Chartered Institute of Ergonomics & Human Factors

PREVIEW

Making human factors and ergonomics work in health and social care CHAPTER 3

A practical introduction to health and care ergonomics based on the CIEHF professional competencies intended for those responsible for implementing human factors and ergonomics programmes and interventions to improve patient safety, system performance and wellbeing of patients, service users and staff.

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Contents

Chapter 3 – Tasks

Designing tasks for human performance

A good starting point for analysing work systems is to look at what people are supposed to do (work-as-imagined) as well as what they actually do in practice (work-as-done), i.e., their tasks. A thorough understanding of the tasks can then inform us about other elements of the work system, such as other tasks that have to be carried out, other people who are involved, the tools and the equipment that are going to be used, the physical spaces where the tasks are carried out, and the procedures, protocols and organisational structures that are in place. For now, we will consider these other elements of the work system in the form of generic factors that affect task performance, so-called performance influencing factors (PIFs). Other chapters will then look at each of these elements in greater detail and provide guidance on how to improve the design of these work system elements.

This chapter describes a systematic approach for analysing people's tasks and for identifying key vulnerabilities in these tasks in order to improve outcomes and everyone's wellbeing. The approach might help you, for example, with (see also Box 1):

- addressing vulnerabilities identified in local incident investigations
- implementing interventions suggested at national level to address known issues
- investigating concerns raised by staff about vulnerabilities in their tasks, and
- contributing to organisational development, quality improvement (QI) and process restructure projects.

Reviews of patient safety incidents reported in a hospital identified a significant number of incidents relating to medications. The medicines reconciliation task is crucial to set the foundation for safe and effective care. If medicines reconciliation is not done accurately or not done at all, then this might result in potentially serious patient harm. A multi-professional team was set up to identify recommendations for improving the reliability and accuracy of this task in the hospital. The team analysed the task and identified several key vulnerabilities, such as failure to do medication reconciliation on admission, incorrect or incomplete transcription of medication onto the medication chart and incomplete discharge letter. The team suggested improvements to address each of the identified vulnerabilities in the existing task set-up but the main recommendation led to a task redesign, including the introduction of an electronic medicines reconciliation system, which provided an improvement across several of the identified vulnerabilities in the task.

Box 1: Improving medicines reconciliation

The overall approach is shown in Figure 1. In this chapter we will walk you through the steps of the approach, with a particular emphasis on two families of HF/E methods: Task Analysis and Human Reliability Analysis. We describe a specific technique for each of these methods in greater detail.

Figure 1: Systematic approach for analysing and improving human contribution to task performance

Chapter objectives and learning outcomes

- ✔ To describe the human contribution to task performance.
- ✔ To analyse systematically the impact of human performance on key vulnerabilities in the task.
- ✔ To reflect critically on the impact of work system and environmental factors on human performance.
- ✔ To assess the relative strengths and weaknesses of interventions aimed at improving human performance.

Task types





A task refers to goal-directed human activity, i.e., something people do in order to achieve a goal. In everyday life, this can be something mundane, such as making a coffee, or in health and social care settings this might be to arrange a GP appointment, to assess a patient, to request an x-ray, to undertake a home visit, etc. A task typically has a clearly defined goal as well as a start and an end point. The notion of task is an analytical concept, and hence what we regard as the task for analysis depends on the scope of the analysis. For example, making a coffee might be the appropriate level of analysis but, equally, to prepare a drink might be regarded as a suitable task and, therefore, level of analysis, if the analysis is concerned with different drink options. In this instance, making a coffee would be a sub-task. At times, you might start with a high-level task and realise that this is not the right level of analysis. In this case, you might wish to consider a lower-level task. For example, to manage patient flow in a hospital might be broken down into sub-tasks, and you could select a specific sub-task as the object of the Task Analysis, such as to prepare the discharge documentation for a patient. It depends on the focus of your analysis.



Tasks can be classified into different types. Some tasks have a predominantly physical aspect and are, accordingly, referred to as physical tasks. These are tasks where we can observe what is being done, for example the administration of drugs during the daily drug rounds. Other tasks, however, have a predominantly cognitive aspect, and we cannot easily observe what is going on. In these instances, we need to rely on people telling us what they are thinking in order to understand what they are doing. An example might be the interpretation of radiological images. These tasks are referred to as cognitive tasks. Lastly, there are tasks where teamwork and collaboration are important characteristics of the task. These are referred to as team (or collaborative) tasks. Emergency care provided to a trauma patient could be considered an example of a task where effective communication and collaboration between different members of the team are critical. Depending on the task type, different Task Analysis approaches might be more suitable than others.

Task selection

The approach described in this chapter can be applied to analyse and improve a broad range of work situations. In practice, there are many tasks that could potentially be analysed, and some form of initial prioritisation needs to be done. It might be that a specific task has already been identified in a local incident investigation as requiring further analysis, or a national body might have suggested improvement interventions that require implementation at the local level. Having such an initial 'hook' can be helpful for ensuring buy-in and adequate organisational support. However, it is equally possible to use the approach for analysing tasks where there might have been concerns in the absence of adverse events or where there is a perceived need for greater clarity about how a task should be structured and carried out.

In order to focus the analysis, it is often useful to consider tasks where the human contribution is particularly important or safety critical. For example, the vignette in Box 1 illustrates how a hospital team used incident investigations relating to medications to identify a broad area for improvement, and then selected medicines reconciliation as a particularly critical task which they wanted to analyse further.

Studying clinical work using Task Analysis

Task Analysis

If you want to improve clinical work and help people achieve their aims, it is important that you understand what people's aims are, how they go about achieving these aims, and how the characteristics of their work might influence this. From a systems perspective, the aims are not the personal motivations of the individual, but represent the operational goals, e.g., transferring a patient from an ambulance to the emergency department, prescribing and administering medications, or requesting (and providing) an investigation. Task Analysis (TA) is an HF/E framework or process that allows you to understand and represent what people do (or are supposed to do) in order to achieve the overall goals, with a view to identifying problems and proposing potential improvements.

TA has been a cornerstone of HF/E for decades and is used in many different work contexts, including designing computer interfaces for air traffic controllers, ensuring safe staffing levels in control rooms in the nuclear and petrochemical industries, improving ambulance dispatch, reducing errors in maintenance tasks and many more. It is estimated that there are more than 100 different TA methods (Stanton et al., 2013). This large number of methods is due to a number of reasons. Each HF/E project might have a slightly different focus and aims, and hence methods were tailored to fit specific purposes. In addition, work and work systems have evolved considerably over the past 50 years, with the increasing introduction of automation, leading to greater emphasis on cognitive over manual work. This is reflected in a sub-category of TA methods with a specific focus on cognitive tasks, such as Cognitive Work Analysis (Vicente, 1999).

However, at their core, all of the TA methods share a similar structure or process, which includes data collection of work tasks and their demands, representation in a format suitable for subsequent analysis, and then analysis of the tasks and the development of suggestions for improvement.

TA is frequently used in conjunction with other methods, which can either feed into the TA or which can use the TA as input for further analysis. Examples of the former include data collection methods such as process walk-throughs or process maps; an example of the latter is the systematic identification and analysis of vulnerabilities, which we will describe in greater detail in this chapter.

Hierarchical Task Analysis

Hierarchical Task Analysis (HTA) is the most frequently used TA method, largely due to its universal applicability. HTA was developed in the late 1960s and early 1970s as a method to represent the broad range of human work activities, including some cognitive aspects, such as monitoring, anticipating and decision-making (Stanton, 2006). HTA represents work based on a theory of goal-directed behaviour – this means it starts with the assumption that there is an overarching system or process goal, and that what people do is aimed at achieving this goal. HTA then structures what people do using a hierarchy of goals and sub-goals linked by plans, which describe how sub-goals combine to achieve the higher-level goal. Plans can be used to express any kind of algorithm, e.g., simple sequential ordering (such as do step 1 to step 3 in order), free ordering (do steps 1, 2, 3 in any order), as well as more complex loops (such as do step 1 and step 2 in order until signal A is active, then do step 3). This representation creates a tree-like structure, where the leaves represent task steps that are considered elementary (e.g., basic manual operations) or where further decomposition is not considered necessary.

Consider two examples to illustrate the workings of HTA. The first example is an everyday activity, in this case making a cup of tea (see Figure 2). If we regard this as our goal, then we could say the essential sub-goals to achieve this might be (1) prepare materials, (2) brew tea, and (3) tailor to taste. Intuitively we know how to order these steps, but the plan can make this explicit: first prepare the materials, then brew the tea for one minute (say), and then tailor to your specific taste (e.g., by adding milk or sugar). It is also clear that we could break down further each of these goals in order to get greater clarity about what is done. For example, preparation of materials could consist of fetching a cup, fetching a tea bag, and placing the tea bag into the mug. When doing the HTA, it is advisable to start every step with a verb (e.g., prepare, brew, tailor etc) and to avoid combinations of steps in a single task step, e.g., you should avoid representing a step as “prepare materials and brew tea”.

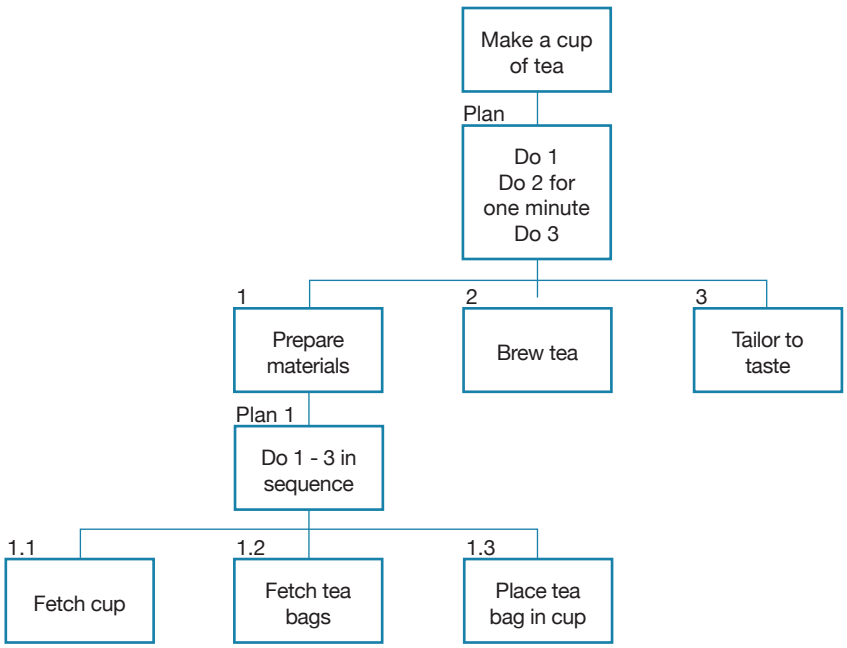

Figure 2: HTA representation for making a cup of tea

As a second example, consider giving an intravenous infusion of insulin. This is a more complicated task and we will use it throughout this chapter. Our purpose with this example is to illustrate how the analysis works, therefore the specific clinical details are not as important. The example is simplified and we do not provide the full clinical context, so do not worry if there are clinical details that remain unclear. As a starting point, we could break down the overall goal into a number of sub-goals (see Figure 3): check the prescription, prepare the syringe, prepare the infusion pump, do the cross checks, start the infusion, monitor the infusion, disconnect when the infusion is done and document the infusion. The plan indicates that steps 1 – 5 are to be done in order, and then step 6 (monitoring) will be done until the infusion is complete. Only then, steps 7 - 8 will be carried out. Each of these steps could be broken down further.

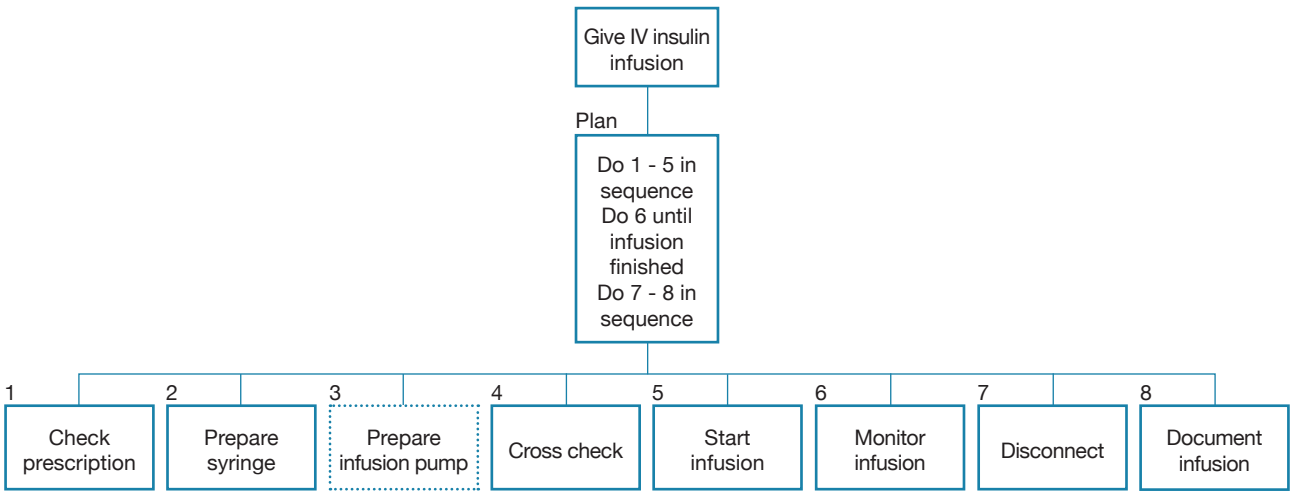

Figure 3: HTA for giving intravenous insulin infusion (high level)

To illustrate this iterative refinement, let us consider the preparation of the infusion pump (step 3), as shown in Figure 4. This sub-goal involves several further activities: the nurse will check for a suitable patient access point (i.e., an existing line going into the patient to which the IV infusion can be connected), program the pump, load the syringe into the pump and connect the tubing. These steps are done in sequence.

Again, we might wish to provide additional detail on these steps if there is value in analysing them further, e.g., if it is known that certain steps are problematic or if there is a lack of clarity about how a step is carried out. In this case, we have analysed checking for an access point (step 3.1) further, see Figure 5. The nurse needs to establish if there is a suitable access point in place and confirm that there are no signs of infection. In case there is no access point, or if an infection prevents its use, the nurse has to request a new IV access point. Once an access point is in place, the nurse checks that the IV device is patent and confirms that there are no contraindications for medications using the same access point.

At this point, we might determine that there is not much gained by breaking down these task steps further and consider some of the other higher-level steps in greater depth. There is no hard and firm stopping rule, and this decision is usually based on a number of criteria such as purpose of the analysis, task complexity and availability of resources for doing the analysis.

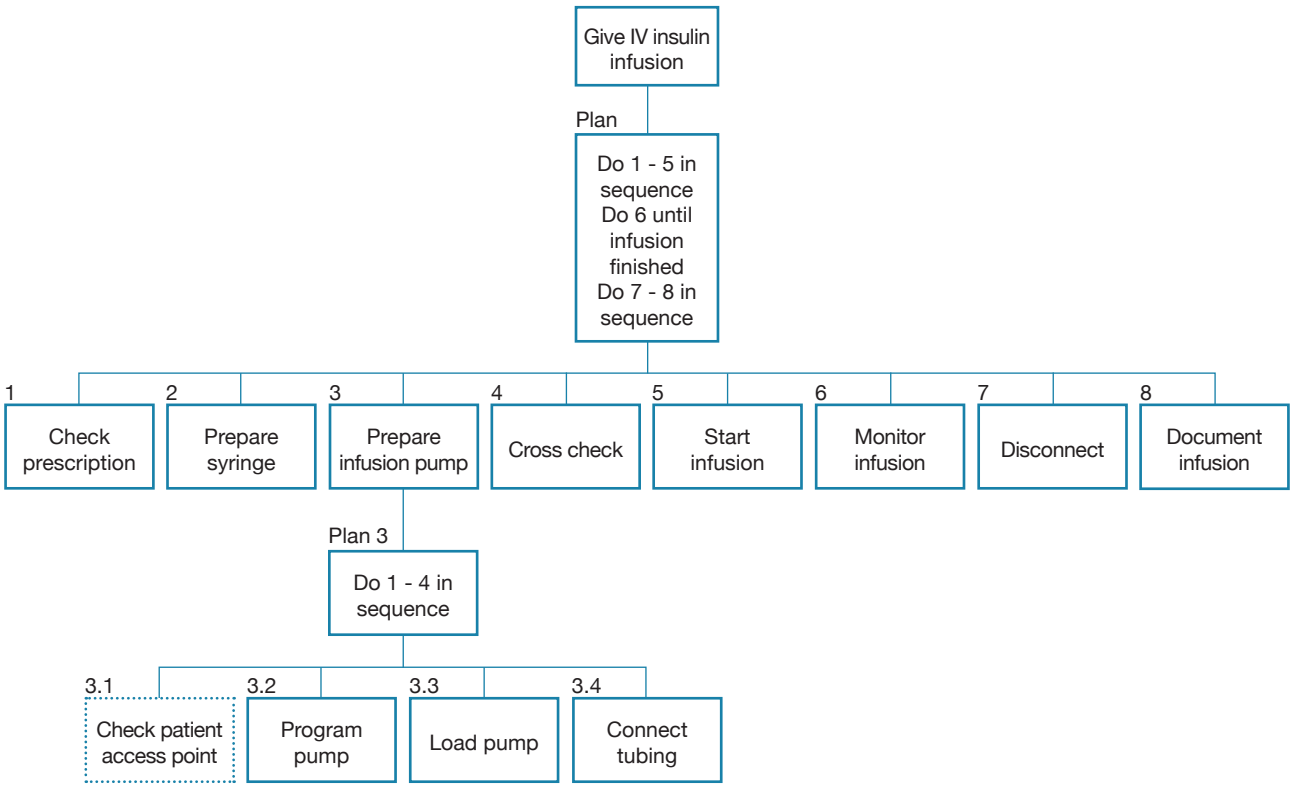

Figure 4: HTA for giving intravenous insulin infusion (first level expansion)

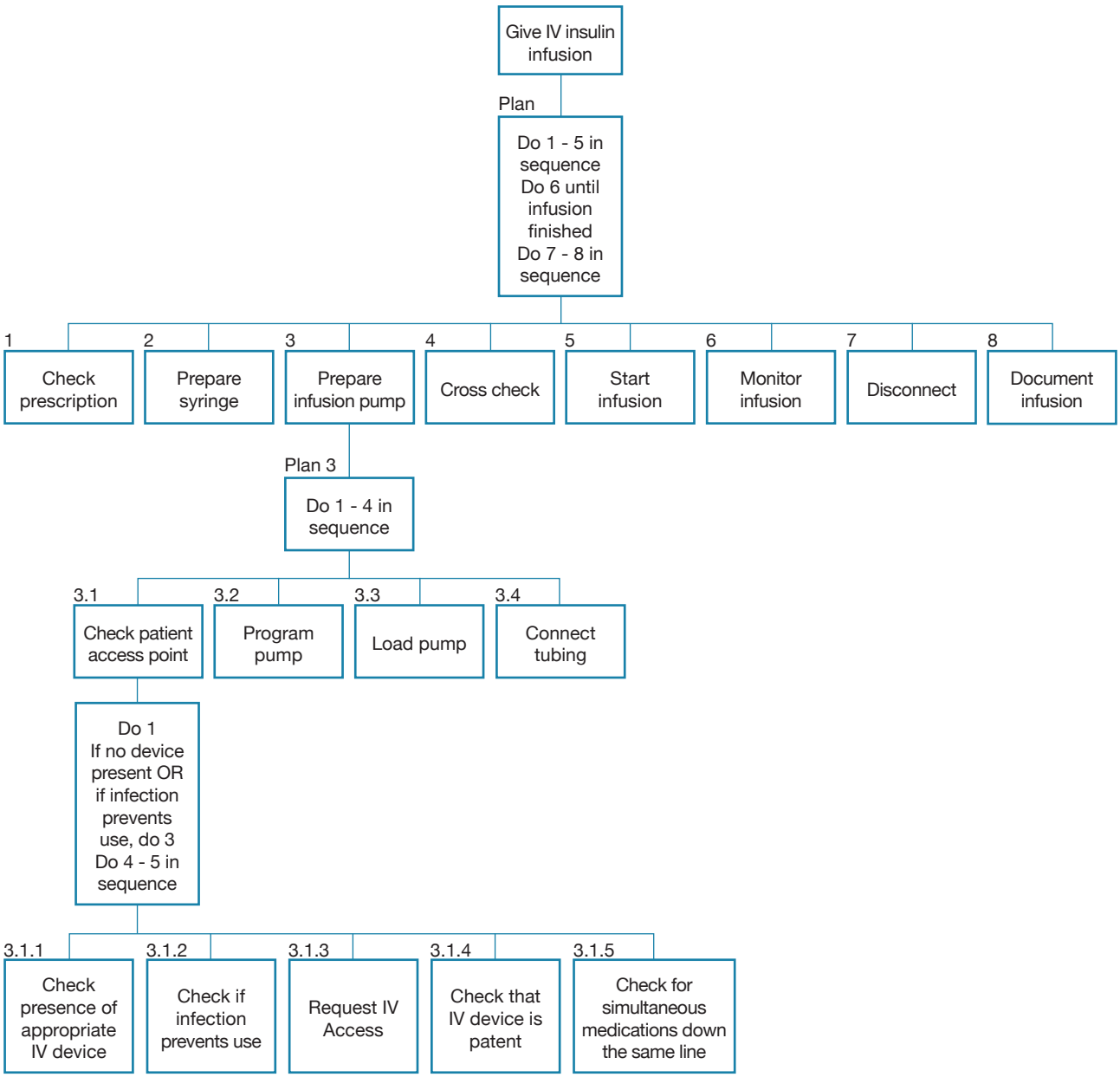

Figure 5: HTA for giving intravenous insulin infusion (second level expansion)

Practical considerations for doing Task Analysis

In order to make TA, and HTA more specifically, work in practice, it is important to consider a few practical issues. It is helpful to have clarity about the purpose of the analysis. The examples demonstrate the very wide applicability of HTA, and there are many published examples available, including those from health and social care (Chana et al., 2017, Lane et al., 2006, Parand et al., 2017). The main strengths of HTA are the flexible hierarchical decomposition, which allows activities to be broken down to the level that is considered adequate for the purpose of the analysis, and the explicit representation of algorithmic plans.

As mentioned above, a number of data collection approaches can feed into the TA or HTA. It is often useful to undertake some form of familiarisation with the task, e.g., by doing process walks, observations and informal interviews. It is also advisable to identify and consider existing documentation, such as work procedures relevant to the task. It is not uncommon that the task itself is not documented in a single work procedure, but different steps might be covered by a broader range of procedures, guidelines or regulations. It is the job of the analyst to make sense of these and bring clarity to the task. HTA is well suited to support clinical teams in defining and understanding health and care processes, which hitherto had not been formally designed or documented.

The analyst can develop a preliminary TA based on this initial understanding of the task. The preliminary HTA (or other TA representation) is usually developed further and refined in focus groups with a small number of representative participants. If the task is fairly small and has a limited number of stakeholders (e.g., just nurses), then one or two sessions with a few participants might be all that is required. On the other hand, if the task is larger and involves stakeholders from different departments or even different organisations (such as transfer of a patient from the ambulance service to the emergency department), then several sessions might be required. It is important that all relevant roles are involved, and that the focus groups allow for meaningful discussion.

The detail to which tasks are broken down depends on the purpose of the analysis, the complexity of the task and the importance of specific steps to successful task performance. It requires some experience with the method to get the level of breakdown right, because there is no exact stopping rule. If tasks are broken down into too much detail, then this requires a lot of effort, which could have been used more productively on other activities, such as analysing the critical steps using additional approaches.

The use of HTA can also provide team members from different backgrounds with the opportunity to build important relationships with each other, which in normal clinical practice they would not have. Creating opportunities to strengthen the social infrastructure of safety and enhancing staff engagement should be a key patient safety improvement strategy (Sujan, 2015).

Identifying vulnerabilities in clinical tasks using structured human failure analysis

Human Reliability Analysis

While the TA by itself is very useful for analysing and understanding clinical tasks, it can be helpful to apply additional, structured methods for identifying systematically vulnerabilities in the task. Such methods come by different names, e.g., hazard analysis or risk analysis. In the HF/E literature, they are commonly referred to under the umbrella term Human Reliability Analysis (HRA).

HRA approaches were developed starting from the late 1960s and gained popularity especially during the 1980s. The traditional aim of HRA techniques is to determine the impact of human error on a system. In a more modern interpretation, HRA techniques are used to reason systematically about human performance, the contextual conditions that impact human performance, and the improvements that can be put in place to improve overall system performance. The contextual conditions affecting human performance are the configurations of the work system and the interactions with other elements of the work system. For the purpose of the HRA they are typically referred to as performance shaping factors (PSF) or performance influencing factors (PIF).

There are more than 75 documented HRA approaches. As with TA, this large number of different approaches is due to the fact that each might serve a slightly different purpose or focusses on a specific aspect. As many HRA approaches can also be used to provide quantitative estimates of human error probabilities, approaches vary in the underlying assumptions and methods for quantification, but we will consider only the qualitative use of HRA. This is because in practice the quantification of failures and their consequences can be extremely time consuming with a lot of uncertainty about the exact figures due to lack of relevant data. In most situations, a good qualitative understanding of potential failures is a sound basis for safety improvement efforts, and this is the approach we recommend in this chapter.

Examples of Human Reliability Analysis methods

In health and social care, a variant of the prospective hazard analysis technique Failure Modes and Effects Analysis (FMEA) is a fairly well-known and well-established approach that can be used to identify and to analyse human errors (DeRosier et al., 2002). Increasingly, however, there are published examples of the use of traditional HRA approaches (i.e., those developed in other industries) in health and social care, such as SHERPA (see below), HEART, SPAR-H and CREAM (Phipps et al., 2008, Chadwick and Fallon, 2012, Deeter and Rantanen, 2012, Sands et al., 2015).

Systematic Human Error Reduction and Prediction Approach

A technique for HRA that is generally regarded as reasonably easy to apply, while providing good reliability and validity, is the Systematic Human Error Reduction and Prediction Approach (SHERPA). SHERPA was originally developed to analyse and reduce errors in the nuclear and process industries but has been used since in many other contexts (Embrey, 1986). It is similar in structure to FMEA but it is based on a simple taxonomy of human errors, which can function as a guide for the identification of failure modes. SHERPA uses the HTA representation and systematically analyses the basic task steps, i.e., the bottom leaves in the HTA tree diagram. The analyst classifies each basic task step according to the behaviour type and then applies the corresponding human error modes. The suggested behaviour types are action, checking, information retrieval, communication and selection. Basic human error modes for each of these behaviour types are shown in Table 1.

Behaviour Type	Code	Error Mode
Action	A01 A02 A03 A04 A05 A06 A07 A08 A09	Action too long / too short Action mistimed Action in wrong direction Action too little / too much Action too fast / too slow Misalign Right action on wrong object Wrong action on right object Action omitted
Checking	C01 C02 C03 C04 C05	Check omitted Check incomplete Right check on wrong object Wrong check on right object Check too early / too late
Information Retrieval	R01 R02 R03 R04	Information not obtained Wrong information obtained Information retrieval incomplete Information incorrectly interpreted
Communication	I01 I02 I03 I04	Information not communicated Wrong information communicated Information communication incomplete Information communication unclear
Selection	S01 S02	Selection omitted Wrong selection

Table 1: SHERPA human error taxonomy

Once a credible human error mode has been applied, the analyst determines the potential consequences of this particular failure. Determining the potential consequences can be difficult and it is often useful to think about both immediate consequences and more distal consequences. The next step is to consider whether there are any existing safeguards in place to prevent this failure from happening or to recover from it. If these are deemed insufficient, then the analyst can consider potential improvements.

Table 2 demonstrates the analysis for a part of the insulin infusion example. The analysis considers only the checking of the patient access point (step 3.1), which contains five sub-task (steps 3.1.1 – 3.1.5) and a corresponding plan, which describes the order in which the sub-tasks are to be carried out. Important steps are, for example, checking whether there are signs of access site infection present, and checking for compatibility with other medications being giving via the same access point.

A credible failure mode for checking for site infections is that this check is not carried out (Code C01 – Check omitted). If there is an infection, then this can become significantly worse from continued and additional use. The current risk controls rely on governance, training, and staff competence. Performance influencing factors include nurses undertaking concurrent activities and having high levels of workload. This can increase the likelihood that this check is forgotten. A potential intervention might be a reminder (or a compulsory check) via an electronic prescription and administration system.

Checking for compatibility with other medications is very important and safety critical. Potential failure modes include not doing this check (Code C01 – Check omitted) or looking up the wrong medication from the different medications that the patient is on (Code C03 – Right check on wrong object). This can result in loss of potency of the drugs, potential toxicity as well as several other serious adverse effects. The current risk control is the medication review at shift handover, where the medications the patient is on and the different access points are reviewed. Performance influencing factors include concurrent activities, high workload, as well as the design of the work environment and the equipment. The work environment and equipment design can lead to situations where there are many different lines tangled up, and it might be hard to see easily which infusion is going through the different access points. Potential interventions might include an automated electronic compatibility check as well as re-design of the work environment and equipment to avoid tangled lines.

Ref	Task Type	Failure Type	Description	Consequence	Existing Controls / Recovery	Performance Influencing Factors	Recommended Risk Reduction
3.1 Check patient access point							
Plan 3.1 Do 1 If no device present OR if infections prevents use, do 3 Do 4 – 5 in sequence							
3.1.1 Check presence of appropriate IV device	Checking	C01 Check omitted	The nurse does not check that an IV device is present.	Delays are possible if there is no IV access, and the nurse will need to request one later.		Concurrent activities Workload	
3.1.2 Check if infection prevents use	Checking	C01 Check omitted	The nurse does not check for signs of site infection.	An existing site infection can become worse.	Relies on governance and training / competence.	See 3.1.1	Include as required step in electronic prescription and administration system.
3.1.3 Request IV access	Communication	I01 Information not communicated	The nurse does not request a new IV access due to lack of suitably qualified colleagues available.	Delays in starting the infusion.		Staffing levels Workload	Provide training to ensure sufficient numbers of suitably qualified staff who can insert access points.
3.1.4 Check that IV device is patent	Checking	C01 Check omitted	The nurse does not check device patency.	Delays in giving the infusion.	The infusion pump will generate an alert based on detection of increased pressure.	Concurrent activities Workload	
3.1.5 Check for simultaneous medications down the same line	Checking	C01 Check omitted	The nurse does not check for other medications going down the same line.	Potential incompatibility of medications.	Review at shift change.	Concurrent activities Workload	Consider potential for automated checks.
		C03 Right check on wrong object	The nurse looks up the wrong medication.	See above.	See above.	Work environment (there can be many different and tangled lines with different access points). Equipment design. Concurrent activities. Workload.	Consider potential for automated checks. Redesign of equipment and work environment.

Table 2: Human Failure and Performance Influencing Factors Analysis Example

Performance influencing factors

As part of the analysis, you need to assess whether and how characteristics of the elements of the work system impact on the potential failures. HRA techniques typically include lists of performance influencing factors (or performance shaping factors) that you can use as prompts for an initial, quick assessment (see Table 3). For example, if the task step involves using a piece of equipment, you might ask whether the usability (or lack of usability) affects task performance; you could check if work procedures are available, up to date and usable; and you could determine whether the physical environment has any impact on the task, for example noise and lighting. The lists serve as prompts, but it is advisable to assess performance influencing factors via data collection techniques, such as observations and interviews.

Table 3: Examples of performance influencing factors

Work System Element	Example Performance Influencing Factors
Person	Physical capability and condition Fatigue Stress Workload Competence Quality of training Motivation Communication
Tasks	Complexity Unusual task Multi-tasking Distractions Time available Availability and quality of procedures
Tools and equipment	Usability Suitability Quality of interfaces Design Availability Maintenance
Physical spaces	Noise Heat Adequate space Lighting Ventilation Accessibility Clutter

Organisation	Work pressures Supervision Staffing levels Clarity of roles and responsibilities Safety culture Change management

Practical considerations for doing Human Reliability Analysis

The principles behind a SHERPA analysis are reasonably easy to understand but doing a good human failure analysis can be challenging. The defining feature of failure analysis approaches is that they are systematic – they intend to provide us with a degree of confidence that we have looked at an issue in depth. Therefore, lists of potential failure modes, such as the one provided in Table 1, are helpful. You should try to make use of these and guard against jumping straight into what might look like the most important failures based on people's experience. Using the experience of people is clearly fundamental, but it needs to be done in a structured and systematic fashion, by going through each task step in turn, and thinking about potential failure modes. In this way, a broader range of situations and failures can be considered. This requires some discipline, and it is often helpful to have an experienced facilitator to keep the group on track.

Arguably, the biggest challenge in running human reliability assessments is the assessment of the consequences, especially when the method is used to create a quantitative output. In practice, we often find that the severity of the consequences is very much dependent on other factors, such as the patient's condition. If the patient is in a critical condition, then minor delays or deviations might result in death, whereas in a stable patient the severity of the consequences of the same failure might be negligible. It can be helpful to distinguish between immediate and more distal consequences, and to describe these qualitatively. For example, the immediate credible worst-case consequence of the failure to check if an infection prevents the use of an IV device (task step 3.1.2 in the example) might be that the IV device in an infected site continues to be used. The more distal consequence could be that the infection gets worse, which puts additional strain on the patient and could cause further complications, which require more explicit consideration from a clinician, thereby also increasing workload.

Intervention selection

The TA and the human failure analysis provide a detailed understanding of the task and the current vulnerabilities. This can form the basis for designing and implementing appropriate interventions to reduce the vulnerabilities. The information provided by these approaches will not be the only consideration, but it can be a helpful starting point for creating a list of potential candidate interventions, which have transparent links to identified risks and which can be appraised according to a range of criteria (e.g., feasibility, affordability, level of risk reduction, ability to address multiple vulnerabilities with fewer interventions etc).

When thinking about candidates for interventions, it is again a useful approach to do this systematically, rather than jumping straight to any specific intervention. For example, when double checks during medication administration are not carried out, it might be tempting to consider training and procedures as potential interventions. However, there might be other options. For example, it might be possible to include technology, such as barcodes, to reduce the risk of wrong medication administration. Of course these can, in turn, introduce new vulnerabilities, which must be analysed and assessed.

In safety-critical industries a simple heuristic is commonly used to help people think about different types of candidate interventions in a systematic way. This so-called hierarchy of risk controls assumes that certain interventions are more effective at reducing risk than others. Accordingly, you should consider whether stronger risk controls are feasible before implementing weaker ones. Generally, the assumption is that it is better to eliminate risks where possible or to engineer safeguards that do not rely on people, before considering interventions that rely on people changing their behaviour or being more careful. So, for each identified risk, ask yourself:

- Can the risk or the source of the risk (the hazard) be eliminated?
- Can the reliance on people be reduced, e.g., through automation?
- Can the performance influencing factors be improved?

If the source of the risk cannot be eliminated, reliance on people cannot be reduced and the conditions within which people work have been optimised, then further behavioural risk controls could be considered, such as additional procedures, training, and reinforcement of messages around desirable behaviours (e.g., hand hygiene campaigns).

In practice, it is advisable to regard the hierarchy of risk controls as a helpful heuristic, but not as a static decision tool. The intention is to help the analyst to consider a range of options before selecting any specific intervention. In health and

social care, the most frequently selected interventions tend to be at the bottom of the hierarchy of control, such as training, standardisation and formalisation of roles and responsibilities. This does not necessarily mean that these have to be ineffective, especially when they are done well (Liberati et al., 2018).

Consider the cross check in the insulin infusion example (task step 4). This is a critical check just before starting the infusion and is intended to be carried out by two nurses. However, potential failure modes are that either the check does not take place at all (Code C01 – check omitted) or that only certain items are checked (Code C02 – check incomplete). A potential engineering intervention could be the introduction of automated checks, which is something that is already included in many modern systems. Smart infusion pumps can check the drugs and the patient ID using barcode scanning, and the infusion activity can be mapped to the electronic prescribing system and compared against the prescription for any discrepancies. Potential interventions lower down the hierarchy of risk controls could include the introduction of a different type of proforma, where nurses can tick off the different types of checks that have been done (thereby also serving as a memory aid and an audit tool). However, for both types of interventions it is important that (a) relevant stakeholders are involved in the design of the intervention, and that (b) you consider potential new vulnerabilities that might be introduced with the intervention.

In addition, you can think about how to improve the performance influencing factors. Excessive workload could be one reason why cross checks are not done, and this could be addressed through changes to staffing levels (which often is very difficult). The existing procedure might not reflect actual practice, and this could be updated and optimised, so that it provides greater flexibility and requires the most rigorous checks only for certain types of drugs.

Implementation and monitoring

The outputs of the preceding steps are (a) a thorough understanding of the task and the main vulnerabilities and (b) a set of candidate interventions that have clear links back to those vulnerabilities. This is very useful in order to enhance transparency of the overall process.

The next step is to implement the selected interventions. The detail of implementation is beyond the scope of this chapter, but it is helpful to bear in mind that interventions need to be monitored and their effectiveness reviewed. One way of doing this is to develop indicators for each intervention, which can be monitored over time. Lagging indicators are indicators that measure failures of risk control systems or interventions, which contributed to incidents and adverse events (e.g., when reviewing incidents), while leading indicators measure the effectiveness of risk control systems during inspections and audits.

For example, if you were to introduce automated checks, then a lagging indicator might be the number of wrong medication administration incidents. A leading indicator for the automated checks could be routine audits to determine (a) the availability of the automated checking system (e.g. whether it is physically available and working) and (b) the accuracy of the automated checks.

Chapter summary

In this chapter you learned about how to describe and analyse the tasks, which people undertake within health and care work systems. You were then introduced to a technique that allows you to identify and describe the main vulnerabilities in the task. You were sensitised to the potential impact of the quality of work system elements on successful task performance. You were presented with examples of different types of interventions. The approaches described in this chapter will enable you to critically reflect on how work is carried out and to create a transparent link between vulnerabilities and potential improvements, which can then be monitored and assessed over time.

CIEHF HF/E Competencies

1. Ergonomics / Human Factors (E/HF) principles

1.3 Demonstrates ability to enhance health, safety, comfort, quality of life, attitudes, motivation, usability, effectiveness and efficiency.

2. Ergonomics / Human Factors (E/HF) theory and practice

2.1 Understands the theoretical and practice bases for analysis of human interactions.

2.2 Understands the theoretical and practice bases for redesign of human interfaces.

2.3 Understands the theoretical and practice bases for data collection and analysis relating to E/HF.

3. Human capabilities and limitations

3.2 Understands the theoretical and practice bases for E/HF relating to psychological and social capabilities and limitations.

4. Design and development of systems including products, tasks, jobs, organisations and environments

4.1 Understands the theoretical and practice bases for E/HF relating to design and development of systems.

5. Professional skills and implementation

5.1 Understands the role of E/HF in change strategies.

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