Accidental falls are a significant health risk for older adults, can often lead to a loss of independence, and frequently shape the course of a person’s later years of life. Previous reports have shown that 40% of individuals who live at home, after reaching the age of 65, will fall at least once each year. The risk of falling has also been shown to be greater among patients who would benefit from treatment in hearing clinics than among their age-matched peers. In fact, a study conducted by Dr. Frank Lin, at John Hopkins University’s Cochlear Center for Hearing and Public Health, identified a 1.4-fold increase in incidence of falls for every 10 decibels (dB) of measured hearing loss.

The Livio® AI Healthable™ hearing aid – the world’s first, ear-level fall detection and alerts system – offers piece of mind in a miniaturized and convenient package. Unlike other fall-detection devices, which hang around the neck or are worn on the wrist, Livio AI benefits from the anatomy and physiology of the human body. During typical, daily activities and instances of falls, muscles in the neck work with the balance system of the inner ear to protect and stabilize the head. Since hearing aids are worn on the head, they are naturally less prone to mistake daily activities for falls than the devices worn on other parts of the body. Instead, head-worn fall-detection devices may be tuned to capture a greater number of falls, while still having a low number of false alarms.

To objectively evaluate the accuracy of Livio AI, a laboratory study was conducted. Participants wore binaural Livio AI hearing aids and the Philips Lifeline® AutoAlert, a pendant-style fall-detection device, during simulated falls and daily activities. The Philips Lifeline® AutoAlert is classified by the U.S. Food and Drug Administration (FDA) as a Class II (Exempt) medical device intended for continuous operation as a personal emergency response system*. The results follow.

METHOD:
Ten young participants each experienced eight types of Falls and Near-falls. The participants also performed eight different types of Activities of Daily Living (ADLs). The conditions each participant undertook are summarized in Table 1. Three trials were acquired for each condition. The fall-detection state of the Livio AI hearing aids and the fall-detection pendant were recorded for each trial. The analysis consisted of 240 falls, 240 near-falls, and 240 ADLs.

The data were collected at the Injury Prevention and Mobility Laboratory at Simon Fraser University. All participants provided written, informed consent, and the experimental protocol was approved by the Research Ethics Board of Simon Fraser University.
Falls

1. Slip forward on moving platform
2. Slip backward on moving platform
3. Trip by ankle tether
4. Incorrect weight transfers due to a misstep
5. Incorrect weight transfer while rising from sitting
6. Incorrect weight transfer while descending from standing
7. Hit or bumped by padded object
8. Loss of consciousness/Collapse

Near-falls

1-8 Same as fall conditions, but the participant was able to recover balance before reaching the ground

ADLs

1. Normal walking
2. Standing quietly
3. Descending from standing to sitting on a chair
4. Descending from standing to lying on the ground
5. Rising from sitting to standing
6. Picking an object up from the ground
7. Ascending stairs
8. Descending stairs

Table 1. Summary of Fall, Near-fall, and Activities of Daily Living (ADLs) trials performed by each participant

RESULTS:

The Livio AI hearing aids were more accurate at detecting falls than the Philips Lifeline AutoAlert fall-detection pendant. Both systems were robust against false-positive detections during activities of daily living. A summary of sensitivity and specificity across all participants and trails is provided in Table 2. A breakdown of sensitivity rate for each type of Fall is provided in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Philips Lifeline AutoAlert</th>
<th>Starkey® Livio AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>True falls detected (Sensitivity rate)</td>
<td>198 (82.5%)</td>
<td>221 (92.1%)</td>
</tr>
<tr>
<td>False positives during Near-Fall trials (Specificity rate)</td>
<td>1 (99.6%)</td>
<td>6 (97.5%)</td>
</tr>
<tr>
<td>False positives during ADLs trials (Specificity rate)</td>
<td>0 (100%)</td>
<td>0 (100%)</td>
</tr>
</tbody>
</table>

Table 2. Sensitivity and specificity rates of Starkey Livio AI hearing aids and Philips Lifeline AutoAlert pendant across all participants and trails. A total of 240 trials took place for each of: Falls, Near-falls, and ADLs.
### Table 3. Breakdown of Starkey Livio AI hearing aids and Philips Lifeline AutoAlert pendant sensitivity during the trials for each fall type. A total of 30 trials took place for each Fall type.

<table>
<thead>
<tr>
<th>Fall type</th>
<th>Philips Lifeline AutoAlert Sensitivity (%)</th>
<th>Starkey Livio AI Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward slip</td>
<td>93.3</td>
<td>96.7</td>
</tr>
<tr>
<td>Forward Slip</td>
<td>53.3</td>
<td>90.0</td>
</tr>
<tr>
<td>Trip</td>
<td>66.7</td>
<td>100</td>
</tr>
<tr>
<td>Incorrect transfer due to misstep</td>
<td>73.3</td>
<td>93.3</td>
</tr>
<tr>
<td>Incorrect transfer during rising from sitting</td>
<td>93.3</td>
<td>93.3</td>
</tr>
<tr>
<td>Incorrect transfer during descending from standing</td>
<td>96.7</td>
<td>90.0</td>
</tr>
<tr>
<td>Hit or bump</td>
<td>86.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Loss of consciousness or lower limb collapse</td>
<td>96.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Mean</td>
<td>82.5</td>
<td>92.1</td>
</tr>
<tr>
<td>Range</td>
<td>53.3 – 96.7</td>
<td>86.7 – 100</td>
</tr>
</tbody>
</table>

**DISCUSSION:**

Both the Philips Lifeline AutoAlert pendant and Starkey Livio AI hearing aids performed perfectly during the Activities in Daily Living in the present study. The Starkey Livio AI hearing aids produced a slightly higher false-positive rate during trials where the participants began to fall but recovered their balance before reaching the ground. The Starkey Livio AI hearing aids were able to detect more of the falls than the Philips Lifeline AutoAlert pendant and were an overall more accurate fall-detection device than the Philips Lifeline AutoAlert pendant.

**CONCLUSION:**

Starkey’s Livio AI* hearing aids detected falls as well as or better than the traditional fall detection device studied.

**REFERENCES**


*Livio AI is not a substitute for emergency services and will not contact emergency services if a fall is detected. Lifeline is a registered trademark of Philips. © 2019 Starkey. All Rights Reserved. 2/19 WTPR2778-00-EE-ST