasal obstruction (nPEFR $\leq$ 75 mL/min), it would be advisable to check for allergic rhinitis, requiring additional treatment.

References

- [1] V. Kirtsreesakul, R.M. Naclerio, Role of allergy in rhinosinusitis, *Curr. Opin. Allergy Clin. Immunol.* 4 (1) (2004) 17–23.
- [2] M.S. Dykewicz, D.L. Hamilos, Rhinitis and sinusitis, *J. Allergy Clin. Immunol.* 125 (2 Suppl. 2) (2010) S103–S115.
- [3] N. Ahmad, M.A. Zacharek, Allergic rhinitis and rhinosinusitis, *Otolaryngol. Clin. North Am.* 41 (2) (2008) 267–281, v..
- [4] H.H. Ramadan, Pediatric sinusitis: update, *J. Otolaryngol.* 34 (Suppl. 1) (2005) S14–S17.
- [5] K.A. Kronemer, W.H. McAlister, Sinusitis and its imaging in the pediatric population, *Pediatr. Radiol.* 27 (11) (1997) 837–846.
- [6] American Academy of Pediatrics. Subcommittee on Management of Sinusitis and Committee on Quality Improvement, Clinical practice guideline: management of sinusitis, *Pediatrics* 108 (3) (2001) 798–808.
- [7] J.B. Anon, Acute bacterial rhinosinusitis in pediatric medicine: current issues in diagnosis and management, *Pediatr. Drugs* 5 (Suppl. 1) (2003) 25–33.
- [8] Y.H. Huang, Y.C. Huang, Use of antimicrobial agents for upper respiratory tract infections in Taiwanese children, *Chang Gung Med. J.* 28 (11) (2005) 758–764.
- [9] W.H. Huang, S.Y. Fang, High prevalence of antibiotic resistance in isolates from the middle meatus of children and adults with acute rhinosinusitis, *Am. J. Rhinol.* 18 (6) (2004) 387–391.
- [10] P.F. Liao, H.L. Sun, K.H. Lu, K.H. Lue, Prevalence of childhood allergic diseases in central Taiwan over the past 15 years, *Pediatr. Neonatol.* 50 (1) (2009) 18–25.
- [11] C. Blair, M. Nelson, K. Thompson, Allergic inflammation enhances bacterial sinusitis in mice, *J. Allergy Clin. Immunol.* 108 (3) (2001) 424–429.
- [12] O.P. Alho, T.J. Karttunen, R. Karttunen, Subjects with allergic rhinitis show signs of more severely impaired paranasal sinus functioning during viral colds than nonallergic subjects, *Allergy* 58 (8) (2003) 767–771.
- [13] L.J. Newman, T.A. Platts-Mills, C.D. Phillips, K.C. Hazen, C.W. Gross, Chronic sinusitis. Relationship of computed tomographic findings to allergy, asthma, and eosinophilia, *JAMA* 271 (5) (1994) 363–367.
- [14] J.N. Romero, G. Scadding, Eosinophilia in nasal secretions compared to skin prick test and nasal challenge test in the diagnosis of nasal allergy, *Rhinology* 30 (3) (1992) 169–175.
- [15] S.G. Johansson, T. Bieber, R. Dahl, Revised nomenclature for allergy for global use: report of the Nomenclature Review Committee of the World Allergy Organization, October 2003, *J. Allergy Clin. Immunol.* 113 (5) (2004) 832–836.
- [16] E.F. Juniper, W.C. Howland, N.B. Roberts, A.K. Thompson, D.R. King, Measuring quality of life in children with rhinoconjunctivitis, *J. Allergy Clin. Immunol.* 101 (2 Pt 1) (1998) 163–170.
- [17] P.G. Kent, MicroRint Operating Manual, May, Micro Medical Limited, England, 1997.
- [18] Wayne, National Committee for Clinical Laboratory Standards: Performance Standards for Antimicrobial Susceptibility Testing, 2002, M100-S12.
- [19] P.R.B.E. Murray, M.A. Pfaller, Manual of Clinical Microbiology, American Society for Microbiology, Washington, DC, 1995.
- [20] H.H. Ramadan, R. Fornelli, A.O. Ortiz, S. Rodman, Correlation of allergy and severity of sinus disease, *Am. J. Rhinol.* 13 (5) (1999) 345–347.
- [21] R.M. Naclerio, M.L. deTineo, F.M. Baroody, Ragweed allergic rhinitis and the paranasal sinuses. A computed tomographic study, *Arch. Otolaryngol. Head Neck Surg.* 123 (2) (1997) 193–196.
- [22] C.Y. Hwang, Y.J. Chen, M.W. Lin, Prevalence of atopic dermatitis, allergic rhinitis and asthma in Taiwan: a national study 2000 to 2007, *Acta Derm. Venereol.* 90 (6) (2010) 589–594.
- [23] A. Bjerg, L. Hedman, M.S. Perzanowski, T. Platts-Mills, B. Lundback, E. Ronmark, Family history of asthma and atopy: in-depth analyses of the impact on asthma and wheeze in 7- to 8-year-old children, *Pediatrics* 120 (4) (2007) 741–748.
- [24] O.P. Alho, Nasal airflow, mucociliary clearance, and sinus functioning during viral colds: effects of allergic rhinitis and susceptibility to recurrent sinusitis, *Am. J. Rhinol.* 18 (6) (2004) 349–355.
- [25] J.S. Reilly, The sinusitis cycle, *Otolaryngol. Head Neck Surg.* 103 (5 Pt 2) (1990) 856–861 (discussion 61–2).

- [26] D.P. Skoner, Allergic rhinitis: definition, epidemiology, pathophysiology, detection, and diagnosis, *J. Allergy Clin. Immunol.* 108 (1 Suppl.) (2001) S2–S8.
- [27] J.H. Krouse, R.W. Brown, S.M. Fineman, Asthma and the unified airway, *Otolaryngol. Head Neck Surg.* 136 (5 Suppl.) (2007) S75–S106.
- [28] B.L. Chawes, K. Bonnelykke, E. Kreiner-Moller, H. Bisgaard, Children with allergic and nonallergic rhinitis have a similar risk of asthma, *J. Allergy Clin. Immunol.* 126 (3) (2010) 567–573, e1–8.
- [29] C.H. Hsin, T.H. Chen, M.C. Su, R.S. Jiang, C.M. Liu, Aspiration technique improves reliability of endoscopically directed middle meatal cultures in pediatric rhinosinusitis, *Am. J. Rhinol. Allergy* 24 (3) (2010) 205–209.
- [30] E.R. Wald, G.J. Milmo, A. Bowen, J. Ledesma-Medina, N. Salamon, C.D. Bluestone, Acute maxillary sinusitis in children, *N. Engl. J. Med.* 304 (13) (1981) 749–754.
- [31] Y.H. Wang, C.P. Yang, M.S. Ku, H.L. Sun, K.H. Lue, Efficacy of nasal irrigation in the treatment of acute sinusitis in children, *Int. J. Pediatr. Otorhinolaryngol.* 73 (12) (2009) 1696–1701.
- [32] Y.C. Huang, K.P. Hwang, P.Y. Chen, C.J. Chen, T.Y. Lin, Prevalence of methicillin-resistant *Staphylococcus aureus* nasal colonization among Taiwanese children in 2005 and 2006, *J. Clin. Microbiol.* 45 (12) (2007) 3992–3995.
- [33] W.H. Huang, P.K. Hung, Methicillin-resistant *Staphylococcus aureus* infections in acute rhinosinusitis, *Laryngoscope* 116 (2) (2006) 288–291.