

# NOVA I4H – Thesis Proposal

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## **Title:**

SYPUMP – SYstem for Pressure Ulcer Monitoring and Prevention: a functional automatic Pressure Ulcer detection and management system, integrated in a smart mattress.

## **Objectives:**

Pressure ulcers (PUs) are injuries that occur in the skin and underlying tissue, occurring as a result of prolonged pressure in combination with shear and friction over bony prominences. The depth of the injury depends on the tissue integrity and nature of the surface (Bouten et al., 2003). PUs still present a major challenge to be tackled, especially in intensive care units, occurring in an estimated 30% of the patients (Jones, 2013), making the prevention of PUs a priority in Healthcare.

In Europe, the main classification system is based on the guidelines for the clinical prevention and treatment of the PUs, from the European Pressure Ulcer Advisory Panel (EPUAP), which in 1999 divided the severity of a PU into 4 Grades. After several revisions (Beeckman et al., 2011) the classification system was changed to:

- Stage I: Nonblanchable Erythema
- Stage II: Partial Thickness Skin Loss
- Stage III: Full Thickness Skin Loss
- Stage IV: Full Thickness Tissue Loss
- Unstageable: Depth Unknown
- Suspected Deep Tissue Injury: Depth Unknown

The latest release, in September 2014, of the International Pressure Ulcer Guidelines (EPUAP, 2014) described that the prevention of PUs should be done at various levels, specifically based on manual inspection equipment, manually repositioning the patient and the use of pressure redistribution surfaces (e.g. beds, chairs) to alleviate the effects of pressure, friction and shear (Clark et al., 2014)

The recent use of Machine Learning techniques for the prevention of PUs has mainly focused on three areas:

- Classification of PUs based on different imaging modes (Garcia-Zapirain et al., 2017; Zahia et al., 2018; Veredas et al., 2015), which has had remarkable success in scoring the stages of the wounds, it is still based on process that can't be easily scalable into an automatic prevention, as nurses need to reposition the patient and take the images.
- Analysis of Risk Factors based on patient data (Genevès et al., 2018; Kaewprag et al., 2017), which can be used to prioritize certain patients with improved care, which could offer cost savings to care providers.
- Development of smart beds, embedded with pressure sensors (Ajami and Khaleghi, 2015; Yousefi et al., 2011), which allied with other sensor

technologies and by using low-cost computational systems could become the standard in automatic PU prevention

In line with research trends, this PhD aims to develop a functional “smart mattress” with an integrated machine learning PU detection algorithm and automatic repositioning actuation. The system’s will be using the patient’s physiological data, as well as simulation-generated information, which will be fed into a Deep Learning framework. SYPUMP’s final goal to actively actuate in the pressure points in order to mitigate the PU problem and to send to the medical staff quality information, so complementary actions could be taken in time.

**Framework:**

Compta SA is a company, with the aim of developing technological solutions with market orientation, based on a strong component of research and development. The company is developing a very active collaboration with NOVA's Faculty of Science and Technology, resulting in a very important and substantial knowledge base between both institutions regarding the subject of this PhD proposal, which motivates the pursuit of new projects in this field.

This project will be supported by Compta and FCT/UNL with a PhD grant assigned by Fundação para a Ciência e a Tecnologia.

**Tasks :**

1. Preliminary Studies – review of the state of the art
2. Identification of the physiological parameters more important to monitor and characterize the methods available to its quantification
3. Development of a computational simulator to the issue in study
4. Development of the physiologic sensors and electromechanics actuators devices. Integration of a network of the sensor/actuator modules in a mattress.
5. Data acquisition and training of a deep learning network, in order to control the pressure actuators, in function of the data of the physiologic sensors
6. Develop of a web-based service for interface with end users.
7. Clinical validation of the developed tools
8. Scientific Writing - The project is expected to result in several articles, to be published on specialty journals.

**Venue:**

This project will take place in Compta-SA, Miraflores, as well as in the Physics Department of FCT-UNL.

**Candidate profile:**

This project main study areas are: instrumentation, data analytics, medical interpretation, development of artificial intelligence algorithms. The candidate must have interest and a strong background in these areas. Prior work experience in these areas is higher desirable.

The candidate must have the capacity of innovate and the necessary critical aptitude to develop and evaluate new instrumentation and software algorithms. It will be only accepted candidates with a master's degree, obtained before September 2019, in Bioengineering, Physics, Electrotechnics or similar.

In addition, since this collaboration is between a faculty of engineering and an enterprise, the candidate must be prepared to develop his/her activity in an enterprise environment.

**Supervisor:**

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