

Topic 3: Understanding systems and the impact of complexity on patient care

Why systems thinking underpins patient safety

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Health care provision is rarely carried out by single individuals. Safe and effective patient care is, therefore, dependent not only on the knowledge, skills and behaviours of the front line workers, but also how the workers work together in the particular work environment, which itself is usually part of a larger organization. In other words, patients depend on many people doing the right thing at the right time for them: that is, they depend on a “system” of care [1].

Keywords:

System, complex system, high reliability organization (HRO).

Learning objective

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Understand how systems thinking can improve health care and minimize patient adverse events.

Learning outcomes: performance and knowledge

What a student needs to know (knowledge requirements)

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- explain what is meant by the terms “system” and “complex system” as they relate to health care;
- explain why a systems approach to patient safety is superior to the traditional approach.

What a student needs to do (performance requirements)

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Describe the term HRO and the elements of a safe health-care delivery system.

WHAT STUDENTS NEED TO KNOW (KNOWLEDGE REQUIREMENTS)

Explain what is meant by the words “systems” and “complex system” as they relate to health care

What is a system

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The word system is a broad term that is used to describe any collection of two or more interacting parts, or “an interdependent group of items forming a unified whole” [2].

Medical students will be familiar with the concept of systems usually in the context of biological and organic systems. Organic systems cover something as small as a single cell to more complex organisms or whole populations. These systems are in a continuous state of information exchange both internally and externally. The continuous process of inputs, internal transformation, output and feedback is characteristic of these systems. These same characteristics apply to the health system and the multiple systems that make up health care.

When medical students first enter a large hospital they are often overwhelmed by the complexity—the large number of health professionals, the diversity of patients, the different departments, the different smells, the geography and so on. What they are seeing and reacting to is the hospital as a system. It appears chaotic and unpredictable and they wonder how they will ever adapt to the environment. Eventually, they are assigned to different wards and departments and they become familiar with the workings of that particular area or discipline. They forget about the rest of the system.

A *complex* system is one in which there are so many interacting parts that it is difficult, if not impossible, to predict the behaviour of the system based on a knowledge of its component parts [3]. The delivery of health care fits this definition of a complex system, especially in a hospital setting. Hospitals are made up of many interacting parts, including humans (patients and staff), infrastructure, technology and therapeutic agents—the various ways they interact with one another and how they collectively act is highly complex and variable [3].

Health-care professionals need to have an understanding of the nature of complexity in health care, as it is important in preventing hazards from occurring and helpful in terms of analysing when things go wrong. Otherwise, there can be a tendency to blame only the individuals directly involved in a situation, without realizing there are usually many other contributory factors. Health care is complex because of:[3]

- the diversity of tasks involved in the delivery of patient care;
- the diversity of patients, clinicians and other staff;
- the huge number of relationships between patients, carers, health-care providers, support staff, administrators and community members;
- the vulnerability of patients;
- variations in physical layout of clinical environments;
- variability or lack of regulations;
- implementation of new technology;
- increased specialization of health-care professionals—while specialization allows a wider range of patient treatments and services, it also provides more opportunity for things to go wrong and errors to be made.

Students visiting patients on the wards quickly understand that each individual patient requires care and treatment tailored to their specific conditions and circumstances. A student can quickly see that when all the individualized health services are combined they form a system of care.

Many health services present as a system—buildings, people, processes, desks, equipment telephones—yet unless the people understand its purpose and aim it will not operate as a whole unified system. People are the glue that binds and maintains the system.

An understanding of the health system requires students to think beyond the individualized service. For the health system to work effectively, the doctors, nurses and other health professionals need to understand each other's roles and responsibilities. It also requires their understanding about the impact of complexity on patient care and that complex organizations such as health care are prone to errors. Until relatively recently, we viewed the hundreds of services provided to patients as separate distinct services. The work of doctors was separate from the tasks of nurses or physiotherapists. Units and departments were also seen as distinct entities.

If the emergency department was not able to see urgent patients quickly enough, we thought that by fixing the broken bit—the emergency department—without any attention to other services that relate to it then we could solve the problem. Perhaps the emergency department was not able to transfer the patients to the wards in a timely manner because there were no beds to put the patients in. The staff may have had too many conflicting priorities that impeded their abilities to be responsive to patient needs.

Even though health professionals daily confront many challenges in their workplaces and may

even understand the multiple components and relationships that are prone to dysfunctionality, they have difficulty in thinking in terms of systems because, typically, they are not trained to think in the concepts or language of systems theory, nor do they use its tools to make sense of the systems in which they work.

Knowledge about the complexity of health care will enable health-care professionals to understand how the organizational structure and the work processes can contribute to the overall quality of patient care. Much of the knowledge about complex organizations comes from other disciplines such as organizational psychology. The Institute of Medicine report *To err is human* highlighted that organizational processes such as simplification and standardization are recognized safety principles, yet were rarely applied to health-care delivery systems.

Systems thinking helps us make sense of complex organizations by enabling us to look at health care as a whole system with all its complexity and interdependence. It removes the focus from the individual to the organization. It forces us to move away from a blame culture towards a systems approach. Using a system approach, a nurse will be able to tell a doctor that there may be a problem with fulfilling an order immediately because of other competing demands. The doctor and the nurse can then work out a solution to the problem together, thus foreseeing and avoiding a problem later on.

In summary, a systems approach enables us to:

- examine organizational factors that underpin dysfunctional health care and accidents/errors (poor processes, poor designs, poor teamwork, financial restraints and institutional factors) rather than focus on the people who are associated with or blamed for the blunders or negligence;

- move away from blaming to understanding;
- improve the transparency of the processes of care rather than focus solely on the single act of care.

The traditional approach when things go wrong in health care—blame and shame

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In such a complex environment it is no surprise that many things go wrong on a regular basis. When something does go wrong, the traditional approach is to blame the health-care worker most directly involved in the patient care at the time—often the nurse or junior doctor—example, a wrong drug has been administered by a junior nurse or medical student. While the tendency to blame an individual (the “person approach”) [4] is a strong one—and a very natural one—it is unhelpful, and actually counterproductive for a number of reasons. Whatever role that the “blamed” health-care worker may have had in the evolution of the incident, it is very unlikely that their course of action was deliberate in terms of patient harm (if the action was deliberate this is termed a *violation*—see topic 5 “Understanding and learning from errors” and topic 6 “Understanding and managing clinical risk”).

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Most health-care workers involved in an adverse event are very upset by the prospect that their action (or inaction) may have been in some way a contributory episode. The last thing they need is punishment—Wu described the health-care worker as the “second victim” in such circumstances [5]. The natural tendency in such situations is to limit reporting because no one would report future incidents for fear that they would be blamed if anything untoward ever happened. If such a blame “culture” is allowed to persist a health-care organization will have great

difficulty in decreasing the rate of adverse incidents of a similar nature occurring in the future (see topic 5 “Understanding and learning from errors”).

Unfortunately many health-care professionals including senior doctors, nurses and managers share with many in the wider community a different view, one that supports the idea that an individual *should* be “blamed”. This represents a major challenge, especially for junior staff (see introduction to topics).

Introduction

Adopting a system approach to errors and adverse events does not mean that students and health professionals are not professionally responsible for their actions. If a medical student administers the wrong medication to a patient because they failed to follow the protocol for checking medications should they be held accountable? An analysis of this case using a systems approach would examine the factors that contributed to the student not checking the medication. What if the student was new to the ward and was not being supervised, if they did not know the steps involved or that a policy existed to help make sure the correct medication is given to the correct patient, if they were unsure but there was no one around to check and they feared getting into trouble for delaying the administration? Systems thinking would suggest that this student was not prepared for such duties. But if the student was prepared, was being supervised and was aware of the protocols but he did not check the medication because he was lazy or sloppy or wanted to finish work early then he would be responsible for the error. Most circumstances surrounding adverse events are complicated so it is best to use a system approach to understand what happened and why and then make decisions about personal accountability.

Accountability is a professional obligation, and no one thinks that individuals should not be held accountable. However, in addition to personal accountability there is also system accountability. System accountability requires that the system look at itself; for too long the system has passed on mistakes and errors in the system of health care to the individual health-care workers.

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The new approach

Safety experts believe that although it is hard to change aspects of complex systems, it is harder to change the behaviour and thinking processes of human beings in terms of their contributions to errors [4]. Therefore, the main response to an error should be to try to change the system through a “systems approach” [4]. A systems approach to errors in health care, therefore, requires an understanding of the multiple factors that are involved in each of the areas that make up the health-care system. Health-care workers are part of the system, and provide the context in which the humans contribute to a situation. Analyses of accidents in other industries indicate that there is rarely ever one cause of an accident; rather, system failures come from a diffuse range of factors. The intention of a systems approach to incident investigation is to improve the design of the system so as to prevent errors from occurring or to minimize their consequences.

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Reason outlined the many elements of the system that should be considered as part of a “systems-thinking” approach to accident investigation in the following categories [6].

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Patient and provider factors

These are the characteristics of the individuals involved, including the patient. It is important to remember that health-care providers, including

medical students and patients are part of the system. This demonstrates that “systems thinking” does not exclude individual contributions to safety, or a lack thereof.

Task factors

These are characteristics of the tasks or jobs health-care providers perform, including the tasks themselves, as well as characteristics such as workflow, time pressure, job control and workload.

Technology and tool factors

Technology factors refer to quantities and qualities of technologies in the organization. Such factors include the number and types of technologies and their availability, usability, accessibility and location. The design of tools and technologies, including their integration with other technologies, the training of the users, propensity to breakdown or crash, responsiveness and other design characteristics would also be included (see topic 2 “What is human factors and why is it important to patient safety?”).

Team factors

Much of health care is provided by multidisciplinary teams. Factors such as team communication, role clarity and team management have been shown to be important in other industries and are now increasingly being recognized as important in health care [7].

Environmental factors

These are the features of the environment in which health-care providers work. These features include lighting, noise and physical space and layout.

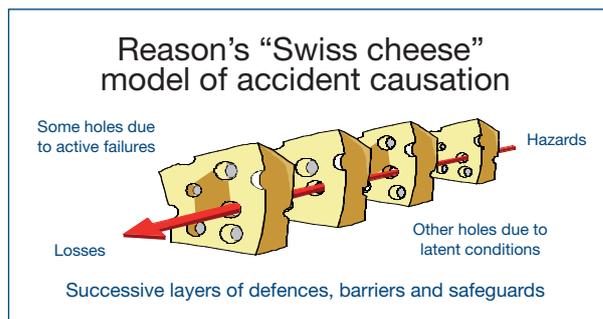
Organizational factors

These are the structural, cultural, and policy-related characteristics of the organization. Examples include leadership characteristics,

culture, regulations and policies, levels of hierarchy and supervisor span of control.

The Swiss cheese model

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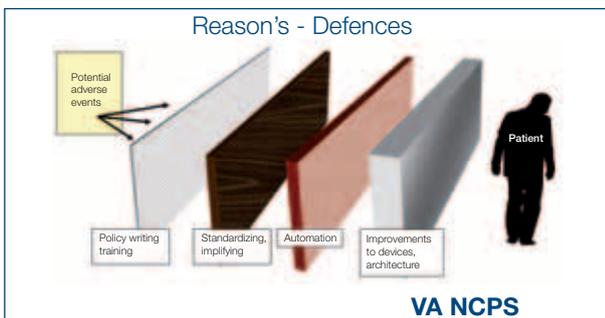
Looking at health care from this broad series of perspectives highlights the multifactorial nature of any single patient safety incident or event. This is why students must carefully guard against jumping to blame someone, and instead consider the systems issues associated with the unwanted event. Usually there are both systems and human issues involved. Reason applied the term “active failures” to any errors made by the workers that have an immediate adverse effect. But he described a second essential precondition for an adverse event to occur, namely the presence of one or more “latent conditions”. Latent conditions are usually the result of poor decision-making, poor design and poor protocols by other humans who do not work at the front line. These conditions are often set in place long before the event in question. Examples of latent conditions for junior medical staff include: fatigue, inadequate staffing levels, faulty equipment and inadequate training and supervision [8].

Reason created the Swiss cheese model to explain how faults in the different layers of the system lead to incidents [4]. The model shows that a fault in one layer of the system of care is usually not enough to cause an accident. Adverse events usually occur when a number of faults occur in a number of layers (for example, fatigued

workers plus inadequate procedures plus faulty equipment) and momentarily line up to permit a “trajectory” of accident opportunity (indicated by the arrow).

To prevent these adverse events occurring, Reason proposed the need for multiple “defences” in the form of successive layers of “protection” (understanding, awareness, alarms and warnings, restoration of systems, safety barriers, containment, elimination, evacuation, escape and rescue) designed to guard against the failure of the underlying layer. The advantage of the systems approach to investigating situations is that this approach considers all the layers to see if there are ways that any of them can be improved.

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WHAT STUDENTS NEED TO DO (PERFORMANCE REQUIREMENTS)

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Describe the term high reliability organization (HRO) and understand the elements of a safe health-care system

The term HRO [9] refers to organizations that operate in hazardous conditions but manage to function at a level of hazard that is almost completely “failure free”—that is they have very few adverse events. These are industries such as air traffic control systems, nuclear power plants and naval aircraft carriers. While there are many differences between these industries and health care, the message for health care is that it is

possible to achieve consistently safe and effective performance despite high levels of complexity and unpredictability in the work environment. HROs demonstrate to health-care organizations that they too can improve safety by focusing on the system.

The differences between HROs and health-care organizations are significant and go to the very heart of the existing problems we have. In health care, we do not routinely think that health care will fail. It is not part of the way of thinking unless it is to do with specific treatments. We do not provide health care being mindful that health professionals might miscommunicate, or that the surgeon may be extremely tired having worked all night or that the doctor’s handwriting was illegible so the student gave the wrong dose. Any one of these may be a factor in an adverse event. Doctors are used to talking about risks to individual patients in relation to knowing side-effects and complications, but they do not apply the same reasoning to the treatment being provided by the people and the system. Systems thinking require that health professionals think about both potential risks: treatment risks and system risks.

HROs are also known for their resilience—they try to pre-empt failures and take steps to prevent them. Patients are the most resilient in our health system and many adverse events are avoided because of the resilience of the patients themselves. They get better not withstanding being given the wrong medication or having the wrong treatment.

We do not yet have a culture of safety in health care. HROs spend a lot of effort, providing incentives and rewards for the workers. People are rewarded in a HRO if they admit a mistake because the admission and the resulting actions to prevent future similar errors save the organization time and money. Imagine a health system where staff could freely admit their

mistakes and we had capacity to put in features and resources that would mean a similar mistake would be prevented or minimized. The adverse event rate would significantly decrease thus saving many lives, reduce suffering and improve staff morale.

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Characteristics of high reliability organizations [9]

High reliability organizations share the following characteristics:

- *preoccupation with failure*: acknowledge and plan for the possibility of “failure” because of the high-risk, error-prone nature of their activities;
- *commitment to resilience*: proactively seek out unexpected threats and contain them before they cause harm;
- *sensitivity to operations*: pay close attention to the issues facing the workers at the frontline;
- *a culture of safety* in which individuals feel comfortable drawing attention to potential hazards or actual failures without fear of criticism from their seniors if they speak up when they uncover a hazard—or even a potential hazard.

Health-care organizations can learn from HROs even though they are different from health care. We can examine their successes and study what factors made them work. We can also learn from their failures—how do disasters occur and what factors are typically present.

Summary

Analysis of adverse events demonstrates that multiple factors are usually involved in their causation. Therefore, a systems approach to considering the situation—as distinct from a person approach—will have a greater chance of setting in place strategies to decrease the likelihood of recurrence.

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CASE STUDIES

A failure to administer preoperative antibiotic prophylaxis in a timely manner according to protocol

This example highlights how system complexities cannot accommodate last minute changes and requests.

The anaesthetist and the surgeon discussed the preoperative antibiotics required for the laparoscopic cholecystectomy that was about to begin. The anaesthetist informed the surgeon of the patient’s allergy to penicillin and the surgeon suggested clindamycin as an alternative preoperative antibiotic. The anaesthetist went into the sterile corridor to retrieve the antibiotics but returned and explained to the circulating nurse that he could not find any suitable antibiotics in the sterile corridor. The circulating nurse got on the phone to request the preoperative antibiotics. The anaesthetist explained that he could not order them because there were no order forms (he looked through a file folder of forms). The circulating nurse confirmed that the requested antibiotics “are coming”.

The surgical incision was performed. Six minutes later the antibiotics were delivered to the OR and immediately injected into the patient. This injection happened after the time of incision, which was counter to protocol that requires antibiotics to be administered prior to the surgical incision in order to avoid surgical site infections.

Case from the WHO Patient Safety Curriculum Guide for Medical Schools working group. Supplied by Lorelei Lingard, University of Toronto, Toronto, Canada.

Wrong substances used in exploratory surgery

This case shows the importance of checking substances at every care episode. The way medications are ordered, stored and delivered to theatres and the method for ensuring correct medications are given to patients involve multiple steps with many opportunities for errors.

Jacqui had an exploratory procedure called an endoscopic retrograde cholangiopancreatography at a large teaching hospital for a suspected disorder of her gallbladder. Under general anaesthetic, an endoscope was inserted into her mouth and was guided through the oesophagus to the duodenum. Cannulas were inserted through the endoscope into the common bile duct and a contrast medium injected so an X-ray could be taken.

Two months later, Jacqui was told she was one of 28 patients who had been injected with contrast medium containing a corrosive substance, phenol. Normally, the pharmacy department ordered 20 ml vials of “Conray 280”. However, for a period of approximately five months they incorrectly ordered and supplied to theatre 5 ml vials of 60% “Conray 280” with 10% phenol in which the label clearly stated “use under strict supervision—caustic substance” and “single dose vial”. A nurse finally picked up the mistake, which had been missed by the pharmacy department and many teams of theatre and surgical staff.

Report on an investigation of incidents in the operating theatre at Canterbury Hospital 8 february-7 June 1999.
<http://www.hccc.nsw.gov.au/downloads/canterbu.pdf>, accessed April 2008.

Chain of errors leading to wrong site surgery

This case raises the latent problems that exist in the system and can result in errors at the sharp end of care.

Neurosurgeon A was performing a craniotomy on a child called Jim. The flap was made on the right side in preparation for the removal of a suspected meningioma. The surgeon paused to recalled the history of the patient. He is puzzled, as he recalls that the meningioma was on the left side, not the right.

The neurosurgeon re-checked the computed axial tomography (CT) scans. The scans showed that the lesion was in the right frontal lobe. The neurosurgeon checked his own notes on Jim, and saw that he has written a diagnosis of a left-sided cerebral lesion. Seeing, however, that the CT scan shows the lesion to be on the right side, he went ahead with the surgery.

To his surprise, there is no evidence of any tumour. The neurosurgeon closed up the flap and sent the boy to recovery. The next day, Jim was sent for a second CT scan. The second set of scans showed that the lesion was indeed on the left, as he had remembered.

The following errors had occurred:

- CT scan had been mislabelled; the marker for “R” (right) had been placed incorrectly;
- mistake made in the booking of the operating theatre, which should have stated the site of the procedure;
- neurosurgeon did not double-check CAT scan and notes prior to surgery.

Reference

Case from the WHO Patient Safety Curriculum Guide for Medical Schools working group.
Supplied by Ranjit De Alwis, International Medical University, Kuala Lumpur, Malaysia.

Miscommunication to a patient about the type of anaesthesia to expect for surgery

This example highlights system complexities that reach outside of the immediate operating room setting and includes communication between individuals not immediately involved in the current surgical procedure, both between and across professions.

A patient arrived in the operating room for an inguinal hernia repair. Although the procedure had been booked as a general anaesthesia case, the anaesthetist discussed a local anaesthetic with the patient. During his pre-operative anaesthesia consultation, it had been established that the patient would receive a local anaesthetic.

When the surgeon entered the room several minutes later, the patient told him that he wanted to have a local anaesthetic. The surgeon examined the hernia and reported that the hernia was too big for a local anaesthetic and would require either a spinal or general anaesthesia. The surgeon was irritated and said that, "if (the anaesthetist who did the pre-op consult) wants to do the procedure under a local that's fine, but I do not". The patient and the anaesthetist discussed the side-effects of a spinal and the patient asked the surgeon which one he would recommend. The surgeon suggested general anaesthesia and the patient agreed to this.

After the patient had been induced and intubated the surgeon asked the anaesthetist to tell the other anaesthetists that they should not speak to patients in pre-admit about local versus general anaesthesia because they had not examined the patient. It has happened three or four times that the pre-admit anaesthetists have told patients something different in their pre-op consult than what the surgeon has recommended. The anaesthetist agreed to speak to his colleagues and the chief of anaesthesia.

Case from the WHO Patient Safety Curriculum Guide for Medical Schools working group. Supplied by Lorelei Lingard, University of Toronto, Toronto, Canada.

TOOLS AND RESOURCES

IHI clinical microsystem assessment tool

Batalden PB et al. *Microsystems in health care: Part 9. Developing small clinical units to attain peak performance*. Joint Commission Journal on Quality and Safety, 29 November 2003, 29(11):575–585 (<http://www.ihl.org/IHI/Topics/Improvement/ImprovementMethods/Tools/ClinicalMicrosystemAssessmentTool.htm>).

Learning to improve complex systems of care

Headrick LA. Learning to improve complex systems of care. In: *Collaborative education to ensure patient safety*. Washington, DC, HRSA/Bureau of Health Professions, 2000, 75–88 (<http://www.ihl.org/NR/rdonlyres/15FB8A41-D6B0-4804-A588-6EC429D326E9/0/final11700version.pdf>).

Organization strategy

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Kohn LT, Corrigan JM, Donaldson MS, eds. *To err is human: building a safer health system*. Washington, DC, Committee on Quality of Health Care in America, Institute of Medicine, National Academy Press, 1999 (<http://psnet.ahrq.gov/resource.aspx?resourceID=1579>).

HOW TO TEACH THIS TOPIC

Teaching strategies



Interactive DVD

WHO *Learning from error* workshop, including intrathecal vincristine DVD, which depicts a case of intrathecal vincristine administration and the systems issues that contributed to the evolution of this incident. The aims of the workshop are: to enhance awareness of the risks of vincristine administration; to develop understanding of the need for a new emphasis on patient safety in hospitals; to equip participants with the skills to contribute to patient safety; and to identify local policies and procedures to make the workplace safer. (This workshop could apply to most of the topics in this Curriculum Guide.)



Lecture on systems and complexity



Small group discussion about the various levels of the “system” in own workplace

- The group could discuss *The wrong patient* article [10] with a tutor.
- Select one of the cases above and discuss using a systems perspective.

Teaching activities

- Follow a patient from the time they enter the service to the time they are discharged and discuss all the steps and types of health-care workers involved.
- Keep a track of the people from the different parts of the health system and discuss their roles and functions in health care.
- Visit unfamiliar parts of the organization.
- Participate or observe a root cause analysis process.

HOW TO ASSESS THIS TOPIC

- Write an account of a patient tracking experience in which a student follows a patient throughout their entire hospital stay.

A range of assessment strategies are suitable for this topic including MCQs, essays, SBA, case-based discussion and self-assessment. Having a student, or a group of students, lead a small group discussion on the various levels of the system in their own workplace is a useful way to elicit understanding.

HOW TO EVALUATE THIS TOPIC

Evaluation is important in reviewing how a teaching session went and how improvements can be made.

References

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Slides for topic 3: Understanding systems and the impact of complexity on patient care

Didactic lectures are not usually the best way to teach students about patient safety. If a lecture is being considered it is a good idea to plan for student interaction and discussion during the lecture. Using a case study is one way to generate group discussion. Another way is to ask the students questions about different aspects of health care that will bring out the issues contained in this topic such as the blame culture, nature of error and how errors are managed in other industries.

The slides for topic 3 are designed to assist the teacher deliver the content of this topic. The slides can be changed to fit the local environment and culture. Teachers do not have to use all of the slides and it is best to tailor the slides to the areas being covered in the teaching session.