Analysis and opinion on the impact of the hearing and tinnitus treatment of the Cheong-Min clinic.

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1 Introduction

In the recent days there was a high excitement among users in the tinnitus talk forum regarding a treatment for impaired hearing and tinnitus (“the treatment” in the following work) by the South Korean clinic Cheong-Min¹ (“the clinic” in the following work). Multiple users gathered some information about the leading doctor and the treatment. Though some users believe that the treatment is legit, it is still unproven whether it is a hoax or not. Despite this vagueness, the results of the treatment were not considered objectively.

This work tries to shed light on the impact of the treatment and wants to highlight potential dangers. This is accomplished by the analysis of the publicly available before and after pictures of the audiograms of the patients. The analysis uses methods from statistics to derive statements about effectiveness and risk. The work is structured as follows. In chapter 2 the data used for the analysis will be described, in chapter 3 a short enumeration of the used methods and links to Wikipedia is given, chapter 4 contains the overall change in the hearing perception threshold of the patients, chapter 5 shows the impact on single frequencies, chapter 6 gives a correlation of the initial hearing perception threshold to the achieved change in the hearing perception threshold, chapter 7 contains an estimation of potential hearing loss and chapter 8 contains the opinion of the author regard the treatment.

This whole work should be viewed as a personal opinion of the author and is not intended to make any implications about the South Korean clinic Cheong-Min. The name of the clinic is only stated for the sake of the unambiguousness of this work and are not meant for defamation.

2 Description of the data used

This section provides information about the data which was used throughout the analysis.

The analysis used before and after audiograms of the patients of the clinic. Though the audiograms included more information, in this analysis only the frequencies from 0.5khz to 8khz were used. The concrete frequency steps were: 0.5khz, 1khz, 2khz, 3khz, 4khz, 6khz and 8khz.

The data was extracted from the website of the clinic. The website contains a picture gallery with scans or photos from ANSI S3.6-1989 audiograms. The pictures usually show 2 audiograms which were made one week apart. One before the treatment and the other one week after the old audiogram.

The data was extracted from those images by hand looking through all pictures and writing the values from the audiograms into a spreadsheet program. The pictures from the 27.06.2015 (dd.mm.yyyy) to the 12.12.2016 were used for the extraction.

There were 71 images with audiograms from which 70 had data for both ears and 1 had data for only the left ear. This sample was omitted.

It was decided by the author, that regardless of where the treatment was done, only on the left, the right or both ears, all data is used for the analysis: For every patient the audiogram for both ears was extracted and used. This was necessary, because it is not always stated whether the treatment was done in only one ear or in both, and it is not clear or trivial to find out which ear was treated from the data provided through the images. In the opinion of the author this should not negatively affect the analysis because the data from not treated ears should only reduce the effect of the treatment in average.

The extraction of the data led to a total of 140 before and after treatment audiogram samples. This samples consist of 70 audiograms for left and right ears each.

Due to unknown judicial conditions (possible copyright violation) the data is not included in this work. It can be requested by e-mailing to the e-mail address of the author.

3 Methods

To keep this work short this section will not provide the description of the methods used. Instead it will only state Wikipedia links, where the information may be obtained:

• Box plots: https://en.wikipedia.org/wiki/Box_plot
• Significance: https://en.wikipedia.org/wiki/Statistical_significance
• Gaussian distribution: https://en.wikipedia.org/wiki/Normal_distribution
• Correlation: https://en.wikipedia.org/wiki/Correlation_anddependence
4 Change in hearing perception threshold

The change of the hearing perception threshold (HPT) is of main interest as it is one possible reason to undergo the treatment of the clinic. Therefore this section is devoted to the analysis of the change in the HPT that can be observed in the publicly accessible data.

For the analysis of the change of the HPT over the whole dataset the following method was used: For each measured frequency from 0.5kHz to 8kHz the new HPT was divided by the old HPT. The quotient will be called hearing perception threshold quotient (HPTQ) in the rest of this section. In this way, the old HPT is the base value and the HPTQ reports the new HPT in relation to the old HPT. For example, the old HPT was 20db and the new HPT is 10db, then the HPTQ is 0.5. This can be interpreted as follows: The new HPT is the half of the old HPT or 50%, respectively. The other way around a HPTQ with a value of 2.0 or 200% would denote a hearing with a doubled HPT. In the rest of this section the HPTQ is always denoted in percent.

Using this method the quotient could not be calculated in 6 cases, because there was a zero denominator. In each of those cases the old HPT was 0db and the new was 5db. The author decided to define the quotient of those cases as 100%. This induces an error of 0.61% to the analysis given that the decision is not suitable.

![Change of hearing perception threshold](image)

**Figure 1:** Quotient of new HPT and old HPT (HPTQ) per frequency. Lower values denote a better hearing, higher values denote worse hearing.
Figure 1 shows the distribution of the HPTQ for the frequencies from 0.5khz to 8khz. It can be seen that 75% of all values are between 100% and a value smaller than 100%. With down to almost 0% for all frequencies. 25% percent of the values are between 100% and somewhere between 100% and 400% depending on the frequency. The box plot shows that the upper 25% are a widely distributed.

Figure 2 shows a zoomed in part of Figure 1. The y-axis is adjusted for values between 0% and 200%. It can be seen, that the range of HPTQ for the core 50% of the values is getting smaller for higher frequencies. This means, that more values are situated in a smaller band near to 100%.

Figure 2: Quotient of new HPT and old HPT (HPTQ) per frequency. Lower values denote a better hearing, higher values denote worse hearing. Y-axis range is between 0% and 200%.
5 Detailed view on hearing change

The distribution of the HPTQ was shown in the previous section. This section will provide a detailed view on the distribution of the values for each frequency. This is done with the help of scatter diagrams. The x-axis show the Initial HPT and the y-axis shows the change in HPT given in decibel. For example, a dot at \((x,y) = (45, -40)\) means that for that sample the initial HPT was 45db and was changed by -40db by the treatment. The lower bound – meaning the best change for a person – is on the line between \((x,y) = (0, 0)\) and \((x,y) = (100, -100)\). The upper bound – meaning the worst change for a person – is on the line between \((x,y) = (0, 0)\) and \((x,y) = (100, 100)\). The scatter diagrams that will be shown show only one dot for multiple values on the same \((x,y)\)-position. Thus it cannot be seen how many samples are situated at the same \(x,y\)-position.

In the following 8 graphs will be shown. Each graph shows the distribution of the initial HPT and change in HPT for a single frequency.

The scatter diagram in figure 3 shows an almost clear triangle shape between the point \((x,y) = (0,5)\), \((x,y) = (100, -100)\) and \((x,y) = (100, 5)\). This indicates that most of the samples induce at least no HPT change or a negative HPT change.

This triangle shape diffuses for increasing frequencies. This diffusion is weak for the frequencies up to and including 4khz and is strong for the frequencies 6khz and 8khz which can be seen in figures 8 and 9.

What can be not directly seen from the scatter diagrams but only in combination with the box plots of the previous section, most of the values lie in an almost square shape between -15db and +5db for 6khz and between -5db and 5db for 8khz. This indicates that most of the samples induce near no HPT change with a tendency to negative HPT change but are highly scattered with many values with positive HPT.
Figure 3: Scatterplot of the distribution of the initial HPT to the change in HPT for 0.5khz

Figure 4: Scatterplot of the distribution of the initial HPT to the change in HPT for 1kHz
Figure 5: Scatterplot of the distribution of the initial HPT to the change in HPT for 2kHz

Figure 6: Scatterplot of the distribution of the initial HPT to the change in HPT for 3kHz
Figure 7: Scatterplot of the distribution of the initial HPT to the change in HPT for 4khz

Figure 8: Scatterplot of the distribution of the initial HPT to the change in HPT for 6khz
Figure 9: Scatterplot of the distribution of the initial HPT to the change in HPT for 8kHz
6 Correlation of initial hearing perception threshold to change in hearing perception threshold

From the previous section one could see that a treatment resulted in negative HPT change for lower frequencies and ambiguous HPT change for higher frequencies. This sections shows a correlation between the initial HPT and the HPT change over all samples.

Figure 10 shows the correlation of the initial HPT and the HPT change for each frequency. For the frequencies from 0.5hz to 4khz the correlation lies around -0.5 which means that there is a high spread but there is a overall tendency for the initial HPT to get negative HPT change. For 6khz and 8khz the correlation is almost zero which means that the HPT change is almost not related to the initial HPT. This can be interpreted as follows: For lower frequencies the treatment seems to have a positive effect, i.e. lowering the HPT, while for higher frequencies the treatment can result is random which also includes negative effects, i.e. increasing the HPT.
7 Risk of hearing loss

From the scatter diagrams one could observe, that there are positive HPT changes after the treatments. This section provides an estimation about the possibility of hearing loss induced by the treatment.

The following method was used to calculate the possibilities: For each frequency the number of HPT changes with more or equal to +10db were counted. This was so decided because +-5db HPT change is regarded as an error of measurement. The number of those positive HPT changes were divided by the number of samples. This resulted in the raw possibility of hearing worsening (RPHW).

The whole set of samples is affected by random processes. Therefore the RPHW-value was additionally worst-case-normalized with the help of a Gaussian distribution approach. Figure 11 shows a scheme of the approach. The red graph is the Gaussian distribution of data samples with a positive HPT change above 10db. The graph shows the case for the 6khz measurements. 21 out of 140 samples had +10db HPT change or more at that frequency. The peak of the graph is defined by the probability of a sample to have +10db HPT change or more. When the probability is increased we get the blue graph. The probability is increased by an amount so that the original probability is a best-case of the actual blue graph.

Table 1: Data for +10db HPT change. Total amount of samples was 140.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0.5 kHz</th>
<th>1 kHz</th>
<th>2 kHz</th>
<th>3 kHz</th>
<th>4 kHz</th>
<th>6 kHz</th>
<th>8 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of samples with +10db HPT change</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Raw possibility of hearing loss</td>
<td>1.43%</td>
<td>4.29%</td>
<td>2.14%</td>
<td>2.14%</td>
<td>7.14%</td>
<td>15.00%</td>
<td>15.00%</td>
</tr>
<tr>
<td>Worst-case-normalized</td>
<td>4.42%</td>
<td>8.28%</td>
<td>5.44%</td>
<td>5.44%</td>
<td>11.81%</td>
<td>20.87%</td>
<td>20.87%</td>
</tr>
</tbody>
</table>
Table 1 shows the Data which was produces by this approach. The first row shows the different frequencies. The second row shows the number of samples which had +10db HPT change for each frequency. The third row shows the raw probability for this event. And the last row shows the worst-case-normalized probability for +10db HPT change or more.

Figure 12 shows the data in a line chart. It can be seen, that the probabilities to have +10db HPT change or more increases rapidly for the frequencies over 4khz.

![Figure 12: Diagram of the probabilities for +10db HPT change or more. Blue graph shows the raw probability of hearing loss, the pink graph shows the worst-case-normalized probability.](image)
8 Discussion

This section wants to give the authors opinion on the treatment and a starting point for a discussion.

Given that the data, that was extracted from the pictures from the website of the Cheong-Min clinic, was not manipulated, a tendency for an improvement in hearing can be seen in figure 2. Around 75% of all treatments show an improvement. The improvement is high for lower frequencies and little for high frequencies.

The statement of the leading doctor, that the result of a treatment depends on the individual person is highly reflected by the scatter diagrams in chapter 5. One can see, that there are people with very high improvement that almost reverts their hearing impairment for a specific frequency, while other people have almost no improvement.

What can be seen from the scatter diagrams and from figure 12 is, that there is an increasing tendency for higher frequencies to worsen the hearing impairment. With 15% raw and around 20% worst-case probability of a worsening, the risk is high for people with a good hearing in high frequencies to have this treatment performed.

It is very unlikely that the pictures from the Cheong-Min website are manipulated. Manipulated pictures would not contain information about such a high probability of a worsening.

The treatment seems to be advertised to be against tinnitus and hearing loss. In the opinion of the author, the treatment should not be performed against tinnitus, when the patient has a very good hearing in high frequencies, because the risk of having the high frequencies destroyed is high. This could lead to additional tinnitus. For a person with hearing impairment especially for the cases when the high frequencies are highly impaired the possible benefit has more weight than the potential risk.

All in all the treatment has a possible benefit to people with hearing impairment especially when high frequencies are highly impaired. As tinnitus is believed to be related to hearing impairment this could also reduce tinnitus. The risk that hearing is destroyed, that the compounds used are unknown and that the long term effects are unknown should be considered in the decision of taking the treatment or not.