Section 1 Generic aspects of complications

Chapter 1

Preventing complications

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'*Primum non nocere*' – first, do no harm

The phrase 'prevention is better than cure' is never more true than when considering complications. A complication in medicine is an additional problem arising after a procedure, treatment or illness. It may be iatrogenic. The prevention of iatrogenic complications is one of the most important considerations for every physician.

Understanding the causes of errors can help to develop error prevention strategy. James Reason proposed the Swiss cheese model to explain failure (Figure 1.1). He said that the majority of accidents could be traced back to one of four main levels: organisation failure, supervision failure, conditions allowing unsafe acts and unsafe acts themselves. Each of these can be seen as a defence layer. Most often there is a sequence of failures leading to the error, and those failures can be active or latent. Healthcare provision is complex. It has a diverse structure and staff mix, with many interconnections that have to adapt and learn from previous events. The Healthcare Error Proliferation Model (HEPM) was designed as an adaption of Reason's seminal work. It takes the complexity of healthcare into consideration when examining the causes of error.

According to the most recent data from the NHS Information Centre, the number of errors are increasing year on year. Between September 2009 and August 2010 there were 17,051,769 finished consultant episodes (FCEs). A finished consultant episode relates to 'a continuous period of admitted patient care under one consultant within one healthcare provider'. Of these 372,786 were due to a complication. Table 1.1 shows the data relating to those FCEs where the primary cause of admission or clinic referral is 'complication of surgical and medical care' (Figures 1.2 and 1.3). The 60 to 79 age group suffered the most complications. Table 1.2 gives a breakdown of the causes of the complications.

This chapter will consider how to prevent complications from occurring in the first instance, and can be considered under two main sub-headings:

- education and training
- departmental and corporate governance.

Education and training

Education

The Royal College of Anaesthetists (RCA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) have led the way in standards and education, and safety,

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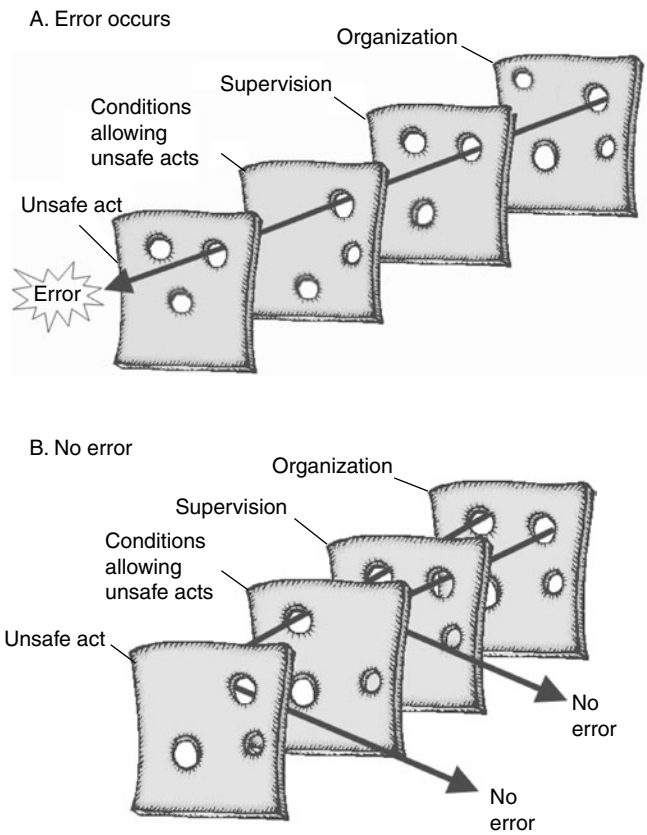

Figure 1.1 The Swiss cheese model shows four levels of failure. If there is a defect in any level (or defence) an error is more likely. If there is a defect in each of these defence levels an error will occur as shown in A.

An example of level 4 failure would be organization failure – cut back on staffing and training levels; supervision failure – consultant surgeon or anaesthetist called away leaving junior inexperienced staff to perform case 'out of hours'; conditions allowing unsafe acts – improper communication about the need to proceed and how long the consultant will be delayed; unsafe acts – junior staff proceed immediately with the case.

In B the error is averted as one of the defence layers remains intact. Using the previous example, it can be seen that if proper communication occurred, i.e. if their consultant gave an accurate time frame for their absence the case could be started later with appropriate supervision; alternatively if the team decided the case was non-urgent it could be postponed, and the error would not occur. The next possibility in the given example is the decision by the team to proceed – any member of the team can take the opportunity to delay or at least call for advice.

respectively. The Postgraduate Medical Education Training Board (PMETB) as part of the General Medical Council (GMC), and now Medical Education of England (MEE), have decided to use a competency-based template to guide doctors in training. Many of these competencies will form part of core transferable modules across specialties. This is the training tool anaesthesia, pain and intensive care medicine are familiar with and have been using for many years. During the 'training years' competency is routinely tested. Competence is less formally assessed once practising independently. This may be addressed by the 360-degree appraisal process. Competence (or lack of competence) can be conscious or unconscious. Individuals who are competent or have a conscious lack of competence are more

Table 1.1 Complications of medical and surgical care. Number of finished consultant episodes where the primary cause is complications of medical and surgical care per 1,000 FCEs (by age group) (adapted from HESonline).

	<16	17–39	40–59	60–79	>80
Sep 2009–Aug 2010	9.7	13.4	24.8	29.6	25.0
Sep 2008–Aug 2009	8.9	12.6	23.2	28.0	23.0
Change (per 1,000)	0.8	0.8	1.6	1.6	2.0

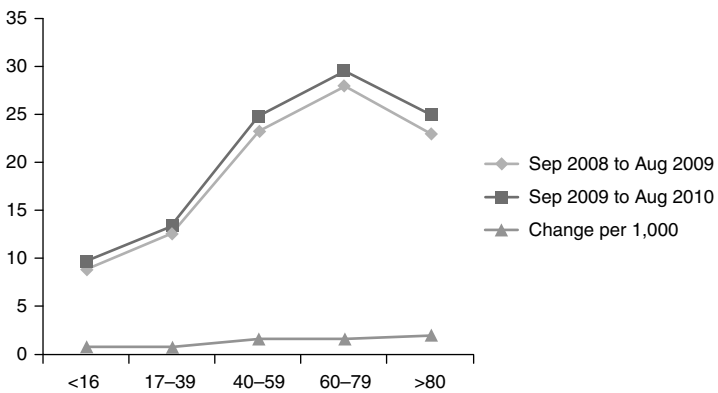

Figure 1.2 Graph to show number of FCEs where the primary cause is complications of medical and surgical care per 1,000 FCEs (*x*-axis: age/years; *y*-axis number per 1,000 cases).

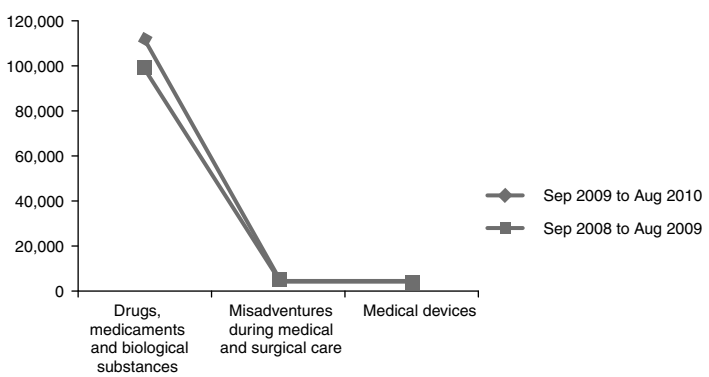

Figure 1.3 Graph to show the primary cause of complication of medical and surgical care (*x*-axis: cause of complication; *y*-axis: number of incidents).

likely to act and prevent a complication than those who are unconscious of their lack of competence (Table 1.3, Figure 1.4).

Knowledge

A clear understanding of human physiology and pharmacology, and the changes that occur under anaesthesia or in particular pathological states is a core requirement for anaesthetists. The planned intervention (e.g. surgery, nerve block, ventilation) should also be considered. This knowledge is tested at postgraduate examination. Detailed knowledge relevant to an individuals' practice is likely to be checked during revalidation.

Table 1.2 Number and causative group for FCEs where the primary cause is complications of medical and surgical care (adapted from HESonline).

	Sep 2009–Aug 2010	Sep 2008–Aug 2009
Drugs, medicaments and biological substances causing adverse events in therapeutic use	111,771 (93%)	99,142 (92%)
Misadventures to patients during surgical and medical care	5,404 (4%)	5,184 (5%)
Medical devices associated with adverse incidents in diagnostic and therapeutic use	3,479 (3%)	3,704 (3%)

Table 1.3 Examples of competence.

	Unconscious	Conscious
Not competent	a person who sees no need to continue to develop and alter their clinical practice according to current evidence/guidance	a person who performs landmark-guided regional anaesthetic blocks may be aware of ultrasound-guided techniques and wish to embark on a course
Competent	a person who performs a task well without having to think about the process required to suceed and may even have difficulty explaining exactly how it was achieved (hand writing)	a person who performs a task well, and is able to replicate the task time and time again. This person will understand the technique, have detailed knowledge and be able to teach others to perform the task (central line insertion)

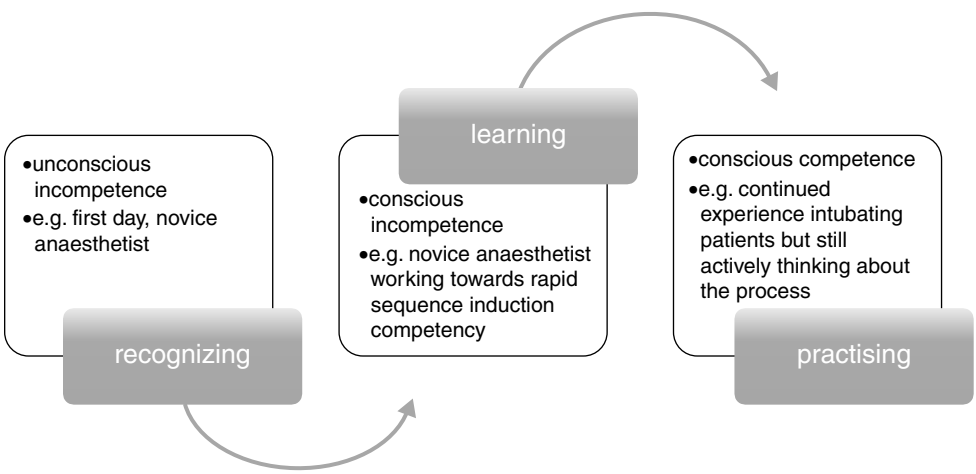

Figure 1.4 The development of competence.

The doctor uses this knowledge to prevent, or at least anticipate and treat, expected complications as they arise. In addition, anaesthetists must be aware of rare or unanticipated complications and prepare strategies to handle them – failed intubation and ventilation, anaphylaxis, malignant hyperthermia. As the clinician becomes more specialized, so the

Table 1.4 Knowledge required to prevent complications.

Types of knowledge
Theoretical
Clinical (including insight into own capabilities)
Environmental – plant and staff
Working of equipment
Available support

Table 1.5 Anticipation of complications.

When are complications more likely to occur?
Tired
Late
Stressed
Task overloaded

knowledge required about specific illnesses increases, for example high-risk obstetrics and cardiothoracic anaesthesia.

Clinical experience complements theoretical knowledge. An awareness of one's own limitations is essential to prevent most complications. Are you able to perform awake intubation or not? Are you aware of the need to be able to perform an awake intubation? Do you need to obtain further training to be able to safely care for your patients?

Good non-technical skills and core clinical knowledge decrease the likelihood of complications. They guide the individual to recognize situations of increased risk and improve resource management. Planning, prioritization and task delegation are just as important to a successful outcome as clinical ability. There are now a number of simulator courses designed specifically to teach non-technical skills; junior doctors are being regularly assessed on them, and they have become part of the medical student curriculum (Table 1.4).

Attitude

The right attitude to work, patient and team is essential. Careful preparation of oneself, the patient and the working environment is important. Knowing when a complication is more likely to happen can also alert you to times of increased risk. This can give the opportunity to delay, or take time to anticipate and prepare. Complications are more likely when you are under time pressure (feeling rushed), when you are task overloaded (supervising more than one operating theatre, have a concurrent non-clinical commitment, in the emergency situation), when you are stressed, when you are tired, when you handover care to another clinician or when you do not have a clear chain of command (tasks become duplicated or are not performed) (Table 1.5).

Behaviour

Individuals may be risk-taking or risk-averse. Human factors training promotes recognition of these intrinsic characteristics, and encourages a change towards risk-averse behaviour.

Maintenance of a logbook can help identify areas of expertise and of deficit. This plays a useful part in directing future training, and can focus discussion during the annual appraisal process to help format an individual development plan.

A professional approach to patients and staff should be maintained. Comments about others' clinical practice must only be given when in receipt of the full facts relating to the clinical incident in question, and only when invited. Comments about patients' illness or treatment plans should not be made in public areas, and notes or data should be stored according to data protection rules. Hospital notes and patient information must not be left in an unsecured area. Complications refer not only to clinical incidents but also to interpretation of those incidents.

If an individual becomes ill they must seek appropriate medical help, report to occupational health and, if necessary, have a risk assessment performed to allow them to either return to work or continue working safely – protecting both themselves and their patients from complications. If you suspect a colleague is ill, you should encourage them to self-report and seek help. If you remain concerned about the effect of ill health on an individual's work performance, you are obliged to report it to your clinical director.

Training and clinical skills

The bulk of training occurs during the foundation and specialist training years, but new skills and knowledge can and should be acquired as a consultant. This should continue throughout a career. Revalidation and recertification will encourage consultants to maintain their breadth of knowledge, and depth, depending on their specialist interest. A learning matrix will guide this. Practitioners should be competent at performing certain tasks (intubation, nerve block, paediatric anaesthesia) and perform them regularly. Learning about the recognized complications and their management (common or serious) is part of task-related training (Table 1.6).

Table 1.6 Foundation and specialist training assessment tools.

Assessment tools for foundation and specialist trainees	Assesses
Mini clinical evaluation exercise (Mini-CEX)	Knowledge, communication and problem solving
Team assessment of behaviours (TAB)	Attitude and behaviour, non-technical skills
Case-based discussion (CBD)	Knowledge, communication and problem solving
Direct observation of procedural skills (DOPS)	Practical and communication skills
Procedural logbook	Clinical case load and experience
Developing the clinical teacher assessment	Teaching, time organization and communication

Safe patient positioning forms part of training. There are cases when the complications of positioning should be discussed with the patient at the pre-operative visit (neuropraxia, visual loss). Attention to detail and knowledge of the potential pitfalls can prevent the complication.

Thorough assessment of the patient guides further pre-operative investigations, e.g. stress echocardiography, coronary angiography, pulmonary function testing. This is best done in

advance of admission. Pre-assessment includes planning for the immediate postoperative period. Postoperative care in an appropriate location should be arranged in advance.

As many hospitals move towards a day of surgery admissions policy, pre-assessment of all patients becomes more important. Most pre-assessment clinics have a nurse-led service. Many are moving towards a consultant anaesthetist dedicated to pre-assessment. Considered anaesthetic management by experienced anaesthetists reduces complications in the high-risk patient.

Departmental and corporate governance

To provide a safe service hospitals need the right direction, the right staff and the right facilities.

Each department must communicate effectively about the services it does or does not offer, and how to access them. New services require careful planning and input from each stakeholder to anticipate and prevent complications. For example, anaesthesia within the radiology department requires input from radiologists and anaesthetists to organize facilities, plant and staff that are acceptable to both parties.

Department responsibility

Each department is responsible for ensuring the correct number of staff and skill mix for the safe running of the theatre suite, pain clinic and intensive care unit. This must include nursing staff (theatre and recovery), ancillary staff, anaesthetic assistance and anaesthetists. Staffing numbers must take annual and study leave into consideration.

Departmental guidelines and protocols should be explained at induction for all new staff and be readily available in all clinical areas. Practices for checking and giving of blood are obligatory.

An induction to the department should include orientation to the working environment. Within theatres the location of the blood fridge, difficult airway trolley, resuscitation trolley, dantrolene, fire extinguishers and fire exits must be demonstrated.

Review of previous complications can help to prevent the same problems recurring. Mortality and morbidity meetings discussing clinical incidents and near-misses can highlight areas of risk, and direct training, guidelines or requests for additional equipment. A robust incident reporting system may identify underperforming individuals, and allow early intervention to prevent complications.

Departmental and individual performance should be monitored and benchmarked. Below-average performance should be investigated. Keeping the use of short-term locums to a minimum can prevent complication. Where locum use is necessary, the locum staff should be given the same induction, and subjected to the same standards (including appraisal) as permanent staff.

Clinical processes need to be clear and uniform throughout the working environment. Checklists have been part of the aviation industry for many decades and are widely recognized as contributing to the safety record of the industry. Other high-risk industries, including healthcare, have sought to use checklists to improve their own safety record.

There has been debate about the similarities between medicine (anaesthesia in particular) and aviation. Pilots use simulation exercises, standard operating procedures and checklists. Simulation can help to prepare for uncommon emergencies, but medical simulation

has, to date, focused on the individual or teams of doctors. Newer courses are available for the whole theatre team.

Doctors (unlike pilots) do not have standard operating procedures, and they have to diagnose whilst making decisions. Standardized procedures for communication and team responses in the emergency situation should decrease complications (e.g. advanced life support protocols, ALS). Each department must ensure their doctors have up-to-date resuscitation training.

SBAR (situation – background – assessment – recommendation) and SHIFT are communication tools that are an example of standardized information handover. They act as an aide memoir to ensure vital patient information is not missed in handover (Table 1.7).

Table 1.7 Handover tools; SBAR (recommended by the NHS Institute for Innovation and Improvement) and the MPS SHIFT model.

S	Situation
B	Background
A	Assessment
R	Recommendations
S	Status of the patient
H	History to this point
I	Investigations pending
F	Fears of what may unfold
T	Treatment planned until care handed back

The Breslow tape and colour-coded, age-specific resuscitation bags are further examples of standard operating tools that serve to prevent complication in paediatric resuscitation.

Healthcare has adopted the checklist for many areas of practice, e.g. hand washing, central line insertion, administering intrathecal drugs. Checklists have been introduced within the perioperative field. A standard method of checking the patient and documentation on the ward, at the entry to the theatre complex, and before induction of anaesthesia may decrease the risk of complication. The World Health Organization (WHO) checklist has been adopted in various forms throughout the UK, and includes a pre-incision and post-operative check. This check includes clear marking of the surgical site on the ward, checking the mark pre-induction and reconfirming the operation before incision. The aim is to prevent wrong-side and incorrect surgery. Checklists can improve team communication but uptake is not universal.

Corporate responsibility

Corporate responsibility includes a hospital induction programme. Each staff member must be given the opportunity to attend. The expectation is that each staff member will attend. It should include manual handling and a fire lecture. There must be a rapid response fire team to arrange and coordinate safe evacuation in the event of an emergency, and a major incident policy. The hospital is also expected to maintain safe staffing levels for the services it provides, according to the departmental recommendations.

Occupational health services must be provided by the hospital to ensure the health of their staff. There must be a needlestick injury policy in place. National standards are adopted and monitored. Control of Substances Hazardous to Health (COSHH) regulations enforce employers to maintain a set standard in the use and disposal of hazardous substances.

The institution must provide diagnostic support for clinical teams (laboratory, radiology and physiological testing). Reliable information technology systems are essential, including training on any IT programs needed during day-to-day activity within the hospital, and support when the systems fail. Clinicians must be able to both order and review routine and emergency tests. In addition the hospital should ensure satisfactory process and engineering backup for equipment, electrical or plant failure.

Corporate expectations and aspirations for service development and delivery must be realistic and achievable, with robust financial and human resource planning. When changes to either plant or process are expected, the corporation is responsible for providing all stakeholders with timely information on the plans and the anticipated time course. A consultation period should follow, and then a response from the hospital. There should also be a business plan detailing projected costs and income. Management must have a strategy for implementing and monitoring change with patient safety at its heart. Cost reduction should not be at the expense of patient safety. Foundation Trusts have a responsibility to maintain financial governance and are overseen by Monitor.

List of further reading

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Section 1 Generic aspects of complications

Chapter 2

Managing complications

Kamen Valchanov and Alistair Steel

History of anaesthesia and complications in context

Anaesthesia dates from prehistoric times in the form of opium, and the first documented recipes are recorded by the ancient Egyptians. The birth of modern anaesthesia is considered to have occurred in 1846 when William Morton publicly administered ether in Massachusetts General Hospital. His first public demonstration of the use of ether was complicated by a failure to induce anaesthesia. Since then anaesthetic practice has vastly expanded and approximately six million anaesthetics are given in the UK each year. Like all areas of life the practice of anaesthesia is also associated with a variety of complications.

A complication is an unfavourable evolution of a disease process or its management.

We perceive anaesthesia and surgery as a safe process. Indeed, mortality related directly to anaesthesia is now estimated to be less than 1 in 250,000. However, despite the improved safety record, complications will inevitably occur in relation to anaesthesia. Some are related to the anaesthesia alone, some related to surgery, but the majority of complications relate to the complex interaction between anaesthesia, surgery, the patient's condition and human factors. In this chapter we will discuss the general principles of managing complications occurring during anaesthesia.

Complications occurring during anaesthesia are often minor but they can lead to serious health problems, disability and death. The ability to competently manage a complication, however minor, can significantly reduce the risk of harm to the patient. The successful management of a complication relies upon the recognition that a complication has occurred, or is occurring, followed by a series of actions requiring knowledge, technical skills and behaviours that mitigate the consequences of the complication.

Importance of managing complications

Complications occurring during anaesthesia can be due to the deterioration of a patient's condition or errors. Errors can involve human factors, equipment problems, medication errors, technical problems or misjudged severity of the patient's condition. The majority of errors in medical practice are due to human factors. They may result from inadequate training and experience, a challenging working environment, poor team-working, stress and fatigue. However, most complications are multifactorial and it is seldom that a complication occurs due to a single factor. In the UK, healthcare organizations are required by law to have implemented processes to reduce the risks to which patients are exposed. The knowledge

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