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A Safety Mnemonic for Pediatric Oncology Patients: Knowledge, Confidence and Skills Accuracy During Simulation

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ORIGINAL ARTICLE

A safety mnemonic for pediatric oncology patients: Knowledge, confidence and skills accuracy during simulation

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Abstract

Cancer is the second leading cause of death in the United States, surpassed only by heart disease [1]. Approximately 1.6 million Americans will receive treatment for a variety of cancers annually [2]. This increase in oncology nursing care opportunities highlights the need to ensure that nurses have the skills, knowledge, and tools that allow them to safely provide care. Because Undergraduate nursing education often does not provide in-depth coverage of the principles of safe oncology nursing care required for children or adults, this study addressed protocols used when caring for chemotherapy pediatric patients using a chemotherapy mnemonic. The purpose of this pilot study (N=85), using quasi experimental methods, was to investigate the effect of a teaching intervention using a "safety" mnemonic and high fidelity simulation to investigate the effect of the teaching intervention and mnemonic on students' reported confidence, knowledge of oncology nursing care content, and skills accuracy. The CHEMO SAFE SOUND mnemonic was evaluated by oncology expert nurses for construct and content validity, and for accuracy of chronology (steps). Results demonstrated that students' confidence was increased by the activity and the use of the mnemonic. Students scored high on the knowledge pre-test. Only 55% of the students (N=70) were able to perform a sterile procedures and 85% of the students (N=108) were able to state the full safety mnemonic accurately. Further research is needed to investigate how students perform on the skills prior to the simulation. An expansion of the methods should include a pre-intervention assessment of chemotherapy skills. A larger sample size should be used and repeated measures to capture retention should be implemented.

Key words

Chemotherapy, Simulation, Mnemonic, Safety

1 Background and significance

In 2012, it was estimated that there were 1,638,910 new cases of cancer in the United States. It is anticipated that about 577,190 Americans will die annually from cancer as it accounts for almost one of every four deaths. Cancer is the second leading cause of death in the United States, surpassed only by heart disease [1]. Due to screening the mortality rate of some cancers has decreased, such as breast cancer, cervical cancer, colon cancer, and prostate cancer (http://www.cdc.gov/cancer/dcpc/data/types.htm). The incidence of other cancers increased between 1975 and 2008 such

as melanoma [2]; tobacco related cancers remain high world-wide [2]. According to the World Health Organization, in 2004, 1.6 million of the 7.4 million cancer deaths, or 22%, were related to tobacco use [3].

It is clear that the need for cancer treatment remains high. Approximately 1.6 million Americans will receive treatment for a variety of cancers annually, with a lifetime risk of a cancer diagnosis being 1:2 for males and 1:3 for females. Vulnerability increases as the population ages [2]. Caring for and providing treatment for patients with cancer diagnoses is becoming more common in acute and critical-care settings [4]. However, nurses may encounter patients with cancer in a variety of settings including in-home and out-patient settings.

Individuals with cancer may be recently diagnosed, experiencing radiation therapy, chemotherapy, maintenance therapy, or in recovery, remission, relapse, or in hospice care. When the patient is receiving chemotherapy, nurses may also provide patient care across three phases of treatment; pre-chemo, intra-chemo, and post-chemo care. This increase in oncology nursing care opportunities highlights the need to ensure that nurses have the skills, knowledge, and tools that allow them to safely provide care for these individuals. Nurses must be educated and ready to respond to the unique needs of the patient with cancer throughout the trajectory of treatment, whether the nursing care is focused on pediatric or adult patients. While patients may receive cancer treatment in various ways including surgery, chemotherapy, gene therapy, hormone therapy, radiation, immunotherapy or using alternative or holistic methods [5], this study addressed protocols used when caring for chemotherapy pediatric patients using a pediatric chemotherapy mnemonic. This mnemonic was tested with under-graduate nursing students.

Undergraduate nursing education does not provide in-depth coverage of the principles of safe oncology nursing care required for children or adults. The National Council Licensure Exam for RNs [6] covers safe effective care (management and safety/infection control), health promotion and maintenance, psychosocial integrity, physiologic integrity (basic care/comfort, pharmacology, risk reduction, and physiologic adaption), but does not specifically deal with how to care for the oncology patient. The Oncology Nursing Certification Corporation [7] provides certification for the experienced oncology nurse and the advanced practice oncology nurse, but the topic of oncology nursing care and cancer treatment has little representation in BSN student learning outcomes and typically takes place in advanced practice nursing oncology programs, such as oncology clinical nurse specialists programs. Given the likelihood that a new nurse may be assigned to care for a patient with cancer in an acute care setting, the undergraduate entry level nursing courses should provide more information about the basics of caring for an oncology patient, with tools that support those entering the oncology nursing profession as new grads. Because nursing students may not have ample exposure to the oncology patient and/or the experiences that would familiarize them with the practice, when new graduates begin their careers, their knowledge is limited, and they may be disinclined or reluctant to work in oncology nursing practice.

At this university, students are exposed to oncology content in their first medical surgical course in their sophomore year; one part of a weekly theory presentation is devoted to the principles of cancer pathology and basics of nursing care. Pediatric/family health care nursing, in the students' junior year, has one unit devoted to childhood cancer pathology, incidence and prevalence, cancer treatment overview, complications of treatment, and symptom management. In the senior year the advanced med surg course offers no learning objectives concerning cancer or cancer nursing care. Unfortunately, within the greater curricular perspective, the few objectives that do exist do not provide adequate information and guidance to increase students' oncology knowledge, skills, or confidence in supporting the cancer patient.

Historically, new graduate nurses were not offered positions in oncology nursing practice as their first nursing job. Now, with the increasing need for this expertise, new graduate nurses can expect to care for oncology patients, across the life span, in a variety of settings.

The purpose of this pilot study was to use quasi experimental methods to investigate the effect of a teaching intervention using a "safety" mnemonic and high fidelity simulation for pre, intra, and post chemotherapy administration and nursing

care and to investigate the effect of the teaching intervention and mnemonic on students' reported confidence, knowledge of oncology nursing care content, and skills accuracy.

Research Questions:

- Do BSN nursing students report greater confidence in working with oncology patients after an educational intervention using a mnemonic for the care of an oncology patient?
- Do BSN nursing students report greater knowledge after exposure to a pediatric oncology patients care scenario using high fidelity simulation?
- What is the accuracy level of students' skills (observed) after the student participates in an educational intervention, using a mnemonic on safe oncology nursing care, and a pediatric oncology case study of pre, intra, and post chemotherapy administration?

Purpose

This quasi experimental pilot study was designed to gather data related to the relationship between confidence, knowledge, and skills accuracy during high-fidelity simulation learning environments, and to identify if an intervention including a mnemonic would influence the students' confidence, knowledge, and skills.

2 Literature review

2.1 Simulation

High-fidelity nursing simulation is the use of high technology life-like mannequins in a simulated clinical environment to teach nursing students the art and science of nursing, or to teach working nurses improved practices, new nursing techniques, or the use of new technology. It is used in both the hospital setting and in nursing education. Advantages are listed as psychomotor skill development, enhanced higher problem-solving and interactive activities, active learner involvement in a real-life situation with consequences, and a guaranteed safe, nonthreatening learning environment [8]. Simulation has shown to be an effective clinical adjunct to hands-on patient care [9]. When clinical educational experiences are difficult to find for pediatric nursing students, simulation is an excellent resource for high risk and low frequency patient experiences in a safe learning environment where participants can receive feedback and guidance. Despite the potential anxiety experienced by the students [9], high-fidelity nursing simulation has been championed as an environment where students can practice without the risk of harming a live patient; the underlying focus being patient safety.

Research suggests that high-fidelity nursing simulation does not replace working with patients, but provides opportunities for students to expand knowledge, utilize critical thinking skills, and build self-confidence in a "safe controlled environment" [10]. High-fidelity nursing patient simulation provides an environment where students can learn in a "complex yet risk-free environment." Others suggest that high-fidelity nursing simulation is helpful in identifying system flaws, problem solving, achieving root cause analyses, and teaching psychomotor skills to nursing students.

Students often perceive high-fidelity nursing simulation as a valuable learning experience, one that improves their self-confidence; increases their awareness; one that is realistic; and one that assists them in gathering data. Additionally, they value the active learning activities [10-14].

2.2 Chemotherapy administration

Care of the oncology patient can be conceptualized through three phases; pre-chemotherapy, intra-chemotherapy, and post-chemotherapy monitoring and care. Pre-Chemotherapy care is focuses on education, consenting the patient or

guardian, and preparing a safe environment. The patient needs to be assessed for potential complications due to the toxicity associated with chemotherapeutic medications including hydration, alkalization and bone marrow stabilization.

During chemotherapy care the focus is on maintaining a safe environment by double checking protocols, dosing calculations, administration guidelines, and by monitoring safe physiological hemostasis. Special attention is given to early chemotherapy associated toxicities and immediate side effects.

Post-chemotherapy care focuses on fluid status, symptom management, education on late effects, securing follow up appointments and laboratory values, and safe home care.

2.3 Mnemonics

Mnemonics are memory tools and the use of mnemonics in health care is a well-established practice. For example "ABCs" of Cardio/pulmonary Resuscitation, SAD to recall aortic stenosis symptoms of Syncope, Angina, and Dyspnea, and the "PRACTICE" mnemonic (prevalence, risk, attitude, communication, testing, investigation, consent, empowerment) to help health care providers provide culturally competent care (http://www.ncbi.nlm.nih.gov/pubmed/16306282). Mnemonics that support skills and competencies can be based on the learning and demonstration of pediatric advanced life support, neonatal resuscitation program, assessment of neurological status such hard-to-memorize cranial nerve assessment. Recall of basic and advanced nursing care can be enhanced by the use of validated mnemonics. Mnemonics are considered an acceptable way to quickly recall important information contained in a long sequence; however, few have been researched to test their effectiveness.

3 Method

After Institutional Review Board for the Protection of Human Subjects (IRB) was secured, instruments were developed and vetted, mnemonics developed, and data were collected during three semesters with three different groups of students.

3.1 Sample

The sample included 83 junior level baccalaureate nursing students who were part of three pediatric nursing theory/clinical courses offered over three academic semesters. Of the sample, 91% were female. The simulation experience was in lieu of a clinical day for the students. All students enrolled in the pediatric nursing theory classes rotated through the simulation experience on one of their assigned clinical days. Students were recruited by way of an announcement that the day included an opportunity to participate in a research study to expand the science of oncology nursing. The students acted as their own control group as the researchers conducted a quasi-experimental design using pre-test post-test.

3.2 Instrument development

The instrument to measure knowledge was developed by investigators supported by a review of the literature, feedback from professional oncology nurses, and suggestions from the Director of Simulation at the university. The instrument posed 10 multiple choice items related to students' knowledge of oncology care and five Likert scales related to confidence caring for patients with cancer. Content and construct validity of the multiple choice test items and the confidence scales were secured by feedback from two professional (one BSN and one MSN) pediatric oncology nurses who provide care at a large teaching hospital in San Francisco, California. Cronbach's alpha for the pre-test confidence levels was a=.891 (5, 82), for post-test confidence level it was a=.881 (6, 82).

3.3 Mnemonic development

Four oncology nurses were asked to review the CHEMO SAFE SOUND mnemonic for construct and content validity, and for accuracy of chronology (steps) of the mnemonic. One of the oncology nurses is a Clinical Nurse Expert and Pediatric Oncology Case Manager. The other three oncology nurses are charge nurses who work at a large Bay Area intercity

teaching hospital and who encounter pediatric oncology patients receiving chemotherapy on a daily basis (see Table 1). Feedback was collected in writing and compared for input. The mnemonic was pre-tested during the researcher's own clinical practice on several children receiving chemotherapy and was deemed rigorous enough for entry into clinical practice. The purpose of the mnemonic was to support students and practicing nurses when administering chemotherapy to children in order to be safe and organized.

Table 1. Pediatric oncology simulation mnemonic

Pre-Chemo:
C: Consent procedures complete for treatment? Cancer treatment protocol "roadmap" secured from national pediatric oncology treatment organization and reviewed.
H: Health Assessment including vital signs, urine pH and specific gravity, CBC, electrolytes, pain assessment and overall developmental status of child
E: Evaluation of parent's or the guardian's understanding of impending treatment plan including assessment of need for language interpreter
M: Securing the presence and engagement of child's mother and/or father, primary caregiver/guardian to provide emotional support, distraction and play as tolerated
O: Overview of treatment road-map including specific pre-chemotherapy requirements such as adequate absolute neutrophil count, minimal platelet count, adequate urine specific gravity, urine pH and any other pre-treatment diagnostics such as audiogram, cardiac echo, chest x-ray and further laboratory studies to provide a safe patient status before drug administration
Intra-Chemo:
S: Safe Administration: double blind two-nurse check of body surface area calculation, correct medication dosing, route, and timing against the protocol "road map" treatment plan. Ensure a pre-chemotherapy call to oncologist to ensure safe treatment go-ahead.
A: Assessments of intravenous central line site and adequate blood return to prevent extravasation of a vesicant drug
F: Provision of IV fluids to keep patient well-hydrated and maintain large volume urine out-put
E: Assessment of electrolytes if chemotherapy drug is electrolyte-wasting (potassium, sodium, magnesium)
Post-Chemo:
S: Symptoms needing attending to such as nausea, fatigue, fear and anxiety
O: Observation for adverse effects of chemotherapy drugs (i.e., allergic reactions)
U: Adequacy of urine out-put as evidence of excreting the chemotherapy appropriately
N: Need for nursing care/further education during the post chemotherapy period such as home care needs for central line care, follow-up pediatric oncology clinic visits during myelosuppressive (post chemo nadir with neutropenia, anemia and thrombocytopenia)
D: Drugs needed for symptom management such as nausea and mouth care, also need for post treatment chemo-protective drugs such as Leukovorin rescue or doses of Mesna to protect the bladder from hemorrhagic cystitis.

3.4 Procedures

After informed consent was secured, all students were given a packet with an article that covered the basics of pediatric oncology cancer care: Pediatric cancer; a comprehensive review. Part 1: Biology, epidemiology, common tumors, principles of treatment and late effects [15], a list of learning objectives for the day, a handout that covered the principles of cancer nursing, and the research instrument with three sections; demographics, confidence scales, and a knowledge test that included basic questions related to the pediatric cancer patient. Each packet was designated "pre-test". A one hour seminar to review the packet and the six educational components took place prior to the simulation experience (see Table 2).

After orientation to the simulation environment by the primary investigator (also the simulation educator), the students were divided into two groups; group one demonstrated their skills by accessing an implanted port central line with a sterile dressing change kit and Huber needle, drawing laboratory specimens and flushing the line with normal saline and heparin 100 units per 1 ml. Group two was given report on a newly diagnosed pediatric patient requiring chemotherapy (see Table 3). They participated in a simulation and debriefing. The groups then switched off so all participants had the opportunity

for skills practice and simulation. Simulations were video-taped and maintained for subsequent review and skills accuracy rating. After rotating between the two stations, located in two different environments, the students came back into the classroom for completion of the post-test. After the post-test was complete, a debriefing took place and the simulation day ended with practicing a chemotherapy spill with a commercially prepared chemotherapy spill kit. The entire educational experience, simulation, skills practice and data collection took approximately 4-5 hours each session. There were 6-8 students per session, repeated over the three academic semesters. Forty-two of the students' responded to both pre and post-test and were matched, 41 students took the pre-test and the post-test but the scores were not matched. Forty one were not matched because the researchers were developing the research protocol and did not maintain data in such a way to match the pre-and post-test.

Table 2. Teaching learning pre-simulation session

1.Review of cancer nursing responsibilities, need for medication administration safety, and an overview of the specialty of pediatric oncology in general
2.Review of mission and vision of the Association of Pediatric Oncology/Hematology Nursing (APOHN): quick web site review
3.Basic principles of the physiology of cancer, tumor growth and spread, and staging of cancer histology
4.Review of two case studies a. Infant with new diagnosis of acute lymphocytic leukemia requiring immediate placement of a central line and the initiation of chemotherapy treatments. b.The same infant six months later who presents to the emergency department with rule/out sepsis; fevers, neutropenia and stomatitis (mucositis)
5.Introduction to the principles of chemotherapy treatment: drug classifications and the meaning of induction, consolidation, maintenance therapy phases as well as a review of pediatric cancer treatment "road maps" used to determine the course of treatment for a child with high (infant) acute lymphocytic leukemia.
6.Maintaining patient and staff safety; using a mnemonic for pre-, intra- and post-chemotherapy administration: Mnemonic was CHEMO SAFE SOUND

Table 3. Case study: Infant with new diagnosis of all

Ten-month-old infant girl demonstrated 3 week history of fevers, fussiness, poor oral intake and irritability. She was seen in public health clinic and treated for a urinary tract infection and bilateral otitis media. After two courses of antibiotics, her mother brought her to an acute care pediatric emergency room with continued fevers and wt loss. An assessment of her laboratory values demonstrated the possible diagnosis of leukemia.
The mother is a single parent of three children. She is Cantonese speaking only. She works full time and lives with her mother who provides the childcare during the day. The family has no means of transportation other than the city bus system. They live in a small one bedroom apartment quite a distance from hospital.
Upon initial assessment in the ER, the child's laboratory studies indicated:
CBC with manual differentiation demonstrating a WBC of 82,000. Microscopic evaluation demonstrated early indication of acute lymphocytic leukemia (ALL).
The child was immediately admitted to the acute care pediatric unit and scheduled for a single lumen central line placement and chemotherapy induction.
Family at bedside needing teaching and support
The Children's Oncology Group road map was delivered to the floor by the primary pediatric oncologist and chemo therapy was to start after the central line was placed. Consent was obtained by the use of a Cantonese interpreter during the first family conference.

3.5 Data collection and analyses

Data were collected two times per group - as an assessment of the students' pre-simulation confidence and knowledge, and for participants' post-simulation confidence, knowledge, and skills accuracy. Faculty used the video-taped copies of the students' skills performance during the simulation to rate the overall skills accuracy of the students' performance. Quantitative data were analyzed using SPSS ® statistical software. Analyses included frequencies, descriptive,

independent and dependent t-tests, and reliability testing. The alpha level established for this study was .05. There were a total of 83 pre-tests and post-tests, of these 42 were matched pairs.

4 Results

4.1 Confidence scores

The confidence scores were collapsed into pre-test confidence scores and post-test confidence scores resulting in a confidence mean for each student. The confidence levels ranged from 0-10. Given that the students had little or no experience in care of the oncology patient, care of pediatric oncology patients, care of the chemotherapy patients, and in maintaining safe oncology environments, the base confidence level for the one-sample t-test was set at two for the one sample t-test; this assumed that some would say they were more confident and others would not feel confidence at all. The anticipated confidence level of post-intervention confidence was set at six, not because we believed that the students would improve as much but because this is what we felt the students' perception of their improvement would be. Paired differences are in Table 4.

Table 4. Student ratings – Matched pairs

		***t*-value**	**df**	**Sig (2-tailed)**
Pair 1	Rate your confidence concerning the care of oncology patients on a 0-10 scale	-9.862	41	$p<.001$
Pair 2	Rate your confidence concerning the care of pediatric patients with cancer on a 0-10 scale	-9.739	41	$p<.001$
Pair 3	Rate your confidence concerning the care of oncology patients receiving chemotherapy on a 0-10 scale	-10.494	41	$p<.001$
Pair 4	Rate your confidence concerning maintain a safe environment for oncology patients on a 0-10 scale	-9.188	41	$p<.001$
Pair 5	Rate your confidence concerning the care of a central line for oncology patients receiving chemotherapy treatments on a 0-10 scale.	-9.407	41	$p<.001$

4.2 One-Sample T-Test

The one-sample pre-test for confidence found significant differences. Students' confidence levels were higher than the pre-test level of two we anticipated. Students' pre-confidence mean was 2.76, sd = 1.86, $t = 3.371$, $p < .001$, n=83; the means ranged from 0 to 8. The highest value was that of "Confidence in maintaining a safe oncology environment" with a mean of 3.78, sd=2.72, $t = 6.052$, $p < .001$. The lowest values was "Confidence in the care of patients receiving chemotherapy", with a mean of 1.86, sd = 1.97, $t = .660$, $p = .511$.

The findings for the one-sample post-test for confidence were more in line with what we anticipated when setting the mean at level six. Students' mean was 6.25 and the difference was not significant.

4.3 Paired-sample T-Tests

The paired samples t-test (n = 42) revealed significant differences for confidence. The pre-test confidence mean for collapsed variables was 2.77 and the post confidence mean was 6.09 with a mean difference of -3.32. The differences were significant, $t = -12.19$, $p < .001$. All five line items were significant at $p < .001$. (See Table 4)

4.4 Knowledge

Student responses to the knowledge questions were coded as 0 = incorrect or 1 = correct. The differences between pre-test and post-test knowledge were insignificant.

4.5 Skills

Students were assessed on two skills during the post-intervention time period only. All simulations were audio/visually taped for later analysis. Faculty scored performance on the preparation of a sterile procedure for a central line dressing change and their ability to state the information on the safe chemotherapy mnemonic during the simulation. Only 55% of the students (n=45) were able to perform a sterile procedure accurately for central line dressing changes, and 85% of the students (n=70) were able to verbally state the full chemotherapy administration safety mnemonic accurately during the simulation.

5 Conclusions

Students' confidence was increased by the activity and the use of the mnemonic. However, given that only 55% of the students were able to correctly perform the sterile procedure in simulation, it seems that more frequent or similar activities are required to boost the students' skills. On the knowledge test, there may have been a ceiling effect for some of the questions since the students scored high on the pre-test and post-test. On some of the questions the responses were low both pre and post-test which may suggest the students' need for more specifics on topics of leukemia, symptom management, and treatments.

5.1 Recommendations

One aim of this study was to create recommendations as to how to educate nursing students during high-fidelity nursing simulations on the comprehensive care of the pediatric oncology patient. Specific recommendations are included but are not limited to those defined in Table 5.

Table 5. Recommendations for expanding the educational experience

1. Debriefing: students request that future simulations include simulations that provide experiences with a young adult, middle adult and older adult with various cancer diagnoses and throughout the three phases of chemotherapy care in order for students.
2. In order to provide a more rigorous evaluation of the students' knowledge, give a more detailed evaluation of knowledge to include questions about chemotherapy drugs, care of a central line, electrolyte imbalances and untoward reactions to chemotherapy infusions.
3. To support student learning, insure the students practice the mnemonic out-loud several times, with accuracy, before beginning the simulation.
4. As part of the learning process, provide students with a copy of their data collection video for skills accuracy so they can view the tape and discern their own knowledge and psychomotor skill deficits.

5.2 Discussions

Mnemonics are used widely in medicine and nursing practice. There are many medical/nursing-related mnemonics available to provide a mental pathway to retrieve necessary information.

Student evaluation may be seen as a "judgment of personal work" [8]. Students may perceive anything less than a perfect performance will be seen as evidence that they are incompetent or that they may be somehow punished such as receiving a failing grade. This reduces student's self-esteem and increases their anxiety. While this study is not about learning theory, it is important to recognize that stress and anxiety experienced during the oncology simulation may have impeded learning and therefore performance. Being "new" at oncology nursing care principles may have affected the overall post-intervention scores.

5.3 Limitations

The limitations of this study included the relatively small sample size and the inclusion of only junior level nursing students in their Family Nursing (Pediatric nursing) course. Additionally, researchers did not know how many students had experienced the care of an oncology patient during their education. All students enrolled in the pediatric nursing course over two academic semesters were requested to participate; therefore there was no control group. An additional limitation is that the content and construct validity of the instrument was determined by the investigators, one advanced practice pediatric oncology nurse and one pediatric educator. Further experts in the field of high-fidelity nursing simulation should have been asked to for a review.

The mnemonic should go through a stronger and more thorough validation process using solicited feedback from multi-disciplinary members of an oncology team (nurses, pharmacists, and oncologists) to determine both content accuracy and sequence accuracy. This mnemonic should be assessed to determine if it is appropriate for both entry level as well as experienced oncology nursing practice through a rigorous validation study.

The most crucial limitation of this preliminary study was the incomplete data set of the video tapes used to assess skills accuracy. Fine tuning in placement of cameras, sound quality and safe storage of the video tapes needs to be secured before a replication study is performed.

5.4 Suggestions for further research

Further research is needed to investigate how the students performed on the skills prior to the simulation. For this preliminary study, there was no assessment of the student's pre-intervention skills on central line accessing and care, safety principles of pre-chemotherapy and intra- chemotherapy. Due to this limitation, further research is needed to expand the methods to include, at a separate session, a pre-intervention assessment of safe chemotherapy skills.

Faculty should continue to ask students how we can best prepare them for confidence in caring for patients with cancer anywhere along the care trajectory. A descriptive study should be performed to investigate what students perceive as needed skills and knowledge through their lens' and diversity in pre-research clinical experiences.

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