

Human Factors *in* Healthcare

From the IEHF, highlighting innovation for the future



Focusing attention

The publication of the National Quality Board Human Factors in Healthcare Concordat at the end of 2013 has focused attention on the contribution that human factors can make in a healthcare setting in a way not seen before.

A growing number of Institute of Ergonomics & Human Factors (IEHF) members are now working on healthcare-related projects and this sheet provides a snapshot of some of these projects.

Medication practices with infusion devices

The National Institute for Health Research (NIHR) has recently awarded funding for a research project called ECLIPSE, Exploring the Current Landscape of Intravenous Infusion Practices & Errors, which studies medication practices with infusion devices.

The project involves human factors and human computer interaction professionals from UCL, and London hospital clinicians and will review the type and frequency of errors. They will deliver recommendations for best practice in different situations, considering different clinical areas, technologies, practices, policies, etc.

There have been various studies of the intravenous administration of drugs in hospitals. These suggest that errors often occur in both preparation and administration. Depending on the methods used and what is counted as an 'error', published error rates vary from 18% of doses to 173% of doses (more than one error per dose). While many of these errors are minor, some can lead to patient harm.

Within the USA, 'smart' infusion pumps are used in most hospitals with the aim of preventing such errors. Whereas normal pumps just require the volume, rate and time for infusion, smart pumps also want to know what drug is being infused. This allows them to limit the parameters for volume, rate and time so they do not exceed agreed safe limits for that drug.

Some research suggests that smart pumps can prevent a significant proportion of errors, other research suggests they have little effect. Smart pump use is much less common in England, and there are no UK studies of their likely effects on medication errors. There is therefore little information available to guide UK hospital staff in deciding how best to prevent intravenous medication errors, and whether or not the costs of smart pumps would be justified by any impact on error reduction.

ECLIPSE aims to address these questions. It will explore how often errors involving administration of intravenous medication occur in UK hospitals, the reasons for these errors, and how they may be linked to, or prevented by, the infusion pumps used. It will compare its results with a similar study ongoing in the USA, and explore reasons for any differences identified.

First, a study will be conducted across English hospitals to find out how often errors occur in the administration of intravenous medication across five clinical areas (critical care, general medicine, general surgery, paediatrics and oncology day care). It will include errors involving administration of the wrong drug, wrong concentration, wrong infusion rate, wrong time of administration, etc. It will investigate any differences in error rates or

types across different wards or hospitals, or for different types of infusion pump. Participating hospitals will be representative, as far as possible, of the range of existing practices, types of hospitals and locations within England.

Second, the project will focus in more detail on a smaller number of selected wards and hospitals, to explore why errors in intravenous medication do or do not occur. It will observe staff administering intravenous medication and setting up infusion pumps in the study wards. This will be supplemented by interviews with staff at all levels and with a variety of roles: managers, those responsible for training and device maintenance, nurses and other staff who use infusion pumps and administer intravenous medication.

Based on the findings, recommendations for best practice will be developed for intravenous drug medication administration in English hospitals. It is anticipated that this work will lead to a reduction in medication errors, and therefore patient harm, as well as providing useful information to hospitals in making decisions about the use of infusion pumps and whether or not to purchase smart pumps.

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Quality improvement in healthcare

This is a shortened version of a full paper, 'Human Factors & Ergonomics and Quality improvement in healthcare: Similarities & Differences', submitted by Dr Sue Hignett and Dr Ken Catchpole to the BMJ Quality & Safety publication.

As part of the response to the catastrophic failings in the quality and safety of care at Mid Staffordshire NHS Foundation Trust, the National Quality Board Concordat has brought together 16 agencies with monitoring, educational, management, professional and legal roles with respect to the National Health Services to implement 'Human Factors in Healthcare' by adopting and best Human Factors & Ergonomics (HFE) practice to "minimise risk to patients and so optimise human performance in healthcare". At two planning meetings to discuss the Concordat it became apparent that there was considerable confusion about:

1. Human Factors - is this the same as Ergonomics, Human Factors Engineering, Organisational Psychology, etc.?
2. Similarities and differences between Human Factors and Quality Improvement (QI) – is Human Factors a new initiative or is it already being achieved through QI projects?

An example of a misconception and limited application of HFE is apparent within training programmes for non-technical skills for surgeons (NOTSS).

Catchpole has commented: "This behavioural safety approach, while entirely legitimate and increasingly well evidenced, is limited. Yet it has dominated perceptions of what constitutes HF[E] and shaped the application of HF[E] principles in healthcare. Frequently espoused by well-meaning clinicians and aviators, rather than academically qualified HF[E] professionals, it has led to misunderstandings about the range of approaches, knowledge, science and techniques that can be applied from the field of HF[E] to address patient safety and quality of care problems".

The similarities and differences between HFE and QI have been mapped by the authors in collaboration with QI colleagues to explore

the relationship between HFE and QI in healthcare. The philosophy of the disciplines is very different, with QI initiatives seeking to eliminate waste (Lean) and decrease variation (Six Sigma) whereas HFE uses task and systems analyses to understand and map human variance and re-design the interfaces and systems based on principles of individual participation and inclusion. There are other differences:

International definition:

HFE: IEA, 2000 (<http://www.iea.cc/whats/>)

QI: No internationally agreed definition.

Also known as:

HFE: Human Factors, Ergonomics, Human Factors Engineering, Applied Human Factors, Human Factors Science

QI: Kaizen, Quality Circles, Total Quality Management (TQM), Lean, Six Sigma, Process Improvement, Improvement Science, QI Science (implementation science)

Role of HFE/QI expert:

HFE: Expert knowledge about problem, propose intervention/improvement based on analysis of problem, facilitation (change agent). Looks at the humans and the system and then re-designs the tasks, interfaces and the system.

QI: Expert in improvement methodology, facilitation and coaching skills, recognition and reworking of barriers to workflow and pace. Looks at the system and then changes the humans with the focus on meeting the needs of customer demand and not necessarily considering the individual worker or optimal efficiency.

There are considerable advantages from a more structured relationship between HFE and QI. To achieve this, benchmarking the quality of all HFE training and expertise using four criteria is recommended: use of HFE tools, use of HFE knowledge, application of HFE to the design of equipment, medical devices, products, buildings, vehicles and systems, and direct involvement of qualified HFE professionals (Chartered or Registered Members of a federated society of the International Ergonomics Association (www.iea.cc/about/council.html))

:: Further details Email Sue Hignett at S.M.Hignett@lboro.ac.uk or Ken Catchpole at Ken.Catchpole@cshs.org.

:: Publications

Flin R, Bromiley M, Buckle P, et al. Changing behaviour with a human factors approach. *BMJ* 2013; 346:f1416.

National Quality Board. *Human Factors in Healthcare: a Concordat* from the National Quality Board. 2013 (<http://bit.ly/1hlsXel>)

Catchpole K. Spreading Human Factors expertise in Healthcare: Untangling the knots in People and Systems. *BMJ Quality & Safety* 2013; 22:793-797.

Carayon P, Xie A, Kianfar S. Human factors and Ergonomics as a patient safety practice. *BMJ Quality & Safety* 2014; 23:196-205.

The role of anaesthetic rooms

A team from the University of Nottingham Human Factors Research Group is investigating the role that anaesthetic rooms play in providing efficient and safe surgical procedures, and how attitudes surrounding them may impact the potential for improvement within the operating suite. The anaesthetic room is a traditional structure within UK surgery, yet has been abandoned in the USA, Canada and Australia.

The research being undertaken takes on a multidisciplinary approach and unravels various dimensions surrounding the current use of anaesthetic rooms and their inclusion in new hospital builds or renovations. The research was designed to gather data from national, organisational and individual levels.

Both quantitative and qualitative methods will be used in conducting several studies focusing on anaesthetic and theatre preferences, management rationale in design, cost-efficiency of anaesthetic rooms, and finding consensus from conflicting evidence.

This research seeks to provide a holistic analysis of the role of anaesthetic rooms in UK surgery provision, willingness to change practice, the significance of tradition and professional domains, and aligning design of theatres with evidence of best practice. Future work may be able to draw on these findings as reflective of other complex systems.

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Exploiting virtual environments

Installing our latest Virtual Restorative Environment (VRE) “window-on-the-world” modules within the Intensive Care Unit of the Queen Elizabeth Hospital Birmingham (QEHB), ready for trials investigating patient cognitive restoration through improvement of sleep quality and the minimisation of delirium, has not been without its challenges.

As well as the inevitable ethics approval (which was, of course, particularly rigorous for the introduction of experimental human interface technologies into an environment such as the ICU), our prototypes were, after much paperwork, deemed to be Class I Medical Devices under classification rule 12 (Annex IX) of the Medical Devices Directive (MDD), requiring compliance with Annex VII of the MDD - 93/42/EEC. We're not altogether convinced of the significance or relevance of this, but a Class 1 Medical Device it is!

However, from a human factors perspective, of greater significance were the challenges faced whilst undertaking early informal, exploratory trials of wearability and usability with a range of interactive technologies. These were conducted both within a mock-up ward facility and at the QEHB, and not only with ICU patients, but also with military amputees, burns victims, the elderly and others, including nursing and associated healthcare personnel.

The trials highlighted a range of issues relating to the exploitation of simulation-based technologies for patient cognitive and physical rehabilitation. The first VRE scenario to ‘go live’ within the ICU is a large-scale Virtual Environment based on a region close to the Devonshire village of Wembury.

Users can, if they wish, explore extensive stretches of coastal paths, beaches and cliff-top regions, experience real-time sunsets and sunrises, observe a variety of animals and even relax on a virtual cabin cruiser. However, expecting ICU patients to possess the same perceptual, cognitive and physical capabilities to be able to navigate the ‘Virtual Wembury’ scenario freely, as might healthy participants using head-mounted displays, complex joysticks, gamepads or non-contact motion/



gesture-sensing technologies, is totally unrealistic.

VR head-mounted displays in a hospital ward, regardless of whether they are full-face, partial face, binocular or monocular are to be avoided at all costs. Not only to avoid any instances of cybersickness (which could be life-threatening for patients of all ages, especially those with medication), but also to promote good hygiene practice, minimise head and limb motion restrictions (especially in the presence of pillows, monitor cabling, catheters and so on), and to avoid facial and eye-to-eye communication problems with healthcare staff (including occlusion of eye-indicative symptoms).

Early trials also confirmed that even the most alert and physically capable ICU patients find the use of isotonic devices (multifunction gamepads or joysticks, even simple 2-axis ‘retro’ joysticks, be they whole-hand- or thumb-actuated) difficult and fatiguing.

One popular solution for many patients, and particularly those who are unable or unwilling to undertake lengthy virtual ‘walks’, is the Genius Ring Mouse (pictured right). This is a ring-mounted device that can be programmed to allow the patient to ‘jump’ between VR viewpoints by means of a single button press. Then, by gentle thumbstrokes of the device’s sensitive miniature touchpad, they are able to look right and left to take in the sights and sounds of the virtual day and night time scenes. These are just a small handful of examples in what has become a complex, patient-by-patient review of the interactive capabilities of hospitalised individuals.

As a result of these early evaluations, we are now in possession of a two-year healthcare technologies grant from the Royal Centre for Defence Medicine. We will be evaluating a range of present-day and near-future interactive device solutions, a good number of which, such as the recently-launched Quadstick, have emerged following successful sponsorship outcomes from crowd-funding platforms such as Kickstarter and Indiegogo.

Nevertheless, there is still a serious need for fundamental human factors research to address the extent to which patients’ perceptual-motor skills are compromised as a result of their injuries, post-operative conditions and extent and type of their medication.

The results of a sensory, motor and cognitive audit is now underway and the results will, in due course, help influence our choice of appropriate, patient-specific interfaces to the VREs and other, more interactive rehabilitation simulations we are developing. These include games-based ‘incentive’ spirometry for early weaning from mechanical ventilation.



:: Further details Email Professor Bob Stone at r.j.stone@bham.ac.uk or read the team’s chapter in the forthcoming Springer-Verlag book, *Virtual and Augmented Reality in Healthcare 1*.

:: Publication

Knight, J F, Stone, R J, & Qian, C (2012). Virtual Restorative Environments: Preliminary Studies in Scene, Sound and Smell. *International Journal of Gaming and Computer-Mediated Simulations* 4(3), Ludica Medica Special Issue; pp73-91.

Designing better cutlery for stroke survivors

Stroke is a chronic condition that causes a range of disabilities, including hemiparesis or weakness in one side of the body. This is the most common disability experienced by patients and the most disabling in terms of mobility.

Enabling patients to eat independently is one of most difficult tasks to rehabilitate. Patients can easily become frustrated as they want to maintain the lifestyle they had before the stroke. Sometimes stroke survivors find ways to overcome the limitations imposed by hemiparesis and this is called accommodation. To achieve this, it invariably involves them using specialised aids to help them eat.

A qualitative study was performed aimed at identifying the universal usability issues that affect the user experience (UX) of stroke survivors using assistive cutlery. The study applied an Interpretative Phenomenological Analysis for collection of verbal, behavioural and emotional data based on the Performance Measures of Universal Design (The Center for Universal Design, 1997). This empathic approach involved healthy participants experiencing mobility restrictions similar to those caused by hemiparesis using the Cambridge Simulation Gloves developed by the Engineering Design Centre at the University of Cambridge.

The UX analysis was made using three assistive forks and looked at how well these forks could be used to enable participants to move food from their plates to their mouths. The study found a relationship between fulfilment of the principles of universal design and reported UX of assistive products. The weight, shape and size of the fork used was significant, affecting how easily participants were

able to use the utensil and how comfortable they were. As soon as participants used the mobility restrictions, this was much more difficult and influenced the time they took to carry out the task. A number of factors influenced how patients coped with the task. The level of confidence they had in holding the fork and then transporting the food to their mouth was significant and this in turn was affected by the physical design of the utensil and the level of impairment experienced by the patient.

The aim now is to increase awareness of universal design approaches in the development of assistive products.

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New healthcare education and support centre

Developments in technology, organisational structures and patient care have made the working environment in healthcare more complex during the last twenty years. This has increased demands on staff and has changed the environment for patients.

With increasing complexity comes an inevitable increase in the risk of errors, and these have to be avoided, managed or mitigated. As a result, there has been an increasing awareness of the value of human factors principles in improving the quality and safety of healthcare.

In response to the need for knowledge in this field, two groups with relevant expertise, the Quality, Reliability, Safety and Teamwork Unit (QRSTU) and Oxford Simulation Teaching and Research (OxSTaR) came together to form the Patient Safety Academy. The Academy is funded by Health Education Thames Valley. Together they are working to prioritise training and support for NHS staff in the Thames Valley with the support of the Oxford Academic Health Sciences Network.

The Patient Safety Academy aims to provide education and support to healthcare professionals in the application of human factors to their work settings.

The Academy's work is currently focused on the following areas: Board level and senior leaders; Acute surgical teams; Mental health; Primary care. The work in these areas provides clinicians with the opportunity to gain a better understanding and practice of how human factors relates to the healthcare working environment and how to utilise this knowledge in the improvement of quality and safety.

:: Further details Email the Patient Safety Academy at info@patientsafetyacademy.co.uk or call 01865 740870.

Electronic notification and documentation

The SEND project, System for Electronic Notification and Documentation, uses the latest computer tablet technology to record and evaluate patients' vital signs, replacing traditional paper charts. It will help alert medical staff to early patient deterioration quickly and reliably, and allow that data to be shared with specialists across the hospital sites.

Medical staff will take regular readings of a patient's vital signs such as heart rate and blood pressure according to current practice, but instead of writing the information on an observation chart, they will input it into a computer tablet.

Using specially developed software, an Early Warning Score will be calculated and displayed instantly. Clinical staff will use this score to help them decide whether further medical intervention is needed.

The SEND project is supported by the National Institute for Health Research Oxford Biomedical Research Centre, a collaboration between Oxford University Hospitals and Oxford University to translate basic science into patient benefit and foster innovation. The Research Council UK's Digital Economy Programme, which is led by the Engineering and Physical Sciences Research Council, funded the team's research underpinning the system.

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