

## Research Article

# Effectiveness of a Nursing Intervention Protocol for Chemotherapy Induced Neutropenia: Nurses and Patients' Related Outcome

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**Submitted:** 16 September 2015

**Accepted:** 15 December 2015

**Published:** 17 December 2015

**ISSN:** 2379-9501

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**Keywords**

- Neutropenia
- Chemotherapy
- Evidence
- Protocol
- Nursing

**Abstract**

**Introduction:** Chemotherapy induced neutropenia (CIN), is a significant problem among cancer patients receiving chemotherapy. CIN is causing serious complications in approximately 80% of patients. There is a pressing need to design evidence based nursing protocols to provide safe and effective care for patients with neutropenia.

**Methods:** The aim of present study has three – folds. First was the assessment of nurses' knowledge and practices for management of CIN patients; the second was the development of an evidence-based nursing intervention protocol according to most recent strong evidences of neutropenia management and the nurses' educational needs; and finally applying the developed protocol and thereafter evaluating its impact on nurses, as well as patients' knowledge and practice. A Quasi- experimental research design was utilized in this study. A convenient sample of 30 oncology nurses, as well as thirty patients was recruited from Oncology Department of Assiut University Hospital. Tools: data collection instruments included; nurses CIN knowledge test; neutropenia guideline observation checklist for evaluating nurses' practice compliance with designed protocols; patients' CIN test; and checklist to assess patient's' practices related to oral care and hand washing.

**Results:** Mean scores for nurses' and patients' post protocol knowledge as well as practice level were significantly higher than the pre protocol scores. A positive significant correlation between total knowledge and practice scores was observed.

**Conclusion:** Designing and implementing evidence based nursing intervention protocol is important for improvement of nurses' knowledge and practice and enhancement of patients' outcomes. Providing patients and their families with the necessary knowledge and practice through implementation of educational programs is a must to equip them with the necessary skills for prevention and management of problems related to alteration in protective mechanisms.

**ABBREVIATIONS**

CIN: Chemotherapy Induced Neutropenia

**INTRODUCTION**

Patients undergoing myelo-suppressive chemotherapy are at risk of developing neutropenia (defined as an absolute neutrophil count below 500/mm<sup>3</sup>), a matter which may lead to life-threatening infections that may quickly lead to sepsis, and death [1,2]. Severe neutropenia and febrile neutropenia (FN) are therefore major causes of morbidity, treatment interruptions and dose reductions in patients undergoing chemotherapy [3].

In addition to clinical impact, the economic impact of neutropenia is considerable [4]. As the rates of hospitalization for febrile neutropenia are extremely high as well as the durations of

such hospitalization are long, this consequently puts a significant economic burden on the healthcare system [5]. Preventing infections including FN is thus extremely important for a successful chemotherapy outcome. Nurses play an important role in the prevention, detection and management of neutropenia, as well as provision of information to patients for ensuring better compliance rates [6].

Nurses should better identify patients at risk for developing neutropenia and monitor patients who already have it for better initiation of interventions to improve patient care as well as improving QOL in patients with cancer receiving chemotherapy [7]. It is also vital that nurses understand the physical, psychological and cost implications to enable them to support patients. Nurses can help families to engage in caring, lend support to family's integrity during the CIN experience;

although the benefits of which may not be evident to the nurse immediately, the long term gains are significant [8].

[6], in the survey of nurses and patients' viewpoints of cancer therapy and neutropenic infections, suggested that there may be a need for improvement in a number of areas of oncology care, including; communication between patients and healthcare professionals as patients need to receive understandable and timely information; links to information for healthcare professionals; provision of effective prophylaxis against neutropenia. Among all, patient education is considered the most crucial for neutropenia management. Oncology nurses need to offer patients tangible education and take-home tools to reinforce what to do when potentially neutropenic to minimize delays in seeking medical attention and the risk of life-threatening sepsis [2]. Patient education should include teaching about the potential for and consequences of neutropenia, preventive measures to decrease the risk of infection, reportable signs and symptoms of infection, and what to do when signs and symptoms occur [9]. However, wide variations exist in what patients are taught, and few evidence-based protocols are available to guide nursing practice and patient education in this area [9].

Staff members should be well prepared and equipped to identify, prioritize, and develop strategies for treatment while getting patients involved in making decisions about treatment because compliance with therapy may be poor if patients do not perceive that treatments are achieving the improvements [7]. There is no definitive evidence about why patients delay seeking help for what might be a fatal condition, if staff does not fully understand the seriousness of this condition, they may not respond quickly and appropriately to the situation. This is highlighted as a specific concern in the need for educating patients and health care providers which should therefore be mandatory and required [10].

Few hospitals had clear policies on neutropenic prophylaxis or the management of patients at high risk. Such policies should be considered mandatory for effective practice; because most of the patients had indicators of high risk for developing neutropenic sepsis and may have benefited from a more proactive approach [10]. The care of immunocompromised patients therefore represents a significant infection control challenge [11] especially for developing evidence-based practice that is cost effective and humane. In nursing, evidence-based practice builds on the premise that making clinical decisions according to the best evidence, via the combination of research literature and clinical expertise, to improve the quality of care and thereafter the patient's quality of life [12].

In recent years, several excellent articles have illustrated the use of research to guide evidence-based practice [13]. Prompt treatment requires development of standards of practice, through put processes and patient and staff education via coordination and communication [2]. Educational tools should be developed and used to reinforce what patients and families can do to reduce the risk of life-threatening complications; moreover nurses should be encouraged to implement this best practice model and to develop educational tools to improve clinical outcomes for this high-risk population [2].

Nurses have a great opportunity to apply such evidence-based guidelines to more effectively minimize the risk of CIN. Reducing the risk of chemotherapy-induced neutropenia and related infections make the use of full-dose chemotherapy possible despite their greater risk of myelo-suppression. Early prediction and treatment of neutropenia is clinically important for ultimate clinical outcome of patients. Ongoing patient and family education and teaching patients to recognize and report early symptoms of potential problems should therefore be integral to such practices. By predicting those patients who have an underlying infection, it may be possible to reduce septic admissions during chemotherapy as well as maintaining low mortality rates [14].

Nurses are therefore the key members of the multidisciplinary teams and the primary advocates of supportive care for their patients (Moore & Crom, 2006). Oncology nurses, who serve as liaisons between oncologists and patients, can have a positive effect on patients' outcome by educating them about potential side effects and the availability of supportive therapies, and by bringing patients' concerns and priorities to the attention of physicians. They can take a more active role in improving the quality of care provided to patients by participating in continuous quality improvement programs and the development and implementation of guidelines for neutropenia [15]. [1], emphasized that oncology nurses are in a unique position to use the results of clinical trials to influence treatment decisions with regard to supportive care, they also added that implementing evidence-based guidelines is another way to improve supportive care. However, the extent to which the guidelines are implemented and how it might improve patient care is not clear [16].

It is considered the 'duty' of oncologists and the specialist nurses to remind patients about their increased infection risk based on the neutrophil count and document these in the notes which can lead to, at least in severe restrictions in patients' physical, social and psychological well-being [17]. Although nurses have these important responsibilities, CIN clinical practice guidelines have not been widely disseminated directly to oncology nurses through publication in nursing journals or continuing education programs [16]. Considerable gaps in evidence exist in the areas of clinical practice, research, and education related to the prevention and management of infection in HSCT recipients with chemotherapy-related neutropenia [18]. Nurses have a holistic perspective, giving them a wider and more comprehensive view of the scope and breadth of the problem of infection in patients with neutropenia. Nurses should take advantage of their unique role to fill in the gaps that contribute to morbidity and mortality in this population [18]. [11] further added that Nurses also can improve clinical practice by creating patient care policies for adults, educating health care staff about evidence-based best practices [5,1].

To sum up, neutropenia presents a significant problem for immunocompromised patients; guidelines which include mandatory precautions are therefore required to reduce the risk of infection. However there are controversies over the different medical and nursing practices. There is evidence that, regardless of practice type or size, implementing guidelines for CIN management within a multidisciplinary team could improve

patient outcomes [4]. Guidelines also promote uniformity of care, patients reassurance particularly for those who are seen by many different clinicians within a large healthcare system, give less-experienced healthcare providers a basis for making decisions and can help more-experienced clinicians stay up-to-date with the latest evidence [4,9,20,21]. Collaboration is thus required between clinicians and researchers to develop and systematically evaluate nursing intervention protocol to improve care for those patients. Such evidence based interventions should be directed toward enhancing nurses and patients' knowledge about the current interventions designed to reduce the rate of infection among neutropenic patients and therefore improving practice.

### Significance of the Study

Chemotherapy induced neutropenia (CIN) is a significant phenomenon for adult cancer patients and a serious complication of many chemotherapy regimen, occurs in approximately 80% of all patients undergoing treatment for cancer. CIN has significant negative consequences including; dose reduction, physical suffering, declining patient's quality of life, potential hospitalization, infection and serious mortality, and healthcare costs [22,23].

Oncology nurse plays critical role not only in the delivery of care, but also in patient education about the importance of recognizing and managing side effects and complications of cancer therapy. Reducing the risk of CIN and its complications with supportive care measures can improve patient' outcomes, quality of life, and reduce financial burden for both patient and the medical system [24,25].

Nursing protocols for the management of CIN could allow more patients to benefit from receiving chemotherapy at full dose on schedule, reduce practice variation, increase the quality of patient care and clinical outcomes, decreasing patient's readmission to hospital, or minimize the risk of neutropenia and its complications [26]. So there is pressing need to design nursing protocols to provide oncology nurses with the opportunity to acquire the necessary evidence-based knowledge and skills for safe and effective, quality care provision for patients' receiving chemotherapy.

## MATERIALS AND METHODS

### Aim of the study

The aim of the present study was three- folds: the first was to assess nurses' knowledge and practices related to managing patients with chemotherapy induced neutropenia, the second was to develop an evidence-based nursing intervention protocol according to most recent strong evidences for neutropenia management and nurses' educational needs. Finally, the study looked at the application of the protocol and the evaluation of its impact on nurses' knowledge and practices as well as patients' outcomes as indicated by their knowledge and practices as related to prevention, early detection and management of chemotherapy induced neutropenia.

To fulfill the aims of this study the following research questions:

1. What is the nurses' knowledge of CIN?

2. What are the nurses practice levels in management of CIN?
3. What is the effect of implementing nursing intervention protocol on nurses' knowledge and practices related to CIN management?
4. What is the effect of implementing nursing protocol on patients' outcome as indicated by their knowledge and practices related to prevention, early detection and management of CIN complications?

### Subjects and methods

**Research design:** A Quasi- experimental research design was utilized in the current study. Pre/post test design was utilized so the participants' pre-test results were considered as the control for comparing their post-test results.

**The study variables:** The independent variable in this study was the developed nursing intervention protocol while the dependent variables were: the nurses' knowledge and practices as well as patients' knowledge and practices related to prevention, and early detection of CIN complications.

**Setting:** The study was conducted in the Oncology Department at Assiut University Hospital, Egypt.

**Subjects:** A sample of convenience including all nurses (secondary school diploma nurse) working in oncology unit (n=30), in addition to a convenient sample of 30 cancer patients. Patients were recruited based on the following criteria: age above 18 years old regardless of their educational level, were on chemotherapy prior to the study, willing to attend educational sessions, free from oral mucositis, infection, chronic obstructive pulmonary diseases and diabetes mellitus.

### Study Tools: Data pertinent to the study were collected utilizing the following four tools

Tool I: Socio-demographic data sheet. This was developed to collect data pertinent to nurses' age, marital status, years of experience, position in the unit. While patient's socio-demographic sheet elicited data related to patient's age, marital status, education and occupation.

Tool II: Nurses' pre/ post knowledge questionnaire was used to measure knowledge level of nurses about chemotherapy induced neutropenia. This tool was administered to nurses before implementation of the protocol, immediately after the implementation as well as after two-month period later to evaluate the gain and retention in knowledge after implementation of the study protocol. It consisted of 48 closed and open ended questions.

Tool III: Neutropenia management observation checklist: data from this tool was collected before implementation of the protocol, immediately after the implementation as well as at two months follow up to evaluate the impact of protocol on nurses' practice level. It consisted of the following 4 main domains including: assessment and monitoring (body temperature, lab value, and signs and symptoms of infection), use of protective measures to decrease risk of exogenous infection, reporting (infection, reporting lab value) and recording (signs and

symptoms of infection, nursing intervention and patient teaching).

**Tool IV:** Patients' pre/post knowledge test was used before and immediately after implementation of the intervention protocol to evaluate patients' gain in knowledge about chemotherapy induced neutropenia, early detection and management of complications. It consists of 28 questions that were offered in a structured form during interview by the researchers.

**Tool V:** Observation checklist for assessment of patients' practice related to oral care (7 items) and hand washing (10 items)

Scoring system for theoretical part: each right answer was given a score of 1, the total score was (48 score for nurses' knowledge, 28 score for patients' knowledge). While Scoring system for practice part was as follow: each observed item, scored as either done correctly = 1 or not done = 0. The total scores for all items were (36 score for nurses' practice, 17 score for patients' practice). These scores were further classified as: unsatisfactory level (less than 50%), satisfactory level (from 50-70%) and good level (above 70%) for both theoretical and practical part.

## Procedure

**Phase one (preparatory phase):** this stage focused primarily on the development of the study tools. Knowledge questionnaire for patients as well as for nurses was developed after an intensive literature search of the knowledge that are necessarily required for effective CIN prevention, detection and management by both patients and nurses. The practice checklist for each party was also simultaneously developed parallel to the development of the knowledge test and the evidence based nursing protocol. Extensive literature search for most recent strong evidence as well as for standard care protocol to support and guide the development of the nursing intervention protocol was carried out by the researchers.

Description of the nursing protocol: content of the theoretical part focused primarily on developing knowledge related to CIN definition, the expected time of nadir, risk factors, causes, complications of neutropenia, nursing management (monitoring for vital signs specially body temperature, lab value). Institutional policies on use of protective measure to decrease risk of exposure to exogenous organism were emphasized, assessing skin and mucosal surface for breaks in natural barriers, inspecting potential site of infection (mouth & oral mucosa, rectum, wound, central line/ intravenous, and site of invasive procedures). Collaborating with physician regarding cultures, initiation of appropriate antibiotic therapy and patient response to treatment were also integral parts. Patient / family education was elaborated and details were provided concerning (signs and symptoms of infection, precaution and measure to prevent/minimize infection, when to contact health care member, oral care, personal hygiene and hand washing, coughing and deep breathing and healthy life style as good nutrition, plenty of sleep, and appropriate level of exercise, ambulation, the importance of the lab investigation, and follow up in oncology clinic).

Practical sessions of the nursing protocol centered on hand washing, oral care, deep breathing and coughing exercises. Demonstration and practice sessions were conducted.

The content and construct validity of the tools and study protocol were then checked and revised by a panel of clinical experts and professors in this field. This was followed by conduction of pilot testing on 10 nurses and 10 patients. This sample was included in the final data management of the study because modifications recommended after piloting were so minimal.

**Phase two (implementation and evaluation phase):** an official permission was obtained from both the Head of Oncology Department at Assiut University Hospital to conduct the study. Consent was thereafter granted from the nurses working on the oncology unit before proceeding with the study. The nature and the purpose of the study were explained to them. Study participants were informed that participation in the study is done on a voluntary basis. Nurses knowledge as well practice were measured to be utilized as baseline data before the protocol implementation.

Patients were also contacted and detailed explanations of the study purpose as well as protocol were provided. They were assured about the confidentiality of their data and were informed that their participation is voluntary and that they can withdraw from study at any time point. Baseline knowledge and observation of their practice were also measured before start of the protocol.

Nurses were then divided into small groups for explanation of the protocol and discussion of how it will be implemented. This was done on 8 sessions, for each group of nurses (number of nurses in each session 2-3 nurses). The duration of each session ranged from 30- 60 minutes according to nurses needs to ensure their understanding and facilitate discussion and reflections from their experiences. Lecturing, discussion, demonstration and re-demonstration were the main teaching methods. Posters and developed booklets were used as teaching aids for facilitating deep learning to promote practice change. Each nurse obtained a copy of the nursing intervention protocol booklet.

Impact of the protocol was evaluated immediately after protocol implementation as well as at 2 months follows up. Nurses' knowledge and practices has been evaluated by the researcher through filling tool (II & III) also patient's knowledge and practices evaluated after protocol implementation through filling tool (IV & V) to measure change in their knowledge and practice as a direct impact of nurses' protocol implementation gains.

**Phase three (data management):** data were analyzed using SPSS version 18. The following tests were carried out: frequency and percentage distributions, means and standard deviations, correlation coefficient, ANOVA and t-test for comparison of means. A probability level of 0.05 was adopted as a level of significance.

## RESULTS

Majority of nurses (70%) had an age range between 18 to 29 years, 76.7% of them were married, majority (93.3%) works as beside nurses, and half have an experience equal to or more than 4 years with mean duration of  $3.22 \pm 2.7$  (Table 1).

### Nurses' knowledge and practices for management of CIN patients

Table 2 shows that the baselines mean scores for total and subtotal nurses' knowledge are very low before protocol implementation (17.06±8.41, 7.6±4.14, 14.3±6.5 and 39.53±13.4, respectively). However, great improvements in the mean knowledge scores were observed immediately after application of the protocol (48.6±9.9, 33.7±9.9, 34.9±8.9 and 117.3±24.2, respectively). This improvement was partially lost after 2 months later as shown by the reduction in the immediate observed post-test scores (44.6±10.8, 19.13±9.8, 26.6 ±8.4 and 90.3±23.8, respectively). A significant statistical difference was found between nurses' knowledge in relation to total and subtotal mean knowledge scores with p-value < 0.001 in all items during the study period. Figure 1 also shows that all nurses (100%) had unsatisfactory knowledge level before intervention however, at post intervention, most of them (63.3%) developed satisfactory knowledge level.

The baseline mean scores for total and subtotal nurses' practices were very low before protocol implementation (3.6±1.9, 4.4±1.3, 1.5±1.1 and 9.5±3.6, respectively) however great improvements in the mean practice scores were observed immediately after application of the protocol (8.6±1.9, 9.0±1.03, 2.9±1.5 and 20.5±3.9, respectively) with significant statistical difference between nurses' practices in relation to total and subtotal mean practices scores with p-value < 0.001 in all items. Nurses' practice improvement was almost maintained at 2-months posttest follow up (Table 3).

As shown in Table 4, a significant positive correlation was shown between nurses' total knowledge and practice scores. While duration of experience showed significant negative correlations with each of nurses' total knowledge, practice scores. Also age had a negative relationship with total knowledge of nurses and an expected positive correlation with years of experience. Significant correlations were observed at p < 0.05.

### CIN patients' knowledge and practices related to oral care and hand washing

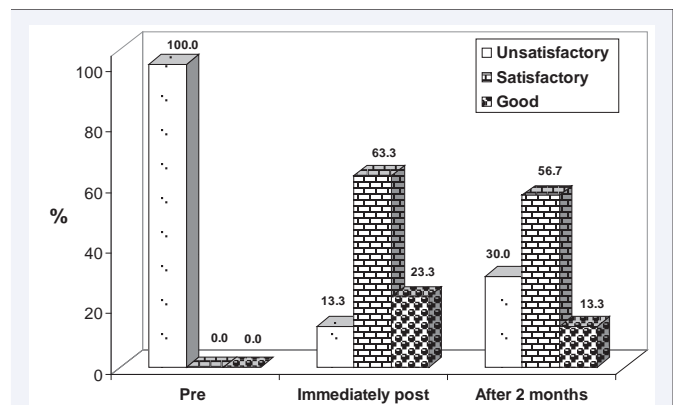
Table 5 shows that, more than half of the patients (63.7%)

**Table 1:** Frequency distribution of the demographic and work related characteristics among participant nurses.

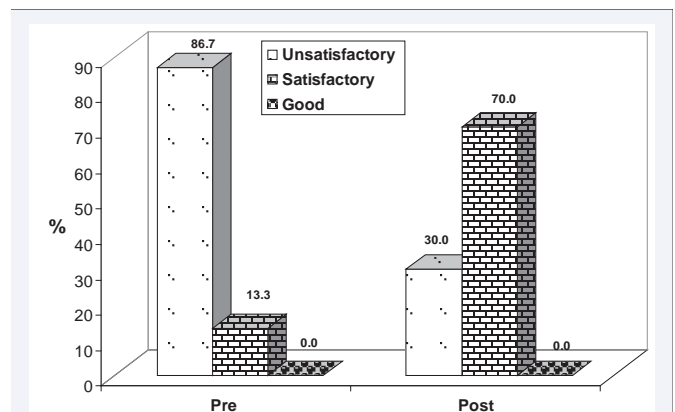
Variables	N (30)	%
<b>Age</b>		
<30 yrs	21	70.0%
≥30 yrs	9	30.0%
Mean ± SD	25.63 ± 3.22	
<b>Marital status</b>		
Single	7	23.3 %
Married	23	76.7 %
<b>Position at unit</b>		
Bedside nurses	28	93.3%
Head nurses	2	6.7 %
<b>Work Experience</b>		
< 1year	7	23.3%
1-3 years	8	26.7%
≥4 years	15	50.0%
Mean ± SD	3.22 ± 2.7	

**Table 2:** Comparison between the total and subtotal mean scores of nurse's knowledge pre-test, immediately post-test and after 2 months.

Knowledge categories	Scores allotted	Mean ± SD	p-value
<b>Chemotherapy induced neutropenia background</b>			
Pre-test		17.06±8.41	.000
Immediate post-test	80	48.6±9.9	.000
After 2 months post-test		44.6±10.8	.000
F -ratio		89.090	.000
<b>Nursing intervention</b>			
Pre-test		7.6±4.14	.000
Immediate post-test	54	33.7±9.9	.000
After 2 months post-test		19.13±9.8	.000
F -ratio		71.99	
<b>Patients teaching</b>			
Pre-test		14.3±6.5	.000
Immediately post-test	58	34.9±8.9	.000
After 2 months post-test		26.6±8.4	.000
F -ratio		50.391	.000
<b>Total knowledge scores</b>			
Pre-test		39.53±13.4	.000
Immediately post-test	192	117.3±24.2	.000
After 2 months post-test		90.3±23.8	.000
F -ratio		105.05	.000



**Figure 1** Total knowledge score level obtained by nurses at pre, immediately post-test and 2 months after application of the protocol.



**Figure 2** Total knowledge score level obtained by patients at pre, immediately post-test after application of the protocol.

had an age equal to or above 40 years with a mean of (44.4±14.9 years). The majority of them were females, housewives, married and illiterates (63.3%, 53.3%, 76.7% and 80.0%, respectively).

Figure 2 shows that most of patients (86.7%) had unsatisfactory knowledge levels before implementation of the study protocol while at post test (70%) of them had a satisfactory knowledge.

Figure 3 demonstrates that more than half of the patients (56.7%) demonstrated unsatisfactory practice of hand washing technique before the study intervention, however at post intervention, 56.7 % and 20% had shown satisfactory and good levels of practice, respectively.

Figure 4 shows that most of the patients (66.7%) had unsatisfactory practice levels regarding oral care technique before intervention while at post intervention 53.3 % of them had satisfactory levels for mouth care practice.

A significant positive correlation was found between total knowledge and practice scores while a negative correlation was shown between total practices scores and participants' age. Knowledge doesn't show any relationship with patients' age. Significant correlations were observed at 0.010 (Table 6).

**Table 3:** Comparison between the total and subtotal mean scores of nurses' practice pre-test, immediately post-test and after 2 months.

Performance categories	Scores allotted	Mean ± SD	p-value
<b>Assessment &amp; monitoring of vital signs, lab value, and sign and symptoms of infection</b>	Pre-test	3.6±1.9	.000
	Immediate post-test	8.6±1.9	.000
	After 2 months post-test	8.2±1.8	.000
	F -ratio	66.45	
<b>Institute protective measure to prevent infection from exogenous source</b>	Pre-test	4.4±1.3	.000
	Immediate post-test	9.0±1.03	.000
	after 2 months post-test	8.53±1.2	.000
	F -ratio	138.769	
<b>Reporting sign and symptoms of infection &amp; positive blood culture</b>	Pre-test	1.5±1.1	.000
	Immediate post-test	2.9±1.5	.000
	After 2 months post-test	2.6±1.4	.000
	F -ratio	8.654	
<b>Documentation of sign and symptoms of infection, nursing interventions and patients teaching</b>	Pre-test	0.0	0.0
	Immediate post-test	0.0	0.0
	After 2 months post-test	0.0	0.0
	F -ratio	101.20	
<b>Total performance scores</b>	Pre-test	9.5±3.6	.000
	Immediate post-test	20.5±3.9	.000
	After 2 months post-test	19.3±3.1	.000
	F -ratio	101.20	

**Table 4:** Correlation coefficient between duration of experience and age of nurses with total knowledge and practice scores immediately after the application of the protocol.

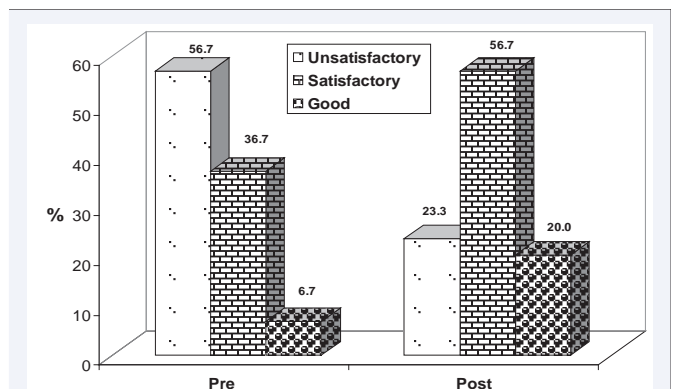
	Total knowledge score.	Total practice scores	Age
<b>Total knowledge scores</b>	-		
<b>Total practice scores</b>	0.632*	-	
<b>Age</b>	-0.259*	-0.26*	-
<b>Duration of experience</b>	-0.354*	-0.49*	0.770***

**Table 5:** Frequency and percentage distribution of demographic variables among patients.

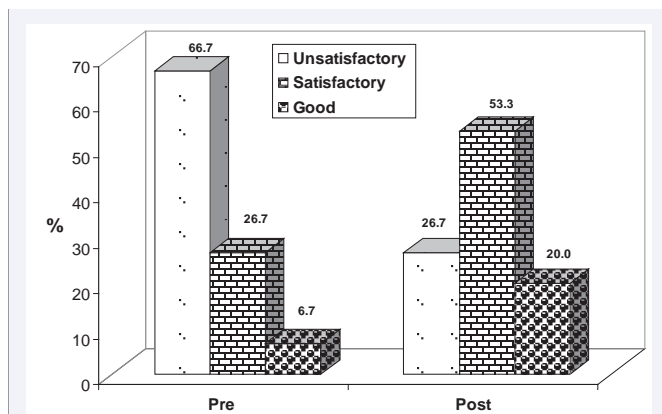
Variables	N (30)	%
<b>Age (in year)</b>	20-39	36.7 %
	≥ 40	63.3 %
	Mean ± SD	44.4± 14.9
<b>Gender</b>	Male	36.7 %
	Female	63.3 %
<b>Marital status</b>	Single	23.3 %
	Married	76.7 %
<b>Level of education</b>	Illiterate	80.0 %
	Can read & write	20.0 %
<b>Occupation</b>	Employee	13.3 %
	Farmer	20.0 %
	Housewife	53.3 %
	Retired	13.3 %

**Table 6:** Correlation coefficients between age of patients with total knowledge and practice scores immediately after the application of the protocol.

	Age	Total practice scores
<b>Age</b>	-	
<b>Total practice scores</b>	-0.53*	-
<b>Total knowledge scores</b>	0.10	0.396*



**Figure 3** Percentage distribution of hand washing practice score level obtained by patients at pre, immediately post-test after application of the protocol.



**Figure 4** Percentage distribution of mouth care practice score level obtained by patients at pre, immediately post-test after application of the protocol.

## DISCUSSION

Myelo-suppressive chemotherapy is commonly associated with neutropenia, resulting in severe infections, treatment delays and, ultimately, adversely affecting patients' outcome [27]. Because neutropenia and neutropenia-related QOL deficits may affect treatment outcomes in patients with cancer receiving chemotherapy, such problems should be avoided [7]. Oncology nurses could play a major role in the management of CIN through implementation of evidence-based preventive and management strategies for patients with neutropenia.

The current study aimed at testing the impact of a developed evidence-based nursing intervention protocol for chemotherapy induced neutropenia on nurses' and patients' related knowledge and practice. The study findings revealed a lack of knowledge and unsatisfactory practices for nurses' working on oncology units before study implementation of the study protocol as depicted by their test scores at baseline. This matter might reflect the lack of necessary scientific preparation required for nurses working and dealing with patients at high risk of developing chemotherapy induced neutropenia.

Moreover, [28] review of the studies that have assessed the effectiveness of selected nursing interventions used in hospitals to prevent healthcare-associated infections in neutropenic patients with cancer, showed that few studies have demonstrated the effectiveness of low microbial food and water and protective environments and clothing in reducing infections in neutropenic patients with cancer, and hospitals vary in these practices. The authors concluded that unfortunately, however, many aspects of the management of hospitalized neutropenic patients are determined by tradition, habit, prudence, theoretical considerations, or expediency rather than evidence, and the appropriate and effective environmental management for these patients is not always clear. Nursing care practices to prevent or control such infections are not often supported by high levels of evidence.

In the current study, nurses with unsatisfactory level of knowledge before exposure to the protocol achieved a significant improvement after implementation of the protocol. Similarly, [16] further found that a large majority of the nurses (86%)

shown a good improvement in knowledge as they gave correct answers to more than 70% of the knowledge items. Almost all respondents felt that assessing patients for chemotherapy side effects was essential (99%) and acknowledged that their practices was a professional expectation that could positively influence patient outcomes and consequences. Nurses observed knowledge improvement in the current study might, in addition to the intensive protocol training program, be related to the fact that majority of nurses were in young age and that people in this young stage show more readiness and more capacity for learning. Similarly, [29] noted that nurses' knowledge scores were higher among younger and newly graduated nurses who attended their in-service program.

The study findings unexpectedly showed some decline in nurses' knowledge scores at two months following implementation of the protocol. These results are in line with [30] who reported that an initial improvement after the training program has been followed by a significant decrease in retention of knowledge at 10 weeks period. In this regard, [31] found that there is a direct relation between memory loss and length of time that lapses after a certain educational event.

As regard nurses' baseline practice, the practice scores were very low. In the current study, nurses were washing their hand only if contaminated with blood during venipuncture for sampling or using IV medication and before eating. This result is in line with [32] who contended that despite hand washing has been proven by multiple studies to be one of the most effective ways to reduce and prevent transmission of infection; clinicians are not always compliant in washing their hand before and after patients contact. Moreover, most nurses were having unsatisfactory knowledge of patient education before application of the protocol. In this respect, [33,34] reported that, teaching is a major aspect of the professional role, patient teaching has been recognized as an independent nursing function and effective health education depend on scientific base and cultural awareness. The patient and their significance other must be taught the essential knowledge and skills for independent care for preventing and minimizing the risk of neutropenic complications.

The current study, however, revealed improvement in the nurses' practice score after implementation of the protocol as shown by the significant differences between results of pre- and post-tests. This finding indicated that practice can be easily acquired and improved especially if linked with relevant strong scientific base of knowledge. This was in line with [35], who reported that educational program has a good effect in improving the nurses' knowledge and performance. In this respect, [36,37] further reported that oncology nurses could impact the quality of management of neutropenia with their different contributions as a direct caregiver, responsible for assessment of patients' potential risk for neutropenia, monitoring of early signs and symptoms of infection, patients education concerning preventive measures related to high risk of infection related to physical environment, hygiene, diet, avoiding trauma to decrease rates of infection.

In line with current study results, [16] examined oncology nurses' use of NCCN clinical practice guidelines for CIN and FN. Almost all respondents (99%) felt competent about their

abilities to care for their patients, and 97% expressed confidence that they provided patient education about neutropenia as a chemotherapy side effect. Similarly, 97% reported that they felt able to identify patient disease- and treatment-related risk factors for CIN and that they instructed patients and families about post chemotherapy home care (98%).

Further, the present study showed a negative correlation between the total knowledge and practice scores of nurses with their duration of experience. This finding could be explained in light of the few in-service training opportunities provided to nurses to maintain their competency, their increased workload, and possibly deficiency of up-to-date evidence based resources present on their individual units. This was in agreement with [35] finding of the significant correlation between nurses' knowledge with their duration of experience.

As regard the impact of the protocol on patients' outcomes, the current study revealed a lack in patients' knowledge related to CIN at baseline where most of them had unsatisfactory knowledge levels. However, post intervention patients had achieved significant improvements in knowledge. Consistently, researchers from the Waukesha Memorial Hospital in Wisconsin issued a survey to 79 oncology patients to assess patient knowledge and understanding of CIN, their results indicated that sixty percent of patients did not know when to contact their physician or oncology nurse and approximately one-third of their patients did not know the signs and symptoms of infection and 41% could not describe self-care measures. Consequently, [38] reported that it is necessary for patients to play a role in the early detection of CIN in order to prevent the development of life-threatening infections, a patient's role, however, is largely dependent upon the information they receive from oncology nurses or physicians.

The current study further revealed that, more than half of the subjects were having unsatisfactory practice score levels specifically in relation to hand washing and oral care techniques, however, after study intervention they showed satisfactory gain in knowledge as well as practice. [39], reported that, hand washing is the best way to stop the spread of infections. [40,41], further revealed strong evidence indicating that, frequent oral care is very important and most effective intervention to prevent oral mucositis from chemotherapy. It is therefore important for the nurse to teach the patients about oral hygiene technique and the importance to comply with it. Educating patients and their families about the risks associated with neutropenia and the possible sources of infection can also reduce the likelihood of some of these potential threats becoming actual problems [42,43] reported that many patients do not understand, or are unaware of the risk of developing neutropenia, FN or infection, and how this can impact on delivery of their chemotherapy and the treatment outcome.

Furthermore, a number of studies have reported improvements in patient outcomes through nurse-led adoption of clinical evidence into clinical practice [45]. In a similar study, [13] reported that through implementation of evidenced-based practice guidelines; they have successfully eliminated neutropenic dietary restrictions and replaced them with patient education regarding food hygiene and safe food handling.

[44], described how an alert card was designed to provide information to patients and healthcare professionals to reduce the risk of morbidity and mortality in this patient group. The implementation of the card has resulted in collaborative working between the nurse specialists and other colleagues in accident and emergency and primary care areas. Its use has also raised awareness of the susceptibility of this group of patients to life-threatening complications, highlighted the CNS role as a resource and point of contact for patients and healthcare professionals [44].

The role of the neutropenic diet in preventing infections in patients receiving chemotherapy studied by [45]. Patients received instructions regarding the neutropenic diet before starting chemotherapy to prevent infections by limiting patients' exposure to food-borne pathogens. Adherence assessment telephone calls were made at weeks 6 and 12. In this study, sixteen patients were compliant with the neutropenic diet, with only four of which were admitted for neutropenia with gram-negative rods.

To sum up, studies have revealed that practical interventions to ensure nurse-driven application of guidelines can affect patient's care. Nurses are ideally positioned and qualified to conduct appropriate risk assessments and are committed to playing an integral role in directing the quality of patient care, which may be accomplished by implementing evidence-based guidelines to prevent neutropenic complications [27].

## CONCLUSION

Designing and implementing evidence based nursing intervention protocols are important for improvement of nurses' knowledge and practice and enhancement of patients' outcomes. Nurses can proactively manage CIN by providing education, information and assessment through influencing guidelines and protocols [8]. This was supported by current study findings. Nurses' knowledge and practice required for quality management of cancer patients receiving chemotherapy have significantly improved after protocol implementation. Patients also showed significant gains in their knowledge and practice of oral and mouth care.

## RECOMMENDATIONS

It is essentially recommended that oncology nurses should be guided to practice based on evidence not on custom or tradition to improve neutropenic patients' quality of care and outcome. It is also important for specialized oncology units to establish nursing libraries that are supplied by recent up to date evidence based data base as well as periodicals in Arabic language.

Research should focus on the best way to develop professional collaborative efforts to ensure that the supportive care delivered by oncology nurses in cancer screening, diagnosis, treatment, survivorship, palliation, and end of life care as the main outcome measures is of the highest standard possible [16]. Moreover, tangible tools, paired with ongoing targeted education of patients, families, and healthcare workers, are keys to prompt recognition and communication about potentially life-threatening symptoms associated with neutropenia [2].



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#### Cite this article

Teleb Osman SM, Mohamed Bayoumy HM (2016) Effectiveness of a Nursing Intervention Protocol for Chemotherapy Induced Neutropenia: Nurses and Patients' Related Outcome. *Ann Nurs Pract* 3(1): 1038.