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# Information technology and patient safety in nursing practice: an international perspective

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## KEYWORDS

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**Summary** When people become patients, they place their trust in their health care providers. As providers assume responsibility for their diagnosis and treatment, patients have a right to expect that this will include responsibility for their safety during all aspects of care. However, increasing epidemiological data make it clear that patient safety is a global problem. Improved nursing care may prevent many adverse events, and nursing must take a stronger leadership role in this area. Although errors are almost inevitable, safety can be improved, and health care institutions are increasingly making safety a top priority. Information technology provides safety benefits by enhancing communication and delivering decision-support; its use will likely be a cornerstone for improving safety. This paper will discuss the status of patient safety from an international viewpoint, provide case studies from different countries, and discuss information technology solutions from a nursing perspective.

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## 1. Introduction

Because nurses care for their patients around the clock in hospitals, they see themselves as primarily responsible for their patient's well-being and the main role they play in the health care team is to serve as a key guardian of patient safety. However, injuries in health care today are all too frequent. Safety is defined as the freedom from accidental

injury [1]. Many injuries occur as the result of errors, defined as the failure of a planned action to be completed as intended, or the use of a wrong plan to achieve an aim [1]. An adverse event is an injury resulting from a medical intervention [1], such as scarring following an infiltrated intravenous line containing chemotherapy.

While errors and adverse events represent a difficult problem, increasing data suggest that information technology may be a powerful tool for improving safety [2]. Most of the work in this area takes either a multidisciplinary or physician-oriented

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perspective, but many of these tools are particularly helpful to nursing and many injuries may be prevented by nurses. In this paper, we discuss the international epidemiology of iatrogenic injury, illustrate these with case examples, and suggest tools and interventions for improving safety, viewed in particular through a nursing lens.

### 1.1. The epidemiology of iatrogenic injury

In the US, the Institute of Medicine (IOM) reported, "To Err is Human: Building a Safer Health System," galvanized the public and the health care industry's interest in this area (2000). It stated that safety was a major problem in the U.S, resulting in large numbers of injuries and deaths. Furthermore, it argued that health care organizations must develop a "culture of safety" so that the workforce and processes focus on improving the reliability and safety of patient care.

A key study regarding the risk of hospitalization, which the IOM used to estimate numbers of injuries and deaths, was The Harvard Medical Practice Study (MPS), which evaluated the frequency of iatrogenic injury in patients discharged from hospitals in New York, in 1984 [3,4]. The primary outcome of this study was the "adverse event," defined as injuries caused by medical mismanagement resulting in disability at discharge or prolonged length of stay. Adverse events occurred in 3.7% of hospitalizations, of which 28% were judged to be due to negligence. Another US study, using the same methodology in a random sample of patients from Colorado and Utah, found adverse events in 2.9% of admissions as compared to 3.7% in the New York study [5], suggesting that these rates are probably reasonably representative for the U.S. Data are now available from a number of large studies around the world regarding the frequency of adverse events, and essentially all of these demonstrate that adverse events are significant problems [6–10]. Most data so far come from the developed world. For example, the Quality in Australian Healthcare Study (QAHCS) identified an adverse event rate of 16.6% [6]. A subsequent study, comparing the adverse event rate in the QAHCS to that from the Medical Practice study, found that most of the differences in incidence were related to methodological differences between the two studies, although there was also a higher adverse event rate in Australia [7]. Vincent found that in United Kingdom, 10.7% of patients experienced one or more adverse events [8]. In New Zealand, an adverse event rate of 12.9% was identified in one study [9]. Numerous studies are currently underway in other countries, including Canada and Japan.

In the developing world, relatively limited data are available, though some studies are now being done, and the issue is often highly charged. For example, in Brazil, a study of 212 patients showed that among 46 patients, 80 errors had occurred relating to pressure ulcers, mechanical ventilation, IV catheters and medications [10]. Korea has no detailed data about iatrogenic accidents, such as adverse drug events, hospital infection, even though some physicians and nurses realize the importance of a systematic approach about these issues. In part for cultural reasons, iatrogenic injuries represent an especially sensitive and political issue in Korea. While the medical malpractice case rate has increased recently, and there is increasing public concern, there are still no organized systems to monitor adverse event rates. The few websites addressing iatrogenic accidents mostly focused on legal issues, such as reimbursement and insurance claims. These data make it clear that iatrogenic injury and adverse events are major international issues

Moreover, many adverse events can be detected, ameliorated or prevented by nurses. For example, adverse drug events are the leading cause of injury in most studies and nurses are in an excellent position to play an active role in this area, since they administer most drugs and interact with patients and families more frequently than other providers. Pressure ulcer prevention is primarily a nursing issue. Surgical adverse events and nosocomial infections are also important. These can be both identified and, in many instances, prevented by nurses. In a study by Needleman, who looked at staffing ratios and level of outcomes for patients in a large multistate study, there was consistent evidence of an association between higher levels of staffing by registered nurses and lower rates of adverse outcomes, such as urinary tract infections, upper gastrointestinal bleeding and hospital-acquired pneumonia [11].

In addition to the harm that they cause to patients, iatrogenic injuries are costly to health care systems. The Medical Practice Study estimated that the total cost for injuries that occurred during 1984 in New York was \$878 million in 1989, including medical care costs of \$161 million [3,4]. The QAHCS estimated that adverse events accounted for 8% of hospital bed days and cost the Australian health care system \$4.7 billion (Australian dollars) per year [6]. A British study suggested that adverse events were responsible for an average of 8.5 additional bed days, and resulted in a direct cost of £290,000 to the trust concerned, and the overall estimate was that preventable events cost the National Health Service approximately 1 billion pounds annually [8].

Taken together, these data suggest that adverse events are highly important international problems with major financial consequences, and that many of the adverse events could be prevented, identified and treated by nurses.

## 1.2. Nursing and safety

In staff nurses' workflow, they consistently double-check orders, confirm questions about medications with pharmacists and physicians, and report their concerns about patient safety. Surprisingly, in a recent study conducted by Clarion Health Systems, a nurse had only an average of 20–50 min per patient, of direct patient contact, over a 12-h period [12]. The rest of the time was spent primarily managing and coordinating the communication of patient information to other departments, physicians, and members of the health care team. However, time spent in managing communication and information is not sufficient to ensure a safe health care environment. Other approaches, including greatly expanded use of information and communication technology, are needed to help nurses prevent errors. The use of a Clinical Information System (CIS) can allow the staff to be more efficient and to provide more time with patients [13].

A CIS is not the only tool that can help nursing improve safety. The International Council of Nurses (ICN) Code of Ethics was established in 1953. It has been revised many times. It is available on their website, and one of the elements includes technology and safety. "The nurse, in providing care, ensures that use of technology and scientific advances are compatible with the safety, dignity and rights of people." This statement links the use of technology, safety and ethical conduct such that the nurse is aware of the patient's safety when using technology and of the ethical implementation of new technologies [14]. The ICN also has a position statement on safety adopted in 2002 [15]. ICN believes nurses and national nurses associations have a responsibility to:

- Inform patients and families of potential risks.
- Report adverse events to the appropriate authorities promptly.
- Take an active role in assessing the safety and quality of care.
- Improve communication with patients and other healthcare professionals.
- Lobby for adequate staffing levels.
- Support measures that improve patient safety.
- Promote rigorous infection control programmes.
- Lobby for standardized treatment policies and protocols that minimise errors.

- Liaise with the professional bodies representing pharmacists, physicians and others to improve packaging and labelling of medications.
- Collaborate with national reporting systems to record, analyse and learn from adverse events.
- Develop mechanisms, for example through accreditation, to recognise the characteristics of healthcare providers that offer a benchmark for excellence in patient safety.
- These responsibilities are available to all nurses when needing support in situations where safety is an issue.

The health care system quality components and implementation varies significantly nationwide in Brazil. The initiatives to achieve patient safety improvement are recent. One important advance was the establishment by law in 26 January 1999 of the ANVISA (National Health Surveillance Agency), with the mission "To protect and promote the population's health, ensuring the sanitary safety of products and services and taking part in developing access to it". The agency is an independently administered, financially autonomous regulatory agency within the structure of Federal Public Administration and it is linked to the Ministry of Health. In addition to the regulatory mission, the ANVISA has created a website for health care providers and consumers to report adverse events. This includes information ranging from problems with generic medications to news updates about severe acute respiratory syndrome (SARS). However, it is important to emphasise that Brazilian nursing is developing a more proactive leadership role in this field, as they essentially perform and control the majority of direct patient care tasks [16].

## 1.3. Health care team

The IOM has suggested that safety is a systems property, and that achieving safety requires a team effort. Nurses clearly represent a key part of the health care team, especially in the hospital. Ideally, both nurses and pharmacists should be included in patient rounds. In terms of hospital safety, the health care team must look at patient care from admission to discharge, and beyond. Safety teams should be created that include not only physician and nurses, but also physical therapists, pharmacists, IT staff, environmentalists, radiologists, laboratory personnel and administrators [17].

Including nurses in decision-making teams can change the culture of safety and how errors are perceived by nursing staff. Larson reported on a two-week pilot study where staff could anonymously

call a consultant to report errors and present ideas for improving safety [17]. During the two-week period, consultants received 400 reports (15 per day). The staff did not have to go to their supervisors and they did not have to identify themselves. This type of reporting can greatly enhance identification of problematic areas within a health care system. The data could not have been gathered if the staff thought there might be repercussion from reporting errors. In the US, the IOM has suggested that Congress enact laws to protect confidentiality in volunteer reporting systems, and such legislation has been introduced.

## **2. Information technology (IT) and nursing: what tools will make a difference?**

### **2.1. Effective design of a hospital unit**

While not considered to be related to information technology, the basic structural design of a hospital unit and workspace can clearly have a significant impact on safety [17]. For example, the layout of a nursing unit can enhance communications, and improve visualisation of patients. Hand-held or mobile devices (laptops on carts) can enhance decision support. A team approach is best in designing hospital units or community clinics to prevent errors. For example, design teams were created for the new facility at St. Joseph's Community Hospital of West Bend, WI, and followed guiding principles to develop the new facility. The design was patient-centred, created a healing environment, was efficient, safe, technologically advanced and staff-friendly [17].

While designing a new structure is attractive, such opportunities are infrequent; more often, renovating existing designs and ensuring that optimum use of technology, such as infra-red scanning for medication and patient location, ensure safety and prevent errors. Standardisation of nursing units in terms of layout, placement of equipment and consistency in location of supplies are relatively inexpensive and cost-efficient.

### **2.2. Safety education**

Throughout their curriculum, student nurses are taught about safety measures. Safety is highlighted in all clinical courses. Students can fail a clinical course by not applying appropriate safety measures. However, learning to use IT to ensure optimum patient safety is just as important. Immediate

reporting of errors and adverse events is essential. In teaching about particular areas, such as medication administration, nursing faculty must include problems that can occur and how to manage them. Students need to know that errors are sometimes made by others, e.g. pharmacists and physicians. Students need to know about where errors are most likely to occur and why it is important to always be vigilant. Electronically reporting of errors and adverse events is increasingly used, and is associated with higher reporting rates. These tools make it possible to obtain coded data about reports.

Today, nursing students have the opportunity to avoid many errors because computer education is now integrated into school curricula. Nursing informatics empowers nurses to be influential partners in the work environment. Computer systems are now a part of nurses' daily routines and the use of the Internet is an important source of health care information, which represents an increasingly important knowledge resource in health care. While some nursing schools already have labs to simulate patient care and separate computer labs to teach applications with nursing scenarios, there should be computers present in the patient care labs to simulate real life. A simulated computerized patient record should be part of the skills lab when educating nurses so that they enter the work force with these skills in place. The University of Kansas School of Nursing has started a technology-based approach to education and has combined forces with the Cerner Corporation to develop such a skills lab [18].

Nursing classifications should be integrated into nursing schools at the basic level of education. These classifications have been developed to describe nursing care and help enhance the nursing process. Their use in computer-based systems should be requested from nursing but they are not usually taught in basic level education. Two examples of these classifications are (1) perioperative nursing data set created by the American Operating Room Nurses (<http://www.aorn.org/research/pnds.htm>) and (2) the Home Health Care Classification, created by Dr. Virginia Saba (<http://www.sabacare.com>). At the international level, the International Classification for Nursing Practice (ICNP) is used. The International Council of Nurses (ICN) advocates the ICNP, which is a terminology for nursing practice that facilitates cross-mapping of local terms and existing vocabularies and classifications [19,21]. The use of nursing vocabularies can be an important tool in tracking nursing care.

The Netherlands carries out a yearly national prevalence survey in different health care institutions, to determine the prevalence and severity



of pressure ulcers. Feedback from the surveys is provided to individual institutions which may increase the consciousness of pressure ulcer problems among health care workers. This feedback may result in better prevention strategies and therefore in a decrease in prevalence [22].

### 2.3. Safety standards

Errors can be made either because standards are lacking, or because approved standards are in place, but are not followed. Even if appropriate standards are in place, a mechanism is necessary to enforce their use. The following case studies demonstrate a lapse in safety standards:

A 13-year-old boy was treated for leukaemia in The Netherlands, in a special paediatric cancer unit of a large university hospital. In addition to his chemotherapy, he was receiving pain medication, and suffered from side effects, such as fatigue, anorexia and vomiting. There was also concern that he was depressed. On day 2 of admission, he reported feeling uncomfortable, had a stomachache, and was listless. On day 3, he was encouraged to be more active, and to take a bath. Although, an established nursing care standard required that any depressed or sedated child be monitored during bathing, the boy wanted privacy and the nurse was busy with other children, so the nurse made an exception and allowed him to bathe unsupervised. The boy was found in the bathtub apneic, and could not be resuscitated.

A 66-yr-old man from Portugal had a complicated stroke with complications and was on a medical ward for 9 days. On the afternoon of the third day, his nurse noted that he was constipated and began nursing interventions to facilitate bowel elimination. The nurse referred the situation to the patient's physician, who prescribed daily laxatives. However, 2 days after treatment, the patient developed diarrhoea. Another nurse called the physician, who ordered an anti-diarrheal, without discontinuing the laxatives. The patient then was receiving both medications, when in fact the diagnosis was fecal impaction, which did not resolve until the patient developed severe discomfort and was manually disimpacted.

#### 2.3.1. IT tools

In the case studies presented, errors could have been prevented by using a well-designed interdisciplinary application and alert system. A system of alerts would help health professionals be aware of data that influence decisions. Having an alert, such as a pop-up message stating the boy was on medications that impaired his cognitive ability and that the

standard was for supervised bathing, would remind the nurse to be present during the child's bathing. In the second case, there were several errors: the patient should have been started on a bowel regimen after the stroke (this should be standard); the nurse may have needed an electronic prompt to assess the patient's bowel situation; and the system should have alerted the nurse and physician that the patient was simultaneously receiving both a laxative and a medication to treat diarrhoea. The case studies presented indicate ways by which information systems can promote patient safety by all health care providers.

### 2.4. Knowledge gaps

A 76-year-old man in the United States had bleeding oesophageal varices, and his doctor ordered an intravenous pitressin drip. The pharmacy misinterpreted the drug as pitocin, and delivered the wrong medication. The nurse injected the pitocin and the patient subsequently suffered a severe stroke.

A 7-year-old patient in Brazil, with renal disease and hypertension, presented to a clinic in hypertensive crisis. The physician wanted to give the patient captopril, but had no paediatric dosing tools available. They estimated a dose based on the adult dosage, but this represented a five-fold overdose and the child suffered a cardiorespiratory arrest.

#### 2.4.1. IT tools

Medication administration standards are part of every nursing curriculum. Still, mistakes occur in today's systems [23]. High noise levels, interruptions, difficult-to-read equipment displays, illegible dosage labels, and bottles that have similar shapes, colors and sizes can all contribute to medication errors [24]. Both of these case studies illustrate errors in the medication system that could have been prevented with IT tools.

In the first example, if bar-coding had been implemented, the nurse would have been notified immediately that it was the wrong drug. The use of this technology for administering medication is available and its benefits are being recognized [25]. Bar-coding is also very useful as a means to identify patients uniquely within a hospital, and can prevent "wrong patient" errors as well as wrong drug errors [26].

In the second case, the physician needed information about the appropriate dose of a medication, but it was not readily available. Such issues are distressingly frequent: in a study by Leape et al. [27], knowledge gaps were the most frequent systems cause of serious medication errors. Dosing information is readily available today, either from a desktop

**Table 1** Which is the correct way of writing an order?

1	10 units	Or	10 u
2	×3 days	Or	×3d
3	.5	Or	0.5
4	6	Or	6.0
5	12 µg	Or	12 mcg
6	No	Or	Ø
7	MSO <sub>4</sub> or MS	Or	Morphine

or a handheld device. In addition, tools that facilitate dose calculations are available, and computers are much more reliable than humans in making correct calculations [2]. Dosing errors are a particularly important problem in paediatrics, and appropriate dose forms are often unavailable [28].

Increasingly, many hospitals are using computerized provider order entry (CPOE) [29]. This tool eliminates the problem of deciphering orders, and allows provision of decision support to providers. As an order is typed into the computer, it is checked for problems and, when complete, sent directly to the pharmacy for verification. This system does away with many of the steps once used to fill medication orders. It is estimated that every time an order is transcribed, a 15% chance of error is introduced [29]. The Johns Hopkins Hospital in Baltimore, Maryland, US, instituted new guidelines for prescribing orders within their institution in 2003 [30]. If an order is written with prohibited abbreviations, the staff is instructed to ask the prescriber to discontinue that order and rewrite it without the prohibited abbreviations. Table 1 is a test that was developed so that employees can learn the new changes. Table 2 explains why certain abbreviations are incorrect and should not be used.

Many low-technology, common-sense approaches formally studied improve medication safety. For example, writing orders in plain English and not using shorthand abbreviations or arcane Latin letters can make medication orders clear and simple [31]. Another example is having a pharmacist make rounds with the team in the intensive care unit. This has been shown to improve medication safety [32].

## 2.5. Knowledge gaps

A nurse measures a patient's blood glucose (BG) at the bedside and documents the BG of 400 on the chart that requires the nurses name, the date and time of the measurement, the BG level, and the identification number of the machine. This is done to maintain quality assurance. The physician must

**Table 2** Correct answers and rationale

1	10 units	The letter "u" for "units" can be mistaken for a "0"
2	×3 days	"×3d" is ambiguous; could mean "times 3 days" or "times 3 doses"
3	0.5	With lack of leading zero could be read as five
4	6	With trailing zero could be read as 60
5	12 mcg	Greek symbol µ could be mistaken for "m" for milligram
6	No	Ø could be mistaken for another number, particularly 4, 6 or 9
7	Morphine	Confusion between morphine sulphate and magnesium sulphate; no need for word "sulphate" with morphine

then be notified of the high level of the BG, by using a text pager or making a phone call and paging the physician. The nurse also documents the BG on the medication administration record (MAR). Then, the bedside flowsheet is updated. After the nurse delivers the appropriate dose of insulin and documents the BG in the numerous required locations, new interventions for this patient are considered. They have tried many interventions, which were unsuccessful, and now the nurse needs guidance for different approaches.

### 2.5.1. IT Tools

These multiple charting requirements can lead to missed charting and errors; it also creates job stress. A clinical information system with integrated CPOE is the best solution for maintaining accurate and up-to-date charting, while minimising errors. At Brigham and Women's Hospital in Boston, an 84% decrease in serious medication errors was reported by using a CIS with CPOE [32]. One benefit of having a CIS is that decision support is built in, and offers the health care worker suggestions for appropriate patient interventions. A CIS can link to bibliographic databases, such as PubMed. Another benefit is the ability to use standardized languages, such as nursing diagnoses, outcomes and interventions [19–21]. The nurse can refer to a list of nursing interventions appropriate for a diabetic patient, providing links between interventions, outcomes and nursing diagnoses. The nurse can then develop a pathway that can be accessed by other care providers. CIS vendors, in the past, have included nursing diagnoses, but have not

linked them to complete standardized vocabularies and are only now seeking nursing input [12].

### 3. Views regarding the future

#### 3.1. Hospital setting

Nursing shortages are a problem around the world. There are several issues that contribute to this shortage, and they lead to job stress and a higher rate of errors than would occur with adequate staffing. Nurses in hospital jobs have patients with high acuity, and fewer staff to share the burden. A recent study on a model for predicting burnout in Korean nurses showed that Korean nurses reported higher levels of burnout than nurses in western countries, such as Germany, Canada, the United Kingdom and the US [33]. These issues can have serious safety consequences. A recent study at University of Pennsylvania Hospital regarding job satisfaction among nursing staff indicated that job dissatisfaction among nurses with high patient-to-staff ratios was associated with higher patient mortality [34]. Another study by Aiken [35] on nurse satisfaction in five countries shows that nurses leave the profession when they perceive that system inefficiencies compromise the quality of care they are able to give.

Nurses are looking towards IT to streamline work and reduce unnecessary and redundant activities, which may in turn allow them to spend more time with patients and have higher job satisfaction. Specific areas affected by IT are charting, care standards and medication administration. Nurses need to know that they are a significant part of the health care system. Nurse administrators and leaders are seeking ways to support their professional staff, by listening to ideas for role improvement and keeping an open line of communication with all nurses. Nurse managers need to discuss safety issues that occur on the nursing unit with their staff, as well as with the multidisciplinary team, to assess ways that errors can be reduced. Discussing journal articles or forming a "Nursing Journal Club" can be an effective way for sharing and promoting evidence-based practice. Asking interested nurses to be a representative on a department committee and giving them time to do so can make staff members feel appreciated and part of the process.

Equipment, such as intravenous pumps and bedside monitoring, will be directly connected to network systems throughout the hospital, not just in ICUs. Data can be captured at the source without transcription errors and automatically entered into the patient's electronic chart.

CIS can help streamline the change of shift report and create an outline for the nurse's daily activities based on each patient assignment. This same connection to patient information provides data to health care providers so that information need not be entered more than once. This can be very helpful when patients transfer to other institutions, such as a nursing home or rehabilitation center.

#### 3.2. Outpatient setting

The CIS can facilitate provision of patient discharge instructions; this will benefit the home health nurse who must closely monitor the patient. All information can be updated prior to discharge. A recent study showed that medication use improved in 50% of the home care patients whose medications were reviewed by a pharmacist, versus 38% of control patients. Concurrently, there were no increases in nurse home visits to intervene because of medication errors [36].

Because patients are being discharged earlier from hospitals, home monitoring becomes very important. Home health nurses are using laptop computers to transfer data and communicate with physicians while still in the patient's home.

### 4. Conclusions

Data now demonstrate clearly that patient safety is an international problem. Many adverse events—such as adverse drug events, pressure ulcers and nosocomial infections—can be prevented or detected by nurses. Increasingly, information and communication technology is playing an important role in improving safety. Nursing needs to be closely involved with the development and application of this technology worldwide. It has the potential both to free nurses to return to more direct patient interaction, and to dramatically improve the safety of health care.

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