Novel challenges of new and emerging digital health technologies

# Introduction

\*Nice start to the paper - “This paper is one in a series developed through a process of expert consensus to provide an overview of questions of current importance in research into engagement with digital behavior change interventions, identifying guidance based on research to date and priority topics for future research.” (Yardley et al., 2016)

\*What is theory? – “*a set of concepts and/or statements which specify how phenomena relate to each other. Theory provides an organizing description of a system that accounts for what is known, and explains and predicts phenomena*.” (Davis et al., 2015)

\*Potential benefits of technology in healthcare (Gibbings & Wickramasinghe, 2020)

# Method

[The wording heavily borrows from (Michie et al., 2017)] A national, expert, consensus-building one-day workshop was held in xmonthx 2020 in Leeds, UK to provide a robust academic appraisal of the evidence base and subject-matter expertise relating to novel patient-safety challenges of new and emerging health information technologies. The workshop was the first in a series led by the National Institute for Health Research Patient Safety Translational Research Centres from Yorkshire and Humber, and Greater Manchester, UK; The proposal for the workshop is available at xlink to proposalx. The xN\_participantsx participants were selected to include those who develop, evaluate and use health information technologies and their data for both research and practical purposes. Participants included xList of roles represented by attendeesx.

## The primary deliverable from this workshop was…

The primary deliverable from this workshop was a publication that begins to define the field of safety informatics and serves as a platform for future research and development.

# What might be the new and emerging technologies?

(Dunn, 2017; Hayward, 2019; Price, 2018, 2019, 2020)

1. Swallowable tech – local drug delivery (Goffredo et al., 2016), imaging (Intzes & Meng, 2016), diagnostics (Schmidt et al., 2019) and other applications (C. Gao et al., 2020; Olano, 2019)
2. Mail-order prescription – Amazon acquisition of PillsPack (<https://www.amazon.com/stores/page/5C6C0A16-CE60-4998-B799-A746AE18E19B?channel=hmd_190420>), Capsule (<https://www.capsulecares.com/>), NowRx (<https://www.nowrx.com/>); Description of implementation (Kappenman et al., 2019)
3. Neural implants and interfaces – an introduction (Fekete & Pongrácz, 2017), an introductory review and summary of challenges (Das et al., 2020), a review and challenges specific to some components (Koch et al., 2019). Examples Neuralink (<https://www.neuralink.com/>), Kernel (<https://www.kernel.co/>), DARPA (<https://www.darpa.mil/news-events/2015-01-19>), Facebook (<https://tech.fb.com/imagining-a-new-interface-hands-free-communication-without-saying-a-word/>).
4. Loneliness and Social Isolation – broad scene-setting review of problem (Stojanovic et al., 2017); A review of IT interventions (Chen & Schulz, 2016); A review of interventions specific to older people (Poscia et al., 2018). Also, keep an eye out for this planned review and meta-analysis of the effectiveness of digital interventions (Shah et al., 2019)
5. Blockchain (i.e. open, decentralised, cryptographic ledger) – Some challenges (McGhin et al., 2019); Reviews of blockchain in healthcare (Agbo et al., 2019; Hölbl et al., 2018); An early case study (Ekblaw et al., 2016); An application to prescribing (Seitz & Wickramasinghe, 2020)
6. Biohacking (i.e. DIY, citizen-science biological investigations and interventions) – the main concern is that it takes place “*outside of typical scientific settings by individuals who may not have traditional scientific training*” (Zettler et al., 2019); An introduction for the uninitiated (Yetisen, 2018)
7. Digital twin (i.e. “*a digital representation of a physical item or assembly using integrated simulations and service data*” (Vrabič et al., 2018)) - the technology, its applications, and the challenges (Fuller et al., 2019); discussion in healthcare (Angulo et al., 2019)
8. -omics (i.e. high-dimensional and high-throughput analytics) - The main problems are epistemological (more data doesn’t mean better information) and statistical (e.g. multicollinearity and bias) (Lay et al., 2006). Review (Hasin et al., 2017); Early example with EHRs (Hanauer et al., 2009); Deep-learning example (Chaudhary et al., 2018); (risky?) attempt to combine large datasets (Karczewski & Snyder, 2018); Technical review of methods (Bersanelli et al., 2016); Challenges (Cambiaghi et al., 2017; Gomez-Cabrero et al., 2014)
9. Conversational AI – In 2016, Amazon launched the Alexa prize for $2.5 million and it created a host of new methods (Ram et al., 2018); Perspectives on evaluation (Jadeja & Varia, 2017); A technical review (J. Gao et al., 2019); Review of applications in healthcare (Laranjo et al., 2018); Example in geriatrics (Fadhil, 2018b); Example in medication adherence (Fadhil, 2018a).
10. Commercial Telemedicine - \*Particular to the US because of its private healthcare system, e.g. Amazon.care and Apple’s AC Wellness: <https://www.mobihealthnews.com/news/north-america/amazon-launches-amazon-care-telemedicine-driven-care-offering-seattle-employees>; Example for diabetes (Garg & Parkin, 2019)
11. Wearables (i.e. sensors you wear) – Forecasts of wearable tech [citation unobtainable] (Hayward, 2019)
12. Virtual, Augmented and Mixed Reality – General review as applied to healthcare (John & Wickramasinghe, 2020); Example in urology (Hamacher et al., 2016); Review of use in medical education (Gerup et al., 2020) and training (Bracq et al., 2019); Application to neurology (K. H. Kim, 2016); Application to decision making (Kobayashi et al., 2018; Li et al., 2020); Easy-to-learn tools lower the bar for unchecked entry (see <https://ravvar.us/>)
13. Internet of Things (IoT) and Industry Internet of Things (IIoT) (i.e. “*a network of devices all embedded with electronics, software, sensors, and connectivity to enable them to connect, interconnect, and exchange data*” (Wickramasinghe & Bodendorf, 2020)) – Managing the risks of IoT (Paxton & Branca, 2020)
14. AI-assisted clinical decision support – Opinions on safety (Challen et al., 2019; Macrae, 2019); Opinion on AI for CDS (Shortliffe & Sepúlveda, 2018); Methodological appraisal of A.I. approaches for suitability to CDS (Abbasi & Kashiyarndi, 2006; Aljaaf et al., 2015).
15. Drone deliveries – Review of drone-delivery models for healthcare (Scott & Scott, 2020); Review of drones in healthcare (Wulfovich et al., 2018); Challenges and opportunities of drones in healthcare (Amukele, 2019); Advantages and disadvantages of drones in healthcare (Balasingam, 2017); Example application to chronic disease in rural areas (S. J. Kim et al., 2017).
16. Mobile health app’s and Patient Portals (i.e. patient access to their EHR) –Review of mobile health app’s, in general (García-Gómez et al., 2014); Example evaluation of patient portal (McAlearney et al., 2016); Example development of pharmacist-facing, medication-review app (Lu et al., 2017); A look at the gaps in mobile patient portal service to enable patient-centred care (Noteboom & Abdel-Rahman, 2020).

## According to literature predictions

# What are the challenges associated with these emerging technologies?

\*Grand challenges in digital health (Kostkova, 2015)

### Interoperability

\*Defining the problem of health IT interoperability (Benson & Grieve, 2016)

\*Suggested connections: Omics, IoT, digital twin

## Novel challenges

### Commercial providers

* Sony mSafety Watch
* Amazon.care
* Apple’s AC Wellness
* Mail-order prescription
* Facebook Preventive Health Tool
* IBM Watson Health

### A.I. safety

\*Ethical and social impacts of AI in medicine and healthcare (Gómez-González et al., 2020)

\*Suggested connections:

## Other challenges

\*Not strictly due to the emerging technologies but they are novel challenges, nonetheless.

### No testing before implementation

\*Linked with commercial providers

\*Linked to continued development of decision-support tools

### Digital inequality

### Calibration drift / Dynamic modelling

\*KEY CONTRIBUTOR: David Jenkins

\*Pre-learned is out of data very quickly (Hickey, Grant, Caiado, et al., 2013; Hickey, Grant, Murphy, et al., 2013; Jenkins et al., 2018)

### Aging population

\*Emerging tech in for aging populations (Neves & Vetere, 2019)

\*Opinion piece on tech in geriatrics (Pilotto et al., 2018)

\*Example of electronic assistive tech for dementia (Daly Lynn et al., 2019)

\*?Can anyone access International Journal of Reliable and Quality E-Healthcare so we can read “*Third age and mobile health*” (<https://www.igi-global.com/article/third-age-and-mobile-health/237992>)?

# How do the technologies relate?

\*Are they related by their challenges/motivations/technical solutions? For example, Biohacking-neural implants; Digital twin-IoT; [Personalised] Digital twin-Biohacking; ‘Mail-order prescription’-loneliness tech; Wearables and everything;

# Potential solutions

## Safety cases

\*KEY CONTRIBUTOR: Ibrahim Habli

\*Example literature: (Denney et al., 2015; Despotou et al., 2012; Flood & Habli, 2011; Habli et al., 2019; Sujan et al., 2016, 2013, 2015)

## Design standards / charter

\*Need for global health tech’ standards (Masum et al., 2013)

\*Design suggestions for risk detection/prediction:

1. learning from Business Intelligence and sociotechnical theories (Moghimi et al., 2020);

## Interoperability

\*The HL7 FHIR standard created by HL7 International (Health Level Seven International, 2020) is a standard for exchanging EHRs (Saripalle et al., 2019). Houta et al. (2019) provide an example use of HL7 FHIR standard for epilepsy data.

\*Roehrs and colleagues suggest a distributed architecture to integrate EHRs (Roehrs et al., 2019, 2017), which also makes use of blockchain approaches (Roehrs, 2019)

## Lessons from open science

\*Could we learn from badges and virtue signalling? I’m not sure it would work because money is the God for business and publications aren’t the lifeblood, either – business get their money before the build.

## ML for data quality

\*Data quality is an issue for all digital tech (Sako et al., 2020)

# Discussion

## COVID-19 pandemic

\*Driver to remote functionality including:

* Remote monitoring
* Remote testing
* Remote imaging
* Robotic care
* Personal preventive medicine

# Conclusion