A Vision for Leveraging the Concept of Digital Twins to Support the Provision of Personalised Cancer Care

Lisa Edwards [2], Stephen Vaughan [2], Rohit Kaul [1] , Nalika Ulapane[1,2] , Abdur Forkan[1] , Chinedu Ossai [1,2], Prem Prakash Jayaraman[1] , John Zelcer [1],, Muhammad Nadeem Shuakat [1,2]and Nilmini Wickramasinghe [1,2]

Swinburne University of Technology [1], Epworth HealthCare [2] Australia.

Introduction

Digital Twins - precise, virtual copies of living or non-living real-world entities are revolutionising every industry. While digital twins have seen faster growth in some industries such as manufacturing, in healthcare, they have been slow to be embraced. Advances in precision medicine, supported to a great extent by increased computational capabilities and developments in analytics, have served to provide significant benefits to clinical care, notably in oncology. However, to date these advances and applications of analytics have generally failed to provide overall superior, personalised, individualised focus around care delivery for most patients. Digital twins are proffered as a way to provide decision support that is not only accurate and precise but also highly tailored and personalised.

Aims

- To explore how we might map the concept of digital twins into the healthcare context.
- To explore how we might develop suitable digital twins to provide decision support in oncology.
- To identify the major barriers, challenges and facilitators with respect to designing and developing digital twins in healthcare.

A framework for developing digital twins for personalized cancer care

Healthcare is complex and many decision types are made thus as depicted in Figure 1 we have identified 3 generic categories (Grey Box, Surrogate and Black Box) for developing digital twins (DT). Critical to each category however are the components the physical world, digital world and digital thread. From these components it is then possible to develop suitable clinical decision support solutions for each category based on the development and training of the machine learning algorithms. We contend that the Black Box approach is most suited for the context of DT in oncology. Currently, we are creating the twins by beginning to identify all the sources of needed data including clinical, physiological, demographic and real word evidence. Next these data inputs will be weighted and then the machine learning algorithms will be developed. The logical design of this approach is captured in Figure 2.

Challenges And Risks

Key challenges include:

1) Completeness and accuracy of input data
2) Correct weighting of all different data sources/types
3) Scepticism about Black Box computation
4) Data security and privacy,

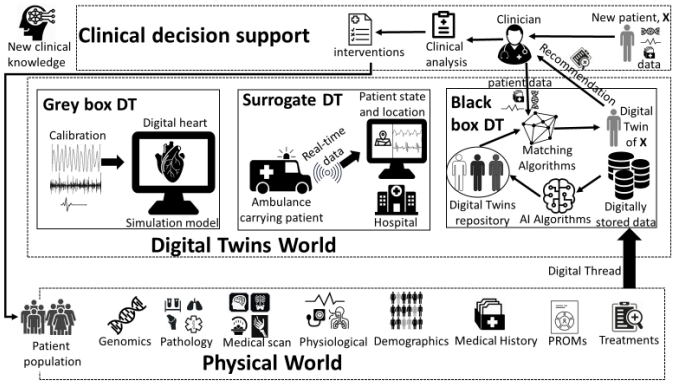

Figure 1: Proffered generic framework for digital twins (DT) in healthcare

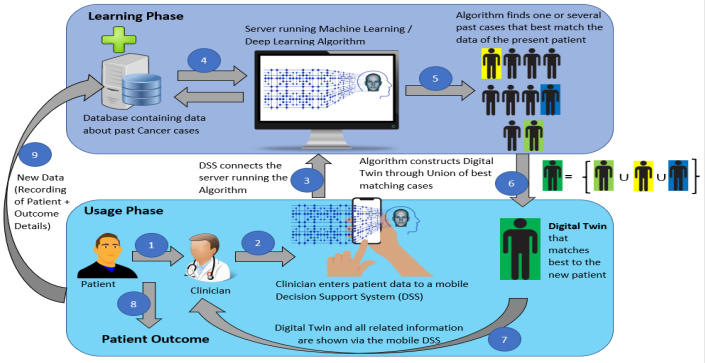

Figure 2: Digital Twin based mobile decision support system architecture.

Conclusions

The application of DT has served to revolutionise manufacturing, leading to greater efficiencies more effectiveness and heighten personalisation. We believe similar benefits can be realised in healthcare through the application of DT. In our presented exploratory research in progress we illustrate this vision by first identifying the 3 major categories for DT in healthcare and then providing our logical model for developing DT to support better cancer treatment and care.

The next steps include developing the digital twin, training the algorithms and then testing the decision support capabilities.

Acknowledgements

This project is funded by a 2019 Epworth Medical Foundation Grant for which the recipients are most appreciative.