Topic 2: What is human factors and why is it important to patient safety?

Why human factors is important

1

Human factors examines the relationship between human beings and the systems with which they interact [1] by focusing on improving efficiency, creativity, productivity and job satisfaction, with the goal of minimizing errors. A failure to apply human factors principles is a key aspect of most adverse events in health care. Therefore, all health-care workers need to have a basic understanding of human factors principles. Health-care workers who do not understand the basics of human factors are like infection control professionals not knowing about microbiology.

Keywords

Human factors, ergonomics, systems, human performance.

Learning objective

Understand human factors and its relationship to patient safety.

2

Learning outcomes: knowledge and performance

What a student needs to know (knowledge requirements):

3

- explain the meaning of the term "human factors";
- explain the relationship between human factors and patient safety.

What a student needs to do (performance requirement):

4

- apply human factors thinking to your work environment.

WHAT STUDENTS NEED TO KNOW (KNOWLEDGE REQUIREMENTS)

The meaning of the terms "human factors" and "ergonomics"

5

The terms human factors and ergonomics (as it is sometimes called) are used to describe interactions between three interrelated aspects: individuals at work, the task at hand and the workplace itself.

Human factors is an established science that uses many disciplines (such as anatomy, physiology, physics and biomechanics) to understand how people perform under different circumstances. We define human factors as: *the study of all the factors that make it easier to do the work in the right way.*

Another definition of human factors is the study of the interrelationship between humans, the tools and equipment they use in the workplace, and the environment in which they work [1].

One can apply Human factors knowledge to wherever humans work. In health care, human factors knowledge can help design processes that make it easier for doctors and nurses to do the job right. Human factors applications are highly relevant to patient safety because embedded in the discipline of human factors engineering are the basic sciences of safety. Human factors can show us how to make sure we use safe prescribing practices, communicate well in teams and hand over information to other health-care professionals. These tasks, once thought to be basic, have become quite complicated as a result of the increasing complexity of health-care services and systems. Much of health care is dependent on the humans—the doctors and nurses—providing the care. Human factors experts believe that mistakes can be reduced by focusing on the health-care providers and studying how they interact with and are part of the environment. Human factors can make it easier for health-care providers to care for patients.

Human factors principles can be adapted to any environment, and industries such as aviation,

manufacturing and the military have applied knowledge of human factors to improve systems and services for many years now [2]. 6

The lessons and examples from other industries show that by using human factors principles we can also improve work processes in health care. For example, the underlying causes of many adverse events relate to the miscommunications and actions of the people in the system. Many people think that communication difficulties among the health-care team relate to the fact that each person has a number of tasks that have to be performed at one time. Human factors engineering research shows that what is important is not the number of tasks but the nature of the tasks being attempted. A doctor may be able to tell a student the steps in a simple operation while he is doing one but if it was a complicated case he may not be able to do that because he has to concentrate. An understanding of human factors and adherence to human factors principles is now fundamental to the discipline of patient safety [3]. 7

Human factors experts help make it easier for the widest range of health-care providers to perform at their best while caring for patients. This is important because the goal of good human factors design is to accommodate all the users in the system. This means not just thinking about design issues as though the task was to be accomplished not only by a calm, rested experienced clinician, but also for an inexperienced health-care worker who might be stressed, fatigued and rushing. 8 9

Human factors experts use evidence-based guidelines and principles to design ways to make it easier to safely and efficiently do things such as: (i) order medications; (ii) hand off (hand over) information; (iii) move patients; and (iv) chart medications and other orders electronically. If these tasks were made easier for the health-care practitioner, then they would be able to provide safer health care. These tasks require design solutions that include software (computer order entry systems), hardware (IV pumps), tools (scalpels, syringes, patient beds) and the physical layout, including lighting of work environments. 10 11

The technological revolution in health care has increased the relevance of human factors in errors because the potential for harm is great when technology is mishandled [3]. 12

In its broadest sense human factors incorporates the human–machine interactions (including equipment design) and human–huzman interactions such as communication, teamwork and organizational culture. Human factors engineering seeks to identify and promote the best fit between people and the world within which they live and work, especially in relation to the technology and physical design features in their work environment. 13

Human factors recognize that the workplace needs to be designed and organized to minimize the likelihood of errors occurring and the impact of errors when they do occur. While we cannot eliminate human fallibility, we can act to moderate and limit the risks. 14 15

Note that human factors is not as *directly* about "humans" as the name might suggest. But it is about understanding human limitations and designing the workplace and the equipment we use to allow for variability in humans and human performance.

Knowing how fatigue, stress, poor communication and inadequate knowledge and skill affect health professionals is important because it helps us understand predisposing characteristics that may be associated with adverse events and errors.

The fundamental basis of human factors relates to the issue of how human beings process information. We acquire information from the world around us, interpret and make sense of it and then respond to it. Errors can occur at each step in this process (see topic 5 on understanding and learning from errors).

Human beings are not machines; machines, when maintained, are on the whole very predictable and reliable. In fact, compared to machines, humans are unpredictable and unreliable, and our ability to process information is limited due to the capacity of our (working) memory. However, human beings are very creative, self-aware, imaginative and flexible in their thinking [4]. 16 17

Human beings are also distractible, which is both a strength and a weakness. Distractibility helps us notice when something unusual is happening. We are very good at recognizing and responding to situations rapidly and adapting to new situations and new information. However, our ability to be distracted also predisposes us to error, because by being distracted we may not pay attention to the most important aspects of a task or situation. Consider a medical student taking blood from a patient. As the student is in the process of cleaning up after taking the blood, a patient in a neighbouring bed calls out for assistance. The student stops what she is doing and goes to help and forgets that the blood tubes are not labelled, which the student forgets when she returns to collect the tubes. Or consider a nurse who is taking a medication order over the telephone and is interrupted by a colleague asking a question; the nurse may mishear or fail to check the medication or dosage as a result of the distraction.

Our brain can also play "tricks" on us by misperceiving the situation and thereby contribute to errors occurring. 18 19 20

The fact that we can misperceive situations despite the best of intentions is one of the main reasons that our decisions and actions can be flawed, resulting in making "silly" mistakes—regardless of experience level, intelligence, motivation or vigilance. In the health-care setting, we describe these situations as errors, which may have consequences for patients. 21 22 23

These are important considerations to recognize because they are reminders that making errors is not so much bad as *inevitable*. In simple terms, error is the downside of having a brain. Reason [4] described "error" as the failure of a planned action to achieve its intended outcome or a deviation between what was actually done and what should have been done. 24 25

The relationship between human factors and patient safety

It is important for all health-care workers to be mindful of situations that increase the likelihood of error for human beings in any situation [5]. This is especially important for medical students and other inexperienced junior staff to be aware of. 26

A number of individual factors impact on human performance thereby predisposing a person to error. 27

Two factors with the most impact are fatigue and stress. There is strong scientific evidence linking fatigue and performance decrement making it a known risk factor in patient safety [6]. Prolonged work has been shown to produce the same deterioration in performance as a person with a blood alcohol level of 0.05 mmol/l, which would make it illegal to drive a car in many countries [7]. 28

The relationship between stress levels and performance has also been confirmed through

research. While high stress is something that everyone can relate to, it is important to recognize that low levels of stress are also counterproductive, as this can lead to boredom and failure to attend to a task with appropriate vigilance. [29]

The aviation industry requires individual pilots to use a number of personal checklists to monitor their performance—an approach that health-care workers could easily emulate. All health-care workers should consider using a series of personal error reduction strategies to ensure that they perform optimally at work. [30]

The acronym IM SAFE (illness, medication, stress, alcohol, fatigue, emotion) that was developed in the aviation industry is useful as a self-assessment technique to determine when entering the workplace each day whether a person is safe for work. [31]

WHAT STUDENTS NEED TO DO (PERFORMANCE REQUIREMENTS)

Apply human factors thinking to your work environment [8]

Medical students are able to apply human factors thinking as soon as they enter a hospital or clinic environment. In addition, the following tips are known to limit the potential errors caused by humans.

Avoid reliance on memory

Success in examinations requires students to remember lots of facts and information. This is fine for exams but when it comes to treating patients, relying solely on memory is dangerous, particularly when the result may be a patient receiving a wrong dosage or drug. Students should look for pictures and diagrams of the steps involved in a treatment process or procedure. Checking one's actions against a picture diagram can reduce the load on the working memory and this frees the student to focus on the tasks in real time such as taking a history or ordering the drugs from the hospital pharmacy.

This is a major reason that protocols are so important in health care—they reduce reliance on memory. On the other hand, having too many protocols is unhelpful, especially if they are not updated in a timely manner. Students should ask about the main protocols used by a ward or clinic so that they are familiar with them. It is important to check when the protocols were last reviewed—finding out more about the process by which protocols are updated reinforces the important point that to be effective, protocol must be a living document.

Make things visible

Students will observe that many wards and clinics have equipment that is necessary in patient treatments—e.g. infusion pumps. Many students will be required to use such equipment. Again, the use of pictures and notices about the steps involved in switching the machine on and off and reading the displays will help the student master the skill. Another good example of making the right thing to do more visible is the use of pictorial reminders to staff and patients about handwashing—this has proven to be effective in improving handwashing compliance and technique.

Review and simplify processes

Simple is better. This statement applies to all walks of life, including health care. Some health-care tasks have become so complicated that they are a recipe for errors—examples include hand-off (or hand-over) and discharge processes. Making handoff simpler by implementing communication strategies that are fewer in number, but more clear in purpose, will reduce errors. Students can help

simplify communication processes by repeating back instructions and ensuring they understand any protocols being instituted. If there is no protocol for handoffs, for example, the student could ask how the health-care professionals ensure their communications are heard correctly and how they are confident the patient has been treated correctly.

Other examples of processes that could be simplified include: (i) limiting the range of drugs available for prescribing; (ii) restricting the number of different dosage preparations of the drugs that are available; and (iii) having inventories of frequently administered drugs.

Standardize common processes and procedures

Even though students will be working in one place (clinic or hospital), they may observe that each department or ward does common things differently. This means that they have to relearn how things are done when moving to each new area. Hospitals that have standardized the way they do things (where appropriate) help staff by reducing their reliance on memory—this also improves efficiency and saves time. Drug order forms, discharge forms, prescribing conventions and types of equipment can all be standardized within a hospital, region or even a whole country.

Routinely use checklists

The use of checklists has been successfully applied in many areas of human endeavour—studying for exams, travelling, shopping and in health care. Checklists are now routine in surgery. Students should get into the habit of using checklists in their practice, particularly when there is an evidenced-based way of implementing a treatment.

Decrease reliance on vigilance

Humans quickly become distracted and bored if there is not much going on. Students should be alert to possible errors when they are involved in lengthy repetitive activities. In such situations, most of us will have decreased attention to the task at hand, particularly if we become tired. Our efforts to stay focused will fail at some point.

Summary

In summary, the lessons from human factors in other industries are relevant to patient safety in all health-care environments—this includes understanding the interaction and interrelationships between humans and the tools and machines they use. Understanding the inevitability of error and the range of human capabilities and responses in any given situation is essential to knowing how application of human factors engineering principles can improve health care. [32] [33] [34]

HOW TO TEACH THIS TOPIC

Teaching strategies/formats

This topic is likely to be very new for most people so it is probably a good idea to teach this as a stand alone topic *in the first instance*. But this topic provides an opportunity for imaginative and creative teaching in the clinical environment and is ideally taught using practical exercises rather than didactic lectures.

Lecture for general introduction

Individual and small group activities:

- practical exercises that explore the human factors considerations of common clinical equipment;
- often good and poor examples of human factors principles can be found in any and every clinical environment.

Examples:

1. Students should be asked to examine medical equipment in various parts of the hospital, e.g. operating theatre, ICU, emergency department. Which environment has the most equipment? What are the hazards associated with having multiple pieces of equipment applied to a patient?

For the various pieces of equipment they discover they should consider:

- How easy is it to find the on/off switch?
- How easy is it for the students to work out how the equipment works?
- Do they observe doctors and nurses struggling to work out how to use the equipment?

2. In terms of alarms:
   - How often do different sorts of equipment alarm?
   - How often are alarms ignored?
   - What happens when the alarm is suspended and is it clear how long it is suspended for?
   - Is silencing the alarm an "automatic" response or is there a systematic approach to finding the cause?
3. Students should consider how the design of infusion pumps is related to safety
   - How easy is it to programme the pump correctly?
   - How many different types of infusion pumps can the students find
     - In the one ward?
     - In the hospital?
     - What hazards are associated with having more than one such device?
4. Design a checklist for undertaking a clinical procedure, e.g. IV cannulation.
5. Use the investigation of an adverse event to review human factors issues (see topic 5 on understanding and learning from errors).

CASE STUDIES

A swab left behind after episiotomy

This case illustrates a failure in checking protocols in theatres.

Sandra, a 28-year-old woman, goes to see her obstetrician complaining of a three-day history of foul-smelling vaginal discharge. Sandra gave birth to a baby boy 10 days earlier. She required an episiotomy during the delivery process. The obstetrician suspects a urine infection and prescribes a five-day course of antibiotics.

Sandra returns to see the obstetrician a week later with the same symptoms. She has completed the course of antibiotics. Vaginal examination reveals tenderness at the episiotomy site and some swelling. The obstetrician goes through Sandra's case notes in detail, looking particularly at the notes relating to the delivery and at the swab count. The count has been documented in the case notes, and verified by a second nurse. A further course of antibiotics is prescribed.

As the symptoms persist, Sandra decides to seek a second opinion and goes to see a different obstetrician. The second obstetrician admits her for an examination under anaesthesia and dilation and curettage (D&C). The obstetrician telephones the first obstetrician of finding a swab left behind during packing of the episiotomy wound and to advise him to inform his professional indemnity insurer.

Reference

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

An unaccounted retractor

This case illustrates the importance of using checklists and listening to patients.

Suzanne's medical history included four caesarean sections in a 10-year period. The second and third operations were held at hospital B and the fourth at hospital C. Two months after her fourth caesarean, Suzanne presented to hospital C suffering from severe anal pain.

A doctor performed an anal dilation under general anaesthesia and retrieved a surgical retractor from the rectum that was 15 cm long by 2 cm wide, with curved ends. It was of a type commonly used by New South Wales hospitals and the engraved initials indicated it came from hospital B. The doctor thought that the retractor had been left inside Suzanne after one of her caesareans and it had worked its way gradually through the peritoneum into the rectum.

During her fourth caesarean, the surgeon noted the presence of gross adhesions, or scarring, to the peritoneum; whereas, no scarring had been seen by the doctor who had performed the third caesarean two years earlier. While it is not known for certain what had occurred, the instrument was most likely to have been left inside Suzanne during her third caesarean and remained there for more than two years.

Reference

Case studies—investigations. Health Care Complaints Commission, New South Wales. *Annual Report 1999–2000*, p. 58.

Tools and resources

Patient safety

National Patient Safety Education Framework, sections 4.2 and 4.5 (http://www.health.gov.au/internet/safety/publishing.nsf/Content/C06811AD746228E9CA2571C600835DBB/$File/framework0705.pdf, accessed May 2008).

Clinical human factors group

(http://www.chfg.org, accessed May 2008).

Medical Simulation Center Rhode Island Hospital

(http://www.lifespan.org/rih/services/simctr/training/materials/, accessed May 2008).

US Department of Veteran affairs

(http://www.va.gov/NCPS/curriculum/HFE/index.html, accessed May 2008).

Toolkit for redesign

Toolkit for Redesign in Health Care. AHRQ Publication No. 05-0108-EF. Rockville, MD, Agency for Healthcare Research and Quality, September 2002 (http://www.ahrq.gov/qual/toolkit/, accessed May 2008).

Device use

Safety Briefing Model, Institute for Healthcare Improvement, Iowa Health System (http://www.ihi.org/IHI/Topics/PatientSafety/MedicationSystems/Tools/DeviceUseSafetyBriefingModelIHS.htm, accessed May 2008).

Mistake-proofing design

Grout J. *Mistake-proofing the design of health care processes.* (Prepared under an IPA with Berry College). AHRQ Publication No. 07-0020. Rockville, MD, Agency for Healthcare Research and Quality, May 2007 (http://www.ahrq.gov/qual/mistakeproof/mistakeproofing.pdf, accessed May 2008).

Inspectors toolkit

Inspectors toolkit: human factors in the management of major accident hazards. Health and Safety Executive, October 2005 (http://www.hse.gov.uk/humanfactors/comah/toolkitintro.pdf, accessed June 2008).

HOW TO ASSESS THIS TOPIC

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 a human factors issue in the clinical area 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. See the Teacher's Guide (Part A) for a summary of important evaluation principles.

References

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6 Flin R, O'Connor P, Crichton M. *Safety at the sharp end: a guide to non-technical skills.* Aldershot, UK, Ashgate Publishing Ltd, 2008.

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SLIDES FOR TOPIC 2: WHAT IS HUMAN FACTORS AND WHY IS IT IMPORTANT TO PATIENT SAFETY?

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.

The slides for topic 2 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.