

Postdoctoral research topic

- Title of the proposed topic: **Creation of an AI-based decision support system to predict abdominal aortic aneurysm outcomes**
 - Research axis of the 3iA: AI for integrative computational medicine (axis 2)
 - **Supervisor (name, affiliation, email):**
Juliette RAFFORT-LAREYRE (CHU NICE/ UNIVERSITE COTE D'AZUR)
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 - Potential co-supervisor (name, affiliation):
Dr Fabien Lareyre (CHR ANTIBES JUAN-LES-PINS/ UNIVERSITE COTE D'AZUR)
 - The laboratory and/or research group:
Inserm U1065, C3M, Team 9
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Apply by sending an email directly to the supervisor.

The application will include:

- Letter of recommendation of the supervisor indicated above
 - Curriculum vitæ including the list of the scientific publications
 - Motivation letter
 - Letter of recommendation of the thesis supervisor
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- Description of the topic: **Creation of an AI-based decision support system to predict abdominal aortic aneurysm outcomes**

Abdominal aortic aneurysm (AAA), defined as a focal dilatation of the aorta, has become a significant health public challenge worldwide. The disease is often asymptomatic but may become life threatening, especially when revealed by an acute rupture (1-3). Imaging is a key step in the diagnosis of AAA and Computed Tomography (CT-scan) is one of the most commonly used technique (1, 2). The only curative treatment of AAA relies on surgery and the decision to treat relies on the evaluation of the balance between the operative risk and the risk of AAA growth and rupture (1).

However, clinicians are confronted to a **critical lack of reliable tools** to assess the risk of AAA progression and the risk of post-operative complications. With the current guidelines, many patients are treated while they would never have ruptured and others with an AAA below the threshold for treatment do develop a rupture. There is a real need in clinical practice to identify new biomarkers and to develop advanced imaging analysis to better evaluate the AAA morphology and facilitate pre-surgical planning. No study has proposed yet to combine clinical, biological and imaging data in a unique and innovative platform. Developing such

application would be a great asset for clinicians to improve the assessment of the prognosis of patients and evidence-based treatment.

The aim of this project is to create an innovative **aid-decision support system to predict AAA outcomes** to enable precision medicine and propose a personalized therapeutic approach for patients with AAA.

This translational project will be achieved through 3 main axes: **1- Identification of new biomarkers of AAA progression and rupture.** Based on biological samples already collected from patients with AAA, new biomarkers related to the AAA progression will be identified at the transcriptomic and proteomic level. RNAs and micro-RNAs sequencing and mass spectrophotometry-based proteomic approach (LC-MS/MS) will be performed. Patterns and profiles will be compared between patients with stable AAA, unstable AAA and healthy aortic tissues obtained from organ donors patients. A panel of biomarkers will be selected and their expression will be validated in the entire cohort. The biological data obtained will be correlated with clinical characteristics of patients and with the outcomes to identify non-invasive markers associated with AAA progression. Several strategies will be tested including differential analysis and Machine Learning (ML) models, with feature importance evaluation and feature selection. **2- Prediction models of AAA outcomes using Machine Learning (ML).** Using an automatic imaging software previously developed, anatomic and morphological characteristics of the AAA will be extracted from CTA on the entire cohort. AI-derived algorithms will be used to combine identified biomarkers, clinical data and imaging data to develop predictive scores of AAA outcomes including risk of progression, rupture and post-operative complications. Distinct datasets will be used for the training and the validation of the DL algorithms developed. A final algorithm in which clinical, biological, and imaging data are balanced will be developed to create a decision support in the choice between conservative and operative treatment by integrating the risk of AAA expansion and post-operative complications. **3- Development of the aid-decision support system to treat patients with AAA.** Pipelines and technologies developed in the previous tasks will be integrated to develop an aid-decision support system that will help clinicians to evaluate the prognosis of patients and propose a personalized therapeutic approach. The main tools developed in the platform will include: - a fully automatic characterization of the AAA morphology, - an objective score of the AAA outcomes including the risk of AAA expansion, rupture and the risk of post-operative complications by integrating clinical, biological and imaging characteristics of patients.

References:

1. Wanhainen A, Verzini F, et al. European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms. *Eur J Vasc Endovasc Surg.* 2019;57(1):8-93. PMID: 30528142
2. Chaikof EL, Dalman RL, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. *J Vasc Surg.* 2018;67(1):2-77 e2. PMID: 29268916
3. Reimerink JJ, van der Laan MJ, et al. Systematic review and meta-analysis of population-based mortality from ruptured abdominal aortic aneurysm. *Br J Surg.* 2013;100(11):1405-13. PMID: 24037558