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8

### Human performance limitations (communication, stress, prospective memory and fatigue)

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A key role in anaesthetic practice is gathering and assimilating information from a variety of sources to construct and maintain an accurate mental model of what is happening to the patient, a model that will influence subsequent decisions made by the anaesthetist on the patient's behalf, as part of a larger team. Effective performance of this role requires a set of mental functions that place great demands upon the physiology and psychology of anaesthetists, functions that are vulnerable to a wide range of factors including those affecting team performance and those affecting the anaesthetist specifically. The number of tasks, their complexity, the physical and mental demands of the job, the underlying health and well-being of the anaesthetist and the environment and context within which the team attempt to meet the demands placed on them will influence the outcome of patient care.

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The past decade has seen an increased awareness of the contribution of human error to adverse outcomes and critical incidents in clinical practice. The aim of this article is to review some of the ways in which limitations imposed by human physiology and psychology can impact on the performance of the anaesthetist in the clinical environment. If we can better understand what may put our patients at potential risk, can better monitor our own performance and can develop and apply countermeasures, then we can make a stronger contribution to patient safety.

Let us begin with a common clinical scenario. Imagine an anaesthetist managing a patient undergoing an elective laparoscopically assisted hemicolectomy as part of an all-day colorectal surgical list. The patient is middle aged and has some co-morbidity. The anaesthetist is assisted by a trained

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assistant, as per UK practice, and also by a relatively junior anaesthetic trainee. The surgeon is assisted by a surgical trainee, and the full complement of operating room (OR) staff is present.

It may seem an obvious question, but what is the anaesthetist doing? The anaesthetist has seen the patient preoperatively and, on the basis of information acquired and discussion with the patient and surgeon, has decided upon a plan for the perioperative care of the patient. As we join the scenario, the anaesthetist is reviewing the patient and the plan. Various practical procedures will already have been performed.

At this stage in the operation, the anaesthetist is collecting and processing data to build up a model of what is happening. This process is described as situation awareness.<sup>1,2</sup> Situation awareness<sup>2</sup> consists of three components: acquiring information, assimilating the information to create a mental model and then using that mental model to anticipate what may happen. This in turn allows the anaesthetist to make appropriate decisions, such as continuing with the perioperative plan or having to make changes to that plan.

The importance of concentrating on the mental processes rather than the practical ones is because these are particularly vulnerable to disruption from the factors that will be subsequently reviewed.

A useful acronym to explore the role of our anaesthetist in monitoring and reviewing events is the SHEL model.<sup>3</sup> This consists of:

S = Software; that is the various protocols, procedures (including standard operating procedures) that we normally use in our workplace, for example, all patients will be given intravenous antibiotics pre surgical incision;

H = Hardware; the anaesthetic machine, the monitors, infusion pumps, blood warmers, etc;

E = Environment; the workspace, in the case of our example, this refers to the OR but will include and be influenced other clinical areas such as the postoperative recovery area, the wards in which the patients are housed, high-dependency units and so on; and

L = Liveware; especially the personnel, who are working in the theatre area, but also those in other parts of the environment.

Our anaesthetist is interacting not only with each of these components but also with the various interactions between the components; for example, monitoring the interaction between the anaesthetic trainee (L) and the anaesthetic machine (H).

### **Basic physiological limitations**

The information from the different SHEL components is absorbed by our anaesthetist via her senses. The zones within which our senses can normally operate have been well described.<sup>4</sup> For example, we can only perceive electromagnetic radiation (light) within a relatively narrow band of wavelengths. These ranges are well known and are used by the manufacturers of hardware, such as anaesthetic monitors or anaesthetic machines. However, there are occasions when the conditions in the OR change – reduced ambient lighting during laparoscopic surgery, additional noise from drills and other orthopaedic equipment.

Changes in any one individual's senses will be influenced by age and by disease.

### **Human information processing**

This very brief guide will explore the main concepts of perception, memory and decision making, concepts that will be referred to in subsequent sections.

#### *Perception*

This term refers to the sensory input and is influenced by the physiological processes and also expectancy and anticipation. We use the sense of feel and touch to gauge where the epidural needle is in the patient's back. This will be supplemented by other information, such as the appearance of the

patient, to judge how much tissue between the epidermis and ligaments. We anticipate that sense of give that will occur as the needle penetrates the ligamentum flavum. Our brains are not foolproof and, on occasions, we imagine that the information we perceive is what we expect it to be or even want it to be, rather than what it is.

### *Memory*

Memory can be divided into the following categories<sup>5</sup>: short-term, long-term, working and motor memory.

#### *Short-term memory*

This refers to information that is stored for a very short time and can be either transferred to long-term memory or forgotten. Iconic memory, such as that used when looking at monitor displays, utilises image, and information is held in this type of memory for 0.5–1.0 s. Echoic memory forms words from sounds that resemble those associated with the object or action to be named and retains information for 2–8 s. Working short-term memory can retain information for approximately 10–20 s. The maximum number of disassociated items that can normally be retained in the short-term memory is  $7 \pm 2$ .

#### *Long-term memory*

This represents the facility to recall information, which has been stored either by repetition or by constant recall (semantic memory), or by a vivid occurrence (episodic memory). Items that are in long-term memory usually remain, although episodic memory can be affected in amnesia, but may not always be easily recalled. The more recalls that are made the quicker the recalls are made, a fact that is used in some types of training, for example, advanced life support type courses, where both procedural knowledge and psychomotor skills are developed. Continuous recall of specific items or conducting motor tasks with a good level of continuity enhances the ability to remember or carry out the tasks. This is known as ‘continuous activity’ and these tasks or actions are more strongly remembered. By contrast, tasks that require separate responses (serial tasks) are more easily forgotten.

#### *Working memory*

This uses information currently in use. For example, when reading from a checklist, working memory is using information from both short- and long-term memory stores to translate the meaning of words into the necessary cognitive and physical actions. Although short-term memory is normally restricted to recalling between five and nine items, it can be improved by ‘chunking’. This is a method of taking unrelated items or letters and associating them with familiar words or numbers so the words can be remembered. For example, if the four digits of an extension telephone number coincided with the year of birth of one’s partner, then the number would become one item rather than four.

#### *Motor memory*

Motor or skills memory is sometimes referred to as precognitive control. Training improves familiarity and allows skills to be developed and refined so that precise motor actions are performed at the subconscious level.

### *Decision making*

There are three stages to this process<sup>6</sup>: first, evaluation of the situation; second, selecting a choice of action and third, monitoring and reviewing the consequences of the chosen course of action. There are four approaches to generating a course of action. These are as follows.

#### *Creative*

In this approach, a new solution has to be generated because the problem has never presented before. Although this approach may not be very common in anaesthetic practice, most anaesthetists will, at some time, have been presented with a particular set of circumstances – the type of surgical

procedure, characteristics of the patient and possibly the chosen location that will force them to come up with a novel solution.

#### *Making a choice*

In this approach, the anaesthetist has to choose between a set of already existing options. A non-anaesthetic example would be that of buying a new car. The rational prospective buyer will have some sense of what the car is for – young family or single male. The patient in the scenario would have taken part in a discussion about methods of postoperative pain relief.

#### *Rule-based*

In this approach, the choice is usually decided by the set of circumstances, which call for a particular response. For example, during resuscitation of a patient undergoing cardiac arrest, if there is no cardiac output and the heart rhythm is one that should respond to defibrillation, then the choice would be to defibrillate (at the appropriate point in the algorithm).

#### *Recognition-primed decision making*

This approach bypasses conscious input. The anaesthetist responds to a set of cues by acting but he/she may not even be aware that a decision has been made. This is often referred to as 'intuitive decision making'. Such decision making is only possible when the decision maker has significant experience in that field. Recognition-primed decision making (RPD) is more likely under the following circumstances<sup>7</sup>:

- ill-structured problems;
- uncertain, dynamic environments;
- shifting, ill-defined or competing goals;
- time stress;
- high stakes; and
- multiple players.

All clinical anaesthetists will have experienced situations where one or more than these apply.

The creative approach requires a good deal of cognitive effort using a lot of working memory, whereas the RPD approach uses very little short-term memory and, hence, very little cognitive effort.

#### *Cognitive and affective influences*

Croskerry<sup>8</sup> has described a dual-process model of reasoning that can be applied to clinical diagnosis and decision making. One process is largely intuitive and the other is largely analytical. This effectively condenses the 'creative' and 'making a choice' categories into the analytical and condenses the 'rule-based' and 'RPD' into the intuitive. This can be summarised in short as "are you thinking (analytical) or are you blinking?" The term 'blink' is inspired by the book *Blink*,<sup>9</sup> which looks at intuitive processes. Croskerry<sup>10,11</sup> has also described how the way in which the brain is hardwired can lead to errors in decision making in the clinical area. He refers to these as 'cognitive dispositions to respond' when dealing with the model of thought. He has listed many of these, such as 'gambler's fallacy', 'confirmation bias' and 'hindsight bias'.

'Affective dispositions to respond' refer to the way in which our feelings influence our decision making. These feelings may be influenced by many factors, and we shall return to this topic later when exploring the impact of stress and fatigue.

## **Communication**

Collecting and gathering information is the first stage in situation awareness. In the case of the intra-operative management of a patient, this requires interaction with each of the domains of the SHEL model. In this section, the emphasis will be on person-to-person communication (liveware-to-liveware interaction).

The main emphasis on communication in today's medical curricula is on doctor–patient interaction. The Royal College of Physicians and Surgeons of Canada framework of competencies, the Canadian Medical Education Directives for Specialists (CanMEDS) 2005 framework,<sup>12</sup> specifies seven roles of a doctor. These roles include the doctor as a communicator and the doctor as a collaborator. The key competencies for each of these two domains are listed in Table 1.

In a consensus statement of the content of communication curricula for undergraduate medical schools in the UK, the emphasis was also very much on the doctor–patient relationship,<sup>13</sup> with very little on the interaction between doctors and other health-care workers. Although effective anaesthetist–patient relationship is necessary for good clinical practice,<sup>14</sup> the remainder of this section will concentrate upon communication between health-care professionals.

### Background psychology

Communication is the exchange of information, feedback or response, ideas and feelings. It provides knowledge, institutes relationships, establishes predictable behaviour patterns, maintains attention to the task and is a management tool.<sup>15</sup>

Communication can be one way or two way. An example of one-way communication may be a routine letter from management. Within the clinical environment, two-way communication is more relevant. The key difference between one-way and two-way communication is the role of feedback. Feedback enables the sender and receiver to ensure that information has been understood. Three types of feedback exist:

- (1) Informational – the receiver provides an objective statement in response to the initial statement – “Can we send for the next patient?” “Yes, we can.”
- (2) Corrective – the receiver challenges or corrects the sender's message – “Are you sure that we are doing patient number four next?” and
- (3) Reinforcing – the receiver acknowledges clear receipt of the message – “OK, we are agreed that the third patient on the operating list is who we are doing next.”

Feedback should include quantity, quality, relevance and manner.

Communication is not only delivered by the spoken or written word. In a series of experiments conducted in the 1960s, the researchers concluded that a receiver pays attention to the components of the sender's message as follows<sup>16,17</sup>:

- words 7%;
- tone 38%; and
- other non-verbal clues 55%.

**Table 1**  
CanMEDS key competencies for communication and collaboration.<sup>12</sup>

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Communicator – Physicians are able to...

1. Develop rapport, trust and ethical therapeutic relationships with patients and families;
2. Accurately elicit and synthesise relevant information and perspectives of patients and families, colleagues and other professionals;
3. Accurately convey relevant information and explanations to patients and families, colleagues and other professionals;
4. Develop a common understanding on issues, problems and plans with patients and families, colleagues and other professionals to develop a shared plan of care;
5. Convey effective oral and written information about a medical encounter.

Collaborator – Physicians are able to...

1. Participate effectively and appropriately in an interprofessional health-care team;
  2. Effectively work with other health professionals to prevent, negotiate and resolve interprofessional conflict.
-

The implications of this work are that non-verbal signals are important; hence, it is not only what is said but how it is said that is important. Four classes of non-verbal communication are relevant to the workplace:

- facial expression and eye behaviour;
- body movement and gestures;
- touching behaviour; and
- voice characteristics and qualities.

Non-verbal communication also complements verbal communication in five ways:

- (1) repeats what is being said, for example, saying “No” and shaking one’s head;
- (2) adds to or reinforces verbal communication, for example, saying that one is angry while frowning;
- (3) highlights verbal communication by emphasising certain words or phrases, for example, “Are you ‘sure’ that’s right!”;
- (4) contradicts the verbal message, for example, saying “I’m angry with you” while smiling; and
- (5) substitutes for verbal behaviour, for example, shrugging one’s shoulders to indicate that one doesn’t care.

#### *Barriers to communication*

Hazards that have reduced the quality of information reported by the UK Civil Aviation Authority (CAA)<sup>18</sup> include:

- failures during the transmitting process (sending unclear messages);
- difficulties due to the transmission medium – background noise;
- failure during receiving (expectation of another message and disregarding a message);
- failures due to interference between the rational and emotional levels of communication, for example, arguments; and
- physical problems in listening or speaking, for example, impaired hearing and wearing masks.

Barriers can be due to the individual (internal barriers) or due to the environment (external barriers) – see [Table 2](#).

**Table 2**

Internal and external barriers to communication.<sup>15</sup>

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Internal
<ul style="list-style-type: none"> <li>• Language difference</li> <li>• Culture</li> <li>• Motivation</li> <li>• Expectations</li> <li>• Past experiences</li> <li>• Prejudice</li> <li>• Status</li> <li>• Emotions/moods</li> <li>• Deafness</li> <li>• Voice level</li> </ul>
External
<ul style="list-style-type: none"> <li>• Noise</li> <li>• Interference or distraction</li> <li>• Separation in location, time</li> <li>• Lack of visual cues (e.g. body language, gestures, facial expressions)</li> </ul>

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The effects of culture and language on communication were described in a qualitative study looking at consultations between primary care physicians in the UK and patients who were not native English speakers.<sup>19</sup>

The dislocation in time and space occurs with telephone conversations. A qualitative study looking at telephone conversations instigated by junior doctors to more senior colleagues identified the following factors that interfered with communication<sup>20</sup>:

- discursive features – pace, accent, organisation and tone;
- context – may be high priority for caller but not so high a priority for person called, especially if more senior;
- fragmented clinical process – lack of visual cues, lack of gut feeling and not sure whether to trust the information being delivered;
- responsibility – sharing responsibility emerged as a possible source of tension; and
- reason for call – for example, caller may want reassurance but person called may not feel that that is an appropriate reason for making the call.

#### *Strategies for improving communication*

Four aspects of communication have been shown to be effective in improving communication between team members<sup>15</sup>:

- explicitness – for example, spelling out ambiguous terms or using techniques, such as SBAR (Situation, Background, Assessment and Recommendation)<sup>21</sup> to structure the communication content;
- Timing – the sender should be sensitive to other activities; as anaesthetists, we know that there are times when the surgeon is preoccupied and interruption is not good. In a similar vein, there are times (for example, intubation) when we do not want to be interrupted.
- Assertiveness – effects described, such as status differences, can have an impact on communication behaviours.<sup>22</sup> Assertiveness can be described as a balance between being passive (failing to stand up for oneself) and being aggressive (standing up for oneself but ignoring the other person's point of view). Flin et al.<sup>15</sup> provide a list of suggestions for improving one's assertiveness.
- Active Listening – usually about only one-third of what is heard is actively listened to if the listener is interested, less if the listener is not. Techniques and strategies to improve active listening have been described.<sup>15</sup>

Other strategies that can help include briefing and debriefing, which are described in further detail in the chapter 5, which deals with the World Health Organization Safer Surgery programme.

## **Teamworking**

A brief description of some of the key concepts in teamworking will help reveal some of the factors that limit effective team performance. Work has been carried out applying some of the lessons learned from other domains to teams in health care. A review of the literature suggests that there is a need to further develop and validate instruments for team performance assessment and to develop sound theoretical models of team performance in dynamic medical domains, integrating the evidence from the existing studies.<sup>23</sup> With the caveat of those recommendations, we can review some principles of teamwork, which will help put some of the above material on communication into its health-care context. Teams can go wrong because of deficits in the individual or deficits in the team.<sup>24</sup>

### **Deficits in the individual**

Some members may lack individual professional skills (they cannot do the task to which they are assigned), while others may not be good team players because of individual characteristics, such as

self-centredness or excessive perfection. Other factors operating at individual level may relate to other individual characteristics such as:

- not wanting work as part of a team (or not seeing the importance of working as part of a team);
- not wanting to co-operate with someone they dislike;
- trying to solve interpersonal conflicts through the team;
- seeking to use the team for their own interests, such as resolving power issues; and
- not working with full motivation but letting others do the work (“social loafing”).

The above factors emphasise the importance of the instilling the mindset and culture of working in a team into the curricula of health-care professionals, such as ‘Doctor as collaborator’ in the CanMEDS framework.<sup>12</sup>

### **Team deficiencies**

#### *Unclear specification of responsibility*

This is more likely during unstructured situations that are not part of the routine set of activities. Strong leadership is required, and one of the roles of the leader is to assign responsibilities and delegate tasks and communicate that activity in an explicit manner.

#### *Shared misconceptions*

‘Group think’ is a term applied to a team that has suspended rational judgement and each member is carrying out their tasks in an uncritical manner. Members may misinterpret some words or terms, especially when joining as a new team member. One of the functions of the team brief is to help dispel misconceptions and to make clear what is expected and required of each team member.

#### *Development of peer pressure*

Group cohesion is important to the functioning of a team and, hence, dissent and challenge may be seen as a threat to that cohesion. The danger is that the culture of the team becomes one that discourages such activity, and the peer pressure from the majority of team members prevents legitimate enquiry or challenge.

#### *In-group and out-group*

A strong sense of cohesion, allied to effective performance, can result in a strong sense of togetherness that may result in boundaries being set between existing team members and other teams. This can bring about an unhealthy rivalry, especially between subteams, which can lay the seeds for future disruption. The strong sense of togetherness may make it difficult for new team members, or temporary replacement members, to be accepted and, hence, make it difficult to question or challenge existing practices.

#### *Communication style*

This will be influenced by the above factors and by those who lead the team. A team that adopts an open style of communication, where questions can be asked and challenges made can help promote a healthy style of communication that is often more effective at resolving conflicts. A more open style is also more likely to result in a shared understanding of team objectives. Reader et al.<sup>25</sup> describe how, in a survey of intensive therapy unit (ITU) staff, a lack of openness in communication correlated with a poor shared understanding of what treatment objectives were being pursued for the patients. Openness in communication was also more likely to provide social support.

Team function will be influenced by policy within the organisation in terms of the degree of autonomy provided, the consistency of the team (are all staff moved around or do they remain with the same colleagues?) and the way in which the workload is managed (to whom is the team accountable?).

Teams not only have to communicate with each other, they must communicate with other teams and many of the above principles will come into effect during handovers and shared briefings. These topics are dealt with in greater detail in Chapter 7.

### **Prospective memory**

Prospective memory (PM) is defined as a psychological process, which enables humans to execute previously formed intentions during an appropriate but delayed window of opportunity without being explicitly reminded to do so.<sup>26</sup> There are five phases in a full PM cycle:

- (1) in the beginning, the intention is formed and encoded, containing three components: that, what and when;
- (2) during the retention phase, the intention is kept in the memory, more or less consciously;
- (3) the window of opportunity begins and the intention could be executed; the agent must recognise that window of opportunity and must be able to retrieve the intention;
- (4) the execution action, putting the intention into practice is considered a separate phase in the model; and
- (5) finally, the acting person must note whether or not the intention was fulfilled and if yes, then to what extent.

The significance of PM in a discussion of limitations of human performance, especially cognitive limitations, is that, during our normal working day, we engage PM on many occasions, especially when we are involved in part of the care of more than one patient.

Delays and interruptions in the OR arise from task-inherent difficulties (complications) and also the social, technical and organisational environment.<sup>27</sup> The different teams often finish their tasks at different times – the surgeons finish before the scrub team, who finish before the anaesthetic team. As delays and interruptions can interfere with PM, it is clear that this is an area in need of further research in terms of underlying psychological models and the development of effective countermeasures.

### **Stress**

Stress can best be thought of as when the demands placed upon a person outweigh the resources available. The UK Health and Safety Executive (HSE) define stress as “the adverse reaction people have to excessive pressure or other types of demand placed on them.”<sup>28</sup> Chronic stress had been defined as “the persistent negative experience or exposure of threat or excessive demand.” A survey of the European Union member states found that 28% of employees reported stress-related illness or health problems.<sup>29</sup> Six categories of workplace stressors have been identified by the UK HSE<sup>28</sup>:

- (1) job demands: factors include too much or too little time to complete tasks, too little training, the work environment (noisy, hot, shift work, etc.);
- (2) lack of control: high workload, hours, pace of work and nature of activities;
- (3) relationships: especially bullying or harassment;
- (4) change: uncertainty about what is happening, fears about job security and restructuring of the job;
- (5) role: staff feeling that the job requires them to behave in conflicting ways; and
- (6) supervision or managers: lack of support from managers and unrealistic goals.

Added to these factors are difficulties arising from the home/work interface.

Symptoms and effects can be seen both at the individual and organisational level. At the individual level, the effects include an impact on physical health and mental health and the condition of burnout.

At the organisational level, the symptoms are high absenteeism (including sick leave), high turnover of staff and poor quality control.

The above applies mainly to chronic stress. Those working in high-risk settings, such as the acute end of health care, are at risk not only of chronic stressors but can also be subjected to acute stressors that can be brought on by periods of high workload, emergencies, attempts to diagnose unusual problems or high costs of failure (patient death or major morbidity).<sup>29</sup>

The acute stressors are described in three categories:

- (1) Environmental: Fatigue (prolonged work, shift work and loss of sleep); and physical environment;
- (2) Novelty and uncertainty: Unknown condition; expectation violated; critical information missing; multiple goals and/or conflicting goals; and unsuccessful implementation;
- (3) Task related: Performance anxiety (due to safety consequences); high workload; time pressure; personal danger; fear of failure; casualties; and threat.

The effects on the individual include post-traumatic stress disorder; disruption of sleep; and guilt. The symptoms on the team include ineffective decision making; poor teamworking; failures in communication and lack of team cohesion.

The indicators of acute stress can be summarised by the acronym BEST<sup>29</sup>:

B = Behavioural: included are behaviours related to 'fight or flight' such as anger, aggressiveness, irritability and those related to 'freeze' such as switching off (withdrawn), disengagement and apathy;

E = Emotional: included are panic, anxiety and fear of failure;

S = Somatic: included are those associated with 'fight or flight' such as dry mouth, sweating, trembling and butterflies in stomach; and

T = Thinking or cognitive: these are included in Table 3 because they impact so much on communication and teamworking.

Nyssen and colleagues reviewed the literature on stress and burnout in anaesthesia.<sup>30</sup> As with Manser's review of teamwork cited earlier,<sup>23</sup> different definitions and methods were used, thus making comparison difficult. However, the main factors that were identified as causing stress were:

- (1) time constraints;
- (2) excessive (physical and mental) workload;
- (3) complexity of the task;
- (4) responsibility (ethical decisions) and fear of harming patients;
- (5) collective dimension of the job, workplace atmosphere and communication issues;
- (6) lack of job control; and
- (7) combining family with being on call.

**Table 3**

Cognitive indicators of acute stress.<sup>29</sup>

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Impairment of memory
<ul style="list-style-type: none"> <li>• Prone to distraction</li> <li>• Confirmation bias</li> <li>• Information overload</li> <li>• Task shedding (abandonment of certain tasks when it is too difficult to concentrate on all of the tasks)</li> </ul>
Reduced concentration
<ul style="list-style-type: none"> <li>• Difficulty prioritising</li> <li>• Preoccupation with trivia</li> <li>• Perceptual tunnelling (attention becomes narrowly focussed on salient cues)</li> </ul>
Difficulty in decision making
<ul style="list-style-type: none"> <li>• Availability bias (resort to familiar routines and not consider plans that are not immediately available in memory)</li> <li>• 'Stalling thinking' – mind blank</li> </ul>

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It is no surprise that this list coincides with the factors listed for both acute and chronic stressors in general. The actual incidence is difficult to calculate not only because of the methodological considerations but also because many of the studies were surveys relying on self-reporting, those participants who perceived themselves to be at risk may be overrepresented. Incidences of burnout ranging from 26% to 40% in different European countries were reported. However, not all aspects of stress should be seen as negative. Larsson carried out a qualitative study of Swedish anaesthetists<sup>31</sup> and noted five themes:

- (1) anaesthesia is inherently difficult;
- (2) anaesthetists sometimes have to make ethically difficult decisions;
- (3) anaesthetists' work is often difficult and tiresome because of hard working conditions;
- (4) other doctors, especially surgeons, sometimes do not respect anaesthetists; and
- (5) there are no external obstacles to doing a good job.

However, the message that comes across from this study is that the anaesthetists had arrived at a reconciliation of their work with its inherent difficulties and problems. Accessing their coping strategies may be helpful to trainees.

### **Stress and illness**

Physical and mental ill-health has been noted above as being a possible outcome of stress. Doctors, as a group, are not very good at dealing with ill-health. Doctors commonly self-diagnose, self-prescribe and often do not consult another doctor for their medical problems.<sup>32</sup> The matter of substance abuse in anaesthetists has also been reviewed. A considerable association exists between chemical dependence and other psychopathology (whether stress induced or not), and successful treatment for addiction is less likely when co-morbid psychopathology is not treated.<sup>33</sup>

### **Fatigue**

Fatigue is defined as the state of tiredness that is associated with long hours of work, prolonged periods without sleep or requirements to work at times that are out of synch with the body's biological or circadian rhythm.<sup>34</sup>

On average, most humans physiologically need nearly 8 h of sleep per night; although, in modern society, most adults report an average of 7.0–7.5 h. Sleep requirements do not lessen with age but, over the age of 45 years, repaying sleep debt by extending sleep time is more difficult.<sup>35</sup> As little as 2 h of sleep loss can result in impairment of performance and levels of alertness. Sleep loss leads to a longer reaction time, reduced vigilance, cognitive slowing, memory problems, time on task decrements and optimum response decrements. It has also been shown that performance variability increases with sleep loss.<sup>36</sup> It is not necessary to sleep for the exact number of hours in deficit to recover sleep debt. Most people find that a 'catch-up' sleep of one-third of the deficit is sufficient. However, sleep debt can become cumulative, leading to decrement in alertness and performance, if the deficit is not recovered within a reasonable time.<sup>36</sup>

Short-term fatigue is akin to tiredness, whereas chronic fatigue is more difficult to recognise, may be due to a combination of one or more factors (such as high workload, physical or mental illness, etc.) and may be very difficult to recognise and quantify.<sup>36</sup>

The effects of fatigue are summarised in [Table 4](#).

These changes have been demonstrated in anaesthetic practice,<sup>37,38</sup> and official bodies have made recommendations.<sup>35</sup>

### **Personality**

Personality is not strictly a limitation, but can influence how we work under normal conditions and how we deal with stressors. Reeve used a 16-dimension system in the selection of recruits to anaesthesia and, although the numbers were small, the practice showed some useful potential.<sup>39</sup> A very

**Table 4**Summary of the key effects of fatigue.<sup>34</sup>

- 
- (A) Cognitive
- Adverse effect on innovative thinking and flexible decision making
  - Reduced ability to cope with unforeseen rapid changes
  - Less able to adjust plans when new information becomes available
  - Tendency to adopt more rigid thinking and to adopt previous solutions
  - Lower standards of performance become acceptable
- (A) Motor skills
- Less co-ordination
  - Poor timing
- (A) Communication
- Difficulty in finding and delivering the correct word
  - Speech is less expressive
- (A) Social
- Become withdrawn
  - More acceptance of own errors
  - Less tolerant of others
  - Neglect smaller tasks
  - Less likely to converse
  - Increasingly irritable
  - Increasingly distracted by discomfort
- 

recent literature review suggests that 'conscientiousness', one of the 'big five' dimensions, is a good predictor of performance in medical school.<sup>40</sup> Further work is required.

## Health and well-being

The impact of both physical and mental diseases on human performance has been described earlier. A useful mnemonic to check on one's status before embarking upon clinical activity is I'M SAFE<sup>41</sup>:

I = Illness

M = Medications

S = Stress

A = Alcohol

F = Fatigue

E = Emotion

## Conclusions

Let us return to the earlier clinical scenario. If everything goes according to plan and proceeds as normal, then the most likely demands will be from the duration of the procedure and the impact of any lack of food or drink. However, should complications arise, then the mental processes of the anaesthetic team will be under greater demand, and establishing with accuracy what is happening and how best to act will require targeted interaction with the wider OR team, review of available information, search for further information and the need to make decisions. These processes are more at risk during conditions of stress or fatigue due to the impact on working memory and the affective condition of the anaesthetist. Our anaesthetist may be slower to detect new information; may not be as receptive to the interactions of the other OR team members; may not be able to assimilate the available information as well as he/she normally may; may not be able to make the appropriate decisions; and may forget to pass on instructions or requests for other patients on the surgical list. Recognising these states and applying countermeasures such as requesting help, offloading and delegating tasks and making the environment less complicated can offset some of the potential hazards to patient outcome. Greater awareness may help prevent the anaesthetist taking on clinical challenges when inappropriate to do so; may help earlier recognition of abnormal situations; and may reduce the adverse consequences of their impact.

### Practice points

- Although our understanding of the limitations of human performance has developed considerably over recent decades, very little has been applied in a formal way to health care in general and anaesthesia in particular.
- The mental processes of anaesthetists are important for effective patient care. These processes are susceptible to degradation due to a variety of different sources.
- Fatigue, stress and ill-health can impair the key mental processes and result in poor situation awareness and, hence, poor decision making.
- A greater awareness of these factors may help anaesthetists monitor their own performance and the performance of others.

### Research agenda

- There is a need for greater consensus regarding the instruments to be used when measuring stress and burnout.
- Many studies on stress rely on self-reporting. There is a greater need for longitudinal studies to follow cohorts of anaesthetists from recruitment to retirement.
- The theoretical models of anaesthetists and teamwork require further development to allow a more consistent study of the important variables.

### Conflict of interest

None.

### References

1. Fletcher G, Flin R, McGeorge P et al. Anaesthetists' non-technical skills (ANTS): evaluation of a behavioural marker system. *British Journal of Anaesthesia* 2003; **90**(5): 580–588.
2. Fioratou E, Flin R & Glavin R. No simple fix for fixation errors: cognitive processes and their clinical applications. *Anaesthesiology* 2010; **65**(1): 61–69.
3. Molloy GJ & O'Boyle CA. The SHEL model: a useful tool for analyzing and teaching the contribution of human factors to medical error. *Academic Medicine* 2005; **80**(2): 152–155.
4. Coren S, Ward LM & Enns JT. *Sensation and perception*. 4th ed. Fort Worth, TX: Harcourt Brace & Company, 1994. p. 103–251.
5. Campbell RD & Bagshaw M. *Human performance and limitations in aviation*. 3rd ed. Oxford: Blackwell Science, 2002. p. 105–10.
- \*6. Flin R, O'Connor P & Crichton M. *Safety at the sharp end: a guide to non-technical skills*. Aldershot, Hampshire: Ashgate, 2008. p. 41–68.
7. Zsombok CE. Naturalistic decision making: where are we now? In Zsombok CE & Klein G (eds.). *Naturalistic decision making*. Mahwah, NJ: Lawrence Erlbaum Associates, 1997. pp. 3–16.
- \*8. Croskerry P. A universal model of diagnostic reasoning. *Academic Medicine* 2009; **84**(8): 1022–1028.
9. Gladwell M. *Blink: the power of thinking without thinking*. London, England: Penguin, 2005.
- \*10. Croskerry P. The importance of cognitive errors in diagnosis and strategies to minimize them. *Academic Medicine* 2003; **78**(8): 775–780.
11. Croskerry P, Abbas AA & Wu AW. How doctors feel: affective issues in patients' safety. *Lancet* 2008; **372**(9645): 1205–1206.
12. Royal College of Physicians and Surgeons of Canada, <http://www.royalcollege.ca/canmeds>; 2005 [accessed 16.01.11].
13. von Fragstein M, Silverman A, Cushing J et al. UK consensus statement on the content of communication curricula in undergraduate medical education. *Medical Education* 2008; **42**(11): 1100–1107.
- \*14. Cyna AM, Andrew MI & Tan SG. Communication skills for the anaesthetist. *Anaesthesia* 2009; **64**(6): 658–665.
15. Flin R, O'Connor P & Crichton M. *Safety at the sharp end: a guide to non-technical skills*. Aldershot, Hampshire: Ashgate, 2008. p. 69–91.
16. Mehrabian A & Ferris SR. Inference of attitudes from nonverbal communication in two channels. *Journal of Consulting Psychology* 1967; **31**(3): 248–252.
17. Mehrabian A & Wiener M. Decoding of inconsistent communications. *Journal of Personality and Social Psychology* 1967; **6**(1): 109–114.
18. *Civil aviation authority crew resource management (CRM) training*. Hounslow, Middlesex: Civil Aviation Authority, 2006. CAP 737, Appendix 7, p. 3.

19. Roberts C, Moss B, Wass V et al. Misunderstandings: a qualitative study of primary care consultations in multilingual settings, and educational implications. *Medical Education* 2005; **39**(5): 465–475.
20. Wadhwa A & Lingard L. A qualitative study examining tensions in interdoctor telephone consultations. *Medical Education* 2006; **40**(8): 759–767.
21. Leonard M, Graham S & Bonacum D. The human factor: the critical importance of effective teamwork and communication in providing safe care. *Quality and Safety in Health Care* 2004; **13**(Suppl. 1): i85–i90.
- \*22. Edmondson A. Speaking up in the operating room. How team leaders promote learning in interdisciplinary action teams. *Journal of Management Studies* 2003; **40**: 1419–1452.
- \*23. Manser T. Teamwork and patient safety in dynamic domains of healthcare: a review of the literature. *Acta Anaesthesiologica Scandinavica* 2009; **53**(2): 143–151.
- \*24. St. Pierre M, Hofinger G & Buerschaper C. *Crisis management in acute care settings: human factors and team psychology in a high stakes environment*. Heidelberg, Germany: Springer, 2008. p. 131–45.
25. Reader TW, Flin R, Mearns K et al. Interdisciplinary communication in the intensive care unit. *British Journal of Anaesthesia* 2007; **98**(3): 347–352.
- \*26. Dieckmann P, Reddersen S, Wehner T et al. Remembering to do things later and resuming interrupted tasks: prospective memory and patient safety. In Flin R & Mitchell L (eds.). *Safer surgery: analysing behaviour in the operating theatre*. Farnham, England: Ashgate, 2009, pp. 339–352.
27. Healey AN, Undre S & Vincent CA. Defining the technical skills of teamwork in surgery. *Quality and Safety in Health Care* 2006; **15**(4): 231–234.
28. *Health and safety executive stress* 2011, <http://www.hse.gov.uk/stress/standards/index.htm> [accessed 15.01.11].
29. Flin R, O'Connor P & Crichton M. *Safety at the sharp end: a guide to non-technical skills*. Aldershot, Hampshire: Ashgate, 2008. p. 157–90.
- \*30. Nyssen AS & Hansez I. Stress and burnout in anaesthesia. *Current Opinion in Anaesthesiology* 2008; **21**(3): 406–411.
- \*31. Larsson J, Rosenqvist U & Holmstrom I. Enjoying work or burdened by it? How anaesthetists experience and handle difficulties at work: a qualitative study. *British Journal of Anaesthesia* 2007; **99**(4): 493–499.
32. Thistlethwaite J, Quirk F & Evans R. Medical students seeking medical help: a qualitative study. *Medical Teacher* 2010; **32**(2): 164–166.
33. Bryson EO & Silverstein JH. Addiction and substance abuse in anesthesiology. *Anesthesiology* 2008; **109**(5): 905–917.
34. Flin R, O'Connor P & Crichton M. *Safety at the sharp end: a guide to non-technical skills*. Aldershot, Hampshire: Ashgate, 2008. p. 191–214.
35. Association of Anaesthetists of Great Britain and Ireland. *Fatigue and anaesthetists*. London: Association of Anaesthetists of Great Britain and Ireland, 2004.
36. Campbell RD & Bagshaw M. *Human performance and limitations in aviation*. 3rd ed. Oxford: Blackwell Science, 2002. p. 157–77.
37. Griffiths JD, McCutcheon C, Silbert BS et al. A prospective observational study of the effect of night duty on the cognitive function of anaesthetic registrars. *Anaesthesia and Intensive Care* 2006; **34**(5): 621–628.
38. Merry AF & Warman GR. Fatigue and the anaesthetist. *Anaesthesia Intensive Care* 2006; **34**(5): 577–578.
39. Reeve PE, Vickers MD & Horton JN. Selecting anaesthetists: the use of psychological tests and structured interviews. *Journal of the Royal Society of Medicine* 1993; **86**(7): 400–403.
40. Doherty EM & Nugent E. Personality factors and medical training: a review of the literature. *Medical Education* 2011; **45**(2): 132–140.
41. Campbell RD & Bagshaw M. *Human performance and limitations in aviation*. 3rd ed. Oxford: Blackwell Science, 2002. p. 86–98.