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Human factors and ergonomics and quality improvement science: integrating approaches for safety in healthcare

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INTRODUCTION

In this paper, we will address the important question of how quality improvement science (QIS) and human factors and ergonomics (HFE) can work together to produce safer solutions for healthcare. We suggest that there will be considerable advantages from an integrated approach between the two disciplines and professions which could be achieved in two phases. First, by identifying people trained in HFE and those trained in QIS who understand how to work together and second, by developing opportunities for integrated education and training. To develop this viewpoint we will:

1. Discuss and explore how QIS and HFE could be integrated by building on existing definitions, scope of practice, knowledge, skills, methods, research and expertise in each discipline.
2. Outline opportunities for a longer-term integration through training, and education for healthcare professionals.

HISTORY AND PERSPECTIVES OF QIS AND HFE

The disciplines and professions of QIS and HFE developed from similar origins in the 20th century to engage workers in the identification of problems and development of solutions.[1 2] They diverged with QIS focussing more on process issues (eg, production quality control) and HFE focussing on wellbeing (occupational health and safety) and performance. Both have been used in healthcare for many years, with several recent papers discussing confusion about jargon in one or both disciplines.[3–7] We will offer a simple outline of our perspectives for each before suggesting an approach for integrated working.

We are using the term QIS to include both quality improvement and improvement science.[8] QIS is used, defined and explained in the literature in many different ways, for example, 'the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge';[9] 'better patient experience and outcomes achieved through changing provider behaviour and organisation through using a systematic change method and strategies'[7] and as 'the combined and unceasing efforts of everyone—healthcare professionals, patients and their families, researchers, payers, planners and educators—to make the changes that will lead to better patient outcomes (health), better system performance (care) and better professional development (learning)'.[10]

QIS can include any change which improves quality (patient experience and/or clinical outcome), a change that uses a generic (eg, training, setting standards) or specific QIS method or approach.[11] Parry[1] outlined a history of QIS by drawing on Deming's System of Profound Knowledge and its influence on the development of Improvement Science. Deming's theory included systems thinking, variation (eg, statistical process control), psychology (or social sciences) and the theory of knowledge.[12] Most QIS practitioners will use a range of improvement methods and tools which may include Plan-Do-Study-Act (PDSA), Model for Improvement, Lean, Six Sigma, Total Quality Improvement and Business Process Reengineering.[11]

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Human Factors, also known as Ergonomics (we are using these terms interchangeably in this paper), is defined by the International Ergonomics Association (IEA)[2]: 'Ergonomics (or Human Factors) is 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 optimise human well-being and overall system performance'. The term Ergonomics was used for professional practice in the UK from 1950 (and internationally from 1961), whereas the term Human Factors was used in the USA from 1957. These terms have been harmonised in USA, UK, Australia and New Zealand by the inclusion of both ergonomics and human factors in society, institute and association names; most non-English speaking countries continue to use the term ergonomics. Wilson[13] suggested that HFE could be regarded as 'one of the first truly multi-, inter-, and cross-disciplinary subjects' by drawing knowledge from design, engineering, psychology, organisational management and human sciences (anatomy, physiology, biomechanics, kinesiology and anthropometry).

WORKING TOGETHER: AN INTEGRATED APPROACH

In 1990, Deming reflected on his experience as a patient with comments on organisational management problems and the design of medical devices (thermometers), showers, room layout (reach distances) and single rooms.[14] We suggest that QIS might not have the methods and tools to develop humanistic design solutions, so HFE brings expertise for the design of both medical devices and healthcare facilities as well as system performance.[15] This change (to eliminate physical, cognitive, system and organisational management problems) might be achieved more successfully through an integrated approach.

Figure 1 proposes an approach for integrated working based on an Institute for Healthcare Improvement (IHI) model for Improvement Science[11]—but could also have used other QIS and HFE frameworks. When a need for change in healthcare is identified, both QIS and HFE projects can be initiated (Step 1). This could be in response to a patient safety event, but it could also be when a new procedure is to be implemented, or a new piece of equipment introduced, or both. In our opinion, the division of Steps 2 and 3 into defining and exploring, design with stakeholders and methods for implementation offers potential for considerable advances in patient safety. The approaches, methods and tools are mostly different so integrating QIS and HFE will provide a framework to:

- Explore and define a problem by looking at the humans and the rest of the system (HFE and QIS),
- Redesign the tasks, interfaces and system (HFE),
- Define the elements of the intervention and process measures (QIS and HFE),
- Implement the change using expertise in improvement methodology, facilitation and coaching skills, and recognition and reworking of barriers (QIS and HFE).

The combination of QIS and HFE has been described in other studies.[3 16] In the first, Colligan *et al*[3] compared the use of a process map (QIS) and an hierarchical task analysis (HFE) to explore quality and safety concerns at a community based anticoagulation clinic. They reported that more concerns were identified using the hierarchical task analysis than the sequential diagram. The second example used a combination of QIS and HFE approaches to improve handover from day to night and illustrates both tensions and benefits.[16] Following baseline observations, a redesign of the process was introduced using a HFE approach. A further adaptation of this was introduced using the PDSA approach, still including most of the HFE-derived intervention. However, a further PDSA and redesign cycle substantially reduced the HFE component of the intervention, and also the measureable efficacy of the process. As HFE uses the understanding of human performance in complex systems to develop interventions and QIS uses the knowledge of complex systems to make changes, the combination of HFE and QIS could be extremely powerful. However, a threat to integrated working was found to be QIS adaptive processes that modified the HFE elements resulting in a deterioration rather than an improvement in human performance.[16] This threat could be managed by identifying people trained in HFE and those trained in QIS who understand how to work together.

DEVELOPING TRAINING AND EDUCATIONAL OPPORTUNITIES

As few professionals will have skills (and qualifications) in both QIS and HFE, to achieve benefits from the proposed approach we will need to raise awareness of opportunities for integrated working while also developing opportunities for education and training. With any new approach in healthcare, there needs to be both training (short courses and continuing professional development) and formal educational qualifications to support career pathways. Figure 2 uses a Clinical Leadership Competency Framework from the UK[17] to suggest levels of training and education in both QIS and HFE from awareness raising, to student, practitioner and expert practitioner.

For HFE, the student, practitioner and expert levels are aligned to the IEA competency framework.[18] There are 9 units with detailed elements and performance criteria, for example, Unit 5 outlines knowledge and skills to develop a plan for an HFE design or intervention. The first element (5.1) outlines the scope of an holistic view of HFE in developing

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Step 1. A change is needed e.g. new processes/technology to be introduced, safety problem identified		
	QIS	**HFE**
Step 2. What is happening before the change?	Measure current situation Define metrics for outcome (e.g. mortality) and process (e.g. weekly review/audit) Methods include: Pareto charts Ishikawa diagrams, Time Series Data / Shewhart Nolan's change ideas Lean: 5S (sort, straighten, shine, standardize, sustain), Spaghetti diagrams Six Sigma: SIPOC (Supplier, Input, Process, Output, Customer), Process mapping; Design of Experiment, Voice of Customer, Culture change methods, Stakeholder assessment, Statistics and control limits	Understand the change requirements with respect to human interactions/behaviour Task analysis methods for: 1. System e.g. hierarchical task analysis 2. Cognitive decision-making, situational awareness and mental models e.g. verbal protocol analysis, cognitive work analysis 3. Physical interactions e.g. link analysis, postural analysis, anthropometry
Step 3. Develop intervention	Use existing knowledge and evidence to develop intervention bundle, Improvement methods and tools and Subject Matter Experts	Design intervention with stakeholders (Participatory Ergonomics) Design Decision Groups Inclusive (Universal) Design
Step 4. Innovation, Testing, Implementation, Spread. Repeat Cycle		

Figure 1 Integrating QIS (quality improvement science) and HFE (human factors and ergonomics) professional practice.

solutions to first (performance criteria 5.1a) identify the relative contribution of organisational, social, cognitive, perceptual, environmental, musculoskeletal or industrial factors to the total problem and the second (performance criteria 5.1b) considers the impact of legislation, codes of practice, government and industry-based standards on the problem and possible solutions.

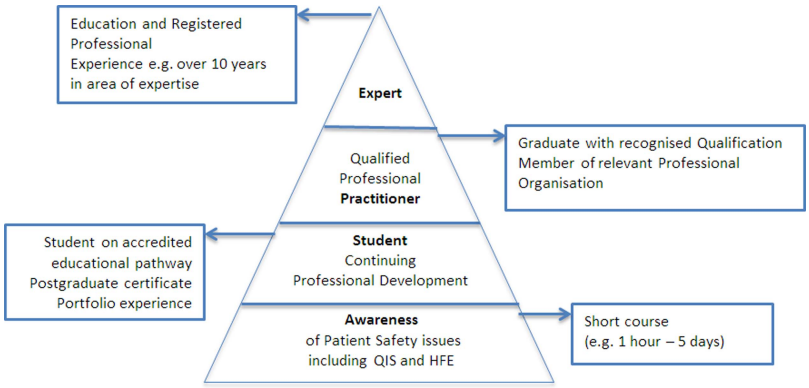

Figure 2 Outline of training and educational opportunities in QIS (quality improvement science) and HFE (human factors and ergonomics) for HCPs (clinical and non-clinical).

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Training and education levels in QIS are defined differently across the world and it has been suggested that some focus more on named methods (eg, PDSA, Six Sigma, Lean, Model for Improvement) and others more on leadership, mentorship and peer review.[19] Similar to the HFE model, there are defined knowledge areas, for example from the IHI 8 domains to examine healthcare as processes within systems by using diagrams that illustrate flow, inter-relationship and cause–effect, narrative descriptions and case examples.[10]

CONCLUSION

HFE explores a problem by looking at the people within a system, their interactions with each other and the system and then redesigning the tasks, interfaces and system. It uses a systems analysis approach where humans will be defined as stakeholders within the system. QIS looks at processes within a system to identify variation and then implement change based on testing different approaches to achieve the desired outcome. It involves the people within the system as stakeholders to first change and then sustain the improvement. The processes are mostly delivered by people but the humans are not the focus of the improvement. It uses systems analysis where processes are the components of the system. Both QIS and HFE can provide powerful philosophical and practical approaches to the improvement of healthcare. Both address complexity: HFE by understanding and structuring improvements/interventions based on human capabilities and limitations, and QIS by supporting frontline staff with a theory and method of improvement to identify problems, and then iterate towards local solutions within that complexity.

We believe that there will considerable advantages from a more structured relationship between HFE and QIS as suggested by the National Quality Board (UK) Concordat[20] 'a wider understanding of human factors [HFE] principles and practices will contribute significantly to improving the quality (effectiveness, experience and safety) of care for patients'. In healthcare, there is a long tradition of multidisciplinary team working and we hope that this culture will promote the integration of QIS and HFE as complementary rather than competing disciplines. We believe that this offers considerable opportunities for increasing safety in healthcare first, by identifying people trained in HFE and those trained in QIS who understand how to work together and second, by developing opportunities for integrated education and training.

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