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Original Article

Severe Acute Otitis Media and Acute Mastoiditis in Adults

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OBJECTIVE: To evaluate and compare clinical and microbiological findings in adults hospitalized for acute otitis media (AOM) or mastoid infections (acute or latent).

MATERIALS and METHODS: We retrospectively reviewed the medical records of all adults (≥17 years old) hospitalized (between 2003 and 2012) at a tertiary referral center for acute mastoid infections or AOM not responding to outpatient medical treatment.

RESULTS: Of the 160 patients in the study sample, 19% had an infection caused by *S. pyogenes*, 14% by *S. pneumoniae*, and 11% by *P. aeruginosa*. AOM was the most common infection (38%), whereas 33% had acute mastoiditis (AM), 18% had latent mastoiditis (LM), and 13% AM of a chronically infected ear (AMc). In contrast to the other infections, *P. aeruginosa* (30%) and *S. aureus* (25%) were most common in AMc. Otorrhea (83%), tympanic membrane perforation (57%), and hearing problems (83%) were common in *S. pyogenes* infections. Patients with *S. pneumoniae* had longer lengths of hospitalization than those with other bacterial infections (7 vs. 4 days). Otorrhea (94%) and retroauricular symptoms were more common in *P. aeruginosa* infections. Hearing symptoms were common (67%) but fever (32%) and retroauricular symptoms were uncommon in AOM. Fever (44%) and mastoid tenderness (65%) were common in AM. Patients with LM underwent the most mastoidectomies (54%). Prior medical conditions, retroauricular symptoms, otorrhea (90%), and post-infection problems were common in AMc.

CONCLUSION: The bacteriological etiology of hospitalized AOM more closely resembled those of LM and AM than that of AMc. Adults hospitalized for AOM or AM required fewer mastoidectomies than those hospitalized for LM or AMc.

KEYWORDS: Otitis media, mastoiditis, complication, bacteriology, adults

INTRODUCTION

Although acute otitis media (AOM) is a common infection with a tendency to spontaneous resolution, it may lead to complications. Acute complications may also occur in a chronically infected ear [1-3]. Purulent infections of the middle ear may spread into surrounding structures and cause acute complications [4]. Intratemporal complications include mastoiditis, petrositis, facial paresis, and labyrinthitis [5]. Acute mastoiditis (AM) may further lead to the formation of a subperiosteal abscess, Bezold's abscess, or Luc's abscess [6-8]. Intracranial complications include meningitis, sigmoid sinus thrombosis, otogenic hydrocephalus, and intracranial abscesses [9, 10].

In the pre-antibiotic era, complications of otitis media (OM) were common [11]. Modern treatments, including antimicrobial agents, have resulted in fewer complications, less chronic OM, and fewer intracranial abscesses [12-14]. Antimicrobial treatment may, however, result in prolonged latent mastoiditis (LM) [14-16]. *S. pyogenes* has been reported to cause a severe, complicated clinical profile of AOM in children [17, 18]. AOM and its complications, however, differ in children and adults, with most studies focusing on children [19, 20].

The aim of this study is to evaluate and compare clinical findings and microbiological results in adults hospitalized owing to AOM or acute mastoid infections.

MATERIALS and METHODS

Participants and Data

We retrospectively reviewed the medical records of all adults (≥17 years old) hospitalized owing to AOM or acute mastoid infections between 2003 and 2012 in the Department of Otorhinolaryngology of a tertiary referral center providing healthcare services to 1.5 million people. The hospital's database was searched using the International Classification of Diseases 2010 codes H65 (non-suppurative otitis media), H66 (suppurative and unspecified otitis media), H67 (otitis media in diseases classified elsewhere), H70 (mastoiditis and related conditions), and H75 (other disorders of the middle ear and mastoid in diseases classified elsewhere). The diagnoses were re-evaluated according to the study inclusion criteria; 167 cases were found. The following criteria were used for AOM: symptoms of acute (≤14 days) illness (fever, earache, or respiratory symptoms) and findings of middle ear effusion with signs

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of infection (bulging, redness, or abnormal mobility) of the tympanic membrane (TM) upon otomicroscopy or recent onset of otorrhea. The following criteria were used for AM: AOM with at least two of the following symptoms: retroauricular redness, swelling, pain, or fluctuation, protrusion of the pinna, an abscess in the external auditory canal (EAC), and/or purulent secretion or acute infection in the mastoid process following mastoidectomy [19].

In this study, patients with clear symptoms of acute mastoid infection who did not fulfill all the study criteria for AM were classified as having LM. Patients who fulfilled the criteria for AM were further classified as having either classical AM or AM of a chronically infected ear (AMc) if they had a history of chronic OM. Only one diagnosis per patient was analyzed, and bilateral infections (contralateral AOM and mastoiditis) were classified as mastoid infections (AM, LM, or AMc); seven (recurrent) cases were excluded, which brought our final sample size to 160 patients. Age, gender, medical history, pre-hospital medication, signs and symptoms of infection, laboratory tests, bacteriological cultures, radiological examinations, medication, surgical treatment, and clinical outcomes were recorded. Samples for bacteriological culture had been taken, as part of routine medical protocol, from a middle ear effusion through an existing tympanostomy tube or TM perforation, via paracentesis, or during mastoidectomy. The microbiology laboratory analyzed the samples according to its standard procedure.

The Ethics Committee of the University Hospital approved the study protocol. This study was retrospective, the study permission was obtained from the Helsinki University Hospital.

Statistical Analysis

For the statistical analysis we used IBM SPSS Statistics for Windows, version 22.0; released 2013 (IBM SPSS Statistics for Windows, version 22.0, IBM Corp., Armonk, NY, USA). Chi-squared tests or Fisher's exact test were employed, where appropriate, to determine significance between categorical variables. The Mann–Whitney U test was used to analyze the equality of medians between continuous variables. Statistical significance was determined to be a p-value of <0.05.

RESULTS

Demographics and Medical History of Patients

The patients' mean age was 47.4 years (range 17–91) (Table 1). Infection was on the right side in 75 (47%) patients, on the left in 67 (42%), and bilateral in 18 (11%). No seasonal variation was seen (43 cases in the spring, 36 in the summer, 40 in the autumn, and 41 in the winter). The annual incidence of acute mastoid infections (AM, LM, or AMc) was 0.8/100,000 and that of AM was 0.4/100,000. Comorbidities were found in 99 (62%) patients, including asthma (n=24, 15%), diabetes (n=18, 11%), cardiac disease (n=15, 9%), neurological conditions (n=13, 8%), chronic sinusitis (n=11, 7%), psychiatric conditions (n=11, 7%), hepatitis (n=5, 3%), and immunodeficiency (n=5, 3%). In our sample, 43 (27%) patients had prior ear problems and five (3%) had a prior tympanostomy tube. Among AOM patients, 13 (22%) had prior ear problems, four had a history of otitis, three had a history of prior ear surgery (two for otosclerosis and one mastoidectomy), three had chronic serous OM, two had prior vertigo, two had prior TM perforation, and one had a prior hearing problem. AM patients were the least likely to have a history of prior ear problems [5 (10%) vs. 38 (35%), p=0.001]; two had prior otitis, two had prior vertigo, one had an EAC exostosis removed, and one had cochlear implantation owing to prior sudden deafness. Patients with AM also had fewer other comorbidities than others [26 (50%) vs. 73 (68%), p=0.036]. Among LM patients, five (18%) had a history of ear problems, four of otitis, and one of EAC atresia. All 20 patients with AMc had a comorbidity (in comparison to only 57% of others, p=0.000) and had prior (chronic) ear problems (in comparison to only 16% of others, p=0.000). The prior ear problems included prior mastoidectomy (7), myringoplasty (3), TM perforation (3), prior tympanostomy tube (2), cholesteatoma (2), prior surgery for EAC exostosis (1), and prior surgery for EAC abscess (1). Cardiac problems [5 (25%) vs. 10 (7%) in others, p=0.024] were common in AMc. Prior antimicrobial treatment had been administered to 114 patients (71%), including penicillin or amoxicillin (29%), amoxicillin/clavulanate (15%), cephalosporins (15%), and macrolides (14%). Prior ear drops had been given to 40 patients (25%). Those with AMc were the least likely to have received prior antimicrobial treatment [10 (50%) vs. 104 (74%), p=0.034].

Clinical Symptoms and Findings, Laboratory Test Results, and Radiological Examinations

The mean duration of acute symptoms was 12.5 days (range 0–90) and the duration of symptoms was longest in LM patients (Table 1). Ear symptoms were common (Table 1); 33 patients (21%) had an infection of the EAC. Ten patients (6%) had neurological symptoms, four had an altered level of consciousness, two had confusion or symptoms of vision, respectively, and one had hypoglossal nerve paresis or seizure, respectively. The patients' symptoms and findings according to the type of infection are presented in Table 1. Computed tomography (CT) was performed on 104 (65%) patients and magnetic resonance imaging (MRI) on 35 patients (22%). Imaging was less common in AOM patients than in those with mastoid infections [CT 17 (28%), p=0.000 and MRI 3 (5%), p=0.000], LM [CT 26 (93%), p=0.000 and MRI 12 (43%), p=0.005], AM [CT 44 (85%), p=0.000], and AMc [CT 17 (85%), p=0.048].

Microbiological Findings

Samples for microbiological culture were taken from 156 (98%) patients; four AOM patients had no sample taken. Cultures were positive for bacteria in 91 cases (58%). The most common pathogens were *S. pyogenes* (19%), *S. pneumoniae* (14%), and *P. aeruginosa* (11%); notably, only three (2%) patients in our sample had *H. influenzae* (Table 2, Figure 1). The most common pathogens in polymicrobial samples (18%) were *P. aeruginosa* (29%), *S. aureus* (29%), and other staphylococci (29%). Among *S. pneumoniae* samples, 18% displayed reduced susceptibility to common antimicrobial agents.

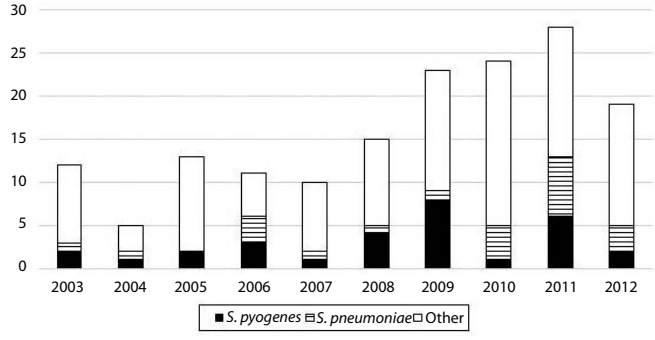

Figure 1. Yearly number of cases caused by *S. pyogenes, S. pneumoniae*, and all other pathogens

Table 1. Comparison† of patients' symptoms, findings, complications, operations, and outcomes, according to their diagnoses

		All patients (n=160)	Acute otitis media (n=60)	Acute mastoiditis (n=52)	Latent mastoiditis (n=28)	Acute mastoiditis of chronically infected ear (n=20)
Age	Years, median	45.5	43.0	46.5	49.0	51.5
Sex	Female	92 (58%)	40 (67%)	31 (60%)	12 (43%)	9 (45%)
Duration of symptoms	Days, median (n=158)	8	8	7	10***	7
Duration of hospitalization	Days, median	4	4*	6***	5**	4
Laboratory test results	CRP value, median (mg/L) (n=155)	28	11**	81**	24	12
	Leukocyte count, median (10^9/L) (n=154)	10.5	9.9***	10.9	12.0**	9.0
Clinical findings	Bilateral infection	18 (11%)	8 (13%)	7 (13%)	1 (4%)	2 (10%)
	Otalgia	153 (96%)	58 (97%)	52 (100%)	24 (86%)***	19 (95%)
	Fever	60 (38%)	19 (32%)***	23 (44%)***	11 (39%)	7 (35%)
	Tympanic membrane perforation	47 (29%)	14 (23%)	18 (35%)	7 (25%)	8 (40%)
	Prior grommet	5 (3%)	0	1 (2%)	2 (7%)	2 (10%)
	Otorrhea	95 (59%)	26 (43%)**	33 (64%)	18 (64%)	18 (90%)*
	Facial nerve paresis	22 (14%)	10 (17%)	6 (12%)	5 (18%)	1 (5%)
	Dizziness	73 (46%)	32 (53%)	23 (44%)	12 (43%)	6 (30%)***
	Nausea	30 (19%)	14 (23%)	11 (21%)	4 (14%)	1 (5%)
	Hearing problem	100 (63%)	40 (67%)***	36 (69%)	19 (68%)	5 (25%)*
	Headache	28 (18%)	8 (13%)	12 (23%)	5 (18%)	3 (15%)
	Retroauricular redness	22 (14%)	1 (2%)*	12 (23%)	1 (4%)	8 (40%)**
	Mastoid tenderness	60 (38%)	7 (12%)*	34 (65%)*	7 (25%)	12 (60%)***
	Retroauricular swelling	22 (14%)	0*	12 (23%)	1 (4%)	9 (45%)*
	Protrusion of the pinna	10 (6%)	0**	6 (12%)	0	4 (20%)***
	Retroauricular fluctuation	8 (5%)	0**	1 (2%)	1 (4%)	6 (30%)*
Complications	Subperiosteal abscess	10 (6%)	0***	1 (2%)	2 (10%)	7 (35%)*
	Subdural empyema	1 (1%)	0	0	0	1 (5%)
	Meningitis	9 (6%)	0***	4(8%)	3 (11%)	2 (10%)
	Labyrinthitis	37 (23%)	23 (38%)**	8 (15%)	5 (18%)	1 (5%)***
	Sinus thrombosis	3 (2%)	0	2(4%)	1 (4%)	0
Operations	Tympanostomy	100 (63%)	33 (55%)	38 (73%)	20 (71%)	9 (45%)
	Mastoidectomy	48 (30%)	4 (7%)*	19 (37%)	15 (54%)**	10 (50%)
	Paracentesis	111 (69%)	45 (75%)	37 (71%)	22 (79%)	7 (35%)**
Outcomes	Later operations, any	23 (14%)	5 (8%)	7 (13%)	6 (21%)	5 (25%)
	Tympanic membrane perforation	26 (16%)	8 (13%)	7 (13%)	5 (18%)	6 (30%)***
	Residual hearing problem	53 (33%)	22 (37%)	18 (35%)	9 (32%)	4 (20%)***
	Full recovery	72 (45%)	31 (52%)	27 (52%)	10 (36%)	4 (20%)***

†Diagnosis groups are compared separately with the data for all other patients using chi-squared tests, Fisher's exact test, or the Mann–Whitney U-test, where appropriate, to determine significance; p-values are classified as follows: *p<0.001, **p<0.01, ***p<0.05
CRP: C-reactive protein

The most common pathogens in AOM, AM, and LM patients were *S. pyogenes* (15%, 27%, and 25%, respectively) and *S. pneumoniae* (10%, 19%, and 21%, respectively) (Figure 2).

The patients' signs, symptoms, and diagnoses according to the pathogens are presented in Table 2. All five patients with prior tympanostomy tubes had otorrhea, and although all had positive bacterial cultures, none were infected with *P. aeruginosa*.

Complications

The most common complications were labyrinthitis (n=37, 23%), facial nerve paresis (n=22, 14%), and abscesses [subperiosteal abscess (10), Bezold's abscess (1, a patient with AMc), and an abscess of the EAC (1, a patient with AMc)] (Table 1, Figure 3). Intracranial complications were seen in 13 patients (8%), with nine (6%) having meningitis.

Subperiosteal abscesses were more common in AMc patients than in others [7 (35%) vs. 3 (2%), p=0.000] and were not seen in AOM patients. In addition, meningitis was not seen in AOM patients. Labyrinthitis was common in AOM patients [23 (38%) vs. 14 (14%), p=0.001] and rare in AMc patients [1 (5%) vs. 36 (26%), p=0.046] in comparison to others (Table 1).

Meningitis was more common in patients with *S. pneumoniae* than in others [5 (23%) vs. 4 (3%), p=0.003] (Table 2); one of these cases of

Table 2. Comparison† of patients' symptoms, findings, complications, operations, and outcomes, according to the respective pathogens^

		All patients (n=160)	*S. pyogenes* 30 (19%)	*S. pneumoniae* 22 (14%)	*P. aeruginosa* 17 (11%)	*S. aureus* 13 (8%)	Other staphylococci 13 (8%)	Other streptococci 6 (4%)	*S. pneumoniae* (resistant) 4 (3%)	Polybacterial 28 (18%)	Culture-negative 65 (41%)
Prior antimicrobial treatment	Number of patients (%)	114 (71%)	19 (63%)	9 (41%)**	12 (71%)	9 (69%)	9 (69%)	1 (17%)**	2 (50%)	17 (61%)	54 (83%)**
Duration of hospitalization	Days, median	4	5	7*	4	4	5	4	6	5	4**
Laboratory test results	CRP value, median (mg/L)	28	73	216*	13	42	5	12	124	42	11**
	Leukocyte count, median (10^9/L)	10.5	13.2***	14.4**	10.0	10.5	11.2	10.5	10.6	10.5	9.8**
Clinical findings	Fever	60 (38%)	12 (40%)	13 (59%)	5 (29%)	5 (38%)	4 (31%)	2 (33%)	1 (25%)	9 (32%)	20 (31%)***
	Headache	28 (18%)	4 (13%)	8 (36%)	1 (6%)	3 (23%)	3 (23%)	2 (33%)	1 (25%)	6 (21%)	10 (15%)
	Otalgia	153 (96%)	29 (97%)	20 (91%)	15 (88%)	13 (100%)	12 (92%)	5 (83%)	3 (75%)	25 (89%)	63 (97%)
	Otorrhea	95 (59%)	25 (83%)**	13 (59%)	16 (94%)**	9 (69%)	10 (77%)	6 (100%)***	1 (25%)	24 (86%)**	25 (38%)*
	Tympanic membrane perforation	47 (29%)	17 (57%)*	6 (27%)	9 (53%)	5 (38%)	6 (46%)	2 (33%)	1 (25%)	11 (39%)	9 (14%)**
	Hearing problem	100 (63%)	25 (83%)**	10 (45%)	7 (41%)	8 (62%)	9 (69%)	2 (33%)	0	16 (57%)**	43 (66%)
	Dizziness	73 (46%)	17 (57%)	6 (27%)	5 (29%)	6 (46%)	8 (62%)	3 (50%)	0	15 (54%)	33 (51%)
	Nausea	30 (19%)	6 (20%)	3 (14%)	1 (6%)	2 (15%)	5 (38%)	2 (33%)	1 (25%)	8 (29%)	18 (28%)***
	Protrusion of the pinna	10 (6%)	0	0	4 (24%)***	2 (15%)	1 (8%)	2 (33%)	0	4 (14%)	1 (2%) ***
	Mastoid tenderness	60 (38%)	10 (33%)	8 (36%)	9 (53%)	8 (62%)	5 (38%)	3 (50%)	1 (25%)	11 (39%)	21 (32%)
	Retroauricular redness	22 (14%)	2 (7%)	1 (5%)	7 (41%)**	3 (23%)	1 (8%)	2 (33%)	0	5 (18%)	7 (11%)
	Retroauricular swelling	22 (14%)	1 (3%)	2 (9%)	6 (35%)***	3 (23%)	1 (8%)	2 (33%)	0	5 (18%)	8 (12%)
	Retroauricular fluctuation	8 (5%)	0	0	2 (12%)	2 (15%)	1 (8%)	2 (33%)	0	5 (18%)**	2 (3%)***
Diagnosis	Acute otitis media	60 (38%)	9 (30%)	6 (27%)	5 (29%)	2 (15%)	1 (8%)***	1 (17%)	2 (50%)	5 (18%)***	34 (52%)**
	Acute mastoiditis	52 (33%)	14 (47%)	10 (45%)	5 (29%)	3 (23%)	7 (54%)	0	1 (25%)	9 (32%)	18 (28%)
	Latent mastoiditis	28 (18%)	7 (23%)	6 (27%)	1 (6%)	3 (23%)	3 (23%)	2 (33%)	1 (25%)	6 (21%)	7 (11%)
	Acute mastoiditis of chronically infected ear	20 (13%)	0***	0	6 (35%)**	5 (38%)***	2 (15%)	3 (50%)***	0	8 (29%)***	6 (9%)
Complications	Paresis of facial nerve	22 (14%)	1 (3%)	2 (9%)	2 (12%)	2 (15%)	2 (15%)	1 (17%)	0	5 (18%)	13 (20%)
	Meningitis	6 (4%)	0	5 (23%)*	0	0	1 (8%)	0	1 (25%)	1 (4%)	1 (2%)
Operations	Tympanostomy	100 (63%)	20 (67%)	9 (41%)***	6 (35%)***	7 (54%)	10 (77%)	3 (50%)	2 (50%)	14 (50%)	48 (74%)***
	Mastoidectomy	48 (30%)	12 (40%)	7 (32%)	5 (29%)	6 (46%)	7 (54%)	3 (50%)	0	15 (54%)***	14 (22%)
Outcomes	Later operations, any	23 (14%)	1 (3%)	3 (14%)	3 (18%)	2 (15%)	4 (31%)	1 (17%)	0	3 (11%)	9 (14%)
	Tympanic membrane perforation	26 (16%)	3 (10%)	5 (23%)***	6 (35%)	3 (23%)	4 (31%)	2 (33%)	1 (25%)	9 (32%)***	6 (9%)
	Residual hearing problem	53 (33%)	18 (60%)**	8 (36%)***	5 (29%)	8 (62%)**	5 (38%)	1 (17%)	0	12 (43%)***	14 (22%)***
	Full recovery	72 (45%)	11 (37%)	12 (55%)	4 (24%)***	4 (31%)	4 (31%)	3 (50%)	3 (75%)	10 (36%)	35 (54%)

†Diagnosis groups are compared separately with the data for all other patients using chi-squared tests, Fisher's exact test, or the Mann–Whitney U test, where appropriate, to determine significance; p-values are classified as follows: *p<0.001, **p<0.01, ***p<0.05

CRP: C-reactive protein

^Only the most common pathogens are listed in the table. Other pathogens (n) not included are: H. influenzae (3), B. fragilis (2), *Propionibacterium* spp. (2), diphtheroids (2), *E. coli* (2), *K. pneumoniae* (2), *E. aerogenes* (2), actinobacterium (1), *Prevotella* spp. (1), and *Citrobacter* spp. (1)

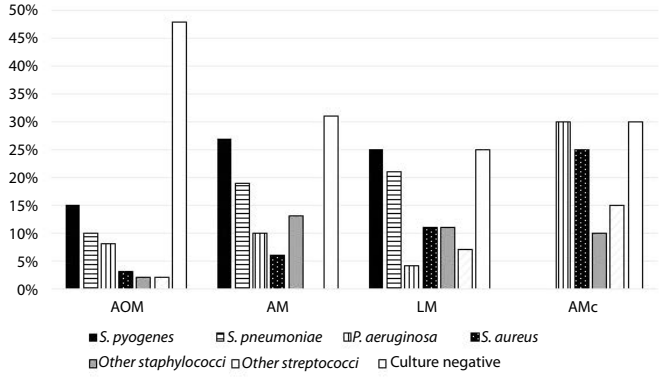

Figure 2. Proportions of pathogens among patients with AOM, AM, LM, and AMc

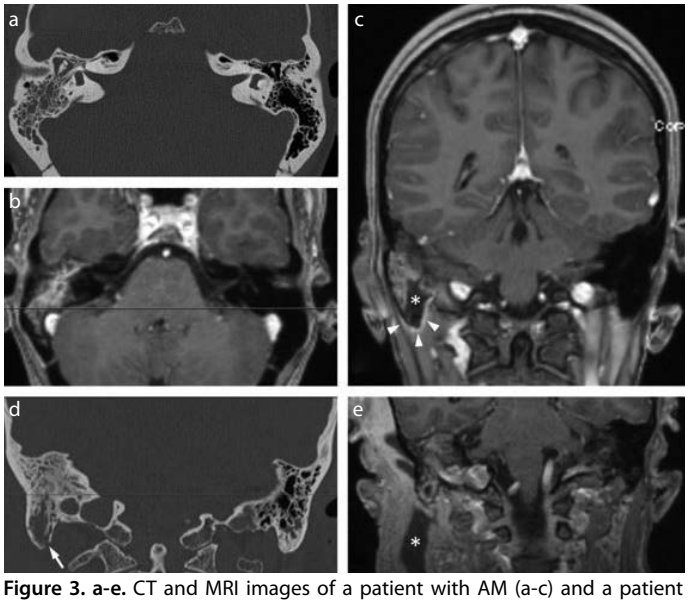

Figure 3. a-e. CT and MRI images of a patient with AM (a-c) and a patient with AMc (d, e). A normal-size mastoid cavity filled with inflammatory secretions and soft tissue is seen in the CT of a patient with AM (a). MRI gives a better overview of the soft tissue component, showing an intense enhancement of the intramastoid-inflamed mucosa or granulation tissue (b), as well as a necrotic unenhanced area at the tip of the mastoid process (asterisk in c) and periosteal enhancement compatible with periostitis (arrowheads in c). In an AMc patient, a sclerotic mastoid cavity is seen in CT with osteolysis and a bony cortical defect at the tip of the mastoid (arrow in d). MRI reveals a large Bezold's abscess (asterisk in e) in the soft tissues of the neck.

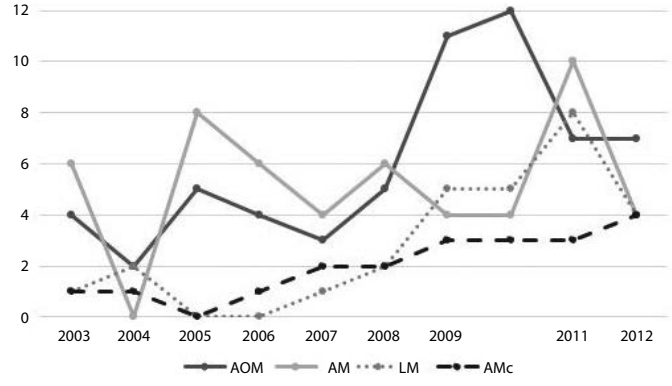

Figure 4. Yearly number of patients hospitalized owing to acute otitis media (AOM), acute mastoiditis (AM), latent mastoiditis (LM), and AM in chronic ear (AMc)

meningitis with *S. pneumoniae* was resistant to common antimicrobial agents. Labyrinthine involvement was more common in patients with culture-negative samples than in others [21 (32%) vs. 16 (17%), p=0.035].

Treatment

The overall median duration of hospitalization was 4.0 days (mean 6, range 2–30), with AM patients having the longest stays (Table 1). The mean duration of hospitalization was longer in patients who underwent mastoidectomy than in those who did not (8 vs. 5 days, respectively, p=0.001). Parenteral antimicrobial treatment was administered to 156 (98%) patients, including cefuroxime (84%), ceftriaxone (11%), and/or metronidazole (10%). Peroral antimicrobial treatment was prescribed to 147 (92%) patients, including cephalexin (55%), amoxicillin/clavulanate (22%), and ciprofloxacin (18%). Topical ear drops were administered to 140 (88%) patients, and peroral or parenteral steroids to 127 patients (79%). Among AM, LM, and AMc patients, 44 (44%) had a mastoidectomy performed, with the procedure being most common in LM patients [15 (54%) vs. 33 (25%), p=0.002] (Table 1). Paracentesis was least common in AMc patients [7 (37%) vs. 104 (75%), p=0.002].

Outcomes of Patients

A full recovery was made by 72 patients (45%) (Table 1). Dizziness remained after the infection in 11 (7%) patients, and neurological problems remained in four patients (3%). Those who underwent a mastoidectomy were more likely to have later operations [12 (25%) vs. 10 (9%), p=0.026], residual hearing problems [25 (52%) vs. 28 (25%), p=0.005], and residual dizziness [7 (15%) vs. 4 (4%), p=0.006] and less likely to make a full recovery [10 (21%) vs. 62 (56%), p=0.000] than those who did not undergo a mastoidectomy. Of the 140 patients with AOM, AM, or LM, a full recovery was seen in 68 patients (49%); 49 (35%) had residual hearing problems, 20 (14%) had residual TM perforations, and 18 (13%) needed later operations. AMc patients experienced the least amount of residual hearing problems (20%, p=0.027), but were most likely to experience residual TM perforations (30%, p=0.021) in comparison to others (Table 1). Of the six AMc patients with residual TM perforations, four had a visible TM perforation upon admission. Patients with AMc experienced the lowest rate of full recovery (20%, p=0.023). Five patients died within three years of follow-up; however, none died as a direct consequence of this infection.

DISCUSSION

Acute complications of OM have become more common at our institution in the last decade (Figure 4). Although the total number of complicated OM cases in adults seems to have risen lately at our institution, our rate of complications remains lower in comparison to that in Italy, for example [14, 21]. Between 1990 and 2004, 50 adult patients were treated at the same institution owing to complications of OM [14]. This rise in the number of complications may be due to recent changes toward the less active treatment of OM. However, prior antimicrobial treatment was more common in our study population (71%) in comparison with the earlier literature; [14, 21] it was least common among patients with AMc (50%). In previous studies, adults with complications from OM have mostly been middle-aged men, whereas most patients in this study were middle-aged females [14, 21]. Younger female patients were more prevalent in the AOM and AM groups, whereas older males predominated in the LM group and especially in the AMc group. Comorbidities were more common in our study population than in the prior literature [14, 21]. In a similar way to the earlier

reports,[14, 21] a quarter of our patients had a history of ear problems; these were most common in AMc patients and least common in AM patients. Patients with AMc also had more other comorbidities, especially cardiac problems, which was probably due to their older age.

The median duration of symptoms was eight days and was longest in LM patients; these results are similar to earlier findings [14, 21]. In a similar way to the prior literature [15], patients with LM often had prolonged, low-grade infection with relatively few TM perforations; CT imaging was common in this group of patients. Patients with AOM had more hearing problems but less fever and otorrhea, fewer signs of mastoid infection, and lower C-reactive protein (CRP) levels than others. Those with AM often had fever, mastoid tenderness, and higher CRP levels than others. Children with AM were also seen to have higher CRP levels than those with AOM [20]. Fever and headache are important early symptoms that relate to complications of OM [22]. Headache seems to be more common in mastoid infections than in AOM (Table 1).

Recent publications recommend imaging for prolonged or complicated cases of mastoiditis [23, 24]. Prior research used imaging more often for complicated OM in adults [14, 21] than was the case in our dataset; our inclusion of patients hospitalized owing to AOM for whom no imaging was needed explains this difference.

Our patients had more labyrinthitis (23% vs. 15%) and less facial nerve paresis (14% vs. 32%) in comparison to a prior Finnish study, but no difference was seen in the number of subperiosteal abscesses (6%) [14]. In this dataset, subperiosteal abscesses were most common in the AMc group. Labyrinthitis, on the other hand, was most common in AOM patients and nearly nonexistent in AMc patients.

Meningitis is the most common intracranial complication of otitis [9]. Only 8% of our patients had intracranial complications, whereas 18% had intracranial complications in the prior Finnish study. [14] In this study population, the occurrence of meningitis was low. In contrast to the prior Finnish study [14], we only included patients treated at the Department of Otorhinolaryngology, whereas most cases of (otogenic) meningitis are primarily treated elsewhere. Three cases of otogenic intracranial abscesses were treated at our institution's Department of Neurosurgery between 2000 and 2012 [12].

The most common pathogens in adult patients with uncomplicated AOM are, according to the few existing studies, *H. influenzae* (26%) and *S. pneumoniae* (21%); *S. pyogenes* (4%) and *M. catarrhalis* (3%) are less common [25, 26]. The bacteriology of complicated OM in adults has not been studied widely, although *S. pneumoniae*, *S. pyogenes*, *P. aeruginosa*, and *S. aureus* are reported to be the most common pathogens [21]. Our results are similar to these findings from complicated cases: [21] the most common pathogens found were *S. pyogenes* (19%), *S. pneumoniae* (14%), and *P. aeruginosa* (11%), whereas only 2% had *H. influenzae* and none had *M. catarrhalis*. Within 15 years in Finland, invasive *S. pyogenes* infections have tripled in children [27]. In our study population, the total number of infections doubled from the first to the second five-year period, but there was no change in the proportions of pathogens (Figure 1).

S. pyogenes was common in patients with AM (27%), LM (25%), and AOM (15%) but was not found in AMc. *S. pneumoniae* was mostly found in patients with LM (21%), AM (19%), or AOM (10%). *P. aeruginosa*, on the other hand, was most common in AMc (30%) patients, in comparison to AM (10%) or AOM (8%) patients.

The bacterial etiology of complicated OM in adults seems to differ from that of uncomplicated AOM, which is quite similar to the case in children [19, 25, 26]. We found that the typical pathogens in AOM, namely, *H. influenzae* and *M. catarrhalis*, are uncommon in both children and adults with complicated OM. Adults in our study, however, had more *S. pyogenes* and less *S. pneumoniae* (especially resistant strains) than children.

In our study, in comparison to patients with different bacteriological etiologies, patients with *S. pyogenes* had higher leukocyte counts, more otorrhea, more TM perforations, more hearing problems, and more residual hearing problems. In comparison to patients with other pathogens, those with *S. pneumoniae* underwent fewer tympanostomies; however, they had higher CRP levels and leukocyte counts, more meningitis, and longer lengths of hospitalization. Full recovery was less common in patients with *P. aeruginosa* in comparison with others. Patients with *S. aureus* often had hearing problems after the infection, whereas those with negative bacterial findings commonly had labyrinthitis.

The median duration of hospitalization was longest in AM patients (6 days, in comparison with 4 days for all patients). A large majority of patients received parenteral antimicrobial treatment; most were also given steroids and topical ear drops. Mastoidectomy was performed on 30% of patients, most commonly in LM. The median duration of hospitalization was longer (8 days) in patients who underwent mastoidectomy than in others. Children with AM also required longer periods of hospitalization and more mastoidectomies than those with AOM [20]. Reflecting the general tendency toward more conservative treatment of mastoiditis, fewer mastoidectomies were performed within this study period than between 1990 and 2004 (56%) [14]. Mastoidectomies are performed on patients with prolonged mastoid infections who do not respond to antimicrobial treatment; [23] this explains why mastoidectomies were prevalent in our patients with LM and AMc.

Patients who underwent mastoidectomy had worse outcomes than others, which was most probably due to the complicated nature of their infections. No perioperative complications were reported among those undergoing mastoidectomies, and no study patients died as a direct consequence of their infection. In this study, 45% made a full recovery, TM perforations remained in 16%, and hearing problems remained in 33%. Patient outcomes in our study were similar to those of patients treated at the same institution between 1990 and 2004 [14]. Full recoveries were least common in patients with AMc in comparison to other groups, which was probably due to their previous history of ear problems. However, patients without prior chronic infection also experienced residual ear-specific problems, especially hearing loss.

The bacterial etiology of complicated OM in adults differed from that of uncomplicated AOM, especially in patients with AMc. Those hospitalized for AMc or LM needed more surgical treatment than those hospitalized for AOM or AM.

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Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

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