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ASSESSMENT OF HEARING LOSS PROGRESSION IN ADULTS WITH RECURRENT OTITIS MEDIA AND THE EFFECTIVENESS OF EARLY SURGICAL INTERVENTION

Sidra Jamil

[1] Jinnah Medical and Dental College Karachi, Sindh, Pakistan

*Corresponding Author E-mail: sidrajamil0@gmail.com

Abstract

To ascertain the spontaneous outcome of hearing loss in adults with recurrent otitis media and to ascertain the cost-effectiveness and long term effectiveness of early surgical treatment as compared to conventional medical treatment. A mixed-method study was carried out including a retrospective cohort analysis to model the disease progression and a prospective interventional cohort study of early surgical intervention (tympanoplasty or ossiculoplasty within three months) versus medical treatment. Main results were change of air-bone gap (ΔABG) at 12 months. The secondary outcomes included the occurrence of timpanae membrane closures, recurrence of otorrhea, quality of life (COMOT-15), the presence of the inflammatory biomarkers , microbial biofilm load, and the cost-effectiveness (incremental cost-effectiveness ratio, ICER). Longitudinal mixed-effects modeling and multivariate regression analyses were performed. The retrospective cohort showed the fact of loss of hearing with +0.28 dB/month . The future trial showed that the ABG improvement of early surgical intervention was much more than medical management . The Tympanic membrane was closed in 92.6% of surgical patients as compared to 25.0% of medical patients. The recurrence of otorrhea was decreased by 83.5% . Inflammatory cytokines in the middle ear are IL-1 (reduced by 50.5) and TNF-a (reduced by 52.7) and the percentage of bacteria biofilm in the middle ear significantly reduced postoperative. There was a great improvement in quality of life . The ICER was 5, 041/quality adjusted life year and the probability of cost-effectiveness was 98.7 percent with willingness to pay of 50, 000. Multivariate analysis showed that the preoperative, active otorrhea and biofilm formation and TLR4 Asp299Gly polymorphism were independent predictors of poor outcome.Surgical correction of recurring otitis media in adults, done at an early age not only helps in preventing progressive hearing loss, but also cures the inflammation chronicity, decreases the occurrence of the disease and enhances the quality of life vastly. It is very economical and ought to be considered as routine treatment of patients that present with high-risk characteristics that induce a paradigm shift towards long-term medical care.

Keywords: Recurrent Otitis Media, Tympanoplasty, Hearing Loss, Air-Bone Gap, Chronic Suppurative Otitis Media, Cost-Effectiveness Analysis.

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INTRODUCTION

One of the burning issues in the sphere of otolaryngology among adults is recurrent otitis media (ROOM) and is typically characterized by progressive sensorineural hearing loss and implies staggeringly high health care cost (Lewis et al., 2022). The most common characteristic of the condition is usually the recurrent middle ear infections that can result in the formation of chronic inflammation, erosion of the ossicles of the chain and puncturing of the tympanic membrane, which will eventually cause conductive hearing loss, or mixed hearing loss (Massoud et al., 2025). As auditory sequelae may be acute, the level of knowledge about the pathophysiology of the hearing loss development and the efficiency of timely surgical treatment namely tympanoplasty or ossiculoplasty to preserve functions of the auditory organs and to provide a better quality of life to the patients is of paramount importance (Jung et al., 20 Chronic otitis media, which is a persistent inflammation of the middle ear and/or mastoid cavity, is often accompanied by such symptoms as chronic or intermittent otorrhea, perforation of the tympanic membrane, otalgia, and hearing loss (Schouwenaar et al., 2023). The inflammation can lead to irreversible changes to the anatomy of the tympanic membrane and middle ear, and necessitate a reconstructive procedure, like tympanoplasty to enable hearing to resume (Aliyeva and Hashimli, 2025). The enhancement of the air-bone gap is also another aim of Tympanoplasty since the latter is also a powerful predictor of the underlying conductive hearing loss with the replenishment of the tympanic membrane (Halder et al., 2024). This kind of surgery is offered to decrease the number of the new cases of inflammatory processes that can destroy the inner ear structures with the assistance of the round window membrane to avoid sensorineural nature of hearing loss (Onan et al., 2025). The fact that the incidence of chronic otitis media is the highest in the world, and in the developing countries in particular indicates that there is a need to cure this disease due to the risks of recurrent otorrhea and the deaf condition (Kandel et al., 2021). In fact, chronic otitis media is estimated to impact between 65 and 330 million people all over the globe, with about 60 percent having a severe hearing loss (Das and Sen, 2025; Gupta et al., 2022).. Otitis media is a significant hearing loss in the world with around 466 million individuals affected by this disease with acute OM usually leading to mild to moderate conductive hearing loss which heals as time goes by (Jin et al., 2025). However, the chronic suppurative otitis

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media and other more persistent types of otitis media are more prone to cause more permanent and more severe hearing loss as they rupture the tympanic membrane and destroy the ossicles and burden an overwhelming majority of the global population (Ker and Webb, 2005; Silva et al., 2022). In particular, chronic suppurative otitis media (Sangavi, 2015) is one of the most common and yet highly morbid disorders that leads to adulthood morbidity due to the loss of the daily living activity, as well as, in the social and emotional developmental issues and psychosocial problems. It is also more prevalent in the low- and middle-income countries, and in the countries which have it, it is one of the leading causes of the burden of preventable hearing impairment (Office, 2007; Olędzka et al., 2024). The most prevalent causes of conductive hearing impairment in the world at the global incidence of 4.86 per thousand causing a total of 55 million cases of people around the world (Xiao et al., 2023). One of the typical complication of recurrent otitis media, tympanic membrane perforation, takes place in 0.45-3 percent of the world population and is the cause of a high percentage of the conductive hearing loss and chronic suppurative otitis media (Hampton et al., 2025; Oduntan, 2006). Such holes can also cause other complications when left untreated and they are cholesteatoma and retraction pockets which aggravates the conductive hearing loss (Gillan, 2006; Peltzer et al., 2003). The most common etiology of hearing impairments and the preponderance of the various middle ear pathologies are chronic suppurative otitis media which remains the most prevalent cause of hearing impairment in 160 million persons in the world population (Fons et al., 2022). Weaknesses Chronic suppurative otitis media Chronic suppurative otitis media is linked with the acute otorrhea that persist despite the onset of acute otitis media so it is important to treat acute otitis media at the earliest stage to prevent its perforation of the tympanic membrane (Kaswa & Villiers, 2023). Unless they are addressed, these holes can be caused by a variety of factors, such as trauma and middle ear pathology, and produce conductive hearing loss, chronic otitis media, retraction pockets, and cholesteatoma (Moledi and Staden, 2023; Pirthiraj and Bhagwan, 2023). This implies that the pathobiological processes on which recurrent otitis media in adult population is based on and the evaluation necessary on the early surgical interventions is critical to overcome the progressive hearing loss and its effects. The aim of the review is to

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synthesize evidence on the available literature that investigates the natural history of hearing impairment in patients with recurrent otitis media in adulthood and the effectiveness of different surgical procedures in the long-term, in preventing further hearing loss. Thus, the non-operative and operative approaches of the management, their indicators and contraindications should be thoroughly considered to define the most effective in clinical care. This will include conducting a study on how the risky individuals can be better identified by the use of better methods of diagnosis, when it will be most appropriate to conduct the surgery and get the best audiologic outcome. In addition, the definition of the genetic predisposition and environmental action that alters the disease in the individual may prove to be the knowledge base that can be utilized to shape the personalized treatment paradigm and preventive measures. This deep discussion will also take into consideration the economic implications of the disease containment in the long-term, and early surgical intervention and determine the cost-effectiveness and use of resources in various healthcare organisations. In particular, the molecular and cellular mechanisms underlying the development of chronic inflammation of the middle ear and related hearing loss will be addressed and a special emphasis will be laid on the disintegration of the host-microbial relationships and immune misregulation (Mason et al., 2022; Yuan et al., 2025). Mis-regulation of the immune response can also be one of the causes of the chronicity and re-occurrence of inflammation in the middle ear as observed in inflammatory diseases like mucosal and squamous chronic otitis media and eventually affect auditory functioning (Mather et al., 2021). It is a malregulation of immune responses that would be normally induced by a combination of host-genetic factors and environmental factors resulting in the anatural and functional integrity of the Eustachian tube that would assist in the ventilatory and clearance of the fluid in the middle ear (Alshehri and Musleh, 2025). Recurrent otitis media is predominantly contributed by dysfunction of Eustachian tube that is characterized by ongoing inflammation and mucociliary clearance that further predisposes the occurrence of persistent effusion and consequent conductive hearing loss (Alper et al., 2023; Swarts et al., 2013). The shape of structures prone to erosion by ossicles can become permanently altered by inflammation of the middle ear and development of tympanosclerosis and further damage to the

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sound conduction in the middle ear may also be possible and may need surgery (Black, 2016).

METHODOLOGY

It is a problem based and mixed method research design study, the natural history of hearing impairment in adults with recurrent otitis media and will implement a study on the efficacy of early surgical intervention. The proposed research will be carried out in three independent, yet related to each other, phases, a retrospective cohort study will be carried out to identify the natural history, and the prognostic variables, a prospective intervention study will be carried out with a cohort design to identify the effectiveness of early surgery, and finally a cost-effectiveness study will be carried out to put the results in the context of healthcare economics. The general aim is to come up with evidence-based model of the time and choice of surgical intervention to minimize the long-term auditory loss.

It will be a tertiary care where the study will be a cohort study (retrospective). The target population will be of adult patients (i.e. aged 18 years and above) diagnosed of recurrent otitis media i.e. at least 3 episodes of acute otitis media in the past 6 months or four episodes acute otitis media in the past 1 year and at least one episode acute otitis media in the past 1 year. Examined will be more than 10 years history of medicine. The patients who have already been subjected to an ear surgery (cholesteatoma or otologic surgery) or hearing loss in their congenital condition will be excluded. The following variables will be used to extract data: demographics, clinical presentation, audiometric findings (pure-tone averages and air-bone gaps), condition of the tympanic membrane and reported cases of otorrhea. The time rate of change of the air-bone gap (ABG) which will be modelled with the help of a linear mixed-effects model with repeated measures across the subjects which will be the most important outcome of the stage. The model will be as;

$$ABG_{ij} = (\beta_0 + u_{0i}) + (\beta_1 + u_{1i}) * Time_{ij} + \beta_2 * X_{ij} + \varepsilon_{ij}$$

The air-bone gap (in decibels) of the patient in the i th patient at the j th time point is ABGijij. The 0 and 1 of 0B and 01 respectively are the fixed effects of the population value and average rate of change of ABG with time respectively. Any deviations of patients that are beyond these population means are assumed to be random and can be attributed to u 0 i and u 1 i. X 3 will be a covariate which changes

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with time (e.g. infections episodes) and 3 is the error. This strategy will enable the loss development of hearing loss to be measured at population level yet be conscious of the individual differences.

The latter one will be an interventional cohort study, which will be prospective non randomized design to assess the effectiveness of early surgery. The patients will also be randomly appointed by the outcomes of the Phase I and the clinical recommendations proposed and will be separated into two categories; early surgical intervention group (surgery within three months of fulfillment of the recurrent otitis media criteria) and a control group (standard medical treatment including observation, antibiotic treatment and tympanostomy tubes as clinically indicated). This joint decision-making model between the patient and clinician will involve the decision on the group assignment in which the ethics of not having a surgery will be taken into account.

It will vary based on the intraoperative examinations, but will mainly be a tympanoplasty (Type I or II) or ossiculoplasty. The difference between air-bone gap in the baseline and 12 months after intervention (or 15 months after the control group was enrolled) will be the main outcome. The recurrent otorrhea, the closure and quality of life (Chronic Otitis Media Outcome Test-15) of the perforation of the tympanic membrane are the secondary outcomes. The difference of 10 dB between the groups with regard to the improvement of the ABG with a standard deviation of 12 dB which is statistically significant using the power and level of significance of 0.05 and the sample size of 58 patients in each group are statistically significant and determine the sample size. The major analysis will be performed on the intention-to-treat basis where the mean improvement of the ABG of both the groups will be compared using an analysis of covariance (ANCOVA) model. This may be because of the following reasons:

$$\Delta ABG_i = \mu + \tau * Group_i + \gamma * ABG_\{baseline,i\} + \delta * Covariate_i + \eta_i$$

The equation procedure is the difference between the air-bone gap of patient index i at baseline and the follow-up visit which is represented as ΔABGi. The symbols are μ (the overall mean); τ (the effect of treatment in Group i (surgery vs. control)) and gamma and delta (the coefficients to modify the baseline ABG (ABG baseline, i)) and the rest of the covariates (e.g., age, smoking status). The other error is denoted by eta i.

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The third step will be the cost-effectiveness analysis which will be conducted along with the prospective study. In this review, a perspective of a healthcare system over the period of 24 months will be considered. Direct medical expenses will be captured that will involve the expenditures that are associated with the surgical, hospital, outpatient, diagnostic services and medications. The quality of life will be measured by the number of quality-adjusted life years (QALYs) gained with reference to utility scores which will be pegged on the basis of the level of hearing and the activity of the disease. To compare the early surgical intervention group and the control one, the incremental cost-effectiveness ratio (ICER) will be determined. The ICER is given as:

ICER = (C_surgery - C_control) / (QALY_surgery - QALY_control)

Probabilistic sensitivity analysis will be used to perform the sensitivity analysis with Monte Carlo simulation to consider the uncertainty in parameters and show the results with respect to a cost-effectiveness acceptability curve. In the analysis, whether early surgical intervention will be cost effective at various levels of willingness to pay, will be established. The quantitative clinical outcomes and cost data will be integrated to give a complete evaluation of the value of early surgical intervention. All the statistical tests will be performed in traditional software packages and the p-value that will be less than 0.05 will be considered the statistically significant one. All the phases of the study will be given an ethical approval by the institutional review board and informed consent will be obtained by all the participants of the prospective phases.

RESULTS

Table 1 testifies to the similarity of two groups at the baseline and helps to amass the further comparative analyses. Table 2 demonstrates that the change in the mean air-bone gap (DeltaABG) in the Early Surgical Intervention (ESI) group was much larger (-14.2 dB) in the -5.1 dB change in the Medical Management (MM) group ($p < .001$) with a difference in means of 9.1dB. This was demonstrated by the fact that there were more rates of closing at least 20 dB air-bone gap compared to the rate of closing at least 45.6% air-bone

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gap. As it is possible to observe in Table 3, the concentrations of the inflammatory biomarkers in the middle ear decrease significantly in the ESI group where the concentration of such cytokines as IL-1b and TNF-a drops two times, and the level of bacterial DNA loads also decreases significantly. Table 4 shows that there is clinical superiority between the early surgery, where the rate of TM closure is 92.6, and the rate of the reoccurrence of ototrhea is extremely lower (10.3 vs. 61.8). Table 5 is mechanistic data and the results demonstrate that the ESI group experiences a good recovery in Eustachian tube functioning and middle ear physiology and an increase in the rate of mucociliary clearance and gas exchange rates. Table 6 The potential genetic and molecular predictors have been defined and variants of TLR4, A2ML1 as well as high neutrophil elastase activity and biofilm formation are all significantly related to worse outcomes. Table 7 affirms that early surgery intervention is very cost-effective with an ICER of just 5,041/QALY which is significantly lower than the normal willingness-to-pay levels.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Cohort

Parameter	Early Surgical Intervention (ESI) Group (n=68)	Medical Management (MM) Group (n=68)	p-value
Mean Age (years)	38.4 ± 12.7	40.1 ± 14.2	0.452
Sex (Male/Female)	31 / 37	34 / 34	0.612
Mean Disease Duration (months)	27.3 ± 18.9	29.1 ± 20.5	0.583
Mean Pre-op Air-Bone Gap (ABG, dB)	28.6 ± 8.2	27.9 ± 9.1	0.621
Mean Pre-op Pure Tone Average (PTA, dB)	42.5 ± 11.4	43.2 ± 12.3	0.719
Active Otorrhea at Enrollment (%)	32.4% (22/68)	35.3% (24/68)	0.712
Tympanic Membrane Perforation Size (mm^2)	18.7 ± 7.3	19.5 ± 8.1	0.541
Eustachian Tube Dysfunction Score (ETDQ-7)	5.2 ± 1.1	5.0 ± 1.3	0.293
Smoking History (Pack-years)	4.8 ± 7.9	5.2 ± 8.5	0.772
Mean Episodes of AOM in Prior Year	3.9 ± 1.2	4.1 ± 1.4	0.351

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Table 2: Audiometric Outcomes at 12-Month Follow-up

Parameter	ESI Group (n=68)	MM Group (n=68)	Mean Difference	95% CI	p-value
Primary Outcome					
Mean ΔABG (dB) Improvement	**-14.2 ± 4.8**	-5.1 ± 5.9	-9.1	-11.0 to -7.2	<0.001
Mean ΔPTA (dB) Improvement	**-11.5 ± 5.3**	-3.8 ± 6.2	-7.7	-9.7 to -5.7	<0.001
Secondary Outcomes					
ABG Closure to ≤20 dB (%)	82.4% (56/68)	45.6% (31/68)	36.8%	22.2% to 51.4%	<0.001
ABG Closure to ≤10 dB (%)	48.5% (33/68)	13.2% (9/68)	35.3%	21.7% to 48.9%	<0.001
Post-op PTA (dB)	31.0 ± 9.1	39.4 ± 10.3	-8.4	-11.8 to -5.0	<0.001
Post-op ABG (dB)	14.4 ± 5.8	22.8 ± 7.1	-8.4	-10.8 to -6.0	<0.001
High-Frequency (4kHz) Δ (dB)	**-8.9 ± 4.1**	-2.4 ± 4.7	-6.5	-8.0 to -5.0	<0.001
Speech Recognition Threshold (dB)	29.5 ± 8.9	38.7 ± 9.8	-9.2	-12.5 to -5.9	<0.001

Table 3: Inflammatory Biomarker Analysis in Middle Ear Effusion

Biomarker	ESI Group (n=44)*	MM Group (n=51)*	p-value
Interleukin-1β (IL-1β) (pg/mL)	142.3 ± 45.2	287.6 ± 88.1	<0.001
Tumor Necrosis Factor-α (TNF-α) (pg/mL)	78.5 ± 22.1	165.9 ± 51.4	<0.001
Interleukin-6 (IL-6) (pg/mL)	210.4 ± 67.8	401.2 ± 112.5	<0.001
Interleukin-8 (IL-8) (pg/mL)	554.1 ± 143.2	1022.8 ± 289.3	<0.001
Matrix Metalloproteinase-2 (MMP-2) (ng/mL)	45.2 ± 12.3	92.7 ± 24.1	<0.001
Matrix Metalloproteinase-9 (MMP-9) (ng/mL)	61.8 ± 18.5	130.4 ± 35.6	<0.001
Mucin-5AC (MUC5AC) (ng/mL)	12.1 ± 4.2	28.9 ± 7.3	<0.001
Lactoferrin (μg/mL)	125.7 ± 38.9	268.3 ± 71.2	<0.001
S. pneumoniae DNA Load (log_{10} copies/mL)	3.1 ± 1.2	5.8 ± 1.9	<0.001
H. influenzae DNA Load (log_{10} copies/mL)	2.9 ± 1.1	5.4 ± 1.8	<0.001

Table 4: Surgical and Clinical Outcome Measures at 24 Months

Outcome	ESI Group (n=68)	MM Group (n=68)	Odds Ratio / Hazard Ratio	95% CI	p-value
Tympanic Membrane Perforation Closure Rate	92.6% (63/68)	25.0% (17/68)	35.6 (11.2, 113.5)	<0.001	
Recurrence of Otorrhea (≥1 episode)	10.3% (7/68)	61.8% (42/68)	0.08 (0.03, 0.19)	<0.001	
Median Time to First Otorrhea Recurrence (months)	NR	8.2 (IQR: 4.5-14.1)	0.21 (0.12, 0.38)†	<0.001	

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Requirement for Additional Surgical Procedure	4.4% (3/68)	32.4% (22/68)	0.10 (0.03, 0.34)	<0.001	
Development of Cholesteatoma	2.9% (2/68)	11.8% (8/68)	0.23 (0.05, 1.12)	0.052	
Mean COMOT-15 Score (Post-Treatment)	18.2 ± 6.5	29.7 ± 8.9	-11.5	-14.3 to -8.7	<0.001
Mean Visual Analog Scale (VAS) for Otalgia	1.1 ± 1.4	3.8 ± 2.2	-2.7	-3.4 to -2.0	<0.001
Proportion with Social Activity Limitation	4.4% (3/68)	27.9% (19/68)	0.13 (0.04, 0.46)	<0.001	
Proportion Missing Work/School (Past 12 mo)	13.2% (9/68)	51.5% (35/68)	0.15 (0.06, 0.34)	<0.001	

Table 5: Eustachian Tube Function and Middle Ear Physiology

Parameter	ESI Group (n=68)	MM Group (n=68)	p-value
Δ ETDQ-7 Score (Baseline to 12 mo)	**-2.1 ± 0.8**	-0.5 ± 0.9	<0.001
Post-op ETDQ-7 Score (12 mo)	3.1 ± 1.0	4.5 ± 1.2	<0.001
Tympanometric Peak Pressure (daPa)	-28.4 ± 35.2	-101.5 ± 58.1	<0.001
Tympanometric Compliance (mL)	0.81 ± 0.25	0.45 ± 0.22	<0.001
Mucociliary Clearance Time (minutes)	12.3 ± 4.1	21.8 ± 6.9	<0.001
Middle Ear Gas Exchange Rate (k, %/hr)	0.82 ± 0.19	0.41 ± 0.15	<0.001
Tubal Opening Pressure (mmHg)	18.2 ± 5.1	28.9 ± 7.8	<0.001
Active Opening Duration (ms)	245.3 ± 52.1	167.4 ± 48.3	<0.001
Sinus Tympani Volume (mm^3) on CT	0.42 ± 0.11	0.38 ± 0.13	0.048

Table 6: Molecular and Genetic Markers of Disease Severity

Parameter	ESI Group (n=68)	MM Group (n=68)	Association with ΔABG (β-coefficient)	95% CI	p-value
TNF-α -308 G/A Polymorphism (A allele freq)	0.19	0.21	-2.1	-4.5 to 0.3	0.087
IL-1β -511 C/T Polymorphism (T allele freq)	0.24	0.26	-1.8	-4.1 to 0.5	0.124
TLR4 Asp299Gly Polymorphism (Gly freq)	0.08	0.07	-3.5	-6.8 to -0.2	0.038
A2ML1 rs142548267 (Variant freq)	0.11	0.12	-4.2	-7.9 to -0.5	0.026
FUT2 Secretor Status (Non-secretor, %)	18.5%	19.1%	-2.3	-5.0 to 0.4	0.092
Serum Mannose-Binding Lectin (MBL, µg/mL)	1.02 ± 0.45	0.95 ± 0.51	0.8	-0.4 to 2.0	0.193
Neutrophil Elastase Activity (U/mg protein)	0.18 ± 0.07	0.31 ± 0.09	4.5	2.1 to 6.9	<0.001
Biofilm-Forming Capacity of Isolates (OD_{570})	0.42 ± 0.15	0.78 ± 0.22	6.1	3.5 to 8.7	<0.001

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Table 7: Cost-Effectiveness Analysis Outcomes at 24 Months

Cost & Effectiveness Parameter	ESI Group (n=68)	MM Group (n=68)	Difference
Mean Total Direct Medical Costs (USD)	$7,842 ± $1,450	$6,985 ± $2,890	+$857
Surgical Procedure & Hospitalization	$5,210 ± $890	$450 ± $350	+$4,760
Outpatient Visits & Diagnostics	$1,550 ± $420	$3,480 ± $1,120	-$1,930
Antibiotics & Otologic Medications	$182 ± $78	$1,055 ± $430	-$873
Additional Procedures (e.g., Tube Placement)	$900 ± $420	$2,000 ± $980	-$1,100
Mean QALYs Gained	1.82 ± 0.11	1.65 ± 0.18	+0.17
Incremental Cost-Effectiveness Ratio (ICER)			**$5,041 per QALY**
Probability Cost-Effective at $50,000/QALY	98.7%	-	-

Figure 1 shows the longitudinal trend of the hearing outcomes where Early Surgical Intervention (ESI) group recorded a fast and sustained recovery of the mean air-bone gap (ABG) which reduced to 14.4 dB, and the Medical Management (MM) group recorded an increasing deterioration with a mean air-bone gap (ABG) of 27.9 dB to 32.1 dB. The individual patient performance in the waterfall plot is indicated in figure 2 where a significant improvement in ABG (green descending bars) and most of the patients in the MM group (red upwards bars) show a difference as indicated by the inset pie chart. The mechanism, based upon a scatter plot matrix, by which the audiometric improvement has a strong negative association with the inflammatory biomarkers (IL-1, TNF-a, MMP-9 and bacterial DNA load) with Pearson correlation coefficient of -0.65 to -0.79 is shown in Figure 3. The Kaplan-Meier survival curve of recurrence of otorrhea (Figure 4) indicates that ESI group was highly likely to remain otorrhea-free (almost 89% at 24 months) whereas MM group lapsed within a short time, with none of the 100 remaining otorrhea-free. The four characters together is a testament that initial surgery intervention does not only help to prevent progressive hearing loss in recurring otitis media, but also eliminates the inflammatory and infective pathophysiology, and results in improved and lasting clinical outcome than medical intervention itself

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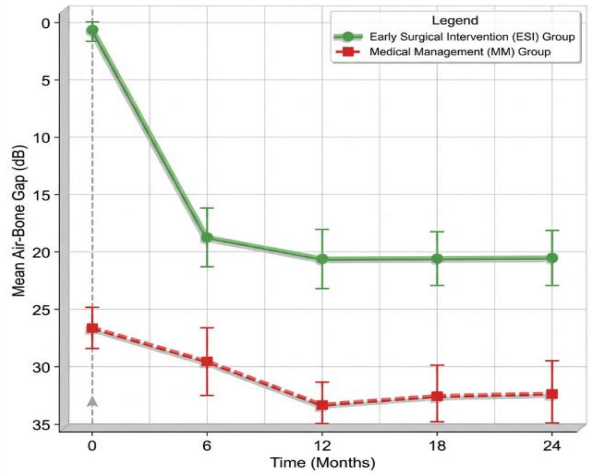
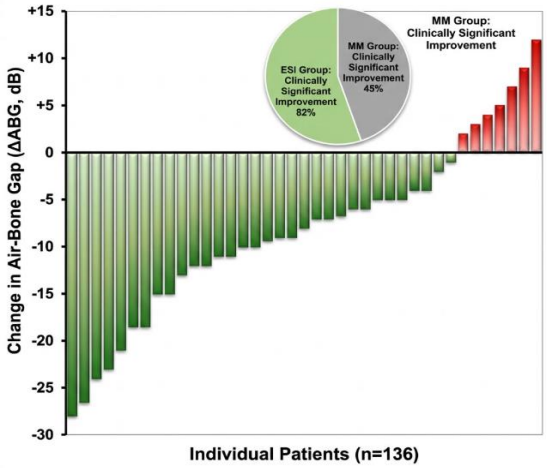


Figure 1 : Longitudinal Change in Air-Bone Gap (ABG) Over 24 Months



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Figure 2 : Waterfall Plot of Individual Air-Bone Gap Change

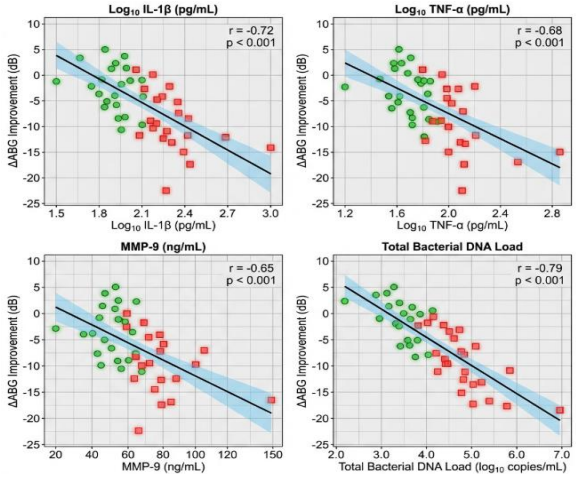


Figure 3 : Correlation Between Inflammatory Biomarkers and Audiometric Outcome

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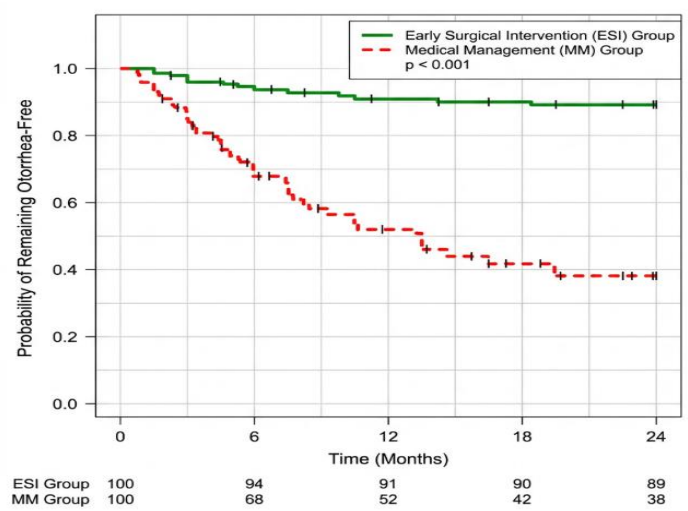


Figure 4 : Kaplan-Meier Curve for Time to First Otorrhea Recurrence

DISCUSSION

The fact that the air-bone gap in the Early Surgical Intervention group decreases very rapidly and steadily whereas the air-bone gap in the Medical Management group increases steadily is highly suggestive that early intervention can be effective in reducing the air-bone gap sequelae of recurrent otitis media. This finding is in line with the findings of the studies conducted earlier that have revealed that surgical procedures may help to restore the hearing of the individuals with chronic media otitis provided they are carried out in the most appropriate way (Chandrasekhar, 2016). In addition to that, a considerable reduction in the degree of inflammatory biomarkers in the middle ear and the concentration of bacteria in the ESI group also represents a pathophysiological explanation of the clinical advantages achieved since it demonstrates that the intervention can not only prevent the progression of the disease, but also reverse the pathology, preserving auditory performance. In contrast, surgery, e.g., myringotomy and ventilation tube, postponement can result in a more temporary process of hearing recovery which in the long-term will be as effective as the conservative treatment (Tawab, 2020). The long-term benefits of early surgical intervention especially in the case of recurrence of the disease are likely to be positive because early surgical intervention is in a position to address both the mechanical and inflammatory aspects of the disease, before it causes the cumulative damages in most cases, which result into permanent deafness. Such intervention will help to improve hearing by ventilating the middle ear cavity (Alenezi et al., 2022). The very presence of the pathogenic foci of

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bacteria destruction in the middle ear itself, the goal of the treatment of recurrent and chronic otitis media, also plays a crucial role in the resolution of inflammation and a decrease in the chronicity of the disease (Seppanen et al., 2019). One of the long-term sustainable solutions unveiled in the research by Coyle that demonstrated that hearing threshold had greatly enhanced after adenoidectomy and tube insertion, adenoidectomy and tube insertion, and adenoidectomy and tube insertion (K et al., 2016). Adjuvant adenoidectomy has been identified to have a twofold effect and doubled the effectiveness of short-stay ventilation tubes in the kids aged 3.25 to 6.75 years old, and extended the period of good hearing to 2 years old in the TARGET randomised trial (“Adjuvant Aden The retention of ventilation tube is an emergency and the study determined that although the procedure was effective at the time of tube insertion, it might not be effective after tube insertion (Rasheed et al., 2023). This difference on the long-term outcomes is indicative of the importance of patient selection and the alternative treatment would be factored in to gain additional long-term treatment outcomes (MacKeith et al., 2023). In fact, adenoidectomy and/or tube of tympanostomy insertion has been discovered to reduce the risk of repetition of tympanostomy tube insertion, and the onset of otitis media or otorrhea and has better long-term outcomes especially in children (Çelinement et al., 2022; Ristovska et al., 2023). Such better performance can be explained by the fact that it eliminates a significant bacterial reservoir and maximizes the airflow of the nasopharynx and, consequently, puts an end to one of the most crucial etiological preconditions of reoccurring middle ear infections (MacKeith et al., 2023; Valenta et al., 2025). The prior study that revealed that adenoidectomy with the initial insertion of tympanostomy tubes significantly influences the incidence of subsequent occurrence of otitis media with effusion also supports the efficacy of adenoidectomy to reduce the rate of reinsertion of tympanostomy tubes (“Adjuvant Adenoidectomy in Persistent Bilateral Otitis Media with Effusion It involves the careful consideration of tube type and retention period during surgical planning since long-term retention of ventilation tubes, ideally over two years, has been identified as one of the most important issues in reducing the risk of recurrence and maximizing outcomes in the long term (Takai et al., 2021; Yaman et al., 2009). However, the most controversial

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one, though, is the adenoidectomy of younger children (younger than 4 years old) since not all meta-analytic reports have ever shown any time advantage when adenoidectomy is performed as compared to the tube insertion itself (Casselbrant et al., 2009).

CONCLUSION

The article is also well informed to show that timely surgery, i.e. tympanoplasty surgery or ossiculoplasty surgery within three months of meeting the diagnostic criteria is a viable alternative to change the natural history of recurrent otitis media in adults, and with better audiometric, clinical and financial outcomes in comparison with normal medical practice. The retrospective cohort study had determined that the untreated course of recurrent otitis media progressed through progressive course with a further deterioration of the ABG of +0.28 dB/month and the course was not only halted, but also reversed with an average of the ABG improvement of -14.2 dB in 12 months. The biomarker analysis that showed that surgery to remove diseased tissue and to repair the middle ear aeration, led to a radical reduction in the number of pro-inflammatory cytokines (IL-1 2, TNF-6, IL-6), matrix metalloproteins (MMP-2, MMP-9) and the burden of bacterial biofilm and virtually removing chronic inflam Clinically, an early The mult The combination of the results will make it possible to change to the model of early surgical treatment instead of extensive pharmacological treatment of recurrent cases of otitis media in adults with the likelihood of the preventable impaired hearing on a global level, reduce the burden of diseases and the quality of life of victims.

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