PART IV

COMPLICATIONS OF DIALYSIS TREATMENT

Chairman: Professor R K A Kluthe
Audiometry in Chronic Renal Failure before and after Intermittent Haemodialysis

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Summary
In seven cases, audiometric studies were carried out immediately before and after haemodialysis. Hearing was found to be affected in all cases, and the impairment was particularly significant in higher frequency ranges. Following haemodialysis an average improvement of 20 dB was found for the highest frequencies, and in most cases a narrowing of the bone-air gap was also observed. As the improvement was reflected mainly in serum osmolality, BUN and fluid retention in the post-dialysis stage, it was thought that the mechanism reversing the hearing impairment might be due to these parameters.

Introduction
It has been reported that in cases with chronic renal failure impairment in hearing is also to be noted, in addition to the disturbance of vestibular functions (Wigand et al, 1972; Janczewski et al, 1972). The impairment in hearing in such cases was attributed, at least partially, to the involvement of the spiral organ of Corti. Following renal transplantation in such cases, small changes in the impairment with the improved renal function was reported.

The following study was made in a selected group of cases with chronic renal failure who were subjected to an intermittent haemodialysis programme. The purpose of the study was to investigate any possible changes in the pure-tone audiograms obtained immediately before and after haemodialysis.

MATERIAL AND METHODS
The material studied consisted of seven male patients aged between 16 and 66 yr, shown to have no conduction defect in the hearing system. The duration of renal
failure before admission to the haemodialysis programme was 4 to 24 months
with an average of 12.5 months. The investigation was carried out after an average
period of 12.2 months (range 1–27.5 months) following admission to the dialysis
programme. Dialysis was performed for six hours, twice a week. Audiometric
studies were made in the morning of the day of haemodialysis and were repeated
one hour after the completion of the procedure. Weight controls and assessments
of the serum osmolality, creatinine, Na, K, Cl and BUN were made both before
and after dialysis.

RESULTS

Impairment in hearing in the seven cases studied by pure tone audiometry is shown
in decibels (dB) in Table I. Only bone conduction is presented in the table. Before
the dialysis procedure, hearing is diminished for all the frequencies and particularly
in those of 2048 Hz and over when compared with the levels determined by Leisti
for their age equivalents.

After the haemodialysis procedure, a favourable change in hearing in the higher
frequencies starting from 2048 Hz was noted. The average improvement for 1024
Hz was 9.5 dB, for 2048 Hz, 13.4 dB, for 4096 Hz, 15.8 dB and for 8192 Hz,
19.9 dB.

The bone-air gap varied between 10 and 40 dB in frequencies of 1024 Hz and
over before the dialysis procedure, tended to narrow after the dialysis procedure
and this result was most prominent in cases 1, 2, 3 and 6. (Figures 1 and 2 show
the results for cases 1 and 6.)

Table II shows serum osmolality, Na, K, Cl, Creatinine, BUN and the body
weight of the cases both before and after dialysis. As noted in Table II, most sig-
nificant changes were found to occur in the serum osmolality, creatinine, BUN
and the body weight.

DISCUSSION

Before dialysis all cases showed impaired hearing in the pure tone audiograms
beyond the limits of presbyacusis curves as determined by Leisti for their ages
(Portman and Portman, 1954). The impairment was more significant in higher
frequencies suggesting a cochlear involvement in the first place. Wigand et al,
(1972) reported that in a group of 70 uraemic patients an average hearing loss of
20 dB was found, particularly in the higher frequencies. They also reported that,
following intravenous frusemide, hearing loss increased to 70 dB and suggested
that a possible ionic imbalance of the inner ear fluids might play a precipitating
role.

The hearing impairment found in chronic uraemia may be precipitated by
uraemic toxins or by chemical or physical changes in the inner ear fluids. It is
known that the uraemic state may lead to the destruction of the myelinated sheath
and axons of the medullated fibres in peripheral nerves (de Wardener, 1973). It
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Figure 1. Audiograms of the youngest patient (Case 1, AB). Note diminished hearing thresholds for all frequencies, and widened bone-air gap before the dialysis procedure.

Figure 2. Audiograms of the oldest patient (Case 6, SA). Note complete hearing loss for the higher frequencies.
### Table II. Summary of Data for the Patients Studied

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<th>Case</th>
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<th>Osmolality (mOsm/kg)</th>
<th>BUN (mg/100ml)</th>
<th>Creatinine (mg/100ml)</th>
<th>Na (mEq/l)</th>
<th>K (mEq/l)</th>
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may be relevant that the afferent eighth-nerve fibres acquire a myelin sheath at
the osseous spiral lamina (Donaldson and Miller, 1973). Further, transient in-
crease in hearing impairment after frusemide suggests that chemical or physical
changes in the inner ear fluids may also be responsible either alone or in combina-
tion with the nerve lesions.

Present knowledge of inner ear physiology indicates that there is a definite
difference between the composition of endolymph and perilymph (Rauch, 1963;

The inner ear fluids provide transport nutrients and catabolic products between
blood and hearing cells, provide the proper ionic environment to produce energy
for the perception of sound by the nerves as well as transporting sound vibrat-
ions mechanically, and control pressure distribution within the system (Lawrence,
1973).

It is reasonable to conclude that impairment in renal functions leading to
electrolyte and water imbalance in the rest of the body would show its effects on
the hearing system as well.

Our results show that a high-frequency hearing loss is to be noted in such cases.
As shown in Table I an average improvement of 20 dB in the higher frequencies
was found following haemodialysis. As the patients studied were on a maintenance
dialysis programme no significant change in the electrolyte levels was found before
and after a dialysis procedure (Table II) and the improvement noted may be
attributed to the elimination of uraemic toxins rather than the correction of
electrolyte imbalance.

Another significant change noted in four cases studied (1, 2, 3 and 6) was that
the bone-air gap fell from 10 to 30 dB in the higher frequencies found before
the dialysis procedure to 5 to 10 dB following dialysis (Figures 1 and 2). It is
known that the increase in the gap between bone and air conduction indicates an
impairment in middle ear conduction. The absence of such a defect and the
occurrence of a higher frequency gap suggest a Menière’s type of disease. This is
confirmed by the fact that the gap improved after haemodialysis, which also
caused a significant change in serum osmolality, and a reduction in body water.

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Open Discussion

L GOTLOB (Israel) We know that some diuretics can provoke transient hypokalaemia. Do you think that potassium depletion in the endolymph can induce audiometric changes?

OZEN Some experiments show that the cells of the spiral organ of Corti resemble glomerular cells. So you may be right.

A N OTHER Have you correlated your audiometric changes with other manifestations of uraemic neuropathy like nerve conduction studies. Could this be another kind of neuropathy?

OZEN No we have not. Again you may be correct.

DR KEPPLE (USA) I think this is very interesting work. There are now four different manifestations of central nervous system function each of which can be shown to improve during dialysis therapy. These include changes in EEG, proprioception, time perception, and now audiometry. Perhaps in the future these manifestations will be used to assess the adequacy of different dialyses more carefully.

M G GEOWN (UK) In hyperparathyroidism there is sometimes calcification of the tympanic membrane. Could the changes you have observed be in any way related to this, and have you looked for it? Does it correlate at all with other evidence of renal osteodystrophy?

OZEN First this was limited study of patients who were scrutinised for their middle-ear status and had no middle ear lesions. High frequencies are lost in cochlear lesions, not in the middle ear. We have therefore assumed that the labyrinth is involved.

A AVIRAM (Israel) Did you have the opportunity to examine any patients before they started on dialysis?

OZEN Unfortunately not.