IHI Call Days | Call 9 (Topic 2 – So2)

Immune cell imaging in cancer patients with AI/ML tools for the genomic and phenotyping estimations of immunotherapies response in solid tumors

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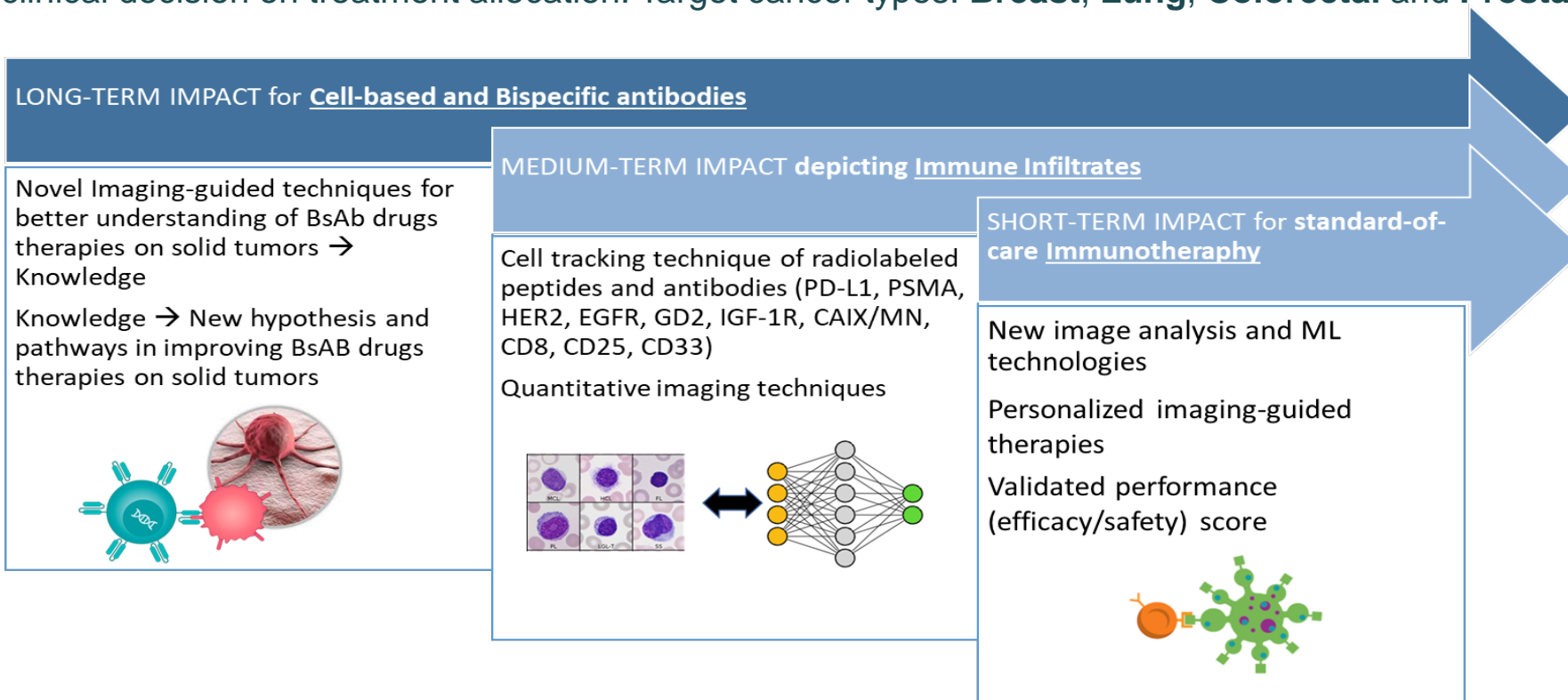
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Link to the IHI brokerage platform:

- Proposal sharing tool: link
- Participant profile: link

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Challenges and objectives

The specific challenge to be solved is to provide early evidence of improved cancer patient care when using next-generation computational image technologies and image-guided solutions as part of cancer therapies.

The project will develop a new generation of **imaging-based guidance and decision support** technologies in cancer management. The project will be focused on researching the applicability of **AI models to several imaging modalities** (CT, MRI, PET/CT, PET/MR, SPECT/CT) for **immunotherapies** and treatment follow-up in the approved immunotherapy drugs for solid tumour malignancies to the clinical decision on treatment allocation. Target cancer types: **Breast**, **Lung**, **Colorectal** and **Prostate**.

LONG-TERM IMPACT for <u>Cell-based and Bispecific antibodies</u>

Novel Imaging-guided techniques for better understanding of BsAb drugs therapies on solid tumors → Knowledge

Knowledge → New hypothesis and pathways in improving BsAB drugs therapies on solid tumors

MEDIUM-TERM IMPACT depicting <u>Immune Infiltrates</u>

Cell tracking technique of radiolabeled peptides and antibodies (PD-L1, PSMA, HER2, EGFR, GD2, IGF-1R, CAIX/MN, CD8, CD25, CD33)

Quantitative imaging techniques

SHORT-TERM IMPACT for standard-of-care <u>Immunotheraphy</u>

New image analysis and ML technologies

Personalized imaging-guided therapies

Validated performance (efficacy/safety) score

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Your approach to solve the problem

IMMUNAGE will develop a customized and <u>trustworthy solution</u> consisting of a set of **AI-based digital biomarkers** integrating both:

1) **repositories** of imaging and related health data with

2) **data management AI tools** (automated data anonymization, harmonization, image segmentation, annotation, among others),

3) **imaging biomarkers** (radiomics, deep features, radiogenomics, pathomics),

4) **AI/ML-based algorithms** for immune-related aspects on cancer growth and image-guided therapies,

5) **advanced visualization tools** to help interact with clinical pathways and decision supports tools and

6) implemented **explainability** approaches to strengthen t**rust in AI/ML**

Image-guided diagnosis & Decision support

Diagnosis	**Prognosis**	**Therapies follow-up**
▪ VIRTUAL BIOPSY: Identification and validation of Imaging Biomarkers ▪ Machine Learning models to assist Diagnosis, using Imaging Biomarkers in combination with molecular biology and clinical data	▪ CANCER GROWTH: Multiscale approach from molecule to tissue ▪ Simulation delivered for different scenarios (e.g. treatments) and local environments ▪ Diagnosis data as inputs	BIOMARKERS PROGRESSION Earlier identification of patients not responding to the treatment, by automated longitudinal assessment of biomarkers vs clinical endpoints by Big Data techniques

- ▪ Providing information on confidence scores to the user
- ▪ Targeted to support decisions for specific clinical endpoints of high relevance
- ▪ Implementing advanced visualisation tools to facilitate interpretation
- ▪ Validated in application context of existing and novel therapies for tumors.
- ▪ Implemented explainability approaches to strengthen trust in AI/ML

Cloud Infrastructure

- ▪ IMMUNAGE Platform implements IT security and Trustworthy measures.
- ▪ An Cloud infrastructure is implemented for storage of data and models
- ▪ Linked to HPC resources for optimised simulation running performance
- ▪ Assisting allocation of simulation modules to computational resources, to facilitate use by non-experts in bioinformatics
- ▪ With intuitive user interfaces and with APIs for interoperability with 3rd parties tools

Data and models repositories

- ▪ IMMUNAGE imaging bank (curated data from all clinical partners + links with all major cancer imaging projects in the EU (already members of the IMMUNAGE consortium)
- ▪ Contributing to on-going international clinical data repositories
- ▪ Contributing to standardization of imaging protocols for acquisition and processing
- ▪ Promoting reuse of IMMUNAGE data repositories and models by the scientific community
- ▪ Promoting integration of additional databases and models from external collaborators

Evaluation and validation framework

- ▪ Robust AI/ML validation and evaluation framework for imaging and image guided diagnosis and image-guided therapy for specific tumours.

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Is your project suitable for IHI?

- **IHI Nature**: IMMUNAGE's inner nature is private-public collaboration. It focuses on progressing in R&D in-silico tools for the clinical management of cancer, given its enormous potential to contribute to delivering personalized diagnosis and treatment. **Personalized medicine in cancer will become the standard of care only if solid, well-thought-out, and constant collaboration occurs between public and private players**.

- **IHI large-scale**: IMMUNAGE is a project that can benefit millions of cancer patients. It is size will be of an estimate of **14-22 partners**, €35 million and 5-6 years duration.

- **IHI Industry contribution:** IMMUNAGE needs the multidisciplinary approach that a strategic and well-planned private-public collaboration requires. Combining expertise from them is crucial for:

  1) **Developing end-to-end solutions** (from image acquisition and processing to AI model development and clinical validation)

  2) **Ensuring real-world applicability** (solutions developed are to be relevant to clinical practice and integrated into existing workflows);

  3) **Accelerating innovation** (knowledge sharing produces further knowledge and new research and commercial opportunities, bringing results in the short, medium and long terms into the market, and hence in the society)

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Outcomes and Impact

1 Improve **knowledge of disease** diversity / subtype	**2** Identify **high risk patients**	**3** Identify **patients most likely to respond**
4 Allow faster, less expensive **drug approval**	**5** Aid in development of safer treatments, thus **reducing the risks and costs of AEs**	

- Some key expected results:

  - **Machine Learning modelling** (generating knowledge from common patterns in big data): Predictive models to assist cancer diagnosis and prognosis, related to (1) risk assessment (identification of high risk patients), (2) the prediction of response to immunotherapy and (3) the prediction of outcomes/endpoints (i.e. progression free survival, overall survival).

  - **Multiscale modelling of functional interactions**: Models to simulate intra and inter-cellular signalling networks for analysing aspects such as interactions between cancer cells and immune cells of the same patient. Also, models of the information flow in regulatory information cascades, to analyse the transcriptional, proteomic and metabolic representations of various cellular alterations/perturbations

  - **Big Data**: the consortium members and their network of hospitals and biobanks can provide **more than 91.000 patient cases in different cancer types, all of them high-quality datasets**. The generation of quality datasets is a resource-intensive endeavour, facing technical, legal, ethical and IT challenges related to the establishment of metadata, data curation and annotation. Sharing of data is not only important from a perspective of resource efficiency, also to enable cross-validation of data and the evaluation of the new image-guided therapies and techniques resulting from the project.

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Expertise and resources

Consortium:

- Leading **Scientific, Clinical and Technical experts,** with **previous relevant results** in Data Repositories and AI/ML tools for prostate, breast, colorectal and lung cancers.

  ✓ Clinical Director: Head of Medical Imaging at Hospital la Fe
  ✓ Research Director: Biomedical Imaging Research Group at IISLAFE
  ✓ Scientific Coordinator: EUCAIM project (European Cancer Imaging Initiative)
  ✓ 600+ scientific publications, *Imaging Insights* Editor-in-chief, Member of the Spain Royal National Academy of Medicine, former President of the European Society of Radiology.

| Oncology | AI/ML | Medical Imaging | Radiology | Digital Pathology | Immunotherapy | Nuclear Medicine |
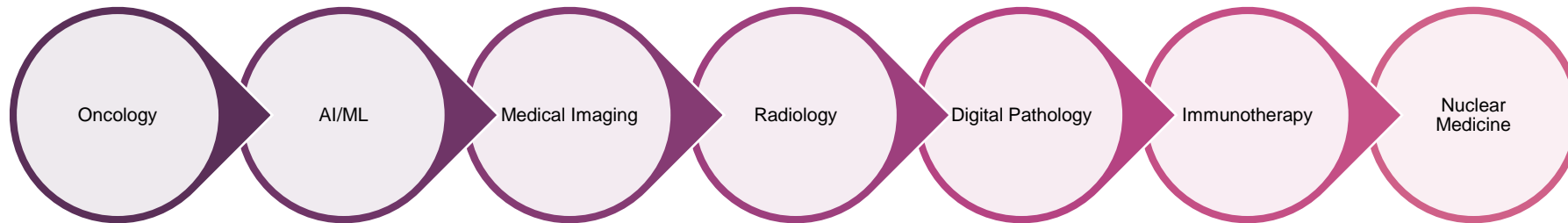
- Leaders of the future **European Cancer Imaging Infrastructure** (EUCAIM) + Leaders from the 5 EU projects in AI, Medical Imaging and Cancer (PRIMAGE, CHAIMELEON, PROCANCER-I, INCISIVE, EUCAN-IMAGE = **more than 91.000 patient cases in different cancer types** (Breast, Colorectal, Lung, Prostate)

Partners sought

- **Pharmaceutical Industry:** IMMUNAGE has the pharmaceutical industry at its core. Pharmaceutical players interested in**:**
  - Provide data on immunotherapy response and patient outcomes; Collaborate on clinical trials to validate AI-based biomarkers; Support the development of companion diagnostics based on imaging biomarkers;
  - Perform collaborative research addressed to R&D AI/ML tools and systems for better, safer, and faster drug development for personalized treatments.
- **MedTech & AI/ML Industry:** in different domains, including:
  - Industry players with commercial and R&D interests in imaging technologies, equipment and systems; data management and data information systems; integration of AI/ML tools in their products and services in healthcare.
  - Interested in collaborative R&D for robust and explainable AI models for image analysis; Creating AI-powered decision support tools for clinicians; Integrating AI models into existing clinical workflows.