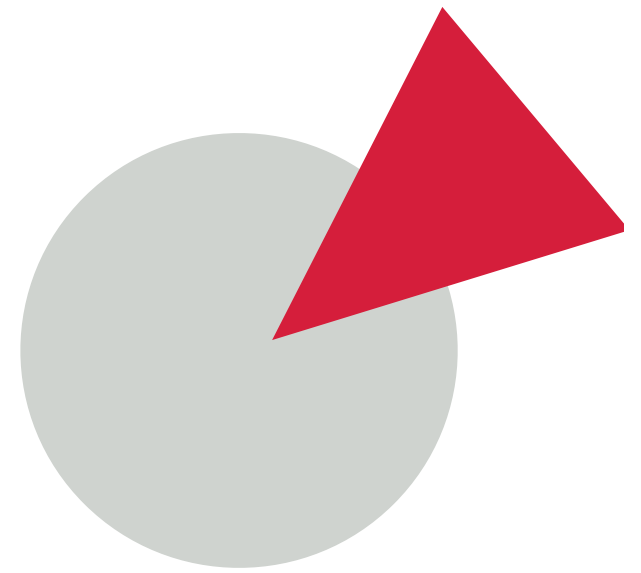


INSIGNEO

Institute for *in silico* Medicine



Insigneo & SoftMech

Marco Viceconti

Executive Director, Insigneo institute



The
University
Of
Sheffield.

Sheffield Teaching Hospitals 
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In silico Medicine? By process



Data



Mechanistic knowledge



Predictive models



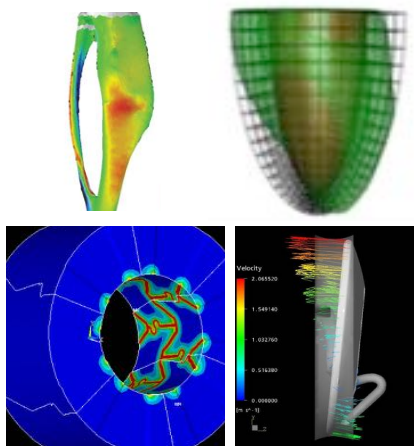
Systems



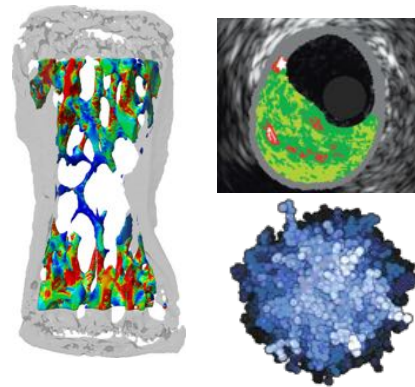
Clinical assessment

In silico Medicine? By Knowledge

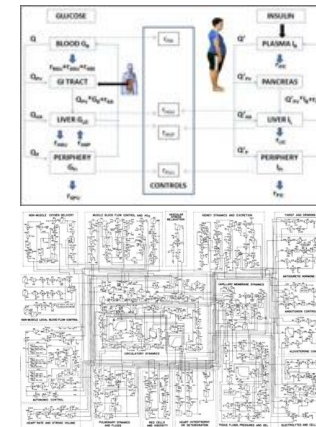
Experimental medicine through the user of computer modelling and simulation



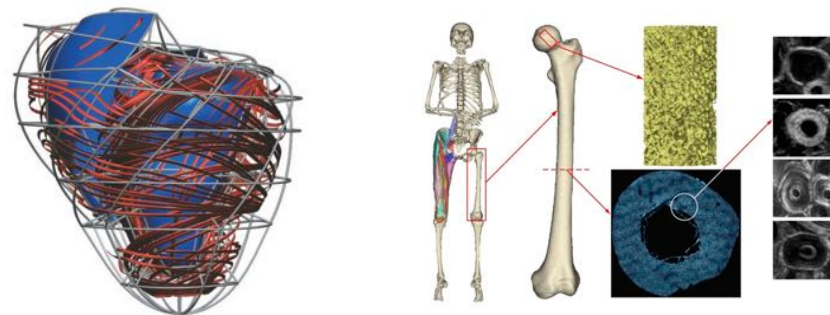
BIOPHYSICS



BIOPHYSICS
BIOLOGY



BIOPHYSICS
PHYSIOLOGY



INTEGRATIVE (MULTISCALE, MULTISYSTEM)

In silico Medicine? By user

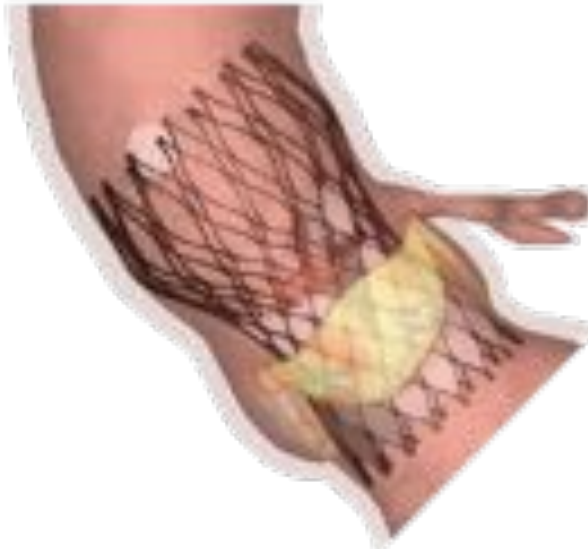
Experimental medicine through the user of computer modelling and simulation



DIGITAL PATIENT

Subject-specific predictions for decision-support, diagnosis, treatment-planning, stratification

FOR THE DOCTOR



IN SILICO CLINICAL TRIALS

Virtual patient cohorts for 3R, surrogate outcomes, augmented clinical trials

FOR THE INDUSTRY



PERSONAL HEALTH FORECASTING

Subject-specific predictive models for mobile and digital health and wellness

FOR THE PATIENT - CITIZEN

In silico Medicine? By use

Experimental medicine through the user of computer modelling and simulation

- Proxy measurement
 - Subject-specific models predict quantities that are difficult or impossible to measure directly from other measurements that are easier to obtain
- Comparative measurement
 - Given a measurement that is subject-specific, use modelling to estimate related quantities that are independent from the individual anatomy or physiology, so that they can be more reliably compared across individuals, or even across species
- Extrapolation
 - Given the value today in a given subject, and the mechanistic knowledge of the biological process, the model predict the value tomorrow in that same subject
- Effect analysis
 - Given the mechanistic model on the temporal evolution of the biological system, and of the effect of interventions on such evolution, predict the effect each intervention will have on that subject
- System dynamics
 - Given mechanistic knowledge of the temporal dynamics of various biological sub-systems (across space-time scales, across organ systems, etc.), use integrative models to predict the dynamic of the whole system

In silico Medicine

- The *In silico* Medicine approach requires a radical transformation on the way biomedical research is conducted
- It is necessary to create a framework of new methods and technologies that enable *in silico* medicine

Virtual Physiological Human



The Virtual Physiological Human is a framework of methods and technologies that once established will make possible to investigate the human body as a whole

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Vision Statement

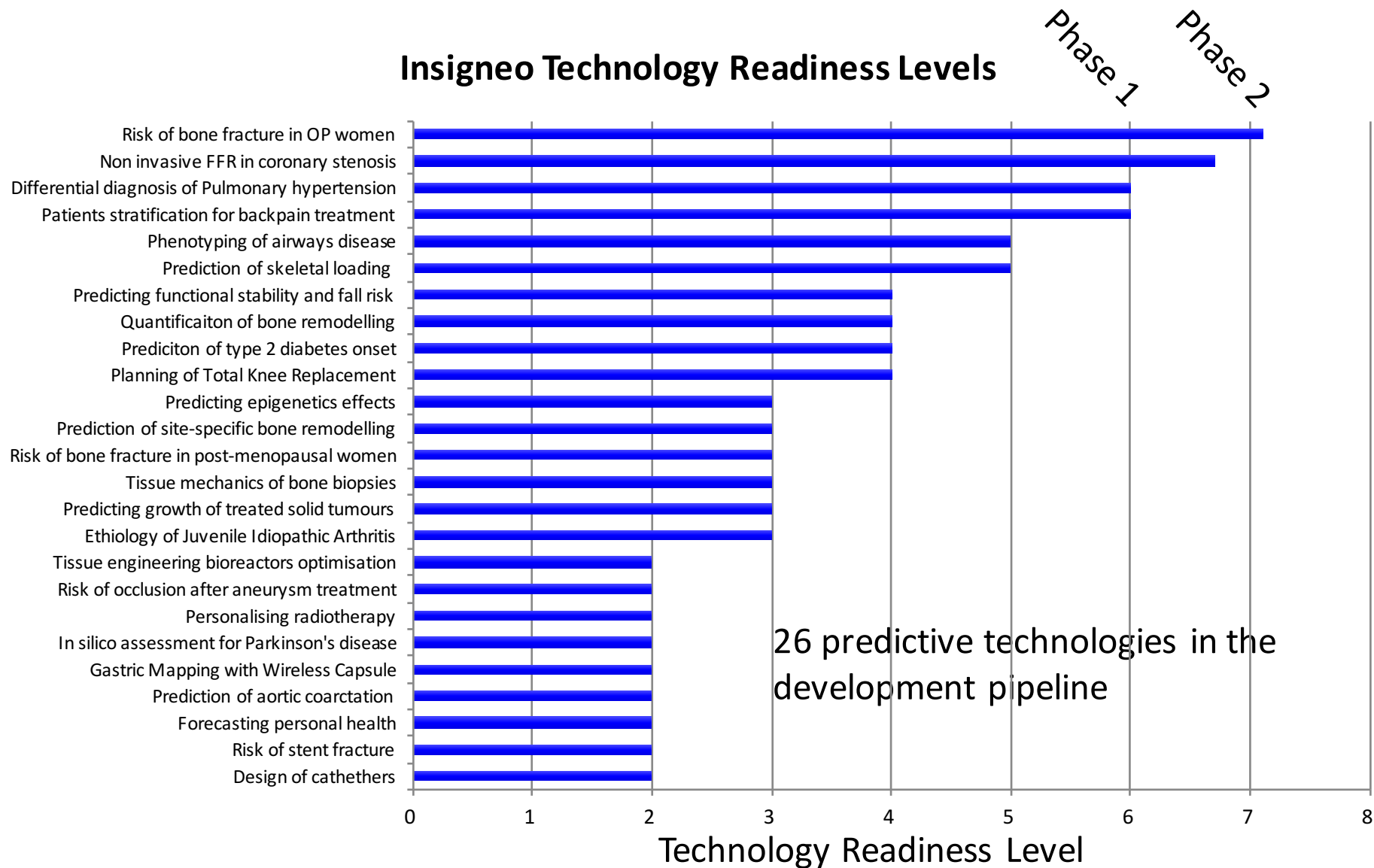


INSIGNEO will realise the scientific ambition behind the Virtual Physiological Human, producing a transformational impact on healthcare.

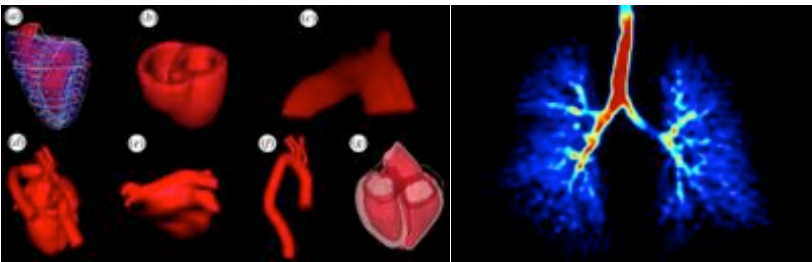
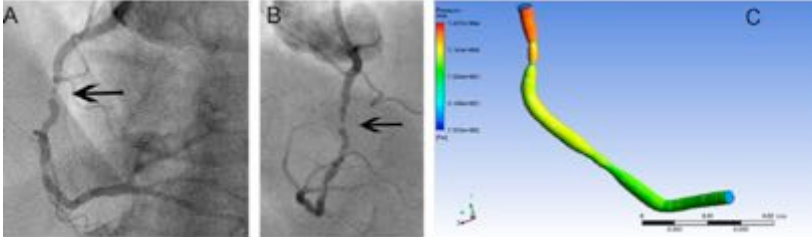
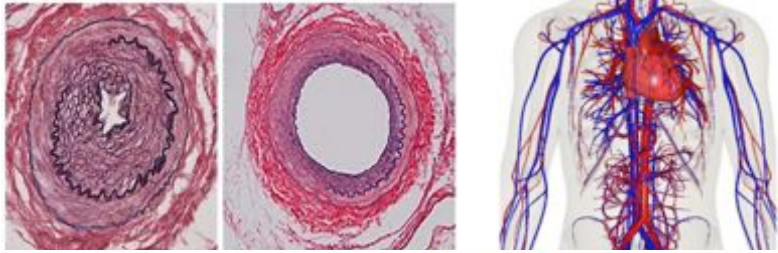
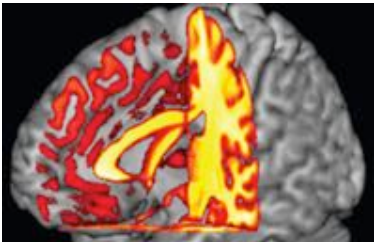
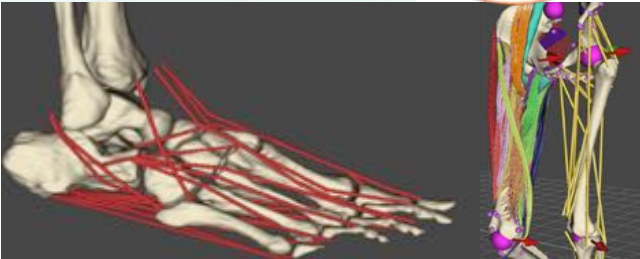
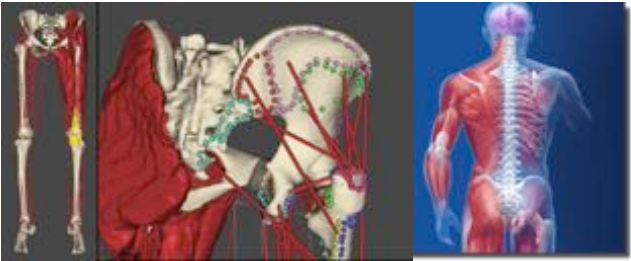
Insigneo by numbers (2015)



Predictive medicine: a reality

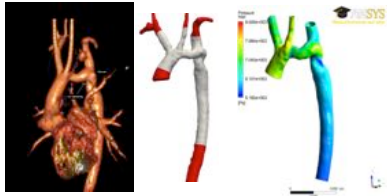


Clinical targets

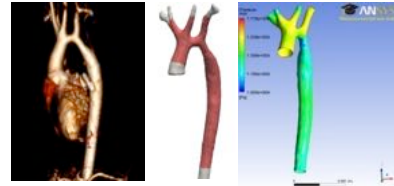


EU-Heart: PPM

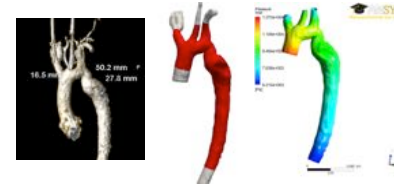
Aortic coarctation, 16 cases, Rest condition, Windkessel BC, KCL & USFD



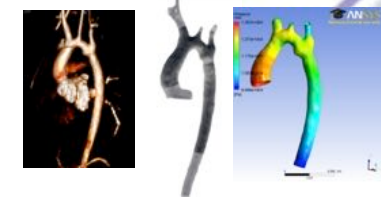
Case 01



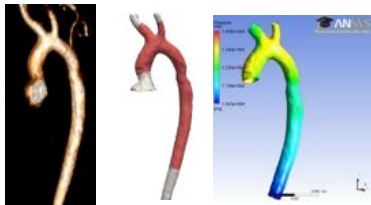
Case 02



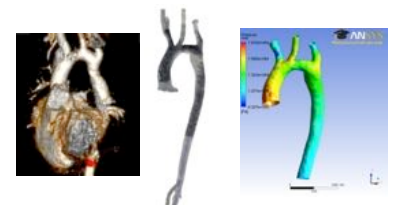
Case 03



Case 04



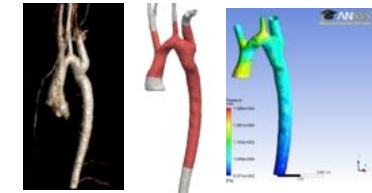
Case 05



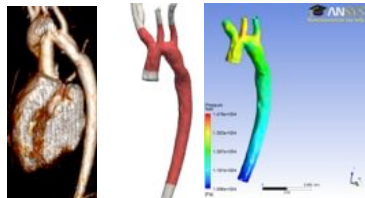
Case 06



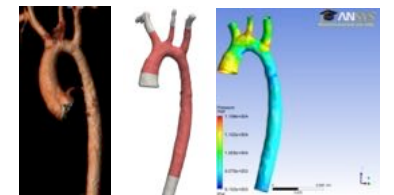
Case 07



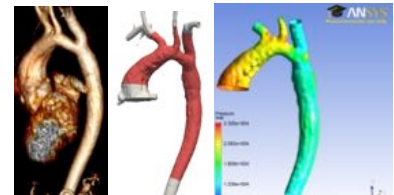
Case 08



Case 09



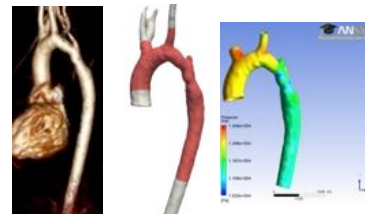
Case 10



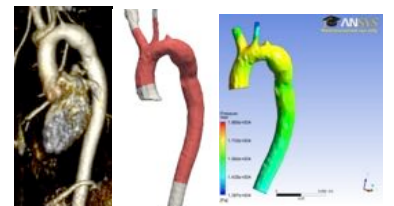
Case 11



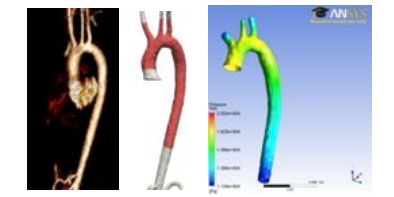
Case 12



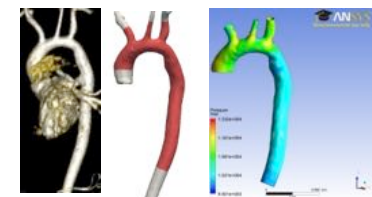
Case 13



Case 14



Case 15

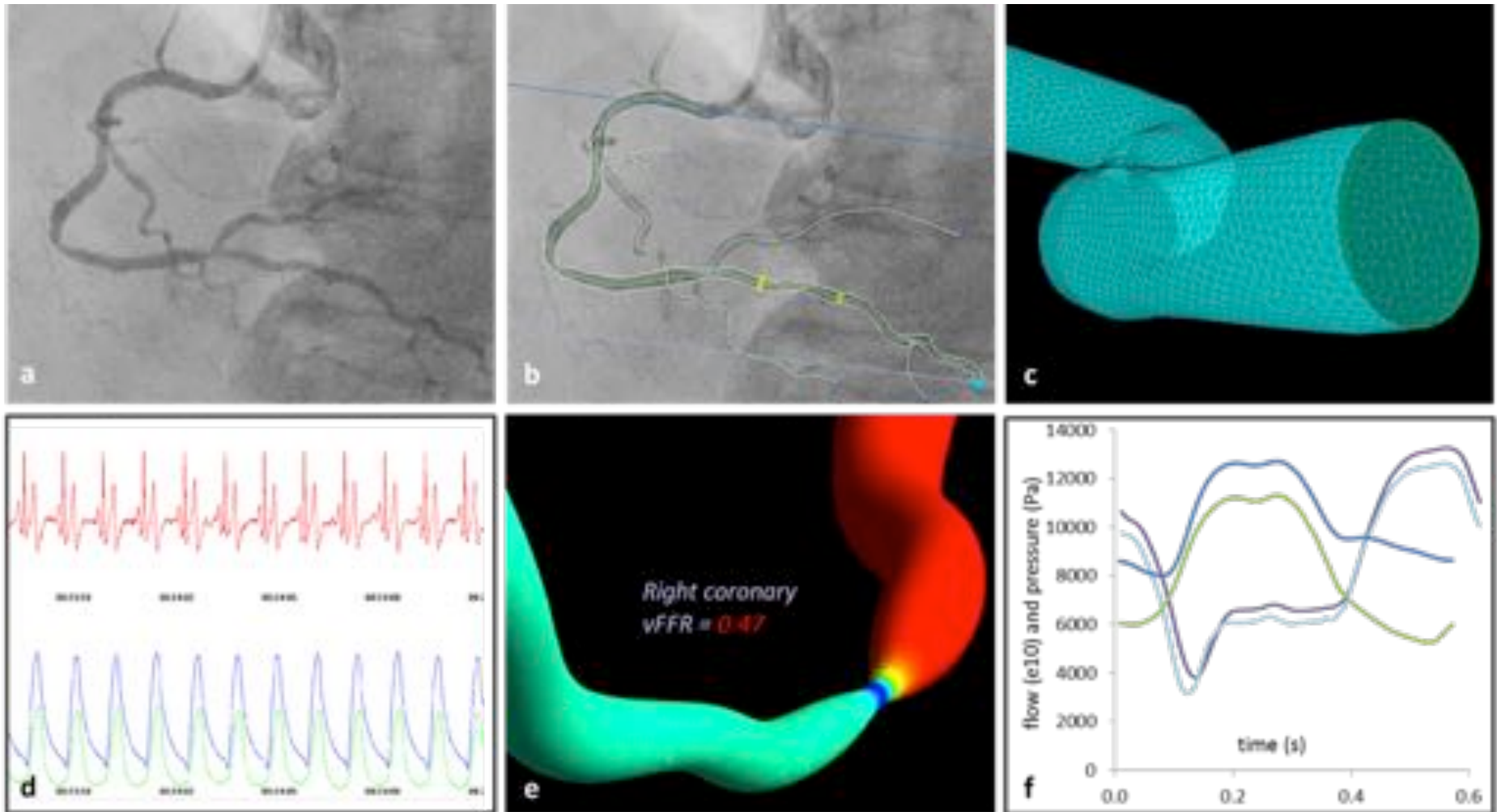


Case 16

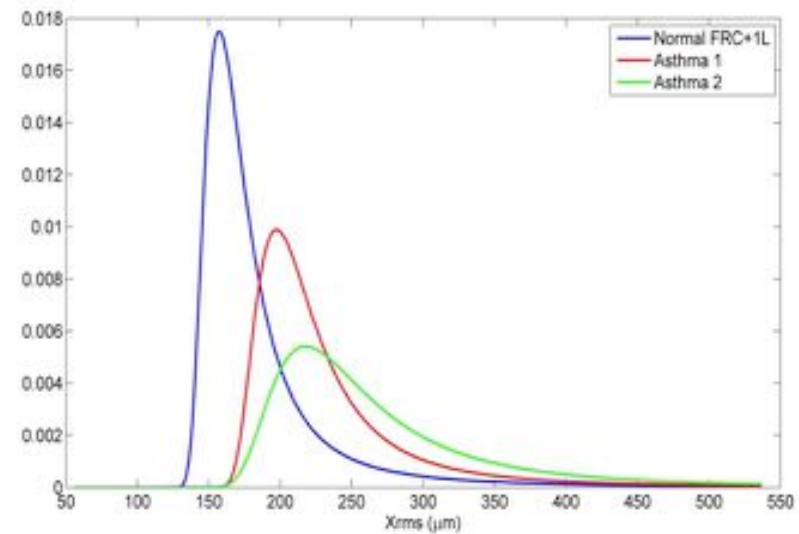
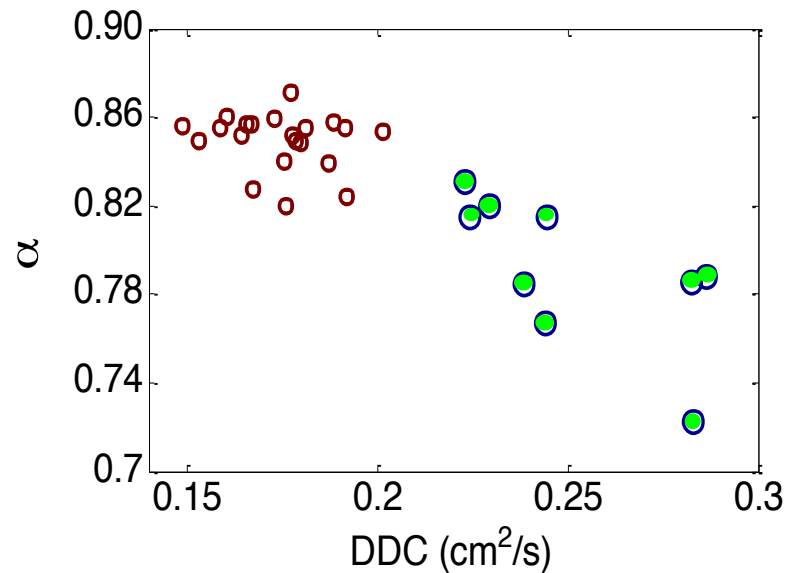
Cases processed by Isra Valverde (KCL), Cristina Staicu (USFD), Yubing Shi (USFD)



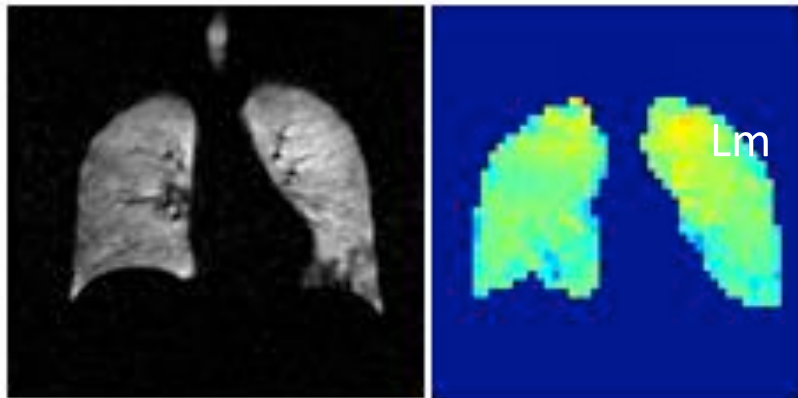
VirtuHeart: Workflow



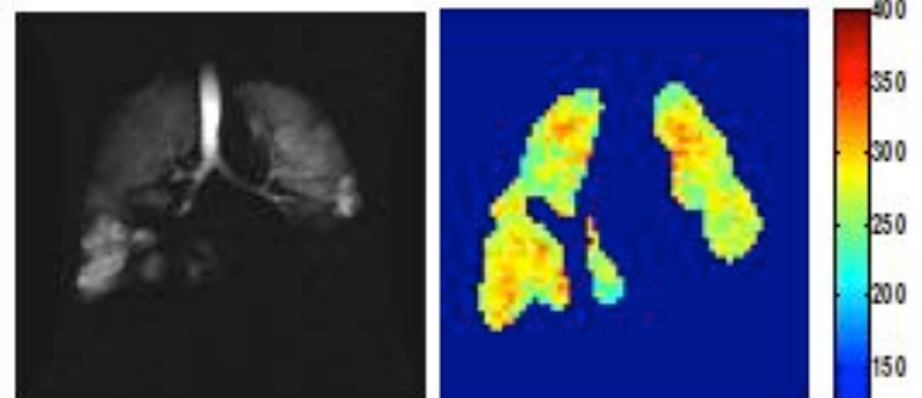
Asthma: Diffusion models of microstructure



Two Asthma 'phenotypes'



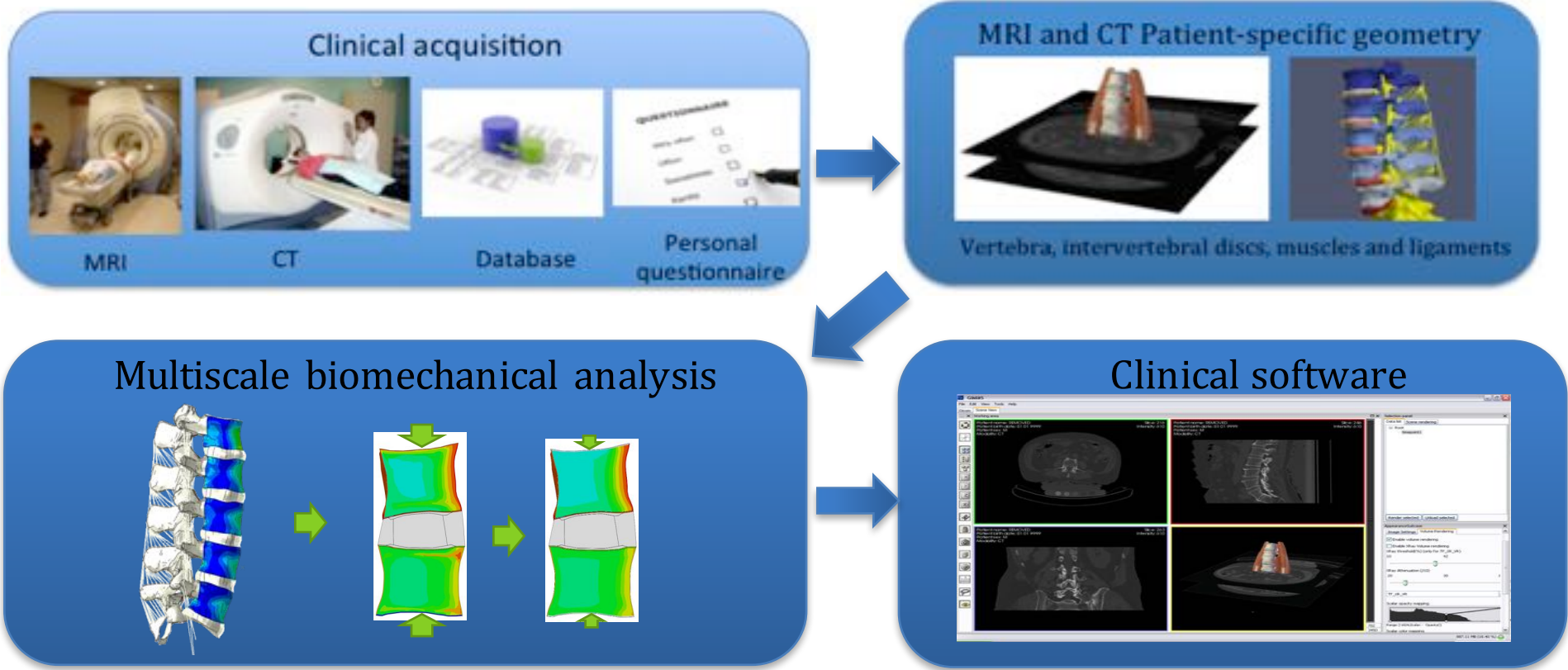
uniform ventilation and normal X_{rms}



heterogeneous ventilation and elevated X_{rms}



Personalised treatment planning



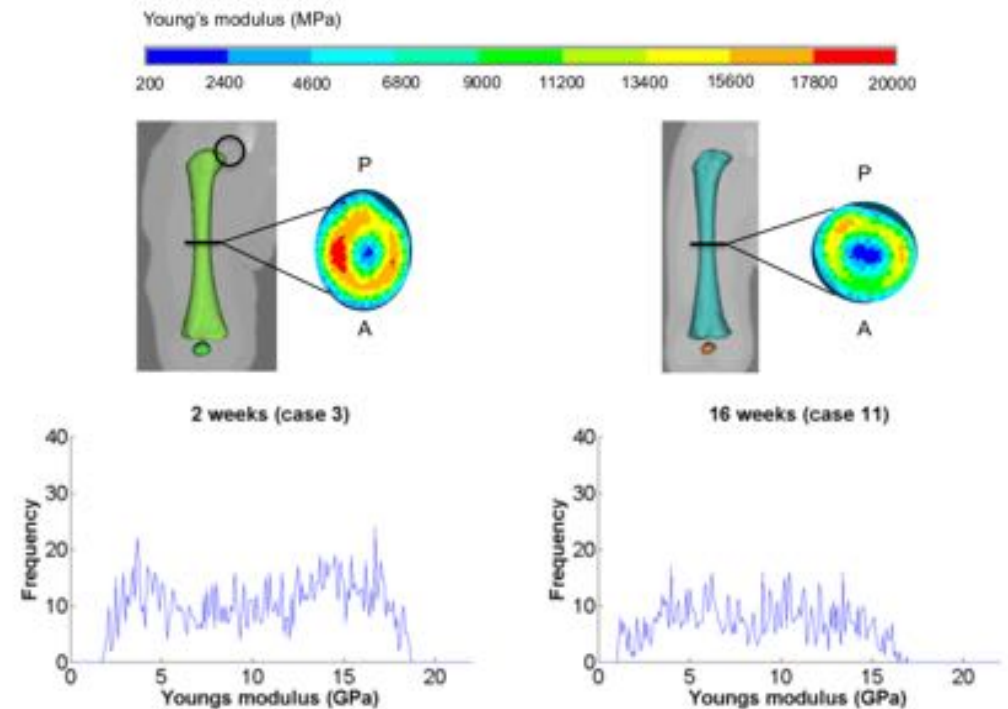
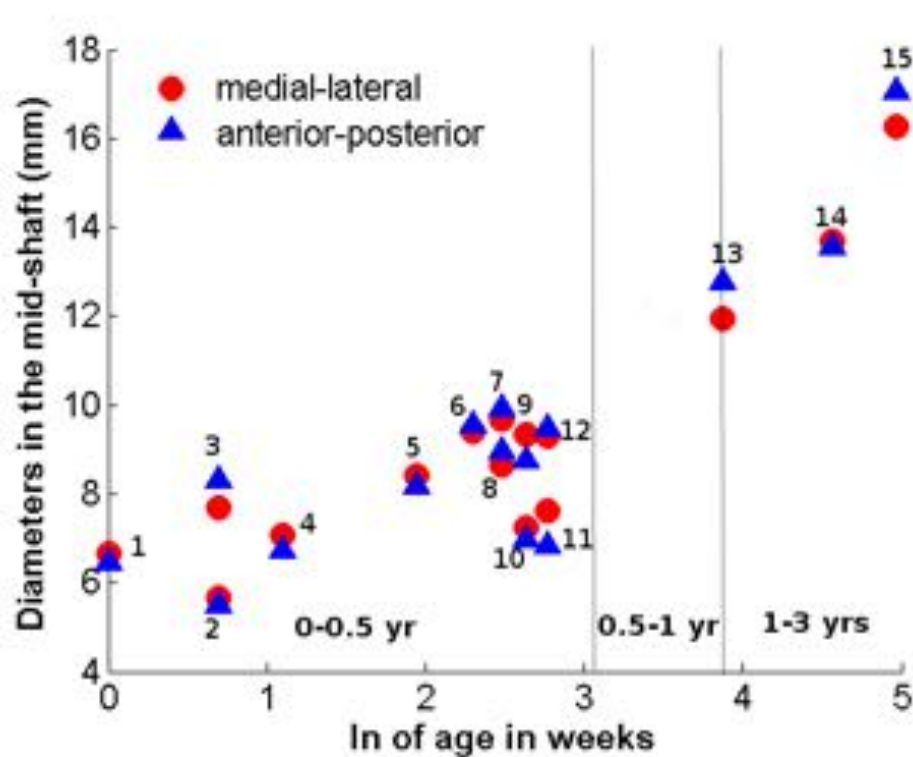
Conservative treatment
 Discectomy
 Spinal fusion



200 patients with 2 year follow-up

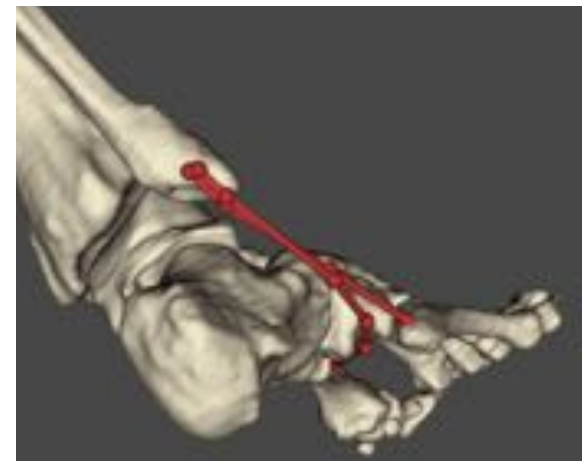
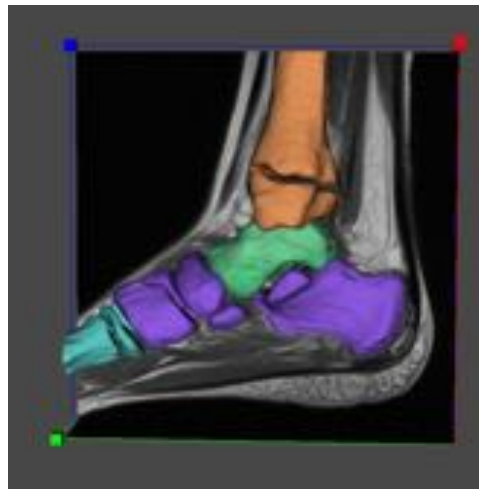


Bone strength in infants



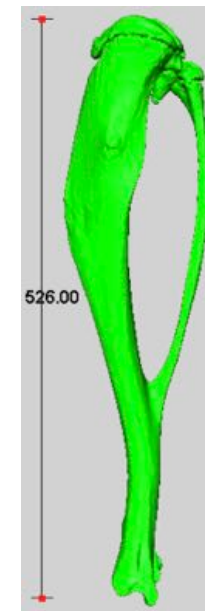
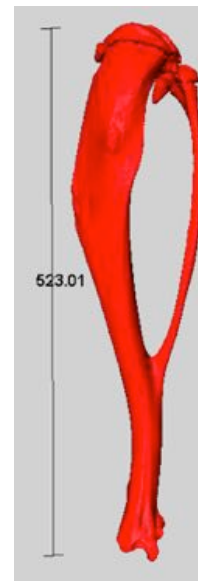
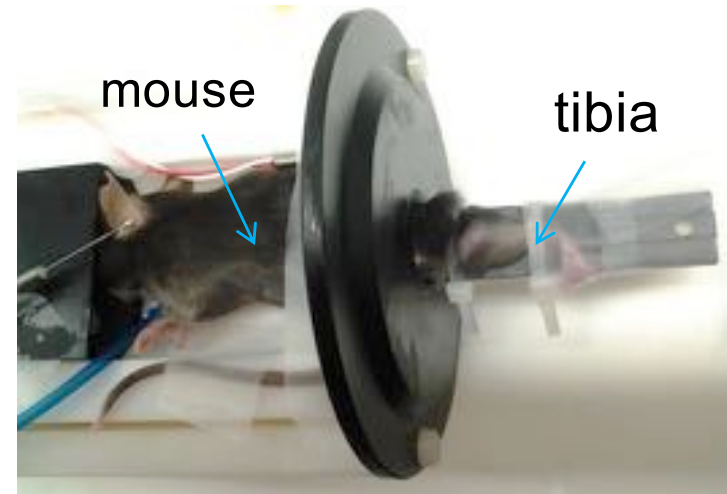
Subject specific gait analysis in JIA children using MRI data

Analysis of the biomechanical determinants of ankle joint damage and bone morphogenesis



Bone morphology and muscles paths are extracted from the images

Animal experimentation: in silico 3R



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Thank You!



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