Monitoring emotions of depressive patients using wearable sensors

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***Abstract*— The aim of this study was to link emotional experience with heart rate and activity in depressed patients. To reach this goal, a linear AutoRegressive model with eXogenous inputs (ARX) was developed with activity as input and heart rate as output for every individual patient. Descriptive parameters from the model were able to register stress as compared with the results of a questionnaire assessing emotions.**

I. Introduction

The occurrence of depression is increasing and affects people of all ages. It has a severe social and economic impact with under-diagnosis, under-treatment, social stigma and high relapse rates. Studies already showed that clinical decision making can be improved by monitoring positive and negative emotions in early stages of depression treatment[1]. Moreover, wearable technology was already used to monitor mental state[2]. Therefore, the combination of the positive aspects of emotional monitoring and the potential of wearable sensors would be a great asset in tackling the increasing burden of depression. We aimed to link (changes in) emotional states of depressed patients with their heart rate and activity in order to register different emotional levels.

II. Methods

Seventeen days of measurements from 7 depressed patients (5 females, 2 males) with an age between 19 and 57 were generated and used for data analysis. Fully hospitalized patients at the Crisis Intervention Centre of UZ Leuven were included in the study, where all patients had diagnosis of a major depressive disorder or had increased level of depressive symptoms. Monitoring was performed for twelve hours during 1 to 4 consecutive days. Heart rate and activity were measured with a smartwatch and a smartphone respectively. A questionnaire assessing emotions (positive affect, negative affect and anhedonia) was filled in by the patient for three to six times a day in intervals of approximately two hours.

A linear ARX model was developed in MATLAB by using the CAPTAIN Toolbox. As already shown [2], activity was used as model input, while heart rate as model output. After obtaining the modelled heart rate, the positive difference (PD) between the measured and the modelled heart rate was assumed to be similar to an emotional heart rate component. Descriptive parameters of this component, such as the average PD, the standard deviation of the average PD and the area under the curve of the average PD were calculated for 30-minute blocks before and after every questionnaire result. The sum of the descriptive parameters in the two blocks was compared to the corresponding questionnaire outcome (Figure 1). For every questionnaire response, a decision for 'no stress expected' or 'stress expected' was made, according to the questionnaire.

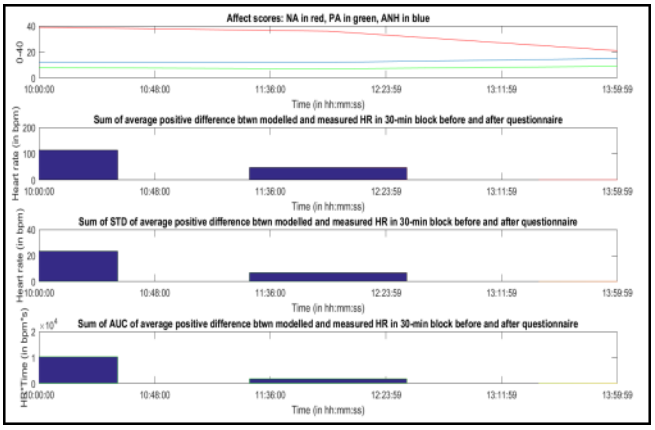

Figure 1. Illustration of questionnaire results and descriptive parameters

III. Results

In general, 71% of the developed ARX models were first order models. A positive trend was established in the means of the descriptive parameters from the 'no stress' to 'stress' category, and this for every day of measurements. It is shown that for every descriptive parameter, the means of the 'no stress' and 'stress' category were statistically different, with p-values of 0.0078, 0.0256 and 0.0078.

IV. Conclusions

This study introduces a method to identify increased level of stress in the subjects suffering from depression. Our descriptive parameters are able to register elevated stress levels.

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References

[1] Geschwind, N., Peeters, F., Drukker, M., van Os, J. and Wichers, M. "Mindfulness training increases momentary positive emotions and reward experience in adults vulnerable to depression: a randomized controlled trial." *J Consult Clin Psychol*, 2011. 79(5): 618–28.

[2] Joosen, P., Exadaktylos, V. and Berckmans D. "An investigation on mental stress-profiling of race car drivers during a race." *Proceedings of the 12th International Conference on Wearable and Implantable Body Sensor Networks*, Cambridge, MA, USA, 9-12 June 2015.