

Research**Hearing impairment in hemodialysis patients with hypertension and diabetes mellitus type-2**

Nyilo Purnami*, **Nunuk Mardiana****, **Sabrina Izzattisselim***, **Alfarika Rosmalia***,
Makhmudyah Indri Cahyani*

*Departement of Otorhinolaryngology- Head Neck Surgery,

** Departement of Internal Medicine,

Faculty of Medicine Universitas Airlangga / Dr. Soetomo General Hospital
Surabaya

ABSTRACT

Background: Sensorineural hearing loss could occur in chronic kidney disease (CKD) patients undergoing hemodialysis. In general, the frequency of hearing impairment in CKD is connected with age and gender, and with associated disorders such as hypertension and diabetes mellitus. **Purpose:** To find out the incidence of hearing loss (HL) in CKD patients with hypertension and diabetes mellitus who were undergoing hemodialysis, in Dr. Soetomo General Hospital. **Method:** This was an observational descriptive study. Subjects were all CKD patients who were undergoing hemodialysis from June until December 2019 in Dr. Soetomo General Hospital. Subjects were categorized demographically and the hearing impairment was examined with audiometric examination and otoacoustic emission test. **Result:** From 52 samples, there were 31 female and 21 male, with the ratio 1.5:1. The highest age group was in 31-40 years old, and the average was 47 years old. Hemodialysis CKD patients with hypertension were 46 subjects, 14 patients with normal hearing and 32 patients had hearing impairment: mild HL 25 patients, moderate HL 5 patients and moderate-severe 2 patients. Hemodialysis CKD patients with DM type-2 were 12 subjects, 3 patients with normal hearing, and 9 patients had hearing impairment: mild HL 4 patients, moderate HL 4 patients, and moderate-severe HL 1 patient. **Conclusion:** In this study, female hemodialysis patients were more than male, and the highest age group was between 31-40 years old. Hearing impairment in CKD subjects with hypertension were mostly mild HL, while in CKD subjects with DM type-2 were mostly mild and moderate HL.

Keywords: hearing impairment, hypertension, diabetes mellitus Type-2, chronic kidney disease, hemodialysis

ABSTRAK

Latar belakang: Tindakan hemodialisis yang dilakukan pada penderita penyakit ginjal kronis (PGK) dapat menyebabkan gangguan pendengaran tipe sensorineural. Perlu dikembangkan penatalaksanaan gangguan pendengaran terkait hemodialisis. PGK dan gangguan pendengaran secara umum berhubungan dengan usia dan jenis kelamin, serta penyakit yang sering menyertai PGK seperti hipertensi dan diabetes mellitus. **Tujuan:** Mendapatkan angka kejadian gangguan pendengaran pada penderita PGK yang menjalani hemodialisis, dengan disertai hipertensi dan diabetes mellitus (DM) di RSUD. Dr. Soetomo. **Metode:** Disain penelitian ini adalah deskriptif observasional dengan sampel semua penderita PGK yang dilakukan hemodialisis di RSUD Dr Soetomo yang memenuhi kriteria inklusi. Sampel yang diambil berdasarkan data demografi kemudian dilakukan pemeriksaan audiometri dan otoacoustic emission. **Hasil:** Didapati penderita PGK perempuan sebanyak 31 orang dan laki-laki 21 orang, dengan rasio 1,5:1. Kelompok usia terbanyak adalah 31-40 tahun, dan rerata usia penderita 47 tahun. Pasien PGK yang dihemodialisis dengan disertai hipertensi ada 46 subjek, 14 orang tanpa gangguan pendengaran dan 32 orang mengalami gangguan pendengaran: derajat ringan 25 penderita, derajat sedang 5 penderita, dan derajat sedang-berat 2 penderita. Pasien PGK yang dihemodialisis

dengan DM type-2 ada 12 orang: tanpa gangguan pendengaran 3 orang, gangguan pendengaran derajat ringan 4 penderita, derajat sedang 4 penderita, dan derajat sedang-berat 1 penderita. **Kesimpulan:** Penderita PGK jenis kelamin perempuan lebih banyak daripada laki-laki. Kelompok usia terbanyak adalah 31-40 tahun. Sebagian besar pasien PGK dengan HD mengalami gangguan pendengaran derajat ringan. PGK yang disertai hipertensi terbanyak mengalami gangguan pendengaran derajat ringan, sedangkan yang disertai DM yaitu derajat ringan dan derajat sedang.

Kata kunci: gangguan pendengaran, hipertensi, diabetes mellitus tipe 2, penyakit ginjal kronis, hemodialisis

Correspondence address: Dr. Nyilo Purnami dr, Sp.T.H.T-K.L. Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Universitas Airlangga / Dr. Soetomo General Hospital. Jl. Prof. Dr. Moestopo 6-8, Surabaya. Email: nyilo@fk.unair.ac.id. Phone: +62 815-5100-081.

INTRODUCTION

There are three types of hearing impairment, which are conductive hearing loss, sensorineural hearing loss and mixed hearing loss. Sensorineural hearing loss (SNHL) is hearing impairment as the result of damage in the cochlea and the 8th cranial nerve.¹ Sensorineural hearing impairment could happen in subjects who has chronic renal disease (CKD) and undergo hemodialysis (HD) treatment.² Hearing impairment in CKD patient who gets HD could be on high frequency or low frequency.³ Gatland et al.⁴ reported that out of 66 chronic renal failure (CRF) patients with hemodialysis, the incidence of hearing loss was 41% in the low, 15% in the middle and 53% in high frequency range respectively. CKD patients who had undergone three times HD had a higher probability to acquire significant sensorineural hearing impairment.⁵

The contribution of hemodialysis to hearing disorder in CKD is still contradictory. The pathophysiology is still obscure, but there are some theories of similarity between the human cochlea and kidney in the structure, physiological, antigenic and pharmacological aspects.^{5,6} Moreover, the development of the cochlea and kidney was regulated by the same gene.⁵ CKD and hearing impairment has similar characteristic and risk factors, mainly hypertension and diabetes mellitus (DM). With such homogeneity, there is an

assumption that similar impairment happens on the hearing apparatus and the kidney.⁷ Many studies had reported that sensorineural type of hearing loss in CKD patients was concomitant with risk factors of hypertension and diabetes mellitus.⁸

Saeed et al.⁹ reported a positive correlation between the duration of hemodialysis and the onset of hearing impairment. At the beginning of the study out of 45 subjects, 66.1% had SNHL and after 12 months follow up the prevalence rate became 76.3%.

The aim of this study was to find out the characteristic of hearing impairment in CKD patients with hypertension and DM who had to undergo hemodialysis treatment at Dr Soetomo General Hospital.

METHOD

This was a descriptive observational study with cross-sectional design. The subjects were chronic kidney disease patients who had to undergo hemodialysis treatment in Dr Soetomo General Hospital, Surabaya. The study was conducted from June until December 2019. The inclusion criteria were CKD patients 18-60 years of age, and willing to participate in the study by signing the informed consent. The exclusion criteria were CKD patients who had a history of ear disease or noise exposure. The data collection was based on demographic characteristic.

All subjects went through anamnesis and routine ear, nose and throat examination, followed by audiometric and otoacoustic emission (OAE) tests.

This study had fulfilled ethical clearance from ethical committee of Dr. Soetomo General Hospital n0.1246/KEPK/VI/2019.

RESULT

General characteristic

Tabel 1. Gender distribution

Gender	n (%)
Male	21 (40,4%)
Female	31 (59,6%)
Total	52 (100%)

The ratio between female and male subjects were 1.5:1.

Tabel 2. Age distribution

Age group (years)	n (%)
21-30	5 (9.6%)
31-40	21 (40.4%)
41-50	10 (19.2%)
51-60	13 (25%)
61-70	3 (5.8%)
Total	52 (100%)

Mean ± SD 47.33 ± 11,45

The youngest age of CKD with dialysis was 21 years of age and the oldest was 70 years old. The highest number of subjects was between 31-40 years of age, with mean age of 47 years of age and standard deviation of 11.45.

Table 5. Hearing impairment in hemodialyzed CKD patients with hypertension and diabetes mellitus type-2.

Category of Hearing loss	Hypertension			Diabetes Mellitus Type-2		
	Yes	No	Total	Yes	No	Total
Normal	14 (30.4%)	1 (16.7%)	15 (28.8%)	3 (25%)	12 (30%)	15 (28.9%)
Mild	25 (54.3%)	4 (66.7%)	29 (55.8%)	4 (33.3%)	25 (62.5%)	29 (55.8%)

Audiometry and otoacoustic emission examination

The audiometry examination results in this study was assessed based on *pure tone threshold average* (PTA) values, and the degree of hearing loss was determined according to ISO criteria. The hearing threshold based on the results of audiometry could be seen in table 3.

Table 3. Degrees of hearing threshold based on ISO criteria

Hearing threshold	n (%)	Mean
Normal (0-25 dB)	15 (28.8%)	19
Mild (>25-40 dB)	29 (55.8%)	32.2
Moderate(>40-55 dB)	6 (11.5%)	48.9
Moderate severe(>55-70dB)	2 (3.8%)	63.1
Profound (>90dB)	0	0
Total	52	13.75

The result showed that 37 out of 52 patients had hearing impairment (71%), and the highest number was mild HL.

Tabel 4. OAE test result

Category	n (%)
Pass	9 (17.3%)
Refer	36 (69.2%)
Absent emission	7 (13,5 %)
Total	52 (100%)

The result of OAE test revealed that most of the subjects were in refer category. Seven subjects (13.3%) showed absent emission on OAE testing.

Moderate	5 (10.9%)	1 (16.7%)	6 (11.6%)	4 (33.3%)	2 (5%)	6 (11.5%)
Moderate- severe	2 (4.3%)	0 (0%)	2 (3.8%)	1 (8.3%)	1 (2.5%)	2 (3.8%)
Profound	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	46 (100%)	6 (100%)	52 (100%)	12 (100%)	40 (100%)	52 (100%)

Table 5 showed that the highest number of hearing impairment in hemodialysis CKD patients with hypertension was in mild category as many as 25 subjects, and in CKD patients with DM were 2 subjects in mild category and 4 subjects in moderate category.

DISCUSSION

In this research we found the number of female subjects was more than male, with the ratio 1.5:1. This was not in accord with previous researches, which reported that the tendency of CKD patients underwent hemodialysis treatment was male more than female because of occupational factor which was heavier physically and mentally for males, and also the lifestyle factor such as smoking. A smoking person has 2.2 higher risks than the nonsmoker to be candidate of CKD. Besides, men are also more prone to hypertension than women, and chronic hypertension lead to severe glomeruli impairment and tubular atrophy which engender renal failure.¹⁰

The reason why the proportion of female subjects of our study were more than male, might be due to fact that female patients were more tolerant and willing to be involved in the examination procedure. In this study, the youngest patient was 21 years and the oldest 70 years of age. The highest age group was 31-40 years old, consisted of 21 patients (40.4%). Age increase is associated with prognosis of a disease and also life expectancy. Life expectancy of CKD patient in hemodialysis treatment for the age > 60 years old is 0.9%, which is very low.¹⁰

Jamaldeen et al.³ revealed that there was a high prevalence of SNHL in CKD patients. Hearing loss is more obvious in the elderly and patients who had received fewer hemodialysis sessions. Ulfa et al.⁶ found in their study, out of 26 subject on hemodialysis, 8 had SNHL consisted of 7 in low grade and 1 moderate grade.

Gatland et al.⁴ found hearing threshold change following hemodialysis in 31 out of 66 CKD patients. The incidence of hearing loss was 41% in the low, 15% in the middle and 53% in high frequency ranges respectively. Of 62 ears studied, 38% had a decrease in low frequency threshold after dialysis and 9% had an increase. Fluctuation in low frequencies with dialysis is common, and the possible mechanism included treatment induced change in fluid and electrolyte composition of endolymph. Their study showed that the low frequency hearing loss improved significantly after dialysis. On the basis that low tone SNHL is known to be a feature of endolymphatic hydrops and hydrops is influenced by fluid balance, it is possible that endolymphatic hydrops may be part of the pathologic process. Sharma et al.¹¹ reported that out of 52 subjects, 44.73% of the ears had mild SNHL, while 42.11% of the ears had moderate SNHL. The study of Rolim et al.¹² about the impact of DM and systemic arterial hypertension on elderly patients' hearing reported that the mean hearing threshold varied from 29.40 dBHL at 1000 Hz to 38.35 dBHL at 8000 Hz. In this study, we found most of the CKD patients had mild SNHL as many as 29 subjects, with average hearing threshold 32.2 dB.

In this study the result of distortion product otoacoustic emission (DPOAE) examination in CKD patients was 36 as refer (69.2%) and 9 as pass (17.3%). DPOAE examination in hemodialysis CKD patients showed decreasing amplitudes.

El Anwar et al.¹³ found that transient-evoked OAE testing showed absent emission in 20 ears, and those with preserved transient-evoked OAE had significantly lower amplitudes in all frequencies. Renda et al.¹⁴ revealed via DPOAE testing that SNHL was common in the non-dialysis CKD and hemodialysis CKD patients. Cochlear activity was lower in the non-dialysis CKD and hemodialysis CKD regardless of hearing loss. The DPOAE testing could be used to monitor the dynamic changes in the cochlea.^{15,16}

Shared risk factors for hemodialysis in CKD and hearing loss included hypertension and DM type-2, and hypercholesterolemia. Those factors affects the inner ear blood flow which directly caused impairment of oxygen and nutrient transport to the cochlear cells and indirectly on auditory nerve degeneration.^{11,17} Some researches stated that hearing loss, tinnitus, and dizziness have been associated with smoking, hypertension, DM, aging, health history, and leisure activities.^{8,18}

Chronic hypertension causes nephrosclerosis and the longer the hypertension the more severe glomerular injury and tubular atrophy that eventually leads to renal failure.¹⁰ Our study found 25 patients of hemodialysis CKD patients with hypertension had mild HL (54.3%). In this study, according to the result of audiometry examinations there was no correlation between the levels of hearing loss with hypertension.

Diabetes mellitus is a common systemic metabolic disease, associated with multiple macro- and microvascular complications, including thickening of the basal membrane of the stria vascularis capillaries on the lateral wall of the cochlea and other microvascular

and neuropathic changes that could induce hearing loss.¹⁹ Horikawa et al.²⁰ in their study found a significantly higher prevalence of hearing impairment in patients with diabetes compared with that in nondiabetic people. They also stated that DM was associated with the development of bilateral hearing loss. DM patients have a moderately increased risk of future hearing loss.

In our study, the subjects with CKD and DM type-2 were 12 patients, 4 had mild SNHL and 4 moderate SNHL. Chronic ongoing DM lead to severe glomeruli impairment which marked by the decrease of GFR and increased creatinine level.¹⁰ Ulfa et al.⁶ found in their study that there was no correlation between hypertension and DM with the incidence of SNHL, but hemodialysis affect the occurrence of SNHL. Bainbridge et al.²¹ found that in pure tone audiometry examination there were a strong correlation between the decreased of hearing level with DM type-2 with microvascular complication. Dalton et al. quoted by Ulfa⁶ reported that subjects with DM were more likely to have a hearing impairment than subjects without diabetes (59% vs. 44%).

In our study, subjects of hemodialysis CKD patients were more female than male, and the highest age group number was 31-40 years old. Most subjects of hemodialysis CKD had mild SNHL as many as 29 patients. Hearing impairment in hemodialysis CKD patients with hypertension were mostly mild SNHL, while in hemodialysis CKD patients with DM type-2 were mild and moderate HL.

REFERENCE

1. Laurent C, Swanepoel DW. Classifications of Hearing Loss. In: Fagan J, ed. Open Access Guide to Audiology and Hearing Aids for Otolaryngologists. Cape Town: University of Cape Town. 2015. p. 1-4.
2. Lasisi AO, Salako BL, Kodyia MA, Amusat MA, Osisanya WP. Hearing threshold in

- patient with chronic renal failure. *Saudi Med J.* 2007; 28(5): 744-6.
3. Jamaldeen J, Basheer A, Sarma AC, Kandasamy R. Prevalence and patterns of hearing loss among chronic kidney diseases patients undergoing hemodialysis. *Australas Med J.* 2015; 8(2): 41-6.
 4. Gatland, D. et al. Hearing loss in chronic renal failure-hearing threshold changes following haemodialysis. *J R Soc Med.* 199; 84(10): 587-9.
 5. Muyassaroh, Ulfa L. Gangguan Pendengaran sensorineural pada gagal ginjal kronis yang dilakukan hemodialysis. *ORLI.* 2013; 43(2): 163-71.
 6. Ulfa L, Muyassaroh, Naftali Z, Arwanto A, Murbani I. Pengaruh hemodialisis terhadap kejadian kurang pendengaran sensorineural pada penderita gagal ginjal kronik. *MKB.* 2016; 48(2): 98-104.
 7. Vilayur E, Gopinath B, Harris DC, Burlutsky G, McMahan CM, Mitchell P. The Association between reduced GFR and hearing loss: a cross-sectional population-based study. *Am J Kidney Dis.* 2010; 56: 661-9.
 8. Meneses-Barriviera CL, Bazoni JA, Doi MY, Marchiori LLdM. Probable Association of Hearing Loss, Hypertension and Diabetes Mellitus in the Elderly. *Int Arch Otorhinolaryngol.* 2018; 22(4): 337-41.
 9. Saeed HK, Al-Abbasi AM, Al-Maliki SK, Al-Asadi JN. Sensorineural hearing loss in patients with chronic renal failure on hemodialysis in Basrah, Iraq. *Tzu Chi Med J.* 2018; 30(4): 216-20.
 10. Yulianto D, Notobroto HB, Widodo. Analisis ketahanan hidup pasien penyakit ginjal kronis dengan hemodialysis di RSUD Dr. Soetomo Surabaya. *JMK Yayasan RSDS.* 2017; 3(1): 99-112.
 11. Sharma R, Gaur S, Gautam P, Tiwari R, Narain A, Lalchandani T. A study on hearing evaluation in patients of chronic renal failure. *Indian J Otol.* 2011; 17(3): 109-12.
 12. Rolim LP, Samelili AG, Moreira RR, Matas CG, Santos I dS, Bensenor IM, et al. PA. Effects of diabetes mellitus and systemic arterial hypertension on elderly patients' hearing. *Braz J Otorhinolaryngol.* 2018; 84(6): 754-63.
 13. El-Anwar MW, Elsayed H, Khater A, Nada E. Audiological findings in children with chronic renal failure on regular hemodialysis. *Egypt J Otolaryngol.* 2013; 29(3): 182-8.
 14. Renda R, Renda L, Selcuk OT, Eyigor H, Yilmaz MD, Osma U. Cochlear sensitivity in children with chronic kidney disease and end-stage renal disease undergoing hemodialysis. *Intl J Ped Otorhinolaryng ens.* 2015; 79: 2378-83.
 15. Tamae A, Ishizu K, Yoshida T, Kubo K, Matsumoto N, Yasul T, et al. Evaluation of the effects of chronic kidney diseases and hemodialysis on the inner ear using multifrequency tympanometry. *J Int Adv Otol.* 2018; 14(3): 447-50.
 16. Govender SM, Govender CD, Matthews G. Cochlear function in patients with chronic kidney disease. *S Afr J Common Disord.* 2013; 60: 44-9.
 17. Dewi AY, Hikmallah MN, Utami S. Hubungan hipertensi dengan gangguan pendengaran sensorineural pada pasien rawat jalan di Poliklinik THT RSUD Provinsi NTB tahun 2014-2017. *Jurnal Kedokteran.* 2019; 3: 563-9.
 18. Melo JJ, Menses CL, Marchiori LLdM. Prevalence of tinnitus in elderly individuals with and without history of occupational noise exposure. *Int Arch Otorhinolaryngol.* 2012; 16 (2): 222-5.
 19. Kim MB, Zhang Y, Chang Y, Ryu S, Choi Y, Kwon MJ, et al. Diabetes mellitus and the incidence of hearing loss: a cohort study. *Int J Epidemiol.* 2017; 46(2): 717-26.
 20. Horikawa C, Kodama S, Tanaka S, Fujihara K, Hirasawa R, Yachi Y, et al. Diabetes and risk of hearing impairment in adults: a meta-analysis. *J Clin Endocrinol Metab.* 2013; 98(1): 51-8.
 21. Bainbridge KE, Hofman HJ, Cowie CC. Diabetes and hearing in the United States: Audiometric Evidence from the National Health and Nutrition Examination Survey. *Ann Intern Med.* 2008; 149(1): 1-10.