

## Acute Otitis Externa and Cost Analysis in a Tertiary in Malaysia

KADAR S<sup>1,4</sup>, ISMAIL A<sup>2</sup>, HAILANI I<sup>3</sup>, ISMAIL F<sup>4</sup>, NAMELA N<sup>5</sup>,  
SHANEENA N<sup>6</sup>, MEGAT ISMAIL NF<sup>1</sup>, MOHD HASBI S<sup>1</sup>, WAN  
MANSOR WN<sup>1</sup>, HASHIM ND<sup>1,7</sup>, ABDUL MALEK S<sup>8</sup>, ABDULLAH A<sup>1,7</sup>

<sup>1</sup>Department of Otolaryngology, Head & Neck Surgery, <sup>2</sup>Department of Community Health Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia

<sup>3</sup>Hospital Kuala Lumpur, Jalan Pahang, 50586 Kuala Lumpur, Malaysia.

<sup>4</sup>Hospital Sungai Buloh, Jalan Hospital, 47000 Sungai Buloh, Selangor, Malaysia

<sup>5</sup>Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia

<sup>6</sup>Department of Anesthesiology, Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia

<sup>7</sup>Center of Hearing and Speech (Pusat-HEARS), Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

<sup>8</sup>Hospital Sultan Idris Shah, 43000 Sedang Selangor

Received: 05 Mar 2024 / Accepted: 23 Apr 2024

### ABSTRAK

Radang telinga luar atau otitis eksterna (OE) adalah satu spektrum keradangan telinga luaran akibat jangkitan atau iritasi. Terdapat kekurangan data tempatan mengenai masalah ini dan OE ini kerap terjadi di kalangan masyarakat. Kajian ini bertujuan untuk menentukan kelaziman kejadian, faktor risiko, komplikasi otitis eksterna akut (OEA) dan untuk mengkaji analisis kos rawatan OE. Analisis kos dilakukan dengan menggunakan analisis top-down dan aktiviti berdasarkan kos dengan data yang disediakan oleh pusat kajian dan jalur klinikal yang dirumuskan untuk kajian ini. Sebanyak 157 pesakit yang mengidapi OEA diperolehi dari kajian ini. Sejumlah 23 daripada 157 orang pesakit mempunyai masalah OEA pada kedua-dua belah telinga, menjadikan jumlah keseluruhan adalah 180 telinga. Umur purata pesakit ialah 29.4 tahun (5 bulan-75 tahun). Sejumlah 110 kes (61.1%) menghidapi masalah OE ('acute diffuse otitis externa'), 48 (26.7%) dengan otomikosis, 18 (10.0%) dengan OEA setempat ('acute localised otitis externa') dan 4 (2.2%) dengan otitis eksterna

Address for correspondence and reprint requests: Prof Dr Asma Abdullah. Department of Otorhinolaryngology-Head and Neck Surgery, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia. Tel: +603-91456599 / +6019-2194166 Email: [asmappukm@gmail.com](mailto:asmappukm@gmail.com)

*eczematous. Sejumlah 117 kes (65.0%) mempunyai sejarah penggunaan putik kapas sebagai faktor penyebab OEA. Penyakit ini memerlukan RM 234.52 untuk rawatan setiap lawatan dan pesakit memerlukan 2.3 lawatan yang melibatkan kos RM 539.40. Penggunaan putik kapas atau penggalian telinga adalah faktor risiko utama untuk seseorang mendapat masalah otitis eksterna.*

*Kata kunci: Analisis kos, kurang pendengaran; otitis eksterna akut; otomycosis*

## ABSTRACT

Otitis external (OE) is referred to a spectrum of external ear inflammation. This study aimed to determine the prevalence, risk factors, complication of acute otitis external (AOE) and a total cost in managing one episode of care of AOE treatment. Costing analysis was done by using top-down analysis and activity-based costing with the data provided by the study centers and clinical pathway, which was formulated for the study. A total of 157 patients of AOE were recruited for this study. Out of 157 patients, 23 patients presented with bilateral disease which make a total numbers of 180 ears. The mean age was 29.4 years (5 months - 75 years ). 110 (61.1%) cases were diagnosed with acute diffuse otitis external, 48 (26.7%) with otomycosis, 18 (10.0%) with acute localised otitis external and 4 (2.2%) with eczematous otitis external. A total of 117 cases (65.0%) had a history of recent cotton bud use as predisposing factor for OE. The disease required RM 234.52 to treat per visit, and the total cost to treat one case of AOE with average 2.3 visits was RM 539.40. The usage of cotton bud or ear digging is a primary risk factor in developing AOE.

Keywords: Acute otitis externa; costing analysis; hearing loss, otomycosis

---

## INTRODUCTION

Otitis external (OE) is classified into acute diffuse otitis external (ADOE), acute localised otitis external (ALOE), fungal otitis external (Otomycosis), eczematous otitis external (EOE), chronic otitis externa and malignant otitis externa (Ong et al. 2005). Acute otitis external (AOE) is defined as rapid onset in the past 3 weeks of symptoms with signs of ear canal inflammation (Guthrie 1999). This

definition, therefore, includes ADOE, ALOE, Otomycosis and EOE as the acute spectrum of otitis externa. The delineation between AOE and chronic otitis externa has been expressed with symptoms of otitis OE which lasts for a period of more than two months.

The symptoms of otitis externa include otalgia, itchiness, warmth, reduced hearing and jaw pain which present along with signs of ear canal inflammation. These signs include tragal tenderness, pinna tenderness,

canal erythema, canal edema and cellulitis of surrounding skin (Guthrie 1999). Ear discharge is also often present while the presence of granulation tissue often accompanies severe disease.

AOE is one of the most common infections encountered by clinicians and affects 5-20% of patients attending ear, nose and throat (ENT) clinics (Ong et al. 2005). The annual incidence of Acute OE is between 1:100 and 1:250 in UK and is estimated to be occurring in 4:1000 people annually in the USA (Guthrie 1999; Rowlands et al. 2001). Lifetime incidence varies according to climate and reported higher prevalence rates in tropical areas than other temperate regions. The estimation prevalence in tropical areas was 10% which attributed to high humidity and elevated temperature (Baoum et al. 2021; Raza et al. 1995; Wiegand et al. 2019). Furthermore, AOE will affect children but most common in adult (Baoum et al. 2021; Hajioff et al. 2015).

The most common pathogen for AOE are *Pseudomonas aeruginosa* (20% to 60% prevalence) and *Staphylococcus aureus* (10% to 70% prevalence) (Agius et al. 1992; Roland et al. 2002). It often occurs as a polymicrobial infection (Agius et al. 1992). Fungal involvement is less common in primary AOE but may be more common in chronic otitis externa or after treatment of Acute OE with topical or systemic, antibiotics (Martin et al. 2005).

There are many predisposing factors for AOE which can be categorised into anatomical abnormalities, canal obstruction, disruption of cerumen or epithelial integrity, dermatological

conditions and increased moisture in the canal. Although there are various risk factors, it is postulated that modifiable risk factors are more commonly associated with the development of AOE compared to non-modifiable risk factors. Modifiable risk factors such as ear digging and swimming without ear protection has been shown to be the predominant cause of otitis externa (Agius et al. 1992; Jayakar et al. 2014). Personal bad practices and reduced hygiene may also contribute to high prevalence of otitis externa (Baoum et al. 2021; Gharaghani et al. 2015; Jayakar et al. 2014; Jia et al. 2012). Other non-modifiable risk factors such as pre-existing canal abnormalities and immunocompromised states such as diabetes and retroviral disease have also been described though to a much lesser degree. Its emergence is often accompanied by the presence of modifiable risk factor (Baoum et al. 2021).

With the high prevalence rate and lifetime incidence of 10%, AOE is estimated to cause a substantial financial burden. In 2007, 2.4 million healthcare visit in US resulted in 0.5 billion USD annually for AOE. Market in the United States is approximately 7.5 million annual prescriptions with total sales of 310 million USD (Piercefield et al. 2011). Despite these vast sums, the estimation for direct and indirect costs for otitis externa is unknown. The cost of this illness should be estimated to formulate an effective strategy in managing it. Thus, this study aimed to determine the prevalence, risk factors, complication of AOE and a total cost in managing one episode of care of

AOE treatment.

## MATERIALS AND METHODS

### Study Implementation

A prospective study was conducted for a period of 18 months. Patients diagnosed with AOE spectrum of disease from Otolaryngology (ORL) clinics at 3 tertiary centers which were, ORL clinic Hospital Canselor Tuanku Muhriz (HCTM), ORL clinic Kuala Lumpur General Hospital (KLGH) and ORL clinic Sungai Buloh Hospital (SgBH) were included in this study. This study was approved by UKMMC (FF-2013-471) and National Malaysian Research Ethics committee as well as registered in the National Malaysian Research Registry (17737).

Patients with AOE who consented for this study were recruited. Patients who were found to have a concomitant perforated tympanic membrane and defaulted patients who were unable to be followed up were excluded from this study.

Data collection sheet for first and follow up visits were used to collect patient data and monitor the progress of the disease. These data collection sheet has been filled by the physician taking care of the patient. The first data collection sheet was used on the first visit upon the diagnosis of AOE. Both of the data collection sheets were designed to gather data regarding demographic parameters, socioeconomic status, presenting symptoms, risk factors, and treatment modalities, the outcome of treatment and incidence of complications.

Briefings with the physician from all centers were conducted to explain the study in detail prior to obtaining patients for the study. All newly diagnosed patients fulfilling the inclusion and exclusion criteria were identified by the respective centers. Patients were reviewed after a period of 3 days to 1 month after the initial visit depending on disease severity. Relevant data required for the costing analysis was also requested from the respective study centers. These included individual hospital plans, furniture expenditures, equipment prices, utility expenditures, salary expenditures and medication prices.

### Costing Analysis

Costing analysis was done by combining data obtained from the respective study centers and data collected during the patients follow up. Costs that were derived were analysed using a combination of top-down analysis and activity-based costing. The 2 main cost types calculated were divided into capital costs and recurring costs.

Top down analysis is a ratio method of estimating a cost by comparing the total cost of the whole establishment to the total built-up area of the hospital in. A proportionate estimate is then derived by calculating the service provider center total size in comparison to the whole hospital. Activity-based costing is calculated using a clinical pathway. A clinical pathway is a data collection method which records all of the activities which are conducted during each clinic visit. All cost bearing

activity such as consultation time, attending personnel and medications prescribed were captured. This was then used to calculate an average estimation of the costs.

Capital costs that were calculated included building costs, furniture costs and equipment costs. A top-down analysis was implemented to derive the estimated costs for all capital costs. Recurring costs included utility costs, administrative costs, human resource and medication costs. Utility and administrative costs were calculated using top-down costing method whilst human resource and medication costs were calculated using activity-based costing. The total estimated cost was the total of capital cost and recurrent costs. These were expressed in the amount of money (RM) needed to treat a person with AOE for each visit to the clinic. The estimated total cost for all the patients in this study was calculated by multiplying the total cost with 2.3, which was the average number of visits required to treat AOE till resolution of disease.

## RESULTS

### Acute Otitis Externa

A total of 157 patients were recruited for the study (53 patients from HCTM, 67 patients from SgBH and 37 patients from KLGH). Of these patients, 23 (14.6%) presented with bilateral AOE, resulting in a total of 180 ears affected by AOE. The sample had a slight female predominance with 85 (54.1%) of the patients being female and 72 (45.9%) being males. The mean age

was 29.4 years (5 months-75 years). 33 (21.0%) patients were in the pediatric age group of 12 years and less. A total of 113 (72.0%) were Malay, 18 (11.5%) were Chinese, 17 (10.8%) were Indians and 9 (5.7%) patients from other races. 77.7% of the sample size had a mid-household income of between RM 1000 - RM 4000 while 12.7% came from a low household income of less than RM 100 per month. The right ear was more commonly affected 107 (59.4%).

Non-modifiable risk factors which constituted pre-existing external ear conditions and comorbidities were studied. A total of 16 (10.2%) had a history of diabetes whilst 6 (3.8%) had a history of skin diseases. 2 (1.3%) of the patients were on long term steroids due to these skin conditions. All of the patients did not have any other known immunosuppressive disease on diagnosis. 53 (33.8%) patients had a history of previous AOE prior to diagnosis.

A total of 117 ears (65.0%) had a history of recent cotton bud use prior to developing symptoms which made it the predominant risk factor. Ear digging with other material such as wooden or metal sticks was present in 59 cases (32.8%). Swimming without the use of ear protection was a risk factor in 15 cases (8.3%). Swimming locations varied from public swimming pools (71.8%) and rivers (21.4%). Other risk factors were a foreign body in the ear canal (3.8%), use of earphones (3.3%) and external ear trauma following motor vehicle accident (2.9%).

The most presenting complaint amongst the 180 cases was ear pain

(75.6%), ear discharge (60.0%) and reduced hearing (31.1%). The severity of the clinical presentation was gauged using the Brighton grading scale (Table 1).

TABLE 1: Severity of AOE during first visit

Severity Brighton Grading	Frequency	%
Grade I - dry eczema/ erythema of canal	27	15.0
Grade II - moist eczema/ erythema of canal	68	37.8
Grade III - moist eczema/ erythema of canal with pus	46	25.5
Grade IV - moist eczema/ erythema of canal with pus and edema	39	21.7
Total	180	100.0

A total of 110 cases of AOE were classified as acute diffuse otitis externa (61.1%), 48 with otomycosis (26.7%), 18 (10%) with ALOE and 4 (2.2%) with eczematous otitis externa. Acute diffuse otitis externa, otomycosis and ALOE shared the same risk factors whereas all of the patients that presented with acute eczematous otitis externa had underlying dermatitis disease or history of eczema whether treated or not.

Six patients developed complications after a period of 3 months. The complications were progression to chronic otitis externa, secondary otitis media, secondary otomycosis, canal stenosis and necrotising OE. A majority of patients required 3 visits from presentation before being adequately treated (90%).

## Costing Analysis

Data for capital costs were only available from one of the study center, which were HCTM. Data for the activity-based costing, however, were representative of all the study centres. The total sum of all the data for each category was averaged. Table 2 showed the total cost per patient for each visit.

TABLE 2: Total cost per patient per visit

Capital costs (per patient per visit)	
Building cost	RM 24.08
Furniture cost	RM 3.57
Equipment cost	RM 26.66
Total capital cost	RM 54.31 (USD \$13.31)
Recurrent costs (per patient per visit)	
Utility costs	RM 116.00
Administrative costs	RM 22.34
Medication costs	RM 34.07
Human resource	RM 7.80
Total Recurrent cost	RM 180.21 (USD \$43.6)
Total cost (per patient per visit): Capital cost + Recurrent cost	RM 54.31 + RM 180.21 = RM 234.52 (USD \$56.74)

Total cost for one episode of care of AOE with an average 2.3 visits was RM 539.40 (USD \$130.49). While total spent for study population was RM 539.40 x 180 cases = RM 97,092.00 (USD \$23,489.05).

## DISCUSSION

AOE is a common condition worldwide and has been reported to have a high prevalence rate which increases in

areas of high humidity (Rowlands et al. 2001). Many studies regarding acute otitis externa use the term AOE synonymous with acute diffuse otitis externa or also known widely as swimmers ear as the risk of prevalence is fivefold higher in their population (Baoum et al. 2021; DAN World 2024; Hajioff et al. 2015). In this study, AOE is considered being a spectrum of diseases of various etiological factors and sub-classified into the previously mentioned terms of ADOE, ALOE, Otomycosis and EOE.

Although this spectrum of diseases has differences, there are similarities in terms of demographics, clinical presentation, severity and potential complications that led it to be previously regarded as a single disease. Its age and gender predominance is almost equivocal and evenly distributed, as mentioned in other works of literature and replicated in this study. AOE commonly affects at young age and male due to potential increase in outdoor activities. (Agius et al. 1992; Baoum et al. 2021; Hui 2013; Rowlands et al. 2001). Its individual incidence however differs, and ADOE has been shown to be the most common condition (Agius et al. 1992; Chow et al. 1986; Jayakar et al. 2014; Ong et al. 2005). This can be attributed to its more abundant bacterial pathogens. *Pseudomonas sp.* and *Staphylococcus aerius* have been repeatedly shown as the most common pathogen in cases of ADOE. Its association with swimming and presence in public pools have been studied and well associated (Agius et al. 1992; Chow et al. 1986; Hajioff

et al. 2013). Although sharing similar pathogens, ALOE has a significantly lower incidence compared to ADOE, which can be attributed to its different pathogenesis.

Otomycosis has a primary incidence rate of 26.6% and occurred as a secondary infection after treatment of ADOE in 2 patients. This incidence rate is higher than previously suggested, which was 9% of AOE cases (Mugliston & O'Donoghue 1985). All of the patients in this study were treated with meticulous ear toileting and antifungal agents. Sixteen (10.2%) patients received topical antifungal cream infiltration to the external ear canal prior to commencement of antifungal ear drops. All cases of primary otomycosis resolved within 3 visits or within 6 weeks of initial presentation. All patients with acute EOE were treated with topical steroids, and all of the patients showed improvements on the next visit, which was within a period of 2 months. Underlying history of eczema presented in all of EOE patients, and it seemed as EOE was just an otological manifestation of the dermatologic condition.

With the exemption of EOE, the other cases of AOE share similar risk factors. A total of 44 (28.0%) cases had underlying medical problems 16 (10.2%) patients had diabetes and others had various non-immuno suppressive conditions such as hypertension, cardiovascular disease dyslipidemia. None of the patients has a history of ear canal abnormalities such as canal stenosis or exostosis that might be a predisposing factor to develop AOE. All of these patients,

however, had a history of either use of cotton buds, history of ear digging, swimming, foreign body insertion or headphone use.

This study revealed that modifiable risk factors are predominant in developing AOE, which is in line with other studies (Gharaghani et al. 2015; Jia et al. 2012; Lee et al. 2005; Nussinovitch et al. 2004). This study found that the most common modifiable risk factor is cleaning ears with cotton buds. The second risk factor is ear digging using other objects. These are consistent with other previous studies which described ear instrumentation to directed to clean the ears as the predominant risk factors towards developing AOE (Afolabi et al. 2009; Lee et al. 2005; Loh et al. 1998; Nussinovitch et al. 2004). This exemplifies that mechanical factors caused by these modifiable risk factors disrupt the integrity of the external ear canal and acts as a precursor towards developing AOE. It is this study's recommendation that emphasis on education be made to promote ear hygiene and to deter the misconception surrounding the necessity of ear cleaning.

A complication of AOE that has been observed in granulation tissue formation (5 cases), secondary otomycosis (2 cases), canal stenosis (1 case) and progression to otitis media (1 case), progression to chronic otitis externa (1 case) and necrotising OE (1 case). All of the above complications developed in patients from the acute diffuse otitis externa group who presented with at least a Brighton grade III severity where canal edema is a

predominant feature. Noncompliance to medications and persistent use of cotton buds after first visit are common features in all 6 patients which developed complications. The difficulty in delivering topical agents in these cases may contribute to the development of complications. A clinical practice guideline is needed to reduce the complication rate (Rosenfeld et al. 2014).

The use of ear wick can improve delivery; however more frequent intervals of monitoring is needed to detect complications. The role of oral antibiotics has been described and suggested in severe cases of AOE (Rosenfeld et al. 2014). The case of necrotising OE which was included in the study was presented with classic symptoms of ADOE in an elderly diabetic patient. His symptoms were worsening despite topical antibiotics which raised clinical suspicion of a more sinister infection during the second visit. The patient was investigated for necrotising OE following his second and subsequent visits to the clinic.

A costing analysis study provides a good estimate of the burden of a disease in a value which can be understood not only by practitioners but also the managers and administrators. In current times, a measure of efficacy in managing a common and resurfacing disease is important as a gauge to crosscheck our practices (Coco 2007; Kaucley & Levy 2015; Onukwugha et al. 2016; Strens et al. 2012).

An estimated 2.4 million U.S. healthcare visits resulted in a diagnosis of AOE with direct healthcare costs



for non-hospitalised AOE visits total as much as \$0.5 billion annually. Clinicians are estimated to spend nearly 600,000 hours annually treating AOE in the U.S (Piercefield et al. 2011). Although this study demonstrated a value which is less to those quoted by the American Centers of Disease Control (CDC), it is of significant amount considering that this value is only at 3 centers.

A similar study was conducted for acute otitis media. The cost-effectiveness of amoxicillin was studied, and it was shown that the mentioned drug was a good first-line treatment (Choffor-Nchinda et al. 2018; Frost et al. 2022). This enforced the current practices of managing acute otitis media. AOE spectrum of diseases has been managed by many clinicians with various methods. In this study, patterns of management were observed and compared to recent guidelines (Rosenfeld et al. 2014). A suggested management strategy based on the available literature and observation of management strategies during the study course had been formulated (Figure 1). The formulated management pathway is intended to act as a guide in managing AOE.

## CONCLUSION

ADOE is the most common spectrum of AOE. The prevalence of AEO in this study was 61.8%. Almost two third have a history of recent cotton bud use prior to developing symptoms which makes it the predominant risk factor in this study. The disease requires a total of RM 234.52 (USD \$56.74) for

one visit for AOE treatment. Public education on the risk factors of AOE could potentially cause a reduction of disease and financial burden. More studies regarding risk factor versus cost analysis in ENT diseases should be started as a measure of efficiency. The phrase of 'prevention is better than cure' is certainly applicable in AOE. Strategies on educating the public would be a better use of finances to reduce the incidence of AOE rather than treating it.

## ACKNOWLEDGEMENT

The authors would like to thank ORL clinic Hospital Canselor Tuanku Muhriz (HCTM), ORL clinic Hospital Kuala Lumpur (HKL), ORL clinic Hospital Sungai Buloh (HSgB), UKM Ethics Committee, National Malaysia Research Registry, Kementerian Kesihatan Malaysia for their participation

## CONFLICT OF INTEREST

The authors have no conflict of interest to be declared.

## REFERENCES

- Afolabi, A.O., Kodiya, A.M., Bakari, A., Ahmad, B.M. 2009. Attitude of self-ear cleaning in black Africans: any benefit? *East Afr J Public Health* 6(1): 43-6.
- Agius, A.M., Pickles, J.M., Burch, K.L. 1992. A prospective study of otitis externa. *Clin Otolaryngol Allied Sci* 17(2): 150-4.
- Baoum, S.O., Mousa, A.A.B., Alshammari, M.Y., Alzاهر, Z.S., Zahrani, H.M., Alhammad, A.H., Alsobhan, H.M., Aleidan, A.A., Alsalhi, S.A., Mansouri, K.A., Halawani, H.K. 2021. Epidemiology, risk factors and monitoring of acute otitis externa. *Inter J Community Med Public Health* 8(12): 6155-9.

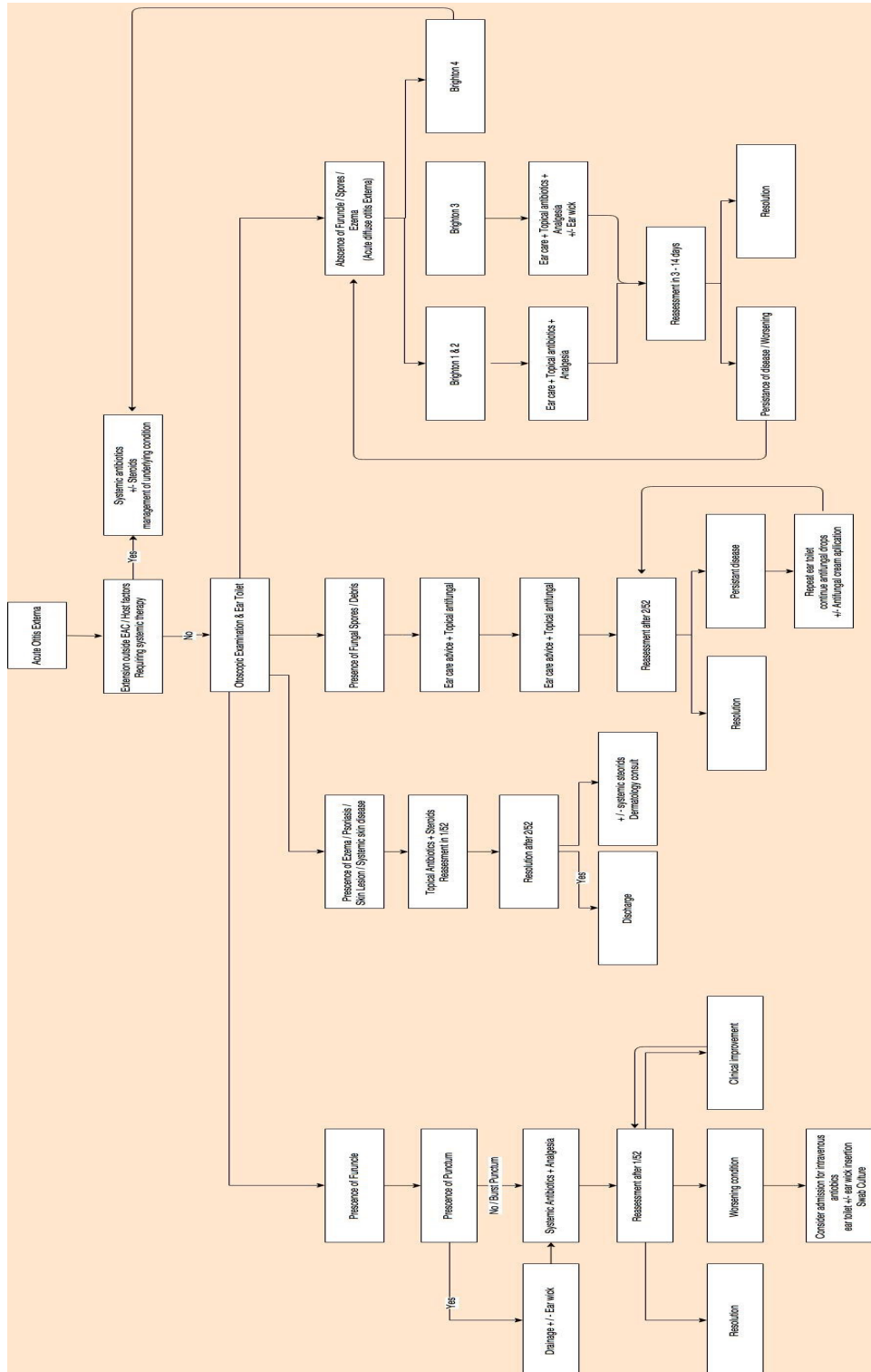


FIGURE 1: Management Pathway for AOE

- Choffor-Nchinda, E., Atanga, L.C., Nansseu, J.R., Djomou, F. 2018. Effectiveness of amoxicillin alone in the treatment of uncomplicated acute otitis media: S systematic review protocol. *BMJ Open* 8(6): e021133.
- Chow, V.T., Ho, B., Hong, G.S., Liu, T.C. 1986. Bacterial and mycotic otological infections in Singapore. *J Hyg* 97(2): 385-92.
- Coco, A.S. 2007. Cost-effectiveness analysis of treatment options for acute otitis media. *Ann Fam Med* 5(1): 29-38.
- Divers Alert Network (DAN) World Website, 2024. <https://world.dan.org/health-medicine/health-resources/diseases-conditions/swimmers-ear-otitis-externa/> [7 July 2023]
- Frost, H.M., Bizune, D., Gerber, J.S., Hersh, A.L., Hicks, L.A., Tsay, S.V. 2022. Amoxicillin versus other antibiotic agents for the treatment of acute otitis media in children. *J Pediatr* 251: 98-104. e5.
- Guthrie, R.M. 1999. Diagnosis and treatment of acute otitis externa. An interdisciplinary update. *Ann Otol Rhinol Laryngol Suppl* 176: 1-23.
- Gharaghani, M., Seifi, Z., Mahmoudabadi, A.Z. 2015. Otitomycosis in Iran: A review. *Mycopathologia* 179(5-6): 415-24.
- Hajioff, D., MacKeith, S. 2015. Otitis externa. *BMJ Clin Evid* 2015: 0510.
- Hui, C.P. 2013. Acute otitis externa. *Paediatr Child Health* 18: 96-8.
- Jayakar, R., Sanders, J., Jones, E. 2014. A study of acute otitis externa at Wellington Hospital, 2007–2011. *Australas Med J* 7(10): 392-9.
- Jia, X., Liang, Q., Chi, F., Cao, W. 2012. Otitomycosis in Shanghai: Etiology, clinical features and therapy. *Mycoses* 55(5): 404-9.
- Kaucley, L., Levy, P. 2015. Cost-effectiveness analysis of routine immunization and supplementary immunization activity for measles in a health district of Benin. *Cost Eff Resour Alloc* 13: 14.
- Lee, L.M., Govindaraju, R., Hon, S.K. 2005. Cotton bud and ear cleaning--a loose tip cotton bud? *Med J Malaysia* 60(1): 85-8.
- Loh, K.S., Tan, K.K., Kumarasinghe, G., Leong, H.K., Yeoh, K.H. 1998. Otitis externa--the clinical pattern in a tertiary institution in Singapore. *Ann Acad Med Singap* 27(2): 215-8.
- Martin, T.J., Kerschner, J.E., Flanary, V.A. 2005. Fungal causes of otitis externa and tympanostomy tube otorrhea. *Int J Pediatr Otorhinolaryngol* 69(11): 1503-8.
- Mugliston, T., O'Donoghue, G. 1985. Otitomycosis--a continuing problem. *J Laryngol Otol* 99(4): 327-33.
- Nussinovitch, M., Rimon, A., Volovitz, B., Raveh, E., Prais, D., Amir, J. 2004. Cotton-tip applicators as a leading cause of otitis externa. *Int J Pediatr Otorhinolaryngol* 68(4): 433-5.
- Ong, Y.K., Chee, G. 2005. Infections of the external ear. *Ann Acad Med Singap* 34(4): 330-4.
- Onukwugha, E., McRae, J., Kravetz, A., Varga, S., Khairnar, R., Mullins, C.D. 2016. Cost-of-Illness Studies: An Updated Review of Current Methods. *Pharmacoeconomics* 34(1): 43-58.
- Piercefield, E.W., Collier, S.A., Hlavsa, M.C., Beach, M.J. 2011. Centers for Disease Control and Prevention (CDC). Estimated burden of acute otitis externa--United States, 2003-2007. *MMWR Morb Mortal Wkly Rep* 60(19): 605-9.
- Raza, S.A., Denholm, S.W., Wong, J.C. 1995. An audit of the management of acute otitis externa in an ENT casualty clinic. *J Laryngol Otol* 109(2): 130-3.
- Roland, P.S., Stroman, D.W. 2002. Microbiology of acute otitis externa. *Laryngoscope* 112(7 Pt 1): 1166-77.
- Rosenfeld, R.M., Schwartz, S.R., Cannon, C.R., Roland, P.S., Simon, G.R., Kumar, K.A., Huang, W.W., Haskell, H.W., Robertson, P.J. 2014. Clinical practice guideline: Acute otitis externa. *Otolaryngol Head Neck Surg* 150(1) Suppl: S1–24.
- Rowlands, S., Devalia, H., Smith, C., Hubbard, R., Dean, A. 2001. Otitis externa in UK general practice: A survey using the UK General Practice Research Database. *Br J Gen Pract* 51: 533-8.
- Strens, D., Knerer, G., Vlaenderen, V.I., Dhooge, I.J.M. 2012. A pilot cost-of-illness study on long-term complications/sequelae of AOM. *B-ENT* 8(3): 153-65.
- Wiegand, S., Berner, R., Schneider, A., Lundershausen, E., Dietz, A. 2019. Otitis externa. *Dtsch Arztebl Int* 116(13): 224-34.