Developing a Human Factors / Ergonomics guide on AI deployment in healthcare

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SUMMARY

Members of the Chartered Institute of Ergonomics and Human Factors (CIEHF) Digital Health and AI Special Interest Group (SIG) identified a need to provide health and social care professionals with an accessible guide to apply a systems approach in the design of healthcare AI tools. The CIEHF Digital Health and AI SIG came together to co-design a new guidance document: 'AI deployment in healthcare – beginning your journey with Human Factors / Ergonomics (HF/E) in mind to support the integration of AI into care practices. A guide for health and social care professionals with an interest in AI.' Group members come from health and social care and HF/E backgrounds. The guide is structured using the Systems Engineering Initiative for Patient Safety (SEIPS) framework.

KEYWORDS

AI, healthcare, Human Factors / Ergonomics

Introduction

Artificial intelligence (AI) refers to machines (including software) that perform functions that normally require human cognition without direct human aid (WHO, 2021). AI can be used in many ways in health and social care, but the majority of examples to date comes from healthcare. Different types of AI applications are starting to be used routinely within healthcare for example: training algorithms using data sets, such as electronic health record (EHR), to create models capable of categorising information or predicting outcomes; natural language processing (NLP) which aims to give computers the ability to understand, generate, manipulate, and respond to text and speech data in natural languages is used in clinical decision support systems; image processing is used to analyse and understand image information on CT and MRI scans; robotic process automation is used to support 'chatbots' which were used widely during Covid-19 to act as symptom checkers for service users and surgical robots, controlled by AI algorithms, are used in operating theatres to assist surgeons performing surgery (Topol, 2019).

The Chartered Institute of Ergonomics and Human Factors (CIEHF) White Paper 'Human Factors and Ergonomics in Healthcare AI'[1] (CIEHF, 2021; Sujan et al., 2022) outlines and sets the direction for the need to move beyond a technology-centric view of AI, and instead approach AI from a systems perspective. This would involve considering the interaction of people with AI as part of the

[1] https://ergonomics.org.uk/resource/human-factors-in-healthcare-ai.html

wider clinical and health system throughout all stages of development and implementation. The White Paper set out generic principles, and it was well received, prompting, for example, the inclusion of HF/E in a recent British Standard setting out an auditable validation framework for healthcare AI (BS30440) (Sujan et al., 2023). As a subsequent step, we identified the need to provide health and social care professionals with an accessible guide to enable them to ask appropriate questions about AI and to contribute meaningfully to the design of healthcare AI tools.

In this paper we describe our initiative to build on the White Paper's identified need for the integration of Human Factors / Ergonomics (HF/E) in healthcare AI by providing specific HF/E advice and guidance to health and social care professionals who are involved in both the development and deployment of AI in clinical practice.

Methods

A co-design approach was taken to the iterative development of the guide building on the expertise of the members of the CIEHF Digital Health & AI Special Interest Group (SIG). The CIEHF Digital Health & AI SIG was set up in 2019 to support the digital healthcare technology (DHT) and AI community from a HF/E perspective. Membership includes HF/E experts and health and social care practitioners all with an interest in DHT and AI. SIG meetings are learning and collaboration spaces where the contribution of HF/E to the development and successful implementation of DHT and AI in a meaningful and safe manner is the focus. SIG membership is international and through internal meetings, external engagements and disseminations the SIG members have worked towards developing and sharing the principles of human-centred healthcare AI development and deployment with each other and broader audiences. The SIG also invites presentations and contributions from technology developers to learn from their experiences of delivering ambitious healthcare AI projects and to further inform them about the potential for HF/E to enhance DHT and AI e.g. Kheiron Medical Technologies, at one SIG meeting, described the development journey of their AI-based breast cancer screening tool, Mammography Intelligent Assistant (MIA); Health Navigator, at another, described their AI guided clinical coaching service, where an AI algorithm is used to predict patients at risk of deterioration and hospitalisation.

A subgroup of the SIG with a specific interest in supporting health and social care professionals in navigating the AI in healthcare space came together. This subgroup consists of the authors of this paper. A co-design approach was taken to the iterative development of the guide where the members worked together during bi-monthly meetings over 18 months (2022-2024) to agree on a framework for the guide and to develop content for each section using collaborative writing tools, making full use of each other's diverse backgrounds in HF/E and health and social care, to co-design the guide (Ward et al., 2018). Presentations on progress were made to the main SIG committee meetings and feedback sought from the SIG members also after each meeting.

Results

The final guide produced is divided into three sections:

- **Part one** uses a systems framework to describe general principles to consider for health and social care professionals when developing and deploying AI in clinical systems.
- **Part two** contextualises the general principles through a clinical example.
- **Part three** provides links to resources for clinicians who wish to learn more.

For **Part one** the HF/E Systems Engineering Initiative for Patient Safety (SEIPS) framework version 3.0 (Carayon et al., 2020; NHS, 2022) referred to in the White Paper was agreed as the systems-focused framework for this guide. The SEIPS 3.0 framework was used by the co-design

team to iteratively identify elements of the health system that would need to be understood and studied by health and social care professionals in relation to AI deployment.

The SEIPS 3.0 framework expounds healthcare as a socio-technical system. In figure 1 elements of this system are outlined, and the framework can help us describe how those elements interact and affect each other to deliver care processes and map outcomes against the care process (see Figure 1). Depending on the nature and variability of these interactions, different outcomes may arise. Using a systems approach enables us to understand how the use of AI might interact with other elements of the work system.

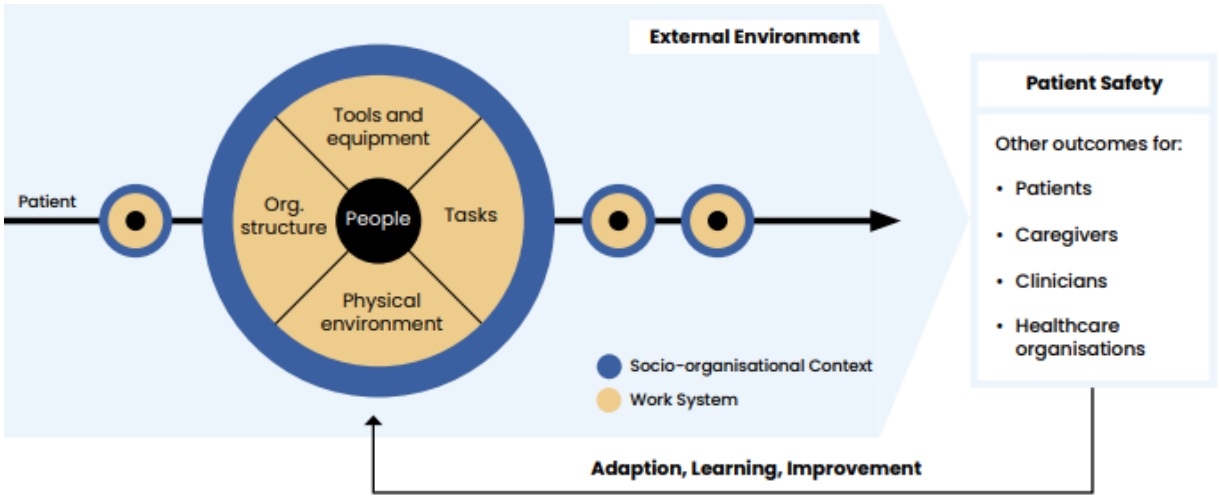

Figure 1: SEIPS 3.0 (Carayon et al., 2020)

Under the framework, people considerations were divided into those for patients and those for the care team. The term ‘service users’ was adopted in our guide to refer to patients and clients, their families and carers, advocates, or any other people receiving health services in institutional or community settings. People - care team refers to any health or social care professional working to provide care to service users. For service users the following issues were discussed: safeguarding their priorities for their care; integrating the AI product or tool into their existing care pathways; and ethics, safety and reliability. Under people - care team the following issues are discussed: impact on the current work of the care team members and their roles and responsibilities; considerations of accountability of the AI tool or product and the care team and how to address the needs of the care team members and their learning.

The guide also provides advice under the areas of tasks; tools and equipment; physical and external environment and outcomes. See Table 1 for sub-categories within these.

Table 1. Categories and subcategories of SEIPS 3.0 framework discussed in the guide.

Tasks
• The role of Task analysis (TA) in understanding the task the AI will support
• Project management (PM) tools to support implementation
• Human-centred design (HCD)
Tools and equipment
• 'AI stack' - the interdependencies between the AI and the existing tools and technologies (referred to as),
• Data quality and governance
Physical environment & External environment
• Environment – physical; space for additional resources.
• Environment – organisation; readiness for AI
• Environment – organisation; trust in AI
• Environment – external; pressure to adopt AI
• Environment – external; government readiness for AI
• Environment – external; standards and regulation
Outcomes
• Safety
• Service user experience
• Clinician experience

Throughout part one, to help the reader practically apply SEIPS 3.0, we identified important questions for health and social care professionals to ask of the AI tool or product and its implementation. We presented these questions in boxes to facilitate the reader's practical use of the document. Systems are adaptive and respond to changes and so these questions need to be re-visited over the course of the lifecycle of the AI tool or technology and may not always be generalisable to different contexts such as when the organisation is operating or when there are changes to the socio-organisational context – e.g. merger of hospitals.

Part two consists of a clinical case study in order to illustrate the types of considerations about the design and use of healthcare AI, which are important from an HF/E perspective. The case study concerns autonomous infusion pumps driven by AI. In the guide, brief context is provided, e.g., it is hoped that the use of highly automated or autonomous infusion medication management systems (smart infusion devices) which incorporate dose error reduction software can contribute to the reduction of the estimated 237 million medication errors that occur in the NHS every year (Elliott et al., 2021). We then illustrate relevant systems consideration by providing prompts that can guide investigation or thinking about the AI, and specific examples from the case study. Lastly, we describe some of the key interactions of elements of the work system. For example, we illustrate that the introduction of autonomous infusion pumps (*technology*) might lead to an increase in the patient:nurse ratio (*organisation*) to deal with demand (*external environment*), and this can lead to nurses spending less time with the individual patient, thus affecting their ability to build relationships (*people*) and affect patient experience and potentially patient safety (*outcomes*).

Part three consists of a set of resources in relation to different aspects of the practical application of HF/E into the design of healthcare AI, including guides to using common HF/E tools, health and social care case studies where they have been used, links to standards and regulation in relation to human-centred design and AI.

Next Steps

This HF/E guide for AI deployment should empower and support health and social care professionals to take an active and informed role in AI deployment in their care settings. Using HF/E supports like this can help co-produce AI that can be used safely and effectively, in order to deliver both better service user outcomes and improve health and social care professionals wellbeing.

The next steps will be to have some design support with the guide to ensure it is easy to use whether people choose to read it electronically or paper based. The guide will then be shared with a wider group of health and social care professionals and patient and public partners to obtain further feedback. A final version of the guide will then be published by CIEHF. Dissemination will be through the national healthcare organisations and ergonomics societies of Ireland and the UK.

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