Research Breakthroughs and Achievements

- **Osteo-Odonto Keratoprosthesis (OOKP)**
  OOKP surgery is a revolutionary ocular procedure which aims to restore vision to the most severely blinded end-stage ocular surface and corneal patients. The 2 stage surgical procedure involves a multi-disciplinary team of ophthalmic surgeons, oral surgeons, radiologists and anesthetists to restore vision to severe cases of Stevens Johnson syndrome, ocular cicatricial pemphigoid, and severe burns victims for which all other forms of surgery, including corneal transplantation and stem cell transplants, have failed. A canine tooth is harvested, drilled to receive an optical cylinder and implanted in the cheek for 3 months. Second stage surgery involves retrieving the tooth-cylinder complex and implanting it into the eye in a complex 6 hour procedure. Prof Donald Tan, PI of the project led the team in performing the first OOKP surgery in East Asia in Feb 2004, and over 10 patients, mostly from the region, have had OOKP surgery this year. Success to date has been high, with vision restored to all these patients to date. The program continues for 2 years.

- **The Singapore Retinal Imaging and Archival Network:**
  **Computer-assisted Imaging Programme**
  The SiRIAN programme is focused on the development and evaluation of computer-based, automatic retinal vascular imaging system for risk prediction. Prof Wong Tien Yin in collaboration with Assoc Prof Wynne Hsu and Assoc Prof Lee Mong Li from the School of Computing in NUS, and Dr Lim Joo Hwee and Dr Liu Jiang from Institute of Infocomm and Research have developed techniques for (1) measurement of retinal vascular caliber, (2) localization and detection of optic disc and cup, (3) detection of abnormal retinal lesions (e.g., retinal hemorrhages, microaneurysms, hard exudates and other lesions), (4) tracking of the vascular structure to compute vessel caliber, branch angles and tortuosity, (5) automatic classification of vessels into arteries and veins, (6) registration of retinal images over multiple time points to detect changes in the images; and linkage of retinal image features with demographic and clinical data.

- **The Singapore Prospective Study Program (SP2)**
  SP2 is a large population-based studies of 5,000+ people to determine vascular risk factors, diabetes and cardiovascular diseases in Singapore. This is led by Prof Wong Tien Yin with Dr Tai E Shyong.

- **The Multi-Center Retinal Stroke Study**
  This study is a prospective investigation of patients with acute stroke seen at the Singapore General Hospital, Royal Melbourne Hospital, Melbourne and Westmead Hospital, Sydney, Australia. This study has already recruited 1,600+ patients with acute stroke.
• **SiMES - Singapore Malay Eye Study**
SiMES is a large-scale population based study to assess the causes and risk factors of blindness and visual impairment in our Malay community, over a 3 year period. Funded by the National Medical Research Council, SiMES examined 3,280 Malay adults aged between 40 to 80 years. Principal Investigator is Prof Wong Tien Yin, Co-PIs are Assoc Prof Saw Seang Mei, Assoc Prof Aung Tin and Prof Donald Tan. SiMES is the first large-scale survey of its kind to be conducted for a Malay community in the world. SiMES will provide important and previously unavailable public health information on the frequency of the most important eye diseases affecting Malay Singaporeans, which will aid in strategic planning of cost-effective public health policies in ophthalmology which may ultimately reduce blindness and visual disability in our ageing population. Since 2008, there have been 10 papers published or in press in the top ophthalmology journals, including *Ophthalmology, IOVS, and Archives of Ophthalmology*.

• **Discovery of relationship between near work and myopia prevalence**
This research, a SERI collaborative effort between department of Ophthalmology and the department of COFM, with Assoc Prof Saw Seang Mei heading the project, and Prof Donald Tan as Co-PI, is a longitudinal cohort study on 2000 primary schoolchildren to determine true prevalence rates of myopia and evaluate possible environmental risk factors responsible. Initial success culminated in a Lancet publication demonstrating, for the first time, the association between near work and parental history of myopia with a higher prevalence of myopia in Primary 1, 2 and 3 schoolchildren. This is a significant breakthrough in our knowledge of the cause myopia, as the possibility for environmental or behavioral modification as a preventive measure for myopia progression is now a reality.

• **Glaucoma Research**
Important glaucoma research continues to be a major thrust of the department, under the expertise of Assoc Prof Paul Chew. Novel research in the field of 3D spatial perception and visuo-motor defects in glaucoma are being evaluated in the Visual Performance Unit of SERI, under the direction of Assoc Prof Chew and SERI vision scientist Dr Valerie Cornilleau Peres. Assoc Prof Chew has also been highly active in leading several clinical trials.

• **The Singapore Indian Chinese Eye Study (SICC)**
This study has started recruitment in 2007, and aims to examine 3,200 Indians and 3,200 Chinese subjects aged 40-80 years. The study will use the same protocol as SiMES, and will have detailed retinal imaging and DNA storage.
• **Using the retina to investigate cardiovascular diseases**

Cardiovascular diseases are the most common causes of death around the world. Traditional risk factors, such as hypertension, allow physicians to identify persons at risk of cardiovascular diseases. However, these risk factors have well-recognized limitations (e.g. many people do not have hypertension or hyperlipidemia), and there is interest in finding other cardiovascular risk indicators. Since the retina of the eye can be viewed non-invasively, the retinal blood vessels offer a unique perspective of the state of the microcirculation in the heart and the brain. Narrowing and other changes of the retinal arterioles reflect cumulative damage due to hypertension, diabetes, and other vascular processes. Studies led by Prof Wong Tien Yin and his collaborators (Prof Ronald Klein, Prof Barbara EK Klein, Prof Paul Mitchell, A/Prof Jie Jing Wang, Dr Ning Cheung, Dr Gerald Liew, Dr E Shyong Tai, A/Prof Seang Mei Saw, A/Prof Wynne Hsu, A/Prof Mong Li Lee) has established that an objective assessment of retinal microvascular changes may provide important prognostic information regarding risk of stroke, coronary heart disease, diabetes and other conditions. These research have been published in the *New England Journal of Medicine, Lancet* and the *JAMA*.

• **Mouse Model of Myopia**

Adjunct Prof Roger Beuerman led in the development of a mouse model of myopia, a world first. Previous animal models of myopia included visual deprivation studies in chicks and tree shrews. This important achievement paves the way to using our knowledge of the mouse genome to facilitate research into understanding biological mechanisms of myopia, which will give us the opportunity to develop new treatments and drugs for human myopia.

• **Formation of Ocular Stem Cell Research Program and Collaborative Stem Cell Research Group**

In 2001, Prof Donald Tan and Adjunct Prof Roger Beuerman initiated an Ocular Stem Cell Research Program, with grants from NMRC, BMRC and SingHealth Research Funds, and the program formed an important research pillar for the formation of a larger multidisciplinary, NMRC-funded Stem Cell Research Group (SCRG) based at the Outram Campus.

Headed by Assoc Prof Lee Seng Teik and Prof Donald Tan, the SCRG will undertake laboratory and clinical stem cell research collaborations in the field of embryonic and adult stem cells. Five major stem cell programs include the NUS Eye Department's own ocular surface stem cell project, and other projects ranging from human oocyte maturation and cloning for tissue engineering, vascular endothelial progenitor cell culture, cultivation of hair follicle stem cells, to CNS neural stem cells, with collaborating clinicians and scientists from the SGH Departments of Plastic Surgery, Neurology, Obstetrics and Gynecology, Department of Clinical Research and the National Cancer Centre. SCRG laboratories are currently based at the SERI Laboratories, and this ambitious multidisciplinary program will not only enhance the university focus on stem cell research, but also create vibrant and productive cross-disciplinary collaborations and interactions between NUS and other clinician scientists and researchers in the Outram Campus.