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ABSTRACT

Patient safety is an emergent property of complex sociotechnical healthcare systems. Human Factors and Ergonomics (HFE), with its design-based systems focus, offers frameworks for developing resilient systems, although use in healthcare has been limited to date. Most healthcare educational curricula articulate requirements for students to develop patient safety competencies, but there is scant direction as to how this might be achieved. The authors have produced guidance on embedding HFE in healthcare curricula, but recognise that examples of effective HFE teaching would further support educational practice. This case study outlines a related set of activities based around the NHS Health Check, a population-wide screening programme designed to identify and manage cardiovascular risk. The Health Check represents a cardiovascular risk management system and is amenable to analysis using HFE frameworks. The educational activities described support students in developing a deep awareness of HFE theory, and early development of HFE competencies. The Health Check is a highly relevant professional activity for pharmacy students but would also be relevant to medical and nursing students, as well as healthcare management staff. This case study will form the focus of a discussion that will provide delegates with an opportunity to share experiences of different approaches to HFE education.

KEYWORDS

Human factors and ergonomics, pharmacy, cardiovascular risk management, education

Introduction

The current focus on patient safety results from recognition that 'medical error' (Box 1) is a leading cause of death in developed countries. Several figures have been quoted, and in a recent update, Mackay and Daniel (2016) calculate a mean rate of 251,454 US 'error'-related deaths but suggest it may be as high as 400,000. Safety is an emergent property of healthcare systems, and the primary goal should be to design and maintain work systems that support good performance (Buckle et al., 2006). Human Factors/Ergonomics (HFE) provides frameworks for this (Carayon et al., 2014).

> Box 1: 'Medical error' – an unhelpful term? Safety and harm are both emergent outcomes of complex sociotechnical systems. The term 'medical error' suggests it is individual – rather than systems failures – that cause harm; it also infers a focus on medical doctors rather than the wider health care system. 'Blame' undermines key elements of resilient systems such as open reporting and learning from things that go wrong – it would be good to see an end to the use of this term.

HFE competencies underpin safe performance in high risk industries, and healthcare should be considered in the same light. The Chartered Institute of Ergonomics and Human Factors (CIEHF) is leading this with the development of a White Paper outlining its vision for integration of HFE in health and social care (Hignett et al., 2017). HFE education (from undergraduate and postgraduate training through to continuing professional development) will be critical to delivering on this vision. This will not be easy; despite the increased focus, patient safety education and research remain underdeveloped, with literature concerning pedagogical strategies for supporting students in developing safety competencies even more so. The authors have proposed a model for a patient safety curriculum, based on HFE principles (Vosper and Hignett, 2017) and developed practical tips for embedding generic HFE principles in educational curricula (Vosper, Hignett and Bowie, 2017). These steps could be usefully supported through discipline-relevant case studies. This paper outlines an example, using the NHS Health Check as the basis for HFE-based learning activities for undergraduate pharmacy students. This case study will form a focus for discussion, allowing delegates to share their own experience.

The problem

The pharmacist role is changing, and modern careers are likely to see pharmacists taking on aspects of the General Practitioner role. Modernising the future pharmacy workforce is a priority, and current education is not considered fit for purpose (Smith and Darracott, 2011). In the UK, undergraduate pharmacy students have limited access to the clinical environment; placement is concentrated in the later years, with science theory delivered in the early years. Students lack opportunities to integrate theory with clinical practice. To ensure future workforce capabilities, curricula must become more integrated, allowing students opportunities to explore links between scientific theory of drug action and what this means to a patient. This is best supported by learning experiences relevant to the professional role.

The second challenge is the development of safety competencies. While Education Standards articulate the need for curricula to be underpinned by patient safety, there is no guidance as to how this might be achieved. This case study describes learning activities based on cardiovascular risk assessment. Cardiovascular disease is a ‘family’ of diseases, including coronary heart disease, stroke and high blood pressure (DH, 2013) which all result from damage to blood vessels. People present with multiple diseases, linked by common risk factors (Goff et al., 2014).

There is a quantitative relationship between risk factors and disease incidence (Heidenrich et al., 2011). High quality longitudinal studies allow this relationship to be mathematically modelled, underpinning ‘risk engines’ such as QRisk2 (Collins and Altman, 2010). This relationship arises because the risk factors are tightly coupled with the processes that cause blood vessel damage.

Targeting population risk is considered effective (Barton et al., 2011), and in England, individual risk is targeted through the NHS Health Check screening programme (McNaughton et al., 2011). During early commissioning, it was envisaged checks would be delivered through GP practices. However, studies indicated a single service-delivery strategy may exacerbate health inequalities. People from lower socio-economic groups are more likely to visit pharmacies for health advice (McNaughton et al., 2011). Pharmacy Checks are usually structured within a local enhanced service, remunerated through retrospective claim of a ‘fee-per-check’ (PSNC, 2013; Saramunee et al., 2014). Data are communicated to the relevant GP practice, which holds the central data repository.

Cardiovascular risk management is therefore an area of practice where (i) there is an unusually tight relationship between the pathology (the damage to the blood vessels) and clinical management and outcomes and (ii) understanding the scientific detail of the pathology allows planning of risk reduction strategies. It is highly relevant to pharmacy and can support meaningful integration of science and practice.

The Health Check involves several interrelated tasks (using multiple tools and technologies) and processes, giving rise to multiple outcomes, many of which are emergent. Some outcomes are proximal (risk estimation and developing an initial risk management plan) while others are distal, such as the impact of this risk management on cardiovascular outcomes. There are also outcomes relating to health and safety, as well as the financial viability of the service. The service itself is a complex sociotechnical system and amenable to analysis using HFE frameworks. The Health Check itself is an example of risk management, introducing students to the concept of *hazards* (high blood pressure, elevated cholesterol etc. are hazards to cardiovascular health). *Risk* is introduced as the likelihood of the harm posed by the hazard being realised in terms of a cardiovascular event. Figures that are put on these hazards by risk engines such as QRisk2 allow students to appreciate the importance of accurate data collection. The rest of the Health Check is about *risk management*. Where possible, the pharmacist should be considering individual person factors, and providing support mechanisms (e.g. smoking cessation programmes) or encouraging clients to 're-design' their lives to support risk reduction, rather than demanding behaviour modification. Targets are agreed, and a timeframe set for review. In short, the Health Check can be used to introduce key HFE principles. Students can then apply this learning to managing the risks of delivering the Health Check itself. The Health Check can only reduce population risk if it is carried out (and reported) correctly. Complexity combined with organisational pressures (time and profitability) make it challenging, and system design is critical to its success. Allowing students to analyse the system and suggest targets for re-design offers them opportunities to link HFE theory with clinical practice.

Investigation & analysis

The aim of HFE education in healthcare curricula is to develop basic competencies. This is likely best served by providing students with an HFE methods 'toolbox', including systems and task analysis tools. The Systems Engineering Initiative for Patient Safety (SEIPS 2.0; Holden et al., 2013) is a simplified descriptive model of healthcare as a complex sociotechnical system and was therefore considered appropriate. Phases 1 and 2 of this project explored the suitability of SEIPS 2.0 for analysing the Health Check, but also its usability from a student perspective.

Phase 1: SEIPS analysis of the NHS Health Check

This involved shadowing pharmacists undertaking Health Checks, using observation and contextual enquiry to capture interacting system elements. The NHS Health Check was described, including boundaries, and the system mapped using the SEIPS 2.0 framework. The care processes identified were subjected to configural analysis (Figure 1). Configural analysis recognises processes are shaped by complex interactions of individual components: while all elements can interact, some interactions are more likely than others. Configural diagrams were used to highlight interactions most strongly influencing performance, with results used to identify hazards and make recommendations for improvement. Tools and technologies (tightly coupled with task factors) featured prominently, and tasks were often made harder by poor design. Work-arounds were observed that suggested the Health Check may not always be run in accordance with NHS guidelines. SEIPS was considered effective for analysing the Health Check system.

Phase 2: Student usability testing of the SEIPS 2.0 framework

One output from Phase 1 was a series of 'simulated patients.' These were mini case-studies based on the real-life patients observed. These highlighted specific issues impacting on the Health Check quality. An example of this is ethnicity, one of the most important risk factors for CV disease. Failing to select this correctly can mean high-risk individuals are missed. Observations suggested staff and students found this difficult to raise, often resulting in inappropriate selection of 'white or not stated'. Consequently, one simulated patient is of Bangladeshi extraction. These simulations were used to create video vignettes of Health Checks for SEIPS mapping. Six pharmacy undergraduate students received training in the Health Check and SEIPS 2.0 and undertook the mapping process for themselves. A group of academic staff carried out the same activities separately. Results of the student and staff SEIPS models were compared, and experience of using the framework was explored through focus groups. Both groups found mapping challenging, but the framework supported effective holistic consideration of the work system. Students picked up similar issues to staff, suggesting SEIPS is appropriate for student use.

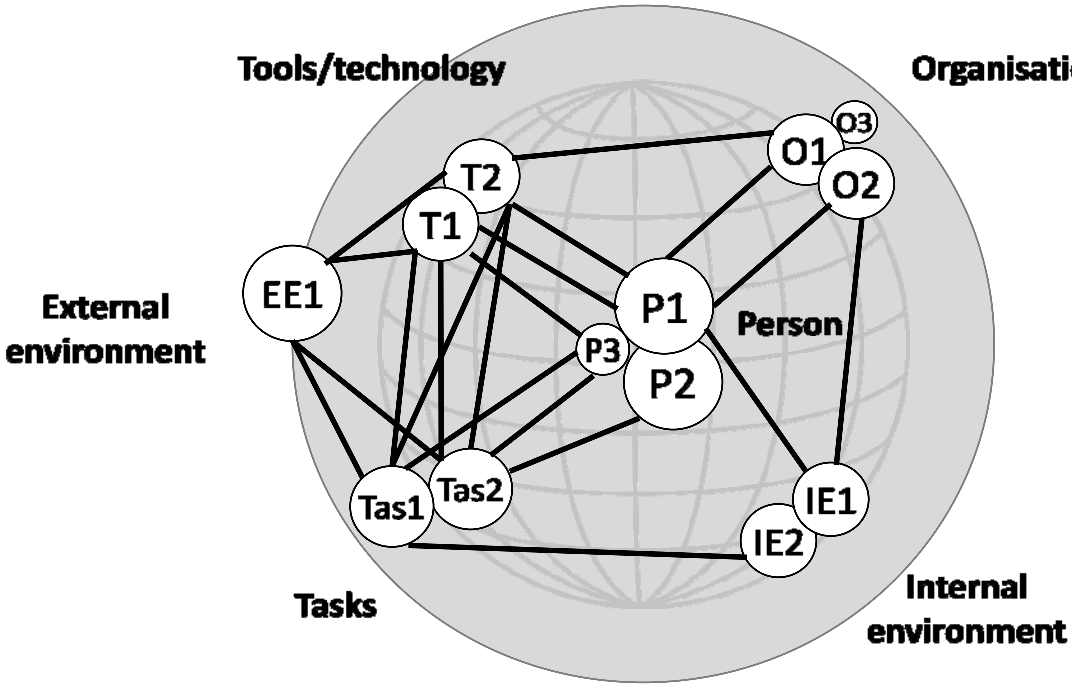
Phase 3: Teaching implementation

The outcomes of Phases 1 and 2 were used to develop learning activities supporting students in developing specific HFE competencies as defined by the IEA (2001):

Element 1.2: Applies a systems approach to analysis
Element 1.3: Understands the requirements for safety, the concepts of risk, risk assessment and risk management
Element 2.1: Evaluates products or work structures in relation to expectations of error-free performance
Element 2.5: Makes justifiable decisions regarding relevant criteria which would influence a new design or a solution to a specified problem
Element 4.1: Appreciates the extent of human variability influencing design
Element 6.1: Understands the hierarchies of control systems (application of primary and secondary controls and the order of introducing controls)

These activities span an entire semester, supported by 8 x 3h coursework sessions and approximately 15 lectures. Students learn the technical skill tasks required, including blood pressure measurement, glucose and cholesterol testing, taking a patient history etc. They are also taught the underlying clinical pharmacology and therapeutics relevant to cardiovascular risk. Delivery of the Health Check is set within an HFE framework. Students learn basic systems theory, and carry out SEIPS modelling, prioritising relevant areas to focus on to promote successful delivery of the Health Check. Students collect data for SEIPS modelling by observing each other's Health Checks, using this data to improve their own performance later in the semester. Hierarchical Task Analysis (HTA; Shepherd, 1998) is taught by selecting one specific element of the Health Check to focus on. The 2016-17 academic session focussed on blood pressure measurement. Students used observation and verbal protocol analysis to collect data, and each student produced a single HTA. These were combined, producing a composite task analysis, which was used to consider task re-design. Common errors in blood pressure measurement included:

- Placing cuffs inside out (the bladder expands outwards and doesn't compress the artery)
- Using an inappropriately sized cuff
- Deflating the cuff too slowly or too rapidly



Process 1: Assessment of cardiovascular risk
Active agents: Client and pharmacist

Performance in this phase is shaped most strongly by a combination of:
Person factors: P1: Ability of pharmacist to approach risk assessment in non-judgemental manner P2: Communication skills of both client and pharmacist P3: Client anxiety about cardiovascular risk
Task factors: Tas1: Complexity of testing (including collecting client history). The complexity is exacerbated by health and safety requirements Tas2: Training and skill level of pharmacist
Tools/technology factors: T1: Design of testing equipment T2: Design of client questionnaire/risk engine interface
Organisation factors: O1: Training strategy for staff involved in Health Check O2: What other appointments are scheduled in the pharmacy for today? O3: Is the staff member carrying out the Health Check also the Responsible Pharmacist?
Internal environment factors: IE1: Is there a private consultation room available? IE2: What is the size and layout of the space used for the Health Check?
External environmental factors: EE1: Clinical guidelines for vascular risk assessment
Other influences: This process is also weakly shaped by many other factors, including costs of consumables, maintenance of equipment, age and health status, as well as gender of client etc.

Figure 1: Configural mapping of the initial risk assessment process.

Resolution of the problem

Initially students tended to recommend training interventions but they were encouraged to think differently. This was assessed in the written examination, where students were asked to describe their use of HTA. Almost without exception, students discussed cuff design (and lack of standardisation), or problems with the cuff valve 'wheel' that meant tiny inputs from the user lead to large changes in cuff pressure and made sensible recommendations for design changes. While it was not possible for students to develop full competency with respect to IEA requirements, it could be seen that these activities were establishing foundations for more advanced skill development.

Impact and implications

Students performed well in the section of the assessment that covered HFE-specific learning outcomes. Internal data collected through sources such as the Student Evaluation Questionnaire suggested that students enjoyed these activities and believed them highly relevant to future practice. Academic staff reflection on delivery recognised that this practice-based approach was much more challenging than simply teaching students about HFE theory; students lead their own learning, and it doesn't always go where staff expect! Blood pressure measurement was selected for HTA as it seemed sufficiently 'meaty' for students to properly engage, yet small enough to be manageable. In reality, staff were surprised at how much variability there was in the task. It was worthy of note that the original user-testing of SEIPS with students involved the School Student Learning Enhancement Team. While these students are not necessarily all high achievers academically, they are highly motivated and may not have been a representative user group. Issues such as this may be barriers to embedding HFE within educational programmes. Further developments, including a move to a competency-based assessment, are challenging and the authors feel that this would benefit from further discussion and sharing of practice.

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