The Medical Undergraduate Research Issue

In this special issue of the NUHS Research Bulletin, we turn the spotlight on research performed by undergraduate medical students at the Yong Loo Lin School of Medicine. These insatiably curious, hardworking individuals took time out from their coursework to work on projects that ranged from comparing the effectiveness of two surgical procedures to treat renal hyperparathyroidism to creating environmentally-friendly plastics made from fish waste.

Making biodegradable plastics from discarded fish scales
You’ve probably heard of fish made out of plastic, but how about plastic made from fish? Specifically, the part of the fish that usually gets dumped in the garbage—those slimy, inconvenient fish scales.

Phase 3 medical student, Ng Qin Xiang, first hit on the idea to use fish scales during his volunteer trip to Cambodia for Habitat for Humanity and Operation Hope Foundation. He noticed that Cambodian fishermen ended up discarding a lot of fish scales as waste. Qin Xiang started thinking about ways to turn these scales into an additional source of income for the fishermen. Through reading the scientific literature, he found out about using fish gelatin to make plastics, a relatively underexplored production method.

Sourcing fish scales from Whampoa Wet Market, Qin Xiang next needed a laboratory where he could perform his experiments. He found a willing and supportive mentor in Professor Sow Chorng Haur, Head of the Department of Physics at NUS. Playing around with experimental methods and conditions, Qin Xiang efficiently extracted gelatin from fish scales by first demineralizing the scales with 0.5M EDTA, followed by hydrolysis with 0.05M acetic acid at 70°C for 6 hours. He checked the quality of the fish-scale gelatin using FTIR analysis and determined that it had a medium Bloom strength, a commonly used measure of gel strength in the gelatin industry.

Qin Xiang then combined his fish-scale gelatin with water, acetic acid, glycerol, and corn starch to make plastic that had a comparable tensile strength (40 MPa) as conventional plastic produced using petroleum by-products. The fish-scale plastic was also waterproof and resistant to acids and alkalis as well as folds and tears. Where it differed from conventional plastic was in its ability to biodegrade in soil after slightly over a month. Qin Xiang performed preliminary biotoxicity tests on the breakdown products in soil, obtaining results that suggested the products were non-toxic. However, he would like to do a more extensive biotoxicity analysis. He would also like to field test his method of gelatin extraction and fish-scale plastic production in Cambodia, leveraging on the large availability of fish scales in fishing communities along the Mekong River.
Although this innovative method of utilizing a ubiquitous waste material to make a useful product is still in its early stages, Qin Xiang already has a pending patent with Sembawang Shipyard. The company underwrote the Green Wave Environment Competition 2013, at which Qin Xiang’s project won first place in the Tertiary category. Sembawang Shipyard selected his work for further development, so one day we just might be carrying our shopping in plastic bags made from fish scales and feeling pretty good about it, environmentally speaking!

Total surgical removal of parathyroid glands results in lower recurrence of renal hyperparathyroidism than partial removal

When medical student Lee Kai Yin was asked by a consultant whether she wanted to participate in a research project, she never thought that it would result in an oral presentation at an international conference. Now in her fifth year of medical school, Kai Yin has just recently returned from giving a presentation at the British Association of Endocrine and Thyroid Surgeons conference in Liverpool, United Kingdom.

Kai Yin’s project with Dr Ngiam Kee Yuan and Dr Rajeev Parameswaran from the Endocrine Surgical Unit of the Department of Surgery compared two types of surgical treatment for renal hyperparathyroidism, which is common in people with chronic kidney failure. In Singapore, most patients with chronic kidney failure are managed using long-term dialysis instead of transplants. Chronic kidney failure causes the body to produce excessive amounts of parathyroid hormone (PTH), resulting in renal hyperparathyroidism. Calcimimetic drugs are useful in controlling the disease, but are very expensive locally. Therefore, surgical removal of parathyroid tissue (parathyroidectomy) is the preferred treatment option in uncontrolled disease.

Total parathyroidectomy with autotransplantation (TPTX + AT) and subtotal parathyroidectomy (SPTX) are both accepted as effective surgical treatments. In TPTX + AT, all parathyroid tissue is removed from the neck, and a small amount of parathyroid tissue is injected into the arm muscle to provide parathyroid function. In subtotal parathyroidectomy, a portion of a parathyroid gland is usually left in the neck.

There were a total of 82 patients in this study: 58 of these patients underwent TPTX + AT, while the remaining 24 underwent SPTX. PTH is a marker of parathyroid activity, and levels are expected to fall after surgery. PTH levels decreased considerably after surgery in both groups, with a significantly greater decrease in PTH levels with TPTX + AT ($P<0.001$). The most common complication seen after surgery (both TPTX + AT and SPTX) was symptomatic hypocalcemia.

Patients were studied for a median of 4 years after surgery. The rate of disease recurrence (re-elevation in PTH levels after post-surgery normalisation) was significantly higher for patients who had undergone SPTX (25%) than for patients who underwent TPTX + AT (19%; $P=0.04$). Therefore, parathyroidectomy for renal hyperparathyroidism is effective and safe, and total parathyroidectomy with autotransplantation should be the preferred type of surgery in patients with no access to renal transplant or calcimimetic therapy.

Besides presenting these results at the conference in Liverpool and at this year’s University Surgical Cluster Undergraduate Research Week, Kai Yin and her mentors are also preparing a manuscript for publication. This and other research experiences have fuelled Kai Yin’s interest in research and motivated her to participate in more projects in the future.
Effects of Area-Level Socioeconomic Status on Cognitive and Psychological Function as well as Healthcare Choices

Wee Liang En, who graduated from the NUS School of Medicine in 2013, is now a resident in internal medicine at the Singapore General Hospital. As a medical student, Liang En was very active in public health research, which led to first authorship of several papers with Associate Professor Gerald Koh at the Saw Swee Hock School of Public Health.

Liang En participated in studies of residents in two neighbourhoods in Singapore that included public HDB rental blocks juxtaposed with owner-occupied blocks. Trained NUS School of Medicine students administered questionnaires to the residents to assess characteristics such as sociodemographic and socioeconomic factors, cognitive function, depression, source of primary healthcare, and management of hypertension.

Individual socioeconomic status (SES) and neighbourhood SES are known to be associated with cognitive impairment in Asian countries. In one of his papers, Liang En and colleagues took it a step further and discussed the link between area-level SES within the same neighbourhood and cognitive impairment in the elderly (aged ≥60 years). Cognitive function was assessed using the Mini Mental State Examination (MMSE) that was translated into Chinese, Malay and Tamil and administered by students conversant in the respective languages. Cognitive impairment was defined as an MMSE score <24. The researchers found that elderly residents in rental HDB blocks (low-SES area) had significantly higher rates of cognitive impairment than their counterparts living in adjacent owner-occupied HDB blocks (higher-SES area) in the same neighbourhood (26% vs 16%; \( P=0.011 \)).

A similar pattern was seen for depression in elderly residents, as measured by the Geriatric Depression Scale (GDS-15). A score of ≥5 on the GDS-15, or self-identifying a history of depression was used to indicate a lifetime prevalence of depression. Depression was more prevalent among residents in the low-SES area (26%) than among residents in the higher-SES area (15%; \( P=0.004 \)). When other factors of disadvantage besides residence in public rental housing were considered, including household income, marital status, and reliance on government assistance, the pattern held. Depression was more prevalent in disadvantaged blocks than in non-disadvantaged ones.

The type of healthcare and the effectiveness of disease management also varied between low-SES and higher-SES areas. Low-SES residents were more likely to prefer alternative medicine (30% vs 2%, \( P<0.002 \)) and less likely to prefer Western medicine (11% vs 30%; \( P<0.001 \)) than were higher-SES residents.

Residents in the two SES areas managed disease, specifically hypertension, differently. Although the prevalence of hypertension was similar between both types of areas, low-SES residents had poorer awareness (62% vs 83%), treatment (70% vs 85%), and control (44% vs 66%) of hypertension than did higher-SES residents. Reasons for the lower rates of blood pressure monitoring and medication adherence among low-SES residents included problems with the cost of monitoring and/or medication, doubts about the effectiveness of the medications, and preference for non-Western medicine.
References

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