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Moisture removal & contemporary hearing aids

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Introduction

Moisture often represents a significant problem for electronics, transducers, and advanced digital circuitry, such as those found in hearing aids, smartphones, laptops, and other computing devices. Among these devices, only one is designed to reside in a deep, dark, moist cavity with almost no airflow; the custom-made hearing aid and many component products such as deep canal receivers. The hearing aid literature is sparse regarding effective moisture control and hearing aids. Relatively few articles address this topic and we have found none which contain objective measurements or outcomes. Previous reports and studies of white rice, commercially available desiccants, as well as silica gel products have been reported in dry regions of the USA[1] indicating the usefulness of moisture removal. However, we have found little data to support these common-sense solutions, beyond an occasional success story. If hearing aids are accidentally worn in the shower, a pool, or drenched in a rain storm, or has experienced perspiration or other weather events, the advice often repeated is to shake the hearing aids to remove moisture, or perhaps place the hearing aids in a sealed zip-lock bag with a cup of uncooked white rice, or a commercially available hearing aid desiccant to (hopefully) remove moisture. The use of hair dryers and other air blower equipment surfaces here and there. Although moisture removal as part of the standard hearing aid maintenance program is recommended and often employed by Hearing Care Professionals (HCPs) and patients, there are few contemporary reports indicating the actual value and outcomes of specific protocols and we are unaware of large scale, quantitative studies, with objectively measured pre and post measures, subjected to statistical analysis.

Protocol and methods

During the summer of 2024, Redux and the TheHearingMattersPodcast.com sought to engage a few of the busiest hearing aid offices across the USA and Canada to acquire pre- and post-Redux treatment hearing aid test-box measures, to determine the impact of the Redux system regarding loudness measures, total harmonic distortion, and moisture removal. Redux technology (see www.redux.com) combines vacuum-chamber drying with humidity-level measurement to vaporize moisture at the lowest and safest allowable temperature in a moisture-resistant aluminum chamber. The total drying time varies from about 6 to 9 minutes. The test protocol was simply to test all hearing aids in the hearing aid test box, then apply the Redux drying protocol, and then re-test and record all metrics. There were no restrictions as to type of hearing aid or brand, and no patient data was collected. The measures acquired included; HFA SSPL90 (in dB), Overall Gain (in dB), HFA gain (in dB), Total Harmonic Distortion (in %) as the hearing aids arrived in the office as worn, then the hearing aid was to be dried using the Redux professional dryer, and then each parameter was re-assessed and the quantity of moisture removed in microliters was recorded. Of note, one drop of water is approximately 5 microliters. Six hearing care professionals (HCPs) from prominent hearing aid centers across the USA and Canada acquired multiple pre-treatment measures using their hearing aid test box and the professional Redux dryer and the data was recorded on data assessment sheets.

Data collection

Data assessment sheets were gathered and sent to two independent third parties for statistical analysis. T-tests comparing pre- and post-treatment values for HFA SSPL-90 (in dB), Overall Gain (in dB), HFA gain (in dB),Total Harmonic Distortion (in %) and moisture removal were performed The differences across pre and post treatment measures were statistically significant across all four measures, and on average, a drop of water or more was removed from each instrument. Although some 275 hearing aids worn in the real world were enrolled, some were disqualified due to being non-functioning, CROS or BiCROS, or over 15 years old. Some measurement problems (hearing aid test box malfunctions) and protocols were unique and disqualifying as they were less representative of the entire pool. Nonetheless, a substantial amount of data was gathered which appeared reliable and repeatable and is reported here. Data collection and analysis revealed the following:

Factor one: HFA SSPL 90 data from 159 data points:

Pre-Treatment Mean Value: 110.33 dB (SD 6.83 dB)

Post-Treatment Mean Value: 111.44 dB (SD 4.88dB)

Increased output 1.11 dB (increase of roughly 1%)

Statistically Significant at $p < 0.01$

The chance of obtaining these results by chance is less than 1%

Post-treatment the SD decreased indicating tighter clustering around the mean, indicating more consistent results.

Factor two: overall gain from 261 data points:

Pre-Treatment Overall Gain Mean Value: 50.97 dB (SD 12.30 dB)

Post-Treatment Overall Gain Mean Value: 51.80 dB (SD 11.14 dB)

Increased output 0.83 dB (increase of roughly 1%)

Significant at $p < 0.01$

The chance of obtaining these results by chance is less than 1%

Post-treatment the SD decreased indicating tighter clustering around the mean, indicating more consistent results.

Factor three: HFA gain from 261 data points:

Pre-Treatment HFA Gain Mean Value: 37.28 dB (23.09SD dB)

Post-Treatment HFA Gain Mean Value: 38.49 dB (22.68 SD dB)

Increased output 1.21 dB (increase of roughly 2.5%)

Significant at $p < 0.01$

The chance of obtaining these results by chance is less than 1%

Factor four: total harmonic distortion (THD) from 261 data points

Pre-Treatment	1.99% (SD 2.84%)
Post-Treatment	1.36% (SD 1.51%)

Decreased THD roughly by one-third

Significant at $p < 0.001$ The chance of obtaining these results by chance is less than 1 in 1000.

Factor five: moisture removal from 258 data points

As we do not have a total moisture number (pre moisture removal) we cannot perform a t-test, or compare pre and post moisture removal. Nonetheless, on average, from 258 data points, 0.51 microliters of moisture was removed, ranging from a pre-set theoretical minimal value of 0.15 to 5.0. Although "one drop of water" is an in-exact measurement, as drops vary based on water parameters (minerals, metals, pH…), as well as standard temperature and pressure, one drop of water is roughly 0.05 microliters (see https://www.kylesconverter.com/volume/drops-to-microlitres).

Discussion

Keeping moisture out of a hearing aid, or reducing/removing moisture from a hearing aid is an important clinical protocol with statistically significant performance-based outcomes as demonstrated via factors 1, 2, 3 and 4. Importantly, although we do not have data indicating how much longer a hearing aid might serve the patient when moisture is regularly minimized, we believe this would be an area worthy of investigation and the probable benefit would be significant. Another factor which remains unknown is the quantity of repairs per device, per five-year life cycle, attributed to moisture damage, or prevented via regular preventative moisture maintenance.

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Conflicts of interest

Dr. Beck and Mr. Delfino declare The Hearing Matters Podcast and Redux Inc have a corporate partnership. No other Conflicts of Interest are present.

References

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