Human factors in anaesthesia for oral cancer surgery: a review

Nicola J. Hogan[1], **Alistair F. McNarry**[2]

[1]St John's Hospital, Livingston, NHS Lothian, Scotland, UK; [2]Department of Anaesthesia, St John's Hospital and The Western General Hospital, NHS Lothian, Scotland, UK

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Correspondence to: Alistair F. McNarry. Consultant Anaesthetist, Department of Anaesthesia, St John's Hospital, Howden West Road, Livingston, EH54 6PP, Scotland, UK. Email: althegasman@btinternet.com.

Abstract: The impact of human factors and ergonomics in healthcare is increasingly recognised. Human error is no longer regarded as a mistake made by an inattentive clinician, but is a multifactorial event with roots in physiology, systems design and team working. A 'HANGry' (hungry and angry) clinician does not perform at their best, and even the most senior clinicians can become fixated with tasks such as tracheal intubation, despite perfectly acceptable alternative oxygenation strategies often being immediately available. Medical errors may lead to many avoidable deaths every year so it is vital that all those involved in delivering healthcare consider how such errors may be mitigated against. The field of anaesthesia for oral cancer surgery is complex, as primary airway management may be challenging, patients are likely to have multiple comorbidities (e.g., cardiovascular disease and chronic obstructive pulmonary disease), the airway is remote from the anaesthetist and shared with the surgeon for most of the procedure, and surgery can be protracted requiring multiple team handovers during the operation. This review aims to provide an overview of human factors and ergonomics in the field of anaesthesia for oral cancer surgery. It outlines strategies to mitigate errors and improve patient safety, including avoidance of factors that lead to errors occurring (designing systems to be fail-safe), implementation of barriers to reduce errors occurring, and methods of limiting the impact or spread of an error once it has occurred. This review explores the science of human factors and ergonomics, highlighting some of the tools that all clinicians may adopt to better improve their practice.

Keywords: Human factors and ergonomics (HFE); human performance; medical error; airway management; adverse event prevention

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Introduction

Everyone has witnessed phenomenal achievements in the field of human performance—from athletes winning a medal to a musician delivering a note-perfect recital in front of an audience. Sadly, these peaks of accomplishment are mirrored by similar troughs of human performance. Parallels are often drawn between the aviation industry and healthcare, with accidents in both often attributed to human error. However, no pilot or clinician ever sets out to make a mistake or respond inappropriately to a crisis—yet humans do both of these.

Conversely, machines do not make unsolicited errors, however, they cannot achieve peaks of performance—machines do what they are programmed or designed to do, at whatever rate they are designed to do it; they cannot change their output under the pressure of a deadline. Human factors are perhaps most readily defined as "anything that affects a person's performance" (1) or all of those factors which make humans behave entirely differently to a very predictable machine.

The Chartered Institute of Ergonomics and Human

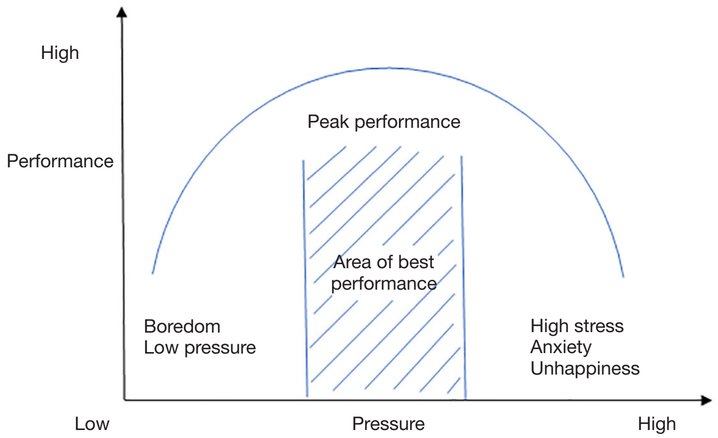

Figure 1 Schematic representation of the relationship between stress and human performance.

Factors defines ergonomics as "*the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimise human well-being and overall system performance*" (2). It also commented that "*we take ergonomics and human factors to mean the same thing. One of the two terms may be used more in certain contexts or sectors. For example, 'ergonomics' tends to be used more in regard to offices and 'human factors' in the healthcare, defence and energy sectors*".

The Clinical Human Factors Group, a charity set up to help address human factors-related errors in healthcare describes clinical Human Factors as "*organisational, individual, environmental, and job characteristics that influence behaviour in ways that can impact safety…in clinical and healthcare contexts that means lives are at stake*" (3).

Background

Whilst there are several definitions of human factors, it is their impact that is important. Individual cases highlight the human cost of human factors errors (4,5), but scientific studies suggest the potential scale of the problem. Studies in the USA report that as many as 251,000 deaths per year could be caused by medical errors—events that could potentially have been avoided, or at the very least mitigated against (6-9). In the UK, Flin and colleagues identified an average of four human factors attributes per case recorded in the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4), which reported all morbidity and mortality relating to airway management (10,11). The most frequent contributing human factors were, failure to anticipate, wrong decision-making, task difficulty, inappropriate staffing, time pressure, tiredness, hunger, stress, poor communication and limitations in competence (12).

Importantly, human factors errors also have a basis in physiology. In 1908, the psychologists Yerkes and Dodson conducted the original experiments that led to the development of the Yerkes-Dodson Law (13). This law states that performance increases with increasing levels of physiological or mental arousal or stress, up to a point where it ceases to increase and performance starts to deteriorate (*Figure 1*). This model has its critics (14), but the idea that human performance can diminish under extreme stress is useful (15).

Rationale and knowledge gap

'Human factors and ergonomics' (HFE) is much more than a trite phrase to explain or excuse deficits in human performance, but describes a complex science which recognises the interplay between human physiology, psychology and external stimuli to determine how humans behave, deliver clinical care or respond to emergency situations.

The aim of this review is to encourage the reader to consider how best to achieve optimal performance in a high-stakes, high stress clinical environment. This might require the use of checklists or cognitive aids, resilience training, recognising relevant input from the team, controlling the impact of physiology on the individual, decreasing the cognitive load, or seeking help from others. Whilst focused on the topic of human factors in oral cancer, any consideration of human factors in anaesthetic practice must include the recently published more broadly based guidelines from the Difficult Airway Society (DAS) and Association of Anaesthetists (16,17).

Recognising that individuals can fail for a variety of reasons is not a sign of weakness but rather a strength that will lead to improved patient care.

Objective

This review aims to introduce the reader to the multifaceted field of HFE, and specifically how it might relate to some of the situations found in the head and neck surgical environment.

Physiology

Grossman and Siddle report that fine motor skills deteriorate when an individual's heart rate increases above 115 beats per minute (bpm), whilst above 155 bpm complex motor skills deteriorate, and above 175 bpm "freezing" is possible (18). This work comes from the field of combat, and illustrates how technical skills performance [e.g., for awake tracheal intubation (ATI) or the creation of an emergency front of neck airway] become more difficult as the release of stress hormones increases heart rate. This physiological deterioration of skills can be anticipated and where stressors and stress levels can be controlled, the performance of individuals within the team can be improved. For example, breathing techniques such as 'box breathing' (19) have been shown to lower heart rate, engaging the parasympathetic nervous system, and attenuating the sympathetic 'fight or flight' response. However, if anxiety levels are raised prior to starting anaesthesia for a surgical case, this may indicate that the individual is out of their depth and additional help should be sought before proceeding—an example of employing situational awareness, recognition of an individual's limitations and directed communication to prevent a suboptimal situation.

Basic physical needs of the healthcare team must also not be over-looked, as demonstrated by Maslow's Hierarchy of Needs (20). Indeed, most healthcare workers will be aware of human factors mnemonics designed to improve performance, which identify underlying causative factors that need to be addressed, e.g., HALT (21,22):

- H—hunger, e.g., missed lunch break, lack of access to facilities;
- A—anger, due to missed breaks, rudeness or increased workload or responsibility;
- L—late, because of overrunning clinical duties or poor transport infrastructure;
- T—tired because of a heavy workload or rota allocation.

Individuals suffering in this way will not perform at their best and may rush decisions or miss vital elements of a patient's clinical assessment.

The language of human factors

Detailed discussion of the *language* of HFE is beyond the scope of this review, for which the reader's attention is drawn to this guide (15) produced by the Clinical Human Factors Group. For the purposes of this review, four key HFE concepts within healthcare are considered:

Non-technical skills

The Applied Psychology and Human Factors Group at the University of Aberdeen define non-technical skills as "*…the social (teamwork, leadership, communication), cognitive (situation awareness, decision-making, cognitive readiness, task management) and personal management (stress and fatigue management) skills necessary for safe and effective performance*" (23). To many, this is their complete understanding of human factors. However, whilst this is a fundamental component of human factors, it is not the only component (see "The Airway Spider", *Figure 2* and *Table 1*) (30).

Cognitive overload

The idea of cognitive load was first developed by Sweller (31) and is the mental effort required to perform a task. Data must be collated, integrated and filtered by clinicians to make decisions. Incoming information overload (e.g., from a complex patient or clinical scenario) is associated with medical errors, individual burnout and less than optimal care for patients—a triple negative effect (32-34).

Task fixation

'Fixation errors' occur when the clinician concentrates solely upon a single aspect of a case to the detriment of other more relevant aspects (25), e.g., when an anaesthetist becomes fixated with achieving tracheal intubation over the need for oxygenation or the avoidance of airway trauma.

Flattening the hierarchy (levelling the authority gradient)

Catastrophic events in aviation have been linked to the

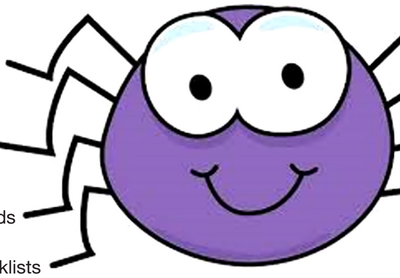

Figure 2 "The Airway Spider": the arachnid mnemonic for teaching HFE in airway management (24). HFE, human factors and ergonomics.

Table 1 The arachnid mnemonic

Arachnid mnemonic	Example or further detail
A—Algorithms (a process or set of rules to be followed)	E.g., the DAS algorithms for unanticipated difficult intubation or awake tracheal intubation (25,26)
R—Resilience (the ability to recover from untoward events)	Allow for improved performance, preventing a critical incident from occurring or dealing with it more effectively when it does
A—Cognitive aids (a prompt or aid memoir to remind the user how to behave during an emergency)	E.g., the ATI cognitive aid or the Vortex (25,27)
C—Checklists (didactic set of instructions to direct behaviour)	E.g., the eFONA action cards by DAS and others (28,29)
H—Handover tools (ensuring that details of a case are effectively transferred between two clinicians)	Particularly important in prolonged head and neck surgical cases
N—Non-technical skills (wrongly presumed to be human Factors, non-technical skills are simply part thereof)	Includes communication, teamworking, situational awareness, leadership, followership, avoidance of task fixation, flattening the hierarchy
I—Incident investigation (this is important as every incident provides a learning opportunity)	It is specifically designed not to find fault or attribute blame, but to facilitate individual and institutional learning to avoid event repetition
D—Design (systems design is often considered the most important barrier to preventing incidents but it is the most difficult to implement)	Operating theatres and anaesthesia monitors can be designed to promote best practice; however, this needs to be considered far in advance of an incident, and cannot necessarily be changed rapidly following an incident

ATI, awake tracheal intubation; DAS, Difficult Airway Society; eFONA, emergency front of neck airway.

rigid hierarchy that existed between the captain and the co-pilot—where either the co-pilot did not feel able to speak-up and call-out a safety-critical situation, or because the captain 'pulled rank' and ignored the warning. The Kennedy inquiry (into children's heart surgery at the Bristol Royal Infirmary, following the deaths of 29 babies) identified a "profoundly hierarchical" team structure in healthcare. All members of any operating theatre team must be empowered to speak-up and identify potentially hazardous events, behaviours or situations that they encounter (35).

Levelling the authority gradient does not mean the hierarchy should be completely flat as that implies a situation where no one leads the team, but all staff should be encouraged to voice concerns without fear of retribution or consequence (36).

HFE in anaesthesia for oral cancer

HFE have been recognised as an important part of anaesthetic practice for several years (37). Despite this, the risk of a human factors-based (or individual attributable) error remains high, with errors in decision-making, and every other aspect of HFE evident in critical incident reports. ATI can be used to exemplify this:

Whilst anaesthetists are encouraged to have a low threshold for performing this technique (38), a lack of the technical competence may lead an individual to errantly decide that “in their hands” an asleep airway management technique would be better. This is more likely given the low numbers of ATIs performed by many anaesthetists, even with an airway interest (39). There are many possible solutions to this problem:

(I) Ensure the widespread availability of flexible bronchoscopes;
(II) Ensure staff are trained and available to set the equipment up, removing a potential obstacle to its use;
(III) Ensure that regular training is available in high and low fidelity simulation models to ensure skill maintenance; and
(IV) Establish a supportive culture to allow clinicians to ‘phone-a-friend’ when faced with the prospect of performing an ATI.

Having made the decision to proceed with an ATI, there are several other areas of good HFE practice that must be addressed in order to facilitate the relatively straight forward technical skill of guiding a tracheal tube into the trachea using a flexible bronchoscope. Competence and confidence in the technical skill of flexible bronchoscopy helps avoid cognitive overload and allows the clinician to consider other important factors (so called “situational awareness”). Anaesthetists who regularly perform the technique are more likely to remember to encourage a patient to inspire deeply whilst spraying the tongue/oropharynx/nasal passages with local anaesthetic, thus ensuring that deposition is optimised. In turn, superior topicalisation allows the operator to concentrate on other aspects of the technical skill involved.

Good communication with the team ensures the ATI process runs smoothly, but communication is a multi-directional process, and team members must speak up if they see an error, e.g., if the process of flexible bronchoscopy has been started without prior loading of the tracheal tube onto the bronchoscope.

A checklist is a useful tool for ensuring that the team are thinking together and have all the necessary equipment. However, whilst there are clear benefits to checklists, even these are associated with potential risks (40).

High flow nasal oxygen (HFNO) is another area where a beneficial novel therapy has the potential to be misused. HFNO improves patient oxygenation during the ATI procedure (41), but it can conceal inadvertent over-sedation and patient apnoea, which can go unnoticed as the patient’s peripheral oxygen saturation remains unchanged. This same over-sedation can also decrease airway tone and patency, causing the ATI procedure to become increasingly difficult, further increasing the cognitive load on the performing bronchoscopist.

A second clinician can be employed to administer the sedation during an ATI, which decreases the cognitive load on the bronchoscopist, however, clear communication between the two clinicians is vital.

The layout of the environment can impact skill performance—a well-constructed procedural environment allows the clinician to visualise the patient, the monitor and the bronchoscopy images in one sweep. Incorrectly positioned equipment can make the job of the bronchoscopist more challenging (*Figure 3*). Physical stress, that increases the discomfort of the bronchoscopist, may act as a distraction from the task and also impair technical performance.

The cognitive load of managing a patient with a complex airway can be mentally and physically exhausting—the clinician who has performed a difficult ATI may not be performing optimally when faced with potential adverse events during the rest of the surgical case. Having a carefully secured airway does not mean the patient is exempt from anaphylaxis to antibiotics, intraoperative haemorrhage or inadvertent tracheal extubation during the procedure.

An airway alert card (42) may identify patients known to have difficult airway management. For this protective barrier to be effective, however, the clinician must take the time to issue an alert card to the patient, the patient must bring it with them to their next anaesthetic assessment, the staff at the assessment clinic must recognise its importance and, finally, the clinician who is given the information must choose to act on it appropriately and treat the patient as if they have a difficult airway.

Videolaryngoscopy is recognised as being superior to direct laryngoscopy (43), however, the evidence also demonstrates that clinicians with more experience in the devices achieve better results than those who have

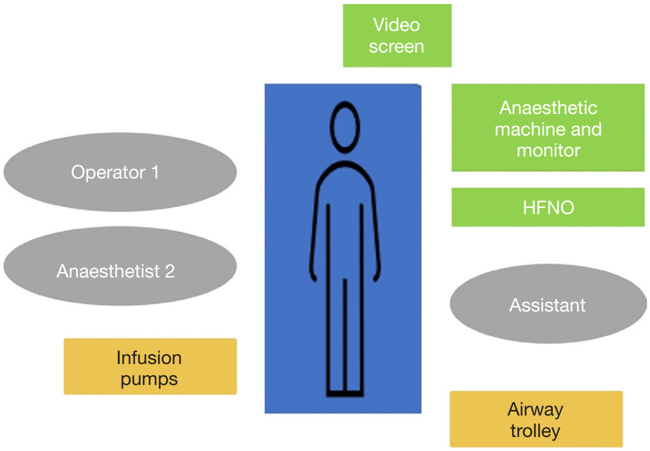

Figure 3 The configuration of the environment for performing ATI at our institution. Operator 1 can readily visualise the patient, the video output and the anaesthetic machine and monitor; Anaesthetist 2 can see the same fields, and is responsible for administering sedation (with direct access to the infusion pumps), but can also assist Operator 1 with administration of local anaesthetic down the working channel of the bronchoscope (spray-as-you-go technique); The assistant is on the opposite side of the patient with immediate access to the airway trolley. ATI, awake tracheal intubation; HFNO, high flow nasal oxygen.

used them less often. A clinician who has never used a particular videolaryngoscope before is unlikely to derive maximum benefit when compared to someone using the device on a daily basis. For example, a clinician faced with a potentially difficult airway resorts to using an unfamiliar hyperangulated blade, without first considering how to overcome the recognised problem of achieving a good view of the glottis but difficulty in delivering the tracheal tube (44,45).

An additional benefit of videolaryngoscopes is the potential for a shared view between the anaesthetist and the assistant, who can then pre-empt the next steps in either procedural success or failure.

PUMA (Project for the Universal Management of the Airway) guidelines on the prevention of unrecognised oesophageal intubation (46) also identify "clinician denial" as a possible factor in critical incidents—whereby the lead clinician simply fails to admit to themselves or the team that they may have failed to effectively intubate the trachea. The introduction of a hard rule (e.g., seven end-tidal carbon dioxide waveforms) helps empower others present to challenge this potentially catastrophic event—but only if this prompts the appropriate action to be taken.

The Association of Anaesthetists Guidelines (16), place barriers to mistakes between designing out the possibility of making mistakes and mitigations when mistakes happen. Barriers can be considered as everything from operating list planning (e.g., not placing two very long cases on one list), or where a long case is predicted providing a team of anaesthetists to safely deliver the care to the use of checklists and cognitive aids which is considered below.

Mitigating factors: individual and team level

Names, flattened hierarchy

Knowing and using team members' first names is a simple tool to improve direct and closed-loop communication, such as in task allocation in an intraoperative emergency. Using names also improves team cohesiveness, increasing individual "buy-in". When team members feel listened to and valued they are more invested in the shared goals of the group and are more likely to apply skills of observation, anticipation and volunteering (47).

Using (first) names and roles on theatre hats/caps can allow comments to be directed appropriately and help flatten the hierarchy. Another constructive practice is to routinely hold team introductions as part of the list brief and to write names and roles on the operating theatre whiteboard (48,49).

Anaesthetic assistants

Similarly, those who assist the anaesthetist should be empowered to ask: "*What is the airway management plan and what are we going to do if that doesn't work*?". Some hospitals have deliberately designed the top of their airway trolleys to be empty until an airway management plan is discussed (50). Anaesthetic assistant training should include specific learning outcomes in human factors. Opportunities to practise using communication aids, which prompt or challenge the anaesthetist during airway management and emergency scenarios, should be provided using simulation training.

Communication tools

'PACE' is a communication tool which can be particularly useful at induction of anaesthesia (51,52). This tool has been promoted by the UK Royal College of Anaesthetists (RCoA), in conjunction with their "No trace = wrong place" safety campaign to prevent morbidity and mortality from unrecognised oesophageal intubation. Example phrases are provided in the campaign teaching materials: Probe—'Do we have an end tidal carbon dioxide ($ETCO_2$) trace?'; Alert—'I cannot see an $ETCO_2$ trace'; Challenge—'I cannot see a $ETCO_2$ trace and the patient is hypoxic. Can we check the tracheal tube position?'; Emergency—'This is an emergency, we need to check the tracheal tube position before the patient arrests' (53).

This tool should be adopted, and anaesthetic assistants should be trained to use it. However, for the greatest impact, anaesthetists must also be taught its benefits. In particular, this tool may be of benefit in challenging task fixation during unsuccessful attempts at securing the airway in patients with oral cancer.

Other useful tools include:

(I) SNAPPI (54):
- ❖ 'Stop'—declare an emergency and gain attention;
- ❖ 'Notify'—the team of a problem;
- ❖ 'Assessment';
- ❖ 'Plan'—share this with the team;
- ❖ 'Priorities'—order the tasks;
- ❖ 'Invite' ideas—leaders should encourage team members to speak up.

(II) CUS (55):
- ❖ I'm Concerned;
- ❖ I'm Uncomfortable;
- ❖ This is a Safety issue.

(III) 'Advocacy and Inquiry': where the onlooker says what they have observed and what is concerning them, then asks about the underlying reasoning for the action or decision.

(IV) 'SBAR' (56,57):
- ❖ Situation;
- ❖ Background;
- ❖ Assessment;
- ❖ Recommendation.

SBAR is a well-used aide for ensuring a concise and informative handover of patient care between staff, including when asking for emergency assistance, which has been shown to improve patient outcomes.

Environment ergonomics

Planning of the environment and equipment, and the interplay between clinician and physical infrastructure is a fundamental aspect of ergonomics. The site where complex airway management is undertaken is a key consideration—some have advocated that management of the anticipated difficult airway, as often encountered in oral cancer cases, should be undertaken in the operating theatre as opposed to within the smaller anaesthetic ante room/induction room (common in the UK). For some high-risk cases where there is a greater possibility of failure to intubate the trachea orally or nasally, a trained surgeon can be scrubbed, with the patient's neck "prepped", marked and infiltrated with adrenaline-containing local anaesthetic (in preparation for creation of a front of neck airway).

Resilience and prevention of burnout

Teaching individuals to recognise heightened levels of stress in themselves and others can help them to address potential causes. Team members and managers should be aware of chronic, as well as acute, stressors and act to mitigate these where possible. Preventing burnout among individuals and teams by prioritising staff wellbeing and promoting joy at work is vital to sustaining the healthcare workforce and building resilience within teams; scoring tools can be used to identify burnout and other negative states (58). Schemes including mentoring or buddying have been used (26,59). Civility within the operating theatre team is vital as rude behaviour and bullying has been shown to have detrimental effects on team functioning (60), lowering the ability of individuals to concentrate, as well as alienating individuals.

Mitigating factors: institutional level

Healthcare systems: design and safety

The term 'system' in healthcare traditionally referred to a technical system. However, with a HFE lens, an understanding of the 'system' includes the functionality and reliability of equipment or processes in the healthcare setting, plus interactions with and between patients and staff.

A practical framework for demonstrating systems design is the Systems Engineering Initiative for Patient Safety (SEIPS) model. It is based on the macro-ergonomic work systems model and the Donabedian Structure-Process-Outcome (SPO) model of healthcare quality. This model illustrates how feedback loops, present in dynamic systems, respond and adapt to system outcomes (*Figure 4*).

Healthcare is viewed as a complex sociotechnical system and has been labelled "ultra-adaptive"—these dynamic and adaptive properties required of healthcare systems are

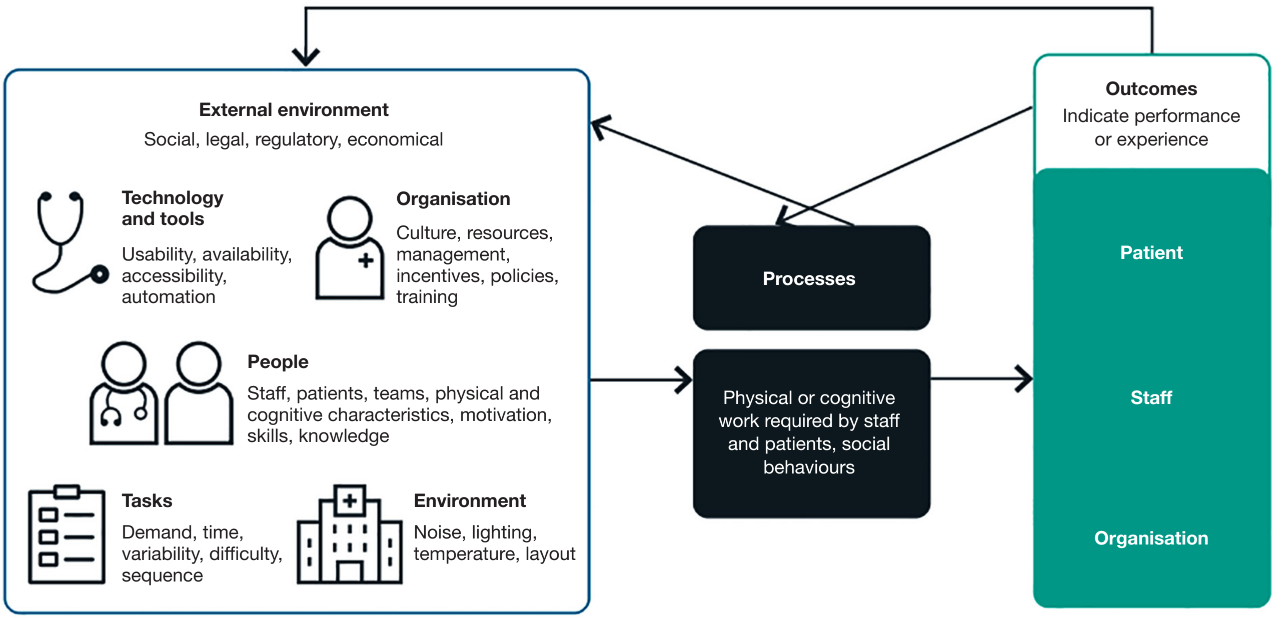

Figure 4 Adapted illustration of the SEIPS (courtesy of the Chartered Institute of Ergonomics and Human Factors reproduced with permission). SEIPS, Systems Engineering Initiative for Patient Safety.

fundamentally a strength. This complexity, however, can result in systems being over-reliant on the resilience of individuals and small teams to respond reflexively to mitigate risks.

'Designing out' the potential for individuals to make mistakes, thereby helping them succeed in what they set out to do, is an essential goal of the application of HFE in healthcare. Reliable and robust systems are integral to safe and effective workplaces. A practical example would be operating theatre teams ensuring that all surgical and anaesthetic equipment required for major oral cancer surgery is available and checked prior to the patient being anaesthetised.

Similarly, medical equipment can be optimally designed to facilitate correct use; flexible bronchoscopic systems should be easy to assemble, videolaryngoscopes should all be different enough to avoid the inadvertent placing of the incorrect blade on the videolaryngoscope and single use blades should 'break-on-removal' preventing inadvertent reuse as seen in the McGrath MAC videolaryngoscopes.

Learning from the 'Safety II' approach (28), where successful systems are analysed to understand how safe practices work, can provide more practical information than simply incident or 'near miss' analysis. Learning from excellence initiatives are popular to aid team morale, however, in-depth reviews of the specific processes should be undertaken to make excellent practice achievable for more teams.

Incident reviews

The systems approach used in HFE highlights that there are many contributory factors to a particular outcome in healthcare. This is useful in significant critical incident reviews (SCIRs) or local 'morbidity and mortality' (M&M) audit. A misconception in healthcare is that rooting out individual "bad apples" will improve patient safety (often resulting in cases where individuals are blamed). A lone element within a system cannot be seen to be the cause of a particular adverse outcome unless it is a critical element within the most basic and simple system; healthcare systems, however, are highly complex even in comparison with other safety critical industries. Learning in the local M&M environment must not focus on what an individual did wrong in a situation but rather how any individual could deal with a similar event more effectively in the future.

In 2016, the Care Quality Commission, the independent regulator of healthcare in England, stated the importance of both moving to a HFE approach in investigating causes of incidents, and moving "*the focus of investigation from the acts or omissions of staff to identifying the underlying causes of the incident*" (27). They emphasised the importance of using HFE expertise to find solutions, to reduce the risk of incidents recurring. The most effective solutions do not focus upon behaviour change to accommodate poorly designed systems but seek to re-design the systems.

Regular teaching and training

Good technical skills are essential to safe and effective patient care and lay the foundation for good non-technical skills. All anaesthetists should continue to be provided with adequate opportunities for skills training to establish and develop independent practice. Simulation training allows practitioners to train in both technical and non-technical skills in a safe environment.

Multi-professional simulation training (e.g., in airway management) gives staff the opportunity to rehearse non-technical skills such as leadership, followership, team-work, situational awareness, use of checklists, and communication (such as summarising and closing the loop). Testing the system, either in relation to those clinical emergencies less frequently encountered, or for testing the design of a new process (such as a new environment or new policy) can be a valuable use of simulation training. This is of most benefit if the simulation training is undertaken "*in situ*".

Checklists, prompts and cognitive aids

Hospitals and departments should decide which checklists and emergency guidelines are most useful to their teams, how to use them, and where to display them. Essential airway management checklists include rapid sequence induction (RSI) checklists for teams in the Intensive Care Unit or Emergency Department. In the UK, widely accepted and used emergency guidelines include, the DAS management of the unanticipated difficult tracheal intubation (61) and The Association of Anaesthetists' Quick Reference Handbook (62). In an emergency scenario, it is often useful to have a team member read aloud and assist the team in following a hand-held guideline (29).

An example of an airway-orientated cognitive aid is the Vortex (24), which gives a clear and simple alternative perspective to the DAS unanticipated difficult tracheal intubation guideline, but ultimately recommends the same actions, culminating in emergency surgical front of neck airway (if other attempts at oxygenation have been unsuccessful).

For maximum effectiveness, any guideline must have been taught to the operating theatre team before it is introduced.

Crucially, in airway management for oral cancer, certain stages of "routine" failed tracheal intubation guidelines may be unhelpful due to anatomical distortion (e.g., rescue oxygenation via a supraglottic airway may be impossible due to marked trismus from previous surgery/radiotherapy precluding oral access). Such cases must be made clear to the multidisciplinary team and a structured strategy described for failure of the 'Plan A' technique.

Guidelines and standard operating procedures

Procedures and policies must consider the usual context and environment where they are used. They should be developed with the user in mind and with input from all staff members affected. They also need to be easy to find (whether electronically or as a paper copy) and should be relevant, useable documents.

These divisions are by necessity slightly artificial as they can all overlap in a clinical scenario. Consider the optimal performance of the creation of an emergency front of neck airway: (assuming that such a procedure is possible in an oral surgery patient, especially if they have had previous radiotherapy) to ensure consistency across an institution this will combine medical device selection, standardisation of airway trolleys, checklists and training not just of airway managers but all of those who might be called upon to assist them (63). The decision about which technique an individual should use in this stressful situation is therefore best made at an institutional level (64).

Standardised airway emergency trolley

Standardisation of airway trolleys across hospitals within the same health board or trust (and ideally, nationally), is an important HFE recommendation, which has been widely adopted in the UK (50,65).

Medical devices and equipment

Equipment availability and functionality is a priority for institutions to ensure their clinical teams can carry out patient care tasks effectively. Using a HFE systems analysis lens, the use of the device should be viewed in the context of its useability and interface with the practitioner in the clinical setting, e.g., factors such as device cleaning or sterilisation turnaround time, will affect the availability of the device.

Anaesthetists use a wide variety of medical equipment. If new equipment is to be introduced, the users (the anaesthetist, anaesthetic assistant and/or surgeon) must be consulted in decisions, and have time to familiarise themselves with the new equipment. Importantly, devices with which the anaesthetist is unfamiliar should not be used in an emergency situation.

Workforce management

Surgery for oral cancer is complex, requiring an experienced team and specific equipment. Coordination of operating theatre lists should ensure that complex cases occur, or begin, in normal working hours, with a dedicated team with appropriate skills and expertise. Where the preoperative airway assessment indicates an anticipated difficult airway, it is wise to have two senior anaesthetists present with expertise in managing the airway for patients with oral cancer. In addition, having a second anaesthetic assistant is beneficial. The surgeon and team should be informed at the brief and a clear strategy for airway management formulated, including contingency plans for failure of 'Plan A'. A plan for managing failure to intubate the patient, with and without the presence of failure to oxygenate, should be verbalised and ideally written down. This can help the assistant to anticipate equipment required and importantly to prompt the anaesthetist if task fixation occurs in the presence of hypoxia.

Debriefs

Team debriefing can provide a platform for valuable reflective learning both in the routine setting and after critical incidents. A surgical team debrief following each case is a recommendation of the World Health Organisation 'Surgical Safety Checklist' where the 'Sign-Out' checklist forms only part of a broader discussion (66). Debriefs are effective tools for improving patient safety and list efficiency when information is recorded and management are involved, thereby forming part of a quality improvement (QI) cycle (67). Seeing results from team learning and feedback can then improve staff engagement in the process.

In the case of a critical incident, it is important to offer staff both a 'hot' debrief soon after and a 'cold' debrief later. The purpose and function of these debriefs are very different. The 'hot' debrief should be a time for staff to be supported, focussing on the reactions and reflections of team members, without going into specific details of the incident or its management. The 'cold' debrief is after incident review and investigation results and a time for staff involved and the wider team to learn what happened. The facilitator should have training in how to conduct these; engaging the whole team, creating a safe space and avoiding psychological harm. There are tools available to aid team leaders in this. Learning points can be identified and addressed at future team training, such as team failed intubation drills (68).

HFE and quality

QI and the application of HFE both aim to increase the level of quality in patient care provided. Both acknowledge that healthcare systems can be chaotic and that a proactive approach to understanding the context of a system and its risks is required. Once areas for improvement are recognised and described, QI tools can be used to measure, implement change and re-evaluate, so that long-lasting positive change can be embedded.

Review strengths and weaknesses

HFE is a vast subject with clear and important implications for healthcare—including recognising that relying upon the clinician to act as the sole barrier between success and failure is unrealistic.

Despite this, randomised controlled trials (RCTs) in human factors are limited, partly because their relevance remains under-recognised, but also because RCTs investigating HFE are very difficult to construct (especially in healthcare), where the measurable outcome might be patient harm.

This review is not an exhaustive summary of all the published evidence on HFE, but is designed to highlight aspects that are important to the head and neck anaesthetist, concepts that they should be cognisant of when managing patients undergoing anaesthesia for oral cancer surgery, and a starting point for an ongoing journey in human factors in head and neck cancer services.

Conclusions

Although HFE may seem relatively abstract concepts, they are fundamental to the safe and efficient running of operating lists for oral cancer surgery. The anaesthetist should recognise and be trained in the importance of HFE to daily practice—how to implement strategies to improve patient safety, reduce stress and facilitate effective team working. These strategies should be rehearsed within teams using human factors-orientated simulation training. The key to success is embedding HFE into workplace systems-design and departmental policies, which incorporate feedback from patients and staff.

HFE can help to ensure new systems are integrated safely, as well as improving current practice by learning from excellence and learning from critical incidents. With more institutions integrating a robotic surgical service into oral cancer care, this may be even more pertinent.

Understanding HFE is especially important to those anaesthetists involved in management, training and policy design and implementation, as those with a theoretical understanding and experience of its practical application, may have significant influence on how behavioural culture and organisational structure and processes continue to evolve to improve patient safety and outcomes.

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