The Journal of Laryngology & Otology (2018), ***132***, *314–317*.
© JLO (1984) Limited, 2018
doi:10.1017/S0022215118000191

MAIN ARTICLE

Microbiology and antimicrobial susceptibility of otitis externa: a changing pattern of antimicrobial resistance

E HEWARD[1], M CULLEN[2], J HOBSON[1]

Departments of [1]Otolaryngology, and [2]Microbiology, University Hospital of South Manchester NHS Foundation Trust, UK

Abstract

Objective: Otitis externa is a common presentation to secondary care otolaryngology clinics. Despite this, few studies have investigated the microbiology and antimicrobial resistance of otitis externa. This study aimed to examine these issues.

Methods: Analysis identified 302 swabs taken from 217 patients (100 male, 117 female), between 1 January 2015 and 30 March 2016, at our rapid access otolaryngology clinic.

Results: In total, 315 organisms were isolated; the most frequent was *Pseudomonas aeruginosa* (31.1 per cent), followed by candida species (22.9 per cent) and *Staphylococcus aureus* (11.7 per cent). *P aeruginosa* was sensitive to ciprofloxacin in 97.7 per cent of cases and to gentamicin in 78.4 per cent.

Conclusion: Compared with studies worldwide, the relative proportions of different organisms causing otitis externa and the patterns of antimicrobial resistance differ. Increasing resistance of *P aeruginosa* to aminoglycosides demonstrates a changing pattern of antimicrobial resistance that has not been previously reported. Reassuringly, quinolone antibiotics remain highly effective when treating *P aeruginosa*.

Key words: Otitis Externa; Microbiology; Antimicrobial Drug Resistance

Introduction

Otitis externa is characterised by inflammation of the external auditory canal, and constitutes a large proportion of presentations to both primary care and otolaryngology clinics worldwide.[1] The annual prevalence in the USA is 0.4 per cent.[2] The most common pathogens known to cause otitis externa are *Pseudomonas aeruginosa* and *Staphylococcus aureus*.[3,4]

For mild otitis externa, topical acidifying drops may be sufficient. However, for the majority of otitis externa cases, topical combined antimicrobial and steroid drops are recommended.[5] Aminoglycoside (neomycin), polymyxin B and steroid drops are used most frequently because of low costs and availability compared with quinolone drops. Oral antibiotics are reserved for severe cases and base of skull osteomyelitis. Increasing antimicrobial resistance is a global problem; resistant organisms are becoming more frequently reported in otitis externa patients.[4,6]

Literature investigating the microbiology and antimicrobial resistance in otitis externa in the UK is limited to a single paper published in 2008.[3] This study aimed to expand current microbiological understanding and identify changes in antimicrobial resistance in the UK.

Materials and methods

Ear swabs taken from patients with otitis externa presenting to the secondary care rapid access clinic at The University Hospital of South Manchester NHS Foundation Trust, from 1 January 2015 to 30 March 2016, were analysed. The rapid access clinic receives referrals from primary care and the emergency department. Microbiological samples are taken from all new otitis externa presentations and repeated if clinically indicated.

Overall, 302 swabs were collected from 217 patients (100 male, 117 female) who were diagnosed with otitis externa by senior house officers. The patients' average age was 49.7 years (range, 3.9–95.5 years). Forty bilateral and 45 repeat swabs were taken. Patients who had otitis media, base of skull osteomyelitis or alternative ear pathologies were excluded. Patients aged under three months of age were also excluded. The

Presented orally at the International Federation of ORL Societies ('IFOS') World ENT Congress, 26 June 2017, Paris, France.
Accepted for publication 16 November 2017 First published online 12 February 2018

https://doi.org/10.1017/S0022215118000191 Published online by Cambridge University Press

sensitivities and resistances of 10 swabs that cultured *P aeruginosa* were unavailable and so were not included in the susceptibility results.

All swabs were collected by senior house officers and processed in the Public Health England microbiology laboratory at our hospital. Columbia blood agar, chocolate agar, cystine lactose electrolyte deficient agar, Sabouraud agar, staph/strep agar and fastidious anaerobe agar plates were inoculated with the swabs. The organisms were identified using standard microbiological techniques. Antimicrobial susceptibilities were determined by the Vitek® automated system, using European Committee on Antimicrobial Susceptibility Testing ('EUCAST') criteria to categorise the antimicrobials as susceptible, resistant or intermediate.

Results

In total, 302 swabs were analysed. Of these, 232 swabs grew organisms, with the most common growth being bacterial (71.4 per cent) followed by fungal (28.6 per cent) (Figure 1). In all, 315 organisms were isolated, with the most frequent being *P aeruginosa* (Table I). Of the bilateral swabs ($n = 40$), 34 (85.0 per cent) grew the same organism. A total of 45 repeat swabs were taken; 24 (53.3 per cent) of these cultured the same organisms.

Swabs identifying *P aeruginosa*, *S aureus*, anaerobes, haemolytic streptococci, *Streptococcus pneumoniae* and methicillin-resistant *S aureus* (MRSA) were tested for antimicrobial sensitivity. *P aeruginosa* was sensitive to ciprofloxacin in 97.7 per cent of cases and gentamicin in 78.4 per cent (Table II). Every *S aureus* species isolated was sensitive to gentamicin (Table III).

Anaerobes were 100 per cent sensitive to metronidazole on the nine occasions tested. Haemolytic streptococcus groups A, C and G were all 100 per cent sensitive to penicillin and clarithromycin. The single isolate of *S pneumoniae* was sensitive to penicillin. One swab containing MRSA was cultured and was sensitive to doxycycline.

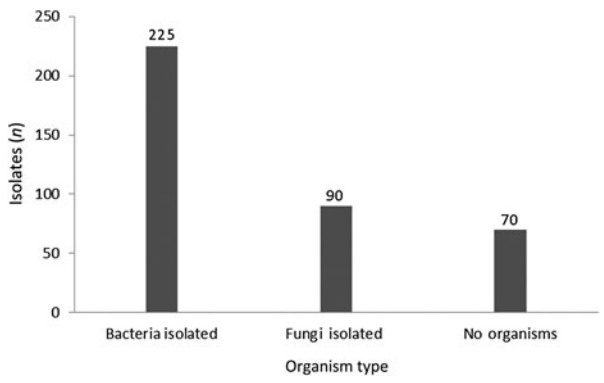

FIG. 1
Swab result categorised by organism type.

TABLE I
EAR SWAB ISOLATES*

Organism	Isolates (n (%))
Pseudomonas aeruginosa	98 (31.1)
Candida species	72 (22.9)
Staphylococcus aureus	37 (11.7)
Coagulase-negative staphylococci	32 (10.2)
Aspergillus species	18 (5.7)
Coliforms	17 (5.4)
Anaerobes	14 (4.4)
Diphtheroids	11 (3.5)
Enterococcus	6 (1.9)
Haemolytic streptococcus group G	3 (1.0)
Haemolytic streptococcus group B	3 (1.0)
MRSA	1 (0.3)
Haemolytic streptococcus group A	1 (0.3)
Haemolytic streptococcus group C	1 (0.3)
Streptococcus pneumoniae	1 (0.3)

*$n = 315$. MRSA = methicillin-resistant *Staphylococcus aureus*

TABLE II
PSEUDOMONAS AERUGINOSA SUSCEPTIBILITY*

Antimicrobial	Susceptible	Resistant	Intermediate
Gentamicin	69 (78.4)	18 (20.5)	1 (1.1)
Ciprofloxacin	86 (97.7)	2 (2.3)	0 (0)

Data represent numbers (and percentages) of swabs. *$n = 88$

TABLE III
STAPHYLOCOCCUS AUREUS SUSCEPTIBILITY*

Antimicrobial	Susceptible	Resistant	Intermediate
Gentamicin	37 (100.0)	0 (0.0)	0 (0)
Clarithromycin	34 (92.9)	3 (0.1)	0 (0)
Flucloxacillin	36 (97.3)	1 (0.03)	0 (0)

Data represent numbers (and percentages) of swabs. *$n = 37$

Discussion

Studies investigating the microbiology of otitis externa have been published worldwide (Table IV).[3,4,7–12] The vast majority of the studies identified either *P aeruginosa* or *S aureus* to be the most common bacterial pathogens causing otitis externa.[3,4,7–11] However, recently, Kiakojuri *et al*. found that bacillus species were the most frequent pathogen causing otitis externa in Iran.[12] Studies from the UK, Ireland and the USA have a higher proportion of *P aeruginosa* isolates compared to developing countries.

- **Otitis externa is most frequently caused by *Pseudomonas aeruginosa, Staphylococcus aureus* and candida species**
- **Rates of gentamicin-resistant *P aeruginosa* are increasing**
- **Quinolone antibiotics remain effective for treating *P aeruginosa***

https://doi.org/10.1017/S0022215118000191 Published online by Cambridge University Press

TABLE IV
WORLDWIDE COMPARISON OF MICROBIOLOGY OF OTITIS EXTERNA

Country	Study (year)	Number of swabs	Total isolates (*n*)	*P aeruginosa* (% of isolates)	*S aureus* (% of isolates)	Candida & aspergillus (% of isolates)
UK	Current study (2018)	302	315	31.1	11.7	22.9
Iran	Kiakojuri *et al.*[12] (2016)	116	116	12.1	6.03	–
New Zealand	Jayakar *et al.*[7] (2014)	126	179	37.4	25.1	2.8
Turkey	Enoz *et al.*[8] (2009)	362	267	12.0	24.3	22.1
UK	Ninkovic *et al.*[3] (2008)	144	116	45.1	9.0	9.7
Argentina	Amigot *et al.*[10] (2003)	294	238	17.2	10.1	29.0
USA	Roland & Stroman[9] (2002)	2240	2887	38.0	7.8	1.7
Ireland	Walshe *et al.*[4] (2001)	239	215	38.1	26.5	10.2
Norway	Dibb[11] (1991)	226	188	26.6	41.0	11.2

By far the largest study investigating the microbiology of otitis externa patients was a multicentre study conducted in the USA. Roland and Stroman found the most frequent pathogen to be *P aeruginosa* (38 per cent), followed by *Staphylococcus epidermidis* (9.1 per cent) and *S aureus* (7.8 per cent).[9] Swabs containing *S epidermidis* at our centre were either reported as coagulase-negative staphylococci or skin flora. The current study bears similarities to the findings of Roland and Stroman regarding the distribution of bacterial organisms found.

This study supplements the current literature surrounding the microbiology of otitis externa in the UK. When compared with the previous UK study, published in 2008,[3] the current study identified a similar distribution of bacterial isolates in otitis externa cases. However, the proportion of fungal isolates was significantly higher in the current study (Table IV). Fungal isolates were most commonly identified in Argentina and most infrequently found in the USA (Table IV). It is known that otomycosis occurs more frequently in mild and wet climates, which may account for these findings.[10] A prospective trial identifying the predisposing factors of otomycosis is required at our centre. Appropriate treatment of otomycosis is essential, as the use of topical antibiotics is known to propagate further fungal growth.[5]

No previous studies have documented the outcomes of taking bilateral or repeated ear swabs in otitis externa patients. We have demonstrated that there is a high likelihood that patients presenting with bilateral otitis externa will have the same pathogenic organism in both ears; hence, culturing a single swab may be sufficient. However, patients who re-present with otitis externa may require additional microbiological cultures because of the high likelihood of a different pathological organism.

Rising antimicrobial resistance worldwide could be one of the greatest challenges currently facing the medical profession. Identification of resistant organisms is therefore essential to guide appropriate antimicrobial use.[6] Alarmingly, MRSA is becoming more commonly cultured in otitis externa.[4]

Studies from Roland and Stroman,[9] and Ninkovic *et al.*,[3] demonstrated that *P aeruginosa* is more frequently sensitive to ciprofloxacin than gentamicin: 99 per cent versus 96 per cent, and 100 per cent versus 98.5 per cent, respectively. The current study reveals a much higher proportion (78.4 per cent) of *P aeruginosa* species resistant to gentamicin. In addition, 97.7 per cent of *P aeruginosa* organisms were sensitive to ciprofloxacin, which is consistent with previous studies. The sensitivities of *S aureus* reported in the current study echo those documented previously showing high levels of sensitivity to gentamicin and flucloxacillin.[3,9]

Systematic review has demonstrated the efficacy of topical antibiotics for otitis externa. Without therapy, resolution occurs in 15 per cent of patients, compared with 65–80 per cent of patients receiving topical antimicrobials with or without corticosteroids.[13] Topical drops containing aminoglycoside and steroid have historically been the mainstay of treatment for otitis externa. Recent evidence in the form of meta-analysis has shown quinolone monotherapy to be superior in treating otitis externa.[14] Quinolones have mainly Gram-negative and some Gram-positive cover, making them the ideal agent to treat *P aeruginosa.* Although quinolones are more expensive, they reduce the risk of ototoxicity and local hypersensitivity compared with aminoglycosides.[5] In many otitis externa patients, ototoxic drops should be avoided when canal debris and swelling prohibits assessment of tympanic membrane perforation.

Topical antibiotic drops are only effective if the ear canal is clear of debris or a Pope ear wick is inserted. It has been suggested that many cases of resistant otitis externa in primary care are caused by a lack of canal clearing before the application of topical antibiotics.[5]

Current UK opinion advocates using aminoglycosides for short periods as first-line therapy in patients with obvious infection, regardless of tympanic patency.[15] Conversely, American guidance recommends the use of quinolone antibiotics rather than aminoglycosides, because of similar efficacy and reduced ototoxicity.[16] Future UK antibiotic guidance should reflect the current literature, which demonstrates the efficacy and safety of quinolones and the increasing antibiotic resistance to aminoglycosides in the UK.[13]

https://doi.org/10.1017/S0022215118000191 Published online by Cambridge University Press

The patterns of prevalence of different organisms causing otitis externa and antimicrobial resistance differ worldwide. This study has demonstrated that in our population the most frequent causative pathogen in otitis externa is *P aeruginosa*. Increasing resistance of *P aeruginosa* to gentamicin may necessitate changes in prescribing guidance, favouring more effective antimicrobials such as quinolones. Studies are required to identify whether similar resistance patterns are apparent worldwide.

References

1 Rowlands S, Devalia H, Smith C, Hubbard R, Dean A. Otitis externa in UK general practice: a survey using the UK General Practice Research Database. *Br J Gen Pract* 2001;**51**:533–8
2 Guthrie RM. Diagnosis and treatment of acute otitis externa. *An interdisciplinary update.* Ann Otol Rhinol Laryngol Suppl 1999;**176**:1–23
3 Ninkovic G, Dullo V, Saunders NC. Microbiology of otitis externa in the secondary care in United Kingdom and antimicrobial sensitivity. *Auris Nasus Larynx* 2008;**35**:480–4
4 Walshe P, Rowley H, Timon C. A worrying development in the microbiology of otitis externa. *Clin Otolaryngol Allied Sci* 2001; **26**:218–20
5 Hannley MT, Denneny JC 3rd, Holzer SS. Use of ototopical antibiotics in treating 3 common ear diseases. *Otolaryngol Head Neck Surg* 2000;**122**:934–40
6 Davies J, Davies D. Origins and evolution of antibiotic resistance. *Microbiol Mol Biol Rev* 2010;**74**:417–33
7 Jayakar R, Sanders J, Jones E. A study of acute otitis externa at Wellington Hospital, 2007–2011. *Australas Med J* 2014;**7**: 392–9
8 Enoz M, Sevinc I, Lapeña JF. Bacterial and fungal organisms in otitis externa patients without fungal infection risk factors in Erzurum, Turkey. *Braz J Otorhinolaryngol* 2009;**75**:721–5
9 Roland PS, Stroman DW. Microbiology of acute otitis externa. *Laryngoscope* 2002;**112**:1166–77
10 Amigot SL, Gomez CR, Luque AG, Ebner G. Microbiological study of external otitis in Rosario City, Argentina. *Mycoses* 2003;**46**:312–15
11 Dibb WL. Microbial aetiology of otitis externa. *J Infect* 1991;**22**: 233–9
12 Kiakojuri K, Omran SM, Jalili B, Hajiahmadi M, Bagheri M, Shahandashti EF *et al*. Bacterial otitis externa in patients attending an ENT clinic in Babol, North of Iran. *Jundishapur J Microbiol* 2016;**9**:e23093
13 Rosenfeld RM, Singer M, Wasserman JM, Stinnett SS. Systematic review of topical antimicrobial therapy for acute otitis externa. *Otolaryngol Head Neck Surg* 2006;**134**:S24–48
14 Mösges R, Nematian-Samani M, Hellmich M, Shah-Hosseini K. A meta-analysis of the efficacy of quinolone containing otics in comparison to antibiotic–steroid combination drugs in the local treatment of otitis externa. *Curr Med Res Opin* 2011;**27**: 2053–60
15 Phillips JS, Yung MW, Burton MJ, Swan IR. Evidence review and ENT-UK consensus report for the use of aminoglycoside-containing ear drops in the presence of an open middle ear. *Clin Otolaryngol* 2007;**32**:330–6
16 Rosenfeld RM, Schwartz SR, Cannon CR, Roland PS, Simon GR, Kumar KA *et al*. Clinical practice guideline: acute otitis externa. *Otolaryngol Head Neck Surg* 2014;**150**:S1–24

Address for correspondence:
Mr Elliot Heward,
Department of Otolaryngology,
University Hospital of South Manchester NHS Foundation Trust,
Manchester, UK

E-mail: elliotheward@doctors.org.uk

Mr E Heward takes responsibility for the integrity of the content of the paper
Competing interests: None declared

https://doi.org/10.1017/S0022215118000191 Published online by Cambridge University Press