BIOGRAPHICAL SKETCH

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NAME: Peter Luke Santa Maria

eRA COMMONS USER NAME (credential, e.g., agency login): SANTAMARIA.PETER

POSITION TITLE: Assistant Professor, Otolaryngology Head & Neck Surgery Stanford University School of Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Stanford University, Stanford, USA	Instructorship	07/12-06/15	Otology and Neurotology
Sir Charles Gairdner Hospital, Perth, Western Australia	Fellowship	11/11-06/12	Otology and Neurotology
Royal Australian College of Surgeons, Perth, Western Australia	Residency	01/06-11/11	Otolaryngology, Head and Neck Surgery
University of Western Australia,Perth, Western Australia	PhD	01/06-03/12	Medicine / Surgery
Royal Australian College of Surgeons Western Australia, Perth, Western Australia		01/03-12/05	Basic Surgical Training
University of Western Australia, Perth, Western Australia	MBBS	01/96-01/02	Medicine / Surgery

A. Personal Statement

I am an early career clinician scientist and I have dedicated my career to helping those with hearing loss. As part of my clinical practice in otology, including through outreach clinics to the indigenous children of northern Australia, I experience firsthand the clinical implications of tympanic perforation and otitis media. This compelled me to find a way to help patients through my clinical practice and scientific research. I began by developing a foundation to do this by completing a combined Otolaryngology Residency and PhD in Australia. I then concentrated my research efforts around tympanic membrane wound healing and middle ear inflammatory conditions. After an initial three years at Stanford, I returned to Australia. I found that without any protected time and a lack of support for research it was very difficult to maintain this research pathway. I made the decision to return to Stanford University where I was most likely to succeed in making a difference to these patients. I now have at least 50% protected research time and am provided with an ideal environment to help me achieve success. This includes the ability to collaborate with Dr Paul Bollyky (expert in pseudomonas biofilms) and Dr Peter Yang (expert in drug delivery) to drive my research into chronic suppurative otitis media using a novel animal model I created. I learnt the process of translating discoveries to the clinic at Stanford SPARK and through my work with them, and through launching a SPARK program in Perth, Australia, I've been able to help other researchers translate their ideas. My own work in tympanic wound healing includes a regenerative treatment that has been licensed to Astellas Pharmaceuticals. I now hope to take my chronic suppurative otitis media model and my understanding of healing and inflammation in the middle ear to identify and potential curative therapeutics. This record in translation and my new efforts in animal models are highlighted through the following publications:

1. **Santa Maria, PL.** Gottlieb, P. Santa Maria, C. Kim, S. Yang, YP. Puria, S. Functional Outcomes of Heparin Binding Epidermal Growth Factor Like Growth Factor Treatment for Chronic Tympanic Membrane Perforations Tissue Eng Part A. 2017:436-444

2. **Santa Maria PL**, Kim S, Yang YP. No systemic exposure of transtympanic heparin-binding epidermal growth factor like growth factor. Drug Chem Toxicol. 2016;18:1-4.

B. Positions and Honors

Positions and Employment

2011-2012 Fellow, Otology & Neurotology, Sir Charles Gairdner Hospital, Perth, Australia
2012-2015 Instructor, Otology & Neurotology, Stanford University, Stanford, CA
2015-2017 Associate Professor, The University of Western Australia, Perth, Australia
2014-present Founder, Chief of Scientific Advisory Board, Auration Biotech (Pharmaceutical start-up), Burlingame, CA
2014- present Founder, , Chief of Scientific Advisory Board, Flotherm (Medical device start-up), Palo Alto, CA
2017-present Assistant Professor, Stanford University, Stanford, CA

Other Experience and Professional Memberships

2000 Council Member, The University of Western Australia, Faculty of Medicine Curriculum
2000 Council member, Australian Medical Association of Western Australia
2000 President, President of the Western Australian Medical Students Society
2002-2005 Council member, Australian Medical Association of Western Australia Doctors in Training
2007 Council Member, Western Australian Surgical Trainees Committee
2007-2008 Vice President and Board Member, Youth Media Society / Groove Radio
2011-2012 Committee member, ESIA Centre for Ear Nose and Throat Education and Research, Curriculum development
2015 – 2017 Committee member, Ear Science Institute of Australia Research Committee
2014 – 2016 Committee member, American Academy of Otolaryngology, Head and Neck Surgery Skull Base Surgery
2015 – 2016 Committee member, American Academy of Otolaryngology, Head and Neck Surgery Implantable Devices Committee
2015 – 2016 Committee member, American Academy of Otolaryngology, Head and Neck Surgery Hearing Committee
2015-2017 Board Member, Lions Hearing Foundation Western Australia
2004-present Member, Royal Australian College of Surgeons
2011-present Member, American Academy of Otolaryngology, Head and Neck Surgery
2012-present Member, American Auditory Society
2012-present Member, North American Skull Base Society
2014- present Editorial board, Journal of Laryngology and Otology (Aus Supplement)
2016- present Director, SPARK Co-Lab (Not for profit education in medical research), Perth, Australia

Honors

2017 40 under 40 award, Western Australia and overall winner of small business / start up category
2015 Robert Howard Next Step Award in Medical Technology Innovation, Stanford CA
2014 William E. Eaglestein Award for Excellence in SPARK, Stanford CA
2014 Neurotology Fellow Award at American Neurotology Society Meeting, Orlando, FL
2008 The University of Western Australia Local Travel Award, Perth AUS
2005 William Allnutt & May G Saw Medical Research Scholarship, Perth AUS
2000 Simon Seow Memorial Prize in Public Health, Perth AUS

C. Contribution to Science

1. Understanding tympanic membrane wound healing

Chronic tympanic membrane perforations are a significant cause of hearing loss, especially in the developing world where access to surgery is limited. Unfortunately, when I began to research this area, I found that there was very little known about tympanic membrane wound healing. There was some potential

treatments for the condition, but there was not an available animal model to progress these through to the clinic. Before an animal model could be developed, there needed to be a comprehensive understanding of tympanic membrane wound healing. To obtain this understanding I performed research that thoroughly documented the histological and post transcriptome response to tympanic membrane perforation in a rodent model over two weeks. With this foundation, I was able to inhibit wound healing to create an animal model for future therapeutic testing. This research was initially performed within my PhD and then this transitioned to work where I served as the primary investigator.

a. **Santa Maria PL**, Atlas MD, Ghassemifar R. Chronic tympanic membrane perforation: a better animal model is needed. Wound Repair Regen. 2007;15(4):450-8.
b. **Santa Maria PL**, Redmond SL, Atlas MD, Ghassemifar R. Histology of the healing tympanic membrane following perforation in rats. Laryngoscope. 2010;120(10):2061-70.
c. **Santa Maria PL**, Redmond SL, Atlas MD, Ghassemifar R. The role of epidermal growth factor in the healing tympanic membrane following perforation in rats. J Mol Histol. 2010;41(6):309-14.
d. **Santa Maria PL**, Redmond SL, McInnes RL, Atlas MD, Ghassemifar R. Tympanic membrane wound healing in rats assessed by transcriptome profiling. Laryngoscope. 2011;121(10):2199-213. doi: 10.1002/lary.22150. Epub 2011 Sep 14.

2. Development of an animal model for chronic tympanic membrane perforation

Through the work above, I was able to create a novel animal model for chronic tympanic membrane perforation that has served as a basis for in vivo testing of therapeutics in this area, including my own. Previously attempts at creating a suitable animal model were unsuccessful, too destructive preventing their use in further wound healing treatment studies, would create a wound not comparable to the real life situation or could not be replicated. Research in this field had therefore relied on testing on acute perforations. Since one hundred per cent of laboratory created perforations heal spontaneously, it was always argued that the perforations would have healed naturally without the intervention. I created three animal models to mimic the human condition including a model for dry perforation, a model that involves Eustachian tube occlusion and another that involves a pseudomonas aeruginosa biofilm. Having reproducible and available chronic animal models provides researchers with an in vivo tool to test their therapies for treating chronic perforations. This inhibitor is also now the basis of another potential therapeutic under development. It is currently being tested in vivo, in a new delivery form, for the potential for maintaining a perforation in the clinical setting.

a. **Santa Maria PL**, Santa Maria C, Kim S, Yang YP. Single Administration of a sustained release formulation of KB-R7785 inhibits tympanic membrane regeneration in an animal model. 2016. J Adv Otol. 2016: 12; 237-40.
b. (Provisional patent) PCT/US2014/033536 - Modulation of heparin binding epidermal growth factor activity for tympanic membrane healing
c. Davidoss, NH. Varsak, YK. **Santa Maria, PL.** Animal Models of Acute Otitis Media – A Review with Practical Implications for Laboratory Research. (In Press)
d. Varsak YK, **Santa Maria PL**. Mouse model of experimental Eustachian tube occlusion: a surgical technique. Acta Otolaryngol. 2016;136(1):12-7.

3. A growth factor therapy for regeneration of tympanic membranes

After creating the chronic perforation animal model I undertook work to test out some potential therapeutics for tympanic membrane regeneration. After a few failures, one of my discoveries led to successful animal proof of concept studies that had the potential to remove the need for surgery. Since then I translated this, by working on drug delivery, safety and showing non-toxicity first in the academic setting at Stanford and then in partnership with industry. This then led to its license to a major pharmaceutical company, Astellas that is aiming to manufacture it and take it to clinical trials in two years. I served as the primary investigator throughout all of the development.

a. **Santa Maria, PL.** Gottlieb, P. Santa Maria, C. Kim, S. Yang, YP. Puria, S. Functional Outcomes of Heparin Binding Epidermal Growth Factor Like Growth Factor Treatment for Chronic Tympanic Membrane Perforations Tissue Eng Part A. 2017:436-444
b. **Santa Maria PL**, Kim S, Yang YP. No systemic exposure of transtympanic heparin-binding epidermal growth factor like growth factor. Drug Chem Toxicol. 2016;18:1-4.

c. **Santa Maria PL**, Varsak KY, Kim S, Yang YP. Heparin Binding – Epidermal Growth Factor Like Growth Factor for Regeneration of Chronic Tympanic Membrane Perforations in Mice. Tissue Eng Part A. 2015;21(9-10):1483-94.
d. **Santa Maria PL**, Weierich K, Kim S, Yang YP. Heparin Binding Epidermal Growth Factor-Like Growth Factor Heals Chronic Tympanic Membrane Perforations With Advantage Over Fibroblast Growth Factor 2 and Epidermal Growth Factor in an Animal Model. Otol Neurotol. 2015;36(7):1279-83.

4. **Repurposing growth factor therapy for post tonsillectomy wound healing**
Additionally, as I had worked to translate a growth factor treatment for tympanic membrane regeneration I also looked at other areas where it could be repurposed, knowing that this growth factor was likely non toxic and able to be formulated. This led to new understanding of how the oral cavity heals after tonsillectomy. Previously, it was thought that a fibrin clot or eshar fell off and led to secondary hemorrhage. My created the new hypothesis that secondary hemorrhage was a result of poor epithelialization which lifts off during a period of muscle contraction and neoangionesis in the underlying muscle bed. Through a growth factor treatment that can accelerate and thicken epithelialization in this setting and reduce epithelial separation during wound contraction, there is a potential for a therapeutic to reduce post tonsillectomy secondary hemorrhage.
    a. Beswick, DM. Capasso, R. Santa Maria C. **Santa Maria PL.** Heparin Binding Epidermal Growth Factor Like Growth Factor Enhances Oral Wound Healing In A Mouse Tongue Model (Under review)

5. **Clinical research into tympanic membrane wound healing outcomes**
To complement my basic science work in the field, I continue to critically evaluate the literature and conduct clinical research into the surgical treatments for chronic perforations and the surgical microbiology. This complements the work performed in the basic science.
    a. Tan, HE. **Santa Maria, PL.** Eikelboom, RH. Anandacoomaraswamy, KS. Atlas, MD. Type I Tympanoplasty Meta-Analysis: A Single Variable Analysis. Otol Neurotol. 2016;37:838-46.
    b. Gluth MB, Tan BY, **Santa Maria PL**, Atlas MD. Unique microbiology of chronically unstable canal wall down tympanomastoid cavities: considerations for surgical revision. J Laryngol Otol. 2013;127(5):458-62
    c. **Santa Maria PL**, Oghalai JS. Is office-based myringoplasty a suitable alternative to surgical tympanoplasty? Laryngoscope. 2014;124(5):1053-4.

Complete List of Published Work in MyBibliography:
https://www.ncbi.nlm.nih.gov/sites/myncbi/1rWMus5xmNv/bibliography/41666950/public/?sort=date&direction=ascending

D. Research Support

Ongoing Research Support

Pilot Research Grant, Action on Hearing Loss – Translational Research Initiative for Hearing Grant
11/12017-11/1/2018
Provides seed funding to characterize a mouse model of pseudomonas chronic suppurative otitis media.
Role: PI

Faculty Start-Up Grant, Stanford University 06/01/17- 06/01/19
The goal of this project is to develop animal models for chronic suppurative otitis media for the identification of therapeutic targets.
Role: PI

Stanford SPARK / Stanford Child Health Research Institute Grant 07/01/17-07/01/18
To test the proof of concept and develop a delivery method for preventing post tonsillectomy secondary hemorrhage
Role: Co-PI

Completed Research Support

Stanford SPARK / Stanford Child Health Research Institute Grant 01/01/14-30/06/15
The goal of this project was to further develop animal proof of concept, safety and non-toxicity of a growth factor therapy for tympanic membrane wound healing through preclinical phase
Role: PI

Stanford SPECTRUM – Innovation Accelerator Seed Grant Award 01/01/14-30/06/15
(Supported by UL1 TR001085)
The goal of this project was to conduct a first in human clinical study of a prototype device for maintaining perioperative normothermia.
Role: PI

Garnett Passe and Rodney Williams Memorial Foundation 01/01/12-30/06/15
The goal of this project was to develop novel therapies for regenerating tympanic membranes including the development of novel models of chronic tympanic membrane perforation and chronic suppurative otitis media
Role: PI

Garnett Passe and Rodney Williams Memorial Foundation 01/01/06-30/06/08
The aim of this research was to elucidate the transcriptional changes that occur in response to TM perforation in rats and to infer key genes and molecular events in the healing process. Research was also undertaken to examine the histological changes and the immunohistochemistry of growth factors (specifically keratinocyte growth factor and epithelial growth factor) in the TM of rats following wound healing
Role: PI