USM J/P-06

Semua laporan kemajuan dan laporan akhir yang dikemukakan kepada Bahagian Penyelidikan dan Pembangunan perlu terlebih dahulu disampaikan untuk penelitian dan perakuan Jawatankuasa Penyelidikan di pusat pengajian

BAHAGIAN PENYELIDIKAN & PEMBANGUNAN

CANSELORI

UNIVERSITI SAINS MALAYSIA

Laporan Akhir Projek Penyelidikan Jangka Pendek

1) **Nama Penyelidik:** Dr. Hari Shankar Sharma
Lecturer, Department of Otorhinolaryngology
Hospital University Sains Malaysia, Kubang Kerian

Nama Penyelidik-Penyelidik Lain *(Jika berkaitan)*
Dr. Wan Mohamad Wan Bebakar
Prof. Mad'ya and Head of Department
Department of Medicine

2) **Pusat Pengajian/Pusat/Unit :** Department of Otorhinolaryngology and
Department of Medicine
School of Medical Sciences, USM, Kubang Kerian

3) **Tajuk Projek:** Hearing thresholds assessment in diabetic patients at Hospital Universiti Sains Malaysia, Kubang Kerian

4) (a) **Penemuan Projek/Abstrak**

(Perlu disediakan makluman di antara 100 - 200 perkataan di dalam Bahasa Malaysia dan Bahasa Inggeris Ini kemudiannya akan dimuatkan ke dalam Laporan Tahunan Bahagian Penyelidikan & Pembangunan sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti).

Clinical records of 542 patients from the diabetic clinic at Hospital Universiti Sains Malaysia were screened for the various factors which are known to cause hearing impairment. There were 28 patients included in the present study and their written consent was taken to participate in the study. Pure tone hearing thresholds for air and bone conduction was done at the ENT clinic and the results were compared with 19 non-diabetic healthy controls using the same screening criterias which was used for the diabetic patients. The diabetic patients were found to have increased hearing thresholds at high frequency (8000Hz)when compared to controls. This hearing loss was found to be more in patients with diabetes mellitus of more than 7 years as compered to patients having diabetes mellitus of less than 7 years. The poor control of diabetes was not found to have positive correlation to this hearing loss. The patients with diabetic retinopathy had significant hearing loss when compared with patients having no diabetic retinopathy.

Our results shows that diabetes mellitus causes hearing loss which is similar to the hearing loss seen in the old age. It seems the diabetic patients in our study has early age changes.

(b) **Senaraikan Kata Kunci yang digunakan di dalam abstrak:**

Bahasa Malaysia	**Bahasa Inggeris**
Diabetis (Kencing Manis)	Diabetes
Audiometri	Audiometry
Kurang Pendengaran	Hearing loss
Retinopati	Retinopathy

5) **Output Dan Faedah Projek**

(a) **Penerbitan** ***(termasuk laporan/kertas seminar)***
(Sila nyatakan jenis, tajuk, pengarang, tahun terbitan dan di mana telah diterbit/dibentangkan).

The study results are sent for publication in the Journal of Laryngology and Otology (UK)

(b) **Faedah-Faedah Lain Seperti Perkembangan Produk, Prospek Komersialisasi Dan Pendaftaran Paten:**
(Jika ada dan jika perlu, sila gunakan kertas berasingan)

.....

Not Applicable

.....

.....

.....

.....

.....

.....

.....

(c) **Latihan Gunatenaga Manusia**

i) Pelajar Siswazah .....

Not Applicable

.....

.....

.....

ii) Pelajar Prasiswazah: .....

Not Applicable

.....

.....

.....

iii) Lain-Lain : Not Applicable .....

.....

.....

.....

6. **Peralatan Yang Telah Dibeli:**

Not Applicable

UNTUK KEGUNAAN JAWATANKUASA PENYELIDIKAN UNIVERSITI

T/TANGAN PENGERUSI
J/K PENYELIDIKAN
PUSAT PENGAJIAN

Hearing Thresholds Assessment in Diabetic Patients at Hospital University Sains Malaysia, Kubang Kerian.

Hari Shankar Sharma and Wan Mohamad Wan Bebakar*
Department of Otorhinolaryngology and Medicine*
School of Medical Sciences, Universiti Sains Malaysia
Kubang Kerian Kelantan.

USM Short term Research Grant Number 331-0500-3080

INTRODUCTION:

Diabetes mellitus is a metabolic disease charaterised by a high level of blood glucose. It can be classified in to insulin dependent diabetes mellitus (IDDM) and non-insulin dependent diabetes mellitus (NIDDM). Commonly the complications due to diabetes mellitus are best considered in three categories: macrovascular, microvascular and neuropathy. The systemic nature of diabetes mellitus justifies the search for its effects on the inner ear and the central auditory pathways. In diabetes, microangiopathic changes affecting the inner ear and the central nervous system are the most important findings, and have been reported by several authors (Jorgensen, 1961, Costa, 1967, Jorgensen and Buch,1961, Jorgensen, 1962, Kovar, 1973, Makishima *et al.*,1971, Wackym and Linthicum,1986, Zelenka and Kozak,1965). The association of hearing loss and diabetes mellitus was first reported by Jordao (1962). Other reported effects of diabetes mellitus on hearing includes; endolympahtic and perilymphatic haemorrhages (Kovar, 1973), cochlear hair cell loss, decrease of nerves of the spiral lamina and atrophy of the spiral ganglion in the cochlea and demyelinization and beading of the cochlear nerve (Makishima and Tanaka,1971) and degenerative abnormalities of the nervous tissue of the brain stem, cerebellum and brain (Reske-Nielsen *et al.*, 1965).

There have been various conflicting reports regarding the incidence of hearing loss in diabetes mellitus which have been stated as varying from 0% (Borsuk *et al.*, 1956; Kindler, 1955) to 93% (Derald, 1966). The typical hearing loss in diabetes mellitus is a progressive bilateral sensorineural type affecting primarily the higher frequencies; similar to that seen in presbyacusis (Colletti *et al.*, 1985). Exceptions to this typical pattern have also been reported like low frequency hearing loss (Taylor and Irwin,

1978) and unilateral hearing impairment with progressive or acute loss (Jorgensen, 1962).

Many authors state that there is no significant difference in pure tone audiometry between diabetic patients and control subjects (Colletti *et al.,* 1985; Buller *et al.,* 1988; Donald *et al.,* 1981; Filipo *et al.,* 1985; Friedmann, 1975; Gibbin and Davis, 1981; Goldsher *et al.,* 1986; Hendriks *et al.,* 1985; Miller *et al.,* 1983; Osterhammel and Christau,1980; Parving *et al.,* 1990; Sieger *et al.,*1983; Taylor and Irwin,1978). Other studies, however have reported a significant hearing loss in diabetic subject when compared with normal control subjects (Kurien *et al.,* 1989; Cullen and Cinnamond, 1993; Virtaniemi *et al.,* 1994). Various factors like diabetic patients with poor control and with other complications have higher incidence of high frequency hearing loss when compared to well controlled and uncomplicated diabetics while the duration of diabetes having no effect on hearing loss (Cullen and Cinnamond, 1993; Virtaniemi *et al.,* 1994). Some studies have reported correlation between diabetic retinopathies and hearing loss (Kurien *et al.,* 1989; Virtaniemi *et al.,* 1994).

Therefore, the aim of this study, done at Hospiptal Universiti Sains Malaysia,was;

1) To compare pure tone hearing threshold in diabetic patients and non-diabetic subjects., and

2) To study the impact of
- duration of diabetes mellitus
- metabolic control of diabetes mellitus and
- association of presence of diabetic retinopathy on hearing thresholds for pure tones in diabetic patients.

MATERIALS AND METHODS:

The present study was conducted at Hospital Universiti Sains Malaysia from December 1995 to January 1998. There are about 600 diabetic patients registered at diabetic clinic of this Hospital and clinical records of 542 of these diabetic patients were screened. All the patients with a history of ototoxic drug intake; head injury; family history of deafness; past history of meningitis mumps or typhoid fever; any neurological or other metabolic disease; blindness and renal insufficiency were excluded from the study. The patients who passed this screening were further interviewed to explore the above history. The diabetic patients who were finally selected explained about the study and their written consent was taken. The particulars of the patient such as age, sex, body weight and body mass index, duration of the diabetes, type of diabetes, type of treatment and medication etc. were recorded. A detailed ENT examination was conducted and any patient with evidence of ear disease or other ENT diseases was excluded from the study. All patients were subjected to a full otological examination, including tuning fork testing using the Rinne and Weber tests (appendix- I).

Clinical examination was done to look for peripheral neuropathy and for the involvement of the autonomic nervous system. These patients were asked to collect 24 hour urine sample in a sterile bottle for the assessment of urinary albumin excretion rate. The urinary albumin above 30 microgram/ml was considered as evidence of diabetic nephropathy. The patients then called to the ENT clinic after over night fasting. Fasting blood samples were collected for biochemical tests; HbA1, serum lipids, fasting blood sugar etc. After that they were allowed to take their antidiabetic drugs and have breakfast.

Pure tone threshold at octave of 250 Hz to 8000 Hz, both by air conduction and by bone conduction was determined. Narrow band masking was used where indicated. The equipment used comprised an Amplaid 450 audiometer (Italy).

On the same day fundus examination was done by Ophthalmologist (after dilating the pupils with 1% tropacamide eye drops in both eyes) to look for the evidence of retinopathy. The fundus findings were classified as no retinopathy, back ground retinopathy, pre-proliferative retinopathy and proliferative retinopathy.

The assessment of the diabetic control was done by the HbA1 level during past few years and at the time of hearing assessment. The Eagle diagnostic, USA method was used for the quantitative determination of glycosylated haemoglobin in the blood. This method employs weakly binding cation exchange resin for rapid separation of glyco-haemoglobin from non-glycosylated haemoglobin. The normal values are 6%-8.3% in our population. The diabetic control was graded as

Good control: HbA1 level less than 7.5% - 8.99%,

Fair control: HbA1 level of 9% - 9.99%

Poor control: HbA1 level more than 10%.

The controls were non-diabetic subjects with no family history of diabetes mellitus and modified glucose tolerance test was used to diagnose diabetes mellitus in this group, otherwise the same criteria were applied as for the diabetic patients. The controls were mostly from the hospital staff and were age and sex matched. Clinical methods and the audiometry examination was done in the same way as for the diabetic patients.

Diabetic patients were 28 (Mean age 41.11 ± 11.53 with a range from 29-65 years) and 19 were non-diabetic controls (Mean age 37.42 ± 9.82 with a range from 28-64 yaers). There was no statistically significant difference of ages between these two groups ($\rho < 0.195$).

In the diabetic group mean duration of diabetes mellitus was 7.18 ± 3.62 years and mean HbA1 level was 9.88. The percentage of associated diabetic retinopaty in the patient group was 39.29%. The mean albumin excretion in diabetics was 0.778 microgram/ml.

The resulting data for pure tone thresholds were analysed using SPSS statistical programme. The Student's 't' test for independent variables was done. Correlation was calculated with Pearson correlation coefficients.

RESULTS AND DISCUSSION:

Adult onset diabetes mellitus has been recognised for centuries and is known to affect neural tissues and special sense organs and perhaps cause premature aging. A review of the audiological literature on hearing abnormalities in diabetics shows a divergence of results both for the prevalence of hearing loss from 0% (Borsuk *et al.*, 1956,

Kindler, 1955, Gibbin and Davis, 1981, Harner, 1981, Colletti *et al.,* 1985, Buller, *et al.,* 1988,) to 93% (Derald, *et al.,* 1966, Kurien *et al.,* 1989, Cullen and Cinnamond, 1993, Virtaniemi *et al.*, 1994) and for the degree of hearing impairment. The divergence of the reported hearing changes in diabetics is hard to understand and may be due to several external variables rather than to the disease process it self; age of the patients, previous disease (ear diseases, acoustic trauma, ototoxicity, other associated metabolic diseases etc.) and methods of auditory evaluation etc. By using three different statistical methods,Taylor and Irwin (1978) obtained variable percentage of hearing losses from 13.2% to 94.7% in the same diabetic population.

In order to reduce the interference of nonspecific variables, the pure tone thresholds assessment in the present study was done after the screening test for various factors which can cause hearing loss. Out of 542 diabetic cases only 28 cases were included in the present study who fulfilled the screening criteria. The excluded diabetics were either on drugs known to affect hearing or had other metabolic diseases which can affect hearing thresholds. The pure tone hearing thresholds result were compared with age and sex matched non-diabetic controls.

Pure tone hearing thresholds in diabetic patients and controls:

Pure tone hearing thresholds result for air and bone conduction are shown in table1 and 2. There was no significant difference at lower frequencies. The difference became statistically significant ($\rho < 0.05$ Wilcoxon W test) at high frequency (8000Hz) both for air and bone conductions.

Table 1. Shows Pure tone air conduction hearing thresholds by frequencies (dB means, ± SD) in diabetics(n=28) and Non-diabetic control (n=19) groups.

Pure tone frequency	Control subjects Mean and SD	Diabetic patients Mean and SD	95% Confidence Interval of Mean Lower	Upper	't'-test (2-tailed)
250 Hz	27.23 (5.8)	26.87 (9.7)	-5.40	4.68	0.886
500 Hz	25.39 (4.9)	26.03 (9.38)	-4.09	5.37	0.787
1000 Hz	23.81 (4.19)	24.78 (8.00)	-3.07	5.00	0.631
2000 Hz	19.86 (5.68)	21.25 (7.40)	-2.67	5.43	0.496
4000 Hz	20.26 (7.94)	24.34 (12.46)	-2.40	10.62	0.210
8000 Hz	23.28 (8.97)	35.98 (19.51)	3.02	22.35	0.001*

* (Mann-Whitney test value = 0.020, significant $\rho < 0.05$)

Table 2.Shows Pure tone bone conduction hearing thresholds by frequencies (dB means, ± SD) in diabetics (n= 28) and Non-diabetic control (n=19)groups.

Pure tone frequency	Control subjects Mean and SD	Diabetic patients Mean and SD	95% Confidence Interval of Mean Lower	Upper	't'-test (2-tailed)
250 Hz	14.86 (6.58)	15.89 (6.49)	-2.88	4.93	0.600
500 Hz	17.63 (4.89)	20.44 (7.48)	-1.12	6.74	0.157
1000 Hz	17.36 (5.80)	17.85 (7.62)	-3.67	4.65	0.814
2000 Hz	16.68 (5.48)	17.41 (8.23)	-3.12	5.57	0.573
4000 Hz	19.86 (6.53)	24.19 (9.42)	-0.69	9.35	0.09
8000 Hz	21.57 (7.50)	29.81 (11.30)	2.24	14.22	0.008*

* (Mann-Whitney test value = 0.008, significant $\rho < 0.05$)

This finding is in accordance with the findings of Cullen and Cinnamond, (1993), Kurien *et al.*, (1989) and Virtaniemi *et al.*, (1994). Similar high frequency hearing loss has been reported by various authors (Jannulis and Delijannis, 1936, Jorgensen and Buch, 1961, Axellson *et al.*, 1978) and supports the hypothesis proposed by Snashall (1977) and by Gibbin and Davis (1981) that diabetes mellitus exacerbate the aging process. Further analysis was done to study the impact of various factore like duration of diabetes mellitus, metabolic control based on HbA1 level and association of retinopathy at this high frequency (8000Hz) pure tone hearing thresholds findings in diabetics.

Duration of Diabetes and hearing loss:

The diabetics were divided into two groups based on mean duration (7 years) of diabetes mellitus. The results are shown in table 3

Table 3. Association of the duration of diabetes with pure tone hearing thresholds at 8000 Hz frequency is shown. The diabetic patients were divided into two groups on the basis of median duration of the diabetes mellitus.

Pure tone frequency	Duration of diabetes < 7 years. n=14 Mean and SD	Duration of diabetes > 7 years. n=14 Mean and SD	Mann - Whitney Test
8000 Hz (Air conduction) 8000 Hz (Bone conduction)	25.35± 13.54 24.82± 8.79	46.60± 19.08 35.19± 11.52	0.003* 0.020*

significant $\rho < 0.05$

Analysis of Pearson correlations was significant between the duration of diabetes mellitus and (mean air conduction and mean bone conduction) pure tone hearing thresholds. The duration of diabetes mellitus had significant effect on the hearing loss and had positive correlation at high frequency (8000 Hz). This finding supports the hypothesis of longer duration of diabetes mellitus giving rise to high frequency hearing loss on pure tone audiometry; a finding which is typical of presbyacusis (Arnst, 1985).

Poor control of Diabetes mellitus and hearing loss:

Poor control of diabetes mellitus was assessted by the HbA1 levels. The results are shown in table 4.

Table 4. Shows the association of the metabolic control with pure tone hearing thresholds at 8000 Hz frequency. The diabetic patients were divided in two groups; Poor control group having HbA1 level more than 10% and other group having HbA1 of less than 10%.

Pure tone frequency	Poor control of diabetes mellitus n=11 Mean and SD	Good/fair control of diabetes mellitus n=14 Mean and SD	Mann - Whitney Test
8000 Hz(Air conduction) 8000 Hz (Bone conduction)	39.31± 16.47 34.77± 10.15	33.82± 21.45 26.40± 11.06	0.306* 0.053*

significant $\rho < 0.05$

Analysis of Pearson correlation was not significant between the poor control of diabetes mellitus and the (mean air conduction and mean bone conduction) pure tone hearing thresholds at higher frequencies (8000 Hz). Virtaniemi *et al.*, (1994) also reported similar results in insulin-dependent diabetes mellitus patients while Kurien *et al.*, (1989) reported positive correlation between poor control of diabetes and hearing threshold. Direct evidence to support poor control of diabetes mellitus and its effect on hearing remains to be proven.

Presence of diabetic retinopathy and hearing loss:

Analysis of presence or absence of diabetic retinopathy was studied and the results are shown in table 5.

Table 5. Shows the association of diabetic retinopathies with pure tone hearing thresholds at 8000 Hz frequency.

Pure tone frequency	Diabetes mellitus retinopathy present n=11	Diabetes mellitus retinopathy absent n =17	Mann - Whitney Test
8000 Hz (Air conduction) 8000 Hz (Bone conduction)	44.31± 16.77 35.45± 9.98	30.58± 19.69 25.93± 10.75	0.038* 0.031*

significant $\rho < 0.05$

Analysis of correlation between pure tone hearing loss at high frequency (8000Hz) and retinopathies was significant in our study. Similar correlationship was reported by Jorgensen and Buch (1961) and Virteniemi *et al.*, (1994). This finding is an indirect evidence of microangiopathic changes in the hearing system (internal auditory artery, vasa nervosa of acoustic nerve, the vessels of modiolus, stria vascularis and spiral ligament) as reported by Costa (1967), Jorgensen and Buch (1961), Jorgensen (1962), Kovar (1973), Makishima *et al.*,(1971), Zelenka and Kozak (1965).

CONCLUSIONS AND RECOMMENDATIONS:

1.Diabetes mellitus causes pure tone hearing loss at high frequency (8000 Hz) compared to that of non-diabetic controls of the same age and sex.

2. Duration of diabetes mellitus of more than 7 years was found to be one of the most important factor causing the hearing loss.

3. Presence of associated retinopathy was also an important factor associated with the hearing loss.

4. Poor control of diabetes as based on HbA1 level was not a factor associated with the hearing loss.

As all diabetic patients are at risk of suffering from hearing loss as well as retinopathy which has been an established fact for the past many years. It is recommended that all patients with diabetes mellitus should have hearing thresholds test done as a base line parameter to monitor the effect of the disease on hearing.

The hearing tests should be done at regular intervals (six monthly) to detect the hearing loss early and advise them accordingly. In the Hospital University Sains Malaysia the equipment and the facilities for hearing tests are already available and can be done at nominal charges. This should be made use for the benefit of the patients who are on regular follow-up for diabetes mellitus. To achieve maximum benefits to the patients it is essential that all the doctors who are involved in the care of diabetic patients should be made aware of the possible complication of hearing loss and the diagnostic facilities available at Hospital University Sains Malaysia.

ACKNOWLEDGEMENTS:

This study was supported by the short term research grant from University Sains Malaysia (No. 331/0500/3080). The authors wish to thank all the staff and persons whose support and assistance made this study complete.

REFERENCES:

Arnst, D.J. (1985) In handbook of clinical audiology. (Katz,J., Gabbay, W.L., Ungerleider, D.S., Wilde,L., eds.), Williams & Wilkins, Baltimore, USA, pp 707-720.

Axellson A., Sigroth,K., Vertes, D. (1978) Hearing in diabetics. Acta Otolaryngology. Suppliment. **356:**1-22.

Borsuk,J., Lisiecha,H.,Majcherska, B. (1956) The audiometric curve in diabetes mellitus. Pol. Archs Med. **26:** 1159-1166.

Buller,N.,Shvili.Y., Laurian,N., Laurian,L., Zohar,Y. (1988) Delayed brainstem auditory evoked responses in diabetic patients. Journal of Laryngology and Otology **102:** 857-860.

Colletti,V., Fiorino,F.G., Sittono,V., Bonanni, G. (1985) Auditory evaluation in diabetes mellitus. Advances in Audiology **3:** 121-132.

Costa, O.A. (1967) Inner ear pathology in experimental diabetes. Laryngoscope **77:** 68-75.

Cullen, J.R., Cinnamond, M.J. (1993) Hearing loss in diabetics. Journal of Laryngology and Otology **107:** 179-182.

DeJong,R.N. (1977) CNS manifestations of diabetes mellitus. Postgraduate Medicine **61:** 101-107.

Donald,M.W., Bird, C.E., Lawson,J.S., Letemendia, F.J.J., Monga,T.N., Surridge, D.H.C., Verette-Cerre, P., Williams, D.L., Williams,D.M.L., Wilson,D.L. (1981) Delayed auditory brainstem responses in diabetes mellitus. Journal of Neurology,Neurosurgery and Psychiatry **44:** 641-644.

Dorald, J., Schiffner, G., Tolnay,S. (1966) Audiological examination of diabetic patients. Orv. Hetil. **107:** 1434-1456

Filipo, R., De Seta,E., Bertoli,A. (1985) High-frequency audiometry in juvenile diabetics. Advances in Audiology **3:** 106-111.

Gibbin, K.P., Davis,C.G. (1981) A hearing survey in diabetes mellitus. Clinical Otolaryngology **6:** 345-350.

Goldsher,M., Pratt,H., Hassan.A., Shenhav,R., Eliacher,I., Kanter.Y. (1986) Auditory brainstem evoked potentias in insulin dependent diabetics with and without peripheral neuropathy. Acta Oto-Laryngologica **102:** 294-208.

Harner, S.G. (1981) Hearing in adult-onset diabetes mellitus. Otolaryngol Head Neck Surgery **89:** 322-327.

Jannulis,G. and Delijannis, G. (1936) Diabetes und Gicht als Ursache von Kochlearisschadigung. Monatsschr. Ohrenheilkund. Laringol. Rino. **70:** 1504-1508

Jordao,A.M.D.(1962) cited in Jorgensen,M.B., Buch,N.H. Function of inner ear and cranial nerves in pregnant diabetics: Clinical studies. Practical Otorhinolaryngol **24:** 111-116.

Jorgensen, M.B. (1962) The inner ear in diabetes mellitus. Archs Oto-lar. **74:** 373-381.

Jorgensen, M.B. (1962) Changes of aging in the inner ear, and in the inner ear in diabetes mellitus. Histological studies. Acta oto-lar., suppliment 188, 125-128.

Jorgensen,M.B., Buch,N.H. (1961) Studies on inner-ear function and cranial nerves in diabetics. Acta Oto-Laryngologica **53:** 350-464.

Kindler,W., (1955) Schwerhorigkeit bei diabetes mellitus . Practica oto-rhino-lar. **17:** 282-288.

Kovar,M. (1973) The inner ear in diabetes mellitus. Journal of Oto-Rhino-Laryngology and its Related Specialities **35:** 42-51.

Kurien, M., Thomas,K., Bhanu,T.S. (1989) Hearing threshold in patients with diabetes mellitus. Journal of Laryngology and Otology **103:** 164-168.

Makishima,K.,Tanaka,K. (1971) Pathological changes of the inner ear and central auditory pathway in diabetics. Annals of Otology,Rhinology and Laryngology **80:** 218-229.

Miller,J.J., Beck,L., Davis,A., Jones,D.E.,Thomas,A.B. (1983) Hearing loss in patients with diabetic retinopathy. American Journal of Otolaryngology **4:** 342-346.

Osterhammel, D., Christau,B. (1980) High frequency audiometry and stapedius muscle reflex thresholds in juvenile diabetics. Scandinavian Audiology **9:** 13-18.

Parving,A., Elberling,C., Balle,V., Parbo,J., Dejgaard,A., Parving,H.H. (1990) Hearing disorders in patients with insulin dependent diabetes mellitus. Audiology **29:** 113-121.

Reske-Nielsen,E., Lundbaek,K.,Rafaelsen,O. (1965) Pathological changes in the central and peripheral nervous system of young long term diabetics (diabetic encephalopathy). Diabetologia **1:** 233-241.

Sieger,A., Skinner,M.W., White,N.H., Spector,G.J. (1983) Auditory function in children with diabetes mellitus. Annals of Otology,Rhinology and Laryngology **92:** 237-241.

Snashall, S.E. (1977) Bekesy audiometry and tone and reflex decay tests in diabetics. Archs Otolar. **103:** 342-343.

Taylor,I.G., Irwin,J.,(1978) Some audiological aspects of diabetes mellitus. Journal of Laryngology and Otology **92:** 99-113.

Wackym,P.A.,Linthicum, F.H. (1986) Diabetes mellitus and hearing loss: clinical and histopathological relationships. American Journal of Otology **7:** 176-182.

Vitraniemi,J.,Laakso,M.,Nuutien,J., Karjalainen, S., Vartiainen,E. (1994) Hearing thresholds in insulin-dependent diabetic patients. Journal of Laryngology and Otology **108:** 837-841.

Zelenka, J., Kozak,P. (1965) Disorders in blood supply of the inner ear early symptom of diabetic angiopathy. Journal of Laryngology and Otology **79:** 31-319.

Appendix

HEARING THRESHOLD ASSESSMENT IN DIABETIC PATIENTS AT HUSM

GUIDELINES

1. To screen all patients registered under diabetic clinic at hospital U.S.M **,below the age of 50 years and having known disease for more than three years .**

2. Exlusion criteria for the study are as follows ;

(I) All patients with history **of excessive noise exposure.** Example : Asking the patient about his/her working place and noise level at working place, etc.
(ii) All patient with history of following ototoxic drugs usage:

(a) Streptomycin
(b) Gentamycin
(c) Other aminoglycosides (Vancomycin, Kanamycin, Tobromycin, Amikacin)
(d) Ethacrynic acid
(e) Frusemide
(f) Cytotoxic agents
(g) Anticonvulsant drug - Phenytoin
(h) Barbiturates
(i) B - Blockers
(j) Antiheparinizing drugs
(k) Dopamine agonist
(l) Oral cantraceptive usage

Example : History of streptomycin intake should be taken by asking the patient about any history of tuberculosis in the past treated with injections for 1 to 3 months period, similarly history of injection gentamycin intake or other drugs usage by seeing patients previous treatment records.

(iii) History of Head Injury
(iv) Family history of deafness or ear abnormalities
(v) Blindness
(vi) Renal insufficiency - Serum creatnine > 120μ ml /litre
(vii) History of Meningitis
(viii) History of Mumps
(ix) History of Neurological diseases (including diabetic coma)
(x) History of other endocrine and metabolic disorder

3. Explain the patient about the study and get their **consent** in proper consent form.

4. The patient will given ENT appointment with following instructions:

- To come to ENT clinic at 8.30 am, with overnight fasting.
- He/she has to collect and bring 24 hours urine sample in the sterile bottle which will be given to him/her.
- The fasting blood sample for the analysis of various biochemical tests will be collected.
- The ENT examination will be done in clinic.
- The pure tone andiometry will be done on the same day.
- The fundus examination will be done on the same day.

5. The control group will be age and sex matched non diabetic healthy individuals with **similar exlusion criterias** as used for diabetic patients. The following will be the guidelines for them :

- To get consent for the study.
- To come to ENT clinic at 8.30 am with overnight fasting as they have to undergo modified glucose tolerance test.
- Detailed ENT examination as in diabetic patients.
- Detailed pure tone andiometry assessment.
- Detailed fundus examination.

Name :----------
(I/C NO:)

Register Number :----------

Age :----------

Race :----------

Occupation :----------

Height :----------

Weight :----------

BMI :----------

Duration of DM :----------

Type IDDM ☐ NIDDM ☐

HISTORY OF DRUG USAGE

	Yes	No
Streptomycin	☐	☐
Gentamycin	☐	☐
Other aminoglycosides (Vancomycin, Kanamycin, Tobromycin, Amikacin etc)	☐	☐
Ethacrymic acid	☐	☐
Frusemide	☐	☐
Cytotoxic drugs	☐	☐
Anticonvulsant	☐	☐
Barbiturates	☐	☐
B.Blockers	☐	☐
Antiheparizing drugs	☐	☐
Dopamine agonist	☐	☐
Oral contraceptive	☐	☐
Head injury	☐	☐
Family history of deafness or ear abnormalities	☐	☐

	Yes	No
Blindness	☐	☐
Renal insufficiency -Serum creatnine>120μml/litre	☐	☐
History of meningitis	☐	☐
History of mumps	☐	☐
History of neurological diseases	☐	☐
History of other metabolic disorder	☐	☐
TREATMENT INSULIN	☐	☐
Oral hypoglycemic agents	☐	☐
Dibenclamide	☐	☐
Glibenclamide	☐	☐
Gliclazide	☐	☐
Glipizide	☐	☐
Metformin	☐	☐
Combination	☐	☐
OTHER SYSTEMIC CONDITIONS		
Hypertension	☐	☐
Ischemic heart diseases	☐	☐
Nephropathy	☐	☐
Neuropathy	☐	☐
Hypérlipidemia	☐	☐

OTHER MEDICINE SPECIFIED :----------

:----------

:----------

:----------

INVESTIGATION

Blood urea nitrogen :----------

Serum creatnine :----------

Calcium :----------

Phosphate :----------

TG :----------

HDL :----------

LDL :----------

C.peptide :----------

HBA_I :----------

FBS :----------

24 hour urine protein :----------

PREVIOUS HBA_I
Level during last few year

1991

DATE	HBA_I LEVEL

1992

DATE	HBA_I LEVEL

1993

DATE	HBA_I LEVEL

1994

DATE	HBA_I LEVEL

1995

DATE	HBA_I LEVEL

1996

DATE	HBA_I LEVEL

ENT EXAMINATION

EAR	Right	Left
External 1. Normal 2. Abnormal State nature of abnormality----------	☐	☐
Wax 1. Absent 2. Present but not impacted 3. Impacted	☐	☐
Ear discharge 1. Present scanty 2. Present profuse 3. Absent	☐	☐
Tympanic membrane 1. Normal 2. Perforation 3. Abnormal without perforation	☐	☐
Mobility of tympanic membrane 1. Mobile 2. Restricted 3. Non mobile	☐	☐
Tuning fork test Rinnes test 1. Positive 2. Reduced positive 3. Equal 4. Negative 5. False negative	☐	☐
Weber test 1. Not heard 2. Normal 3. Right lateralized 4. Left lateralized	☐	☐
Absolute bone conduction test 1. Normal 2. Reduced	☐	☐

Any other ear finding

THROAT

Oral hygine
1. Good
2. Bad

Tonsils
1. Normal
2. Congested
3. Enlarged
4. Follicles
5. Cheesy material comes on pressure

Pharynx
1. Normal
2. Acute inflammation
3. Chronic inflammation

Post Nasal Examination
1. Normal
2. Post nasal drip
3. Adenoid hypertrophy
4. Adenoid hypertrophy with post nasal drip
5. Not possible

Any other throat problems

NOSE

Anterior rhinoscopy
Right/Left/Both
1. Normal
2. Abnormal

Septum
1. Normal
2. Deviated
3. Spur
4. Spur with deviated

Secretions
Right/Left/Both
1. Absent
2. Watery
3. Mucoid
4. Purulent
5. Mucopurulent

Inferior terbinate
Right/Left/Both
1. Normal
2. Congested
3. Allergic hypertropy

Any other nasal findings

Cervical glands
1. Palpable non tender
2. Tender
3. Non - palpable

Ophthalmic examination of fundus

1. No retinopathy.
2. Background diabetic retinopathy.
3. Pre-proliferative diabetic retinopathy.
4. Proliferative retinopathy (end-stage diabetic eye disease)

Pure tone andiometry result