

# Surgical Hearing Implant Program

Otolaryngology - Head & Neck Surgery

ANNUAL REPORT 2020



© December 2020  
SHIP Annual Report  
Health Sciences Centre  
Shared Health Services  
Manitoba Health, Seniors and Active Living



PEDIATRIC COCHLEAR IMPLANT RECIPIENT – MATHEW S.

# 2020 Annual Report

Surgical Hearing Implant Program



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Manitoba



University  
of Manitoba

REPORT HIGHLIGHTS

## Message from the Director

by Dr. Jordan Hochman – SHIP Director

2020 has been a challenging yet productive year for the Surgical Hearing Implant Program (SHIP). As Covid-19 significantly impacted the surgical output of the program, our team members adapted quickly to ensure patient needs were being addressed; employing new and innovative processes.

Our team successfully pivoted to virtual technologies to ensure patient care. Group information sessions for new candidates were converted to individual counselling opportunities and (re)habilitative services were offered by telehealth.

SHIP continued its academic focus, helping to generate standards for use of rotational magnet technology. The schema developed allowed SHIP to integrate this technology and still maintain surgical volumes. Our student, Azam Davari Dolatabadi graduated with a Master's Degree in Biomechanical Engineering. Her work serves as the basis of many pending publications.



SHIP was the first implant program in Canada to provide a novel bone conduction device to adults and children. Congratulations to Dr. Les Garber!

I would like to formally thank our Program Coordinator, Justyn Pisa, who worked with the surgical team to prepare implant candidates for surgery. He also guided the program through our 3rd Request For Proposal (RFP) process, securing device costs through 2025.

I would also like to acknowledge our patients' for their incredible dignity and understanding during this challenging year.

It's been a difficult year for everyone, but I would like to express my sincere gratitude to our team members at HSC, in the Department of Otolaryngology as well as at our offsite location, the Central Speech & Hearing Clinic for ensuring a very prolific and collaborative year. We look towards 2021 and a bright future!



### Cochlear Implant Summary

A detailed description of cochlear implant surgical production for 2020, including information on program finances, changes in wait times and the current adult waiting list.

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### Bone Anchored Implant Summary

A detailed description of bone anchored implant surgical production for 2020, including information on program finances, changes in wait times and the current adult waiting list.

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# Program Personnel

- Jordan Hochman MD – Adult CI Surgeon
- Darren Leitao MD – Pediatric CI Surgeon
- Les Garber MD – BAHD Surgeon
- Justyn Pisa AuD – Program Coordinator
- Kristy Mackie MSc – Audiologist
- Daniela Stangherlin AuD – Audiologist
- Jacob Sulkers MSc – Audiologist
- Janelle Kent MSc – AV Therapist
- Debbie Brown MSc – AV Therapist
- Kelly Boyd – Clinic Office Manager
- Pam Campbell – ED, Central Speech

## Coordinator Program Summary

by Justyn Pisa AuD, Program Coordinator

The following report will outline the current status of the Surgical Hearing Implant Program (SHIP) of the Department of Otolaryngology – Head & Neck Surgery at Health Sciences Centre (HSC) as of December 31, 2020.

Obviously, Covid-19 has been a catastrophic global event that has impacted SHIP like so many other aspects of society. As the virus quickly changed the landscape for 2020, it forced all of us to quickly adapt in order to navigate the health care crisis with SHIP being no exception.

In Manitoba, we have experienced mask mandates, shifting public health restrictions and elective surgery cancellations. As a result, surgical output for SHIP was negatively affected and estimated adult wait time for surgery is expected to rise in the future.

Despite the challenges presented in 2020, SHIP maintained a productive year with regard to program development, vendor contract negotiations, patient flow improvements and research output.

Additionally, a pediatric referral roadmap was developed for all provincial audiologists to ensure consistency and efficiency in treatment for hearing loss.

Due to Covid-19, SHIP successfully transitioned all speech and language therapy sessions for adult and pediatric implant recipients to virtual/online sessions to ensure consistency of care.

Finally, SHIP also successfully completed a new 5-year contract for medical devices to limit cost increases and secure quality products until the year 2025.

### CI Sound Processor Upgrades

In 2020, a total of **14** pediatric patients were granted **23** cochlear implant sound processor upgrades through the provincial cochlear implant replacement program. This program provides 80% of the cost towards processor upgrades for pediatric recipients every 5 years. Since 2013, the program has processed **58** applications for a total of **62** sound processors.

### Universal Newborn Screening

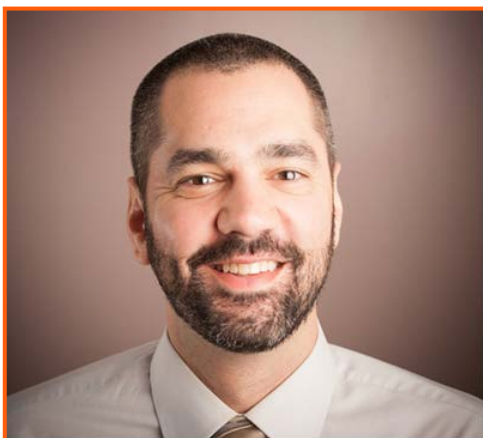
Since 2016, Manitoba's universal newborn hearing screening program has identified a total of **20** potential candidates for cochlear implantation with an average of just over **6** infants per year. To date, **15** of these infants have been implanted under 12 months of age, representing a significant decrease in the average age of implantation for pre-lingually deafened recipients. We look forward to following the progress of this cohort.

### Virtual Therapy Sessions

Covid-19 required SHIP to adapt quickly throughout 2020 and our speech and language therapy sessions were no exception. Our auditory-verbal specialists devised several new ways to deliver therapy to adult and pediatric populations, in an effort to decrease physical contact and adhere to strict healthcare guidelines (see [page 6](#) for more details).

### RFP Contract Negotiations

Over the past 9 years, SHIP has maintained a consistent patient flow and adopted new patient cohorts, despite having a static device budget. This is due to previous negotiations with vendors to ensure the cost of medical devices remains as low as possible. In 2020, SHIP successfully completed negotiations for a new contract, ensuring our patients receive state of the art technology through 2025.



JUSTYN PISA – PROGRAM COORDINATOR

Justyn Pisa is an implant audiologist and has been the coordinator of SHIP since the program was initiated in 2011.

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# Cochlear Implant Summary

by Justyn Pisa AuD, Program Coordinator



Due to Covid-19 and associated elective surgery closures, the Cochlear Implant (CI) Program completed a reduced number of **21** surgeries in 2020 (approximately 50% of capacity). These surgeries included **16** unilateral procedures and **4** bilateral procedures on **14** adult patients and **5** pediatric patients (24 devices total). Since the start of the program, SHIP has implanted a total of **341** cochlear implants on **307** individual patients.

## Wait Times

There are currently **11** patients awaiting trial for audiological candidacy assessment and **30** adult patients awaiting cochlear implant surgery.

Although slightly reduced due to Covid-19, the cochlear implant program continues to generate an average of approximately **3** new surgical candidates per month.

The average surgical wait time was approximately **11.2** months for adult cochlear implant recipients in 2020. This represented an average increase of **0.4** months from the previous year, essentially representing no change from 2019. The average wait time is expected to rise to approximately **16.5** months by the end of 2021 due to elective surgery closures during 2020 due to Covid-19.

## Rotational Magnet Technology

Given the cost management detailed in our [previous publication](#) on rotational magnet technology in 2020, SHIP was able to incorporate this new technology for the majority of implant recipients in 2020. This technological advancement is important as it allows cochlear implant recipients to undergo MRI scans at both 1.5 and 3.0 Tesla without requiring a head wrap procedure or surgery for magnet removal. We are proud to be able to offer this new technology to so many of our implant recipients.

## 2020 RFP Negotiations

Since program inception there has been persistent need to address expanding indications for implantation and the increase in candidacy associated with demographic migration. We have recently completed a five year agreement for primary and secondary vendors for cochlear implants. The new RFP is designed to restrain cost increases and maximize the programs ability to effectively manage adult wait times. Further, limiting cost escalation, allows SHIP to quickly adapt to changes in care and incorporate new patient cohorts into the program.

## Program Promotion

Justyn Pisa, program coordinator, was asked to [present on cochlear implant technology](#) by the national Speech-Language and Audiology Canada (SAC) organization in early December 2020. Justyn took this opportunity to highlight how cochlear implants have improved the lives of Canadian recipients as well as promote the work of SHIP to a national audience of 100 attendees.

The Program was represented with presentations at the American Academy of Otolaryngology Meeting (virtual), Combined Otolaryngology Spring Meeting (San Diego) and at the Canadian Society of Otolaryngology Meeting (virtual). Publications were achieved in Otolaryngology Head and Neck Surgery and Annals of OtoRhinoLaryngology.

## Future Outlook

Covid-19 has required the Program to adapt to sudden and significant change. As a result, SHIP has begun examining more effective ways to service remote populations including virtual (re)habilitative therapy and remote programming. We will continue to enhance this aspect of the program in the coming years.

# 24

## 2020 CI Production

The surgical hearing implant program utilized 24 cochlear implant products on 19 individual patients in the 2020 calendar year. Due to covid-19, this represents a 51% decrease in surgical output from 2019.

# 11.2 mos

## 2020 Average Adult Wait Time

The average adult wait time in 2020 was 11.2 months (+/- 6.1 months). This represents an average increase in wait times by 0.4 months from 2020 which is expected to rise in the coming years due to covid-19.

# 30

## Current Adult Waiting List

The current adult wait list comprises 30 patients. SHIP cleared an average of 2.58 new cochlear implant candidates per month in 2020, with a projected wait list of 40 patients by the start of the next fiscal year in 2021.



# Bone Anchored Implant Summary

by Justyn Pisa AuD, Program Coordinator



The Bone Anchored Implant (BAI) Program completed **8** surgeries in 2020. There were 7 adult cases and 1 pediatric case, all unilateral. Since the start of the program, SHIP has implanted a total of **124** bone anchored implants on **123** individual patients.

## Wait Times

There are currently **7** patients awaiting trial for audiological candidacy assessment and **9** patients awaiting bone anchored implant surgery.

The bone anchored implant program continued to generate an average of **1.1** new surgical candidates per month, essentially stable from previous years.

The current surgical wait time is **9.1** months for bone anchored implant surgery, representing an average decrease of **2.0** months from the previous year. Considering BAI production over the past two years, the overall wait times for adult patients has remained fairly consistent and has not been significantly impacted by the SHIP device budget.

## A New BAI Option

One of the leading bone anchored implant manufacturers released a completely subcutaneous product in 2020 that has the potential to dramatically increase patient satisfaction for our implant recipients. In addition, this product will also drastically reduce the number of post-operative skin infection issues associated with traditional BAI surgeries.

This new type of implant truly represents a novel treatment option for patients with conductive hearing loss. The benefits of this device include actual osseointegration with the skull, ensuring efficient transfer of sound directly to the cochlea.

The system leverages the same 4-mm titanium implant that is used in traditional BAI surgeries, but with an additional receiver-stimulator that drives the bone oscillator beneath the skin.



This allows for a quick, minimally invasive surgery using much of the same hardware, but with dramatic improvement for patients and post-operative wound management.

Since this implant transmits the amplified signal electromagnetically through skin and soft tissue, it does not require an abutment to protrude through the skin for an efficient connection.

This means that patients can experience all of the benefit of a bone anchored implant without sacrificing cosmetics from a traditional abutment-based system. It is our hope that the other bone anchored implant vendors introduce similar technology in the coming years.

## First Implant in Canada

SHIP was proud to be the very first Canadian implant centre to implant this system on both an adult and pediatric patient. To date, SHIP has implanted **4** recipients with this technology with another **4** patients awaiting surgery.

Our clinical audiology team has been impressed with the performance of the device with patients reporting ample volume and clear sound quality. Our surgeon appreciates the familiar surgical procedure and reduction in post-operative care required.

# 8

## 2020 BAI Production

The surgical hearing implant program utilized 8 bone anchored implant products on 8 individual patients in the 2020 calendar year. This production represents a 40% increase in output from 2019.

# 9.1<sub>mos</sub>

## 2020 Average Adult Wait Time

The average adult wait time in 2020 was 9.1 months (+/- 2.8 months). This represents a decrease in the average wait time by 2 months compared to 2019 and represents a positive change in wait times since the program's inception.

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## Current Adult Waiting List

The current adult wait list comprises 9 patients. SHIP cleared an average of 1.1 new bone anchored implant candidates per month in 2020 with a projected wait list of 16 patients by the start of the next fiscal year in 2021.

# Clinician's Corner: *A Challenging Year*

by Kristy Mackie MSc, Implant Audiologist

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### Cochlear Implant Centre Update

As with every sector in healthcare, 2020 has been a different year for the clinicians at Central Speech and Hearing Clinic. Last year at this time we were reflecting on the success of our group information meetings for potential adult cochlear implant candidates while this year we returned to individual meetings for the safety of our patients and staff.

This year has also seen our Listening and Spoken Language Specialists shift the majority of their therapy sessions to virtual platforms. Despite the challenges that this year has presented, the world of hearing implant technology continues to evolve and improve.

Candidacy criteria are also expanding, allowing us to offer this cutting edge technology to more people.

### Expanding Criteria

Unilateral profound hearing loss, also known as single-sided deafness, is a challenge for audiologists to manage as treatment options are limited.

Traditional methods include contralateral routing of signal or CROS hearing aids, and bone anchored implants.

However, newly expanded criteria for cochlear implantation now allow this option to be extended to patients of all ages who fall into this category.

Cochlear implantation is the only treatment method that provides hearing sensation directly to the affected ear, instead of sending sound to the better hearing ear.

This means that there is a better chance of improved hearing in noise, improved sound localization, and for some patients, suppression of debilitating tinnitus.

### Bone Conduction Advancements

One of the bone anchored implant manufacturers released a new implant for conductive and mixed hearing loss this year.

This new implant allows for powerful bone conduction hearing without the use of a percutaneous abutment, greatly reducing the risk of infection.

The few patients who have been implanted in Manitoba with this technology report excellent sound quality and ease of use.

This novel sound processor also offers Bluetooth streaming to compatible smartphones, ranking it among the most sophisticated hearing technology available.



Our audiology implant team has been providing specialized care to all of our recipients since 2010: Kristy Mackie (back left), Daniela Stangherlin (front left), and Jacob Sulkers.

### Future Outlook

While it is largely unknown what 2021 will bring us, we do know that we will continue to offer our patients the latest in hearing technology and provide the highest quality of patient care.

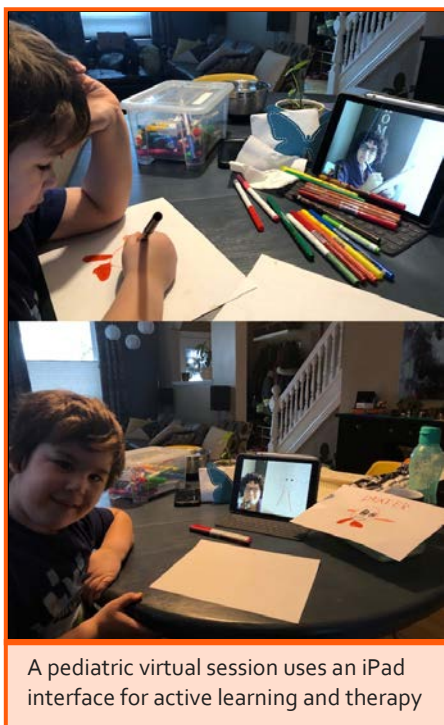
With an entire new line of technology set to be released by our primary cochlear implant vendor, we hope to affect the lives of many people and provide them with the best hearing possible.

# Patient Spotlight: *Virtual Therapy Sessions*

by Janelle Kent M.Sc. CCC-SLP, LSLS Cert. AVT, Level 1 Cert. AST

## Virtual Solutions to Covid-19

Over the past year, COVID-19 has forced the therapists at CSHC to rethink the traditional ways of connecting with clients and families. In order to continue providing listening and spoken language intervention, we had to adapt from our traditional in-person sessions to fully virtual sessions through facetime, skype, zoom, Microsoft teams or Google meets.



A pediatric virtual session uses an iPad interface for active learning and therapy

We now connect with all families over their preferred virtual platform for cochlear implant candidacy sessions, listening and language assessments, individual therapy, team meetings and equipment troubleshooting. These changes have helped us to be more flexible with family schedules, more adaptive to connecting with families in various environments such as their home or workplace and allowed us to support more families over time.

Virtual sessions over the past year have allowed us to continue to provide effective listening and spoken language intervention to our families without

disruptions in service due to current restrictions.

These types of sessions also help us to overcome the negative effects from social distancing and the use of face masks without degrading speech or limiting access to facial expressions and cues which are important for spoken language development.

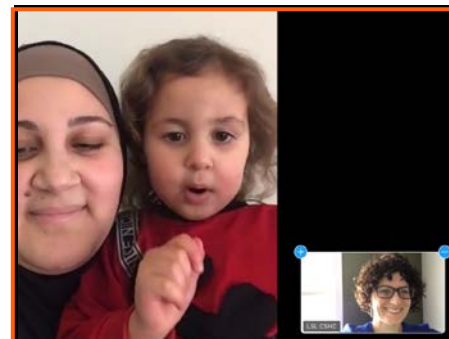
Another benefit from virtual therapy is the increase in parent/caregiver accountability, which not only improves the quality of interactions, but also allows therapists to better tailor guidance and coaching for each and every family.

## Additional Online Supports

Some of the other changes we have implemented this year include organizing online support groups for families and creating pinterest accounts specific to activities, tips and resources related to the needs of children with hearing loss.

We have now also transitioned our Communication Options Program Meetings to monthly virtual meetings over zoom. This allows families to learn about the options for children with hearing loss in Manitoba from any location. We have also expanded our therapy services to support children and families through Jordan's Principle. Families now have more options on how to connect with us throughout the Province.

Despite the many benefits to virtual therapy, it does not replace the importance of in-person connections. As a result, we are looking forward to the day when we can see families again for in-person meetings and therapy; however virtual sessions may continue to be an integral part of our therapy regimen as we move forward, especially for those in more remote areas of the Province.



A pediatric patient receives 1:1 virtual therapy from Janelle via Zoom call

## Virtual Therapy for Adults

The transition to virtual and online services is also very exciting for our adult population, as recipients now have access to therapy that provides them with guidance and coaching similar to the support we provide our children with cochlear implants. Last summer, I was proud to be part of a class of international clinicians who became the first in the world to receive certification in Level 1 Auditory Skills Training (AST).

AST is a type of aural rehabilitation that follows nine guiding principles with the goals of facilitating healthy auditory brain change and auditory skills development following cochlear implantation. Adults are supported with real voice, in real time within real life. Since the beginning of the certification training, four adults have been supported with AST with excellent feedback received from both the patients and their audiologists.

AST helps clients to manage their expectations, improve their self-confidence, understand their strengths and weaknesses, learn strategies to use in their everyday, and improves their ability to communicate their needs to the audiologist. I hope that as we move ahead, I can continue to connect with more adults with cochlear implants and their families through AST.



# SHIP Research Production

by Justyn Pisa AuD, Program Coordinator

## Presentations

Hochman J., Unger B., Kraut J., Hombach-Klonish S. **Gesture-Controlled Three Dimensional Anatomy: A Novel Teaching Tool in Head and Neck Surgery.** American Academy of Otolaryngology Annual Meeting. Washington DC. September 2012.

Kraut J, Hochman JB, and Unger B. 2013. **Temporal bone surgical simulation employing a multicore architecture.** Proceedings of 2013 26th Annual IEEE Canadian Conference on Electrical and Computer Engineering (CCECE – Regina, SK) pp. 1–6.

Wong D, Hochman J, Unger B, Kraut J. **Face and Content Validation of a Rapid Prototyped Temporal Bone Model.** Presented at the 2013 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, June 2-4. Banff, AB.

Wong D, Hochman J, Unger B, Kraut J. **Soft Tissue Modeling in Temporal Bone Simulation.** Presented at the 2013 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, June 2-4. Banff, AB.

Wong D, Hochman J, Unger B, Kraut J. **Controlled Interactive Three Dimensional Anatomy: A Novel Teaching Tool in Head and Neck Surgery.** Presented at the 2013 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, June 2-4. Banff, AB.

Le T., Leitao D., Hochman J. **Hair Barrette Induced Cochlear Implant Receiver Stimulator Site Infection with Extrusion.** Canadian Society of Otolaryngology, Banff AB, June 2013.

Kraut J., Unger B., Hochman J. **Temporal Bone Surgical Simulation Employing A Multicore Architecture.** Canadian Conference on Electrical and Computer Engineering, Regina SK, June 2013.

Unger B, Kraut J, Hochman JB. **A Novel Rapid Prototyped Temporal Bone Model for Surgical Dissection.** American Academy of Otolaryngology Annual Meeting. Vancouver BC. Sept. 2013.

Unger B., Kraut J., Hochman J. **Comparison of Isomorphic 3D Printed and Virtual Haptic Temporal Bone Simulation in Education.** Simulation Summit, RCPSC, Vancouver BC, Nov. 2013.

Wong D., Kraut J., Unger B., Hochman JB. **Comparison of Isomorphic 3D printed and Virtual Haptic Temporal Bone Simulation.** Canadian Society of Otolaryngology (CSO), Ottawa ON, May 2014.

Wong D, Unger B, Kraut J, Hochman J. **Comparison of Cadaveric and Isomorphic Virtual Haptic Simulation in Temporal Bone Education.** Presented at the 2014 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, May 11-13. Ottawa, ON.

Bertram J. Unger, Kraut J, Hochman J. **Design and Validation of 3D Printed Complex Models with Internal Anatomic Fidelity for Training and Rehearsal.** Medicine Meets Virtual Reality. Manhattan Beach CA. Feb 2014.

Hochman J, Rampersad V, Sepehri N, Kraut J, Pisa J, Unger B. **Import of Haptic Manipulandum & Device Fidelity on Expert User Perception in Virtual Temporal Bone Surgery.** Presented at 2015 Annual Combined Otolaryngology Spring Meetings (COSM) April 22-25; Boston, MA.

Hochman J., Kraut J., Pisa J., Rhodes C., Unger B. **Comparison of Anatomically Matched 3D Printed and Virtual Haptic Temporal Bone Simulation.** Combined Otolaryngology Spring Meeting COSM, May 2014, Las Vegas, NV.

Hochman J, Tordon B, Unger B, Pisa J. **Importance of Stereoscopy in Haptic Simulation for Temporal Bone Surgical Training.** Presented at the 2015 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, June 6-9. Winnipeg, MB.

Hochman J, Rampersad V, Sepehri N, Unger B, Pisa J. **Import of Haptic Manipulandum and Device Fidelity on Expert User Perception in Virtual Temporal Bone Surgery.** Presented at the 2015 Annual Canadian Society of Otolaryngology - Head & Neck Surgery Meeting, June 6-9. Winnipeg, MB.

Moore P., Hochman J., Blakley B. **Vestibular Hypofunction as an Indicator of Lateral Skullbase Pathology.** Canadian Society of Otolaryngology (CSO), Winnipeg Canada, June 2015.

Pisa J, Sulkers J, Butler J, West M, Hochman J. **Impact of Stereotactic Radiosurgery on Cochlear Implant Performance in Patients with Neurofibromatosis Type II.** Presented at the 2016 Annual American Cochlear Implant Alliance Conference. May 11-14, Toronto, ON.

Hochman J, Unger B, Pisa J, Fliker A. **Mixed Reality Simulation.** Presented at 2017 Annual AAO – HNSF Meeting & OTO Experience. September. Chicago, IL.

Kazmerik K, Unger B, Pisa J, Hochman J. **Evaluation of Trainee Drill Motion Patterns during Temporal Bone Simulation with 3D Printed Models.** Presented at 2017 Annual Combined Otolaryngology Spring Meetings (COSM) April 26-30; San Diego, CA.



Unger, B. Tordon, B., Pisa J., Hochman J. **Importance of Stereoscopy in Haptic Training of Novice Temporal Bone Surgery.** Medicine Meets Virtual Reality. Los Angeles CA, April 2016.

Kazmerik K, Pisa J, Gentile L, Unger B, Hochman J. **Comparison of Drill Technique; Cadaveric and Printed Temporal Bone.** Presented at 2017 Annual Combined Otolaryngology Spring Meetings (COSM) April 26-30; San Diego, CA.

Gousseau M, Unger B, Pisa J, Mowat S, Westerberg B, Hochman J. **Validation of Novel Temporal Bone Dissection Scale.** Presented at 2017 Annual Combined Otolaryngology Spring Meetings (COSM) April 26-30; San Diego, CA.

Sulkers J, Mackie K., Stangherlin D., Pisa J., Hochman J. **Cochlear Implant Benefit by Age: Comparing Speech Perception Outcomes in Adults Implanted Prior to and After Seventy.** ACI International Cochlear Implant Conference, Toronto ON, May 2016.

Hochman J., Pisa J., Rampersad V., Unger B., Sepehri N. **The Effect of Haptic Force Resolution in Virtual Temporal Bone Surgery.** American Academy of Otolaryngology Annual Meeting. San Diego. Sept. 2016.

Kazmerik K, Pisa J, Gentile L, Unger B, Hochman J. **Printed Bone Hand Motion Analysis.** Presented at 2017 Annual National Medical Students Research Forum. April. Galveston, TX.

Dolatbadi A.D., Hochman J., Mousavi Z., Unger B. **Automated Assessment of Temporal Bone Surgical Simulation Employing an Improved Model of Bone-Drilling Force Feed Back.** EuroHaptics. Pisa Italy. May 2018.

Wong V., Pisa J., Unger B., Hochman J. **Construct Validation of a Printed Bone Substitute in Otolologic Education.** Canadian Society of Otolaryngology Meeting, Quebec City Quebec. June 2018.

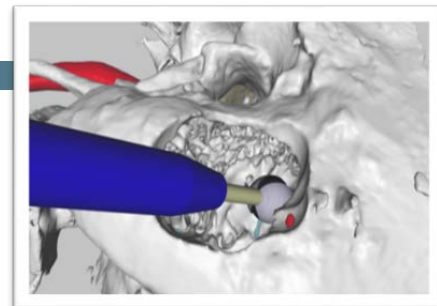
Gigiotti D., Blakley B., Moore P., Hochman J. **MRI is not Indicated in the Management of Isolated Vestibular Weakness.** Canadian Society of Otolaryngology Meeting, Quebec City Quebec. June 2018.

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Pisa J. **Hearing Health Care: An Investment in the Future.** Presented for the Faculty of Medicine, University of Manitoba. Winnipeg, Manitoba. October, 2018.

# SHIP Research Production

by Justyn Pisa AuD, Program Coordinator



Singh S, Pisa J, Unger B, Hochman J. **Distinct Temporal Bone Dissection Scales Demonstrate Equivalence in Distinguishing Trainee Performance.** Presented at 2019 Annual Combined Otolaryngology Spring Meetings (COSM) May 1-5; Austin, TX.

Wong, V, Pisa J, Hochman J. **Construct Validation of a Printed Bone Substitute in Otolologic Education.** Presented at 2019 Annual Combined Otolaryngology Spring Meetings (COSM) May 1-5; Austin, TX..

Pisa J. **Bone Conduction Hearing Devices – Practice and Pitfalls from a Canadian Implant Centre.** Presented at 2019 Annual Conference for the Canadian Academy of Audiology (CAA). October 26-30; Halifax NS.

Davari, A. **Automated Assessment of Trainee Temporal Bone Surgical Skill Employing Simulated Surgery.** Presented for Thesis Defense, Faculty of Medicine, University of Manitoba. November 2019; Winnipeg, MB.

Andrews C, Hochman J, Pisa J. **Rationing Rotational Magnet Cochlear Implant Technology in a Single Payer Healthcare System.** Presented at the Combined Sections Meetings, Triological Society. January 2020; Coronado, CA.

Singh S, Pisa J, Unger B, Blakley B, Leitao D, Jones J, Hochman J. **Comparison of Summative Temporal Bone Dissection Scales Demonstrate Equivalence.** Presented at AAO-HNSF 2019 Annual Meeting & OTO Experience, September 15-18; New Orleans, LA.

Pisa J. **Cochlear Implantation in Canada: Current Status and Future Outlook.** Presented at 2020 Annual Conference for Speech-Language and Audiology Canada (SAC). December 2020 - Virtual

## Peer-Reviewed Publications

Forzley B, Chen J, Nedzelski J, Lin V, Shipp D, Godlovitch G, Hebert P, Hochman J. **Considerations of Candidacy for Bilateral Cochlear Single Payer Universal Health Care System.** Laryngoscope. 2013 Dec;123(12):3137-40.

Kraut J., Unger B., Hochman J. **Temporal Bone Surgical Simulation Employing A Multicore Architecture.** Electrical and Computer Engineering, 2013 26th Annual IEEE Conference. 10.1109/CCECE.2013.6567771, Page1-6.

Unger B., Kraut J., Hochman JB. **Method and System For Rapid Prototyping Of Complex Structures.** United States Patent and Trademark

Unger BJ, Kraut J, Rhodes C, Hochman J. **Design and Validation of 3D Printed Complex Bone Models with Internal Anatomic Fidelity for Surgical Training and Rehearsal.** Stud Health Technol Inform. 2014;196:439-45.

Hochman JB, Kraut J, Kazmerik K, Unger BJ. **Mixed reality temporal bone surgical dissector: mechanical design.** Otolaryngol Head Neck Surg. 2014 Mar;150(3):448-54.

Wong D, Unger B, Kraut J, Pisa J, Rhodes C, Hochman JB. **Comparison of cadaveric and isomorphic virtual haptic simulation in temporal bone training.** J Otolaryngol Head Neck Surg. 2014 Oct 13;43:31.

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