Assisting Agricultural Villages in India in Achieving Early Detection of Chronic Kidney Disease Through a Memorandum of Understanding Between National Yang Ming Chiao Tung University and Sri Ramaswamy Memorial University

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The Department of Photonics and the Institute of Physics of National Yang Ming Chiao Tung University (NYCU) collaborated to research and develop a low-cost, semiconductor-based sensor for detecting ammonia gas in exhaled breath. Clinical detection of ammonia gas in exhaled breath was conducted on patients in National Taiwan University Hospital, Hsin-Chu Branch and Chang Kung Memorial Hospital, Linkou, to analyze the correlation between the ammonia gas content of exhaled breath and kidney function. The results can be applied to develop rapid screening test kits for early diagnosis of chronic kidney disease. To assist people in agricultural villages in India in the early detection of chronic kidney disease, NYCU and Sri Ramaswamy Memorial University (SRM) Medical College Hospital and Research Centre signed a memorandum of understanding on September 8. The two parties plan to conduct clinical studies and recruit participants in India to promote the application of medical devices related to detecting ammonia gas in exhaled breath.

More than 10% of the global population has chronic kidney disease, which can be divided into 1–5 stages. Patients with Stage 5 chronic kidney disease must undergo hemodialysis or kidney replacement. Therefore, early detection and control of the progression of the disease are crucial. However, the early-stage symptoms of chronic diseases are often unobservable and individuals with such diseases may not be aware of their conditions. In normal individuals, metabolism generates urea, which is discharged through urine. When renal functions become abnormal, a portion of the urea is converted into ammonia, which increases the levels of ammonia gas in exhaled breath. The ammonia gas in exhaled breath can be used as an indicator of chronic kidney disease.

Researchers have generally used bulky and expensive spectroscopy and mass spectrometry devices to analyze the ammonia gas in exhaled breath. A low-cost and sensitive semiconductor-based ammonia gas sensor may be crucial for increasing the prevalence of the detection of ammonia gas in exhaled breath. Professor Xiao-Wen Zan of the Department of Photonics of NYCU and Professor Hsin-Fei Meng of the Institute of Physics began to research and develop low-cost, semiconductor-based sensors for detecting ammonia gas in exhaled breath in 2010. They developed a current channel that was hundreds of nanometers long and perpendicular to substrates. Variations in the currents were used to detect ammonia gas concentrations, and the device achieved extremely high sensitivity and stability. The professors obtained an invention patent for the structure. The professors subsequently collaborated with Professor Chia-Jung Lu of the Department of Chemistry of National Taiwan Normal University and Vate Technology Co., Ltd. to develop a portable detection system. Dr. Chang-Chiang Chen of the Department of Nephrology of National Taiwan University Hospital Hsin-Chu Branch assisted them in detecting and identifying decreases in the ammonia gas concentrations in the exhaled breath of clinical patients who had received hemodialysis.

In 2018, the professors teamed up with the medical team led by Ya-Chung Tian, the director of the Department of Nephrology of Chang Kung Memorial Hospital, Linkou, and the Dean of the College of Engineering of Chang Gang Memorial Hospital, Professor Chao-Song Lai to improve detection of ammonia gas concentrations in the exhaled breath of patients with chronic kidney disease and to analyze the correlation between ammonia gas concentrations in exhaled breath and renal functions. A clinical study involving more than 120 people was conducted. The results revealed that exhaled ammonia gas concentrations were highly correlated with the estimated glomerular filtration rate, a key parameter of chronic kidney disease. The professors proposed that an ammonia gas concentration of up to 0.9 ppm in exhaled breath could be used as an indicator for rapid screening tests for the early detection of chronic kidney disease. Using this result as a basis, the research team recruited participants for an on-site physical examination event at Linkou and verified that the indicator could be used to identify people with abnormal renal functions. The results of the event supported that ammonia gas concentrations in exhaled breath can be applied to predict chronic kidney disease. The research received the 2018 FutureTech Award and the Clinical Innovation Award in the 2021 National Innovation Awards.

The proposed equipment was used to complete ammonia gas screening tests in a community to determine participants' renal functions (Sep 5, 2020).

The research team has continued to expand the applications of the technology for detecting ammonia gas concentrations in exhaled breath, which is expected to be exceptionally valuable in regions with low blood test rates. National Science and Technology Council Deputy Minister Minn-Tsong Lin connected the research team with Taipei Economic and Cultural Center in India and thereby facilitated the collaboration between the research team and the SRM Medical College Hospital and Research Centre. Pro Vice-Chancellor Dr. A. Ravikumar of SRM University and the Medical Research Dean Dr. Rajiv of the SRM Medical College Hospital and Research Centre and their teams responded to the team's invitation to collaboration with enthusiasm. They expect the research results to improve the area's blood test rates and, consequently, detect chronic kidney disease early on because agricultural villages in India generally have large populations. Both parties signed a memorandum of understanding on September 8. Taiwanese Representative to India Bau-Shuan Ger was invited to deliver a speech at the signing ceremony. The Science and Technology Division of the Taipei Economic and Cultural Center in India, Taipei Economic and Cultural Center in Chennai, and Professor Pao-Ann Hsiung of the Taiwan–India Joint Research Center on Artificial Intelligence jointly witnessed the signing ceremony. In the future, clinical participants will be recruited in India to participate in research to promote the application of the technology for detecting ammonia gas in exhaled breath.

Signing with SRM Medical College Hospital and Research Centre. Sitting on the left is Pro Vice-Chancellor Dr. A. Ravikumar of SRM University and sitting on the right is Director Chin-Tsan Wang of Science and Technology Division, Taipei Economic and Cultural Center in India

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