Medication errors that occur in or out of U.S. hospitals account for more than 7,000 deaths annually (Institute of Medicine, 2000). Each year, more than 48,000 newly diagnosed patients with cancer experience adverse events related to their medical care. Historically, a fifth of those adverse events are medication related, and two-thirds are preventable (Dinning, Branowicki, O’Neill, Marino, & Billet, 2005). Chemotherapy tops the list of high-alert medications in a survey of nurses and pharmacists, outranking IV potassium chloride and insulin as a potential threat to patient safety (Institute for Safe Medication Practices, 2003). High-alert medications have a high risk of substantially harming patients if a medication error or adverse event occurs. Chemotherapeutic agents are in that category; errors related to their use can be lethal because their therapeutic index is lower and safety margin narrower than those of other drug classes (Muller & Kloth, 2005). The advent of supportive agents has lessened potentially life-threatening occurrences such as neutropenia, but no agents can repair fatal cardiac, renal, or pulmonary toxicities that can arise from a chemotherapy error (Muller & Kloth).

Chemotherapy is prone to errors for many reasons; even small errors can cause major harm. As a classification of medications, chemotherapy is unique in that dosing is individualized, not standardized. Doses are computed based on factors such as body size or renal function and require patient-specific calculation. Sometimes dose adjustments are required, which adds a second calculation (Sheridan-Leos, Schulmeister, & Hartranft, 2006). Also, complex multidrug chemotherapy protocols often are used to treat cancer, and the more medications administered, the greater the potential for error. Furthermore, chemotherapeutic agents are given in several ways (subcutaneously or via IV) and in different doses (standard or high doses) over various periods of time (bolus or continuous infusions). Some agents can be given safely by one route but not by another. For example, some agents can be given intrathecally, whereas other agents administered that way are potentially life-threatening. The many variations in chemotherapy prescriptions and administration can lead to errors. In addition, the proliferation of new chemotherapeutic agents requires nurses to continuously update their knowledge. Apart from oncology-specific risk factors for error, chemotherapy errors can occur because of understaffing, poor communication, human error, fatigue, and environmental factors (Cohen, 2000). Finally, patients with cancer can be compromised physically for various reasons: past

At a Glance

✦ Many variations in chemotherapy prescriptions and administration can result in life-threatening errors.

✦ Chemotherapy errors usually are attributed to a number of events involving staff members from various disciplines; therefore, participation in chemotherapy error prevention is essential for all staff who order, prepare, and administer chemotherapeutic drugs.

✦ Devising an educational model for novice oncology nurses can support a culture of safety by preventing chemotherapy-related errors.
multimodality treatment with different toxicity profiles, older age, comorbid conditions (Boyle, Schulmeister, Lajeunesse, & Anderson, 2002), previous radiation therapy, and concurrent chemotherapy and radiation therapy.

Guidelines for preventing chemotherapy errors have been published by various organizations, such as the Oncology Nursing Society (Polovich, White, & Kelleher, 2005) and the American Society of Health-Systems Pharmacists (2002). However, many novice oncology nurses are not familiar with the recommendations and lack the detailed knowledge and experience needed to translate the theory of chemotherapy error prevention into tangible day-to-day practices in the workplace.

The goal of this article is to describe how chemotherapy education was redesigned using a proactive approach to help novice oncology nurses who were perceived to be the most likely to make treatment-based errors. Nurses who attended the redesigned education programs promoted a culture of safety by learning and then implementing error prevention techniques in their daily work.

**Program Development**

**Setting**

The project took place at a 450-bed community hospital over 24 months. The hospital has a dedicated oncology program consisting of an oncology medical and surgical inpatient unit, an ambulatory treatment center, an on-site radiation therapy center, and a community outreach program. The hospital also offers extensive clinical trials. The inpatient unit was expanding, and experienced oncology nurses were not available. Nine newly graduated nurses and three experienced nurses with little oncology experience were hired over the course of the project to work in the inpatient or outpatient unit.

**Proactive Approach**

The existing process for teaching novice oncology nurses about chemotherapy was a two-day (16-hour) lecture based on the Oncology Nursing Society’s chemotherapy guidelines (Polovich et al., 2005) and was considered effective. Nevertheless, the hospital wanted to enact a proactive approach to prevent chemotherapy errors by redesigning its chemotherapy education to better meet the learning needs of individual novice oncology nurses. Before planning the content for the chemotherapy education, a multidisciplinary chemotherapy error prevention team was assembled to study current chemotherapy processes and then change any hospital processes that were not supported by the error prevention theory. After the improved processes were in place, chemotherapy education for the nurses could be devised to meet their various learning needs.

On the basis of their investigation, the chemotherapy error prevention team improved processes associated with chemotherapy, from the ordering of the agents to monitoring patients for adverse effects. The focus of the chemotherapy education for novice oncology nurses was on error prevention. The approach was proactive; the team was not assembled to redesign chemotherapy education in response to an error or to any perceived failure in existing processes.

**Multidisciplinary Participation**

Chemotherapy errors do not occur in isolation. Instead, they usually are attributed to a number of events, often involving several staff members from various disciplines. As a result, all staff members who have a role in chemotherapeutic drug preparation and administration must participate in chemotherapy error prevention (Sim & Joyner, 2002).

Staff members involved in chemotherapy processes (ordering, order transcription, chemotherapeutic drug preparation and administration, patient education, and monitoring) participated in the error prevention team. The team consisted of a clinical nurse specialist certified in healthcare quality, a medical oncologist, a doctorally prepared pharmacist, and RNs and unit secretaries from all areas who administer chemotherapeutic drugs. Two RNs regularly attended the meetings, and one RN attended less often and acted as a consultant. Two unit secretaries, one from the inpatient unit and one from the outpatient center, participated in the project on a rotating basis. Risk management personnel, safety and environmental services staff, a cancer survivor who volunteered at the organization, and cancer survivors employed at the organization acted as consultants during team formation and focused on the treatment concerns of patients. In addition, an administrative assistant employed by the hospital who was not involved in physically caring for patients was included on the team. Initially, the administrative assistant attended the meetings as a scribe but later became intrigued with the process and helped the team to question the rationale for certain processes.

**Successfully Evaluating the Potential for Error**

**Open Communication**

Teams composed of people who work together often can experience communication problems. For the error prevention team in this project, day-to-day work-related communication often centered on patients and was different from communication required for a multidisciplinary group to critically examine policies, procedures, medication errors, and adverse events on an organizational level. Team leaders may have to deal with team members who bring a history of conflict, disagreement, or dislike of other team members to the table, which can impede group collaboration and progress. Some team members may be hesitant to impart their opinions, especially if their supervisors are in the group; therefore, the team leader may need to specifically solicit their input. Teaching communication techniques to members of the team can be helpful because difficulties in this area often reflect an absence of learned communication skills (Tiernan, 2003). During the project, open lines of communication helped the error prevention team members feel comfortable discussing safety issues and unsafe conditions (a concept that was helpful when planning for the subsequent education for novice oncology nurses). Open communication was encouraged with a verbal agreement among team members (sometimes called the rules of trust). Members knew that what was said in meetings would stay in those meetings, and comments would not be critical of one provider over another. Selecting team
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Evaluating Chemotherapy as a System

As the members of the error prevention team began their work, they made certain to remember that health care is a complex system with many subsystems, each with a distinctive subculture, specific rules and regulations, and unique norms of behavior, even within the same organization (e.g., inpatient versus outpatient chemotherapy administration). Using a systems approach helped the team devise safer ways to administer chemotherapy. System components that were important to consider included the work environment, individual human behavior, team and group behavior, and the technology used; many of the components interact, interface, or overlap (Levenson, 2003; Simpson, 2004; Thompson & Burns, 2004). Therefore, when examining chemotherapy administration or designing and implementing chemotherapy education, the entire system must be considered from multiple perspectives.

In general, teams working to improve practices for the administration of chemotherapeutic agents tend to focus on the system components that are not working well. In contrast, the error prevention team first considered the processes that worked well and determined why they worked well, then examined problematic areas. Repeatedly asking “why” helped the team delve into practices that were effective and those that needed improvement (see Figure 1).

Education and Competency

To promote patient safety, oncology nurses who prepare, dispense, and administer chemotherapeutic drugs and monitor patients receiving the drugs need to be competent to perform those necessary functions. The error prevention team decided that the best time to start the learning needs assessment of novice oncology nurses was at the hiring interview. Prospective nurses were evaluated regarding chemotherapy knowledge, prior experience, and skill level. Deficiencies found in the assessment were shared with each nurse after being hired. At that time, the novice nurse and the clinical nurse specialist devised a plan to meet the learning needs (see Figure 2).

During the initial orientation, novice oncology nurses were introduced to the chemotherapy processes. After observing the processes for one to six months based on the nurses’ comfort level, the novice oncology nurses attended an introductory chemotherapy course and a class about cancer pathophysiology. They then attended a 16-hour chemotherapy course based on the Chemotherapy and Biotechnology Guidelines and Recommendations for Practice (Polovich et al., 2005) (see Figure 3) to learn more about error prevention. In addition, as new chemotherapeutic agents were developed and released, their unique potential for errors was incorporated immediately into the course. When a new agent was released into the market, an in-service class or formal lecture was presented about that agent before it was administered in the clinical setting. The educational events were open to all oncology nurses. Textbooks, treatment guides, and article reprints were given to each nurse, and resources were available at each site where chemotherapy is ordered and administered.

Before administering chemotherapy for the first time (a precepted clinical practicum), novice oncology nurses completed a written chemotherapy examination that was composed of

Figure 1. Actions Taken by the Chemotherapy Error Prevention Team

- Before the first error prevention team meeting, the clinical nurse specialist team leader taught the team members about their roles, open communication, systems theory, and medication error prevention theory.
- A failure mode effect analysis (i.e., a proactive approach used to identify the potential for error) was completed. In the process, the team assigns a numeric score based on their perception of the effect of harm to the patient, the frequency that harm will occur, and the ease in detecting when an error has occurred before it reaches the patient. The numbers are multiplied, resulting in a risk priority number. The higher the number, the greater the perceived risk. Then, an action plan is devised and implemented. The team repeats the process, based on the new procedure, and a new risk priority number is generated. As a result of the analysis, the risk priority number was reduced by 50% in 12 months from the score at the start of the project (Sheridan-Leos et al., 2006).
- The content and location of chemotherapy spill kits were reviewed.
- The type, placement, and use of personal protective equipment in all areas where chemotherapeutic agents are mixed and administered were reviewed.
- Preprinted chemotherapy orders used at the institution were reviewed, modified when applicable, designed, and placed online.
- The existing chemotherapy policy was reviewed.
- Existing employee health procedures for staff who mix and administer chemotherapeutic agents were reviewed and revised, when applicable.
- Nurse competencies regarding chemotherapy administration were revised.
- The team worked with the institutional safety office regarding the safe disposal of chemotherapeutic agents.
- A system for reporting near-miss events was devised as well as a system for recognizing and awarding staff who report near misses.
- A process was developed to monitor staff’s adherence to the revised chemotherapy processes.
- Patients’ and family members’ educational materials about chemotherapy were reviewed.
- Educational materials were prepared for patients receiving chemotherapy at home.
- Reference materials for staff were reviewed and placed in any area where chemotherapeutic agents are ordered, mixed, and/or administered.
- Processes in the pharmacy regarding the safe handling of chemotherapeutic agents were reviewed and, when applicable, designed.
- The process of transporting chemotherapeutic agents from the pharmacy to the administration units was improved.
- The process for inserting IV tubing into the IV bag containing the chemotherapy was changed to reduce nurse exposure to the agents.
- Informal nursing practices were identified that are not formally recognized by existing policy but used by staff to complete tasks.
- The team studied why staff prefer informal processes over written policies.
- Administration processes were standardized, allowing for ease in error detection from one area to another.
**Figure 2. New Employee Chemotherapy Assessment and Education Plan**

*Instructions:* This form is used to assess an applicant’s experience in oncology and chemotherapy treatment. It serves as a guide to planning education for the applicant, who may be new to oncology nursing, and should be used with the applicant’s input regarding his or her progress and learning needs. In addition, the observed use of personal protective equipment and clinical techniques can be documented.

**Applicant’s name:**

**Date of hiring interview:**  
**Educational preparation:**

**Years in nursing:**  
**Years in oncology:**

**Setting:**  
- [ ] Private practice  
- [ ] Hospital outpatient center  
- [ ] Inpatient unit

**Describe the applicant’s clinical experience.**

- [ ] Adults  
- [ ] Children

**Describe the applicant’s previous experience with chemotherapy.** (Check all that apply and answer the process statement.)

- [ ] Mix  
- [ ] Administer  
- [ ] Monitor during treatment  
- [ ] Assess for side effects

**Is the applicant an oncology certified nurse?**

Describe the applicant’s current or future certification in oncology nursing.

**Discuss healthcare worker risks when giving chemotherapy agents.**

**Date of hire:**

**PLAN**

(This is devised during the initial orientation with input from the new nurse, typically three to four weeks after starting the new position.)

**Phase 1**

Observe preceptors and other staff members during chemotherapy administration for one to six months *(varies based on experience and skill set).*

- **Date received the most recent copy of the *Chemotherapy and Biotherapy Guidelines:***  
- **Date studied the agents used for patients under the nurse’s care:**  
- **Date practiced dose calculations with preceptor:**  
- **Date attended cancer pathophysiology class:**  
- **Date attended Chemotherapy 101 (i.e., one-hour introductory class):**  
- **Date attended the 16-hour chemotherapy course:**  
- **Score on chemotherapy examination:**

**Phase 2**

Date(s) an experienced oncology nurse observes administration of two to five different agents, including one vesicant:

**Phase 3**

An error prevention team member observes the use of personal protective equipment during chemotherapy administration and while caring for patients who have received chemotherapy.

- **Date (one month after phase 2):**  
  - **Findings:**
- **Date (three months after phase 2):**  
  - **Findings:**
- **Date (six months after phase 2):**  
  - **Findings:**
- **Date (nine months after phase 2):**  
  - **Findings:**

**Phase 4 (12 months after passing the chemotherapy course in phase 2)**

Written open-book examination

- **Date:**
- **Score:**  
- **Findings from observation of clinical techniques:**

---

*Figure 2. New Employee Chemotherapy Assessment and Education Plan*
multiple-choice questions addressing issues concerning orders, chemotherapy administration, and side-effect management. After completing the initial examination and clinical practicum, novice nurses were retested yearly. An open-book examination also was administered yearly to the experienced oncology nurses. The nurses had a week to complete the examination, which included questions regarding new agents in use after the last test, safety concerns identified at the organization, and issues documented in the literature. The examination was pilot tested to ensure that the questions were clear. If the nurses had any issues about specific questions, they were encouraged to voice those concerns, just as they would with a confusing chemotherapy order. Many experienced nurses wanted immediate feedback on their results and set up appointments after the testing period to retrieve their scores. Although generating a new examination each year is time consuming, a yearly examination allows for testing about new agents, can be a tool to address process issues that occurred during the previous year, and ensures that staff members are aware of any new processes that occurred during the past year. Also, an open-book examination promotes collaboration among staff members, encourages discussion of relevant issues, and helps ensure that staff members are aware of resources and know how to use them.

Patient education was another aspect of the nursing program. Because informed patients and their family members are a vital component of patient safety programs, they can participate in the chemotherapy administration process in various ways (Oncology Nursing Society, 2001). The nurses were taught how to educate patients and family members about the chemotherapeutic agents and the treatment regime and to encourage patients to actively participate during the time-out that precedes chemotherapy administration. For example, the patient and family members review chemotherapeutic agents with the nurse before administration, verify the identity of the agents to reduce the risk that they will be administered to the wrong patient, and confirm that the chemotherapy is being administered at the correct time (e.g., every four weeks).

In addition, nurses were taught to instruct patients about the institution's safety procedures, such as nurses' double check of prepared chemotherapeutic agents, the waste disposal policy, and the need for nurses to wear personal protective equipment. With an ongoing approach to education about chemotherapy treatments, patients and families are encouraged to ask questions and obtain satisfactory answers.

Another important point that was stressed in the revised nursing education is that patients and family members can be instrumental in averting medication errors when they perceive something unusual and need to be supported when they assertively express their concerns. In such cases, nurses are taught to stop and take a time-out to address the concerns. Nurses also were taught how to implement a new reporting process to identify potential or actual unsafe chemotherapeutic conditions.

Safe Handling of Agents

The safe handling of chemotherapeutic agents was identified as a vulnerable area for novice oncology nurses. The error prevention team assessed the location, placement, and types of personal protective equipment and spill kits to ensure that they were available and used appropriately. The error prevention team also studied hazardous waste containers and biologic safety cabinets because they are essential to the safe preparation, administration, and disposal of chemotherapeutic agents. As a result, the team instituted a schedule to routinely evaluate the use and availability of those components.

Evaluating the Education of Novice Oncology Nurses

Issues Related to Using the Quantity of Errors as a Measure of Success

Error prevention is an ongoing quality improvement process that requires continuous informal evaluation and a more formal periodic evaluation. Evaluating the effectiveness of medication

- Use the most recent version of the Oncology Nursing Society’s Chemotherapy and Biotherapy Guidelines and Recommendations for Practice when devising course content. At a minimum, each nurse should receive his or her own copy of the text. Pharmaceutical companies may be able to offer other reference books at no cost to nursing staff.
- Break the existing 16-hour course into two eight-hour courses scheduled a week apart. Obtain state board–approved continuing nursing education units for the program.
- During the course, share errors that happened at the organization and elsewhere as a learning opportunity.
- Include five-minute breaks every hour, in addition to a lunch hour. Serve high-protein foods with complex carbohydrates and a variety of fluids throughout the program.
- Consider the use of aromatherapy during the course.
- When reviewing individual chemotherapeutic agents, point out look-alike and sound-alike drug names (e.g., vincristine and vinblastine, docetaxel and paclitaxel).
- Drill nurses on calculating the absolute neutrophil count and chemotherapy dose.
- Although most orders may be preprinted, share examples of handwritten orders so that nurses gain experience in reading them.
- Teach the factors that increase the chance of human error (e.g., environmental, personal, task).
- Assign homework, including a chemotherapy order that contains an error, during the first class that should be completed before the second class. The assignment allows nurses to simulate what they would do in that situation. During the second class, each nurse presents the case.
- Explain how error reporting and near-miss information are used by the organization to improve care.
- Role-play how to educate patients and family members about treatment agents and regimens. Teach nurses how to apply the concept of a time-out before chemotherapy administration.
- Ask the nurses to write chemotherapy orders so they recognize what an order should contain.
- Describe the risks of hazardous drugs.
- Describe chemotherapy precautions and the organizational policy, give a demonstration of gowning and gloving, show samples of chemotherapy gloves compared with vinyl gloves, and open a spill kit and demonstrate its use.
- Ask nurses to demonstrate the use of a spill kit, gown, and gloves.
- Role-play accidental exposure.

Figure 3. Strategies to Enhance Learning During the Chemotherapy Course
error prevention programs has been difficult because, based on retrospective data, medication error rates historically have served primarily as the criterion for measuring patient safety. Problems with that approach include the unreliability of the data: specifically, voluntary reporting of medication errors captures only an estimated 47%–60% of actual errors (Blegen et al., 2004; Wakefield et al., 1999). Some medication errors are never detected, and many errors that do not harm patients often are not reported and thus are not included in the medication error data.

Prospective measurement of medication errors includes observational methods. One approach is to inform nurses that their medication administration practices are being observed; however, in one study, observation did not significantly affect the medication error rate (Dean & Barber, 2001). In other words, even when nurses knew that their medication administration techniques were being scrutinized, they made errors at the same rate as when they were not being observed. In another study, when disguised observation was used (nurses were told that the researchers were collecting data on common problems associated with medication administration), at least one error occurred in almost half (212 of 430 [49%]) of IV medication doses prepared (Taxis & Barber, 2003). The error prevention team ultimately decided to use a different approach to measure nurses’ application of their chemotherapy education.

### Effective Evaluation Methods

After completing the initial chemotherapy course, passing the first open-book examination, and completing the practicum, members of the error prevention team returned as observers to the chemotherapy administration areas to determine whether novice oncology nurses had integrated their new knowledge into their work practices. If noncompliance was discovered, the observers attributed it to a lack of understanding by the novice nurses rather than using a punitive approach. The use of error prevention processes was rechecked again at three, six, and nine months. The structured observations, along with daily observation by the supervisors, were used to verify that the nurses’ chemotherapy education was being applied.

The number of reported near-miss events was used in the evaluation of the revised chemotherapy education program and served as part of the ongoing assessment for chemotherapy safety. A near-miss incident was indicative of potential process problems. Flaws in the process were identified using a back-tracking approach, because, by definition, near-miss events are those that are averted near or at the last minute. Staff members who reported near-miss incidents were rewarded. Praising those efforts allowed nurses to see that the organization valued error prevention. Reporting near-miss events was recognized verbally and with a small token of acknowledgment, such as award certificates, modest gifts, and pins.

Nurses were encouraged to report occasions in which they discovered an error before it reached the patient (i.e., a near miss) (see Table 1). The information served to document the increased vigilance of the nursing staff and helped to identify process issues. The timeliness of the report also was used as a measure of success. If the report reached the error prevention team leader within one business day, it was considered a prompt report. In addition, two qualitative measurements—the number of unsolicited positive remarks from staff members who were involved in the chemotherapy process and the number of unsolicited remarks from patients and family members indicating that staff members were actively protecting patients during the chemotherapy experience—were used in the evaluation. Remarks such as “They are always checking the identification band here” and “Everyone takes time with you here” were viewed as positive indicators. The conclusion reached by the comments was that patients seemed to appreciate the efforts by the nursing staff to keep them safe.

### Conclusion

Complex multidrug chemotherapy protocols commonly are administered to patients with cancer; however, the potential for error exists at every step of the chemotherapy process. A proactive approach to chemotherapy education, combined with ongoing formal and informal evaluations, can be used to help novice oncology nurses prevent errors and thereby improve chemotherapy safety. Error prevention is an ongoing quality improvement process, in which nurses play a vital role.

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