



The Patient Safety
Education Program™
CANADA

Module 6: Technology:
Impact on Patient Safety

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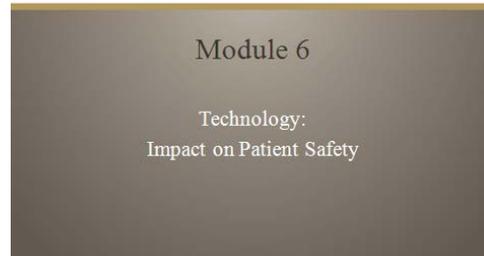
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[Revised 2017]

PSEP – Canada Objectives	Related CPSI Safety Competencies
<p>The knowledge elements include an understanding of:</p> <ul style="list-style-type: none"> • The benefits and risks of technology • How new technologies are regulated • Strategies to improve technology use <p>The performance elements include engaging in exercises to:</p> <ul style="list-style-type: none"> • Provide input during the development and customization of new technologies • Provide feedback on issues that arise during the use of new technologies • Ensure full training in the use of new technologies 	<p>Domain: Work in Teams for Patient Safety</p> <p><i>1. Health care professionals who participate effectively and appropriately in an interprofessional health care team to optimize patient safety are able to:</i></p> <p>1.6. Apply technology appropriately in team safety practices</p> <p>Domain: Communicate Effectively for Patient Safety</p> <p><i>4. Health care professionals who apply communication technologies appropriately and effectively to provide safe patient care:</i></p> <p>4.1. Understand the benefits, limitations and professional care responsibilities of using technologies, such as the Electronic Health Record, the Electronic Medical Record, Computerized Professional Order Entry, the telephone, the fax machine, email and other such technologies</p> <p>4.2. Employ critical thinking tools and structured approaches to communications (e.g., Situation-Background-Assessment-Recommendation [SBAR] and read-back of orders on the telephone) when using technology</p> <p>Domain: Optimize Human and Environmental Factors</p> <p><i>3. Health care professionals who appreciate the impact of the human/technology interface on safe care are able to:</i></p> <p>3.1. Define human factors and human factors engineering and understand their application in health care environments</p> <p>3.2. Describe the role of usability assessment in the safe application of technology</p> <p>3.3. Recognize the importance of ergonomics in safety design</p> <p>3.4. Describe principles of workflow analysis to enhance care</p>

Abstract

Slide 1



Technology, including devices and computer-based software applications, is integral to the delivery of modern healthcare. This module reviews how technology impacts patient safety and focuses on:

- what technologies are used in healthcare and how they are regulated;
- how technology can improve patient safety;
- the pitfalls associated with the use of technology in healthcare; and
- how individuals and organizations can contribute to the successful implementation and use of technology to improve patient safety.

Keywords

Technology, Information System (IS), Health information technology (HIT), EHR (Electronic Health Record), medical devices and equipment, health informatics, regulation, standards, design, implementation, Clinical Decision Support Systems, computerized prescriber order entry systems, software systems and patient safety, electronic health records, unique patient identifiers, event or incident notification systems, obstacles, unintended consequences

Teaching methods

Interactive lecture, case-based teaching

Learning objectives

Slide 2

Knowledge requirements

- Understand:
 - benefits and risks of technology
 - how new technologies are regulated
 - strategies to improve technology use

Slide 3

Performance requirements

- Provide input for development and customization of new technologies
- Provide feedback on issues of new technologies
- Support full training in new technologies

Knowledge requirements

The knowledge elements include an understanding of:

- the benefits and risks of technology;
- how new technologies are regulated; and
- strategies to improve technology use.

Performance requirements

The performance elements include the ability to:

- provide input during the development and customization of new technologies;
- provide feedback on issues that arise during the use of new technologies; and
- support full training in the use of new technologies.

Clinical case on trigger tape

Slide 4

Trigger tape



A nurse is at the medication cart, using a bar-coding device to separate out medications for three different patients. She delivers the medications without checking the patients' wrist bands or identifying the cups. Upon delivery to the third patient, it is brought to her attention that the medication is not the correct one. The nurse realizes that she may have delivered the wrong medications to all three patients.

Introduction

Slide 5

Introduction

- Technology has transformed healthcare delivery
- The use of technology impacts on patient safety
- Regulation, design, implementation and appropriate use of new technologies

Technology has transformed healthcare delivery and now pervades almost all aspects of care. The case to use technology to improve healthcare delivery is compelling and indeed the use of technology is becoming a necessity, as the complexity of healthcare delivery increases to the point that clinicians cannot function optimally without technological assistance.

While there is an exciting wave of applications that are being developed to specifically improve patient safety, the use of any technology in healthcare can impact on patient safety. Factors such as poor design, poor maintenance and implementation, inadequate training, misuse of equipment and over reliance on technology can all result in technology compromising safety.

The focus of this module is on how technology, including devices and computer-based software applications, affects patient safety and how the benefits of new technologies can be maximized through effective regulation, design, implementation and use.

Use of technology in healthcare

Slide 6

Technology in health care

- Use of technology is ubiquitous and includes
 - common desktop applications
 - medical devices and equipment
 - medical system software applications

The growth of technology in healthcare is exponential, and healthcare personnel are increasingly becoming more reliant on technology for their day to day practice.

Technology has traditionally referred to the development of new medical devices and equipment, such as pumps and implants. However, information technologies are increasingly affecting the way healthcare is delivered. In fact, the explosion of information technologies has challenged the definitions of a medical device as many devices cannot function without on-board software applications. Furthermore, a number of “software applications” such as electronic decision support aids can be considered as a device in their own right if they impact directly on the care of a patient.

Common types of technology in healthcare include:

- **common desktop applications**, such as:
 - email;
 - word processors;
 - spreadsheets; and
 - internet-based programs;
- **medical devices and equipment**, such as:
 - imaging technologies such as Positron Emission Tomography (PET), Computerized Tomography (CT), digital radiology and remote cameras;
 - advanced surgical applications such as robotic surgery;
 - monitoring devices such as blood sugar and falls monitors;
 - automated devices such as bed lifts and sterilization equipment; and
 - implants, such as pacemakers and prosthetic joints; and
- **medical system software applications**, such as:
 - electronic health records;
 - event notification systems;

- practice management software;
- digital image repositories and distribution software; and
- information technology (IT), such as electronic reminders, electronic clinical decision support aids and electronic medication ordering systems.

A number of these applications will be looked at in more detail later in the module.

Regulation and standardization of technology in healthcare

Slide 7

Regulation of technology

- Development of new devices and equipment regulated by Standards Council of Canada (SCC)
- Some IT systems, such as electronic health records, computerized provider order entry, and electronic medication administration records (eMAR) are still not subject to these regulations.

According to Health Canada, the term Medical Devices is defined per the *Food and Drugs Act* and covers a wide range of health or medical instruments used in the treatment, mitigation, diagnosis or prevention of a disease or abnormal physical condition. Health Canada reviews medical devices to assess their safety, effectiveness and quality before being authorized for sale in Canada. The Medical Devices Program is managed through the Drugs and Health Products Branch of Health Canada.

Central to ensuring that new technologies do not compromise patient safety is an effective regulatory system for testing new products prior to broad release and the development of standards to support interoperability of systems. In Canada, the Standards Council of Canada ([SCC](#)) regulates the development and release of medical devices and equipment.

Even though regulations are increasingly covering software applications that are either a component of a device or a standalone, some Information Technology (IT), such as electronic health records, computerized provider order entry, and electronic medication administration records (eMAR) are still not subject to these regulations.

How can technology enhance patient safety?

Slide 8

Enhancing patient safety

- New patient safety technologies
 - devices and equipment
 - “smart” pumps
 - automated dispensing cabinets
 - software systems
 - computerized care documentation
 - clinical decision support systems

Many new medical devices, pieces of equipment and IT systems have been developed with the aim of improving patient safety. New technologies can reduce patient safety incidents through good design, facilitating a response should an incident occur, and providing feedback after an event. They can operate at the level of the individual clinician delivering care, or at a systems level aggregating patient data or providing access to information surrounding an incident.

While the following section provides a brief outline of how some of these technologies can improve patient safety, it must be noted that research on the impact of technology on patient safety incidents and patient outcomes has been limited to date, and has often focused on the assessment of locally developed applications. More research and evaluation of commercial and large scale applications is required.

The Canadian Agency for Drugs and Technologies in Health ([CADTH](#)) provides decision-makers with the evidence, analysis, advice, and recommendations they require to make informed decisions in health care. Funded by Canada’s federal, provincial, and territorial governments, CADTH is an independent, not-for-profit agency that delivers timely, evidence-based information to health care leaders about the effectiveness and efficiency of health technologies.

Other resources for health information technology research and development projects can be found from sites such as the [AHRQ National Resource Center for Health Information Technology](#) and [Canada Health Infoway](#).

Devices and equipment

Medical devices and equipment designed to improve patient safety are commonplace and range from relatively simple items such as single use instruments to complex automated systems and software applications. Here are a few examples of new technologies designed to improve patient safety.

“Smart” pumps

“Smart pumps” are infusion pumps with dose calculation software that are designed to identify and correct pump-programming errors. When error occurs with incorrectly programming IV pumps, especially with high-hazard drugs, it can result in serious adverse drug events because there is little ability to correct the error before the drug reaches the patient. Smart pumps allow clinicians to pre-program standard concentrations and upper and lower dose limits for a variety of drugs. These pumps are programmed to warn the administering healthcare provider if the dose is too high, and record what happens if the dose is overridden.

In the first large trial of this technology conducted by Rothschild et al. (2005), smart pumps did not significantly reduce the overall rate of serious medication errors. The findings indicated that a significant number of errors were due to healthcare providers bypassing the drug database or overriding alerts. Further refinement and consideration of human performance may be needed to show the true impact of this technology in reducing serious medication errors.

Automated dispensing cabinets

Automated dispensing cabinets are computerized point-of-use management systems for medications and supplies. These systems are storage devices that electronically dispense medications and supplies at the point of use in a controlled fashion and track their use. Most systems require user identifiers and passwords, and internal electronic devices track healthcare providers accessing the system, track the patients for whom medications or supplies are given.

Despite their intended design, the use of automated dispensing cabinets may still result in the occurrence of patient safety incidents. In 2006, an error in filling a unit-based automated dispensing cabinet resulted in the deaths of three premature infants in an Indiana hospital. The incident occurred after a pharmacy technician delivered adult-strength heparin vials (1-mL vials of 10,000 units/mL) to a neonatal intensive-care unit (1-mL vials of 10 units/mL is the typical infant strength). The nurses on the unit did not notice the difference in label color and used the incorrect strength to flush umbilical lines, leading to a 1,000-fold overdose (Institute for Safe Medication Practices, September 2006). To avoid the potential of these types of patient safety incidents, there needs to be a double-check and triple-check system involving the nurses and pharmacists during the medication restocking and administering process. Special attention needs to be paid to cabinets that are used for neonates and pediatric patients, since these are especially high-risk patients. Automated dispensing cabinets coupled with bar-code systems can provide an additional barrier to medication error.

Bar code technology

Bar code technology is intended for assisting medication administration. The bar codes placed on unit doses of medications include information on the patient's name, drug, dose, route, and time of administration. Bar code scanners, which are placed in the patient's room, are linked to computerized databases containing the patient's drug regimen. The database may be cross-linked to other health information systems, such as a patient identification master file, an electronic medication administration record, an order entry system, and a pharmacy database. The nurse scans the bar code on the medication package and the patient's identification wristband, allowing the system to determine whether there is a match. Following a confirmation signal, the nurse administers the medication. If there is an alert, the nurse stops the process from going forward, preventing a potential medication error.

The Institute for Safe Medication Practices (ISMP) Canada collaborated with the Canadian Patient Safety Institute and other partners to reach a national consensus on using GS1 global bar codes as the standard format for labelling medication packages throughout the Canadian healthcare system. (ISMP Canada, 2013). This practice allows pharmaceutical products to be tracked through the supply chain until they are administered to the patient.

While bar code technology has been credited with a significant reduction in medication administration errors, Patterson et al. found that some medical professionals had problems with the technology. They cited system-imposed performance pressure and technology-imposed, time-wasting annoyances as their primary complaints. Some nurses felt that the computer system's demands forced them to focus on pill-pushing. If medications were not given on time, nurses had to take time out to tell the system why. Many feared this could result in poor performance evaluations. Nurses quickly learned shortcuts around the appropriate use of bar codes to save time, which in turn undermined safety. For example, if a patient's bar code didn't scan correctly on the first try, nurses often entered the seven-digit bar code number manually rather than rescanning it. Some physicians and pharmacists did not accept the bar code technology and simply opted to evaluate medication orders less frequently. Furthermore, there were some incidents in which the bar code system deleted medication orders if medications were not dispensed within a specific time window. Proper training and system upgrades are needed to solve many of these problems and to overcome the fear of using the technology in clinical settings. In addition, workflow should be adjusted to allow nurses a more reasonable medication dose-due-time window.

Software systems

As opposed to IT applications or devices designed to support the clinician at the point of care delivery, a number of large scale software systems are also under development to improve patient safety. These systems are involved with gathering, storing, aggregating

and reporting health information on the patient and potential patient safety incidents. Successful deployment of IT will depend on how well the technology fits into the current workflow. Improper fit of technology to work environment can cause disruptions and delays in the care process, unnecessary work duplication, and even introduce new errors attributable to the human interaction with computer systems. (see PESP – Canada Module 2: Human Factors Design: Applications for Healthcare). Furthermore, there are additional legal concerns that need to be addressed associated with the exchange of sensitive health data (see PSEP – Canada Plenary 2: External Influence: Issues of Law, Capacity & Policy).

The following are some common software system examples.

Computerized care documentation

Computerized documentation of care allows the healthcare team to directly enter information about service delivered into patient charts via a computer. To automate and streamline documentation, these systems provide document templates, copy-and-paste functions, and automated insertion of clinical data. The key advantage is that direct entry of care information can occur from anywhere within a healthcare system and the information is available real-time in all locations with access to the computer-based health record. For example, if a nurse completes an electronic form for fall risks during an assessment, a protocol of care can be immediately triggered and delivered to the multidisciplinary care team elsewhere in the health clinic. By design, computerized care documentation can increase efficiency by eliminating redundant charting, make communication and care coordination seamless, and make data available anywhere within the site of care. In addition, quality of care can be improved by programming prompts into the computerized system and advanced systems can incorporate decision aids.

Clinical Decision Support Systems

Computerized Clinical Decision Support Systems (CDSSs) are IT applications designed to improve clinical decision making, increase coordination between practitioners and promote the use of guidelines. CDSSs match patient characteristics against a knowledge base and computer algorithms then generate patient management recommendations.

The development of CDSSs is rapidly evolving and systems have been developed for many clinical situations including diagnosis of chest pain, assessment of abdominal pain, appropriate prescription and timely administration of immunizations. It is likely that the benefits of CDSSs will increase as more sophisticated computer algorithms and neural networks are developed.

While there are studies that indicate improvements in practice such as reduced drug dosage error associated with use of CDSSs, the effects of CDSSs on patient outcomes remain understudied and when studied, findings are inconsistent – especially in relation

to demonstrated improvements in patient outcomes. Common features of CDSSs that have been demonstrated to improve practice include: automatic provision of decision support as part of clinician workflow; provision of recommendations rather than just assessments; and provision of decision support at time and location of decision making. A number of studies have found that physicians wanted to continue working with CDSSs once such tools were in place in their units. In systematic reviews, “homegrown” systems, rather than “off-the-shelf” products, produce the largest improvements.

Computerized Prescriber Order Entry

Computerized prescriber order entry (CPOE) is a computer-based system that allows direct entry of medical orders by a physician, nurse practitioner or healthcare provider. Directly entering orders into a computer can reduce errors associated with hand-written orders. CPOE may be implemented in combination with other clinical decision support tools, thus minimizing the potential for patient safety incidents and improving healthcare quality and efficiency. CPOE has yet to be widely implemented, in part because of its perceived difficulty to implement successfully.

Electronic health records (EHR)

Slide 9

Electronic health records (EHR)

- Use of electronic patient records to improve patient safety:
 - increases accurate information
 - reduces lost patient information
 - reduces errors associated with poor handwriting



Storing health records electronically can improve patient safety through improving communication across the patient journey (such as reduced adverse drug interactions), reducing the loss of patient information, and removing errors associated with translation factors (such as poor handwriting). As well, Wang et al. (2003), found that EHRs provided a net benefit of \$86,400 per physician over five years due to improving the process for drug expenditures, improved utilization of testing and improved billing practices.

The National Physician Survey in 2014 found that 79% of Canadian Physician respondents currently use some form of electronic records in their practice, with only 21% exclusively using paper-based charts. The use of electronic charts was greatest among the youngest cohort of physician respondents (<35 years of age) and there was a trend of decreasing use among older physician respondents. Tertiary hospital-based systems have lagged behind in terms of the implementation of effective systems.

There are challenges with the implementation of electronic medical records and unique patient identifiers. Some of the reasons for this are below.

- For maximum impact records should be transportable across jurisdictions and between healthcare providers and this presents considerable challenges in terms of common standards and interoperability. In Canada, Canada Health Infoway has created a technology framework that is helping to guide the sustainable development of interoperable Electronic Health Record systems across Canada.
- There is debate regarding what information should be stored on such records and consumers continue to have concerns regarding the misuse of electronic health records and the compulsory implementation of such systems. There is an increasing focus on Personal Health Records where patients can control the information stored on their record.
- Significant challenges exist around converting existing paper-based records into electronic records.
- User habits such as “cutting and pasting” can reduce information relevance and accuracy.
- In a survey of accountable care organizations, two of the top three barriers to using health information technology were financial, with #2 being cost and #3 being lack of funding (Premier, 2014).

Incident notification systems

Slide 10

Incident notification systems

- Gathering data on patient safety incidents assists in preventing future events
- Legislation protects QI information, deliberations, records and documents from being disclosed in legal proceedings

Patient safety incidents occur despite the dedication, training and professionalism of healthcare providers. Obtaining information regarding how many incidents are occurring, where they are occurring and how they are occurring is vital if the incidents are to be prevented in the future. A number of incident notification systems are in use around the world and the identification and reporting of patient safety incidents has correspondingly increased. In Canada, a growing number of healthcare organizations and in some cases provinces have adopted electronic notification systems.

Once notified, organizations have a responsibility to follow up through analysis of the incident. Unfortunately, a perceived barrier for the analysis of incidents has been the

protection of opinions during the analysis process. To mitigate this, legislation in each Canadian province and territory has been enacted to protect quality improvement information, deliberations, some records and documents from being disclosed in legal proceedings. While facts cannot generally be protected, the opinions generated during analysis regarding system issues can be protected.

Sharing Public Sector Information through a process of aggregation within the organization is helpful when trying to understand patterns related to patient safety. Sharing post analysis information about individual event analysis can be challenging but many healthcare organizations in Canada are beginning to do so through a process de-identifying the story and including the lessons learned within and external to their organizations. Both methods, pattern recognition and storytelling are compelling ways to make excellent use of a notification system. As well, aggregating data and increasing the timeliness of data dissemination, facilitated by electronic systems, can allow a more detailed review by a quality improvement program, of staff who were involved in the case.

Obstacles to introducing technology to improve patient safety

Slide 11

Obstacles to technology ...

- Access to budget and resources
- Resistance from clinical staff
- Lack of evidence
- Lack of IT resources
- High turnover rate
- Resistance from organizational leadership

While the arguments for introducing new technologies to improve patient safety are becoming increasingly compelling, there are a number of obstacles and challenges to introducing new technologies, particularly in the case of new IT applications and systems.

Access to budget and capital resources to introduce major initiatives

The costs involved in introducing commercial IT patient safety systems can be prohibitive for all but the largest organizations. There are a number of vendors offering similar products and choosing the right system can be challenging. No single vendor is yet dominant in the marketplace and this gives rise to issues around compatibility between systems and long term support.

Resistance from clinical staff to new technologies

Lack of safety prioritization in the work culture of an organization and/or appropriate skepticism can lead to resistance from clinicians and administrators towards new technologies – especially IT-based innovations. The mistrust is further fueled by recent high profile failures of IT systems. As discussed in the next section, great care must be taken in the design, development and implementation of new systems to ensure uptake of the systems by clinical staff.

Lack of fit with workflow

Inadequate integration of newly implemented technology into the workflow can cause disruptions and delays, inefficient use of resources, unnecessary task duplication, and can introduce new incidents resulting from the complexity of human interaction with computer systems. Technologies need to be redesigned to accommodate the cognitive and workflow demands of care processes and the larger context of the work setting, without imposing unnecessary complexity or increasing the cognitive effort of clinicians required for device interaction in clinical decision-making and care delivery. Designing complex technologies requires an understanding of human actions and their contribution to incidents in order to support user tasks in complex healthcare systems.

Lack of safety evidence

As mentioned previously, although evidence is growing that technology can improve patient safety and many devices are improving care practices, few studies have demonstrated major improvements in patient outcomes from the introduction of IT-based applications. There needs to be considerably more research into the effectiveness of large commercial applications.

Lack of IT staff resources

Implementing and managing new IT systems requires significant and ongoing investment of time and resources devoted to the IT staff. This can be especially challenging for many organizations with limited resources.

High turnover rate

Some technologies can be quite complex and require learning and practice over time to gain proficiency in use. High turnover rates in clinical and administrative staff will result in few personnel who truly understand the proper use of the technology. That in turn can lead to misuse and to patient safety incidents. Because information technology, in particular, is only as useful as the data that the system contains, proper staff training and low turnover rate are essential for successful implementation. Organizations that have high levels of staff turnover will have problems making the technology work for them.

Resistance from facility’s executive and organizational leadership

The costs, uncertainty around effectiveness and resistance from senior staff can all result in resistance from the senior management of facilities towards introducing new technologies. While this reticence can be helpful in ensuring the organization does not jump too early into using new unproven technologies, it can also result in delaying the implementation of new technologies that will benefit patient care.

Slide 12

... Obstacles to technology

- Lack of common terminology
- Usability testing issues
 - paradox of expertise
 - paradox of preference vs performance
 - paradox of choice



Lack of common terminology

Even if the technology excels at recoding and transmitting data effectively, there is still the human component that can cause an issue. Clinicians from different regions of the country can develop different terminologies for referring to problems reported by patients, which is something that basic technologies may not account for.

Usability testing issues

Usability testing allows for the identification and mitigation of issues that arise with the design and use of medical technology. The test results, however, can be paradoxical and therefore be misinterpreted, limiting their usefulness. A paper published by the University of Toronto and the University Health Network (UHN) found paradoxical results with usability testing done, some of which could lead to misinterpreting the results or reaching false conclusions (Morita and Cafazzo, 2016). There were three key paradoxes of testing technology that were explored by the report: expertise, preference versus performance, and choice.

Paradox of expertise

The report found that there were dramatic inconsistencies between the way an expert would describe a task performed to those developing the technology and the way that the expert would actually perform the task. The expert would have cognitive shortcuts that he or she was unaware of, taking information for granted that would not be obvious to

observers. Experts also tend to be set in their ways, resulting in a resistance to innovation that may ultimately be more efficient.

Paradox of preference versus performance

The general expectation for health technology is that the user will prefer the technology that allows them to perform the best during usability testing. However, Nielsen and Levy found several instances of people preferring the devices where they performed worse due to issues such as aesthetic that are independent of the device's functionality or efficiency (Nielsen and Levy, 1994).

Paradox of choice

There are many studies regarding the indecision caused by having too many choices. When applied to health technology, too many choices or options on an interface results in visual noise that can problems with errors, efficiency, and the overall user experience, particularly in any high-volume environment.

How can technology compromise patient safety?

Slide 13

Compromising patient safety

- Factors that compromise patient safety:
 - poor design
 - poor implementation
 - lack of integration into workflows
 - lack of maturity of technology
 - lack of compliance with standards
 - lack of standardized equipment
 - over-reliance on technology

As well as enhancing patient safety, technology has also been associated with unintended consequences that compromise patient safety. This is particularly the case with IT systems where the effects of introducing such systems are hard to predict and there are often no precedents. Nanji et al's 2014 qualitative study of patient safety concerns with electronic prescribing systems identified 26 unintended consequences that were grouped under the themes of communication, workflow disruption, cost, technology, and opportunity for new errors. Graber et al (2015) found 248 cases of malpractice suits and claims that were associated with health IT. The four common issues were: hybrid systems and EHR conversions, delayed, missing or incorrect data, services or actions, over-reliance on EHR and risks using copy/paste function, overriding alerts and using workarounds.

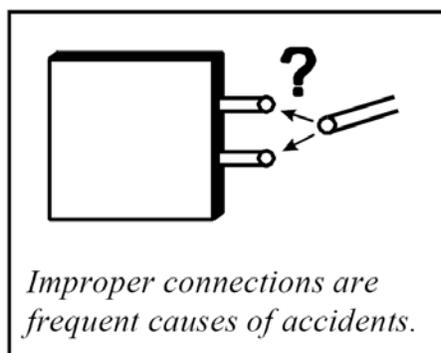
Poor design

Poor design of technology can result in unintentional misuse of equipment that can compromise patient safety (for an example of latent conditions causing active errors, see PSEP – Canada Module 1: Systems Thinking: Moving Beyond Blame to Safety).

Technology implementations often fail due to the failure to acknowledge the importance of human-technological interfaces and the human factors that surround this interface. Human factors and patient safety are discussed in detail in PSEP – Canada Module 2: Human Factors Design: Applications for Healthcare.

For example, Figure 1 demonstrates a tubing connection where two similar outlets are poorly identified. Equipment using cables, tubing, connectors, etc., should be designed to either not allow improper connections or make them readily obvious.

Figure 1: Poorly Designed Connector (Sawyer, 1996)



Poor implementation

Many technology implementations fail due to poor implementation. This includes:

- implementing systems without prior and adequate consultation with clinical staff;
- inadequately customizing a new technology to the workplace;
- not providing adequate training of end users; and
- not phasing in major new initiatives over a period of time.

Lack of integration into workflows

Any technology must be designed and customized to integrate into clinical workflows of the organization and end users or it will not be used or not used appropriately.

Lack of maturity of technology

While technology has great promise for improving patient safety, many IT-based technologies are still maturing. Over-enthusiastic release of technologies prior to them reaching the required level of sophistication to be useful can reinforce negative feelings towards technology and cause unintended incidents. That being said, it has to be

acknowledged that no technology can mature without being first tested in a real-world environment.

Lack of compliance to standards

Systems that are developed in isolation from emerging standards inhibit the sharing of aggregate data and comparisons between organizations. This is particularly the case with applications such as electronic medical records and event notification systems.

Lack of standardized equipment

Other industries have long understood the human factor challenges associated with not standardizing equipment use within an organization. Multiple variations on a given machine such as a perfusion pump increase the risk for incorrect usage.

Improper reliance on technology

Reduced clinical judgment and over reliance on any IT-based system can result in patient safety incidents. For example, incorrect default values for doses or routes in a CPOE system may produce erroneous orders because clinicians tend to trust the suggestions of computers, even if the suggestions contradict their clinical judgment.

In addition, improper reliance on IT can also unnecessarily reduce or compromise face-to-face interactions and teamwork – both of which are acknowledged as being vital in preventing patient safety incidents. For example, it has been suggested that electronic medical records could benefit from voice recordings and narrative data as well as purely factual information to acknowledge that communication around patients involves conversation between practitioners. Electronic health records have also been criticized for encouraging the cutting and pasting of large amounts of irrelevant material into patient records and reducing face-to-face contact with patients during rounds and other provider/patient interactions.

Slide 14

Unintended Consequences of Health Information Technology: The Case of EHRs

Unintended consequences include impacts on:

- Time efficiency and workflow
- Documentation quality
- Communication and coordination
- Work arounds
- Privacy and confidentiality

(Zheng et al., 2016)

A recent review of studies from across health care settings explored the transient and persistent impacts of health information technology. Of the 34 studies identified, 68% were on the impact of electronic health records. The unintended consequences were

grouped into themes of patient safety, time efficiency and workflow, documentation quality/clinician performance/quality of care, communication and coordination, workarounds, financial impact, staff attrition, privacy and confidentiality (Zheng et al 2016). Zheng et al’s 2016 review provides a comprehensive summary of research on unintended consequences associated with implementation and use of health information technology (health IT).

Unintended consequences associated with health IT implementation requires healthcare organizations to remain vigilant and prepare and anticipate for possible unintended consequences.

How can we contribute to technology improving patient safety?

Slide 15

Technological improvement

- Clinician involvement in design and customization of technology
- Well-planned and adequately resourced implementation
- Training in use of new technology
- Technology used appropriately
- Issues with technology are reported and acted upon

In your roles as clinicians, administrators and technologists there are many things you can do to help ensure IT systems are developed, implemented and used effectively.

Clinicians should:

- ensure you use available online resources such as health related databases and practice guidelines to improve your practice;
- use available technology appropriately in your workplace;
- lobby for introduction of proven systems into your workplace;
- get involved in the development and implementation of technology in your own workplace;
- insist on technologies that are well designed for your performance and the contexts in which you use them;
- get involved in the development of standards for the development of new systems
- get involved in the customization of new technologies in the workplace - all technologies require a degree of customization to make them useable within an organization and practitioner input is vital for subsequent usability;
- ensure you and your staff are fully trained in the use of any new technologies; and
- ensure you provide feedback regarding how any new technologies are performing in the workplace and how they could be improved.

Administrators should:

- insist on technologies that are well designed for your performance and the contexts in which you use them;
- ensure participation of appropriate clinical staff in the development and customization of new technologies;
- develop appropriate implementation strategies for new technologies;
- provide adequate financial and human resources for the implementation of new technologies;
- ensure all appropriate staff are trained in the use of new technologies;
- where possible attempt to standardize equipment (e.g. avoid unnecessary purchase of the same machine from different vendors);
- ensure there are adequate pathways for clinicians and consumers to provide feedback on the implementation of new technologies; and
- learn from others – visit sites such as the [CMPA](#) (Canadian Medical Protective Association), [Canada Health Infoway](#), [IHI](#) (Institute for Healthcare Improvement) and [AHRQ National Resource Center for Health IT](#), to find out what others are doing.

Technologists should:

- design technologies for the end users;
- insist on technologies that are well designed for your performance and the contexts in which you use them;
- ensure participation of appropriate clinical staff in the development and customization of new technologies;
- actively seek feedback on the usefulness and impact of the technology on patient care and safety;
- establish a suitable life cycle model for software development that is appropriate for their product and organization; and
- ensure proper maintenance and upgrades of technology in a timely manner.

Summary

Slide 16

Summary

- ❑ Technology impacts on all aspects of care
- ❑ Potential for technology to improve safety is substantial
- ❑ Many challenges to introducing new technologies
- ❑ Regulation, design, implementation and ongoing support for new technology

Technology now impacts all aspects of healthcare delivery and there is a growing confidence that technology will play an increasing role in improving patient safety in the future. However, we must be aware of the unanticipated consequences and pitfalls that can accompany the introduction, misuse or overuse of any new technology.

The challenge we face is in ensuring technology reaches its full potential through playing an active role in ensuring any technology we use is designed well, carefully implemented and fully supported in the workplace.

Potential pitfalls

Slide 17

Potential pitfalls

- ❑ Over relying on technology to reduce risk in practice
- ❑ Not putting sufficient resources into technology implementations
- ❑ Letting technology drive clinical improvement rather than vice versa

1. Over relying on technology to reduce risk in your practice
2. Not putting sufficient resources into technology implementations
3. Letting technology drive clinical improvement rather than vice versa

Pearls

Slide 18

Pearls

- Engage in the customization and implementation of new technologies
- Be aware of both the benefits and risks associated with technology
- The only certainty with technology is that what is current is likely to change
- Feedback on failings in new technologies must be provided for improvement

1. Engage in the customization and implementation of new technologies in your workplace as you are going to be the end user
2. Be aware of both the benefits and risks associated with the use of technology in healthcare
3. The only certainty with technology is that what you are currently using is likely to change
4. If you don't provide feedback on any failings in new technologies, they will not improve

Toolkits & outcome measures

- **Electronic Records Handbook:** Canadian Medical Protective Association (CMPA). 2014. https://www.cmpa-acpm.ca/static-assets/pdf/advice-and-publications/handbooks/com_electronic_records_handbook-e.pdf 
- **Privacy and Electronic Medical Records:** Canadian Nurses Protective Society. 2009. <http://www.cnps.ca/index.php?page=140> 
- **Nursing Information and Knowledge Management.** Canadian Nurses Association. 2006. https://www.cna-aiic.ca/~media/cna/page-content/pdf-en/nursing-information-and-knowledge-management_position-statement-2006.pdf?la=en 
- **Costs and benefits of health information technology:** Shekelle PG, Morton SC, Keeler EB. Costs and Benefits of Health Information Technology. Evidence Report/Technology Assessment No. 132. (Prepared by the Southern California Evidence-based Practice Center under Contract No. 290-02-0003.) AHRQ Publication No.06-E006. Rockville, MD: Agency for Healthcare Research and Quality. April 2006. <http://www.ahrq.gov/clinic/tp/hitsystp.htm>

Resources

- **AHRQ National Resource Center for Health Information Technology:** This Portfolio's mission is to produce and disseminate evidence about how health IT can make health care safer, higher quality, more accessible, equitable, and affordable. <https://healthit.ahrq.gov/>
- **Canada Health Infoway:** This agency helps to improve the health of Canadians by working with partners to accelerate the development, adoption and effective use of digital health across Canada. <https://www.infoway-inforoute.ca/en/> 
- **Electronic Health Records and Patient Safety: Future Directions for Canada:** Canada Health Infoway, Canadian Patient Safety Institute. <https://www.infoway-inforoute.ca/en/component/edocman/342-ehr-patient-safety-report-full/view-document?Itemid=101> 
- **CMPA Perspective.** June 2010, Vol 2, No 2. 
- **Canadian Agency for Drugs and Technologies in Health (CADTH):** Is an independent, not-for-profit organization responsible for providing health care decision-makers with objective evidence to help make informed decisions about the optimal use of health technologies. <https://www.cadth.ca> 
- **Health Canada – Drugs and Health Products, Medical Devices, Safe Medical Devices in Canada Fact Sheet.** (Internet accessed July 2017) <https://www.canada.ca/en/health-canada/services/drugs-health-products/medical-devices/activities/fact-sheets/safe-medical-devices-fact-sheet.html> 
- **Institute for Safe Medication Practices Canada (ISMP Canada)**
Canadian Pharmaceutical Bar Coding Project - Medication Bar Code System Implementation Planning: A Resource Guide Canadian Pharmaceutical Bar Coding Project ©2013 <https://www.ismp-canada.org/barcoding/> 
- **Nursing Informatics Inventory Existing Teaching and Learning Resources**
Canadian Association of Schools of Nursing, August 2012. <https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/clinical-adoption/1176-nursing-informatics-inventory-existing-teaching-and-learning-resources?Itemid=101> 
- **Quality & Safety in Healthcare.** Aug 2010, Vol 19, Suppl 2:i1-i47. Full supplement on use of technology to improve patient safety.
- **Using Diffusion of innovation concepts to enhance implementation of an electronic health record to support evidence-based practice:** Geibert 2006. RC. Nurses Admin Q. 3:203-210.
- **Healthcare Information and Management Systems Society**
<http://www.himss.org/>
HIMSS Ontario Chapter <http://ontario.himsschapter.org/> 
- **National Institutes of Health Informatics – Canada:** <http://www.nihi.ca/> 

- **Standards Council of Canada (SCC)** is a federal Crown corporation whose mandate is to promote efficient and effective standardization in Canada. <https://www.scc.ca/> 

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Principal message

The single most important message your audience should come away with is that *while technology can improve overall patient care and safety, it can also cause unintended consequences*. As a part of this insight, the participant should come away convinced that many factors contribute to effective implementation of new technology.

Module overview

Healthcare delivery has become increasingly complex as technology has expanded not only the types and methods of treatment that are possible, but also the way in which healthcare teams communicate, monitor, and track patient care. Medical devices and equipment such as smart pumps, automated dispensing cabinets, and bar code technology allow for more efficient and precise delivery of medication. Software systems have enabled electronic tracking and storage of patient records, in addition to computerized entry of medical orders. IT applications even exist to assist with clinical decision making. These technological improvements have clearly expanded the scope of medicine and improved the potential for patient care, yet their impact on patient safety has been mixed.

This module describes common challenges associated with implementation of technology in the healthcare setting. The module lists common examples of technology in the workplace, showing the benefit of each to patient safety. Importantly, the module emphasizes steps that clinicians, administrators, and technologists can take to ensure that technology is implemented effectively and safely.

Preparing for a presentation

1. Assess the needs of your audience

Choose from the material provided in the module according to the needs of your expected participants. It is better for participants to come away with a few new pieces of information, well learned, than to come away with a deluge of information from which they can remember little or nothing.

2. Presentation timing

The suggested timing for each part of this module is:

Introduction	2-3 minutes
Trigger tape & discussion	5-7 minutes
Presentation	30 minutes

<u>Summary</u>	<u>2-3 minutes</u>
Total	45 minutes

3. Number of slides: 18

4. Preparing your presentation

The text in the module was not designed to be used as a prepared speech. Instead, the text provides material you may want to use. The slides have been designed to trigger your presentation. Although the slides closely follow the text of the module, they do not contain all of the content. Their use presumes that you have mastered the content.

You may want to make notes on the slide summary pages to help you prepare your talk in more detail and provide you with notes to follow during your presentation.

Remember that you can adjust the slides to suit your presentation content, your style, and to make it feel fully familiar and your own.

Practice your presentation using the slides you have chosen, and speaking to yourself in the kind of language you expect to use, until it is smooth and interesting and takes the right amount of time. The most accomplished presenters and teachers still practice prior to a presentation; don't miss this step.

5. Preparing a handout for participants

The module text and slides were designed to be reproduced and provided to participants as a handout. Take the portion you need; they can be used in their entirety, module by module, or for just one specific topic. Please ensure to acknowledge the source of the material, the PSEP – Canada Acknowledgment Page at the front of the module provides the formal citation.

6. Equipment needs

- Screen, computer and projector
- Flipchart and markers for recording discussion points

Test your equipment beforehand to ensure that it works.

Review your video to assess which portions you would like to use.

Have a back-up plan so that if there is any equipment failure you can move without panic to your back-up plan. For instance, have in mind that:

- if the video fails, you can read the vignette of the trigger tape story;
- if the slides cannot be shown, you can refer to the hand out slides; and
- if flipcharts and markers are not available, you can have participants list items on their hand outs that you would have written up for all to see.

Making the presentation

1. Introduce yourself

If you have not already done so, introduce yourself. Include your name, title, and the organization(s) you work for. Briefly describe your professional experience related to the information you will be presenting.

2. Introduce the topic

Show the title slide for the module. To establish the context for the session, make a few broad statements about the importance of topic as a patient safety matter. Tell participants the format and time you will take to present the session. Identify the teaching styles that you intend to use.

3. Review the session objectives

Show the slide with the session objectives listed. Read each objective and indicate those that you are planning to emphasize.

4. Show the trigger tape

After reviewing the objectives for the session, show the PSEP – Canada trigger tape for this module. The trigger tape should engage the audience and provide appropriate context for the session. The trigger tape does not need to demonstrate an ideal interaction, but to “trigger” discussion.

Trigger tape content

Keep in mind that the facilitator may choose to use any one of a number of trigger tapes.

This module’s specific trigger tape shows a physician entering patient information becomes frustrated by her inability to enter medications into an electronic record. A colleague gives a hint on how to bypass this “annoyance.” A hospital administrator notices the exchange and acknowledges that although the process is cumbersome, bypassing this “annoyance” could have significant downstream safety implications for the patient in question.

A teachable moment: discussion after the trigger tape

After the trigger tape, ask the participants for their comments about the issues and the interaction they have just seen. To affirm what they contribute, consider recording the important points on a flipchart or white board.

If the discussion is slow to start, you may want to ask more direct questions, like:

- What could be done to prevent such technology workarounds from occurring? (Don't focus strictly on what can be done after technology is implemented, such as punishment or additional training; encourage participants to think of ways that technology could be designed or implemented more effectively.)
- Have you ever encountered a situation where technology was meant to be an improvement, but actually made your job more difficult?
- What obstacles can be encountered when introducing new technology?
- How do you think technology can either help or harm the safety of patients?

Use the discussion to set the stage for the material to follow. Do not let the discussion focus on a critique of the technical quality of the video or how “real” the players seemed. If the participants do not like something that was said or done in the trigger tape, acknowledge that there is always room for improvement and ask them how they would do it themselves.

Setting limits to discussion time

It is usually best to limit discussion of the tape to no more than five minutes, then move on to the presentation. To help move on if the discussion is very engaged, try saying something like:

- let's hear two last points before we move on, and
- now that you have raised many of the tough questions, let's see how many practical answers we can find.

For the more advanced facilitator who is confident of both the patient safety material and his or her pedagogic skills, it is possible to use the trigger tape as a form of case-based teaching and to facilitate the discussion to draw out the teaching points of the module. If this approach is used, it is essential to write up the points on a flip chart as they arise, to fill in any gaps and to summarize at the end. The hazard of this approach is that the discussion will not yield the desired teaching points. Return to the slides if this happens.

5. Present the material

Recommended style: interactive lecture

An interactive lecture will permit you to engage your audience, yet cover your chosen material within the time. You can use as your interactive components the trigger tape stimulated discussion and an interactive exercise. To foster discussion, ask participants for examples from their institutions or experiences. Look for examples of both failed and successful technology implementations, focusing on the underlying reasons for failure or success of each case. Ideally, the examples could be linked to one of the major teaching points.

Alternative style: case-based teaching

Use the trigger tape to include some case-based teaching. To help participants feel involved and invested, you may invite them to give you a case from their institution or experience. However, it is usually best to return to the trigger tape to draw out analytic points for teaching since the case is known to you and you do not need to ‘think on your feet’ too much.

Interactive exercise: design of electronic medical records

Ask your audience members to give examples of their experiences with electronic medical records. Try to find a case where implementation of the EMR was not ideal. Ask the participant to describe the EMR system in as much detail as possible. Use a flip chart to capture the user’s ideas, perhaps including a schematic of the design. Next, ask other audience members how the described EMR system could be improved. Elicit examples of successful EMR implementation from the audience. Try to identify design aspects that are critical for successful electronic medical records.

6. Key take-home points

1. Be aware of both the benefits and risks associated with the using technology in healthcare.
2. Engage in the customization and implementation of new technologies in your workplace. Input from end users is critical to the design of effective and user-friendly systems.
3. If you don’t provide feedback on any failings in new technologies they cannot improve.
4. Technology is not a panacea; avoid over-reliance on technology as a solution to all safety problems.
5. Ensure sufficient resources are available for effective implementation.
6. Do not allow technology to drive clinical improvement rather than vice versa.

7. Summarize the discussion

Briefly, review each part of the presentation. Recap two or three of the most important points that were discussed.