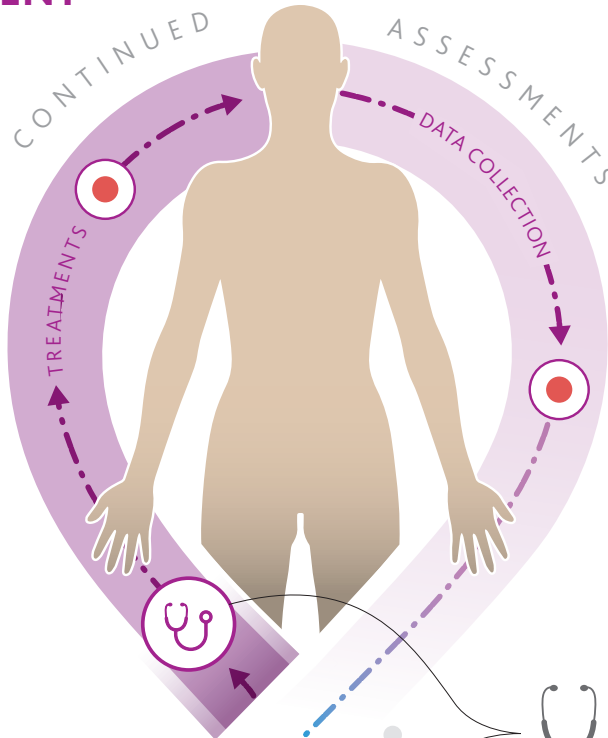


# Digital Twin of a Cancer Patient and Tumor

This example of a digital twin demonstrates the dynamic bidirectional interaction between the real world patient and digital twin to inform clinical decisions regarding interventions including treatments and clinical assessments, which in turn informs the digital twin.

## REAL WORLD PATIENT

The patient and the tumor from which data is gathered using various clinical assessments to inform the digital twin.



### VVUQ

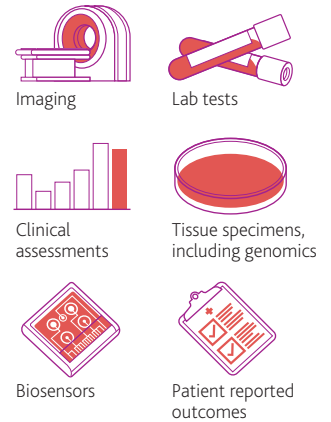
Verification, validation, and uncertainty quantification

As the patient and tumor are constantly evolving and the data collection can also change over time, VVUQ must occur continually for digital twins.

Uncertainty quantification needs to be addressed for all aspects of the digital twin, including the patient's data, modeling and simulation, and decision making.

### Clinical assessments

Data are collected in many ways:



### Human and digital twin interaction

Utilizing the simulated predictions and related uncertainties, the clinician and patient can make informed clinical-decisions around treatment and also the clinical assessments, which affect the data informing the digital twin.

## DIGITAL TWIN

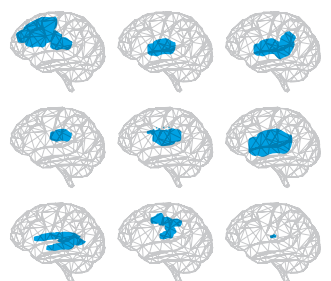
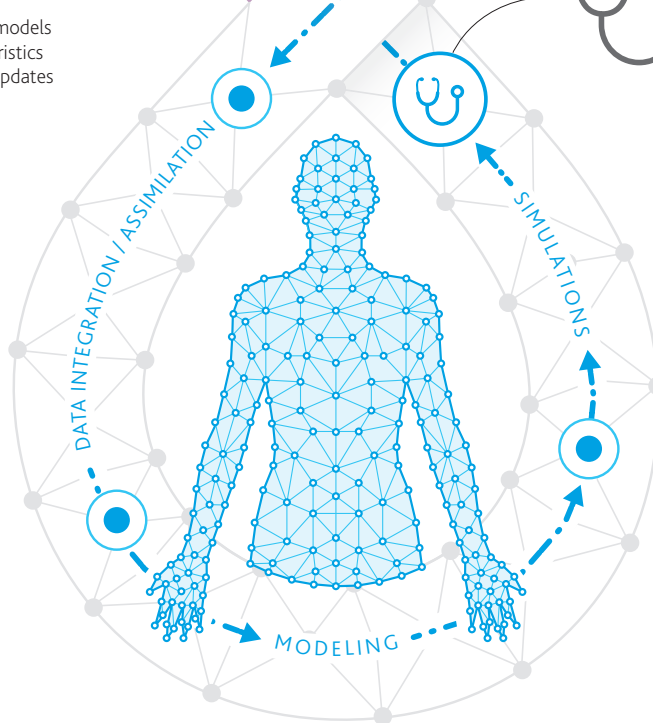
The virtual representation comprised of models describing temporal and spatial characteristics of the patient and tumor with dynamic updates using data from the real world patient.



### Modeling

Models spanning a range of fidelities and resolutions may be utilized and potentially integrated together.

As new observed data are acquired, the data are assimilated and the models are calibrated, updated, and estimated.



### Simulations & predictions

Simulations of potential treatments can generate predictions of outcome and in turn can be optimized to determine the most favorable treatment options.



This information is from *Foundational Research Gaps and Future Directions for Digital Twins* available online at [www.nationalacademies.org/digital-twins](http://www.nationalacademies.org/digital-twins). Copyright by the National Academy of Sciences. All rights reserved.