

Implementing

**Human factors**

in healthcare

*'Taking further steps'*

# Implementing Human Factors in healthcare

## 'How to' guide - volume 2

### *'Taking further steps'*

Prepared by [Dr Jane Carthey](#) on behalf of the [Clinical Human Factors Group](#) (CHFG)

This 'How to' guide was commissioned by the [Clinical Human Factors Group](#) and supported by funding from [The Health Foundation](#)

## Acknowledgement

Although Dr Carthey is the principal author of this 'How to' guide it is important to acknowledge the collective effort and teamwork that contributed to its production.

Healthcare teams, human factors researchers and consultancy firms, working in healthcare and other domains, responded to a request from the Clinical Human Factors Group to provide illustrative case studies. On behalf of patients we would like to thank everyone who has shared their insights and information - without their respective contributions, we would not have been able to produce this 'How to' guide.

## The Clinical Human Factors Group

In the last five years, the Clinical Human Factors Group (CHFG), amongst others, has raised awareness of the importance of applying human factors to the design of healthcare systems. The Clinical Human Factors Group is a broad coalition of healthcare professionals, managers and service users who have partnered with experts in human factors from healthcare and other high-risk industries to campaign for a healthcare system that places an understanding of human factors at the heart of improving clinical, managerial and organisational practice. You can find further information on the work of the CHFG at [www.chfg.org](http://www.chfg.org).

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# Foreword

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This 'How to' guide is about the science of human factors; the interaction between people and the environments in which we live and work.

The guide rightly acknowledges that human factors awareness is improved whilst highlighting that more needs to be done.

If we are to use safety science to benefit patients, we need to extend our understanding of how to apply human factors and how to embed and sustain proven interventions, in the everyday business of healthcare.

Focused on four major themes; design, teamwork, incident investigations and working in the real world, this guide illustrates that quality and effective performance for patients cannot be assured without consideration of the interdependencies of the system.

Through research, case studies and practical tips, the guide illustrates how human factors can reduce harm and improve both patient and staff safety. Providing invaluable insights for all concerned with quality the guide will support commissioners, and providers of healthcare; leaders, frontline clinicians and managers, in all care settings.

## Improving quality, through a human factors lens; what do we need to do?

First, we need to tackle variation and improve the reliability of all that we do. Using this guide will help us understand the powerful role that design can have in creating intuitive systems and devices: human factors based design can help build safer clinical systems for all.

Second, we need to enable and support people to work interdependently, even if working in new and different teams every day. The guide ably describes the importance of working together towards a shared purpose, and enhancing what we do with non-technical as well as technical skills.

Third, we need to embed human factors thinking into incident investigations and share lessons across the system. The guide highlights the importance of an open and transparent culture and a just culture, where no one is afraid to speak up, afraid of sounding stupid or talking out of turn. Cultures in which everyone, Board to ward and support services, are constantly aware of the potential for failure, so that speaking up is encouraged, heard and remedial action is taken where necessary.

Fourth, we need to address the difficult art of compliance with policies and procedures. Accepting that compliance is the threshold for 'good enough', there is an urgent need to collectively commit to continuous improvement in the pursuit of excellence. In a world of new technology we need to identify new ways to help rather than hinder implementation of national policy, evidence based research, local policies and procedures. The guide helps us understand the many factors that lead to non-compliance and the gradual erosion of safety standards, described as 'organisational drift'.

We need to intensify our efforts to implement proven strategies and interventions that reduce harm; sharing rapidly across the system to increase understanding of what works and what doesn't. This guide exemplifies that principle.

Implementation is a process not an event, detailed references and resources will help readers explore the subject further, in support of their journey.

Our hope is that this publication will provide the much needed support for people who face the challenge of providing complex health care to millions of patients across the NHS in an ever changing world. For those who are harmed and sometimes die as a result of unsafe care, implementation of the interventions featured in this guide is not just something nice to do, it is a must.

### **Professor Jane Reid.**

Independent Consultant and Nurse Advisor to the DH Human Factors Reference Group. Researcher, Queen Mary's University and NHS Non-Executive Director.

### **Dr Suzette Woodward.**

Director of Safety, Learning and People.  
NHS Litigation Authority.

# 1: Introduction

## In this Chapter

- What is human factors?
- The 'How to' guide to Implementing Human Factors in Healthcare
- Why are human factors important in healthcare?
- Understanding the breadth of human factors
- Further reading and resources.

In healthcare many professionals coordinate care across organisational, departmental and team interfaces. Like all humans, healthcare professionals are fallible and will make errors irrespective of how experienced, committed and careful they are (Reason, 1990) but the design and complexity of healthcare systems increases the likelihood that errors will harm patients. Reducing patient harm is a strategic priority for the NHS. Integrating human factors science into the design of healthcare systems, processes and tasks can play a significant role in reducing patient harm.

## What is human factors?

Human factors is the science of understanding human performance within a given system. Translated into a healthcare context, human factors has been defined as:

*"Enhancing clinical performance through an understanding of the effects of teamwork, tasks, equipment, workspace, culture, organization on human behaviour and abilities, and application of that knowledge in clinical settings." Catchpole, 2011*

Developing healthcare systems that are founded on human factors principles can positively impact on safety by:

- reduction of harm through better design of healthcare systems and equipment
- understanding why healthcare staff make errors and how 'systems factors' threaten patient safety
- improving the safety culture of teams and organisations
- enhancing teamwork and improving communication between healthcare staff.
- improving how we learn when things go wrong by improving current approaches to incident investigation
- predicting 'what could go wrong' in the design of new hospitals and healthcare processes, for example, through the application of cognitive task analysis, prospective risk assessment tools, workload assessments etc

## The 'How to' guide to Implementing Human Factors in Healthcare

The first *'How to' guide to Implementing Human Factors in Healthcare'* (see box on next page) written by the CHFG, was implemented as part of the Patient Safety First campaign in July 2009 (Carthey and Clarke, 2009). It provided an introduction to human factors and explained the benefits of applying human factors in healthcare.

Many healthcare organisations have carried out work on implementing human factors since this time and the first 'How to' guide created a demand for more information from the service. With these factors in mind, the Clinical Human Factors Group commissioned this second volume, with support from The Health Foundation, with the aim of:

- Broadening understanding amongst healthcare teams of the potential ways in which human factors methods can be applied to improve patient safety
- Sharing practical experience of applying human factors in healthcare, using case studies from different care settings
- Signposting healthcare teams to further information and resources to support them to implement human factors in their own organisations.

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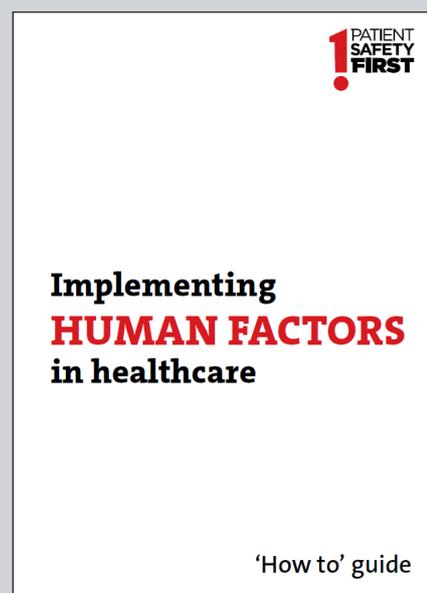
## Why are human factors important in healthcare?

On the following page is an excerpt of a 'letter to oneself' written by Dr Christina Petropolous, Clinical Director in the Paediatrics Division at UCLH NHS Hospitals Foundation Trust. The letter is used in training sessions with junior doctors who may, at some point in their careers, take on a clinical management role. It demonstrates the importance of human factors in healthcare.

Dr Petropolous's letter clearly illustrates the importance of and links to several of the sections of this Guide. For example, the letter shows us that:

- Humans are fallible and their performance at work is affected by personal life experiences, external pressures and lack of a robust support structures
- Non-technical skills like leadership, teamwork, workload management and communication play an important role in improving patient safety
- Incidents are opportunities to learn and improve, especially when the patient's perspective is included
- Developing an open and fair culture is essential to enable learning to take place
- Improving patient safety involves collaboration across team and departmental interfaces.

### Volume 1 of the 'How to' guide to Implementing Human Factors in Healthcare



Download at [www.patientsafetyfirst.nhs.uk](http://www.patientsafetyfirst.nhs.uk)

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## A letter to oneself by a Clinical Director

Dear Self

### 1. Mind Body and Soul

*It is important to remember that in order to look after a team and/or a service you need to be in good nick yourself and feel that your personal life is as in control as it can be. If your home life is in chaos, this will spill over into your professional life. With this in mind, I would recommend the following to try and maintain a work life balance:*

- Put aside some protected time every week for yourself whatever it is you are into, be it fly fishing or zumba dancing
- Prioritise time with your family...and make sure that your childcare arrangements are as robust as they can be
- Think about who you will turn to for emotional and practical advice. Coaching and mentoring? People in the same role in another organisation? One size does not fit all.

### 2. As long as you put the patient at the centre of everything you do, you will succeed

*How can you implement positive change without upsetting your own or outside teams where you think improvements can be made?*

- Sometimes you just have to be firm if something is not right and face the fall out – remember that it is for the greater good!
- Never let a serious incident go to waste – if you feel passionately about what went wrong, offer to investigate. Remember the recommendations are yours to create, (within reason – you need to check that they are realistic) and they go straight to the top. Locally, try and use existing structures- education, M&M, grand rounds to maximise your audience {so lessons are learnt}.
- Learn from families as much as possible and use this to create change.

### 3. Learn the governance structures in your organisation and department and how to access them

*Most departments have local governance arrangements that are sometimes not well understood by junior members of the team. Do try and engage.*

- Use incident report forms whenever you can. Remember the value of incident reporting
- The importance of an open and honest culture in teams is of real importance here – everyone must feel safe to speak out. Sometimes you need to test this by asking people their opinion or by giving them permission to speak out
- Try and resolve issues face-to-face without 'shroud waving' – try and help to find the solution.

### 4. Make sure you have the right team around you, know their strengths & how to get the best out of them

*A team needs a good leader but you also need the right people around you.*

- The better you get to know your colleagues and their strengths, the sooner you can delegate to them
- Treat everyone the same – some will be more vocal than others- make sure everyone has a voice. The quietest person may make the best point
- 'Special colleagues' {i.e. disruptive colleagues} are a challenge. Try and keep cool with them and remember to consider: Are they looking after themselves? Are there health problems? Is the patient safe? Is the governance around their practice and the way they behave safe? Does HR need to be involved?
- You need to be squeaky clean yourself – you need to walk the walk.

### 5. Time management – plan your diary and manage your email

Learn how to manage your time effectively, always plan ahead and try not to minimise your time on emails.

Before you send ask yourself, 'Is it easier, quicker and less likely to cause upset if you have a conversation?'

Keep your cool if the email has wound you up – almost always you will have got the wrong end of the stick

Allocate the time that you need to do things properly.

### 6. If you snooze you lose –learn how to schmooze

*To lead your team you need to know what's out there, who is doing what, where your department's strengths and weaknesses lie and strategically what makes sense. This is important both internally and externally.*

### 7. Don't go native

*Always remember why you took on this role in the first place; to improve patient care and facilitate the creation of something really good. If people start revolting, disengaging or generally seem unhappy you won't have followed the points above and may well have gone native. Don't do it!*

Regards, You.

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## Understanding the breadth of human factors

Unlike other high technology industries, healthcare has not yet fully understood, embraced and applied human factors in all of the areas where it could improve patient safety (see [Figure 1](#)).

This guide could not and does not aim to provide comprehensive coverage of all of the areas of human factors shown in [Figure 1](#). Human factors is a large and diverse field whose literature and resources have evolved over several decades in many different domains. Therefore this guide focuses on a few key areas, as follows:

1. Integrating human factors into the design of work environments and medical devices (chapter 2)
2. Integrating human factors into the design of healthcare systems (chapter 2).
3. Applying human factors methods to build safer clinical systems (chapter 2).
4. Enhancing teamwork through human factors-based team training (chapter 3).
5. Measuring non-technical skills (such as leadership, communication, teamwork and situational awareness) (chapter 3).
6. Integrating human factors into incident investigation (chapter 4).
7. Understanding work as it is imagined in healthcare policies and procedures, non-compliance and organisational drift (chapter 5).

The following chapters explore each of these areas and use research findings and case studies to illustrate their importance in healthcare.

At the end of each section or chapter you will find a signpost to some key references, books, websites and resources relevant to the content.

Further information on wider resources and reading for human factors is provided in [Appendix A](#).

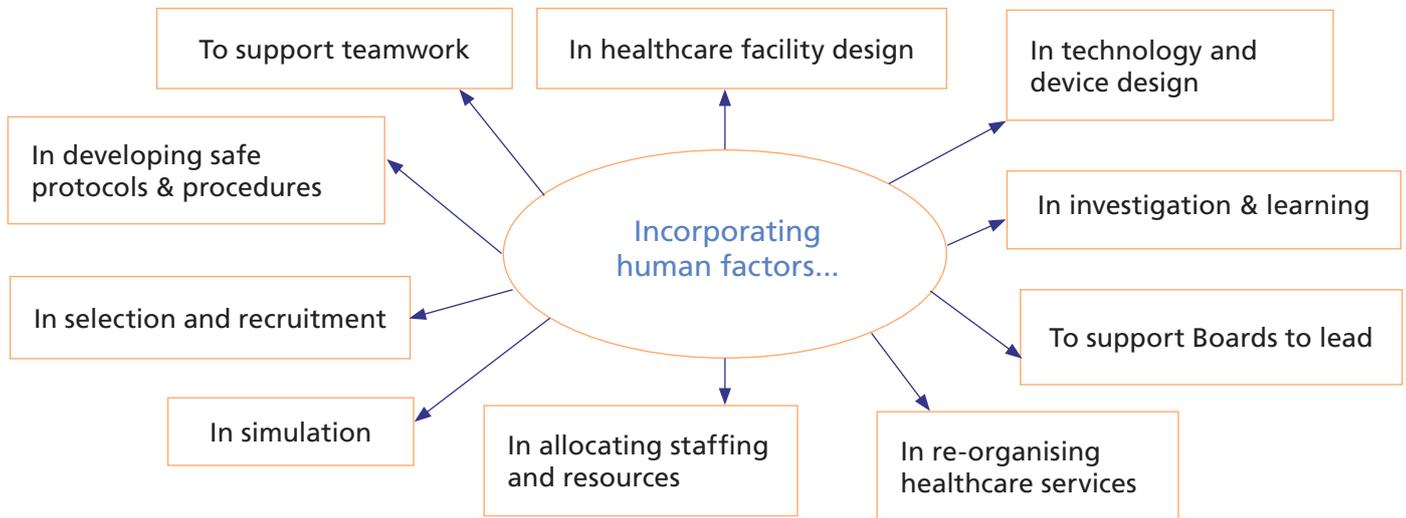


### Implementation tip

*Are you faced with clinical or management colleagues who are sceptical about the importance of human factors in healthcare or who do not understand how human factors impacts on their performance?*

*Consider photocopying Dr Petropolous's letter and share it with your colleagues. You could also write your own letter that relates to your role and use it to explain the importance of human factors to your work colleagues.*

Figure 1: Human factors methods and applications



**To support teamwork**

- Training needs analysis
- Crew resource management & human factors training
- Non-technical skills competency
- Assessments
- Checklists

**In simulation**

- Performance observation
- Questionnaires
- Physiological measures
- Mental workload assessment
- Non-technical skills assessment (situational awareness, communication and teamwork)

**In healthcare facility design**

- Anthropometry
- Environmental assessment
- Task analysis and system modelling
- Prospective risk assessment
- Safety cases
- Mock ups and prototyping
- Hazard identification
- Human reliability analysis
- HF based procedure design

**In technology and device design**

- Allocation of function analysis
- Usability assessment
- Interface design and analysis
- Anthropometrics
- Mental workload assessment
- Task analysis and system modelling
- Safety cases
- Mock ups, prototyping and walk throughs
- Simulation

**In re-organising healthcare services**

- Task analysis and system modelling
- Prospective risk assessment
- Hazard identification
- Human reliability assessment
- Environmental assessment
- Workload assessment
- Safety cases
- Shift design

**To support Boards to lead**

- Safety culture & climate tools
- Strategic risk assessment
- Strategy for patient safety
- Error taxonomies
- Organisational accident models & concepts (e.g. organisational drift)
- Staffing assessment
- Task analysis and system modelling

**In allocating staffing and resources**

- Aptitude testing
- Psychometric testing
- Non-technical skills assessment
- Shift design
- Fatigue assessment
- Workload assessment

**In investigation & learning**

- Interviewing techniques
- Investigation approaches & methods
- Error taxonomies
- Organisational accident models
- Safety performance measures
- Performance variability analysis
- Incident modelling

**In selection and recruitment**

- Aptitude testing
- Psychometric testing
- Non-technical skills assessment

**In developing safe protocols & procedures**

- Task analysis and system modelling
- Prospective risk assessment
- Human reliability analysis
- HF based procedure design

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## Further reading and resources



### Useful human factors references and books

1. Carayon, P. (Editor) Handbook of Human Factors and Ergonomics in Healthcare and Patient Safety
2. Wickens, C.D.; Lee J.D.; Liu Y.; Gordon Becker S.E. 1997. An Introduction to Human Factors Engineering, 2nd Edition. Prentice Hall
3. 'How to' guide to Implementing Human Factors in Healthcare - volume 1. Available at [www.patientsafetyfirst.nhs.uk](http://www.patientsafetyfirst.nhs.uk)

### Useful websites

1. Institute of Ergonomics and Human Factors: [www.ergonomics.org.uk](http://www.ergonomics.org.uk)
2. Clinical Human Factors Group: [www.chfg.org](http://www.chfg.org)
3. Human Factors and Ergonomics Society: [www.hfes.org](http://www.hfes.org)

### Human factors resources

1. Just a routine operation: [www.institute.nhs.uk/safer\\_care/general/human\\_factors.html](http://www.institute.nhs.uk/safer_care/general/human_factors.html)
2. World Health Organisation. 2009. Human Factors in patient safety. Review of topics and tools. Available at: [www.who.int](http://www.who.int)

## 2: Human Factors in design

### In this Chapter

- Integrating human factors into the design of medical devices and healthcare systems
- Integrating human factors into the design of healthcare systems
- Further resources and reading.

It is difficult to overstate the importance of integrating human factors into the design of systems, processes or tasks. This is the case whether one is designing a nuclear power plant, aircraft cockpit, a patient pathway, new clinical service or a medical device. Consideration should be given to how human memory and attention mechanisms work, how humans process information from their environment and how human performance is influenced by environmental and situational factors like distractions and interruptions. Considering the impact of human factors is an essential component of safe system design.

### Integrating human factors into the design of medical devices and equipment

The report, 'Design for Patient Safety' (2003), demonstrated the importance of integrating ergonomics and human factors into healthcare system and medical device design. Although Design for Patient Safety was published nine years ago, two of its key findings are still relevant today:

- i. The NHS is "seriously out of step with modern thinking and practice" on design, leading to avoidable risk and error
- ii. Design practice and understanding is less advanced in the NHS than in other safety-critical industries

Healthcare systems are replete with poor design: Some frequently cited examples include:

- Drug preparation areas in wards and community pharmacies where there are frequent interruptions by people and telephones, insufficient workspace and high ambient noise levels
- Placement of key equipment and supplies in different locations on different wards in the same hospital. Activity sampling evidence from The Productive Ward™ Programme showed that ward nurses travel up to 5 miles a day hunting and gathering supplies (NHS Institute for Innovation and Improvement 2010, 2011)

- Syringe drivers where the numbering on keyboards is not standardised and differs across different manufacturers' products
- Electronic prescribing systems where drop down menus for different drugs put sound-a-like drugs next to each other on a drop down list, thus increasing the risk that the wrong drug will be selected
- Poor storage for medications in acute, mental health and community pharmacies meaning that look-a-like, sound-a-like medications are stored next to one another
- Poor medical device design. For example, there have been numerous incident reports associated with defibrillator design. These include paddles that are hard to remove from their retaining wells and confusing arrays of poorly-labelled controls and displays that inhibit safe, efficient use (Sawyer et al., 1996).

In healthcare, medical device design has been identified as a contributory factor to patient safety incidents (Boakes, Norris and Scobie, 2008). One review of incident reports submitted to the National Reporting and Learning System identified several device design issues including:

- Device designers and developers often do not understand the healthcare context in which their device will be used and therefore do not anticipate likely error traps or incident scenarios
- Medical devices are often not designed with users' expectations in mind, resulting in errors occurring when the device did not function as the user had expected (Boakes, Norris and Scobie, 2008)

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To be considered 'well-designed' a medical device must be clinically effective, safe AND meet the needs of the people that will use it and be treated by it (Martin, Clark, Morgan, Crow and Murphy, 2012). Device designers need to consider a number of factors including the capabilities and working patterns of clinical users, the needs and lifestyles of patient users, the environments in which the device will be used, and the system(s) of which it will be part (Martin et al., 2008; Sawyer, 1996; Money, Barnett et al., 2011). In short, the same principles of user-centred design that are widely applied in other high technology industries need to be applied to healthcare.

Other industries, like aviation, the nuclear industry, and oil and gas production integrate human factors methods into the design of work environments (see for example, the summary report, 'Lessons from high hazard industries for Healthcare', NPSA, 2010).

We can illustrate the different approaches between high hazard industries and healthcare by contrasting how control room design has evolved in the oil and gas industry and comparing this to the design of a typical NHS operating theatre:

## Oil and gas platform control room versus operating theatre design

### The Oil & Gas Platform Control Room

One company operated a number of fixed oil and gas platforms with 20-year old control rooms. Many had been modified and upgraded over time and the design of the working environment caused difficulties for Control Room Operators. A review found that the layout of the controls, displays and annunciators made it difficult for Control Room Operators to understand developing situations. Control rooms were hot and noisy making concentration difficult. Lighting caused glare and reflection on display screens. Alarms weren't prioritised making it possible for operators to miss a crucial alarm. There were too many alarms during normal operations many of which were "nuisance" alarms.

The company redesigned the control room layout, lighting and air conditioning. Alarms were prioritised so that important information was easier to spot and nuisance alarms were engineered out. The company recognised that the control room design was compromising the CROs ability to guarantee the integrity of the systems barriers. Failure to integrate human factors science into successive control room modifications was corrected with a complete redesign. This improved the ability of the control room operators to manage the platform safely (Step Change in Safety, 2010).

### The NHS Operating Theatre

Now compare the above scenario to the design and working conditions in a typical NHS operating theatre: The placement of monitors displaying a patient's haemodynamic status sometimes means that not all members of the operating theatre team have good visual access to this information. Glare from theatre lights sometimes compromises visibility of information on monitors.

The design of anaesthetic machines means that nuisance alarms occur frequently, leading theatre teams to disable them to reduce distractions and interruptions. Alarm systems design is often not discriminatory – making it difficult to differentiate high importance alarms from less important ones.

For the majority of surgical teams, who often carry out long cases with a full theatre list, there is no sit-stand workplaces, meaning team members have to stand for long periods of time. Fatigue therefore becomes an issue.

Operating theatres are usually an ergonomics nightmare; cables, monitoring leads and equipment create accessibility problems but these are tolerated because this is the working environment theatre teams are accustomed to.

Overlaid onto these design issues are defective working practices; external distractors are an accepted fact of theatre life (for example, colleagues coming to the operating theatre door to ask consultant surgeons and anaesthetists to make decisions about other patients). Short turnaround times between cases sometimes make it difficult for theatre team members to eat lunch – especially where there is no designated theatre coffee area within the theatre suite. Poor operating theatre suite design puts team members into situations where they make 'trade-off decisions': *'Do I un-scrub, take off my theatre greens and go and buy lunch, OR do I skip lunch knowing I have two more cases this afternoon OR do I violate infection control policy by walking to the hospital canteen in my theatre greens?'*

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As well as poorly designed work environments, research studies have illustrated the consequences of the failure to consider human factors when designing medical devices. One example, sourced from human factors experts working at the University of Nottingham is shown below:

### Integrating human factors into device design: The EpiPen

Anaphylaxis is a life threatening allergic reaction which affects the respiratory and/or cardiovascular systems (Muraro, Roberts et al., 2007). Whilst anaphylaxis may be triggered by exposure to latex rubber, insect venom and medication, the most common cause is exposure to foods including peanuts, nuts, fish, milk and eggs (Ewan, 1998). In the UK, there was a seven fold increase in hospital admissions due to anaphylaxis between 1990/1 and 2003/4 (Gupta, Sheik et al., 2007; Sheik et al., 2008). The treatment of anaphylaxis is a prompt intramuscular injection of epinephrine, typically administered by the patient themselves.

In the MATCH study, fifteen patients who had been prescribed EpiPens were interviewed. The study explored the patient perceptions and use of prescribed epinephrine auto-injectors to support patients to self-care and manage anaphylaxis.

The findings showed that some patients were reluctant to carry their EpiPen because its design made it look like a 'weapon-like' device. As well as poor device design, limited patient education led to patients choosing not to carry their EpiPen: Some of the patients interviewed were confident that the emergency services would provide them with the appropriate care they needed, and therefore did not carry the device in urban areas.

Patient quotes from the interviews clearly show the importance of considering the context in which a medical device will be used when it is being designed. For example, one of the patients' interviewed stated:

*'Well, when I go to football, once a week... you get searched going into every away game, these days, and I didn't want to be sitting there causing a scene because I've got an EpiPen, you know, in case I'm going to sort of run on the pitch and stab one of the players with it. That's obviously what they think. You're not allowed knives, not allowed anything in, so why not this, you know?'*

Another patient commented:

*I think...I think there's the reliance of, oh, I'm in the city, I'm going to be okay, there's so many hospitals, there's ambulances...you're covered kind of thing, compared to if you was in the middle of the mountains in Scotland or something like that.*

Supplied by the MATCH team. University of Nottingham. UK

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## Examples of key human factors design principles

Human factors principles state that control and display design should consider:

- Importance & frequency of use, i.e. place important controls or those used often within easy reach and important displays centrally in the visual field of the person using the equipment
- Functionality, i.e. group controls and displays that relate to the same functions together
- Sequencing; place controls in the same sequence that the task will be carried out.
- Ease of use: i.e. design controls and displays that are easy for human operators to use and where the only way to use the equipment is the correct way (Salvendy, 2006).

Showing consideration of human memory and attention limitations, manual dexterity, as well as situational awareness, is essential when designing controls, displays and devices.

Ensuring design is intuitive (i.e. matches peoples' expectations) is also important, counter-intuitive design increases the risk of human error. Sawyer et al., 1996, discuss an example where an anaesthetist treating a patient with oxygen set the flow control knob between 1 and 2 litres per minute, not realising that the scale numbers represented discrete rather than continuous settings. The design of the device meant that there was no oxygen flow between the settings, yet the knob rotated smoothly, providing misleading feedback to the anaesthetist that intermediate settings were possible. The patient, an infant, became hypoxic before the error was discovered.

### Understanding the interactions between patients, healthcare professionals and medical devices

One of the key principles of human factors is 'user-centred' design. Translated into a healthcare context, 'user-centred design' means ensuring that the attitudes, beliefs and behaviours of healthcare professionals, patients and carers, and the context in which the device will be used, are integral to decision making about how medical devices and healthcare systems are designed. There are examples in other high technology industries, for example nuclear power plant control rooms and air traffic control computer interfaces where 'user-centred design' has removed error traps and improved safety.

In healthcare, as in other industries, the people who purchase or procure equipment and commission buildings, pathways and information systems need to understand user-centred design. To do this effectively they need to appreciate the science of human factors AND work alongside clinicians to reflect their operational needs.

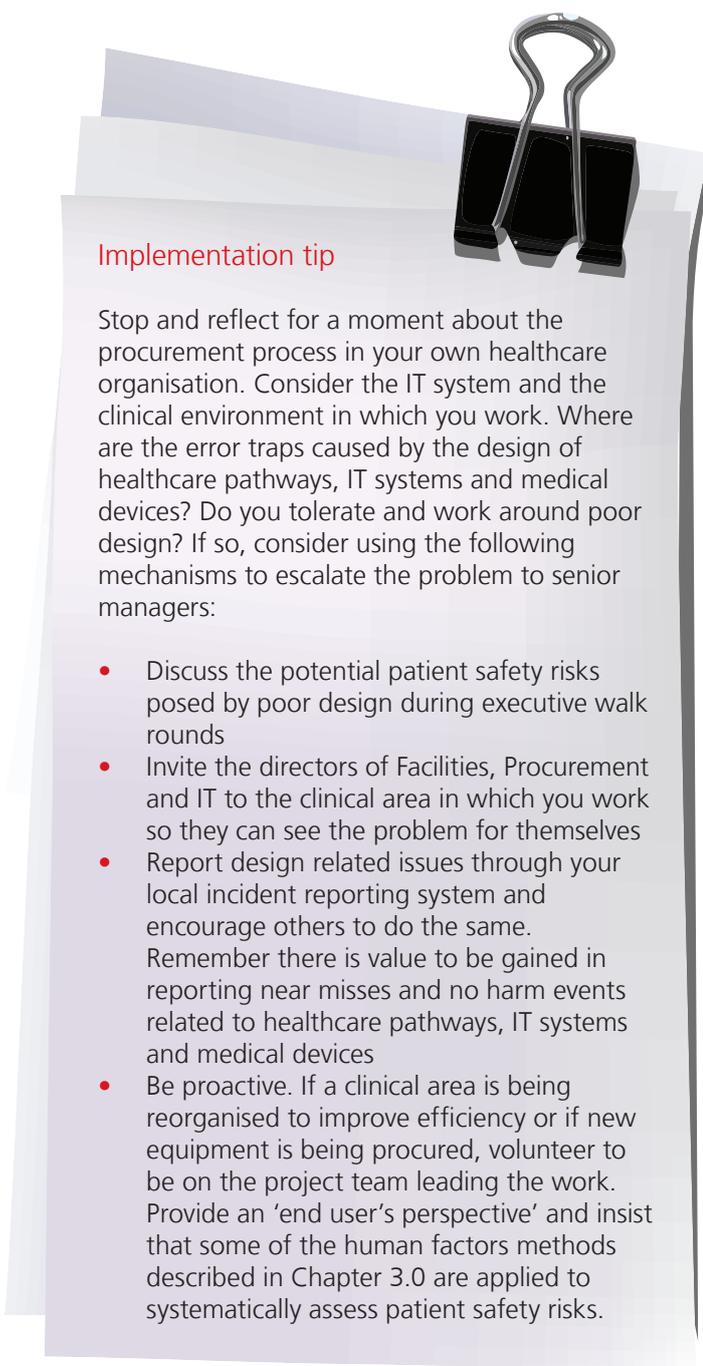


### Implementation tip

The NPSA report, Lessons from High Hazard Industries for Healthcare (NPSA, 2010) has more detailed information on user-centred design. The report describes key human factors design considerations including standardisation, usability, functionality, flexibility, simplicity, visibility, workflow and focus on systems, not individual elements. It also outlines seven steps for a user centred approach to designing safer healthcare facilities, based on learning from other industries. These steps are:

- Step 1: Determine the project scope
- Step 2: Identify users and key activities
- Step 3: Identify the safety issues
- Step 4: Analyse and prioritise the safety issues
- Step 5: Develop potential design options and solutions
- Step 6: Evaluate design solutions
- Step 7: Implement the design.

Reading 'Lessons from High Hazard Industries for Healthcare' (NPSA, 2010) will provide you with a more detailed understanding of how to integrate human factors into healthcare system design. Both a summary and full report are available at: <http://www.nrls.npsa.nhs.uk/resources/?EntryId45=74930>



### Implementation tip

Stop and reflect for a moment about the procurement process in your own healthcare organisation. Consider the IT system and the clinical environment in which you work. Where are the error traps caused by the design of healthcare pathways, IT systems and medical devices? Do you tolerate and work around poor design? If so, consider using the following mechanisms to escalate the problem to senior managers:

- Discuss the potential patient safety risks posed by poor design during executive walk rounds
- Invite the directors of Facilities, Procurement and IT to the clinical area in which you work so they can see the problem for themselves
- Report design related issues through your local incident reporting system and encourage others to do the same. Remember there is value to be gained in reporting near misses and no harm events related to healthcare pathways, IT systems and medical devices
- Be proactive. If a clinical area is being reorganised to improve efficiency or if new equipment is being procured, volunteer to be on the project team leading the work. Provide an 'end user's perspective' and insist that some of the human factors methods described in Chapter 3.0 are applied to systematically assess patient safety risks.

## Further reading and resources



### Useful human factors references and books

1. Handbook of human factors in medical design. Weinger M, Gardner-Bonneau M, Wiklund M. Taylor and Francis 2009
2. Handbook of human factors and ergonomics methods. Stanton N, Hedge A, Brookhuis K, Salas E, Hendrick H. 2004. CRC Press. Boca Raton. Florida
3. Norris B, 2012. System human factors: How far have we come? BMJ Quality and Safety, 2012, 713-714.

### Useful websites

1. Health and Safety Executive: [www.hse.gov.uk/humanfactors/topics/design.htm](http://www.hse.gov.uk/humanfactors/topics/design.htm)
2. Ergonomics in design leaflets produced by IEHF Society: [www.ergonomics.org.uk/resources](http://www.ergonomics.org.uk/resources)
3. Human Factors methods for Design. Nemeth C. Available at: [www.books.google.co.uk](http://www.books.google.co.uk).

### Human factors in design guidance

1. National Patient Safety Agency. Design for Patient Safety series 2008. Guidance and reports available at: [www.nrls.npsa.nhs.uk](http://www.nrls.npsa.nhs.uk)
2. National Patient Safety Agency, 2012. Lessons from high hazard industries. Available at: [www.nrls.npsa.nhs.uk](http://www.nrls.npsa.nhs.uk).

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## Integrating human factors into the design of healthcare systems

Doctors use signs and symptoms of illness as key information in guiding their journey towards diagnosis of a medical condition. Without a proper diagnosis treatment may be incorrect or ineffective. The same principle applies when creating safe healthcare systems. All too often inappropriate or unsustainable safety interventions are introduced because doctors are focused on treating only the problem that is seen and the underlying causes are not fully diagnosed. Human factors methods however can be applied to help us better understand the culture, workload, communication interfaces, design requirements, workflow and goal conflicts that exist.

Here we consider how to build safer clinical systems through two examples:

- Two methods used to understand the context within which tasks are performed and to predict and mitigate the types of failures likely to occur (i.e. task analysis and prospective risk analysis)
- The Health Foundation's Safer Clinical Systems programme, where a structured approach to human-factors based clinical system design is being tested.

When carrying out a diagnosis of a healthcare system, other methods may be used as well as task and error analysis, including (amongst others) workload, safety culture and environmental assessments, and end-user testing.

The last time there was a reorganisation of healthcare services where you work how did your organisation anticipate the patient safety risks that the service reorganisation could introduce? Was consideration given to designing shift patterns and tasks to fit with human performance limitations and to ensure the workload was manageable? Were clinical, nursing and allied healthcare professionals empowered to lead decision making about the design of the ward or clinical area?

Compare your reflections to the description of the implementation of the new control tower at Heathrow Airport shown on the following page.

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## Using human factors methods to safely implement organisational change in air traffic control

The changes brought about by the expansion of London Heathrow airport when terminal five was developed were complex. The organisational change brought about by introducing the new control tower meant changes to procedures, lines of sight, transition to computerised flight data input and display, different communication methods, and a very different spatial layout.

### Approach

To safely manage this major organisational change, the National Air Traffic Service (NATS) prepared a full system safety case, applying a 'human error safety assurance process' (HESAP), a five-step iterative process that is applied throughout the lifecycle technical systems changes. The five steps are:

**Step 1. Understand** – understand the changes to the system and context, and determine the possible effects on task performance.

**Step 2. Identify** – identify and assess the potential human hazard risks associated with the changes, and set safety requirements to achieve an acceptable residual risk.

**Step 3. Mitigate** – specify, plan and (where appropriate) facilitate the specific mitigation activities to meet the safety requirements.

**Step 4. Demonstrate** – gather evidence to provide assurance that the safety requirements have been met and that human hazard residual risks are tolerable prior to implementation.

**Step 5. Monitor** – gather evidence to provide assurance that the human hazard risks associated with implementation remain adequately identified and mitigated in service.

Applying HESAP involved carrying out a detailed task analysis, hazard analysis, human factors literature review and performance observation. The process identified HF safety issues that would not have been identified without such a focus on human performance. The process also delivered a set of safety requirements and specifications, and provided assurance that the safety requirements had been met.

Applying HESAP was a resource intensive but successful process. But the analytical approach could not provide a robust argument that task performance would be acceptable and NATS recognised that usability and acceptance issues could emerge once the control tower opened. Therefore, prior to the opening of the new tower, an observational study was conducted to collect pre-operational data on controller performance, focusing on workload, situation awareness, and teamwork. An HF specialist observed controllers during team-based 360 degree real-time simulation training and 'shadowing' exercises in the new tower. The observational data showed no negative indicators for task performance. Observation and debriefs suggested that behaviours were consistent during shadowing and simulation. Indicators of workload, situation awareness and teamwork showed signs of improvement from the start of shadowing. The output of the exercise provided evidence that the safety requirements had been met for HESAP Step 4 ('Demonstrate'). A second set of observations was later conducted during live operations. The output of the exercise was used as evidence in the HESAP Step 5 ('Monitor').

### Outcome

Overall, the process provided robust assurance of both safety and human performance in the tower. In the early hours of 21 April 2007, the team successfully transitioned to the new control tower.

*Source: Human Performance in Air Traffic Management Safety. A White Paper. Eurocontrol, 2010*

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'The Terminal five case study demonstrates how using a combination of human factors techniques in the design and planning stage provides a comprehensive approach to assuring safety when organisational change and new technology is introduced. The notable difference between the Heathrow control tower example and the majority of organisational change in healthcare systems is that standardised human factors approaches, such as those used in the case study, are not widely embedded in healthcare. The result is that we do not fully understand the workflow and culture into which design solutions are being introduced. We therefore miss the opportunity to anticipate and mitigate all the risks before new clinical systems become operational.

Now contrast the example with work carried out on integrated patient pathways at the University of Loughborough:

### Designing healthcare systems – the need for a human factors based approach

Patient pathways which cross secondary, primary and social care boundaries are the major highways that patients travel (Eason, Dent, Waterson, Tutt, Heard and Thornett, 2012). Communicating patient information and coordinating care across organisational boundaries that form part of the pathway is challenging.

One human factors study, carried out at the University of Loughborough, examined the implementation of large-scale electronic patient information systems that aim to communicate and coordinate care across primary, secondary and social care boundaries. The study examined whether the sharing of e-Health records between two Primary Care Trusts (PCTs) and related agencies within Local Health Communities (LHCs) can contribute to improved clinical care and better management. The study also explored factors in the design, implementation and evolution of these systems that have facilitated or acted as barriers to the successful inter-organisational uptake of the systems by all healthcare partners.

The research team used a mixture of observation, task analysis of nine care pathways (i.e. mapping key tasks and processes using human factors techniques), interviews and workshops with IT and healthcare professionals. The study's findings were:

- Firstly, where top down, national strategies are used, there is often insufficient attention paid to the requirements of the *front line staff* that need to share information to co-ordinate care in the pathway
- Secondly, the patient's views were not sufficiently considered when the health record systems were developed
- Thirdly, the domination of the top down, national strategy approach meant that the information sharing needs by frontline staff working in different organisations was given insufficient attention when the electronic health record systems were designed. As a result frontline healthcare staff developed 'workarounds' to achieve information sharing and, after implementation, modified the system so that it evolved in a way that met their needs.

The authors concluded that there is a need to create more mature health care systems development processes that can cope with the many challenges of bringing together a diverse set of stakeholder interests across different healthcare organisations (Eason, Dent et al., 2012). In short, there is a need to integrate human factors into the design and implementation process for electronic patient records.

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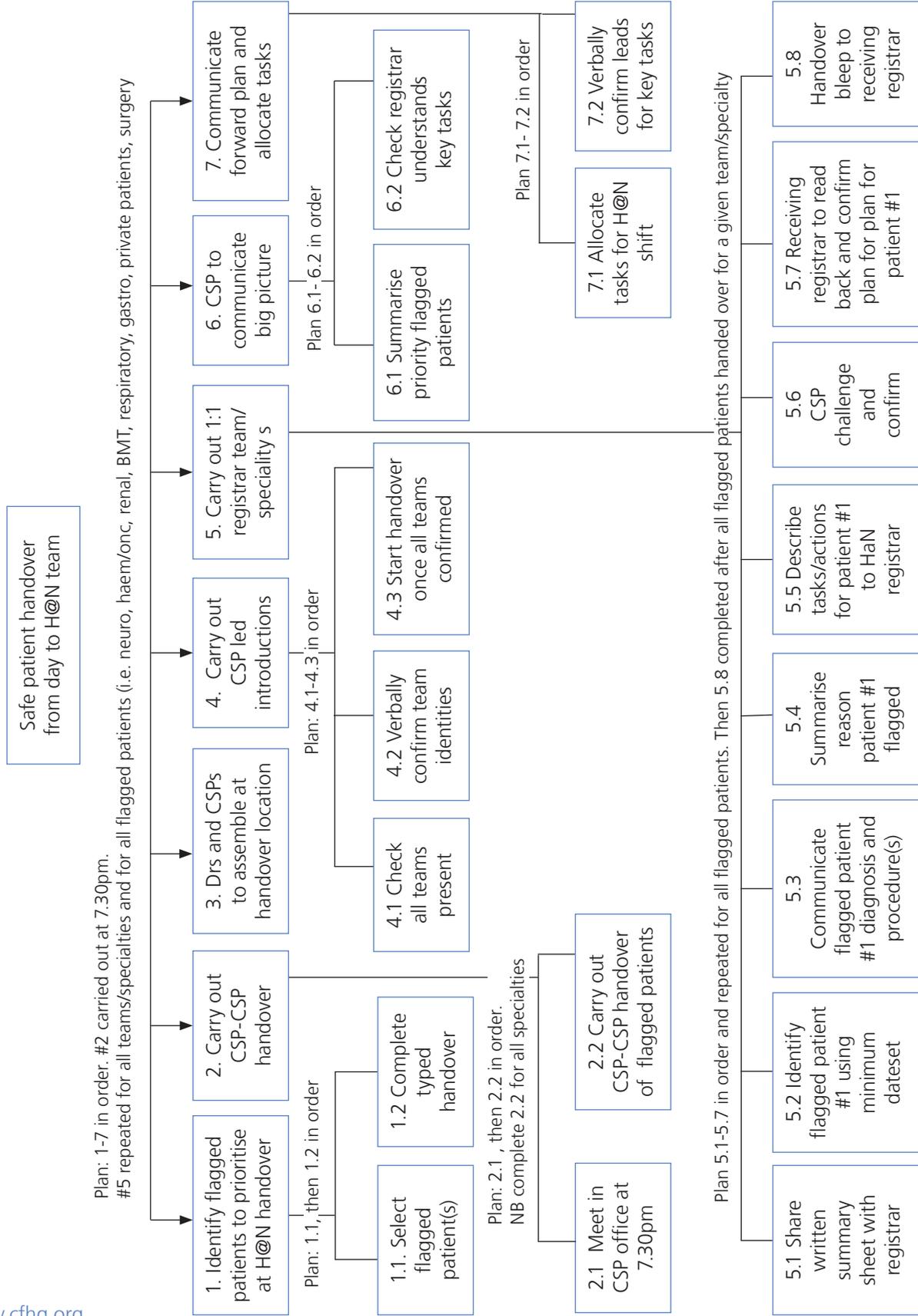
## Examples from human factors research studies

Task analysis involves breaking a clinical process down into its constituent sub-tasks. By developing a micro-level understanding of the sub-tasks that need to be carried out, one can start to identify workload peaks, safety critical tasks, points where there are interfaces between care providers and how the allocation of roles and responsibilities is distributed. Quite often, task analysis provides a 'window on the system' identifying points where patient safety risks are prevalent. One study, carried out at Great Ormond Street Hospital NHS Foundation Trust (GOSH), used process mapping and task analysis of the handover between the cardiac operating theatre and cardiac intensive care unit to develop a new handover protocol, based on human factors principles. Results showed reductions in the mean number of technical errors and the mean number of information handover omissions following implementation of the new handover protocol. The duration of handover was also reduced from 10.8 min to 9.4 min (Catchpole, de Leval et al., 2007).

Hierarchical task analysis is one of many different task analysis methods that human factors specialists have developed (for further information see Kirwan and Ainsworth, 2007 or Stanton et al., 2005). In another study carried out at GOSH, hierarchical task analysis and human error analysis tools were applied to understand the handover process and to proactively identify patient safety risks during the Hospital at Night (H@N) handover (see page 21).

Figure 2 shows a hierarchical task analysis of the H@N handover between the day and night teams at the hospital. This was then used as the basis for carrying out a prospective error analysis of the handover process. Failure Modes and Effects Analysis (FMEA) is one of many types of error analysis tools that are routinely applied in other industries to predict what could go wrong. The outputs of FMEAs and other human reliability analysis assessments are used to inform the development and implementation of solutions to reduce the overall risk profile (see Kirwan, 1994 for other examples of qualitative and quantitative error analysis methods).

Figure 2: Hierarchical task analysis of Hospital at Night handover



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## Involving staff in using a human factors analysis tool

### Case study: Hospital at Night handover at Great Ormond Street Hospital NHS Foundation Trust

In the GOSH H@N study, applying FMEA helped the team identify over twenty different types of communication, workload prioritisation and decision making errors that could occur during Hospital at Night handover. The FMEA was facilitated by a human factors expert who supported members of the H@N team to review the hierarchical task analysis and to identify:

- What could go wrong?
- What causes this type of error to happen?
- What are the consequences, likelihood and predicted severity if a particular failure mode occurs?
- How could we redesign the handover to reduce the chances that this type of error will occur?

Table 1 shows an example of one of the failure modes identified which relates to acutely unwell patients not being handed over from the day junior doctors to the night team at the H@N handover. By using hierarchical task analysis and FMEA, the H@N team members involved were able to stop and reflect on the current handover process, discuss its flaws and identify how it could be improved. The task and error analysis methods used in this study informed the redesign of a H@N handover protocol grounded in human factors science (McQuillan, Carthey, Catchpole, McCulloch and Goldman, 2013)..

Table 1: Failure Modes and Effects Analysis example from the Creating a Safer Hospital at Night study (McQuillan et al., 2013)

HTA task step	Failure mode (i.e. What could go wrong?)	Cause (why?)	Consequences	Current controls	Current risk score			Recommendations (i.e. suggested improvements to the handover process)	Risk score following implementation of improvements		
					S	L	R		S	L	R
1.1 Select flagged patients	Patient who should be prioritised by the H@N team overnight is not identified at H@N handover.	<ul style="list-style-type: none"> <li>• Memory lapse</li> <li>• Workload</li> <li>• Handing over multiple wards (e.g. MEGA).</li> <li>• Poor team communication</li> <li>• Change in patient's condition since last clinical review</li> </ul>	Acutely medically unwell patient is not handed over to the H@N team. H@N team are unaware that the patient should be prioritised for clinical review overnight because of the potential risk of sudden patient deterioration overnight.	CSP knowledge and leadership acts as a safety net, but this is not full proof.	5	4	20	1. Develop and implement prioritisation criteria to assist junior doctors to identify patients who should be prioritised overnight (include these 'flagging criteria' in the H@N standard operating procedure).	5	2	10
								2. Introduce a standard operating procedure (SOP) which includes early flagging of patients at ward rounds to enable consultant level engagement in decision making.			
								3. H@N induction training for new junior doctors to teach what constitutes a 'flagged patient'.			

## Applications of Human Factors Methods in Healthcare

There is landmark work being carried out by research teams and The Health Foundation in this field (notably the Safer Clinical Systems programme). Some elements of quality improvement programmes also incorporate human factors approaches, recognising that empowering the 'end user', i.e. frontline healthcare teams to lead the development, testing and implementation of solutions improves sustainability. One notable example here is the NHS Institute for Innovation and Improvement's Improvement Faculty for Patient Safety and Quality programme ([www.institute.nhs.uk/qiposters](http://www.institute.nhs.uk/qiposters))

### The Safer Clinical Systems Programme

Safer Clinical Systems (SCS) is a programme that utilises a structured approach incorporating systems thinking to building safe and reliable patient care through proactively searching for and managing risk, ensuring feedback to create continuous learning, engagement and sustainable solutions. It originated from concerns that traditional methods of improving patient safety were not achieving the desired sustainable impact. A team based at Warwick Medical School has developed and tested this programme with eight NHS Trusts. The team includes a range of expertise including clinical academia, leadership,

safety engineering, human factors and organisational development.

Phase 1 of the programme was initially designed in collaboration with four health organisations using learning from other sectors, including technical areas such as high reliability industries, with an emphasis on systems thinking, human factors and sustainability. However it also recognised that healthcare is different and in particular that it is a complex socio-technical system, so potentially human factors may have an even greater impact. It was recognised that the existing system is reactive in responding to incidents of harm, whereas other sectors are searching for the risk before harm occurs.

Phase 1 also recognised the importance of the organisational context, the safety culture and human factors in both the origins of harm but also their current absence in many solutions. The results of individual projects in phase one are available at <http://www.health.org.uk/areas-of-work/programmes/safer-clinical-systems/projects-phase-one/>.

Figure 3 summarises the outcomes from Phase 1.

Figure 3: The Safer Clinical Systems (SCS) model



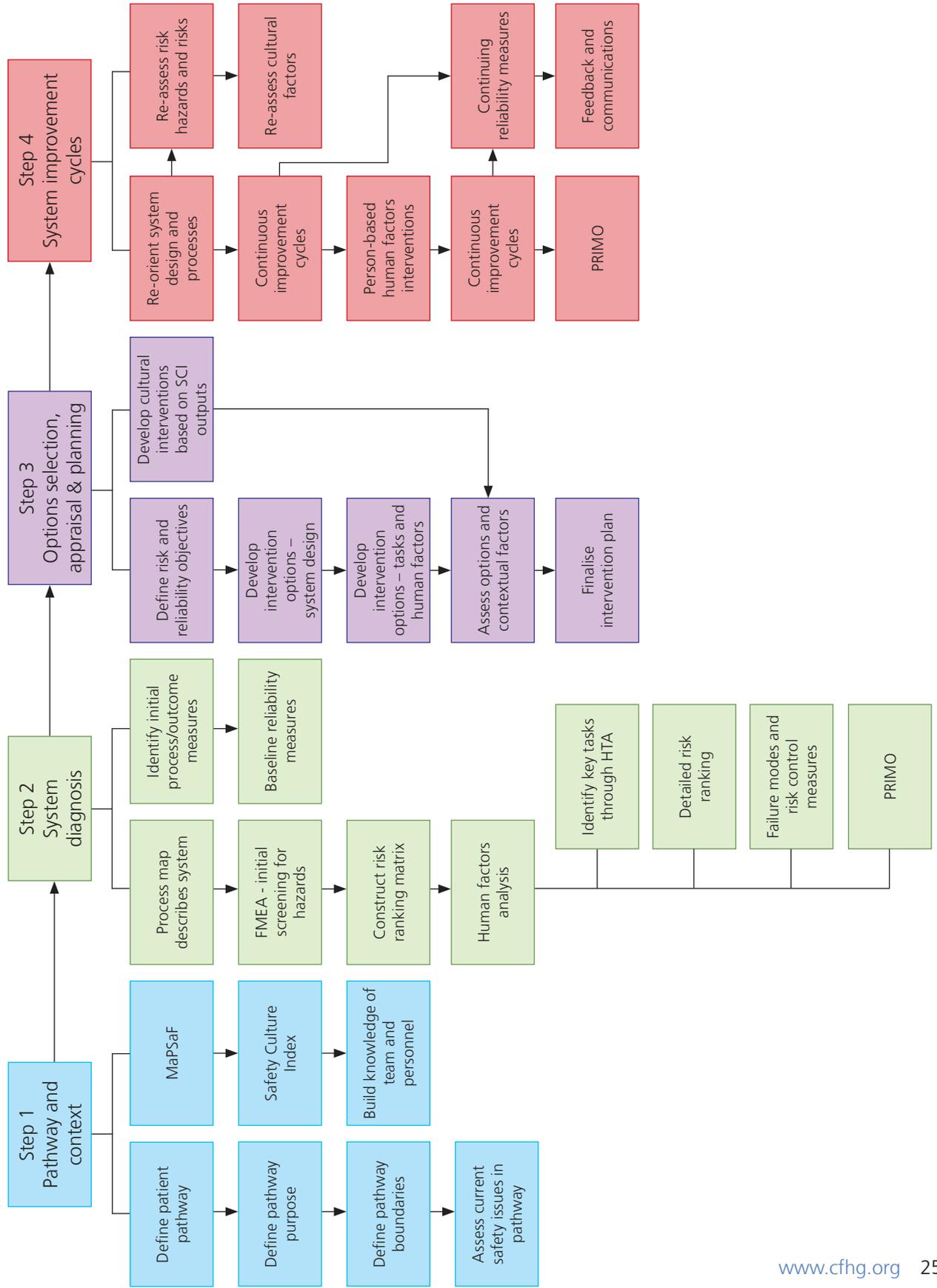
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In Phase 2, Safer Clinical Systems evolved into a four step approach based on a proactive detection of risk. The importance of structuring the improvement process in this way was emphasised by introducing a “gate” at the end of each step which has ensured the appropriate work has been completed before proceeding to the next step and that the highest risks are addressed in a systems based way. This four step approach is now being tested with eight acute NHS Trusts. Their individual project descriptions can be seen at <http://www.health.org.uk/areas-of-work/programmes/safer-clinical-systems/projects-phase-two/>

The four steps, shown in [Figure 4](#), are:

1. *Pathway Definition and Context.* In this step, sites “zoom-in” to develop their ideas and closely define the pathway to be studied. They then “zoom out” to understand the organisational context that influences the pathway. This includes a Manchester Patient Safety Framework (MaPSaF) workshop which discusses safety culture and use of the safety culture index to explore the characteristics of the organisation and its staff. This latter tool explores the shared attitudes, values and beliefs that support patient safety. Discussion of the results of these has helped to ensure the incorporation of human factors in subsequent diagnostic and intervention work.
2. *System Diagnosis.* A variety of tools are used to understand the pathway, including hierarchical task analysis, FMEA and human factors analysis. This exploration stresses looking at performance influencing factors. This step is completed by writing a safety case; a narrative document which brings together the evidence to describe the present state of safety in the pathway. Key learning in this stage was that this structured approach looking at more than just harm and focusing on risk revealed new and unexpected hazards and led to a better appreciation of performance influencing factors. As with many projects staff engagement was often challenging but recognised as vital. A new tool PRIMO was utilised to obtain more qualitative data.
3. *Option Appraisal and Planning.* In this step the teams’ assess the options for change and select a series of high risks. Key learning here was that the risk scoring must be considered first to ensure that change will focus on where the greatest risk exists in the system. In this stage the measurement framework was also established for their work. Developing both the template for the safety case and the details of the measures of reliability (the safety set) took longer than expected but was considered essential to the success of the programme.
4. *System Improvement Cycles.* The final step was to implement their improvements and measure the resulting change. Throughout this period they are using A3 reporting techniques to record changes and project manage their work.

Figure 4: Steps in the Safer Clinical System programme



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Human factors is essential to achieving sustainable change. Specific training has focused on team working, safety culture, design for safety and clinical & executive engagement with many other discussions on leadership and other aspects of human factors.

Success of the programme will be measured in a variety of ways including:

- i. Narrative on the methodology to show it has exposed risks not just harm (via the safety case)
- ii. Description of any risks eliminated as opposed to reduced (via narrative in safety case and through risk comparisons in mapping or FMEA reviews).
- iii. Reliability of processes that contribute to highest risks in the study pathway (via the Safety Set)
- iv. Improved organisational context (via Safety Culture Index, learning capture/interviews conducted by support team adding to the narrative in safety case)
- v. Management of performance influencing factors (narrative in safety case including human factors analysis)
- vi. Continuous improvement (via all above monitored over a longer period plus evidence in a sustainability framework, developed in the programme, that issues have been addressed).

Human factors is a key element throughout the programme. In some site interventions it is the core component of an intervention and is more directly measured, e.g. reducing interruptions in a handover meeting to reduce distractions. In other sites it is more indirectly measured as a sustained change in reliability. Some examples of human factors issues identified during the diagnostic phase and now being addressed through a range of interventions are:

- *Dumfries* - Changes to ward rounds to improve teamwork
- *Nottingham* - changes to ward rounds and work to address the perceived steep authority gradient between junior docs and consultants
- *Salford* - re-introduction of a daily multi-disciplinary 'huddle' to discuss safety and medication issues
- *Bath* - addressing interruptions and distractions during medication rounds on wards, with a focus on nursing staff
- *Bristol* – creating early consultant involvement in care as the cultural norm
- *Birmingham* – creating a handover where challenge is allowed and encourage
- *Manchester* – promoting behaviours to include timely attendance at handover meetings.

The Safer Clinical Systems Programme is still in progress and results will be published in 2014.

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## NHS Institute for Innovation and Improvement The Improvement Faculty for Patient Safety and Quality programme

Although quality improvement science and human factors science are different, (especially in terms of the approach to diagnosing safety problems and measuring improvement), they have a common aim of building safer clinical systems and advocate the view that empowering healthcare teams in the development, testing and implementation of solutions is essential to success.

The NHS Institute for Innovation and Improvement has supported a group of NHS organisations to use quality improvement approaches, like Plan Do Study Act (PDSA) cycles to test and implement prototype solutions for a wide range of patient safety problems. The Royal Wolverhampton Hospitals NHS Foundation Trust and Norfolk and Norwich NHS Hospitals Foundation Trust both carried out projects aimed at improving the response to deteriorating patients.

Norfolk and Norwich defined the problem they were seeking to address as follows, *'The Early Warning Score system does not reliably get a doctor to the bedside of an acutely deteriorating patient.'* Task analysis of the Early Warning Score (EWS) Pathway showed that the pathway has several dependent steps. Therefore failures at each step result in a sequential 'cascade of failure' and a much larger composite failure to get a doctor to the bedside. Iterative PDSA cycles were used to improve the EWS surveillance system and redesign the ward observation chart. Initial results have shown improvements in EWS accuracy and completeness of observations, although as yet no reduction in the number of cardiac arrests.

Similarly, the Royal Wolverhampton focused on system re-designs of how nurses record the escalation of the deteriorating patient. PDSA cycles were used to engage nurses in re-designing the SBAR (Situation-Background-Assessment-Recommendation) form, resulting in improvements as measured by 'Days between Cardiac Arrests' data.

From a human factors perspective, two key lessons from the Advanced Improvement Capability programme support the integration of human factors in design:

- Empowering and involving healthcare teams in the development, testing and implementation of solutions improves sustainability. Solutions that were adopted and sustained were those that made sense to the healthcare teams involved. They could see the benefits of implementing the change and this created a 'pull' effect where the solution was welcomed and spread. Such solutions were called 'sticky solutions'
- As with human factors approaches, carrying out a systems-level diagnosis of the problem was essential to develop workable solutions.

The following page shows a case study of work carried out in the The Improvement Faculty for Patient Safety and Quality programme.

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## Applying human factors and improvement methods in primary care

### Case Study: An example of implementing NICE guidance for febrile children

NICE recommends all febrile children should have their temperature, heart rate, respiratory rate and capillary refill time measured and their subsequent management be based on a traffic light system to identify those with potential serious illness. This project was conducted in a large GP surgery, specifically aiming to improve the assessment using ALL four of assessment criteria. The project went beyond conventional audit and used the principles of improvement science to make it easier for clinicians to do the right thing and harder to do the wrong thing, and if they did forget to create systems spot and stop the omission.

The first phase was a diagnostic phase to understand why the assessments were not taking place. A combination of staff questionnaire, direct observation and “leadership walk-rounds” were used to develop a real understanding of the reasons that the assessment was not being conducted.

A series of interventions were then considered and tested using the PDSA methodology. The series of interventions included:

- Making the equipment available (a workplace organisation tool from Lean methodology known as 5S was used)
- A human factors intervention of a visible prompt on the tympanic thermometer just below the screen with a picture of the child and a checklist
- Mouse mats with a picture of the same child having her temperature checked and a table of the normal values was placed in each room
- The traffic light table was placed on the practice intranet site for ease of reference.
- A recording template was created on the clinical system making it easier to code and record the assessment
- An electronic algorithm was created on the clinical system (EMIS LV), so that if a code was entered for a child that would suggest a condition with a fever e.g. OTITIS MEDIA the computer system would check to see if the four items had been recorded and if not it would create a ‘forcing’ function reminding the clinician to conduct these components of the assessment, and would then automatically call the data recording template. Those clinicians persistently not conducting all four features of the assessment would be sent a personalised postcard reminding them of the guidance.

### Results and evaluation

The progress was monitored using another tool from improvement science (known as a Statistical Process Control {SPC} chart). Each patient was given a score of 1, 2, 3 or 4 depending on how many components of the assessment they had conducted. Each patient was then plotted on the SPC chart and the chart was annotated with the interventions. This clearly demonstrated the interventions were leading to an improvement. In addition, a balancing measure of length of consultation was measured. The data clearly demonstrated that there was no increase in consultation length.

Paresh Dawda, Whilst a GP Principle at South Street Surgery

Abstract and supporting material at:

<http://www.nice.org.uk/usingguidance/sharedlearningimplementingniceguidance/examplesofimplementation/eximpresults.jsp?o=564..>

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## Further reading and resources



### Useful task and error analysis references and books

1. Kirwan B and Ainsworth L. (2007) A Guide to Task Analysis. Taylor-Francis
2. Kirwan B. (1994) A Guide to Practical Human Reliability Assessment. London: CRC Press
3. Stanton N, Salmon P, Walker G, Baber C, and Jenkins D (2005). Human Factors Methods: A Practical Guide for Engineering and Design. Ashgate Publishing Ltd.

### Useful websites

1. Information on The Health Foundation's Safer Clinical Systems programme can be found at:  
[www.health.org.uk](http://www.health.org.uk)
2. The UK air traffic control introductory guide on human factors can be found at:  
[www.eurocontrol.int](http://www.eurocontrol.int)

### Human factors resources

1. Lyons M, Adams S et al. (2004) Human reliability analysis in healthcare: A review of techniques. International Journal of Risk & Safety in Medicine 16:223-237. Available at: [www.class.uidaho.edu](http://www.class.uidaho.edu)

# 3: Human Factors and teamwork

## In this Chapter

- Enhancing team work through human factors-based team training
- Measuring non-technical skills like leadership, communication, situational awareness and teamwork
- Further resources and reading.

### *What human factors research tells us*

Human factors research has shown that attitudes, teamwork and behaviour could be improved and technical and process errors reduced by delivering human-factors based team training to operating theatre staff (McCulloch, Mishra, Handa et al., 2009, Ricci and Brumstead, 2012). In aviation, this type of training is commonly known as crew resource management (CRM) training. Many healthcare organisations in the acute sector have implemented human-factors-based team training, particularly with operating theatre teams (Johnson and Kimsey 2012), but also with obstetrics (Haller, Garnerin et al., 2008; Petker, et al., 2011, Shea-Lewis et al., 2009; Strachan, 2010; Bahl, Murphy and Strachan, 2012) and emergency teams (Morey, Simon et al., 2002; Pruitt, Liebelt et al., 2010). There are also examples where the training has been implemented in primary care (Taylor, Hepworth et al., 2007).

Research on the effectiveness of the training has shown that the organisational context in which such training is delivered influences its success or failure. For example, one study showed that although aviation-style training can improve compliance and team performance, the positive effects can be reduced by latent organisational and management factors (Catchpole, Dale, Hirst, Smith and Giddings, 2010).

### Enhancing team work through human factors-based team training

The following two case studies are about local human factors training implementation.

### North East Strategic Health Authority's human factors training programme

As part of the Safer Care North East Programme (2008 – 2011), NHS Northeast established a Human Factors Faculty which developed a human factors education package for healthcare teams. Initially the training was developed in collaboration between aviation experts, senior clinicians, nurses, midwives and AHPs, led by a consultant neurosurgeon and the Programme Manager for Nursing, Midwifery and Patient Safety at the Strategic Health Authority.

To support healthcare teams understand human factors within their own clinical context, a human factors e-learning programme was developed. The e-learning comprised examples of how non-technical skills influence our behaviour and includes everyday life examples and those set in the context of clinical scenarios. The purpose is to complete the e-learning prior to more in-depth training to provide a useful foundation which enables healthcare staff to develop a preliminary understanding of what human factors is.

The education package also consists of a trainers' manual and handbook on human factors which includes information on cognition, personality type, situational awareness, decision making, leadership, teamwork, stress and communication. The content of the train the trainers' manual has been validated in collaboration with experts at Durham University, funded by a Health Foundation grant. This work has also involved training the trainers' initiative to develop a core faculty of staff who are able to deliver training on non-technical skills to healthcare teams.

Future work is planned to implement human factors training with the Safeguarding Adults team, where issues like cross-team communication is essential to ensure safe patient care. The Human Factors education package developed in the North East will be available free of charge to NHS organisations.

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## Luton and Dunstable NHS Foundation Trust's human factors training programme

Between 2008 -2010, the Associate Medical Director at Luton and Dunstable NHS Foundation Trust led a multi-disciplinary human factors project in the maternity unit at the Luton and Dunstable Hospital. Following on from the success of this training, the Associate Medical Director is now leading another human factors training project in the hospital's Emergency department. The project has clear aims, a project plan and a built in evaluation strategy. The outline project plan is shown below and has been included in the Guide so that others who are planning to deliver human factors training can learn from the approach:

### Project design

- Understand context
- Understand nature of problems
- Wrap around Human factors knowledge and expertise

### Funding

- Seek and secure

### Evaluation

- Appoint research psychologist to evaluate the programme
- Select evaluation measures
- Liaise with evaluator throughout the project

### Clinician engagement

- Obtain buy in with key stakeholders
- Raise awareness amongst staff through talks in different staff forums
- Run monthly meetings with Champions

### Immersion event

- Source external trainers
- Organise and co-ordinate event

### Monthly team training

- Train a team of trainers to deliver multi-disciplinary simulation training
- Aid new trainers in developing educational content for simulation training
- Develop educational content for half day course in the human condition, HF, teamwork and communication
- Train in the use of specific interventions developed

### Work place interventions

- Observe existing practice for diagnosis of development opportunities
- Decide the purpose of the intervention required
- Develop interventions working alongside Champions
- Introduce interventions and modify based on feedback
- Obtain initial evaluation of interventions in order to gain evidence of the value of interventions to use for further influencing to enable spread
- Measure compliance
- Develop a quality standard against which to measure quality
- Measure quality against agreed standard
- Communicate results in order to drive up quality of interventions

### Evaluation

- Teamwork and Safety culture
- Evaluation of efficacy of interventions
- Evaluation of value of training

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## What we have learnt from experience

The following acute organisations have implemented CRM training: *Luton and Dunstable NHS Foundation Trust, Great Western Hospitals NHS Foundation Trust and Wiltshire Community Health Services, Royal Cornwall NHS Foundation Trust, Royal Devon and Exeter NHS Trust, Northeast Strategic Health Authority and University College London NHS Foundation Trust.*

In order for other organisations who are considering investing in this area to learn from their experiences their collective wisdom has been captured in the implementation tips below:

### Implementation tips for human-factors based team training

#### *i. Senior management commitment:*

Remember that when you start out, you have to sell the concept of human factors-based team training to senior managers (i.e. medical directors, chief executives, chief nurse, and the director of finance) as their support for the training is essential. It also has to translate into action so be clear about what actions you need Boards and Clinical and Nursing Directors to carry out. For example, Boards need to commit to releasing staff for the training in a context when theatre time, utilisation, efficiency and financial performance loom largest on their minds.

If you are a local champion of human-factors based team training, get yourself on the agenda of quality and governance audit days or other forums where you know senior managers will be present. Present an evidence-based argument, citing research which has shown that it can improve non-technical skills and reduce errors. Link this to an incident that has occurred in your own organisation – this should help circumvent the ‘it would not happen here’ counter-argument for not investing in the training.

Be sure to make clear links to internal and external performance targets and regulatory requirements. Several Trusts initiated the training after the Care Quality Commission compliance reviews identified poor levels of compliance with theatre staff using the World Health Organisation Surgical Safety Checklist.

#### *ii. Train multi-disciplinary teams together*

Remember that human-factors based team training aims to build on non-technical skills like teamwork, leadership and shared situational awareness. It is therefore essential that the training is delivered in a multi-disciplinary team context. Avoid using a uni-professional training model.

#### *iii. A flexible training delivery model is essential*

Being flexible about the training delivery model will enhance your chances of success. Scheduling human-factors based team training to coincide with an operating theatre deep clean was one practical solution used in one organisation to ensure staff was released for training. Other Trusts scheduled the training for each theatre team in their own theatre area on each theatre directorate’s Continuing Medical Education morning (i.e. protected education time) or monthly audit day. One Trust purchased a mobile 3G wireless SimMan (i.e. a high fidelity mannequin simulator), which enabled the training to be delivered in the operating theatre suite.

#### *iv. Clearly communicate the purpose and aims of the training*

Communicate the aims and purpose of the training often using different media. Whilst some Trusts have used a ‘launch day’ or monthly CME/audit days to communicate the aims and purpose of the training to staff, others have factored these conversations into executive walk rounds and used articles on Trust intranet sites. Informal conversations are also useful because they enable you to listen to the concerns of individual team members on a one-to-one basis, and allay fears relating to hidden agendas or lack of confidence.

In short, communicating about the training’s purpose and aims will reduce the likelihood of situations where, on the day of training, facilitators are faced with delegates who say, “I can’t stay for the majority of the training because there is a suture rep. coming at 11 o’clock”.

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#### v. Start where the will is

One of the common mistakes people make when trying to implement change is to try to persuade sceptical colleagues that an innovation is a good idea. Don't fall into this trap when planning how to roll out your human-factors based team training. Start by delivering the training to colleagues who are enthusiastic and seem open to new ideas. Seek their feedback on how the training content and delivery could be improved. By starting where the will is, you will build up a network of colleagues who sell the training to colleagues in conversations they have. Over time, momentum builds and those colleagues who were on the fence may find their own curiosity growing.

*'Once the nurses have been to a session...the word starts to spread and it has been getting easier to make the training happen.'*

Paul Sice, Consultant Anaesthetist, Derriford Hospital

*'Within a few weeks of delivering the training, one of the theatre nurses challenged a consultant in theatres and was thanked for preventing an error. Word of this spread through the theatre team grapevine...the story of this challenge was a turning point...it gave theatre team members confidence that constructively challenging consultants was the right thing for patient safety.'*

Aidan Halligan, Director of Medical Education UCLH

#### vi. Look beyond the cover story when faced with sceptical or disruptive colleagues

Sometimes senior team members are resistant to human-factors based team training. All too often, our response to sceptical or disruptive colleagues is to label them as a problem and walk away. However, looking beyond their initial reaction to identify the underlying reasons for resistance is important. One of the contributors to this section of the Guide tells the following story:

*'...when we started out the Director of Surgery was very resistant to taking part in the training. He would not commit and this had a cascade effect because other surgeons thought 'well if the director of surgery is not doing it, why should I?'. A one to one conversation with him shed a lot of light on the underlying reasons for his resistance. He was a world expert in his field but leading a briefing or debriefing were entirely new concepts. Quite simply, he was worried about being embarrassed*

*in front of his team. We did a one-to-one talk through of what a good briefing and debriefing looked like based on a case he had done the day before and talked through the training content in detail. He is now one of our greatest advocates.'*

#### vii. Use patient stories

Patient stories like the film "Just a Routine Operation," (a case study of Elaine Bromiley's death during a routine ENT procedure), developed by the NHS Institute are an excellent way to illustrate the importance of leadership, team culture and situational awareness. The resources section of the Guide signposts you to where you can access this and other patient stories

#### vii. Don't be deterred

Recognise that embedding the training in your organisation may take considerable time. Organisations which have successfully implemented human-factors based team training have local champions who persisted after encountering barriers because they understood that embedding the training would take a long time. For example, one of the Trusts who contributed to this section of the Guide described overcoming a situation where their local champions were competing with mandatory training targets driven by financial pressures from above.

*'It is a long game and you need to steadily plug away at organising, promoting and pushing to do the training.'*

Paul Sice, Consultant Anaesthetist, Derriford Hospital

#### ix. Make training content relevant

Remember to make training content relevant to the theatre team to whom you are delivering the training. Striking the right balance between examples and scenarios from other high technology industries (like aviation, off-shore oil and gas, the nuclear industry) and those from healthcare keeps teams engaged. Training content that is over-loaded with too many aviation examples may elicit a 'but healthcare is different' response from trainees.

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*x. Plan for spread and sustainability*

Planning how you will spread and sustain the human-factors based team training over time is important. Remember to make spread manageable by breaking your spread plans into bite sized chunks.

Building a local faculty of human-factors based team trainers enables training workload to be shared. Also ensuring that there is feedback and follow up after training events aids spread and sustainability. For example, one organisation developed a quarterly newsletter called 'The Emmentaller' (after the Swiss cheese model of accident causation by Reason, 1990). It reports on important or educational patient safety events that have happened with a summary of the root cause analysis of them and then emphasises the learning points.

*xi. Start planning how you will measure success early*

You will need to demonstrate that the training has been effective if you want to secure its survival. Make contact with the Risk Manager or whoever holds incident report data in your organisation. Take a baseline incident reporting rate which separates incidents with harm from near misses and prevented patient safety incidents. Remember that your reporting rate is likely to increase as a result of delivering the training and that your objective is to show an increase in near misses and a decrease in serious incidents and severity of harm over time.

You can also use tools like the Safety Attitude Questionnaire or Manchester Patient Safety Framework to take a baseline measure of safety culture. Plan to re-test 6 - 12 months later to see if there has been a cultural shift. Collect stories or 'saves of the week' which illustrate how specific incidents were prevented as a result of lessons learnt from the training. Utilise the power of storytelling to persuade others of the value of continued investment in the training.

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## Measuring non-technical skills like leadership, communication, situational awareness and teamwork

### *What human factors research tells us:*

Human factors research has shown that technical skills are necessary, but not sufficient to ensure patient safety in the perioperative period (Carthey et al., 2003, Catchpole et al., 2008; Mishra et al., 2008). Non-technical skills are also important. They are “the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance.” Non-technical skills like leadership, communication, situational awareness, workload management and teamwork can have either a positive or negative impact on patient safety (Patey et al., 2005; Yule et al., 2006a, 2006b; Hull et al., 2012; Shields and Flin, 2012).

Non-technical skills have not traditionally been a core part of training curricula in medical schools, or for nurses and allied healthcare professionals. Rather they have been learnt ‘on the job.’ The introduction of human-factors based team training, together with more widespread use of simulation, are changing this. By integrating the assessment of non-technical skills into simulation and human-factors based team training we can build safer health care teams.

Several taxonomies to evaluate non-technical skills for surgeons, anaesthetists and scrub practitioners have been developed. Typically, such tools rate a healthcare

professional or team’s performance using a set of ‘behavioural markers’ which provide a structured method for training and rating non-technical skills. Such tools have been developed for anaesthetists (Fletcher et al., 2003; Flin and Patey 2011), 2003; Flin and Patey 2011), surgeons (Yule et al., 2006; Yule, Flin and Maran, 2008; Parker et al., 2012), surgical teams (Mishra, Catchpole and McCulloch, 2009; Sevdalis et al., 2008) emergency department clinicians (Flowerdew, Brown et al., 2012;) trauma resuscitation teams (Steinemann et al., 2012), obstetrics teams (Tregunno et al., 2009; Morgan et al., 2012) and scrub nurse practitioners (Mitchell 2008; Mitchell et al., 2012a, 2012b).

Reviews of non-technical skills required in other healthcare domains have also been carried out, for example, paramedics (Shields and Flin, 2012) and histopathology (Johnston et al., 2011). Training programmes which educate healthcare professionals how to use non-technical skills frameworks to rate performance have also been developed. For example, one ‘Train-the-Trainers’ programme has been developed by the team at Imperial College London.

Table 2 provides an example of one non-technical skills framework which was developed to evaluate the non-technical skills of scrub practitioners (Mitchell et al., 2012a, 2012b)

## Table 2: The SPLINTS framework

SPLINTS: A framework for evaluating non-technical skills of scrub practitioners (Flin, Mitchell et al., 2010; Mitchell, Flin et al., 2012a, 2012b)

The SPLINTS system provides scrub practitioners with a structured method for discussing, training and rating non-technical skills that are required for safe and effective performance, during surgical procedures.

The SPLINTS system is deliberately concise but incorporates a set of non-technical skills in as few categories and elements as possible, to produce a single-page rating form. This makes the tool practical and usable. The system predominantly covers behaviours in the intra-operative (scrubbed up, gloves on) phase of surgery although crucial elements of Task Management (e.g. preparing, planning) are also included.

SPLINTS is intended for use by senior perioperative practitioners when teaching/training junior team members in the scrub role. It may also be used for peer rating of experienced scrub practitioners and for self-assessment.

The non-technical skills rated in SPLINTS is based on the following taxonomy:

Category	Elements
Situation Awareness	<ul style="list-style-type: none"> <li>Gathering information</li> <li>Recognising and understanding information</li> <li>Anticipating</li> </ul>
Communication and Teamwork	<ul style="list-style-type: none"> <li>Acting assertively</li> <li>Exchanging information</li> <li>Co-ordinating with others</li> </ul>
Task Management	<ul style="list-style-type: none"> <li>Planning and preparing</li> <li>Providing and maintaining standards</li> <li>Coping with pressure</li> </ul>

Each element is then broken down into good and poor practice behaviours. For example, **anticipating** involves thinking ahead to predict what might happen and what could be required in the near future. Behavioural markers which are rated for this element of situational awareness are:

Example behaviours for good practice	Example behaviours for poor practice
<ul style="list-style-type: none"> <li>Hands appropriate instruments to surgeon in correct order</li> <li>Predicts when plan of procedure is going to change; e.g. laparoscopy to open</li> <li>Requests equipment from appropriate person before it is required by the surgeon</li> <li>Times requests appropriately (e.g. warm saline, suction)</li> </ul>	<ul style="list-style-type: none"> <li>Fails to respond to evolving surgical progress</li> <li>Waits for a predictable problem to arise before requesting required instrumentation or equipment</li> <li>Asks for items late</li> <li>Loses track of surgical activity, i.e. is caught unaware</li> </ul>

The SPLINTS rating system is shown below. Both categories and individual elements are rated on a 4 point rating scale.

Rating label	Description
4 – Good	Performance was of a consistently high standard, enhancing patient
3 – Acceptable	safety; it could be used as a positive example for others
2 – Marginal	Performance was of a satisfactory standard but could be improved
1 – Poor	Performance indicated cause for concern, considerable improvement
N/R – Not Required	Skill was not observed because it was not required in this case

*NB The information provided in this table has been taken from the following key reference: Flin R, Mitchell L, Coutts K, Youngson G and Mitchell J. (2010) Scrub Practitioners' List of Intraoperative Non-Technical Skills (SPLINTS). Structuring observation, rating and feedback of scrub practitioners' behaviours in the operating theatre. University of Aberdeen. NHS Education for Scotland. Available at: [www.abdn.ac.uk/iprc/splints](http://www.abdn.ac.uk/iprc/splints)*

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### *What we have learnt from experience*

The SPLINTS system can be used to assess scrub practitioner performance during a whole variety of surgical procedures whether they are a junior member of staff learning to scrub for a procedure or more senior staff member scrubbing for a novel case or as part of an appraisal process. A feedback session should take place

after the observation to discuss the observed behaviours and any actions required to address areas for improvement.

The SPLINTS manual, (Flin et al., 2010) gives further practical advice on using the SPLINTS system.

### **Introducing SPLINTS to scrub practitioners**

My experience of implementing SPLINTS showed that barriers to application of non-technical skills assessment of scrub practitioners occur at numerous levels. The first barrier is the introduction of the concept to practitioners who are not aware of the influence of non-technical skills on their ability to effectively practice. The application of non-technical skills in scrub practice is a new context for scrub nurses and Operating Department Practitioners. The skills of communication and situational awareness are developed ad hoc through experiential learning and are held as tacit knowledge by scrub practitioners. From holding informal corridor conversations with colleagues it became evident that this deficit in explicit knowledge made it difficult to explain the relationship between effective application of non-technical skills and effective scrub practitioner performance during surgery.

I felt that this barrier was overcome by developing a short teaching session introducing generic aspects of human performance such as automaticity and confirmation bias and how they contribute to accident and incident development. The session introduced aspects of non-technical skills specific to scrub practice and how they promote situational awareness and effective communication to prevent the psychological stressors which may trigger automaticity and confirmation bias at the level of the scrub practitioner and affect the performance of the surgical team.

The second barrier I experienced was trying to deliver the teaching session. The organisation where I am employed as an ODP has a monthly audit session which can be used for staff training and development. I was allocated a session on an audit programme but this was later taken away because the manager felt that another training issue was more important and should be covered in the allocated time. The barrier of tacit awareness and application therefore exists at a management and practitioner level.

The audit sessions are also subject to stressors which reduce staff attendance at training events, i.e. releasing staff to attend the training session proved problematic. If I had not been given the opportunity to deliver the session again since the initial opportunity, I estimate that I may have only reached two or three of the scrub practitioners working in the operating department.

The third barrier is based on my experience of trying to deliver a session and recruit staff to undertake the assessment process. Co-ordinating off duty to ensure contact time between the assessor and assessed practitioner during an actual operating session may be difficult to organise. To allow the process to work at an optimal level I also believe that the assessor should be supernumerary from the operating theatre to optimise observations and assist collection of data for feedback to the assessed practitioner. Supernumerary status would also provide protected time to allow immediate feedback and assist with the process of critical reflection. This dialogue seems to be the most crucial part of the process by exploring positive and practice during the assessment to trigger behavioural change.

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## Introducing SPLINTS to scrub practitioners continued...

### What I learnt from introducing SPLINTS to colleagues

Developing my knowledge of generic human performance and those non-technical skills specific to scrub practice has allowed me to become critically reflective of my scrub practice. This has enabled me to recognise latent threats generated by the surgical team, patient conditions and organisational systems and how they impact on me and increase stressors I experience during the intraoperative phase. Explicit recognition of these stressors has allowed me to increase the barriers to prevent an incident developing. Essentially, my practice has been transformed from actions based on automaticity to a cognitive process where I feel that I have greater control of my actions and awareness of the impact of those actions on the surgical team.

I have also been able recognise positive and negative behaviours in my colleagues. Reassuringly, the vast majority display overtly positive behaviours and application of non-technical skills at all times. However, my major concern with experiential learning through implicit knowledge is that this is not through critically reflecting on practice and does not develop the ability of the practitioner to recognise and respond appropriately when latent threats become more apparent in the clinical environment. SPLINTS provides the framework to introduce and embed critical reflection in to clinical practice and allows an observer to challenge negative behaviours.

### What I would advise others to do differently

I believe that using an assessment tool is just one part of the process and practitioners intending to use SPLINTS need to consider introducing the concept of human performance, coordinating the assessment and secure protected time to feedback. One of the factors which may have prevented my ability to embed the tool within my organisation is a lack of personal power or influence. Practitioners wishing to try the assessment may find it useful to strategically recruit practitioners with influence. My operating department does not benefit from a Training and Development co-ordinator but practitioners may consider increasing their personal influence by gaining allies with influence (and potentially supernumerary status beyond clinical practice) to develop the process to embed the tool.

Personally, SPLINTS is not only about producing an assessment but promoting the psychological safety by having a colleague who you feel comfortable to discuss incidents with and help develop practice. This safe environment is often missing from contemporary healthcare.

*Supplied by Guy McLelland, Lecturer, School of Health. UCLAN.*



### Implementation tip

Thinking about how to persuade colleagues about the importance of enhancing non-technical skills?

#### Observe and reflect

Share the SPLINTS framework with a couple of senior consultant surgeons who you know are open to accepting new ideas. The next time his/her surgical registrar is leading a case under supervision, ask each consultant surgeon to observe the interaction between the scrub nurse and the surgical registrar. Ask each surgeon what he/she observed. They will invariably flag up issues with poor coordination, disruptions in surgical flow caused by anticipation, leadership, teamwork and communication problems. One senior consultant surgeon who recently carried out this task commented that it was apparent that his surgical registrar was reaching the limits of her performance because of non-technical skills issues he observed. The observation was a quick way to ensure buy-in from a key champion.

Remember there are non-technical skills frameworks for surgeons, anaesthetists and other healthcare professionals so you can tailor the observational exercise above to meet your local needs.

#### Presenting an evidence base

Collate evidence from the last ten or so serious incidents that have been investigated in your organisation, preferably in your department. If you don't have many incidents in your own department start keeping your own detailed accounts of examples or near misses. Incident investigation reports often identify safety culture, teamwork, leadership, communication and lack of clear roles and responsibilities as contributing to patient harm. Collating and presenting this data makes the link between non-technical skills and patient harm transparent. It will help you to avoid a 'that does not happen here' type of response from colleagues and to get buy in.

## Further reading and resources



### Useful human factors training and non-technical skills references and books

1. Flin R, O'Connor P and Crichton M. (2008) Safety at the Sharp End. A Guide to Non-Technical Skills Aldershot: Ashgate
2. Mitchell L, Flin R, Yule S, Mitchell J, Coutts K, & Youngson G. (2012). 'Evaluation of the Scrub Practitioners' List of Intraoperative Non-Technical Skills (SPLINTS) system'. 'International Journal of Nursing Studies, vol 49, no. 2, pp. 201-211
3. Catchpole KR, Dale TJ, Hirst DG, Smith JP, Giddings TA. 'A multicenter trial of aviation-style training for surgical teams'. Patient Saf. 2010 Sep;6(3):180-6

### Useful websites

1. The Clinical Human Factors Group website has a section on useful links. From here you can identify and link various providers of human factors based training: [www.chfg.org/resource/useful-links](http://www.chfg.org/resource/useful-links)

### Human factors resources

1. Further information on non-technical skills frameworks together with key references from the University of Aberdeen research team can found at: [www.abdn.ac.uk/iprc/staff/details/r.flin](http://www.abdn.ac.uk/iprc/staff/details/r.flin)
2. The NHS Institute for Innovation and Improvement commissioned a review of aviation style human factors training in the NHS. The report is available at: [www.institute.nhs.uk/humanfactors](http://www.institute.nhs.uk/humanfactors).

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# 4: Integrating Human Factors to improve the quality of incident investigation

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## In this Chapter

- The role of human factors in incident investigation
- How to Integrate Human Factors into the Investigation Process
- Further resources and reading.

## The role of human factors in incident investigation

Investigating and learning when things go wrong with a patient's healthcare treatment is an essential part of improving patient safety. This chapter focuses on the importance of integrating human factors into incident investigation.

### *What human factors research tells us*

In the last decade, approaches from other industries have been adapted and applied to investigate incidents, claims and complaints in healthcare (Reason, 1990; Vincent and Taylor-Adams et al., 2000; Woloshynowych, Rogers et al., 2005). In some healthcare organisations this work has improved the understanding that human error is most commonly a systems problem. It has also provided frameworks and resources for carrying out systematic incident investigation of patient safety incidents (Vincent, Taylor-Adams et al., 2000; National Patient Safety Agency, 2005-2012).

There is no doubt that widespread use of a standard root cause analysis (RCA) framework has greatly improved the quality of incident investigation in healthcare and staff are enthusiastic about its use. However, staff are not always successful in applying it due to their trust's culture, systems and approach to how RCA is conducted and resultant learning is disseminated (Wallace et al., 2006). For example, the authority and credibility of the lead investigator can affect their ability to engage others in the investigation process. In terms of organisational culture, research has shown that where multi-disciplinary team meetings are held to identify why things went wrong (contributory factors and root causes), medical consultants often dominate the discussion but nurses and junior doctors are sometimes reluctant to challenge senior consultants in an open forum (Wallace et al., 2006).

*Excellence in root cause analysis depends upon leadership and the enthusiasm of individuals as well as supportive structures, processes and culture compatible with root cause analysis.' (Wallace et al., 2006).*

More complex system issues such as the influence of culture, non-technical skills and behaviours of senior staff may also be side-lined in the investigation process as they may be difficult to quantify and provide evidence for having been "fixed."

Overall, more work needs to be done to place human factors at the heart of incident investigation and manage expectations on the speed with which some of these issues can be addressed.

### *What we have learnt from experience*

Enhancing the focus on human factors in incident investigation will improve the quality of investigations and ensure that recommendations, once implemented, prevent a similar incident from recurring. Some innovative work is already being carried out in this area by healthcare organisations in the UK. Three case study examples are summarised below:

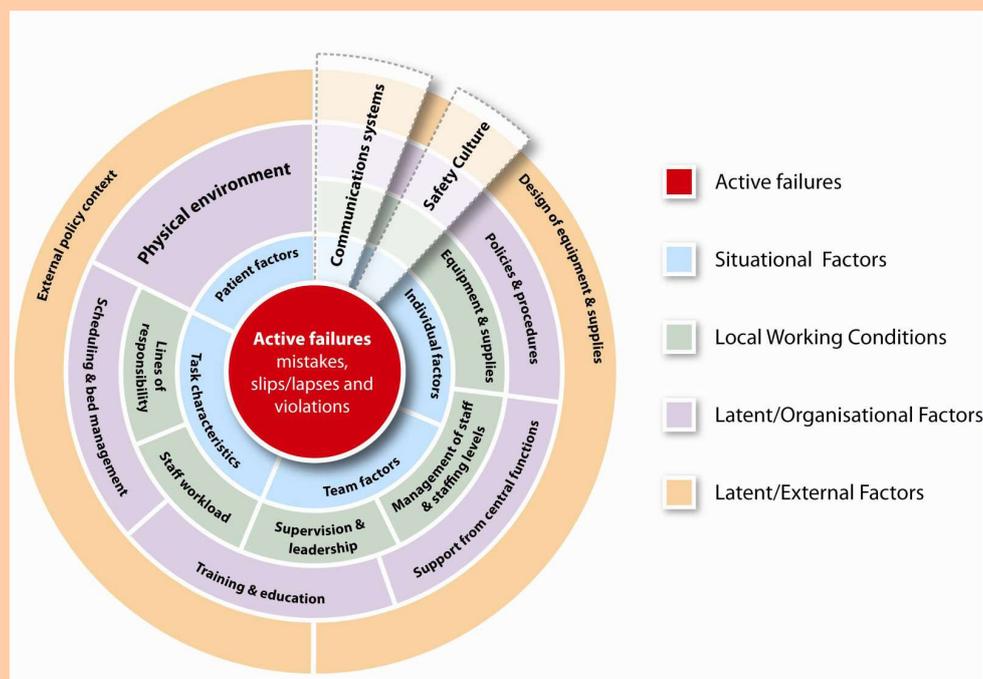
#### *Case study 1: The Yorkshire Contributory Factors Framework*

The Yorkshire Contributory Factors Framework (Lawton, McEachon et al., 2012) is a tool which integrates human factors into the investigation process. The following describes the development and piloting of the framework:

## The Yorkshire Contributory Factors Framework

Lawton, McEachon et al., (2012) have developed an evidence-based and standardised list of contributory factors that can be used as a basis for understanding causation. Previous frameworks to understand factors that contribute to incidents (known as contributory factors) have the limitation that they have often been adapted from non-healthcare settings that are very different in their structure and function to the healthcare domain. Although these frameworks have a theoretical basis, they are not empirically-based. The Yorkshire contributory factors framework overcomes this issue because it was developed from a review of previous studies carried out in healthcare.

Figure 5: The Yorkshire Contributory Factors Framework



By reviewing ninety-five studies, representing 83 different datasets, Lawton and her research team showed that the overwhelming majority of contributory factors that were identified in the review (irrespective of hospital setting or methodology) were active failures or individual factors. Hence, healthcare is still focusing on the proximal causes of incidents and not drilling down to identify the underlying systems factors that increase the chances doctors, nurses and allied healthcare professionals will make errors that harm patients. Lawton, McEachon et al., (2012) states '...a focus on individual responsibility for errors is likely to be ineffective as an incident reduction strategy.'

The Yorkshire Contributory Factors Framework has been applied to the investigation of 9 related serious incidents within Bradford NHS Hospitals Acute Foundation Trust. Applying the framework improved the focus of the investigation on 'systems factors' or 'latent failures' rather than 'active errors'. Applying the framework also demonstrated the challenges of embedding human factors into incident investigation when working with colleagues who are not human factors experts.

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## Case study 2: After Action review at University College London NHS Hospitals Foundation Trust

Creating a culture where openness to learning and willingness to acknowledge lessons learnt and put changes into practice is still far from being the norm in healthcare organisations (Walker, Andrews et al., 2012). The Education Service at University College London NHS Hospitals Foundation Trust has addressed this problem by adapting a method originally developed in the US Army, After Action Review, for use in healthcare settings:

### After Action Review

After Action Review (AAR) supports healthy team behaviours like listening and asking questions and uses the “free lessons” of everyday events, as well as serious incidents, to improve the safety and quality of patient care. It supports the creation of a ‘culture of reflection’ where staff learn why things did or did not go according to the way they planned and what they might do the same or differently next time. Central to the AAR process is the belief that lessons can be learnt and shared without the need to blame others.

Every AAR follows the same structure with the ‘AAR conductor’ (i.e. facilitator) getting agreement for the ground rules at the outset and ensuring everyone is clear about the specific purpose of the AAR. AAR uses the four questions shown in Table 3 to structure the analysis:

**Table 3: After action review**

The Four After Action Review Questions
1. What was expected?
2. What actually happened?
3. Why was there a difference?
4. What have we learnt?

By implementing AAR through a multi-professional training programme, the Trust has improved reflective learning when things go wrong: 53% of externally reported Serious Incidents last year had an AAR conducted (as well as the formal incident investigation). Integrating AAR early on in the incident investigation process helps to create collective insights and reminds teams that the purpose of investigation is to learn, not to blame.

*‘The culture of attaching blame to others for the problems which we encounter in everyday work is a ‘comfort zone’ which we all show varying degrees of reluctance to leave. To leave our default position of others being to blame means we have to risk the reality that we ourselves may be part of the “problem”.’ (Walker, Andrews et al., 2012).*

## Case study 3: Reviewing the quality of incident investigation locally

Our third case study highlights work carried out at NHS Bedfordshire and Luton Cluster.

### Integrating human factors into investigation

The Quality Manager and Safeguarding Adults Lead at NHS Bedfordshire and Luton Cluster recently completed a MSc. thesis which evaluated how to integrate human factors into incident investigation (Saunders, 2012). The research adapted an investigators quality tool, originally developed in aviation, to examine the quality and the continuity of identifying human factors in the RCA process. The key findings showed that human factors were often not identified by the root cause analysis process. Mismatches were also identified between a contributing factor identified in the investigation and the recommendations, and action plans. That is to say, there was no logical flow between the underlying causes of the incident, the recommendations that were made and the action plans that had been developed (Saunders, 2012). Saunders’ findings are supported by external human factors reviews of incident investigations which some healthcare organisations have commissioned to review the quality of local investigation processes.

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## How to Integrate Human Factors into the Investigation Process

Just as we need to design healthcare systems, processes and equipment to support delivery of safe care, the infrastructure, tools, and culture that support incident investigation largely determines the quality of the output. Given these findings, the implementation tips illustrate how to improve the integration of human factors into the investigation process.

### Implementation tips

#### Executive and non-executive directors

Seek assurance that your organisation has a robust system in place for investigating and learning from incidents. The following assurance-seeking questions provide a useful framework for executive and non-executive directors:

- i. Have staff in your organisation that take on the role of lead incident investigators received formal training in root cause analysis or a similar investigation technique?
- ii. Is peer review between lead-investigators commonplace?
- iii. Do lead investigators have protected time to carry out incident investigations or are they fitting it in around their 'day job'? (the latter shows there are problems with the infrastructure to support robust investigation).
- iv. Does your organisation use a team approach to investigation (versus a single investigator)? Where a single investigator model is used, your organisation increases the risk that investigations will be based largely on the assumptions and interpretation of one person.
- v. Ask your Risk Management team to review serious incident investigation reports from the last three years to identify:
  - The proportion of 'root causes' that identify underlying 'systems factors' versus the proportion that focus on 'active errors' and 'non-compliance.'
  - The percentage of recommendations have been implemented and sustained over time
  - The proportion of investigations where statements and perspectives from patients and carers were fed into the investigation
  - The number of near misses that had the potential to cause severe patient harm or death that have been thoroughly investigated using a structured incident investigation technique like RCA (if the proportion subject to thorough investigation is low this may show that your organisation does not have sufficient investigation capacity and/or that you are missing the opportunity to learn systems lessons from near misses)
  - The types of serious incidents or near misses with potentially severe harm which keep recurring. Recurrent incidents are indicative of weaknesses in the investigation process. They suggest that weak recommendations have been developed and/or that the implementation process has somehow failed.
- vi. Think about how your Board seeks assurance that recommendations from incident investigations have been implemented and sustained? Do you rely solely on information presented in Board summary reports on incident investigations? If so, remember that executive walk rounds or informal 'coffee mornings' between executives/non-executives and clinical staff provide an opportunity to cross check this information.





### Implementation tips

#### Incident investigators

- When carrying out an investigation, check that your analysis does not stop at identifying active failures and non-compliance by healthcare professionals. Have you identified and described WHY errors and non-compliance occurred?
- Apply the Yorkshire Contributory Factors framework in your next investigation
- Remember that applying lessons from human factors can improve the quality of investigations. Consider the types of recommendations that you have made as a result of your investigation. Human factors research has shown that different types of barriers and recommendations are more or less effective (Troost and Nertney, 1985) whereas re-training staff, writing or amending a policy or telling people to do things differently do not provide long-term, robust solutions that will prevent an incident from recurring. All too often in healthcare investigations, recommendations are put forward that do not address the underlying cultural, workplace and equipment design, workload, teamwork and leadership issues. Consider asking a peer reviewer to cast fresh eyes on your recommendations with this in mind
- Don't forget to elicit the patient or carer's perspective on what went wrong and why.



### Implementation tips

#### Risk Managers and/or Patient Safety Leads

- Review the last ten incident investigation reports. How many root causes are focused on active failures (i.e. errors and non-compliance committed by healthcare professionals in the direct provision of healthcare treatment)? How many address 'systems factors' that conspired to create the error traps which healthcare professionals fell into?
- Now read through the recommendations from the last ten incident investigation reports. Do the recommendations focus on writing or amending a policy, re-training a member of staff or reminding groups of staff that their behaviour is unsafe? If the majority of recommendations fall into these three categories, the chances are that the incident will recur because the recommendations focus on solutions which human factors research tells us are the least robust or failsafe
- Does your organisation use a serious incident investigation recommendation action tracker where all of the key findings and recommendations from investigations are collated in one document? By locating all of the key findings and recommendations into a single source document, you will simplify the system in place locally for tracking what recommendations have been implemented and which have not
- Carry out a review of the quality and comprehensiveness of local incident investigations. Make sure that whoever leads this work is independent.

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## Further reading and resources



### Useful incident investigation references and books

1. Vincent C, Taylor-Adams S, et al. (2000). How to investigate and analyse clinical incidents: clinical risk unit and association of litigation and risk management protocol. *BMJ*. 18;320(7237):777-81
2. Lawton R, McEachan RR et al. (2012). Development of an evidence-based framework of factors contributing to patient safety incidents in hospital setting: a systematic review. *BMJ Quality and Safety*. 21(5):369-80.

### Useful websites

1. The National Patient Safety Agency's root cause analysis tools and templates are available at: [www.nrls.npsa.nhs.uk](http://www.nrls.npsa.nhs.uk)
2. Cranfield accident investigation centre: [www.cranfield.ac.uk/soe/departments/airtransport/csaic/page13461.html](http://www.cranfield.ac.uk/soe/departments/airtransport/csaic/page13461.html).

### Human factors resources

1. Dekker S. 2006. The field guide to understanding human error. Ashgate Publishing
2. The CHFG's report on Never Events in the NHS 'Never?' is available at [www.chfg.org](http://www.chfg.org)

# 5: Understanding the human factors of non-compliance

## In this Chapter

- Learning from healthcare staff non-compliance with policies and procedures
- Understanding organisational drift
- Further resources and reading.

## Learning from healthcare staff non-compliance with policies and procedures

### *What human factors research tells us*

Human factors research across a number of industries has shown that the more prescriptive rules workers have imposed on them, the less likely they are to comply (Reason et al., 1998; Lawton, 1998). Humans are also naturally adaptive and tend to improvise, which makes some levels of non-compliance inevitable (Amalberti et al., 2005; 2006).

In healthcare, the response when non-compliance occurs is all too often disciplinary action. Other high technology industries, like commercial aviation, nuclear power and

off-shore oil and gas production have carried out numerous human factors projects to understand the causes of procedural non-compliance (Health and Safety Executive, 1995; Federal Aviation Authority, 2007; Institute of Petroleum, 2003; Reason, 1997; Lawton, 1998; Phipps et al., 2008).

A range of individual, team and organisational factors lead to procedural non-compliance (Carthey, 2011) (see [Table 4](#))

**Table 4: Factors that increase non-compliance**

### Factors that lead to non-compliance with policies and procedures

1. Perceived low likelihood of detection
2. Lack of awareness/understanding of policies and procedures
3. Misperception or lack of recognition of risk
4. Self-perceived authority to violate (ignore the rules)
5. Time pressure/pressure to get the job done
6. Copying behaviour (i.e. learn to do the procedure from a colleague who is non-compliant)
7. Lack of leadership
8. Lack of end-user engagement when policies and procedures are written.
9. Policy and procedure overload (for example, confusion over which procedure applies when)
10. Ambiguous or conflicting messages in the policy/procedure
11. Lack of training and reinforcement of key policy messages over time.
12. No sanctions imposed for non-compliance
13. Lack of monitoring systems to check procedural compliance
14. Policies and procedures are inaccessible
15. Out of date procedures/policies
16. Mismatch between the policy/procedure and how the job is actually done.

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### *Can the application of human factors improve current practice?*

Just as in the development of medical devices, applying tools like task analysis, workload assessments, walk-throughs and simulation etc. during design and development helps to produce policies and procedures that are simple and easy to follow.

In the oil and gas production industry, levels of compliance have been improved by using non-compliance workshops as a forum to openly discuss procedural violations with maintenance engineers. The workshops are used by managers to provide feedback on incidents that have involved non-compliance. They also support open communication between managers and engineers about whether procedures are easy to understand and are usable.

Where procedures are unworkable in practice, the feedback from the maintenance engineers is used to simplify or amend them. No sanctions are imposed on the maintenance engineers who participate in the workshops. They are carried out in the spirit of learning and improving, thus providing important feedback mechanism to maintenance engineers about the potential safety risks of non-compliance and for managers about the design and usability of procedures.

### *What we have learnt from experience?*

A recent human factors study in healthcare has identified the factors that contribute to procedural non-compliance (Carthey et. al 2011). These factors include:

- Volume, i.e. the total number of procedures
- Length and complexity of procedures (i.e. total number of pages and navigability)
- Naming and accessibility
- Multiple different procedures on the same topic
- Trivial procedures (i.e. procedures that are written as a knee jerk response to an issue. Some examples identified were the Wearing of Crocs in Theatres policy and the Managing adverse weather conditions procedure)
- Conflicting requirements
- Poor version control.

The complexity of healthcare procedures was clearly illustrated in this study which showed that a patient admitted to hospital for emergency treatment for a fractured neck of femur would be treated using 75 different procedures and guidelines! One hospital had a 122-page "Medicines Policy" in which Operating Theatre staff who were interviewed could "never find the controlled drugs section".

The following page shows an example of good practice from one healthcare organisation that have carried out a human factors analysis of procedural non-compliance and developed an action plan for improvement:

## Using human factors methods to improve policy compliance

One London acute Trust applied human factors analysis to understand non-compliance with policies and procedures. The work involved a human factors specialist carrying out an aggregate analysis of claims, complaints and incident report data to identify the frequency with which non-compliance was a contributory factor and which healthcare policies and procedures had high levels of non-compliance. Task analysis and interviews with a cross-section of healthcare staff were also carried out to understand the challenges they faced when accessing and understanding policies and procedures. The aggregate analysis findings acted as an impetus for the Executive Board to invest in work to change the way that policies and procedures were developed, implemented and monitored. Search terms on the Trust's intranet site were changed so that they matched the expectations of healthcare teams and the process for writing and approving policies was simplified. The organisation's culture and approach to managing non-compliance also improved. When the study started, writing a policy or procedure was the knee jerk response to a problem. As a result of the study, senior managers realised that this was ineffective and actually increased the likelihood of non-compliance.

Remember, if healthcare professionals can see the need for a policy or guideline, if the way they are written shows a practical understanding of the 'real world' and if they are easy to access and follow, staff are more likely to comply with them (Carthey et al., 2011).



### Implementation tips

#### Risk Managers and/or Patient Safety Leads

- Openly discuss with your healthcare team the challenges they face when accessing and using healthcare procedures. Such discussions provide valuable intelligence about how workable procedures are in the real world
- Review a sample of complaints, incidents and claims to identify the frequency with which non-compliance contributes to these events. Having baseline data on the frequency and nature of non-compliance in your own organisation will help to convince senior managers and senior clinicians to change current practice. It will also mean you can measure improvement
- Engage a human factors professional to apply task analysis, walk-throughs etc... when developing healthcare procedures
- Consider holding non-compliance workshops, like those used with maintenance engineers in the oil and gas industry, to learn about the challenges people face when implementing policies and procedures and to feedback lessons learnt from incidents, claims and complaints
- Use Patient Safety executive walk rounds as an opportunity to discuss procedural non-compliance with healthcare teams. Ask if the procedure is workable in practice. If not, find out how it needs to be revised to make it workable in the 'real world.'
- Raise awareness amongst Human Resources and Workforce teams that non-compliance is a 'systems problem.' Remember that all too often in healthcare organisations, staff are disciplined for not following policies and procedures. As part of the drive to develop an open and just culture, it is important to understand the reasons for non-compliance. Where procedures were inaccessible and/or unworkable in the 'real world' it may not be appropriate to impose sanctions against individuals.

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## Understanding organisational drift

Organisational drift is the gradual erosion of safety standards that takes place without the message of the degradation being received and understood by senior managers (Berman, 2012, Dekker, 2012). Organisational drift has been a topic of increasing concern within other high technology industries because of the occurrence of high profile events (e.g. the Deepwater Horizon oil spill and the Fukushima nuclear incident). In each case, up to the time of the event, the organisation was perceived as having good safety performance and an effective 'safety management system' in place (see below for a description of the key elements of a safety management system). The gradual erosion of safety performance did not appear to enter organisational consciousness until a major accident or near miss made everyone sit up and take notice.

### The key elements of a Safety Management System

*What is a safety management system?*

*"An organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures"* (International Civil Aviation Organisation, 2006).

High risk and other industries have evolved their approach to measuring safety by implementing an overarching Safety Management System (SMS) and measuring performance against it. SMS's combine data from reactive (for example, incident reporting, incident investigations) and proactive indicators (prospective risk assessments, walk rounds) to measure, monitor and manage safety performance on an on-going basis (Waring, 1996).

Elements of a Safety Management System
1. A safety policy.
2. Organisational arrangements to support safety (i.e. the organisation, supervision, recruitment, and training of staff to support the safety policy and processes).
3. A safety plan, i.e. standards and processes for safety, including using risk assessment
4. A means of measuring safety performance. Processes and data are required in order to monitor the current and past safety performance
5. A means of reviewing safety performance. Able to assess and understand safety performance against the safety objectives e.g. incident investigation, safety surveys, audits and reviews
6. A feedback loop to improve safety performance, i.e. mechanisms to ensure that any lessons learnt, or changes needed are properly accounted for and communicated.

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Healthcare systems are dynamic; competing efficiency targets, financial pressures, high labour turnover and conflicting initiatives all create ideal pre-conditions for organisational drift.

To identify organisational drift, healthcare managers need to recognise the need to triangulate traditional types of measurement data with 'soft intelligence' that provides insights into the culture, behaviour and challenges faced by healthcare teams. By soft intelligence we mean information on how 'work as imagined' (i.e. how your organisation's procedures describe how work should be carried out) differs from 'work in the real world' (how clinical care is actually delivered). The example below of implementing a SKKIN care bundle to reduce Hospital Acquired Pressure Ulcers (HAPU) in an intensive care unit illustrates this point

### SKKIN care bundle example

Monthly performance data from St Elsewhere NHS Trust's safety dashboard showed that the frequency and severity of HAPUs had increased in the intensive care unit. This indicated the gradual erosion of good practice following implementation of the SKKIN bundle throughout the Trust. The safety dashboard data did not inform healthcare managers about why safety performance had deteriorated. Root cause analysis findings for Grade 3 and 4 HAPUs identified the root causes as 'non-compliance with the SKKIN care bundle' and 'too few ICU staff trained about the SKKIN bundle'. Triangulating performance and root cause analysis data with 'soft intelligence' gathered from conversations with ICU staff provided further insights about why the erosion of good practice had occurred.

The prevailing culture in the intensive care unit was that ICU patients get pressure ulcers because it is difficult to turn them regularly. In short, HAPUs were viewed as an inevitable side effect of treatment rather than as patient safety incidents. Furthermore, the 'soft intelligence' showed that ICU ward sisters had been provided with the SKKIN bundle and told to implement it. When the ward sisters asked if they could adapt the SKKIN bundle locally to fit their patient's needs, nursing managers said 'no' because they wanted a standardized bundle used across the whole organization. Thus, an opportunity to empower the ICU ward sisters to lead the implementation of the bundle was lost. The new result was short term compliance and a gradual erosion of good practice over time.



### Implementation tips

How is 'soft intelligence' on organisational drift gathered? And what can you do to ensure your department/ organisation learns from it?

Soft intelligence can be gathered in several ways. Some examples were recently gathered from sites that participated in the Health Foundation's Measurement and Monitoring of Safety report (Vincent, Burnett and Carthey, 2013)' (see [www.health.org.uk](http://www.health.org.uk)):

- Gathering soft intelligence about the gap between work in the real world versus work as imagined by having informal conversations with junior doctors
- Non-executive directors and executive directors hosting informal coffee mornings with front-line healthcare teams and discussing safety threats as part of the conversations held.

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## Further reading and resources



### Useful references and books

1. Amalberti R, Vincent C, Auroy Y, de Saint Maurice G. Violations and migrations in healthcare: a framework for understanding and management. *Qual Saf Health Care*. 2006 15:i66-i77
2. Carthey J, Walker S, et al. Breaking the Rules: Understanding non-compliance with policies and guidelines. *BMJ* 2011 Sep 13;343:d5283. doi: 10.1136/bmj.d5283
3. Hollnagel E, Woods DD and Leveson N (2006). *Resilience Engineering: Concepts and Precepts*. Ashgate Publishing.

### Useful websites

1. Further information on resilience can be found at: [www.resilienthealthcare.net](http://www.resilienthealthcare.net).

### Human factors resources

1. The article 'A tale of two safeties. A Polemic Essay, written by Erik Hollnagel, can be accessed at: [www.resilienthealthcare.net](http://www.resilienthealthcare.net).

# Summary and conclusions

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The 'How to' guide clearly demonstrates that human factors science is a broad discipline which has potential to improve patient safety through numerous applications.

Although there is increasing recognition throughout the NHS of the relationship between non-technical skills and patient safety, other areas of human factors science are less well understood.

For example, widespread integration of human factors into the design of medical devices and clinical systems is not embedded in the NHS. Nor are approaches to measure organisational drift and to understand the systems causes of non-compliance.

The aim of this 'How to' guide was to broaden the understanding of human factors amongst healthcare teams and organisations and we hope that you have found the information useful and informative. Most of all we hope you will feel inspired to implement human factors in your own organisation.

As evidenced by the case studies and research showcased here, there is already a huge amount of energy and passion for human factors in healthcare. But we need to do more, both at national policy making level and at local level, before human factors science is fully integrated and leads to sustainable safer clinical systems.

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# Appendix A

## Further human factors reading and information

Below are some examples of further reading, resources and websites which readers of the 'How to' Guide may find useful:

### Human factors books (General methodology)

- Meister D. (1999). The History of Human Factors and Ergonomics. Mahwah, N.J.: Lawrence Erlbaum Associates.
- Stanton N, Salmon P, Walker G, Baber C., Jenkins D. (2005). Human Factors Methods; A Practical Guide For Engineering and Design. Aldershot, Hampshire: Ashgate Publishing Limited
- Wickens CD, Lee JD, Liu Y, Gordon Becker SE. (1997). An Introduction to Human Factors Engineering, 2nd Edition. Prentice Hall.
- Donald Norman, (1998). The Design of Everyday Things. MIT Press
- Wilson JR & Corlett N (2005), Evaluation of Human Work (3rd edition). CRC Press.
- Wickens and Hollands (2000). Engineering Psychology and Human Performance. Prentice Hall.
- Kirwan B and Ainsworth LK (1992). A guide to task analysis. London. Taylor and Francis.
- Kirwan B (1994). A guide to practical human reliability assessment. London. Taylor and Francis.

### Human Factors Books (understanding human and organizational performance)

- Dekker S (2002). The field guide to human error investigations. Aldershot, UK. Ashgate
- Flin R, O'Connor P and Crichton M (2008). Safety at the sharp end. Farnham. UK. Ashgate
- Reason J. (1990). Human Error. Cambridge University Press
- Reason J (1997). Managing the risks of organisational accidents. Aldershot, UK. Ashgate.
- Reason J. (2008) The human contribution: Unsafe acts, accidents and heroic recoveries. Farnham. UK: Ashgate.
- Hollnagel E. Woods DD and Leveson N. (2006) Resilience Engineering: Concepts and precepts. Aldershot. UK, Ashgate.
- Hollnagel E, Paries J, Woods DD and Wreathall J. (2010). Resilience Engineering in practice. Aldershot. UK, Ashgate.

- Matthews G, Davies DR, Westerman SJ and Stammers R. (2000). Human performance, cognition, stress and individual differences. Hove UK. Taylor and Francis.
- Glendon, I. et al. (2006) Human Safety and Risk Management (2nd ed) Sydney: CRC Press.
- Salas, E. et al. (2001) Improving Teamwork in Organisations NJ: Lawrence Erlbaum.
- Salas, E. et al. (1997) (Eds.) Team Resource Management Mahwah, NJ : Lawrence Erlbaum.
- Carayon, P. (Editor) Handbook of Human Factors and Ergonomics in Health Care and Patient Safety, Lawrence Erlbaum Associates, Hillsdale, NJ, 2007.

### Human factors websites

- Institute of Ergonomics and Human Factors. <http://www.ergonomics.org.uk/>  
*UK professional body for human factors specialists and ergonomists. Key resource for human factors and ergonomics standards.*
- Clinical Human Factors Group. [www.chfg.org.uk](http://www.chfg.org.uk)  
*Charity set up by Martin Bromiley to promote awareness of human factors in healthcare.*
- The Health Foundation. Safer Clinical Systems programme. <http://www.health.org.uk/areas-of-work/programmes/safer-clinical-systems/>  
*Provides an overview of current and past projects being carried out as part of the Health Foundation's Safer Clinical Systems programme.*
- Human Factors and Ergonomics Society. <https://www.hfes.org/Web/Default.aspx>  
*Contains useful further reading and information about human factors research in a wide range of domains.*
- Health and Safety Executive human factors website <http://www.hse.gov.uk/humanfactors/index.htm>  
*Provides examples of the application of human factors in other industries.*
- National Centre for Human Factors Engineering in Healthcare <http://medicalhumanfactors.net/>  
*Good source of further human factors in healthcare references*
- The Sky Library. [http://www.skybrary.aero/index.php/Category:Human\\_Factors:](http://www.skybrary.aero/index.php/Category:Human_Factors)  
*Useful resource containing excellent information about human factors applications in aviation.*
- Royal Aeronautical Society human factors group. <http://www.raes-hfg.com/>  
*The Group promotes improvement of standards of safety in aviation by promoting better industry understanding of human factors hazards and techniques for dealing with them.*

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## Human Factors journals

The following journals publish human factors research. However, please note that human factors research is also regularly published in healthcare journals. The purpose here is to signpost healthcare professionals to journals they may not have heard of:

- Ergonomics
- Applied Ergonomics
- Human Factors
- Safety Science
- International Journal of Industrial Ergonomics
- Travail Humain
- Behaviour & Information Technology
- International Journal of Human Factors and Ergonomics
- International Journal of Occupational Safety and Ergonomics

Implementing Human Factors in healthcare  
'How to' guide - volume 2  
*'Taking further steps'*

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