Phonak Insight

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Lyric™

Lyric3: Combating Feedback

Tips for successfully remediating, and even preventing, feedback

Studies indicate that, with the improved Lyric3 device, the prevalence of feedback requiring intervention is 17%. Feedback can be successfully mitigated (i.e., without adversely affecting overall outcomes) by improving the physical fit of the device, applying a situation-specific solution, or adjusting the fitting settings. The proximity between programmed volume setting and the Maximum Stable Volume (MSV; the highest volume setting that can be achieved without feedback), predicts as much as 75% of the instances of feedback requiring intervention. In order to improve the overall, out-of-the-box experience for Lyric users, it is recommended that clinicians spend a few minutes to assess MSV for each patient, and take steps to address the individual needs, as appropriate.

Introduction

Lyric is a unique hearing solution that created a new, extended-wear hearing device category when it launched to the public in 2007. "Extended wear" means that the device is worn 24 hours a day, 7 days a week for months at a time. Lyric provides amplification for individuals with mild to moderately-severe hearing loss. The deep placement of Lyric in the ear canal is intended to make the device invisible, to require less gain, and to take advantage of the natural acoustic cues provided by the lateral portions of the external ear. Since 2007, Lyric has undergone many major and minor product improvements.

The latest improvement to Lyric3 device, were released in 2015 and features two main enhancements — increased headroom with the addition of a "Maximum" Output Compression Control (OCC) setting, and a less sensitive Giant MagnetoResistive (GMR) switch. These improvements are designed to yield benefits in speech understanding, sound quality and more reliable phone use (Banerjee, 2015).

This paper describes the prevalence of feedback with the improved Lyric3 device, proven techniques for mitigating feedback, and suggestions for preventing feedback at the outset. Most importantly, the goal is to deliver information that readily translates into clinical application.

Facts About Feedback & Lyric

Acoustic feedback occurs when sound leaking out of the ear canal enters the hearing aid microphone and is re-amplified over and over again in an endless loop. This produces a high-pitched squealing or whistling sound, which is often heard by the person wearing the device and sometimes by those around them.

For conventional hearing aids, sound leaks out of the ear canal through the vent as well as through any gaps around the edges of the device or earmold. With Lyric, the leakage may occur due to gaps or folds around the edges of one or both foam flanges. In general, the better the flanges seal off the ear, the lower the likelihood of feedback. This is because the sound leaking out of the ear is attenuated to a greater extent by the physical presence of the device in the ear canal.

Whether or not feedback will occur in a given ear depends on the gain of the device, and not the output. [This is an important point when considering the methods for remediating feedback.] Specifically feedback occurs when the gain of the device is greater than the attenuation provided by the physical presence of the device. As such, the quality of the physical fit of the device in the ear canal becomes increasingly important for persons with higher degrees of hearing loss (which require more gain).

A second condition that must be met in order for feedback to occur in a given ear is that the sound re-entering the microphone must be in the same phase as the original sound. High-frequency sounds have shorter wavelengths, which increases the likelihood of meeting the phase requirement. Combined with the higher gain often needed to compensate for greater high-frequency hearing loss, this explains why feedback is predominantly a high-frequency phenomenon.

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Feedback may occur even if squealing and whistling are not audible. Although not as disruptive as audible feedback, this sub-audible feedback could be more subtly problematic because of its potential to degrade sound quality.

One final note about feedback is that modern digital hearing aids are commonly equipped with feedback cancellation algorithms. These are very effective in reducing the occurrence of feedback, but they also have their limitations and potential side-effects (e.g., Merks et al, 2006). In contrast, Lyric is an analog device with no feedback cancellation capabilities, and must rely only on the attenuation properties of the foam seals and the quality of the physical fit of the device in the ear canal.

Brief Methodology

In the interest of providing the appropriate context for the information presented here, let's start with a brief summary of the methods used to gather the data.

The new, improved Lyric3 device, was validated in 2 studies — one internal and the other external — involving 10 study sites and 13 clinicians. A total 81 individuals participated in the study, wearing Lyric3 for 4-5 weeks each. Study participants included new and experienced Lyric users. The studies utilized a variety of outcome measures. [A description of the study methods and outcomes can be found in Banerjee (2015).]

Of relevance here, are the methods and outcomes related to feedback. The occurrence of feedback during daily Lyric use was reported by study participants. Clinicians determined the need for as well as the specific methods by which to remediate feedback. In addition, for each study participant, clinicians performed an assessment of the feedback risk. [The specific assessment method is described in a subsequent section.] These data were used to determine the prevalence, mitigation and prediction of feedback.

Prevalence

Prevalence refers to the proportion of the population found to have (or experience) a condition. It is computed by comparing the number of people experiencing the condition with the total number of people studied, and can be described as a percentage.

Because of the ear-specific nature of feedback — i.e., its dependence on the physical fit and gain of the device — the prevalence of feedback was calculated on the basis of the number of ears (rather than the number of people) in which it occurred. Stated differently, there were 162 ears (81 people) in which feedback could occur.

As mentioned previously, the occurrence of feedback during daily use was reported by study participants. Clinicians used this information to determine the need for intervention. For example, brief and/or sporadic feedback may be an anomaly that the Lyric user does not find disruptive. In contrast, loud bursts of feedback that occur often and/or at inopportune times can be very frustrating to the Lyric user. While the clinician may do nothing in the first scenario, the second scenario definitely warrants intervention. To determine the number of ears experiencing feedback, only those instances requiring intervention were included in the count. Clinicians received no specific guidance in making this determination; they were free to rely on their clinical judgment as they do in routine practice.

As shown in Figure 1, the prevalence of feedback requiring intervention for the improved Lyric3 device was 17%. Stated differently, about 1 in 6 ears fitted with the new Lyric3 device, required intervention. [The next section addresses the methods of intervention and their success.] There is no doubt that, ideally, we would want no occurrences of feedback requiring intervention. However, even in modern digital hearing aids with feedback cancellation algorithms, the prevalence of feedback is approximately 10% (Banerjee et al, 2006).

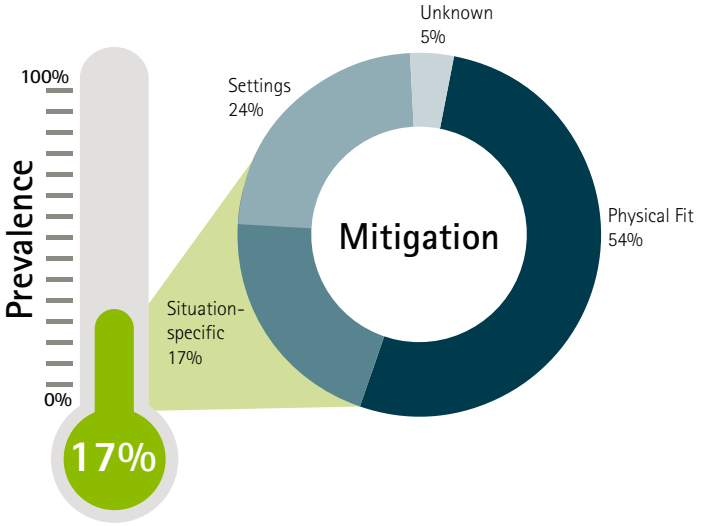

Figure 1: Prevalence of feedback requiring intervention (left) and the distribution of methods used to mitigate feedback (right). Mitigation method unknown for 5% of cases because it was not specified by the clinician.

Mitigation

You will recall that feedback occurs when the gain of the device (especially at high frequencies) is greater than the attenuation provided by the physical presence of the device in the ear canal. It follows, then, that feedback can be mitigated by either decreasing gain or increasing attenuation.

As shown in Figure 1, at 54%, adjusting the physical fit of Lyric3 in the ear canal was by far the most common method for mitigating feedback requiring intervention. The physical fit of the device can be adjusted in several ways:

1. Re-positioning the device in the ear canal for angle and depth of insertion;
2. Re-inserting the device in the ear canal while carefully attending to the trajectory of the "flight path";
3. Applying a lubricant (e.g., glycerin) to the flanges in order to facilitate their adherence to the ear canal wall;
4. Re-sizing to a larger or smaller device size if gaps or folds, respectively, are observed.

These adjustments to the physical fit of the device may be used sequentially (going from 1 to 4, above) or in combination.

Figure 1 also shows that, in 17% of cases, a situation-specific solution was used to mitigate feedback requiring intervention. Specifically, some study participants only experienced feedback when sleeping with the ear against a pillow. If this problem persists even after adjustments to the physical fit, Lyric users could put the offending device into sleep mode in order to avoid feedback when sleeping. Although this did not specifically occur during the validation studies, a situation-specific solution can also be applied for feedback associated with the use of ear buds — i.e., by recommending the use of headphones instead.

Finally, in 24% of cases, mitigation of feedback requiring intervention involved changes to fitting settings (Figure 1). For any fitting, the prescribed gain is intended to ensure audibility while maintaining loudness comfort. As such, decreasing the gain to eliminate feedback is not the most desirable solution. The best and most direct method for decreasing high-frequency gain is to reduce the volume setting, 1 step at a time. If the volume setting must be reduced by several steps in order to eliminate feedback, it may be necessary to compensate for the loss of audibility and loudness by reducing low-frequency cut (LFC; move toward 200 Hz), reducing slope control (SC; move toward "off"), and/or increasing output compression control (OCC; move toward "max"). The exact magnitude of any change in fitting settings will depend on what other changes have been made as well as the preference of the Lyric user.

Our experience with the validation studies suggests that all reports of feedback requiring intervention can be successfully mitigated — i.e., eliminate feedback without compromising fitting outcomes — using one or more of the methods described here.

To summarize, feedback can be mitigated in several ways.

1. The most common and desirable method is to adjust the physical fit of the device, including re-positioning, re-inserting, re-lubricating or re-sizing.
2. A situation-specific solution can be applied under certain circumstances, such as putting the devices in sleep mode or using headphones (rather than ear buds).
3. Volume setting can be reduced, 1 step at a time, as a last resort. It may be necessary to compensate for loss of audibility and loudness by reducing LFC, reducing SC and/or increasing OCC.

Prediction

The ability to successfully mitigate feedback is reassuring from the perspective of ensuring positive outcomes and the ability to troubleshoot potential problems in any fitting. Nonetheless, the fact remains that 1 in 6 ears (or, 1 in 3 patients if all are bilaterally fitted) can be expected to experience feedback that requires intervention. What if you could change this expectation about feedback requiring intervention to approximately 1 in 20 ears (or, 1 in 10 patients)? Would it be worth a few additional minutes of your time in the clinic?

But, first, here's some background. As previously mentioned, during the Lyric3 validation studies, clinicians performed a feedback risk assessment for each fitting (Figure 2). The goal of the assessment was to determine the Maximum Stable Volume (MSV), which is the highest volume setting achievable without feedback. Volume setting is used as a proxy for gain. Starting at the programmed volume setting, clinicians attempted to elicit feedback by having the study participant perform a variety of common actions known to cause feedback — e.g., head and jaw movements, objects (phone, hand) at the ear, and wearing ear buds. This could result in one of two outcomes — no feedback elicited or feedback elicited.

If no feedback was elicited at the programmed volume, clinicians followed the right branch of the flow chart shown in Figure 2. That is, the volume setting was increased, and the actions to elicit feedback were repeated at this higher volume setting. The entire process — increasing the volume setting 1 step, and attempting to elicit feedback — was repeated until feedback was elicited. The MSV was then determined to be 1 volume step below the current setting. When the maximum volume of the device (11) was reached without feedback being elicited (~25% of ears), MSV was noted as 11.

If feedback was elicited at the programmed volume, clinicians followed the left branch of the flow chart (Figure 2).

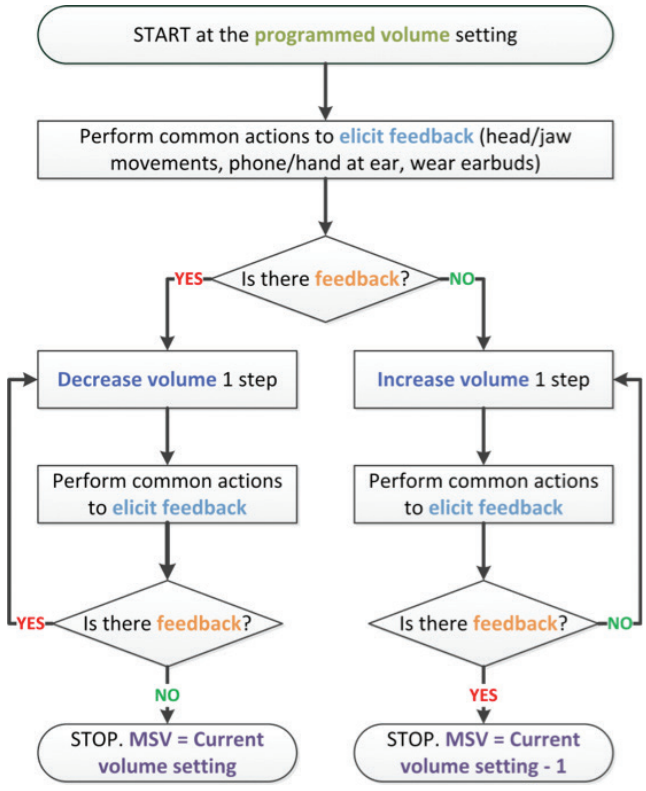

Figure 2: Procedure for conducting a feedback risk assessment in the clinic.

That is, the volume setting was decreased, and the actions to elicit feedback were repeated at this lower volume setting. The entire process – decreasing the volume setting 1 step and attempting to elicit feedback – was repeated until feedback could not be elicited. The MSV was then determined to be the current volume setting.

The feedback test was conducted independently in each ear. For the purposes of the studies, clinicians then returned the devices to the programmed volume and continued with the fitting and fine tuning process as they normally would. Subsequent analysis of the data revealed that, in ~75% of ears that experienced feedback requiring intervention, the programmed volume setting was greater than, equal to, or just 1 volume step below the MSV.

The clinical implication of this finding is that, by spending a few minutes determining the MSV for a patient, it may be possible to reduce the prevalence of feedback requiring intervention to as low as ~5%. For example, consider a situation where the programmed volume is 6 and MSV is found to be 10. Since the MSV is 4 volume steps above the programmed volume, feedback will likely not be an issue. On the other hand, if the programmed volume and MSV are both 6, there is a high likelihood that feedback will occur and require intervention. In this case, the clinician can take the steps previously described to mitigate feedback before the patient experiences it in the field. Alternately, the patient can be forewarned about the possibility of feedback and the steps she/he can take to alleviate it, thereby reducing the shock and frustration of experiencing feedback. Or, the clinician may choose to do nothing if previous experience has shown feedback to not be a concern for the patient.

Another suggestion, offered by a clinician, is to apply MSV as a limit to the range of volume adjustments available to the patient when using the SoundLync™. So, for example, if the programmed volume is 6 and MSV is 8, the upper end of the user-adjustable volume range is set to +1 (i.e., volume 7). This minimizes the likelihood that the patient will inadvertently experience feedback when adjusting the volume.

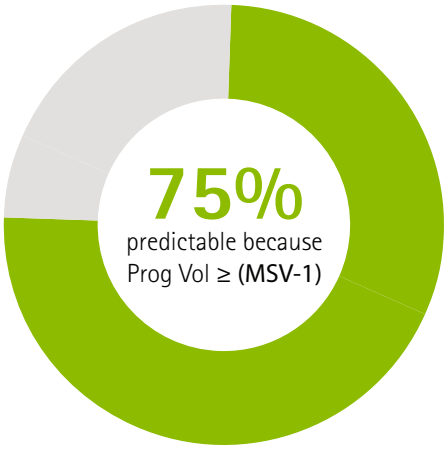

Figure 3: Proportion of feedback requiring intervention that could be predicted based on the Maximum Stable Volume (MSV) for each fitting.

Summary & Conclusion

With the improved Lyric3 device, the prevalence of feedback requiring intervention is 17%. This feedback can be successfully mitigated (i.e., without adversely affecting outcomes) by improving the physical fit of the device, applying a situation-specific solution, or adjusting the fitting settings. The proximity between programmed volume setting and the Maximum Stable Volume (MSV; the highest volume setting that can be achieved without feedback), predicts as much as 75% of the instances of feedback requiring intervention. It is recommended that clinicians spend a few minutes to assess MSV for each patient, and take steps to address the individual needs, as appropriate. In principle, this could reduce the prevalence of feedback requiring intervention to as little as ~5%. More importantly, it would improve the overall, out-of-the-box experience for Lyric users by minimizing the occurrence of feedback and/or better preparing them for when it does occur.

References

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Author & Investigator

Shilpi Banerjee, PhD, studied audiology at Northwestern University, USA. Since completing her PhD, she has had extensive experience in hearing aid research, teaching Audiology, and speaking globally on a variety of topics. In the past year, in her capacity as a consultant to Phonak-Lyric, Shilpi has overseen clinical research on Lyric3.