Human factors and design in future health care

Peter Buckle¹, Simon Walne¹, Simone Borsci ¹,² and Janet Anderson³

1. NIHR London In Vitro Diagnostics Co-operative, Division of Surgery, Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, UK.

2. Department of Cognitive Psychology and Ergonomics, University of Twente, The Netherlands

3. Florence Nightingale Faculty of Nursing and Midwifery, King's College London, UK.
Structure of the presentation

• Who we are, what we do and why we feel we have something useful to say
• Aims of the paper
  • Some definitions that we have used
  • Context for human factors
  • Key questions and key response points
  • Recommendations
We have all noticed, through our research and practice, that there has been – and remains – a tendency for healthcare systems to evolve, rather than to be “designed”.

This seems particular evident with digital technologies as many devices and applications are being introduced without detailed human factors assessment of the work system – or indeed any kind of risk assessment.

Each new device and application will change the system in predictable – but also unpredictable – ways, and there is a significant danger that latent failures are imported into the system unnoticed.
Aims of the paper

• To present the case for a human factors to be central to the design of digital healthcare

• To support this case with evidence from research (including within the NHS)

• To demonstrate the value and (potential) benefits of a human factors, system approach
Some definitions: Ergonomics/human factors from IEA

“the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.”
Digital healthcare

• Digital health, or e-health, encompasses several distinct technologies including but not limited to:

  • decisional support systems that use algorithms derived through mining clinical datasets, such as the work carried out by Google DeepMind;
  • mobile health apps, or m-health, which can support and monitor healthy behaviours;
  • connected biometric sensors, such as continuous glucose monitoring;
  • consultations via video link (“telemedicine”);
  • electronic personal health records.”

• Editorials Digital healthcare: regulating the revolution  BMJ 2018; 360  (Published 15 January 2018)
Digital healthcare

• The FDA consider that “The broad scope of digital health includes categories such as mobile health (mHealth), health information technology (IT), wearable devices, telehealth and telemedicine, and personalized medicine.”

• Many other definitions also exist.
Structure of the presentation

• Who we are, what we do and why we feel we have something useful to say
• Aims of the paper
• Some definitions that we have used
  • Context for human factors
  • Key questions and key response points
  • Recommendations
• Human factors recognises the importance of the interaction between many components of a system, including essential aspects including the variability of humans within such systems.

• For a system to perform appropriately, the role of the human in the system must be appreciated.
Holden et al., 2013
• Technologies form part of a healthcare work system,

• The introduction of new devices will change the system - either in positive ways, negative ways, or both (some positive and some negative).
• Because healthcare systems are complex, digital (and other) technologies will change the system in predictable – but also unpredictable – ways, and there is a significant danger that latent failures are imported into the system unnoticed.

• This points to the need for a systems approach to integrate digital technologies into healthcare, as well as for design approaches that minimise negative effects for people.
• For a system to perform effectively, the role of the human in designing, interacting with or completing an engineered system must be recognised.

• All systems involve human contributions.

• Even ‘autonomous’ or ‘automatic’ systems will have been designed and maintained by humans.

• Therefore, recognising the capabilities, needs and limitations of humans within complex systems is essential.
Structure of the presentation

• Who we are, what we do and why we feel we have something useful to say
• Aims of the paper
• Some definitions that we have used
• Context for human factors

• Key questions and key response points
• Recommendations
• Why is the discipline of human factors/ergonomics so important to digital healthcare?

• Because all digital healthcare is designed by humans, for human use in complex socio-technical systems, careful consideration of human factors is essential.

• Key issues range from the initial design, to testing and use, and even to decommissioning and disposal.
How complex is healthcare and how does human factors help our understanding of this complexity?

“Top down and Bottom up”

**Bottom-up:** represents the visible and tangible part of DH in terms of digital technology such as mobile applications and sensors.

**Top-down:** represents the infrastructure healthcare services use to enable collection of, and access to, information; the co-ownership of the data among patient and clinicians, and a shared healthcare decision making process.

A major risk of digital health is that too much attention will be focused on the bottom-up components, and too little on the top-down approach.
• As we said earlier.......Healthcare systems tend to evolve rather than be “designed”.

• Particularly evident with digital technologies as many devices and applications are being introduced without detailed human factors assessment of the work system – or indeed any kind of risk assessment.

• Each new device and application will change the system in predictable – but also unpredictable – ways, and there is a significant danger that latent failures are imported into the system unnoticed.
• Can human factors, and a user-led approach, solve the problem of design for complex systems, including digital innovation?

• HF discipline has developed methods for understanding complex systems and has had some success with modelling them.

• Knowledge of these approaches is often drawn from sectors other than healthcare (and may be highly technical).

• Their application in healthcare has often been limited, perhaps due to limited resources.

• The unpredictability of some systems behaviors in health care leads us to the need to design for resilience.
• How complex is healthcare and how does human factors help our understanding of this complexity?

Work as imagined v Work as done

..........finding out what really happens
• What are the key drivers for change in healthcare systems and where does value lie in a human-centred, systems approach to digital health?

Diagnosics – Potential **Value**

- **System Benefits**
  - Speed up recovery
  - Optimize treatment choice
  - Reduce hospitalization
  - Reduce length of stay
  - Reduce process time required
  - Different staff grade or type

- **Patient Benefits**
  - Improve compliance
  - Improve health outcome
  - Enhance dignity
  - Enable self-care
  - Reduce unnecessary interventions

Diagnostics Assessment Programme (DAP) assesses the **value proposition** of diagnostic technologies i.e. pathological tests, imaging, endoscopy, algorithms or test combinations, physiological measurement and genetic/molecular tests.

Other benefits?
• **Which are the risks of, and opportunities for, digital health?**

• By aiming to deconstruct medicine and ensuring the wide distribution of health data, too much attention of manufacturers and the scientific community will be focused on the bottom-up components, and too little on the top-down approach.

• A main threat of this digital transformation is that it leads to the widespread introduction of many digital tools and sensors without clear and integrated frameworks to efficiently and effectively use the generated clinical and health data.

• This adds digital layers of complexity and generates extra work for healthcare professionals.
Which are the risks of, and opportunities for, digital health?

From a systems perspective, the main opportunity for DH is to develop systems that are able to accommodate:

• the emerging innovation - e.g. information from devices and sensors
• the emerging needs of all stakeholders involved in the healthcare system.

Digitalization of healthcare offers the opportunity to transform the workflow in healthcare.

HF can help to maximise the benefit and minimise the costs of using a distributed network of tools able to gather personalized data.
• Which are the risks of, and opportunities for, digital health?

Because a ‘one-size-fits-all’ system is not realistic, the main challenge of implementing DH is the development of local healthcare service systems.

These local systems have to be designed through evolutionary adoptions (driven by evidence) that take into account the local constraints to integrate bottom-up and top-down components.

Therefore, the value of implementing DH is not in the massive introduction of new and smart technologies, but in the full realization of the digital transformation throughout the development of digital contexts and infrastructures of data gathering, use and practice (i.e. system) in which the potential benefit of the new technologies (bottom-up component) can be maximised.
• How can human factors systems design approaches be used to support the development of digital health systems and transform health systems?
How can we better organize care and the patient journey within this new system to ensure high quality care and better match digital health technology to the demands of the healthcare environment?

We need to go further to design devices and technology to explicitly support adaptive, flexible working.

This is not simple but we cannot afford to keep designing technology that makes clinical work more difficult.
• **What is needed to ensure that human factors expertise, design methods, and approaches are applied in designing health systems of the future and digital technologies that support this transformed system?**

• Methods that take account of the level of complexity in healthcare environments to design to support adaptive capacity.

• That means knowing what challenges workers have to cope with, understanding how they deal with them, and then explicitly supporting this in the design.

• Constraining how people can perform tasks often makes work more difficult and introduces new risks that are difficult to identify.

• Resilience engineering provides a framework to support this understanding, and other human factors methods are designed to analyse how work is achieved, which forms the basis of this approach.
How can digital technology empower patients and their families to be engaged in and take more responsibility for their own health?

Research provides a critical perspective of the concept of the “empowered patient” in regard of digital health technologies.

The technological vision for digital health may contrast with complexity and ambivalences that arise when applications involve, for example, self-monitoring and self-care.

Emotional responses from patients, the additional load on their families and carers and even the changing role of health care workers engaged with the delivery of patient care must all be acknowledged if digital technology is to deliver the intended benefits.

These challenges also embrace issues such as training needs in data collection, transmission, interpretation and storage.
• **Why is human factors/ergonomics (HFE) not fully recognised in healthcare and is there limited access to HFE knowledge in healthcare?**

• In NHS England one trust out of 233 employs a Chartered Ergonomist

• A world agenda and a (virtual) network of HFE experts, in collaboration with other key organisations, could define frameworks and guidelines to ensure cost-effective and scalable methods of HFE

• This could generate evidence to support the appropriate diffusion of DH in tune with the different countries settings and needs.
Recommendations and Key points

• Development of DH in terms of systems and distributed technologies requires a growing involvement of potential stakeholders to define both the rights and responsibilities of all the stakeholders and also how data should be collected, presented and use.

• HF experts use participatory methods to achieve this.
Recommendations and Key points

• Humans design digital healthcare systems and humans make them functional to deliver healthcare

• Failure to make these systems human focused will result in failure and poor value

• HF knowledge and methods must be integral to the design process

• AI based systems present new challenges that only a human factors approach can address