FRAME final report: F.R.A.M.E. (Facial Remote Activity Monitoring Eyewear) An inconspicuous, non-invasive, mobile sensor device for real-time control of assistive technologies through facial expression.

Lay Summary

This project was designed to help patients suffering with the consequences of facial paralysis with their muscle rehabilitation. Facial Remote Activity Monitoring Eyewear (F.R.A.M.E.) aimed to develop a pair of glasses that discreetly provides real-time feedback to the wearer about their facial muscle function, helping them practice their rehabilitative exercises regularly and correctly, thereby speeding recovery of normal, symmetric facial expressions.

Studies show that following facial paralysis rehabilitative exercises speeds recovery and improves the patient's outcome. However, patients usually have limited awareness of the abnormal movements (called synkinesis) their faces display. Therefore, without muscle feedback about these movements, their facial function may worsen, developing permanently abnormal movements.

Research gathered in the initial work packages (via patients and therapists focus groups) highlighted the fact that most patients with synkinesis are not under the care of a rehabilitation specialist and will therefore not be ready to start active facial movements. Their high facial muscle tone means that significant work will be needed to stretch tightened facial muscles and lower resting muscle tone. It was recognised that prior to use of the rehabilitation technology for active rehabilitation, patients will need to lower their resting facial muscle tone through the use of contact sensors on the cheeks and around the eyes

To ensure a thorough understanding of user needs, a facial palsy research priority setting exercise was undertaken in collaboration with the Centre for Appearance Research (University of the West of England) to ensure that the potential needs of stakeholders were being considered. The results were published in the Journal of Plastic Reconstructive and Aesthetic Surgery
https://www.researchgate.net/publication/327383015_Consensus_research_priorities_for_facial_palsy_A_Delphi_survey_of_patients_carers_clinicians_and_researchers

In terms of glasses technology development, facial muscle sensor locations were defined to capture 8 key expressions. This required the development of 3 iterations to achieve a sufficient degree of accuracy.
• Data collected from the first 38 subjects were subjected to newly developed machine learning methods and incorporated into an accurate algorithm.
• The device was optimised for stability and accuracy and expression engine software

Variations in signal amplitudes across selected facial expressions was assessed in healthy volunteers ensuring sensor positioning is adaptable across different facial morphologies. This allows accurate facial expression mapping to underlying muscle activities to facilitate device calibration with different wearers. Results of this work were presented at an international conference: McGhee, JT, Hamedi, M, Fatoorechi, M, Roggen, D, Cleal, A, Prance, R, and Nduka, C, Towards a novel biometric facial input for emotion recognition and assistive technology for virtual reality, Proc. 11th International Conference on Disability, Virtual Reality and Associated Technologies, PM Sharkey, AA Rizzo (Eds), pp. 339-342, Los Angeles, California, USA, 20-22 Sept. 2016)

PPI Involvement & dissemination

A feedback sessions held at QVH, engaged with 10 Facial Palsy patients and asking them to give their reactions to the design of the prototype EMG goggles, and for them to wear the goggles for a more extended period and give feedback on the comfort. The patients were all asked to complete a questionnaire, and the outcome was a 100% positive reaction to the design. All would be willing to wear the goggles at home while

practicing relaxation exercises, and found the device comfortable to wear. Some felt that the device felt fragile, and this has been fed back into the prototype design work package.

Between January and March 2019, glasses data was collected from patients who used them paired with a smartphone. There were 18 Facial palsy patients and 13 healthy volunteers. Recruitment was slightly lower than planned due to high incidence of sickness and chest infections. Participants performed a protocol of daily use at home, conducted usability feedback and watched emotive videos to assess real-world facial expression responses

PPI was conducted via Facial Palsy UK, and a presentation was made by the lead investigator to update the community on the project.

The economic viability of FRAME technology was assessed in a separate work package. An economic analysis was conducted based on expected or average costs and outcomes, while review evidence on the effectiveness of facial rehabilitation therapy demonstrates substantial variation in recovery patterns across patients. Such heterogeneity in effectiveness should be accounted for in a final economic evaluation. The results of the review are awaiting publication in the journal Clinical Rehabilitation, entitled: Physical therapy for facial nerve paralysis (Bell's palsy): An updated and extended systematic review of the evidence for facial exercise therapy [Amir Khan; Ala Szczepura; Shea Palmer; Chris Bark; Catriona Neville; David Thomson; Helen Martin; Charles Nduka].

A cohort based study or a RCT is recommended for a full economic evaluation of the FRAME technology. Since the study completed, further work has been undertaken to set up a larger clinical evaluation.