# The Hospital For Sick Children

## OtoSim™ Lab

### Paolo Campisi, Vito Forte

OtoSim™ has enjoyed another successful year thanks to the ongoing efforts of its team members and collaborators. Dr. Vito Forte is the acting CEO and lead of the 'Hammers and Nails' program at the Hospital for Sick Children. This has resulted in a successful collaborative team with engineering students.

Product development remains a key component of OtoSim Inc. such as the introduction of advanced self-learning software and remote teaching capabilities. Modified simulators that can be applied to smart phones are currently in development and will be piloted in an education study funded by a Harry Barberian Scholarship.

A list of recent and current projects includes:

Objective Evaluation of Otoscopy Skills amongst Primary Care and Otolaryngology Residents. Poster Presentation, Canadian Society of Otolaryngology – Head & Neck Surgery Annual Meeting. Charlottetown, PEI, Canada. Presenter(s): Oyewumi M, Brandt MG, Carrillo B, Atkinson A, Iglar K, Forte V, Campisi P. ***Awarded 2nd prize for the Poster Competition.

Evaluation of an ophthalmoscopy simulator to teach normative anatomy and fundoscopy skills to paediatric residents. To be presented at the International Conference on Medical Education. September 2016, Niagara Falls, Ontario, Canada. Presenter(s): Kouzmitcheva E, Ali A, Carrillo B, Atkinson A, Forte V, Campisi P, Grover S, Berenbaum T, Yeh EA.

## Pediatric Voice & Airway Research Lab

### Paolo Campisi, Vito Forte, Evan Propst

The Paediatric Voice Laboratory has been involved in various voice outcomes-based research studies. The laboratory collaborates with Jennifer Allegro and Laurie Russell, speech-language pathologists and Kim Simpson, research nurse. Recent and ongoing projects include:

Voice therapy for the management of vocal fold nodules in children. This was a multi-centre (Toronto, Boston, Milwaukee, and Philadelphia) randomized-controlled trial comparing two types of voice therapy. The data collection is complete and the study is being prepared for publication. This study was funded by an NIH grant.

Canadian JoRRP surveillance study. Data collection for the 2012-2017 time frame will be initiated this year. The national prevalence and incidence of JoRRP 10 years after the introduction of HPV vaccination strategies will be assessed.

## Cochlear Implant Research Lab

### Karen Gordon, Blake Papsin

The Cochlear Implant Laboratory at the Hospital for Sick Children continues to investigate auditory development and plasticity. We ask: 1) What aspects of auditory and vestibular development are arrested in children with hearing loss; 2) What changes in the auditory and vestibular system occur during the period of deafness; and 3) To what extent can auditory and vestibular plasticity and development be promoted by cochlear implant use? We are also interested in innovations in cochlear implant design and programming which seek to improve the resilience of the device as well as to preserve residual hearing and binaural cues. Our work is supported by research funding from the Canadian Institutes of Health Research along with the Cochlear Americas Chair in Auditory Development and generous donations. Specific hypotheses which stem from these questions are tested through a number of studies currently underway.

Our team includes Carmen McKnight, our research project manager, and we recently welcomed Christina Lavallee, our new research project co-

ordinator. Dr. Hiroshi Yamazaki completed his fellowship in February 2016, Joshua Gnanasegaram is preparing to defend his M.Sc. thesis in late July 2016 and Dr. Vijayalakshmi Easwar is expected to complete her post-doctoral fellowship at the end of this summer.

Dr. Yamazaki worked with Dr. Easwar to explore hemispheric differences in responses to tone bursts and clicks presented monaurally and binaurally to children and adolescents with normal hearing. Importantly, tonal stimulation showed increased responses in the right auditory cortex than broad band clicks in young children. Decreases in tone burst evoked peak activity occurred with age in the left but not right auditory cortex, suggesting increased role for the right hemisphere in processing tone bursts throughout childhood and adolescence. These results were most recently presented at the 14th International conference on cochlear implants and other implantable technologies, Toronto, Canada, May 11-14, 2016.

Dr. Easwar is a clinical audiologist. During her post-doctoral fellowship in the lab, she compared responses to click stimuli in children with normal hearing to children who received bilateral cochlear implants simultaneously at young ages. Main results demonstrated the preservation of right hemispheric dominance as found in the normal hearing peer group but several abnormalities in cortical processing were also revealed: 1) reduced contrasts between unilaterally and bilaterally presented stimuli; 2) reduced contralateral aural preference; and 3) reduced change in cortical activity with changes in binaural timing or level cues. These data are in preparation for publication. Dr. Easwar also used the datalogging capabilities of recent cochlear implant speech processors to assess children's listening environments. She found that children are in noisy environments daily and for longer than adults. They are also exposed to music most frequently in their early years. She has also explored the role of listening exposure to speech perception outcomes. These results were published earlier this year and were also most recently presented at the 14th International conference on cochlear implants and other implantable technologies, Toronto, Canada, May 11-14, 2016.

Joshua Gnanasegaram has worked in collaboration with Dr. Sharon Cushing, and with present otolaryngology fellow, Dr. William Parkes, to investigate whether the vestibular system can be evoked by electrical stimulation from a cochlear implant in children. Results have been encouraging, revealing evoked responses in a proportion of children with and without residual vestibular function and improved perception of vertical with cochlear implant stimulation. Both Dr. Parkes and Mr. Gnanasegaram have been able to present this work at international conferences. A manuscript outlining the results at this stage is being prepared for publication.

Melissa Polonenko, a clinical audiologist, continued to make great gains in her PhD thesis work. She is studying the use of bimodal hearing (acoustic hearing in one ear and electrical hearing through a cochlear implant in the other). She has received an impressive 10 major studentship awards. Over the past year, she received the Ontario Student Graduate Award as well as the prestigious SickKids Scientist-Training Program Award. Most recently, her abstract was chosen for podium presentation at the Gordon Research Seminar.

We have enjoyed the opportunity to work with 4 summer students: Joshua Baitz (innovative recording of vestibular myogenic responses); Hayley Wilson (cortical activity in unilateral deafness); Mark Sandor and Jonah Gorodensky (binaural hearing in children with hearing loss). We continue to have important collaborations both locally, with Robert Harrison, Sharon Cushing, Adrian James, Sam Doesburg, James Rutka, Sandra Trehub, Susan Blaser, and Frank Russo, nationally, with Sam Doesburg and internationally, with Robert Cowan and Richard van Hoesel.

The past year has been very productive: 11 publications came out or are in the press. Between this summer and last, we collectively presented over 20 abstracts at international meetings and gave more than two dozen invited talks internationally.

Some highlights from the past year include: Invited talk at the Gordon Research Conference (Gordon); 6 presentations at 14th International conference on cochlear implants and other implantable

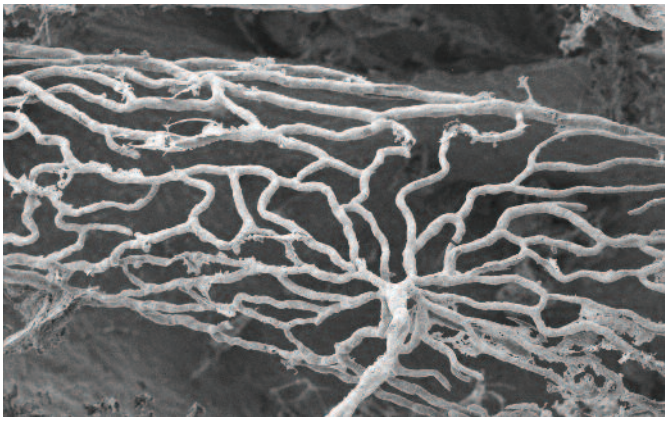
technologies, Toronto, Canada; 11 student awards (Polonenko, Easwar, Gnanasegaram, McCann); 2nd Cochlear Americas Chair (Gordon).

## Auditory Science Lab
### Robert V. Harrison

The Auditory Science Laboratory has been associated with the university Department of Otolaryngology-Head & Neck Surgery over three decades. Our mission is to increase our knowledge about the complex biological mechanisms that allow us to hear and to understand the exact nature of hearing deficits. This new knowledge may lead to improved strategies for prevention, diagnosis and remediation of hearing disorders.

We use a wide range of research tools to explore the structure and function of the pathological inner ear, as well as the developmental plasticity of the auditory brain. Our electrophysiological techniques include measurement of single neuron response properties in auditory midbrain and cortex. We also use evoked potential and otoacoustic emission research in human subjects and in animal models.

In our anatomical studies, we make histological evaluations of the inner ear with light and electron microscopy. In recent years we have mastered corrosion cast studies of vascular structures in the inner ear. Note the image below of the cochlear vasculature in a mouse model. We make extensive use of immuno-labeling techniques to visualize cochlear structures and toe assess neural activity patterns in central auditory pathways.



*Capillary network of the mouse cochlear stria vascularis (scanning electron image of a corrosion cast specimen).*

A continuing research interest over the past year has been an investigation of the damage to cochlear capillary networks (e.g. stria vascularis) resulting from cytomegalovirus (CMV) infection. This work is part of thesis research by our PhD candidate Mattia Carraro, and our project is in collaboration with Dr. Albert Park at the University of Utah. Mattia's work was supported in part by a Barberian scholarship award. Mattia has also introduced some novel imaging techniques, including laser thin sheet microscopy, and has refined the method to allow whole cochlear specimens (mouse) to be viewed in detail without bone removal. In the examples shown below individual spiral ganglion cells, cochlear vasculature can easily be recognized.

This past year has also been productive for our project manager Jaina Negandhi. She has been working on projects ranging from recording ABRs in animal models as well as studying auditory midbrain activity patterns with c-fos labeling.

In this last year, our research has resulted in publication of a number of peer-reviewed papers ranging from studies of cochlear vasculature in animal models of hearing loss, to a review of cochlear implant patients diagnosed with auditory neuropathy spectrum disorder (ANSD). Harrison has also contributed to the latest edition of The Comprehensive Handbook of Pediatric Audiology (Plural Publishing).

A sincere thank you to all those associated with the Auditory Science Laboratory; we have had a productive year.