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Can the NHS learn about Human Factors from the Ministry of Defence?

ABSTRACT

The National Health Service (NHS) in England has ambitious plans to drive innovation in health information technology (HIT) to improve patient safety, quality and cost effectiveness. Acute trusts are complex socio-technical systems that are required to implement a number of large information technology projects in order to meet national targets for digital maturity. This research explored whether the Ministry of Defence (MOD) Human Factors Integration Model for the acquisition process could be applied to a HIT project. A qualitative research study was undertaken in a large English NHS acute trust using the experience of implementing an electronic observation system to explore transferability of the MOD approach to acute healthcare. Data were collected using semi-structured interviews and focus groups and analysed thematically with reference to SEIPS 2.0 (Holden et al, 2013) healthcare systems model and the MOD framework. Key findings included limited awareness of Human Factors in healthcare; information system design/specification to deliver positive outcomes around patient safety and financial savings. Human Factors negative systems issues included alert fatigue, changing mental models, inability to maximise data for patient benefit, system resilience, local and national interoperability issues.

KEYWORDS

Health information technology, socio-technical systems, healthcare

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Introduction

Health information technology (HIT) is seen as a key component to improve health outcomes for populations in United States of America (US) and Europe as well as improving efficiency and safety (Salzberg et al, 2012). HIT encompasses a range of technologies including medication administration, electronic health and medical records. It is expected to bring improvements in efficiency and safety however there are concerns regarding unintended consequences, safety and usability across a wide range of systems (Zahabi, 2015; Kushniruk et al, 2013; Bloomrosen et al, 2011; Ash et al, 2004).

The National Health Service (NHS) in England has recently experienced high profile and costly failures in HIT implementation (www.parliament.uk, 2013). The *Five Year Forward View Next Steps* (NHS England, 2017) and *The Forward View into Action* (National Information Board, 2016) projects set out ambitious plans to drive innovation in HIT and digital maturity in order to address gaps in health and social care quality, health inequalities, funding and efficiency. The aim for the NHS 'paperless 2020' is all patient and care records to be digital, interoperable and real time (National Information Board, 2016). This includes creating hospital 'global digital exemplars' and a NHS Digital Academy to train Chief Information Officers (CIO) and Chief Clinical Information Officers (CCIO) to meet digital maturity targets (National Information Board, 2016).

However Wachter's report (National Advisory Group on HIT, 2016) questioned the timeframe, scale and funding of these plans and identified ten principles and recommendations for implementation including speed of implementation, user centred design, interoperability and an understanding of adaptive versus technical change:

" digitising effectively is not simply about the technology, it is mostly about the people' (National Advisory Group on HIT, 2016).

The Concordat for Human Factors (National Quality Board, 2013) identified the need for a national strategy to implement Human Factors (HF) within healthcare to improve patient safety and outcomes. It advocated a system-wide adoption of HF to empower the NHS and highlighted the need to learn from other high reliability industries including the military. The US Institute of Medicine (2012) also recommended that HF should be integral to HIT implementation and safety.

However there is limited evidence for successful NHS HF implementation with Hignett et al (2013) identifying a gradual increase in HF techniques in healthcare and US research suggesting there are insufficient HF specialists to support HF integration (Duffy, 2011). Waterson (2014) identified the complexity and variability of HIT as key issues and the need to adopt a sociotechnical, systems wide approach to implementation.

UK Ministry of Defence (MOD) has a long history of Human Factors Integration (HFI) and published the MOD HFI JSP912 Directive and Guidance that is implemented across all military services (MOD, 2015a, b). JSP 912 Part 1: Directive (MOD, 2015a) outlines the policy and direction for HFI, illustrated as seven HFI domains with a '*systematic process for identifying, tracking and resolving human – related considerations, to ensure a balanced development of both the technological and human aspects of capability'* (MOD 2015a). JSP 912 part 2 (MOD, 2015b) provides a framework by which to implement HF across a procurement and implementation pathway.

The aim of this qualitative study was to explore whether this approach could translate into NHS HIT by considering the MOD seven HF domains (Figure 1) and six high level HFI process activities (Figure 2) in the context of a large acute NHS Trust electronic patient observation system.

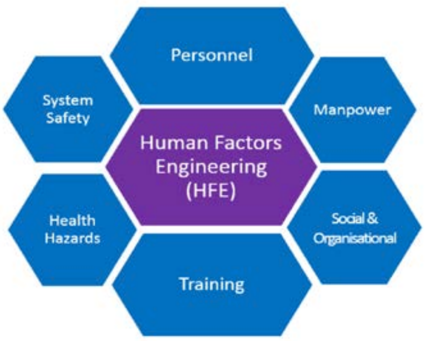

Figure 1 MOD Seven HF Domains (MOD, 2015)

HFI Process Stage	HFI-1.0 User Need Definition	HFI-2.0 System Requirements Definition	HFI-3.0 Assess Tenders	HFI-4.0 Detailed System Design	HFI-5.0 Test & Acceptance	HFI-6.0 In-Service Feedback

Figure 2 MOD 6 HFI Processes (MOD, 2015)

A qualitative research study was undertaken in a large English NHS acute trust using their experience of implementing an electronic observation system to explore transferability of the MOD approach to acute healthcare. Patient observations are a critical element of safe care and are taken on a regular and frequent basis to monitor patient status and to allow appropriate escalation of care when safe limits are exceeded. The trust moved from a paper-based observation and recording system to a digital system – E-obs, which was driven by national and local priorities around "failure to rescue" to identify deteriorating patients and prompt escalation to the most appropriate clinician (Nursing Times, 2011).

Ward staff, predominantly nurses and healthcare assistants, record all patient observations using individual handheld devices. The digital platform allows a range of observations to be recorded and the Trust typically records 15,000 observations per day across different many electronic platforms (Figure 3). Escalation parameters such as early warning scores (EWS) are automatically calculated and staff are prompted to escalate care to a senior clinician (nurse or doctor).

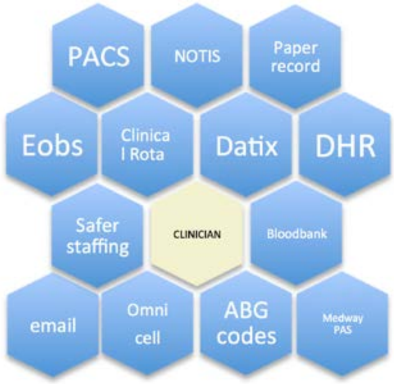

Figure 3. Clinical Electronic Systems

Method

A purposive sampling strategy was used with 11 participants recruited on a voluntary basis provided they had a defined role within the E-obs project including Clinical ICT project leads, users, designers, suppliers (inclusion/exclusion criteria).

The participants were Clinical ICT (n=5), non-clinical (n=3), senior nurse (n=1), medical consultant (n= 1) and external supplier Clinical Director (n= 1). The study had ethical approval from Loughborough University and was confirmed as a service evaluation by the NHS (no ethical approval required).

Qualitative data were collected at 4 semi-structured interviews (n=4 participants) and two focus groups (n=7) between March and June 2017. The following topics were explored (interview/focus group schedule):

- Role and involvement in E-obs (including stages of process)
- Awareness and understanding of HF
- Impacts of the project, positive and negative
- Challenges experienced

The data were transcribed and analysed using a thematic analysis approach to code up emerging themes from the data and code down using SEIPS 2.0 (Holden et al, 2013) as a conceptual framework for the system themes. Eleven themes were identified, see Figure 4.

User centred	Testing	System	External Factors
Supplier	People	HF	Design
Data	Consequences/ Impact	Challenges	

Figure 4 Eleven Coding Themes

Results

SEIPS 2.0 (Holden et al, 2013) offers a socio-technical approach to describing and understanding the inter-relationships between the various elements of a healthcare system and the primary research findings are represented in Figure 5 using this framework and discussed below.

The results provide a view of the complexities of HIT implementation from the perspective of those charged with designing and implementing it.

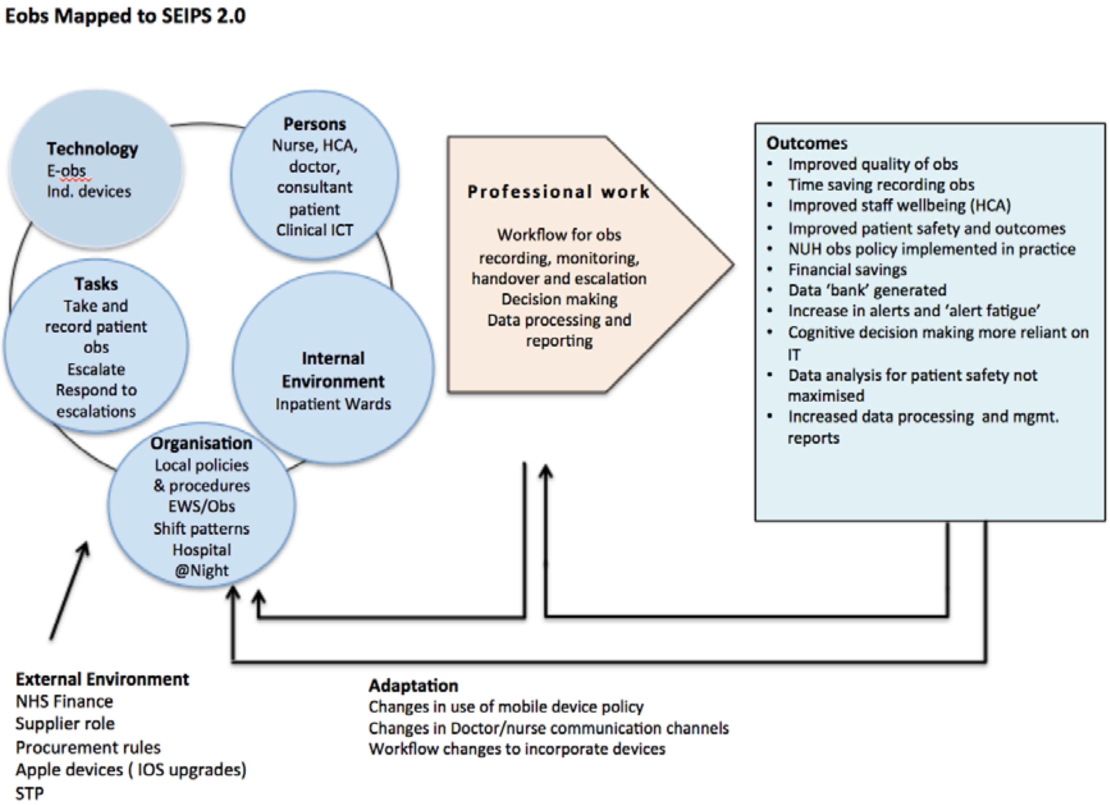

Figure 5. Summary of E-obs results mapped to the SEIPS 2.0 (Holden et al, 2013)

A small number of clinicians and the clinical/ICT team were instrumental in developing the original design, testing and implementation and their role was seen as critical to the success of the project, bridging the gap between technical IT experts and front line clinical teams. This extended to recognising the benefit of working with a supplier who uniquely employed a clinical team who were involved at every stage of the design and implementation.

A number of positive outcomes were reported including junior staff feeling valued *"by giving people a device, a really good bonus was how they felt- empowered"* and financial savings were identified. Positive improvements in patient safety and quality of care were achieved relating to reduced time to record observations, increased accuracy and a 10% reduction in critical care admissions.

Participants defined E-obs users as frontline staff – nurses, doctors, healthcare assistants and felt that primary user needs drove the system design. This approach excluded other secondary system users whose needs were not initially considered *" we just bought the application, only afterwards they said we need a reporting application, only then that they built us a reporting databas*e".

E-obs produces around 15,000 data entries per day creating a large data set. Participants recognised its potential for improving patient safety, some of which was being implemented, but felt that the use of this data to drive local and national patient safety policy were not being optimised due to capacity and capability issues. "*At the moment we don't have the staff with the skills to interrogate the data and …use that data for improvement"*.

Unanticipated consequences of E-obs included increases in the number of patient escalations and subsequent alert fatigue by the receiving clinicians, with alert fatigue recognised as on-going issue *"they may get 4 escalations for the same patient in an hour .. sometimes staff don't have the confidence not to escalate"*. Such issues are reported widely in healthcare (www.psnet.ahrq.gov) with Ancker et al (2017) finding that clinicians (in primary healthcare) were less likely to accept alerts as they received more of them, particularly more repeated alerts. Participants described staff reliance on E-obs rather than using their clinical judgement to decide when and who to escalate *"Reliance on ' I've put my numbers in, it's told me what to do, that's what I deal with' rather than my clinical acumen"*. Research by Patel et al (2013) reported that '*reasoning is mediated and influenced by how they use the technology available within the clinical department*' and that HIT systems fail to support clinicians' reasoning and decision making processes.

Changes to workflow and policies were identified with some staff having difficulty in adjusting to new nurse/doctor communications *"we had some senior regs, telling staff that you can escalate but if you really need me you can phone me. Which was then breaking the chain."* This links to research that HIT changes practice and healthcare staff rely on distributed cognition across people and system artefacts (paper, electronic) so changes can have positive and negative effects (Beuscart-Zephir et al, 2010, Holden et al, 2015).

The Trust has a strong IT safety culture and commitment to testing prior to any new implementation or system changes via protocols and use cases. However there is a reliance on user feedback to identify on-going problems. System resilience challenges and interoperability issues were reported when the handheld device software was upgraded but could not be supported by E-obs creating short term operational difficulties *"We had about 300-400 devices out of use as people updated to IOS 10"*.

Whilst some participants had attended study days where HF had been presented or had been exposed to HF via connections with colleagues, most had limited understanding of HF. The supplier had no HF trained staff in the company and felt that this was normal for their industry. All felt that education and training in HF would be beneficial for future projects.

Discussion

The E-obs project highlighted the complexity of operating in the NHS and the external, national drivers around timeframes, funding and suppliers that influenced how the project could be implemented and by whom. The findings echoed Wang and Hajli's research (2017) that healthcare lags behind other industries in realising the benefits of big data analytics. Interoperability issues across multiple external systems and suppliers highlights the need for national and international interoperability standards to be agreed. Although this is emphasised in Wachter's report (National Advisory Group on HIT, 2016) there appears to be no single driver to ensure a HF approach to HIT, supporting Waterson's (2014) findings about a lack of systems approach in healthcare.

The Trust's supplier contract promoted innovation in design and implementation, but the supplier's unique clinical business model presents challenges for future NHS HIT projects with other suppliers, risking technology driven solutions (Eason, 2015). It also highlights the importance of the supplier's role in contributing to long-term system safety whilst acknowledging the potential conflict of commercial interests versus patient safety (Schiff et al, 2015).

At Trust level, this study looked at E-obs in isolation and did not consider interoperability across the multiple internal systems and the effect on clinicians and workflow. Research (Feufel et al, 2011, Beuscart-Zephir et al, 2014) found poor integration between systems and it is suggested a similar situation would be found in the Trust, highlighting the need for individual HIT to be planned as part of the wider socio-technical system and in the users' context.

Table 1 compares the Trust's approach to the MOD HFI model, showing differences in approaches between the two organisations.

MOD Domains and Trust Processes						
Manpower	**Personnel**	**Training**	**Health Hazards**	**System Safety**	**Social and Organisational**	**HF Engineering**
Trust – primary users, less focus on secondary/distal	Assumption of digital literacy. Physical, sensory or psychological not defined	Training as part of roll out. Limitations due to speed of project timeframe. Secondary users limited training.	No data collected	System security via NHS IT protocols. Clinical via clinical guidelines Unclear if tested in adverse conditions	Consultants excluded by EWS policy affected engagement. Automatic escalation changed communication patterns. Junior staff felt valued. Data function not anticipated.	No HF methodologies Strong user testing and piloting
HFI Processes	**User Need Definition**	**System Requirements**	**Assess Tenders**	**Detailed System Design**	**Test and Acceptance**	**In-service Feedback**
	Strong primary user need focus	High level goal of patient safety. Reporting secondary consideration Software upgrades not predicted	No data collected	Combined step as part of iterative design process. Strong clinical input to design Unanticipated consequences – alert fatigue, escalations. Use cases and protocol testing		Updates tested before release. Rely on user feedback for problem identification

Table 1 E-obs mapped to MOD Domains and HFI Processes

The strength and benefit of clinical involvement and role of Clinical/ICT team was clearly demonstrated but Trust understanding of HFI is in its infancy with participants recognising the need for HF input and education to support future HIT projects. A human centred approach would allow all users (primary and secondary) and their needs to be identified along with a wider systems approach to address unanticipated consequences and interoperability concerns.

The MOD model provides a clear, structured approach to HIT procurement with detailed guidance at every stage of the process. It is suggested that whilst the Trust is not in a position to fully integrate HF, elements of the MOD approach could be adopted:

- Presenting a financial argument for HFI and using a cost benefit model at the project planning phase to demonstrate that HFI can generate greater cost savings the earlier applied (Taylor et al, 2014). The MOD scopes HF involvement at the start of a project and commissions HF expertise at key stages (MOD, 2015) and this approach is transferable to the NHS to maximise the benefit of HFI.

- MOD (2015) 'customer friend' could be adopted to provide independent HF input at procurement and tender assessment stages, addressing in part the lack of supplier and NHS HF expertise.

- Wachter (National Advisory Board on HIT, 2016) suggests that the average trust requires five individual clinical roles with advanced informatics training. The inclusion of HF capability in such roles would support wider HF leadership and system development. Capability could be defined by reference to CIEHF's professional standards (www.ergonomics.org.uk) which the MOD already use to define their HF practitioner and SQEP capabilities (MOD, 2015).

- Trust approach to usability and user acceptance was strong although participants acknowledged the scale of this task and their lack of training. Clinical ICT teams could receive training in core HF principles incorporating user needs, workflow, usability and HCI design and use the MOD (2015) model to define a range of HF tools and methodologies for application at project stages.

This is a single site study with a focus on one HIT project and experiences in other NUH projects or NHS organisations are likely to be different. The interviews did not capture all users such as nurse users independent from the project and their contribution may have identified other themes. A multi site study with a wider selection process and longer study timeframe could address these issues.

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