**Title of the PhD project:** Quantification of pulmonary aeration in CT images of patients with acute respiratory-distress syndrome.

**Disciplines:** image processing  
**Laboratory:** CREATIS CNRS 5220, INSERM U1206 (head O. Beuf, team MOTIVATE)  
**Doctoral school:** Interdisciplinary Doctoral program in health-sciences (EDISS) - ED 205

**Description**

**Scientific background and rationale:** The acute respiratory-distress syndrome (ARDS) is a life-threatening state of the lungs (mortality 40-50%) characterized by alveolar collapse, edema, and parenchymal inflammation. During treatment, patients are oxygenated by mechanical ventilation, which may aggravate their state if the settings are not carefully customized. CT images give access to air ratio in tissues, but existing methods use manual lung segmentation and don't account for lung motion. Automated methods used in other diseases are unable to cope with large opacities and with heterogeneous density changes observed in ARDS.

**Aim:** Develop and validate automated fast algorithms and smart software tools to assess the patient's response to ventilation and assist physician's decision based on CT images. Namely, the proposed methods should accurately quantify stress, strain and recruitment (reopening of collapsed alveoli), and identify the regions where either over-distension or recruitment occur.

**Description of the project methodology:** The project will start from methods developed by the team within a study on an animal model of ARDS and based on image registration. The methods will be adapted to a smaller number of images and lower signal-to-noise ratio due to lower dose in patients. To propose faster and more accurate algorithms, the use of atlases and of machine learning, combined with a-priori anatomical and biomechanical knowledge will be explored. The optimized algorithms will be integrated in a graphical interface permitting their execution with minimal user interaction. Methodology for algorithm validation will be proposed and used to assess the performance of the developed methods. For this purpose, anonymized CT-scans from several centers will be collected into a database within a study coordinated by the intensive-care unit of the Croix-Rousse hospital in Lyon.

**Expected results:** Validated algorithms capable of: delineating the lungs in 3D CT-images, following the tissue displacements, quantifying the global and local changes in aeration and in mechanical behavior (recruitment, strain, stress, over-distension...) – all this in presence of large opacities changing shape and size between different ventilation conditions, and within a short time compatible with intensive-care requirements (less than one hour). User-friendly software integrating these algorithms within a smart interactive graphical interface.

**Perspectives:** Definition of image-based criteria permitting the best patient-specific choice of the ventilation settings. Definition of an optimal imaging protocol, as a trade-off between minimal irradiation and maximum information for the therapeutic decision. Improvement of survival.

**Skills required:** signal and image processing, image segmentation, image registration, applied mathematics, programming (C++, Matlab), computer graphics

**Bibliography:**


**Key-words:** lungs – intensive care – mechanical ventilation – CT scanner – 3D image processing

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Application should include: CV, application letter, Names and addresses of two references.  
The application file should be sent before May 14, 2017 to: (email of the supervisor).  
The open competitive recruitment process is in two steps: 1. Internal laboratory procedure. 2. Interdisciplinary jury of EDISS.