

## Short Paper

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# Seasonal variation of *Pseudomonas aeruginosa* in culture positive otitis externa in South East England

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**Abstract**

Otitis externa is the inflammation of the external auditory canal. The disease is common and shows a seasonal variation with a greater incidence in warmer months. *Pseudomonas aeruginosa* is a common pathogen in otitis externa and in this retrospective study, we show a corresponding seasonal variation in the proportional incidence of *P. aeruginosa* isolates from otitis externa in South East England. In total 7770 patients were diagnosed with otitis externa over a period of 9 years from January 2008 to December 2016. *P. aeruginosa* was isolated from 2802 patients (proportional incidence of 36%). Incidence was higher in the months of August, September and October and in patients between 5 and 15 years of age. We postulate a combination of increased contact with water during warm weather in the holiday season and increased rainfall in the preceding season as a putative mechanism for the seasonal trends.

Otitis externa is the inflammation of the external auditory canal. It is a common problem in general practice [1]. *Pseudomonas aeruginosa* and *Staphylococcus aureus* are common pathogens in otitis externa [2, 3].

Otitis externa displays a characteristic seasonal variation with a greater disease burden in warmer months [1, 4]. However, this seasonal variation in disease incidence has not been correlated to seasonal trends in the proportional incidence of pathogen isolates. In this retrospective, observational study, we show a seasonal variation in the proportional incidence of *P. aeruginosa* isolates in otitis externa and correlate the observed variation to changes in environmental conditions.

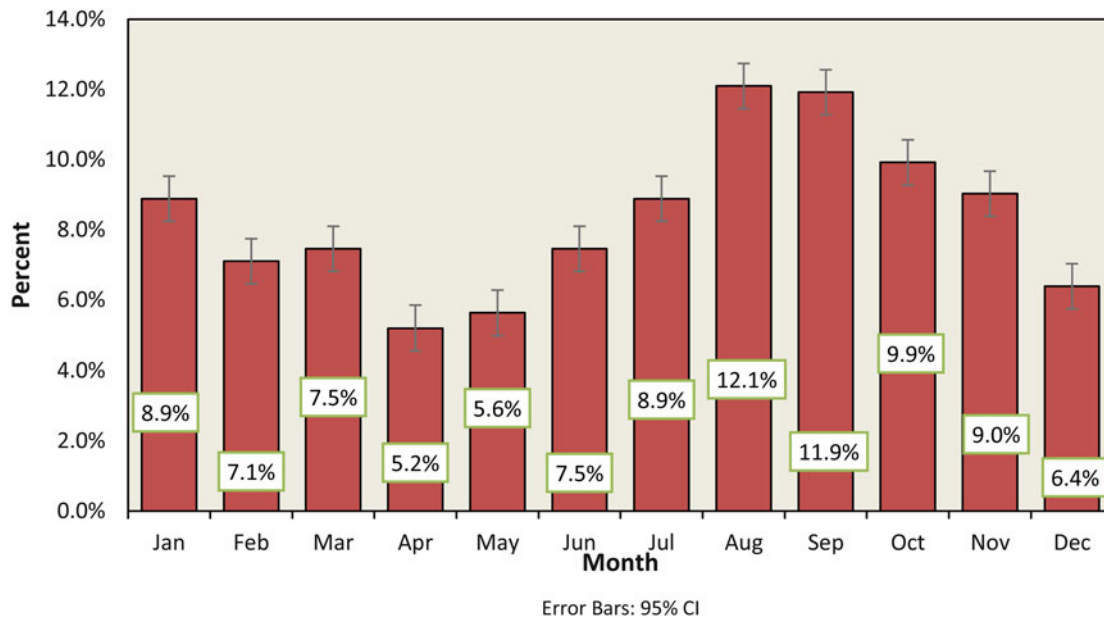
After institutional ethical approval, records of patients with the diagnosis of otitis externa on the sample request forms from January 2006 to December 2016 at Mid Essex Hospitals NHS Trust were analysed. Isolates were obtained from ear swabs cultured on agar following the standard operational procedure for ear swabs; based on the UK standards for microbiology investigations [5]. The proportional incidence of *P. aeruginosa* was the ratio of culture-positive patients with *P. aeruginosa* to the total number of patients with any other species isolate. Peak incidence date was estimated using Edward's method [6]. Environmental data for the study period was obtained from the UK Meteorological Office. The number of rainy days was correlated with the number of *P. aeruginosa* isolates. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 23.0.

In the 9-year study period, 7770 patients had a positive bacterial culture. The commonest isolate was *P. aeruginosa* ( $n = 2802$ , proportional incidence 36%), followed by *S. aureus* ( $n = 1850$ , 24%), *Aspergillus* and *Candida* sp. ( $n = 1410$ , 18%), *Enterobacteriaceae* ( $n = 1289$ , 17%), anaerobic bacteria ( $n = 1212$ , 16%), beta-haemolytic streptococci ( $n = 811$ , 10%) and the *Haemophilus*, *Streptococcus pneumoniae*, *Moraxella* group ( $n = 610$ , 8%). More than one organism was isolated from 3014 patients (39%).

The average proportional incidence of *P. aeruginosa* was 25.9% (95% CI 25.0–26.9). However, there was a clear seasonal trend every year with a peak during the months of August–November (Fig. 1). No seasonal variation was evident for the other species isolates.

The proportional incidence of *P. aeruginosa* also showed age-related differences, with the greatest incidence in the 45–65 age group (25%), followed by over 65 and the 5 to 15 age groups (19% and 18% respectively). The seasonal variation in proportional incidence was clearly observed in 5–15 age group with peaks in August and September (21% and 14% respectively, compared with a yearly average of 8% (95 CI 7.1–9.6)).

The number of *P. aeruginosa* isolates each month correlated with the number of rainy days ( $r = 0.7$ ). However, there was no correlation between the total number of patients with otitis externa and environmental factors ( $r = 0.2$ ).



**Fig. 1.** Monthly incidence of *P. aeruginosa* in otitis externa infection from 2008 to 2016.

The relationship between diseases and seasons have been recognised since antiquity, with Hippocrates postulating changes in environmental factors such as air, water and food as explanatory causes [7]. Our observational study confirms previously documented increases in otitis externa infections during summer months and the relative contributions of different agents to this incidence [1–4]. We have, for the first time, identified *P. aeruginosa* as a possible causal agent for the seasonal variation in otitis externa. This seasonal variation in the proportional incidence of *P. aeruginosa* occurs mainly in the 5–15 age group and correlated with the number of rainy days. These associations have only been sparsely described in the literature [1, 8]. Neither the seasonal variation nor the environmental association was observed with other putative pathogens.

Predisposing factors for otitis externa include the presence of moisture, long exposure to moisture with an increased risk of maceration and cerumen loss, contact with contaminated water and increased water temperatures that promote rapid growth of the organism [9, 10]. These factors provide a clear causal mechanism for the observed association between the proportional incidence of *P. aeruginosa* and the number of rainy days. The seasonal variation in the 5–15 age group can be explained by behavioural changes leading to increased exposure to water in the warm summer months.

The associations described in the study have practical relevance in choosing empirical antibiotics for otitis externa, especially in younger patients in late summer months. In the absence of a bacterial culture, empirical treatment targeting *P. aeruginosa* and *S. aureus* would cover approximately 60% of the isolates in otitis externa.

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