This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 801126 (EDIT).

EDIT – H2020-FETOPEN-2016-2017

https://www.edit-h2020.eu/

Title: Novel precision technological platforms to promote non-invasive early diagnosis, eradication and prevention of cancer relapse: proof of concept in the bladder carcinoma

Unmet clinical needs in the management of bladder cancer (BCa) are the prevention of tumour onset, progression and relapse, and therapy of the aggressive carcinoma in situ (Cis), requiring weekly treatments and prolonged follow-up, with a poor quality of life and the highest cost per patient among all cancers. Therefore, early BCa detection protocols are required to improve the management of this disease. An advanced technology is proposed, termed EDIT, combining a novel high-resolution ultrasound elastography and photoacoustic imaging on the bladder instilled with targeted plasmonic gold nanorods (GNRs). EDIT approach exploits the structural and mechanical properties of the bladder extracellular matrix (ECM) as a unique biomarker of the early onset/progression/relapse of carcinoma. Engineered novel GNRs targeted at the ECM are used as intravesical antennas generating photoacoustic signal which with the help of machine learning algorithms (MLAs) identifies areas of increased stiffness of ECM that is associated with progression of cancer. The results are conveniently presented in a visualization platform. EDIT is designed to detect preneoplastic area and eradication of local areas at few cell resolution with high sensitivity and specificity. GNRs will be further utilized as heat-releasing effectors at nanoscale for targeted cancer photo-thermal therapy.
Outcomes of EDIT will revolutionize the management of BCa with the introduction of sensing and effector nanotechnologies combined with non-invasive organ imaging with high resolution/definition by 3D ultrasound and photoacoustic imaging.
EDIT platforms will also pave the ways for the earlier management of other bladder-related pathologies and solid tumours.

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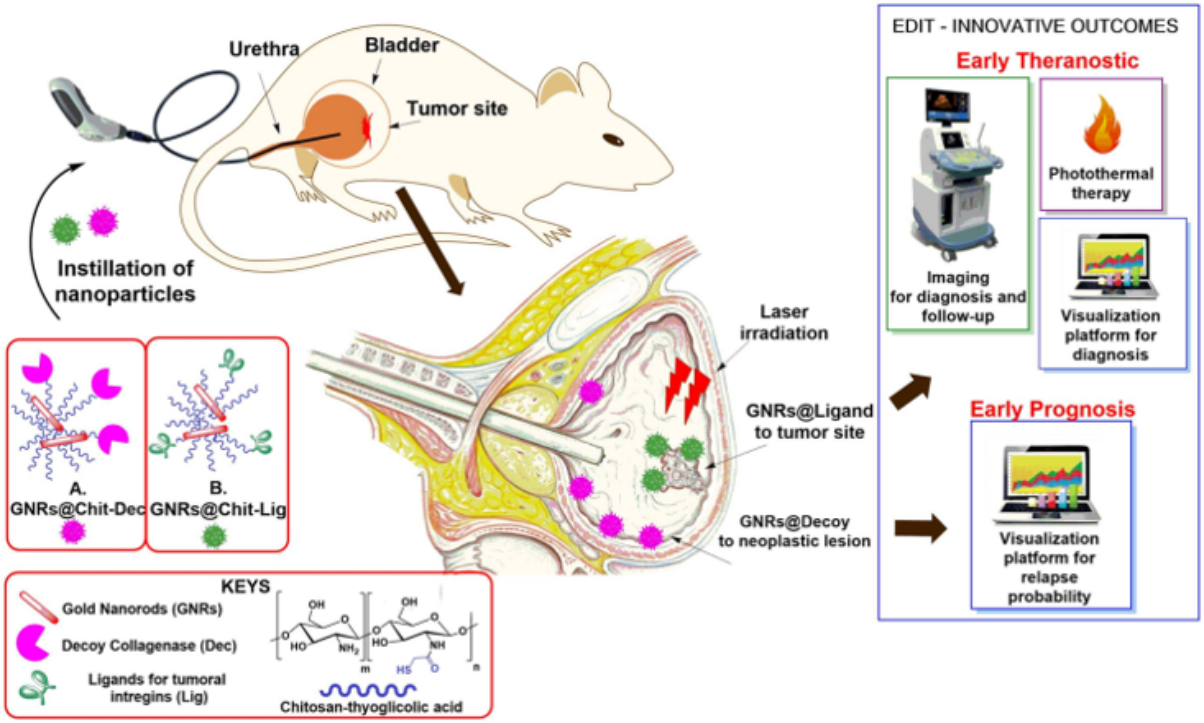
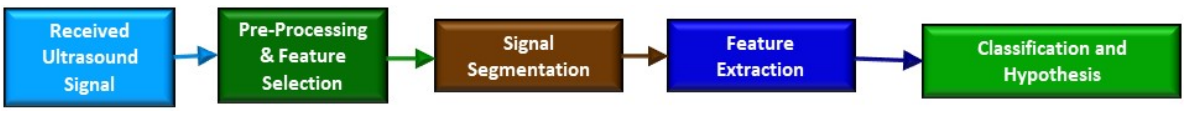


Role of Ascend Technologies Ltd in the EDIT project

The main role of Ascend Technologies in EDIT project is: (i) development of machine learning algorithms (MLAs) for identification of early tissue modification, and (ii) heat-transfer models for estimating the required diagnostic and treatment parameters (GNRs concentration, pulse duration, LASER radiation intensity).

1. Machine Learning Algorithms

The data obtained from backscattered power spectrum of the radiofrequency echoes and sound beam attenuation will be used to differentiate between healthy and diseased tissues in the bladder wall.



Pre-processing and feature selection

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The received ultrasound signal is pre-processed which also includes filtering out the unwanted parts of the signal, e.g., noise, unwanted frequencies. Chromophore feature selection is carried out in order to identify those that are strong indicators of cancer.

Signal Segmentation

Separating sections, or segments, of the signal which are likely to contain significant information for the classification of tissue by using MLA. The algorithms are usually: distance-based segmentation; the model-based segmentation; and hybrid techniques.

Feature Extraction

MLAs will be used for feature extraction characteristic for the non-tumoral and neoplastic tissue. A number of MLAs that can be classified as, e.g., Support Vector Machines, Random Decision Forests and Neural Networks will be tested, as well as hybrid/cascaded methods, and the best selected for further work.

Classification

The end result is an algorithm which is capable of determining the regions of neoplastic tissue. It is expected that the algorithm will become more accurate as there will be more data available.

Features that may be used: (i) peak amplitude of the signals; (ii) major chromophore concentrations (oxy-hemoglobin, deoxyhemoglobin, water and lipid); (iii) Fourier transform of the signal at each pixel location; (iv) various characteristics of the Fourier transform of the signal (slope, mid-band fit and intercept from a straight line fit to the Fourier transform data, centroid frequency values in the Fourier transform).

Data obtained on stiffness of healthy as well as neoplastic tissue, measured by state-of-the-art atomic force microscopy (AFM), will be used for development, training and validation of the machine learning algorithms. This analysis should help us determine the best combination of algorithm / RF features to be used.

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2. Heat Transfer Model

A heat transfer model is developed for both modes of operation, diagnostics and treatment. The model considers the GNRs on the luminal side of the bladder wall as heat source and calculates the temperature rise in the surrounding tissue. The model will be used to calculate the maximum concentration of GNRs, for a given laser radiation intensity, which will not cause damage to the surrounding tissue during diagnostics. The model will also provide the information on the minimum concentration of GNRs which will be effective during treatment and also impact of the treatment on the surrounding bladder wall tissue. The results from this task will provide the information on the required concentrations on the luminal side of the bladder wall during diagnostics and treatment.