HEADLINER

Patient digital twins for personalised medicine

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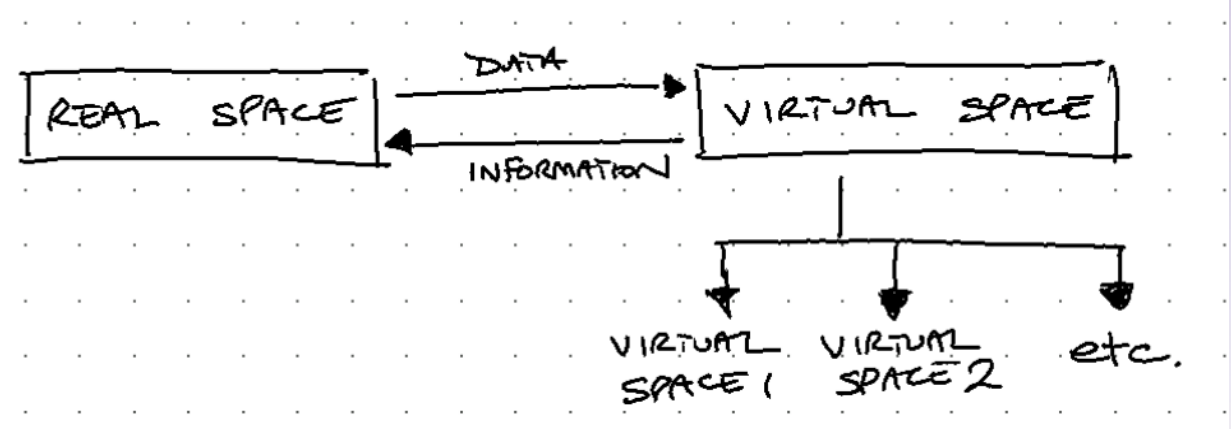
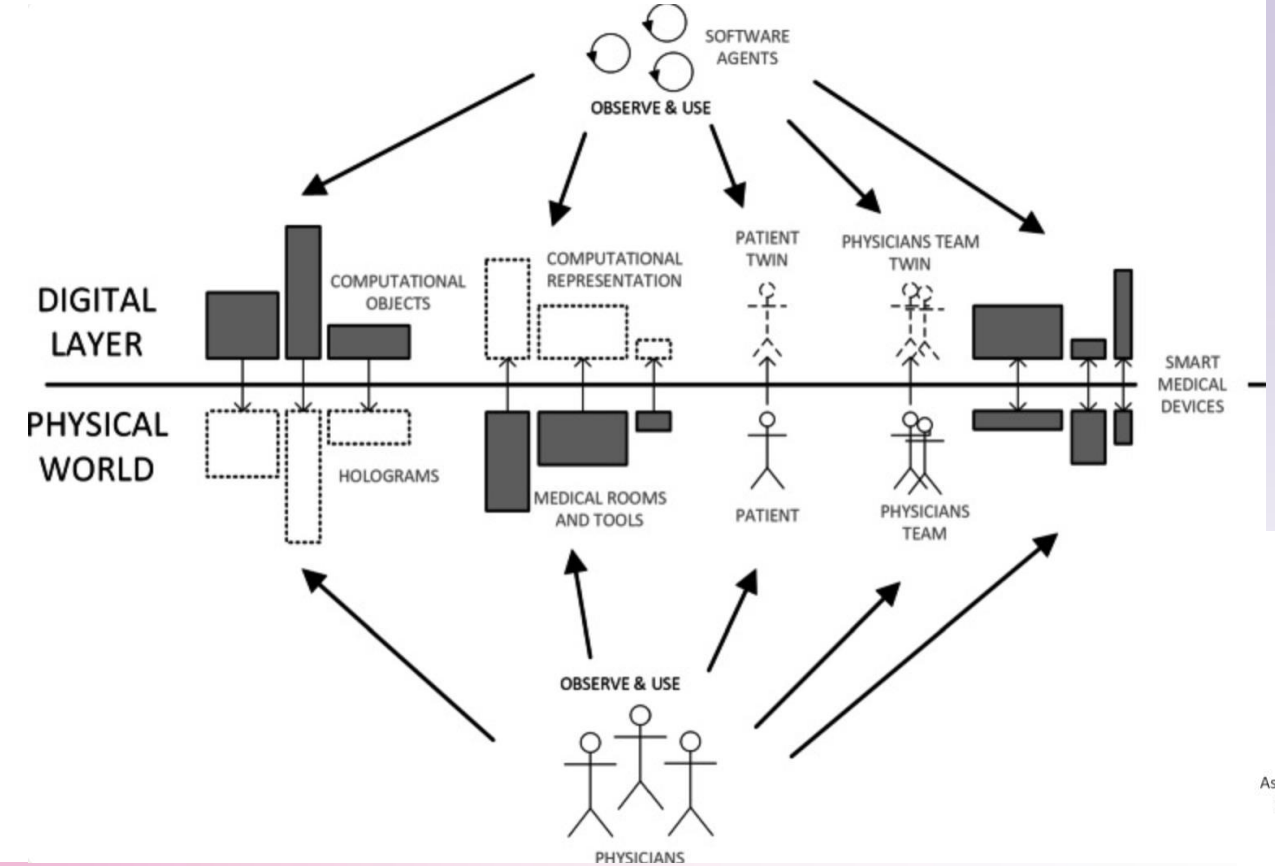
Alder Hey Innovation

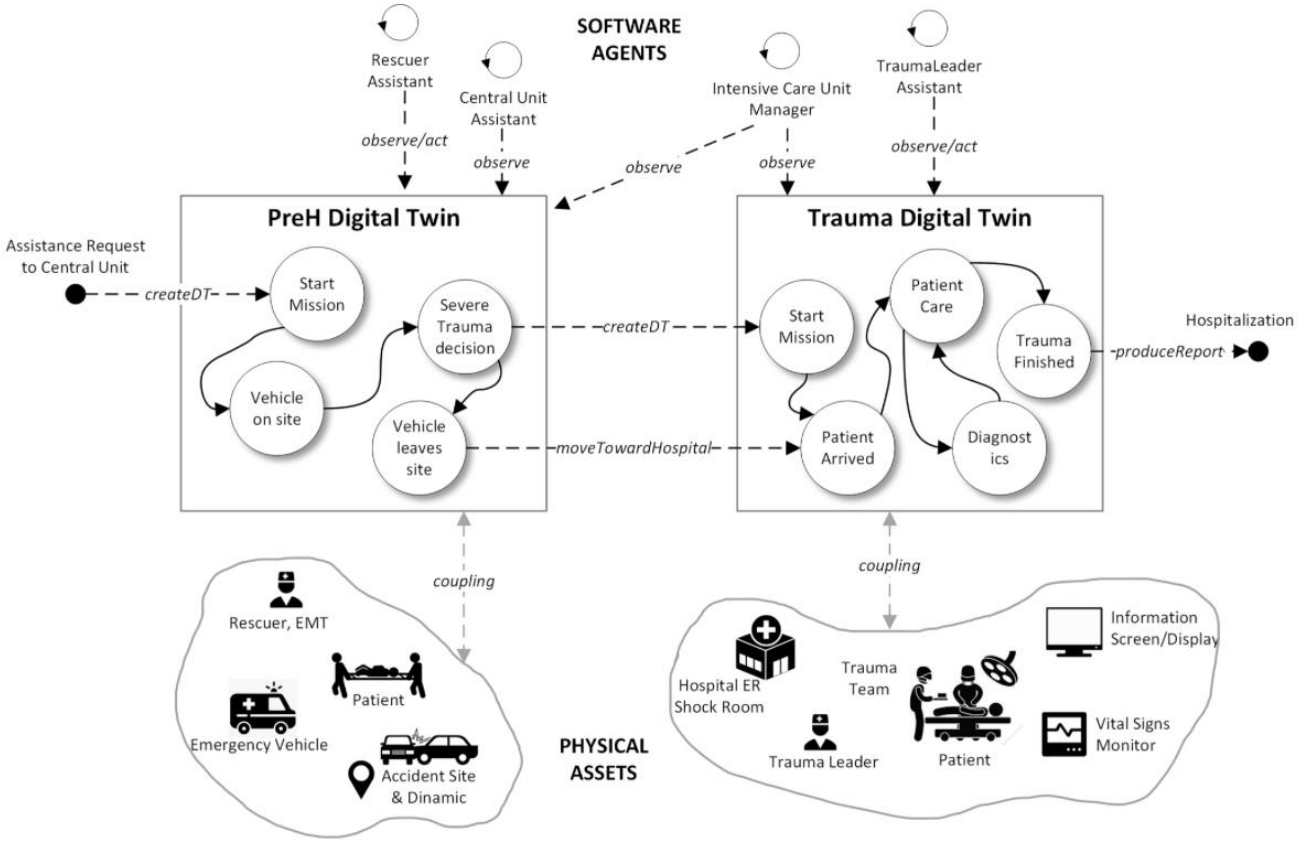


- close monitoring of time-varying physical asset
- precursors = virtual and simulated models
- wide application across industries
  - anomaly detection
  - predictive maintenance
  - early intervention
  - optimisation
  - ‘what-if’ simulation

‘a digital twin is a virtual representation of real-world entities and processes, synchronised at a specified frequency and fidelity’

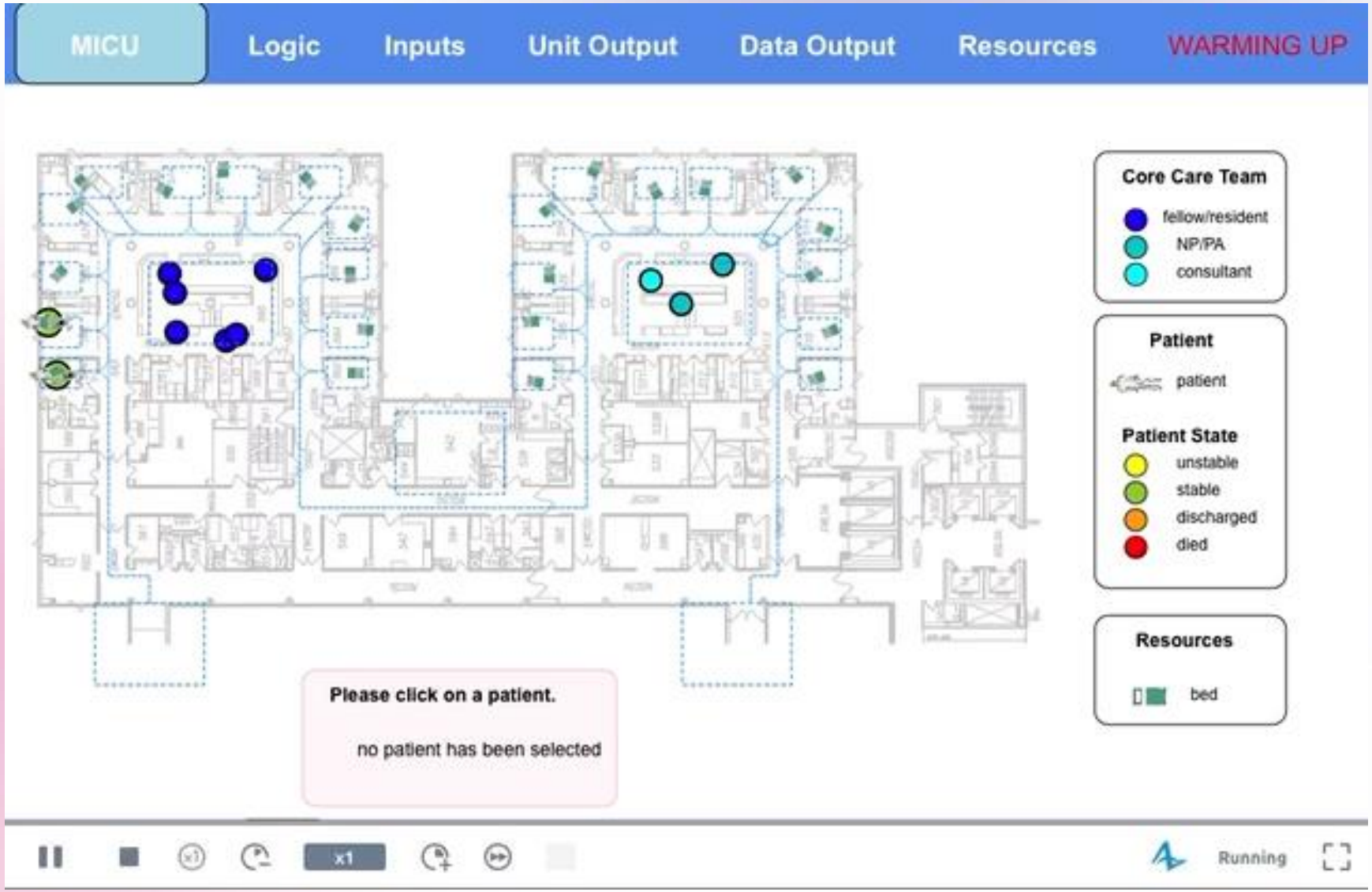
data + a model + update





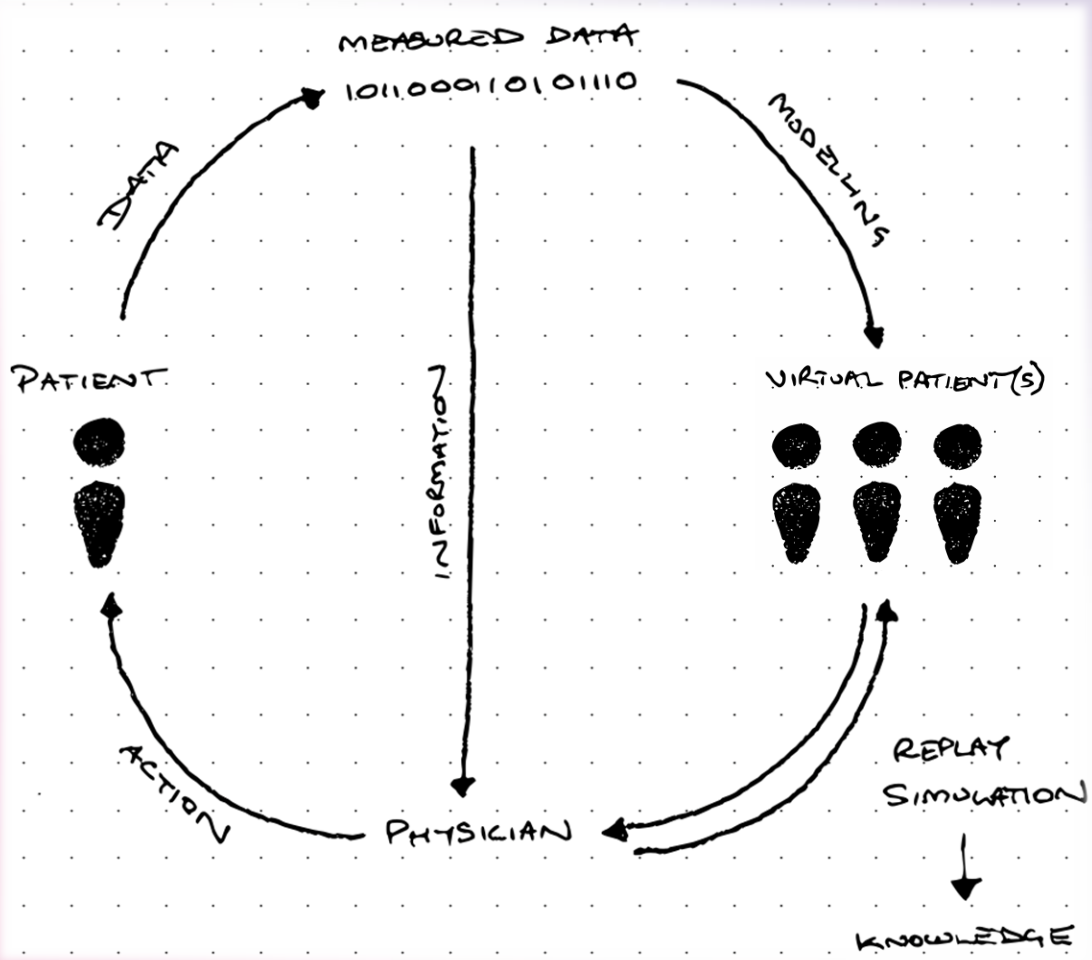
A conceptual representation of the involved digital twins for the trauma management process

Croatti, A., Gabellini, M., Montagna, S. et al. On the Integration of Agents and Digital Twins in Healthcare. J Med Syst 44, 161 (2020). https://doi.org/10.1007/s10916-020-01623-5



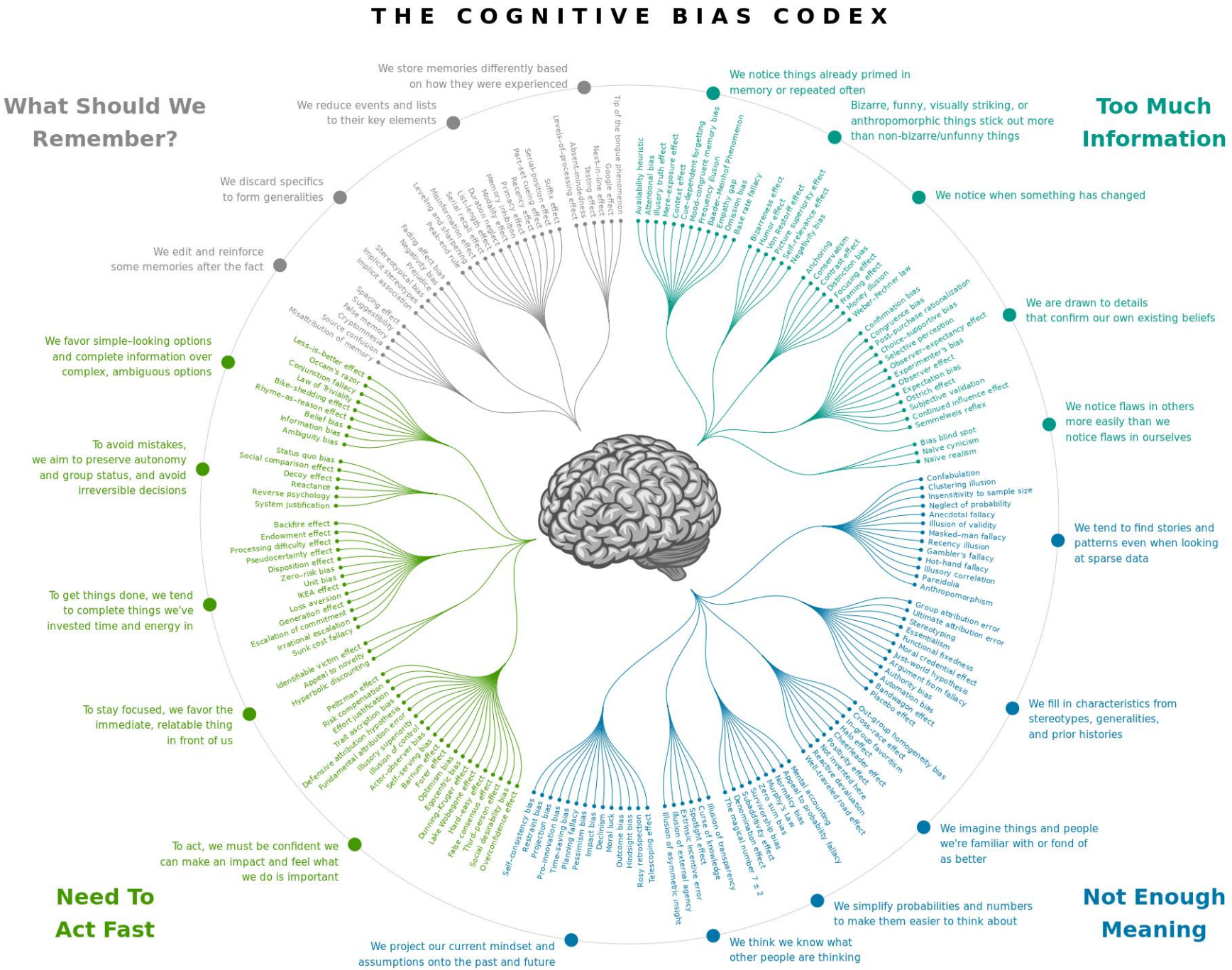
X Zhong et al. A multidisciplinary approach to the development of digital twin models of critical care delivery in intensive care units. International journal of Production Research. Dec 2021 MUSC ICU

Patient ‘avatars’



- patient state
- patient trajectory

  - ➢ Risk scores
  - ➢ Smart alerts
  - ➢ Alternative diagnosis
  - ➢ Similar patient correlation



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- Confirmation bias
- Semmelweis effect
- Availability heuristic
- Illusory correlation
- Dichotomous thinking
- Anchoring
- Etc.

Patient ‘avatars’

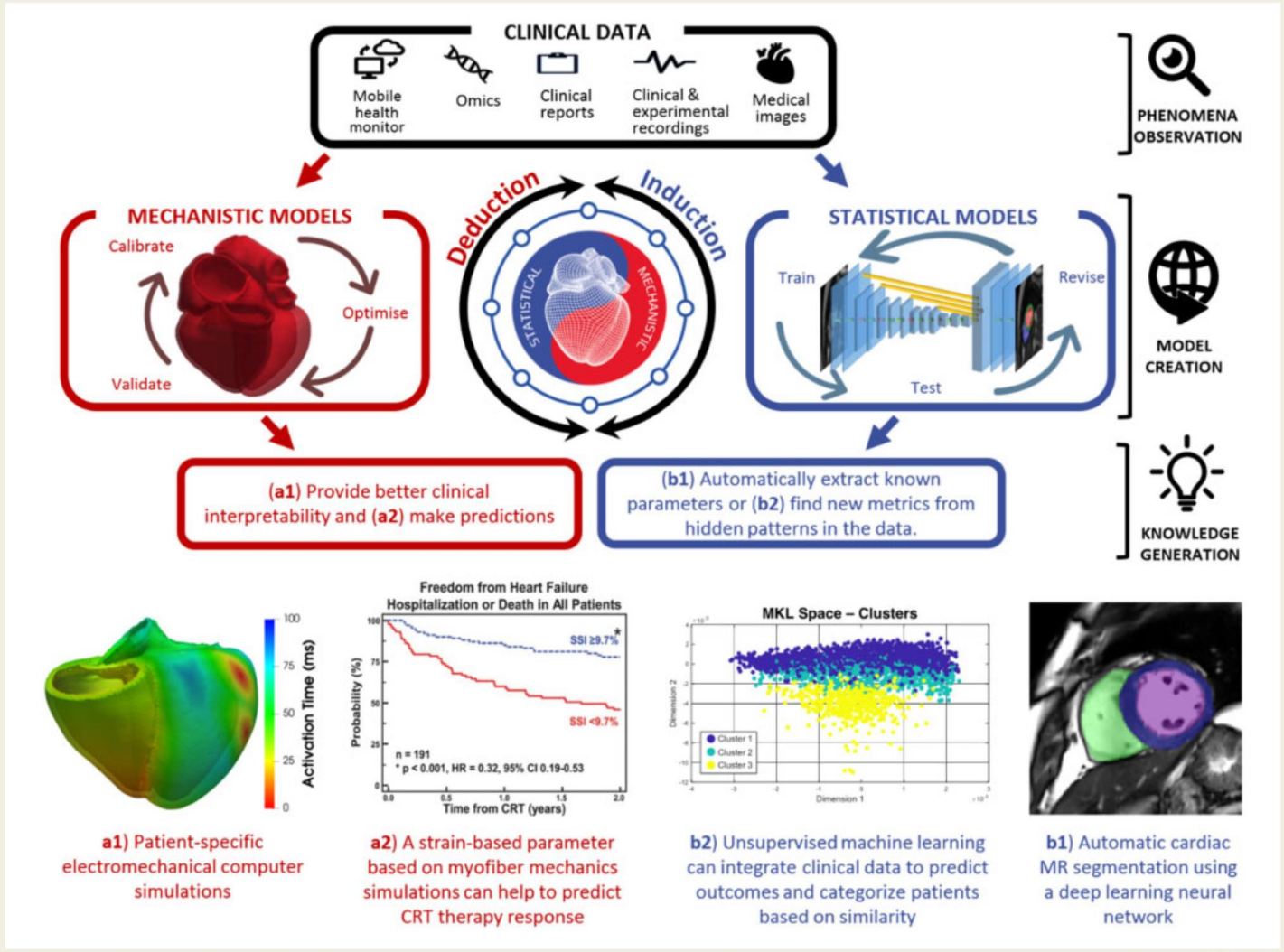
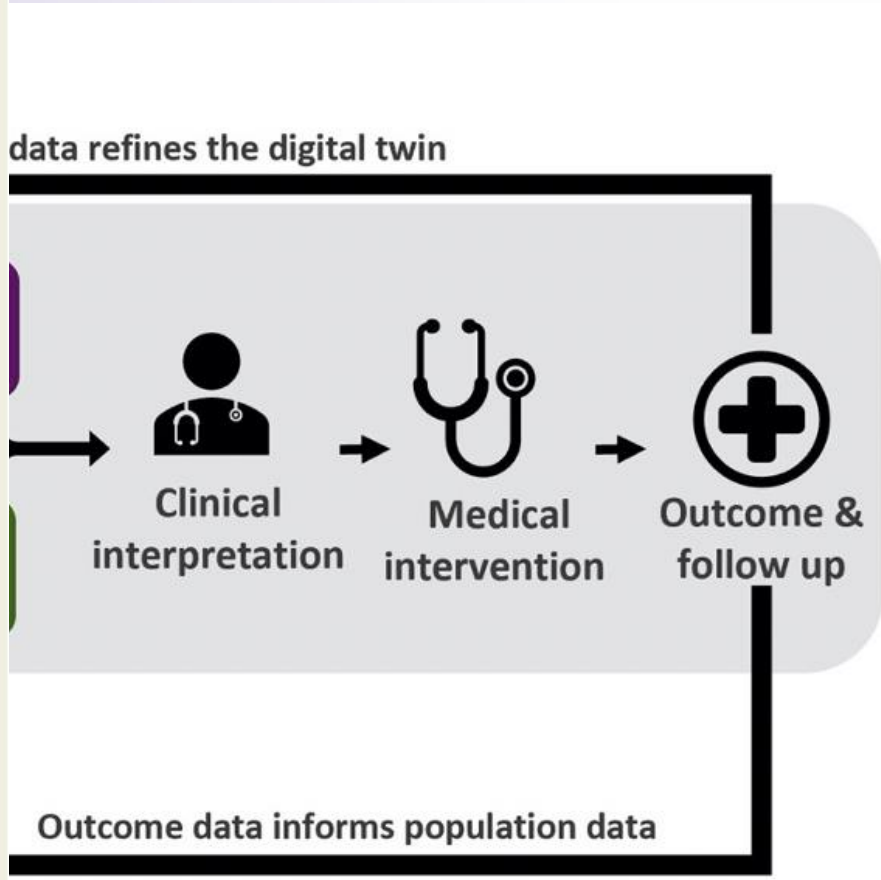
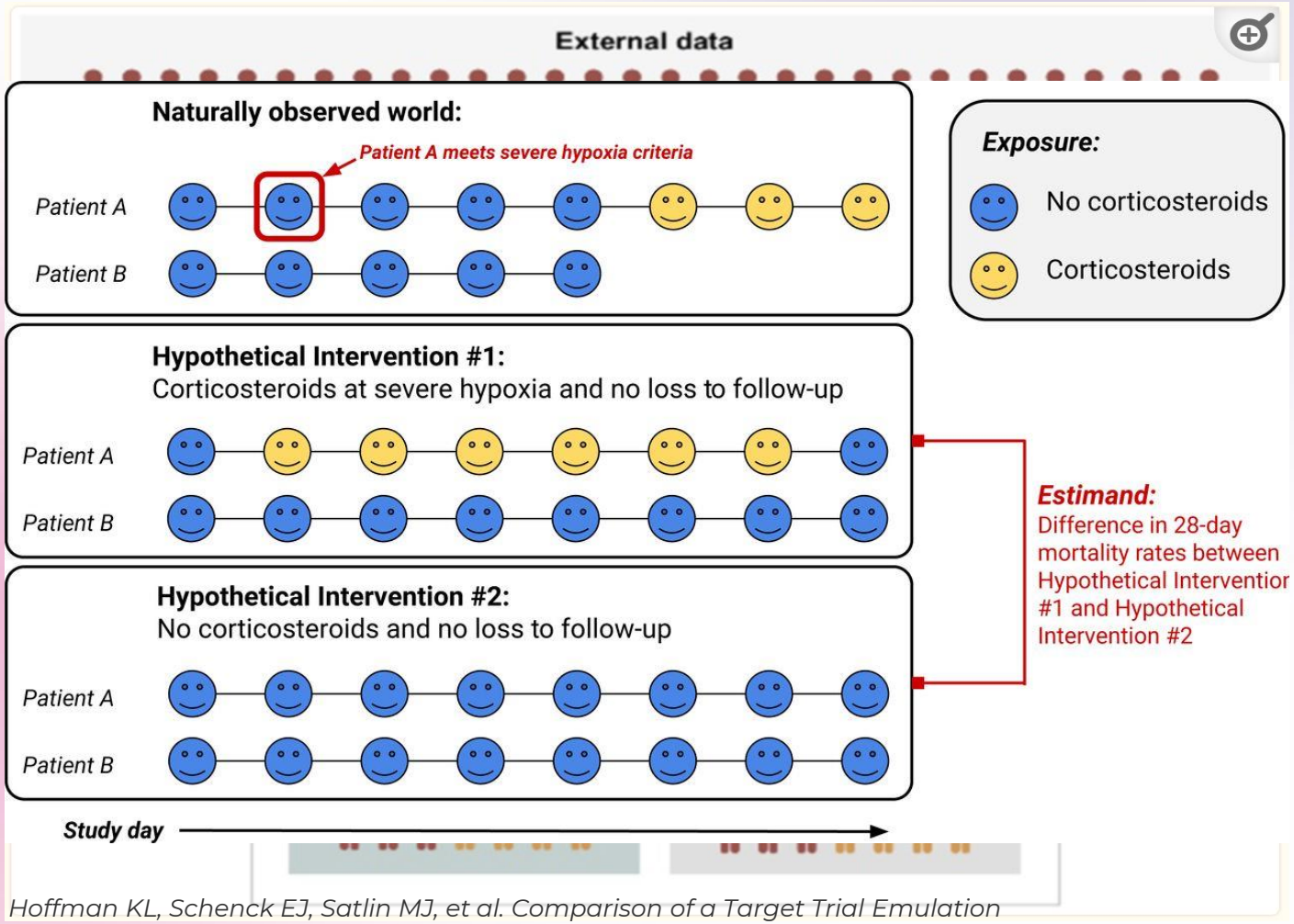


Figure 1 The two pillars of the digital twin, mechanistic and statistical models, illustrating its construction and four examples of use: **a1**,[10] **a2**,[11] **b1**,[12] **b2**.[13]



J.Corral-Acero et al. The digital twin to enable the vision of precision cardiology. EHJ 2020

In-silico / virtual + target trials



Synthetically generated patients:

‘hypothetical patients that represent the range of human variables for a particular condition’

Hoffman KL, Schenck EJ, Satlin MJ, et al. Comparison of a Target Trial Emulation Framework vs Cox Regression to Estimate the Association of Corticosteroids With COVID-19 Mortality. JAMA Netw Open.2022;5(10):e2234425. doi:10.1001/jamanetworkopen.2022.34425

Thorlund K, Dron L, Park JJH, Mills EJ. Synthetic and External Controls in Clinical Trials--A Primer for Researchers. Clin Epidemiol. 2020 May 8;12:457-467. doi: 10.2147/CLEP.S242097. PMID: 32440224; PMCID: PMC7218288.

Organ modelling

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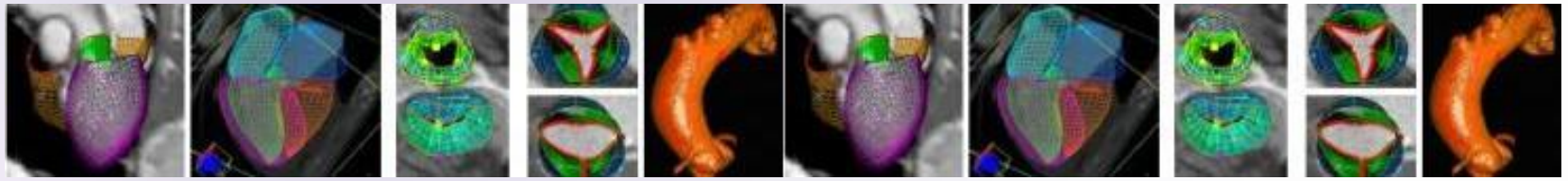
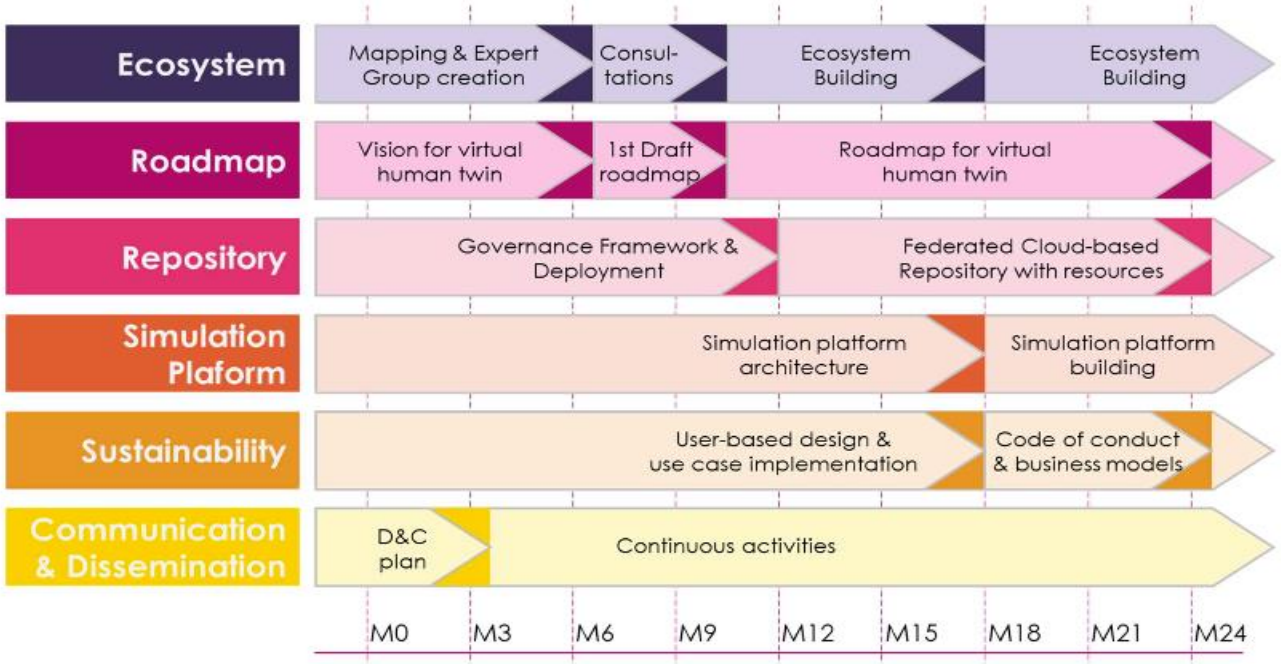
VPH Institute
Building the Virtual Physiological Human





http://www.edith-csa.eu

Next-generation, personalised, model-based critical care medicine: a state-of-the art review of in silico virtual patient models, methods, and cohorts, and how to validation them

J. Geoffrey Chase, Jean-Charles Preiser, Jennifer L. Dickson, Antoine Pironet, Yeong Shiong Chiew, Christopher G. Pretty, Geoffrey M. Shaw, Balazs Benyo, Knut Moeller, Soroush Safaei, Merryn Tawhai, Peter Hunter & Thomas Desaive

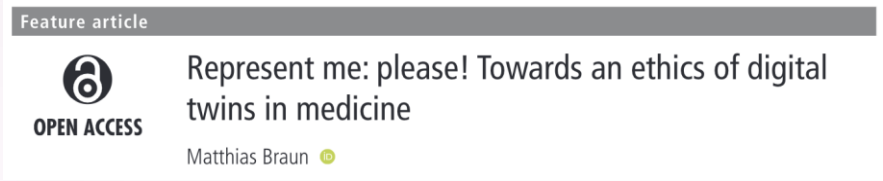
BioMedical Engineering OnLine **17**, Article number: 24 (2018) | Cite this article

Digital Twins in Critical Care: What, When, How, Where, Why?

J. Geoffrey Chase *, Cong Zhou *, Jennifer L. Knopp *, Geoffrey M. Shaw **, Katharina Näswall ***, Jennifer H K Wong ***, Sanna Malinen ****, Knut Moeller *5, Balazs Benyo *6, Yeong Shiong Chiew *7, Thomas Desaive *8

Current challenges

- defining frequency / fidelity / complexity
- optimizing data streams / signal processing / unstructured data
- better mechanistic and statistical model integration
- potential coordinated models
- integration to workflow / trustworthiness / risk
- regulatory / legal
- privacy / ethics


Feature article

OPEN ACCESS

Represent me: please! Towards an ethics of digital twins in medicine

Matthias Braun

Thank you

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"it is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts"

- Sherlock Holmes

"it is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts"

- ChatGPT 😉