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RHINOLOGY

# *Pantoea dispersa* rhinosinusitis: clinical aspects of a rare sinonasal pathogen

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## Abstract

**Purpose** There is no report in the literature targeting the role of *Pantoea dispersa* in rhinosinusitis and *P. dispersa* has not been identified as a commensal bacterium in the sinonasal cavity. We aimed to investigate the role of *P. dispersa* in rhinosinusitis.

**Methods** We retrospectively reviewed the data of patients diagnosed with rhinosinusitis at a medical center in Taiwan.

**Results** A total of 274 rhinosinusitis patients underwent sinus culture between July 2017 and July 2019. All 23 patients with acute *P. dispersa* rhinosinusitis experienced purulent rhinorrhea; three (13%) had nasal obstruction, but none had olfactory dysfunction, facial pressure/pain and nasal polyp. The patients with *P. dispersa* received a significantly shorter duration of antibiotic treatment ($19.9 \pm 2.6$ vs. $28.9 \pm 2.5$ days, $P = 0.015$) and had lower surgery rate (0% vs. 16.7%, $P = 0.043$) than other patients. Patients with olfactory dysfunction were more likely to receive surgical treatment ($P = 0.018$).

**Conclusion** Acute rhinosinusitis caused by *P. dispersa* resulted in less surgical interventions and shorter treatment durations. Olfactory dysfunction may imply longer course and possibility for surgical intervention in chronic rhinosinusitis. The present study revealed that *P. dispersa* had the potential to colonize in human sinonasal cavities and cause rhinosinusitis.

**Keywords** *Pantoea dispersa* · Rhinosinusitis · Antibiotics · Surgery · Olfactory dysfunction

## Introduction

*Pantoea* is a genus of ubiquitous Gram-negative, non-encapsulated, non-spore-forming rod. It can be isolated from diverse environments among plant and human feces. The genus *Pantoea* was first separated in 1989 from the genus *Enterobacter* [1]. To date, there have been few reports in the literature regarding *Pantoea* infection. *P. agglomerans* is the most reported and prominent species in humans and is regarded as a human opportunistic pathogen [2]. However, the number of reported infections caused by *P. dispersa* has increased steadily since 2000 and *P. dispersa* has been reported to cause infection, including respiratory infection, neonatal sepsis and bloodstream infection [3, 4]. Although most reports described the infections in immunocompromised patients, there was also a report about *P. dispersa* bacteremia in immunocompetent patient in 2019 [5].

Rhinosinusitis is one of the most common infection, currently facing healthcare professionals, with a prevalence of 8% in China [6]. The most common pathogens in acute bacterial rhinosinusitis are *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Moraxella catarrhalis* and *Staphylococcus aureus* [7]. Compared with acute rhinosinusitis, chronic rhinosinusitis is a multifactorial disease. The microbiology is influenced by the pathogen, normal flora, vaccination and previous antibiotics treatments [8]. There is a gradual transition of microbiology from aerobic or facultative to anaerobic bacteria as the infection persisted [9].

Newer studies employing molecular technique demonstrated that anaerobic species predominated, while S. aureus was detected in half of the specimens [10]. The recent review summarized *Staphylococcus aureus, Staphylococcus epidermidis* and anaerobic Gram-negative bacteria predominate in chronic rhinosinusitis [11].

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Prior to this study, we were not aware of any earlier report targeting the role of *P. dispersa* in rhinosinusitis. Our study collected the results of sinus culture from patients diagnosed with rhinosinusitis. We analyzed the microbiology of rhinosinusitis at our hospital and elaborated on the characteristics of the *P. dispersa* rhinosinusitis. This study included the most cases of patients with *P. dispersa* infection in the literature, with an aim to better ascertain the potential role of *P. dispersa* in rhinosinusitis.

## Materials and methods

A retrospective review was conducted in patients diagnosed with rhinosinusitis who underwent sinus bacterial culture at the Taipei Veterans General Hospital between July 2017 and July 2019. A total of 390 patients were identified through a database search of sinus culture data (Fig. 1). Patients diagnosed with rhinosinusitis were included. The exclusion criteria included patients who had no bacteria growth or normal flora growth in sinus culture, who were less than 20 years of age and cases complicated with odontogenic rhinosinusitis and fungal rhinosinusitis. A total of 274 patients were finally included in this study and their medical records were retrieved (Fig. 1). The study protocol was approved by the institutional review board of the Taipei Veterans General Hospital (IRB file number: 2021-02-009BC).

The diagnosis of rhinosinusitis was made according to the criteria by the European position paper on rhinosinusitis and nasal polyps 2020 [12]. Acute rhinosinusitis is defined as symptoms lasting < 12 weeks; and chronic rhinosinusitis is defined as symptoms lasting ≥ 12 weeks. The reliable diagnosis was facilitated by consistent endoscopic findings (purulent discharge and nasal polyp) and radiographic abnormalities on sinus X ray or computed tomography (CT) scan (Fig. 2). In our hospital, we routinely performed rigid nasal endoscopy for those patients with rhinosinusitis. If purulent nasal drainage presented, we routinely collected culture under endoscopy. Rayon swab with Amies and Stuart transport medium were used. Blood agar plate (BAP)/phenylethyl alcohol agar (PEA) and chocolate agar media were used for aerobic culture. Aerobic BAP/PEA and Bacteroides Bile–Esculin agar (BBE)/Kanamycin–Vancomycin Laked Blood agar (KVLB) media were used for anaerobic culture. The isolates were identified using Matrix-Assisted Laser Desorption/Ionization Time-of Flight Mass Spectrometry (MALDI-TOF MS). If patients complained of hyposmia, we performed modified Sniffin' sticks 12-identification test. Olfactory dysfunction was defined as patient scoring less than 12 [13].

At our hospital, cefadroxil or amoxicillin/clavulanic acid were used as first-line antibiotics for bacterial rhinosinusitis. Depending on the patient response, the regimen could be changed to cefixime, ciprofloxacin, clindamycin or erythromycin. Aside from antibiotics, nasal saline irrigation was also used as an adjunct and topical nasal steroids were administrated in patients with nasal polyps. Patients exhibiting poor medical response and

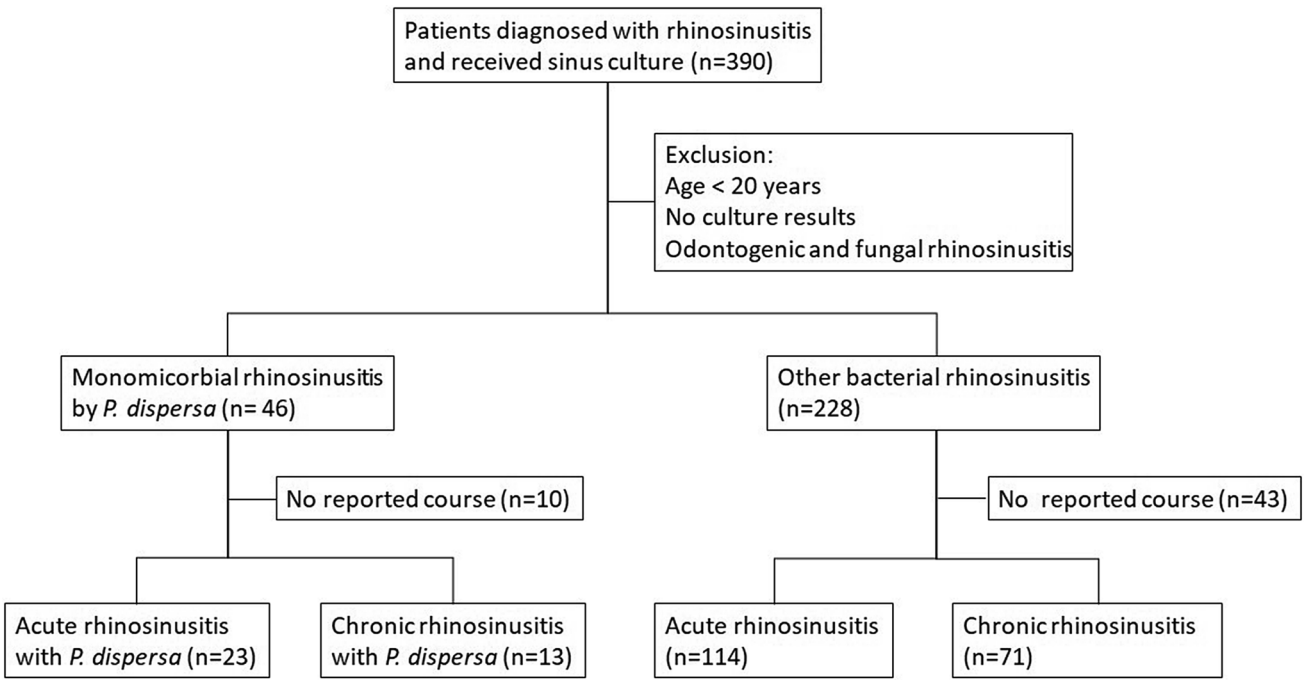


**Fig. 1** Flowchart of subject recruitment into the study

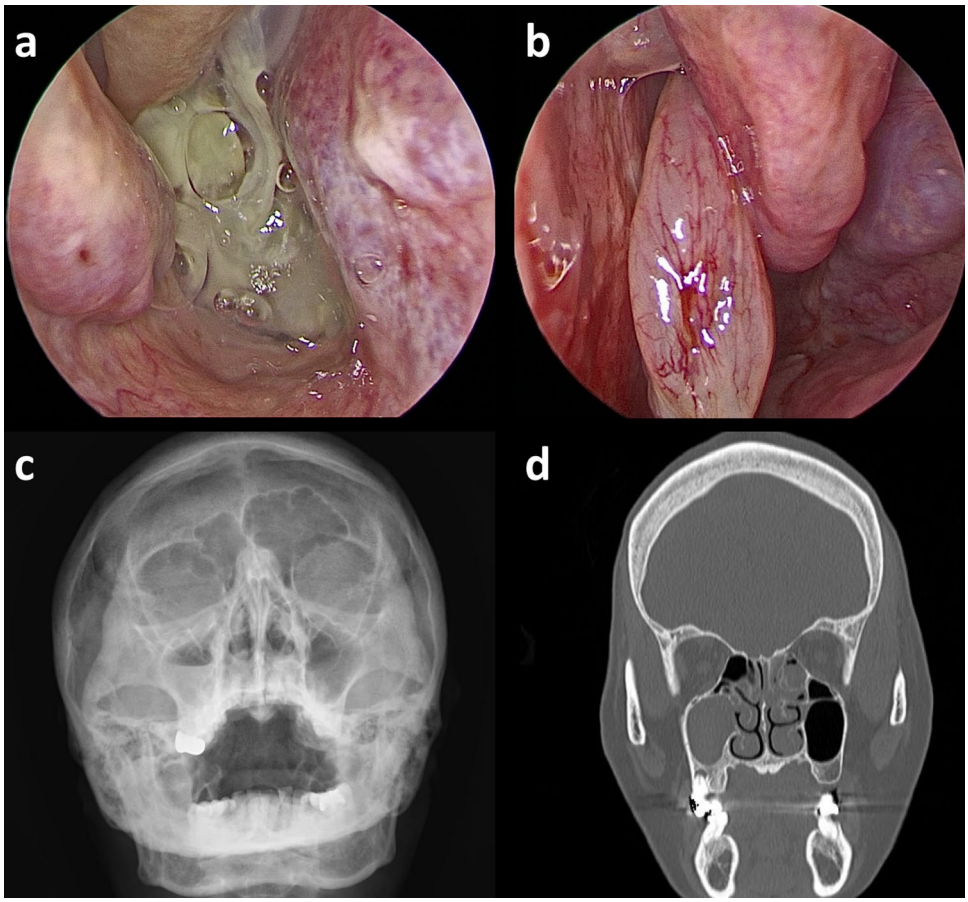


**Fig. 2** The endoscopic and radiographic features of *Pantoea dispersa* rhinosinusitis. **a** Much mucopus was noted in the right posterior nasal cavity. **b** A huge polyp was noted in the left superior meatus. **c** Plain sinus X ray revealed the air-fluid level on right maxillary sinus. **d** Computed tomography scan revealed complete opacification of right maxillary sinus

candidates for surgical intervention underwent sinus CT. Thereafter, CT result severities were assessed using the Lund–Mackay score [14]. The sinuses are grouped into frontal sinus, anterior/posterior ethmoidal cells, maxillary sinus, sphenoid sinus and ostiomeatal complex. We assessed the opacification in imaging and scored from 0 to 2 for each location.

The data were summarized using descriptive statistics. The data documented included age, gender, presenting clinical manifestation, medical history and comorbidities, symptoms duration before treatment, imaging results, microbiology results and treatment option (including antibiotics, length of antibiotics use, surgical intervention). Categorical data were compared using Chi-square or Fisher's exact test and differences between two groups with continuous variables were analyzed using the independent *T* test or Mann–Whitney *U* test. We used mean ± standard error mean (SEM) to represent the precision of estimated mean of population. Logistic regression analysis was performed to examine the predictors of surgical treatment. Factors with $P < 0.05$ in univariate analysis were recruited into multivariate analysis. All statistical analyses were carried out using SPSS Statistics version 24.0. The results were considered significant at $P < 0.05$.

## Results

A total of 274 rhinosinusitis patients who had positive sinus culture were included in the study. The number of isolates in each culture varied from one to three. Overall, the predominant identified aerobic bacteria were *P. dispersa* (80 isolates, 29.2%), *S. aureus* (77, 28.1%), *K. pneumoniae* (32, 11.7%), *M. catarrhalis* (27, 9.9%) and *C. koseri* (26, 9.5%). Anaerobic bacteria were recovered in 11 (4.0%) isolates. The respective bacteriology results in acute and chronic rhinosinusitis are shown in Table 1. Patient ages ranged from 20 to 99 (mean 53.6 ± 1.0) years; 156 were males and 118 were females. There were 137 and 84 patients with acute and chronic rhinosinusitis, respectively. The mean duration of symptoms in acute and chronic rhinosinusitis were 17.9 ± 1.5 and 206.0 ± 39.3 days, respectively.

### P. dispersa in acute rhinosinusitis

The infection was monomicrobial with growth of *P. dispersa* in 23 patients with acute rhinosinusitis. The mean age of these patients was 51.3 ± 3.6 years. Nine cases were males and 14 were females. There were four (17.4%) patients that reported history of smoking. With regard to

**Table 1** Bacteriology of sinus culture from 274 culture-positive patients with rhinosinusitis

| | Total ($n=274$) | Acute rhinosinusitis ($n=137$) | Chronic rhinosinusitis ($n=84$) |
|---|---|---|---|
| Aerobic bacteria | | | |
| *P. dispersa* | 80 (29.2%) | 43 (31.4%) | 22 (26.2%) |
| *S. aureus* | 77 (28.1%) | 30 (21.9%) | 32 (38.1%) |
| *K. pneumoniae* | 32 (11.7%) | 15 (10.9%) | 10 (11.9%) |
| *M. catarrhalis* | 27 (9.9%) | 18 (13.1%) | 5 (6.0%) |
| *C. koseri* | 26 (9.5%) | 17 (12.4%) | 4 (4.8%) |
| *H. influenzae* | 20 (7.3%) | 11 (8.0%) | 7 (8.3%) |
| *E. aerogenes* | 19 (6.9%) | 10 (7.3%) | 4 (4.8%) |
| *P. aeruginosa* | 17 (6.2%) | 7 (5.1%) | 5 (6.0%) |
| *S. pneumoniae* | 16 (5.8%) | 8 (5.8%) | 4 (4.8%) |
| Subtotal aerobes | 74 (27.0%) | 26 (19.0%) | 29 (34.5%) |
| Anaerobic bacteria | | | |
| *P. acnes* | 3 (1.1%) | 0 (0%) | 3 (3.6%) |
| Subtotal anaerobes | 8 (2.9%) | 6 (4.4%) | 2 (2.4%) |

comorbidities, 10 (43.5%) patients had allergic rhinitis, none had asthma and one (4.3%) had a history of head and neck cancer. All presented with purulent rhinorrhea (Fig. 2a), three (13%) had nasal obstruction, but none had olfactory dysfunction, facial pressure/pain and nasal polyp. The symptoms lasted for $16.6 \pm 3.9$ days on average and nine patients (39.1%) received treatments before being referred to our hospital.

Comparing patients of acute rhinosinusitis with *P. dispersa* and other acute rhinosinusitis, there was no significant difference in patient demographics, clinical symptoms (Table 2). The patients with *P. dispersa* received a significantly shorter duration of antibiotic treatment ($19.9 \pm 2.6$ vs. $28.9 \pm 2.5$ days, $P=0.015$) and had lower surgery rate (0% vs. 16.7%, $P=0.043$) than other patients. All cases with known outcomes, which included 21 (91.3%) cases, recovered eventually and two (8.7%) cases were lost to follow-up. There was no significant difference in outcome between patients with *P. dispersa* and others.

## *P. dispersa* in chronic rhinosinusitis

Thirteen patients with chronic rhinosinusitis had culture growth of only *P. dispersa*. Seven (53.8%) had chronic rhinosinusitis with nasal polyps and six (46.2%) had chronic rhinosinusitis without nasal polyps (Fig. 2b). Among these patients, seven (53.8%) cases had allergic rhinitis, two (15.4%) had asthma and one (7.7%) had a history of head and neck cancer. All patients presented with purulent rhinorrhea as the major symptom. Six (46.2%) had nasal obstruction, five (38.5%) had olfactory dysfunction, one had (7.7%) facial pressure/pain. They experienced the symptoms for $249.7 \pm 93.5$ days on average and three patients (23.1%) received treatment before being referred to our hospital.

**Table 2** Demographic characteristic of acute and chronic rhinosinusitis

| | Acute rhinosinusitis | | | Chronic rhinosinusitis | | |
|---|---|---|---|---|---|---|
| Characteristic | *P. dispersa* ($n=23$) | Other patients ($n=114$) | *P* value | *P. dispersa* ($n=13$) | Other patients ($n=71$) | *P* value |
| Age (years), mean ± SEM | $51.3 \pm 3.6$ | $52.2 \pm 1.6$ | 0.822 | $54.5 \pm 4.6$ | $55.85 \pm 2.0$ | 0.794 |
| Gender (Male), *n* (%) | 9 (39.1%) | 64 (56.1% | 0.136 | 6 (46.2%) | 45 (63.4%) | 0.242 |
| Smoking habit, *n* (%) | | | | | | |
| Current smoker | 3 (13.0%) | 14 (12.3%) | 1.000 | 2 (15.4%) | 10 (14.1%) | 1.000 |
| Lifetime exposure | 4 (17.4%) | 27 (23.7%) | 0.511 | 2 (15.4%) | 15 (14.1%) | 1.000 |
| Previous treatment | | | | | | |
| Treated before, *n* (%) | 9 (39.1%) | 27 (23.7%) | 0.125 | 3 (23.1%) | 13 (18.3%) | 0.706 |
| Symptoms duration (days), mean ± SEM | $16.6 \pm 3.9$ | $18.2 \pm 1.6$ | 0.708 | $249.7 \pm 93.5$ | $188.6 \pm 42.4$ | 0.524 |
| Comorbidities, *n* (%) | | | | | | |
| Asthma | 0 (0%) | 4 (3.5%) | 1.000 | 2 (15.4%) | 2 (2.8%) | 0.111 |
| Allergic rhinitis | 10 (43.5%) | 33 (28.9%) | 0.171 | 7 (53.8%) | 25 (35.2%) | 0.227 |
| Head and neck cancer | 1 (4.3%) | 9 (7.9%) | 1.000 | 1 (7.7%) | 2 (2.8%) | 0.400 |
| Major symptoms, *n* (%) | | | | | | |
| Nasal obstruction | 3 (13.0%) | 32 (28.1%) | 0.132 | 6 (46.2%) | 26 (36.6%) | 0.546 |
| Purulent rhinorrhea | 23 (100%) | 113 (99.1%) | 1.000 | 13 (100%) | 69 (97.2%) | 1.000 |
| Olfactory dysfunction | 0 (0%) | 11 (9.6%) | 0.210 | 5 (38.5%) | 30 (42.3%) | 0.799 |
| Facial pain & pressure | 0 (0%) | 11 (9.6%) | 0.210 | 1 (7.7%) | 8 (11.3%) | 1.000 |

*SEM* standard error of mean

Generally, there was no significant difference between patients with *P. dispersa* and other bacteria in patient demographics, clinical symptoms and outcomes (Table 2). The average duration of antibiotic treatment was 41.6 ± 8.1 days. Four (30.8%) patients with *P. dispersa* received surgery due to poor medical response. Ten (76.9%) cases recovered eventually.

### Treatment options for *P. dispersa* infection

Thirty-three *P. dispersa* rhinosinusitis patients were treated successfully with antibiotics alone. The most used effective antibiotics were amoxicillin/clavulanic acid (11 cases with a mean of 12.6 ± 1.3 days), erythromycin (seven cases with a mean of 12.9 ± 3.7 days) and cefixime (five cases with a mean of 12.8 ± 2.8 days) (Supplementary Table 1).

Aside from antibiotic treatment, four patients received surgical intervention. The surgical rate was lower than other patients (8.7% vs. 26.8%, $P = 0.009$). In univariate logistic regression analysis, nasal obstruction ($P = 0.048$, OR 11.000, 95% CI 0.844–64.881) and olfactory dysfunction ($P = 0.003$, OR 60.000, 95% CI 4.148–867.991) were associated with surgical treatment (Table 3). Multivariate logistic regression analysis was performed for further analysis. The study found that olfactory dysfunction ($P = 0.018$, OR 35.562, 95% CI 1.837–688.343) remained an independent predictors of surgical intervention in *P. dispersa* rhinosinusitis.

## Discussion

*Pantoea dispersa* is a relatively rare pathogen in humans. Most literature were case reports or case series with small number of cases and most described the infection in immunocompromised patients [3, 4]. Our hospital is a tertiary referral hospital, which enabled us to collect a sufficient number of patients to analyze the infection caused by *P. dispersa*. This study identified *P. dispersa* as a potential pathogen in the human sinonasal cavities and is the first to describe the characteristics of *P. dispersa* rhinosinusitis.

We routinely perform rigid nasal endoscopy culture in patients with purulent rhinorrhea. Cultures using sinus aspirate had a fair correlation to the presumed sinus pathogen [15]. Previous studies have also shown that endoscopic cultures demonstrated an accuracy of 89.1% compared with sinus puncture and aspiration and caused less adverse events [16].

There was no report in the literature describing the prevalence of *Pantoea* in Taiwan. Jivianne T et al. [17] reviewed microbiome in the paranasal sinus and *P. dispersa* was not previously reported as a sinonasal commensal bacterium. Since *P. dispersa* was prevalent in our study, our infection control staff evaluated the outpatient department and equipment, including endoscope to survey environmental factor. Cultures from the environment, staff and equipment did not yield *Pantoea* species. The culture methodology was a standard procedure and was not biased toward detecting *Pantoea* species. There was difficulty in accurate identification of *Pantoea* species. A previous report documented 13.6% of *Pantoea* species isolates were misidentified as *Enterobacter*

**Table 3** Logistic regression analysis for predictive factors of surgical treatment in *P. dispersa* rhinosinusitis

| | Univariate analyses | | Multivariate analyses | |
|---|---|---|---|---|
| | OR (95% CI) | *P* value | OR (95% CI) | *P* value |
| Age (year) | 1.017 (0.955–1.082) | 0.602 | | |
| Male | 1.333 (0.171–10.389) | 0.784 | | |
| Smoking habit | | | | |
| Current smoker | 2.000 (0.177–22.550) | 0.575 | | |
| Lifetime exposure | 1.222 (0.113–13.208) | 0.869 | | |
| Previous treatment | | | | |
| Treated before | 1.200 (0.113–12.711) | 0.880 | | |
| Symptoms duration | 1.004 (0.996–1.011) | 0.344 | | |
| Comorbidities | | | | |
| Asthma | 13.667 (0.674–277.123) | 0.089 | | |
| Allergic rhinitis | 3.632 (0.349–37.826) | 0.281 | | |
| Major symptoms | | | | |
| Nasal obstruction | 11.000 (1.018–118.873) | 0.048 | 2.817 (0.137–57.915) | 0.502 |
| Nasal polyps | 7.400 (0.844–64.881) | 0.071 | | |
| Olfactory dysfunction | 60.000 (4.148–867.991) | 0.003 | 35.562 (1.837–688.343) | 0.018 |

*OR* odds ratio, *CI* confidence interval

species by the VITEK MS system [18]. The prevalence of *Pantoea* species might have been underestimated before and might be revealed increasingly by the advancing identification methods like MALDI-TOF MS system.

The presence of *P. dispersa* in symptomatic patients suggests a pathogenic role. As culture-based studies miss parts of microbial community, it is possible that the positive culture is not able to detect the true causal pathogen. However, in those diagnosed with rhinosinusitis and with monopositive culture of *P. dispersa*, they presented the uniform characteristics. Culture-based therapy and eradication of bacteria coincided with improvement of clinical condition, suggesting a causal relationship. Further studies targeting the virulence of *P. dispersa* will help elucidate the pathophysiology.

The shorter treatment duration was observed in acute *P. dispersa* rhinosinusitis. *P. dispersa* is a relatively rare pathogen and carries less antibiotic resistance. According to the sensitivity tests for *P. dispersa* performed at our hospital, it was susceptible to most of the antibiotics tested, which included second-generation cephalosporins, ciprofloxacin, piperacillin–tazobactam and ertapenem. In comparison, the common respiratory pathogen generally had higher levels of resistance at our hospital, particularly the gram-negative bacteria. Gajdács M studied the susceptibility patterns of *Pantoea* species and found that isolates were susceptible to most antibiotics. However, the reported highest levels of resistance were to amoxicillin–clavulanic acid and ampicillin (resistance 53/80) [19]. Proper antibiotics should be chosen if antimicrobial susceptibility testing is available. Besides, patients with *P. dispersa* rhinosinusitis received less surgical intervention than other patients, which was consistent with their shorter disease course.

There was no significant difference between chronic *P. dispersa* rhinosinusitis with other chronic rhinosinusitis. Chronic rhinosinusitis is a multifactorial disease and treatment targeting bacteria alone is often unable to achieve satisfying results. Nasal obstruction and olfactory dysfunction were more prominent in chronic *P. dispersa* rhinosinusitis, as with higher Lund–Mackay score (Fig. 2 c&d). Topical steroid spray and nasal douching were also used as adjuncts. In all chronic rhinosinusitis patients undergoing surgery, it was found that nasal polyps, facial pressure, olfactory dysfunction were independent poor prognostic factors for antibiotic treatment (Supplementary Table 2). When specified to *P. dispersa*, olfactory dysfunction was still a predictor of surgical intervention. Olfactory dysfunction may be related with mechanical sinonasal obstruction by swollen mucosa or polyp. It may also be associated with neuronal injury by toxins released by bacteria. When patients report olfactory dysfunction, the poor prognosis should be discussed.

Our study has certain limitations. There was no report in the literature describing the prevalence of *Pantoea* in Taiwan. Thus, we could not be certain regarding the extent of role of environmental factor in our study. Given the small case cohort of mono-microbial infections, it was difficult to perform bacteria-to-bacteria comparison and the selection bias may occur. In addition, our study did not specify the site of rhinosinusitis. In the future, larger scale studies addressing specific sinus sites, employing molecular technique or genetic analysis will be necessary to further analyze the role of *P. dispersa*.

## Conclusions

In this study, the characteristics of *P. dispersa* rhinosinusitis have been described. Acute rhinosinusitis caused by *P. dispersa* had less surgical interventions and shorter treatment durations. Olfactory dysfunction may imply longer course and possibility for surgical intervention in chronic rhinosinusitis. The present study revealed that *P. dispersa* had the potential to colonize human sinonasal cavities and cause rhinosinusitis.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s00405-022-07266-1.

**Author contributions** YWS and CFY conceived of the presented idea and design of study. YWS, WHH and CFY acquired the data. YWS and CFY analyzed and/or interpreted the data. YWS and CFY drafted the manuscript. CFY revised the manuscript critically for important intellectual content. YWS, WHH and CFY approved the version of the manuscript to be published.

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**Availability of data and material** The data supporting the findings of this study are available within the article and supplementary materials. Additional clinical data are available from the corresponding author on reasonable request.

**Code availability** Not applicable.

## Declarations

**Conflicts of interest/Competing interests** The funder had no role in the study design, data collection and analysis, decision to publish or preparation of the manuscript. The authors have no financial relationships or conflicts of interest related to this work.

**Ethics approval** The study protocol was approved by the institutional review board of the Taipei Veterans General Hospital (IRB file number: 2021–02-009BC).

**Consent to participate** The informed consent was not applicable due to retrospective study. The study protocol was approved by the institutional review board of the Taipei Veterans General Hospital (IRB file number: 2021-02-009BC).

**Consent for publication** The informed consent was not applicable due to retrospective study. The study protocol was approved by the institutional review board of the Taipei Veterans General Hospital (IRB file number: 2021-02-009BC).

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