

# Application Fields and Innovative Technologies

**A Serious Game of Swallowing Exercises for Post-Stroke Dysphagia Patient** M.J. Su, B.J. Yang, H.L. HSIEH, W.Y. Lee, M.L. Dai, W.Y. Chen, Y.H. Su. *Gerontechnology* 25(s)

**Purpose** Cerebrovascular disease (CVD) has been a persistent health concern in Taiwan for over three decades. Acute stroke imposes a significant impact and burden on patients, their families, and the social healthcare system. Literature indicates that approximately 30% to 75% of stroke patients experience dysphagia (swallowing difficulties) during the acute phase[1,2]. Dysphagia subsequently leads to aspiration pneumonia, prolonged hospital stays, and significantly increases the risk of mortality. Dysphagia is a common and challenging problem in stroke patients. Due to impaired oropharyngeal function, the majority of these patients require nasogastric tube (NGT) feeding to maintain nutrition. However, long-term indwelling NGTs can lead to several complications, including nasal passage pressure injury, accidental tube dislodgement, causing patient discomfort and preventing oral intake. Moreover, a severe shortage of clinical care staff in hospitals, speech therapists and nurses have limited time to provide swallowing training in order to improve patients' swallowing ability. **Method** we established an interdisciplinary team comprising Biomedical Engineering, neurosurgeons, neurologists, physiatrists, nurses, and Speech-Language Pathologist to jointly develop an Interactive AI Gaming System centered on Swallowing Exercises based on Serious Game. Through the serious game intervention, we aim to strengthen the function of the patient's orbicularis oris muscle and suprahyoid muscle groups, thereby improving swallowing capability. The goal is to help patients restore their dignity of oral feeding, which serves as the core motivation for this research. This system utilizes Gamification design to transform the traditional, monotonous rehabilitation exercises for the orbicularis oris and suprahyoid muscle groups into a digital training process equipped with a user motivation module and a training performance analysis module. Through this high-frequency, highly interactive training modality, the system effectively enhances stroke patients' training motivation and adherence, thereby accelerating their recovery of swallowing function and achieving high-efficiency clinical rehabilitation, showing in Figure. For the auto-assessment the swallow ability, we utilize a multimodal approach incorporating sound intensity features to build the following models based on the sound analysis: STFT-CNN, MFCC-CNN, STFT-VGG19, MFCC-VGG19, STFT-CNN (multimodal), MFCC-CNN (multimodal), STFT-VGG19 (multimodal), and MFCC-VGG19 (multimodal). **Results and Discussion** Patients showed significant improvement in swallowing function. The FOIS score increased from a baseline mean of 1.12 (standard deviation = 0.33) to a post-test mean of 3.56 (standard deviation = 1.01). Paired t-tests confirmed that this improvement was statistically significant ( $t = -13.95, p < 0.001$ ). Furthermore, the nasogastric tube removal rate reached 55.6% during the observation period. The multimodal AI model achieved a 92% accuracy rate in identifying target phonemes in the clinical setting. A significant p-value ( $p < 0.001$ ) supports the effectiveness of serious games in promoting dysphagia rehabilitation. This system transforms repetitive muscle exercises into an engaging digital format, thereby maintaining patient engagement and reducing the burden on healthcare workers. This study, by integrating AI, game design, and clinical care, aims to improve the quality of life for elderly stroke survivors, aligning with the interdisciplinary scope of gerontology. Future research will integrate this technology into mobile devices for post-acute care patients in home care settings.

## References

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Figure 1. Clinical patients performing interactive AI game-based breathing and swallowing exercises.