Prediction of individual positioning in a range of lying postures.

Silvia Caggiari[1], Peter Worsley[1], Yohan Payan[2], Marek Bucki[3], Dan Bader[1]

[1]Skin Health Group, Faculty of Environmental and Life Sciences, University of Southampton, UK

[2]Univ. Grenoble Alpes, CNRS, TIMC-IMAG, 38000 Grenoble, France

[3]Texisense, France

Introduction: During prolonged lying postures, the interaction between an individual and the underlying support surface can lead to damage of the skin and underlying tissues, in the form of a pressure ulcer (PU). Pressure mapping systems have been used to evaluate this biomechanical interaction and determine the optimum postures and pressure redistribution strategies [1]. However, the short-term nature of this measure provides limited insight into the temporal changes in pressure during evoked or self-induced movements. Our recent study has examined the performance of selected biomechanical parameters derived from continuous pressure monitoring and actimetry to detect postural changes [2]. Inevitably, these technologies yield large data sets, which would benefit from intelligent processing. This motivates the present study, which examines the accuracy of machine learning algorithms for the prediction of lying postures.

Methods: Nineteen healthy subjects adopted a range of lying postures, evoked by adjusting both the head of bed (HOB) angle between 0-60^{o} and a tilting system to achieve sagittal and lateral (left and right) postures, respectively. A series of time-related biomechanical parameters were estimated from pressure monitoring at the support surface interface (ForeSitePT, Xsensor, Canada) and actimetry systems (Shimmer, Ireland) placed on the sternum. Two supervised machine learning algorithms were examined, namely K-nearest neighbors (KNN) and Naïve-Bayes (NB), established with training data (n=9) and validated with test data (n=10).

Results: Ranking of the biomechanical parameters revealed that the contact area >20mmHg at the support surface interface and trunk tilt angles provided the greatest discrimination between postural changes. Separate clusters were identified in data derived from principal components (PCs) for postures incorporating 20^{o} HOB increments (Figure 1). Analyses of KNN with different *k* values were performed and *k*=40 resulted in the highest accuracy among subjects. The accuracy in predicting the range of sagittal and lateral postures was >80% for all subjects using NB approach, which was also demonstrated for KNN in 8/10 subjects. Exemplar of both results are presented for one subject (Figure 2).

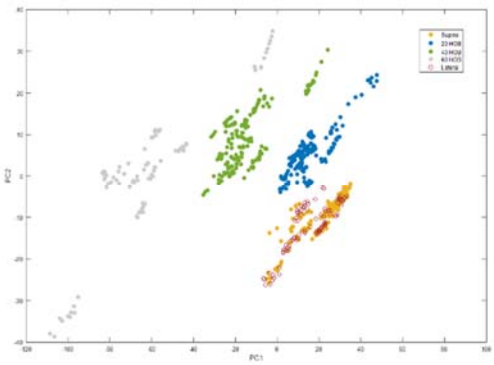

Figure 1: Clusters representing each of the postures in the PCs space.

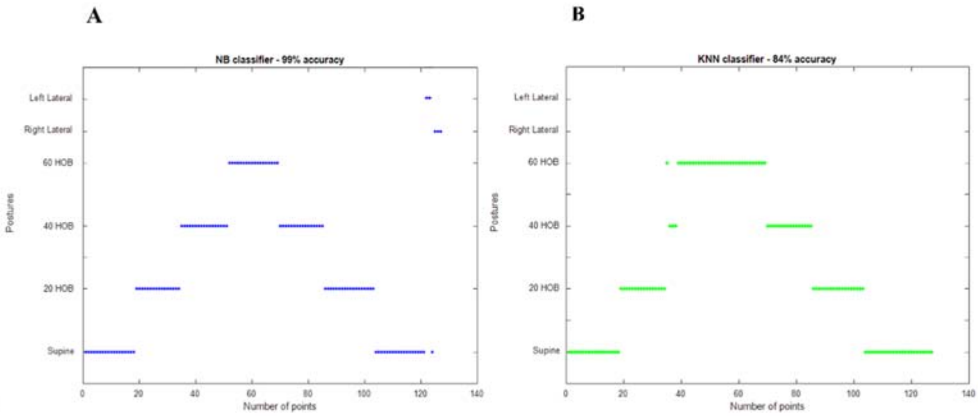

Figure 2: Classification of the range of sagittal and lateral postures corresponding to one subject. The classification was performed using NB (A) and KNN (B) classifiers. It resulted 99% and 84% of points correctly classified, respectively.

Conclusions: Accurate prediction of supine postures was achieved by applying machine learning approaches on time-related parameters estimated from two commercial monitoring systems. Current approaches for individual positioning is based on an arbitrary threshold, incorporated into the algorithm of the pressure monitoring system to predict the frequency of movements with the associated risk of developing PUs. This work represents an advanced method of monitoring postures, based on robust biomechanical parameters indicating both segmental movements of the body and associated changes that occur at the body – support surface interface.

Acknowledgments

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References:

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[2] Caggiari, Med Eng and Phys (2019)