## Bioinstrumentation Service Learning: Transfer Newly Designed Rehabilitation Devices to Clinical Service for the Public

In this project, we aimed for a high impact teaching-and-learning model started from the invention of rehabilitation devices to the application of the invented devices into practical community services. We motivated the students to be actively involved into the real clinical service, encouraged them to invent new devices to improve the current practice, and nurtured the students to be an active learner, creative inventor, and brave entrepreneur.

The device inventions were initiated from the classroom projects of BME 3112 (Principles of bioinstrumentation) in the first year of the project, and BME 31103 (Applied Electrophysiology), BME 31121 (Fundamentals of Biomedical Instrumentation II), and BME 21111 (Biomedical Engineering Research and Design Studies I) in the second year, due to the transition of curriculum from three years to four years in the university. The course content of BME 3112 has been absorbed into the courses of BME 31103, BME 31121 and BME 21111. Totally, five new training devices designed by the students were evaluated to be feasible in the clinical practice. They are: 1) mouse trainer (Fig 1), 2) rainbow device for upper limb training (Fig 2), 3) wrist pronation/supernation trainer (Fig 3), 4) functional electrical stimulation (FES) robot hand (Fig 4), and 5) rehabilitation system with virtual reality (VR) for stroke (Fig 5).



Fig 1. The mouse trainer device group and the setup of the system



Fig 2. The rainbow device group and the setup of the system



Fig 3. The wrist pronation/supernation trainer group and the setup of the system



Fig 4. Functional electrical stimulation (FES) robot system



Fig 5. Rehabilitation system with virtual reality for stroke.

Among them, the rehabilitation system with advanced VR successfully enter into the shortlist in the innovative competition of *i*-CREATe 2015 Conference in Singapore (<u>http://www.icreateasia.org/</u>) (Fig 6). The device was demonstrated at the exhibition with other inventions from all over the world. The FES-robot hand has won a micro fund competition in PolyU for further commercialization by the students (Fig 7). The FES-robot hand has been further improved by the technicians in JCREClinic for the further application on stroke rehabilitation training in the clinic. Two more sets of FES-robot hands are available for the daily training service.



Fig 6. The VR team in the event of i-Create 2015.



Fig 7. The micro fund obtained by the students based on the FES-robot hand class-room project.

The achievements in the invention of rehabilitation devices are highly related to the clinical practice of the students in the Jockey Club Rehabilitation Engineering Clinic (JCREClinic) of the

BME division. In this project, totally 29 undergraduate students registered in BME 3112, BME 31103, BME 31121, and BME 21111 applied for the clinical service scheme. Twenty one of them were recruited in the routine clinical service of JCREClinic, after the interview conducted by the project leader, Dr. Eric Tam who is the director of JCREClinic. Each recruited student received three tutorial sessions on a stroke patient under the supervision of Dr. Eric Tam (PI) and Dr. Xiaoling Hu (Co-I) of the project, before they provided the device assisted rehabilitation training to the patient in the clinic. Supervision and assistance were always available to the students during their practice in the clinic. Totally, twelve patients after stroke received the device-assisted training by the students. It was observed that the upper limb function of the patients improved after the training, as measured by the clinical scores of Fugl-Meyer Assessment (FMA), Modified Ashworth Scale (MAS). All the scores have been documented in the patients' clinical files in JCREClinic. Fig 8 shows a patient who was happy with the training effects.



Fig 8. The photo sent from a patient (left 2) to the project team for the appreciation of the training.

In this project, we successfully established the teaching-and-learning model through the real clinical practice in community service to stimulate the invention in bioinstrumentation by the students. The invention by the students also brought new elements to the current service. The clinical service and the classroom learning guided the students recognize the society demands and the fast development in the area of bioinstrumentation. They also obtained the fundamental skills in bioinstrument operation, design, maintenance, service planning and promotion, e.g., the successes in the i-Create competition and Micro-fund application. The teaching-and-learning model proposed in this project will be carried on in the related courses, i.e., new students will be recruited for new designs, and in the clinical rehabilitation service in JCREClinic. The students will be encouraged to attend international competition with their inventions for promotion and further commercialization. Suitable training devices will be fine-tuned and applied in the routing training in JCREClinic.