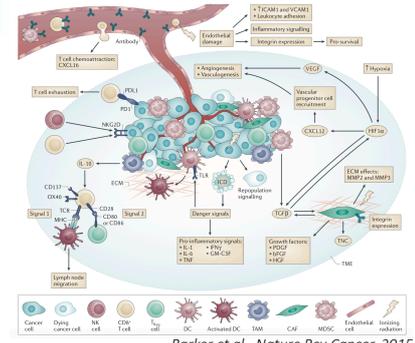


Background

Radiotherapy is a common treatment for tumour aimed at damaging and killing cancer cells. Even if improvements of radiotherapy administration techniques have enabled a more accurate dose delivery, partial irradiation of healthy tissues unavoidably occurs. Indeed, even if the complexity of the microenvironment has certainly an effect of the treatment outcome both as tumour control (TCP) and healthy tissues complications (NTCP), the mechanism of these phenomena are not completely understood.

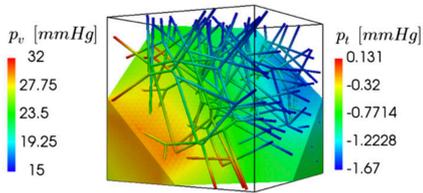
The microvasculature constitutes one of the main components of the microenvironment, and it allows delivery and removal of solutes and gasses to/from tissues. Thus, damage of the microvasculature may impair the microenvironment conditions, possibly harming healthy tissues or altering radiotherapy effects in cancer cells, i.e. due to altered oxygenation. Describing the damaging mechanism of microvasculature is a very interesting step towards the understanding of complex phenomena occurring within the microenvironment due to radiotherapy.



Barker et al., Nature Rev Cancer, 2015

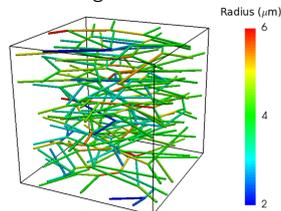
Modelling microvascular environment

Coupled model to describe microvasculature interactions with the surrounding environment (e.g. fluid filtration)



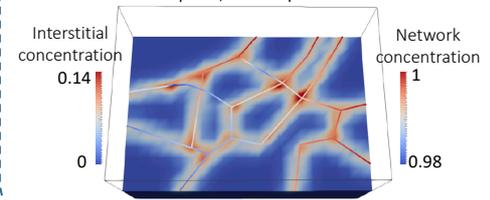
Adapted from: Possenti et al. IJNMBE (2018)

Complex network geometries including many vessels and different vascular radii along the network.



Adapted from: Possenti, PhD thesis (2018)

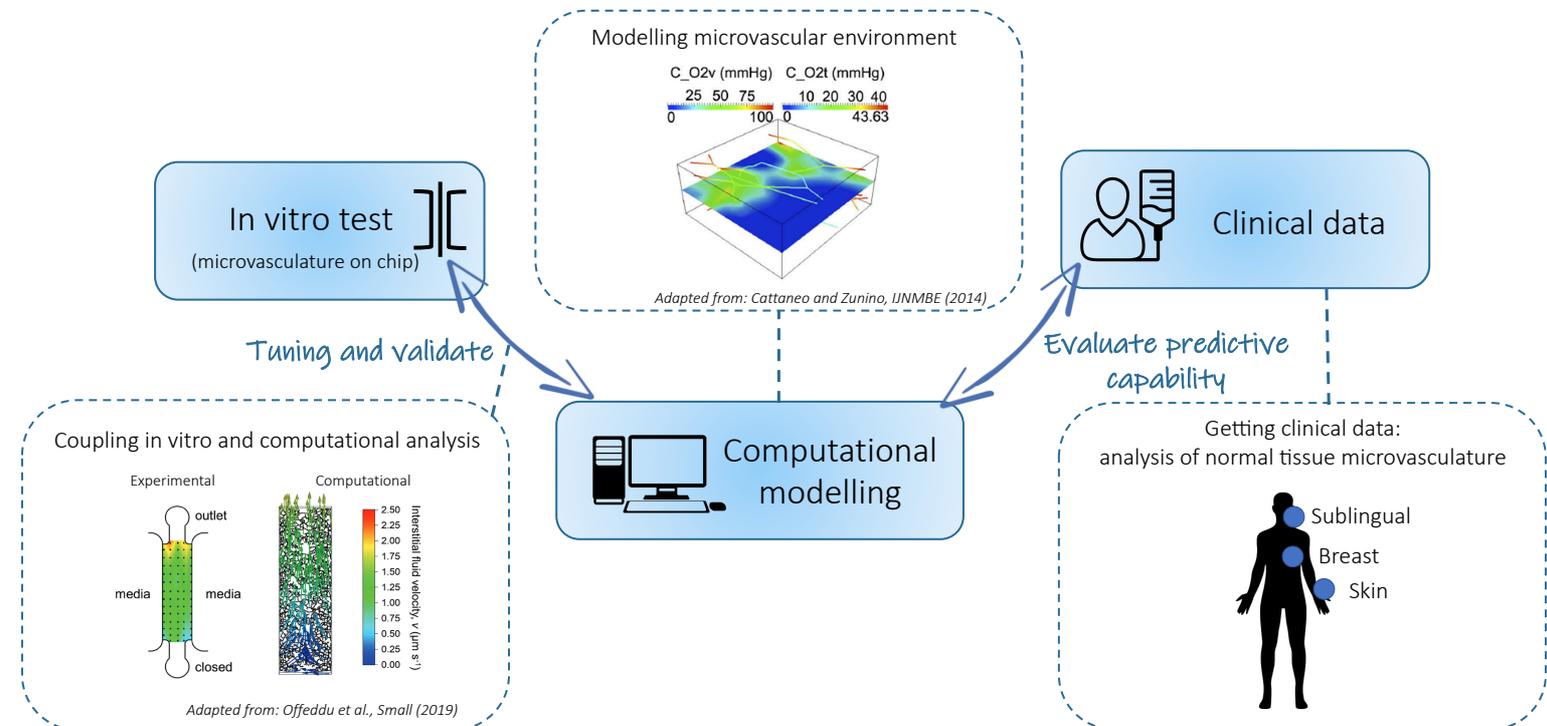
Multiphysics description of the microvascular environment: fluid dynamics, mass and heat transport, nano-particles



Adapted from: Tiozzo, Master thesis (2018)

Project outline

We propose a multi-modal approach to test the hypothesis that the microenvironment affects radiotherapy outcome on both normal tissue and cancer. The computational model has a pivotal role in this study allowing the comparison of experimental and clinical data with modelling results in this complex scenario.



The computational model enables the spatial description of the vascular microenvironment, and it has been used to compare outcome of different tumour treatments. The computational model has already been used to describe both artificially generated networks and microvascular network from in vitro studies, paving the way for computational-experimental interactions. For these reasons, the computational model interaction with experimental and clinical data enables the mechanistic analysis of phenomena involved in radiation damage to microenvironment.

References

- Cattaneo and Zunino, *International Journal for Numerical Methods in Biomedical Engineering* (2014) • Cattaneo and Zunino, *Networks & Heterogeneous Media* (2014) • Nabil et al., *Royal Society Open Science* (2015) • Nabil and Zunino, *Royal Society Open Science* (2016) • Tiozzo, *Master thesis at Politecnico di Milano* (2017) • Possenti et al., *International Journal for Numerical Methods in Biomedical Engineering* (2018) • Possenti, *PhD Thesis at Politecnico di Milano* (2018) • Pascucci, *Master thesis at Politecnico di Milano* (2018) • Possenti et al., *Microvascular Research* (2019) • Offeddu et al., *Small* (2019)