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Nurses' Knowledge and Attitudes in Relation to Wound Infection and Wound Culture: A Quasi-Experimental Study

Yara Enfeksiyonu ve Yara Kültürü Almada Hemşirelerin Bilgi ve Tutum Düzeyleri: Yarı Deneysel Çalışma

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ABSTRACT Objective: This study investigated the effect of training by measuring nurses' knowledge, attitudes in relation to infected wounds, methods and times of taking cultures from infected wounds, and the effect of wound cultures in guiding wound management. **Material and Methods:** A quasi-experimental study was conducted with 153 nurses working in surgical and intensive care units. Data were collected between July-November 2022, before (pre-test) and after (post-test) training on wound infection and wound culture, using a questionnaire consisting of 3 parts: "nurses' demographic characteristics", "nurses' knowledge" and "nurses' attitudes towards wound infection and wound culture." **Results:** Nurses' knowledge of wound infection and wound culture increased after training, but this did not affect their attitudes. While nurses' knowledge scores were found to be low, particularly in issues of timing of wound culture and the process of obtaining wound culture specimens, nurses' attitude scores were found to be low before and after training in relation to the timing of wound culture and the interpretation of what microorganisms can be found as a result of wound culture. Knowledge and attitude scores were found to be unaffected by years in the profession and wound care experience, whereas their gender was significantly affected. While a significant increase in knowledge scores was observed in males and in attitude scores was observed in females. **Conclusion:** Due to the lack of a practical unity of practice and gaps in knowledge on wound infection and wound culture collection, a comprehensive training programme focusing on evidence-based practice is needed to ensure better clinical practice.

Keywords: Wound infection; culture techniques; education; nursing; nursing care

ÖZET Amaç: Bu çalışmada, enfekte yaralar, enfekte yaralarda kültür alma yöntemleri ve zamanı, yara kültürlerinin yara bakımı ve tedaviyi yönlendirmede etkisi konularında hemşirelerin bilgi, tutum ve beceri düzeylerini ve verilen eğitimin etkisini incelemek amaçlandı. **Gereç ve Yöntemler:** Tek merkezli, ön test-son test tek gruplu yarı deneysel tasarımda olan bu çalışma, bir üniversite hastanesinin cerrahi birimlerinde ve yoğun bakım ünitelerinde çalışan toplam 153 hemşire ile gerçekleştirildi. Veriler, Temmuz-Kasım 2022 tarihleri arasında, yara enfeksiyonu ve yara kültürü eğitiminden önce (ön test) ve sonra (son test) "hemşirelerin demografik özellikleri", "hemşirelerin bilgisi" ve "hemşirelerin yara enfeksiyonu ve yara kültürüne yönelik tutumları" olmak üzere 3 bölümden oluşan bir anket kullanılarak toplandı. **Bulgular:** Bu çalışma, hemşirelerin yara enfeksiyonu ve yara kültürüne yönelik bilgi düzeylerinin eğitim sonrasında arttığını, ancak bilgi düzeyindeki artışın tutum düzeylerini etkilemediği belirlendi. Hemşirelerin özellikle yara kültürü alma zamanı ve yara kültür numunesi teslim süreci ile ilgili konularda bilgi puanları düşük bulunurken; yara kültürü alma zamanı, yara kültürü sonucunda hangi mikroorganizmaların bulunabileceğini yorumlama konularında eğitim öncesi ve sonrası tutum yönünden düşük puanlara sahip oldukları belirlendi. Hemşirelerin bilgi puanı ve tutum puanını meslekte çalışma yılı ve yara bakım deneyimlerinin etkilemediği, cinsiyetlerini ise anlamlı derecede etkilediği belirlendi. Erkeklerin bilgi puanlarında, kadınların ise tutum puanlarında anlamlı oranda yükselme görüldü. **Sonuç:** Yara enfeksiyonu ve yara kültürü alma konularında pratik olarak bir uygulama birliği olmayışı ve bilgi düzeyindeki eksiklikler nedeniyle daha iyi klinik uygulamalar sağlamak için kanıta dayalı uygulamaya odaklanan kapsamlı bir eğitim programı gereklidir.

Anahtar Kelimeler: Yara enfeksiyonu; kültür teknikleri; eğitim; hemşire; hemşirelik bakımı

Wound infection, particularly in chronic wounds caused by immune system issues, damages tissues and wounds.[1] Delayed wound healing, hospital stays, sepsis death, increased healthcare costs.[2,3] Global challenge in managing chronic wounds, affecting 6.5 million patients and costing $25-50 billion annually,

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with 2% of developed countries experiencing chronic wounds.[4] Therefore, wound care in surgical clinics is one of the necessary elements of nursing care and the quality of wound care is very important.[5] Wound care is one of the primary and routine tasks of nurses who focus on restoring the structural and functional integrity of the skin.[6] According to the Turkish Nursing Act, the nurse is responsible for mechanical cleansing, irrigation and dressing of the wound, development of wound application forms and updating information on wound care principles and products by following new developments.[7,8] Infection is a major challenge in wound management and can lead to delayed healing. Too many deaths are reported as a result of wound infection. In one surveillance study, approximately 8.2 million people had at least one type of wound infection during their lifetime. A remarkable increase in life expectancy worldwide, together with age-related diseases and changing lifestyles, has resulted in a high prevalence of readily infected chronic wounds in older adults.[9,10] It has been reported in the literature that nurses' knowledge and practice of wound site infection prevention is low. It has also been reported that 38.7 to 50.9% of microorganisms isolated from infected surgical wounds exhibit antibiotic resistance patterns.[11] The literature also suggests that the development of competency-based wound infection assessment and management programme for nurses is urgently needed. Nurses are the largest healthcare workforce and are among the primary caregivers in the management of patients with chronic wounds. In addition, nurses play a key role in breaking the chain of infection at the wound site. Therefore, nurses' knowledge and practice, based on standardized guidelines, is very important in preventing infection in order to reduce morbidity and mortality due to wound infection and to achieve faster healing.[12] Detecting wound infection in chronic wounds remains a debate, but accurate diagnosis can prevent complications and prevent unnecessary antibiotic use.[2,3] Incorrect swabbing methods can lead to incorrect culture results, causing concerns for wound care practitioners.[13] Correct identification of causative pathogens and antimicrobial susceptibility can facilitate treatment and guide care. Wound cultures are essential for detecting and guiding treatment.[14] There is a considerable lack of knowledge and clarity among nurse professionals about when a wound is infected, when to culture an infected wound, which culture method to use, and how wound cultures define microbial load to guide antimicrobial treatment.

This study aimed to investigate the effect of training by measuring nurses' knowledge and attitudes in relation to infected wounds, methods and times of taking cultures from infected wounds, and the effect of wound cultures in guiding wound management.

MATERIAL AND METHODS

DESIGN AND PARTICIPANTS

This quasi-experimental design study was conducted on total of 153 nurses. The study population consisted of 161 nurses who worked in the hospital's surgical wards. To ensure the success of the training and to avoid disrupting the data collection process, the training was planned to be held every week by dividing the nurses into groups with 161 nurses participating. However, due to incomplete completion of the post-test, 8 nurses were eliminated from the study. As a result, the study included 153 nurses. Data were collected between July 2022-November 2022.

RESEARCH QUESTIONS

- What are nurses' attitudes and levels of knowledge regarding the clinical indications and symptoms of wound infection?
- What are nurses' attitudes and levels of knowledge regarding the proper time to take a wound culture in cases of wound infection?
- What are nurses' attitudes and levels of knowledge of wound culture techniques?
- What are nurses' attitudes and levels of knowledge regarding what to do next after collecting a wound sample?

DATA COLLECTION AND MEASUREMENT TOOL

Training content and delivery: The training was scheduled. The number of nurses in each group was limited to 15 for planning purposes. The day of the

training was announced to the nurses in each group. The training lasted 40 minutes and was delivered via an online training platform. According to the literature information, the visual presentation content used in the training was supported by concept maps and mind maps and consisted of 21 slides entitled "Clinical signs and findings in wound infection, timing of wound culture collection in wound infection, methods of wound culture collection, which method of culture collection is used for which wound, what to do after wound culture collection."[1-4,13,14] The nurses who were unable to attend the training during the scheduled week did so in the weeks that followed.

Administration of pre- and post-tests: Pre-test and post-test were administered via Google Forms (Alphabet Inc., USA) using the online method. Before the training presentation, the pre-test link was sent to the participants, and they were asked to fill it in before the training. End of the training, the data collection link was sent again, the participants were asked to complete only the second and third parts of the data collection form, and the post-test was administered.

Sociodemographic characteristics of the nurses: In the first part of the data collection form, 5 questions were asked to determine the socio-demographic characteristics of the nurses (age, gender, marital status, current unit/clinic, years in the profession, and years of interest in wound care).

Nurses' knowledge of wound infection and wound culture: In the second part, literature-based questions were used to measure nurses' knowledge of wound infection and wound culture, using true/false answers.[1-4,13,14] The knowledge test included 34 questions about clinical signs and wound infection (7 questions), when to take a wound culture (3 questions), the method of taking a culture from the wound (5 questions), which method of taking a culture is used for which wound (7 questions), the process of taking wound culture samples (8 questions), and the process of delivering wound culture samples (4 questions). Nurses received one score for correct answers, while their incorrect answers received zero score. The highest possible score was 34 (Table 1). Three academics who are authorities in the field reviewed the structured questionnaire form for clarity, comprehensibility, internal consistency reliability, and content validity. The final questionnaire was given to 5 nurses who weren't a part of the study after content review. The Cronbach's alpha coefficient of the 34-item questionnaire to measure the nurse's knowledge was 0.718. According to the alpha coefficient obtained, it was determined that the knowledge test was reliable.

Nurses' attitudes towards wound infection and wound culture: In the third part, nurses were asked eight questions to evaluate their attitudes towards wound infection and wound culture. Nurses' attitude scores were categorized into 3 levels: very much (3 points), little (2 points), and not at all (1 point). Accordingly, the highest attitude score was 24, while the lowest was 8. The Cronbach's alpha coefficient of the 8-item questionnaire to measure the nurse's knowledge was 0.931. According to the alpha coefficient obtained, it was determined that the knowledge test was reliable.

STATISTICAL ANALYSIS OF DATA

In the study, knowledge and attitude scores regarding wound infection and wound culture were evaluated using t-test for dependent groups, Kolmogorov-Smirnov test for normality, ANOVA test for 3 or more groups, and t-test for independent groups. Results are presented as mean ±s.d. and frequencies and percentages for categorical data. The relationship between knowledge and attitude scores was analyzed using Spearman's rho correlation coefficient.

ETHICS OF RESEARCH

Ethical approval was obtained from the Eskişehir Osmangazi University Non-Interventional Clinical Research Ethics Committee (date: February 22, 2022, no: E-25403353-050.99-294104/2021-364) and institutional approval from the University Health, Practice and Research Hospital Directory (date: April 6, 2022, no: E-93877713-044-314310). Informed consent was obtained from participants, who were informed that the data would be used for scientific purposes and would remain confidential. The principles stated in the Declaration of Helsinki were followed in the research.

TABLE 1: Knowledge test on wound infection and wound culture.

Subhead	Questionnaire	Research question
Clinical signs and symptoms of wound infection	- Wound cleansing should not be performed routinely or without justification. - Wound infection is classified according to a spectrum of 5 stages. - Diagnosis of wound infection is usually based on a combination of clinical diagnosis and microbiological culture based on the patient's physical signs and symptoms. - The synonyms NERDS and STONEES are useful in the clinical setting to easily identify the clinical signs and symptoms of wound infection. - Increased pain may be a sign of infection. - It is necessary to observe 5 (five) defined stages of microorganisms on wounds. - A comprehensive assessment of both the patient and the wound should also be undertaken for signs and symptoms of wound infection.	How can clinical signs and symptoms of wound infection be recognized?
Time for wound culture	- Wound cultures should be obtained in patients with signs and symptoms of critical colonization before microorganisms enter the systemic circulation and cause sepsis. - Chronic wound cultures are not routinely performed unless clinical infection is suspected. - Microbiological assessment alone may not diagnose wound infection because the wound may be colonized with bacteria that do not interfere with healing.	When is a wound culture taken for wound infection?
Wound culture method	- Deep tissue or punch biopsy is used to culture wound tissue to identify wound infection. - Needle aspiration and swab culture are used to obtain culture from wound exudate to identify wound infection. - Tissue biopsy sent for culture and susceptibility testing is the gold standard for identifying bacteria causing infection in the wound bed. - Two techniques for swab culture are the Levine technique and the Z technique. - Wound biopsy may be considered when patients do not respond to antibiotic treatment selected according to swab culture results.	What methods are there for taking wound cultures?
Which culture method is used in which wound	- If malignancy is suspected, the biopsy area should be at the wound margin and should not include the wound bed and surrounding undamaged deep tissue. - Patient morbidity such as severely damaged wound tissue, wounds with visible bone tissue and the risk of uncontrolled bleeding are not suitable for tissue biopsy cultures. - Needle aspiration is the most effective method of obtaining purulent fluid samples from cutaneous abscesses with intact wound culture. - In pressure wounds with pocket or tunnel formation, an aspiration sample can be obtained after washing the wound with sterile saline to provide fluid for needle aspiration. - Deep tissue biopsy is most useful in determining the optimal time for skin grafting and surgical wound closure. - Swab cultures can be reliable in guiding antibiotic therapy in diabetic patients with grade 3 foot wounds. - Tissue biopsies and swabs are taken for anaerobic bacteria in burn wound infections.	Which culture method to use for which wound?
Wound culture sample collection process	- Since pain in the wound area usually increases with infection, the patient is asked about the type and degree of pain in the wound area using a scale of 0- 10. - If the patient requires analgesia, it is administered 30 minutes before the start of the culture collection for maximum effect. - Since pain in the wound area may cause anxiety or fear during culture collection, the patient's understanding of the need for wound culture and ability to cooperate are assessed. - Culture swab must be moistened with 0.9% sodium chloride. - Before aspiration, the skin is cleansed with 2% chlorhexidine or 10% povidone iodine followed by 70% alcohol. - If an adequate sample cannot be obtained by aspiration, sterile saline is injected into the abscess. - Ideally, at least 3 mL of pus sample/purulent material is aspirated with a syringe. - Pieces of tissue 9 to 10 mm in size are taken.	What is the procedure after the collection of a wound culture sample?
Wound culture sample delivery process	- Relevant clinical information should be recorded on the request form, such as the location and type of wound, the culture method used, and any medication the patient is taking that may affect the result. - The sample should be transported to the laboratory as quickly as possible, ideally within 48 hours. - In venous ulcers and pressure ulcers, the predominant bacteria are *Bacteroides species, Staphylococcus aureus, Pseudomonas, Corynebacterium species,* various anaerobes and *Serratia*, Firmicutes Proteobacteria and Actinobacteria. - The patient's recent or current antibiotic treatment is noted on the laboratory request form.	What is the procedure after the collection of a wound culture sample?

RESULTS

SOCIODEMOGRAPHIC CHARACTERISTICS OF NURSES

When the socio-demographic characteristics of the nurses were examined, the mean age was 37.3±7.2 years, with 87% being female, 60.9% having over 15 years of professional experience, and 56% interested in wound care for 1-5 years (Table 2).

NURSES' KNOWLEDGE LEVEL OF WOUND INFECTION AND WOUND CULTURE

Table 3 shows a statistically significant improvement in knowledge of wound infection and wound culture after the educational intervention, with higher mean scores at post-test (pre-test=19.18±3.37, post-intervention=30.71±2.59) (p<0.001). Statistically significant improvements were observed in all test subcategories.

Table 4 shows that nurses' attitudes towards wound culture were statistically significantly higher at post-test than at pre-test [pre-test=18.62 (3.47), post-test=19.00 (3.84), p=0.023]. When analyzing the mean scores for attitudes to wound culture, statistical significance was found between pre-test and post-test attitudes scores to defining clinical signs and symptoms of wound infection, performing wound culture methods, choosing the appropriate method and knowing what to do after taking a wound culture sample (p<0.001). On the other hand, there was no statistical significance between pre-test and post-test mean attitude scores for the time to take wound culture, microorganism identification, and understanding responsibilities in wound culture (p>0.05).

RELATIONSHIP BETWEEN NURSES' DEMOGRAPHIC CHARACTERISTICS AND WOUND INFECTION AND WOUND CULTURE KNOWLEDGE SCORE AND ATTITUDE SCORE

Table 5 presents data comparing nurses' demographic characteristics with their knowledge mean scores and attitude mean scores. A statistically significant difference was found between the pre-test and post-test mean score differences for knowledge and attitudes of wound infection/culture and the variables of gender (p<0.05). While a significant increase in knowledge scores was observed in males and in attitude scores was observed in females.

TABLE 2: Socio-demographic characteristics of nurses.

Age (mean±S. deviation)	**37.3±7.2**	
	n	**%**
Gender		
Female	134	87.6
Male	19	12.4
Profession		
0-1 year	12	7.8
1-5 year	19	12.4
6-10 year	6	3.9
11-15 year	21	13.7
16 year and ⇑	95	62.1
Wound care experience		
0-1 year	32	20.9
1-5 year	54	35.3
6-10 year	33	21.6
11-15 year	14	9.2
16 year and ⇑	20	13.1

TABLE 3: Comparison of wound infection and wound culture knowledge.

	Pre-test Mean (SD)	**Post-test Mean (SD)**	**T test**	**p value**
Total	19.18 (3.37)	30.71 (2.59)	-49.441879	**<0.001**
Subcategories				
Clinical signs and symptoms in wound infection	3.52 (1.37)	6.31 (0.70)	-23.099518	**<0.001**
Time for wound culture	1.66 (0.87)	2.50 (0.55)	-23.099518	**<0.001**
Wound culture method	2.68 (1.02)	4.53 (0.65)	-19.869146	**<0.001**
Which culture method is used in which wound	3.99 (1.22)	6.41 (0.79)	-25.196582	**<0.001**
Wound culture sample collection process	6.85 (1.30)	7.09 (1.12)	-6.142022	**<0.001**
Wound culture sample delivery process	2.44 (0.83)	3.84 (0.35)	-20.925549	**<0.001**

TABLE 4: Comparison between pre-and post-test scores of nurses' attitudes towards wound infection and wound culture.

	Pre-test Mean (SD)	Post-test Mean (SD)	T test	p value
Total	18.62 (3.47)	19.00 (3.84)	-2.289	**0.023**
How important do you believe it is to be able to assess the wound?	2.95 (0.21)	2.65 (0.47)	8.210	**<0.001**
How well can you describe the clinical signs and symptoms of wound infection?	2.31 (0.55)	2.44 (0.58)	-3.677	**<0.001**
How well can you interpret the time of wound culture in wound infection?	2.23 (0.51)	2.26 (0.53)	-1.148	>0.05
How well can you perform wound culture methods?	2.22 (0.51)	2.35 (0.64)	-2.900	**0.004**
How well can you choose which culture method to apply on which wound?	2.09 (0.66)	2.22 (0.59)	-4.642	**<0.001**
How well can you interpret that you know what to do after taking the wound culture sample?	2.22 (0.66)	2.43 (0.58)	-4.566	**<0.001**
How well can you interpret which microorganisms you may encounter as a result of wound culture?	2.18 (0.57)	2.21 (0.59)	-0.870	>0.05
How well would you describe how well you know your responsibilities in obtaining a wound culture?	2.42 (0.65)	2.42 (0.65)	0.000	>0.05

Although there was no statistically significant difference, it was found that the knowledge and attitude scores of those who had worked in the profession for 0-1 years and 1-5 years, and the knowledge scores of nurses who had been involved in wound care for 11-15 years and 16 years or more, increased with training, whereas the attitude scores of nurses who had been involved in wound care for 0-1 years and 6-10 years increased.

RELATIONSHIP BETWEEN KNOWLEDGE AND ATTITUDE SCORES FOR WOUND INFECTION AND WOUND CULTURE

Table 6 compares nurses' knowledge scores on wound culture and wound culture attitudes, showing that increasing nurses' knowledge level did not affect their attitudes, as there was no significant relationship between knowledge scores and attitude scores.

DISCUSSION

NURSES' KNOWLEDGE OF WOUND INFECTION AND WOUND CULTURE

Nurses must possess comprehensive wound knowledge to care for patients with varying aetiologies in various settings.[15] This study investigated the effect of training by measuring nurses' knowledge, attitudes on infected wounds, methods and times of taking cultures, and the effect of wound cultures in guiding wound management.

A study reported a significant increase in nurses' wound culture knowledge levels after training.[12] Literature shows wound care knowledge scores range from 58-61%, depending on questionnaire or test.[15-17] Tegegne et al. found 40.3% of nurses had good wound care knowledge, indicating a need for improvement in practice.[18] Our study found, in line with the literature, nurses correctly answered over half of knowledge test questions before training and increased their scores by approximately twice as much as the pre-test. Study shows nurses have high knowledge of wound infection and culture, possibly due to actively providing wound care in clinical settings.

Altaweli et al's study found 74.66% of nurses correctly identified inflammation signs and 66.97% identified wound infection signs in acute surgical wound management.[19] Similarly, a study reported most healthcare professionals (90%) correctly described the symptoms of localized wound infection and the characteristics of an infected wound (97%) but the rate decreased for topics like the balance between colonization and infection (64%) and wound dressing (38%).[20] Our study revealed nurses correctly answered the definition of wound infection clinical signs and symptoms, increasing their knowledge score by 40% after training. The fact that the nurses' pre-test knowledge levels (50.28%) regarding the recognition of clinical signs and symptoms of wound infection were lower than those found in the literature studies showed that they did not have sufficient knowledge about wound infection control in the current situation. The fact that the post-test knowledge levels (90.14%) were at the levels found in the liter-

TABLE 5: Comparison of socio-demographic characteristics and differences between pre- and post-test scores on the attitudes test and the knowledge test.

	Wound infection & culture Knowledge				Wound infection & culture Attitudes			
	Pre-test mean (SD)	Post-test mean (SD)	Difference mean (SD)	p value	Pre-test mean (SD)	Post-test mean (SD)	Difference mean (SD)	p value
Gender								
Female	19.29 (3.34)	30.58 (2.60)	11.29 (2.87)	0.006*	18.80 (3.67)	19.35 (4.01)	0.54 (1.94)	0.001*
Male	18.42 (3.56)	31.63 (2.38)	13.21 (2.41)		17.31 (0.47)	16.31(0.47)	-1.00 (0.81)	
Profession (year)								
0-1	18.50 (4.37)	31.08(2.77)	12.58 (2.19)	>0.05**	18.50 (1.56)	17.50 (052)	1.00 (1.04)	0.000**
1-5	19.52 (4.26)	31.47 (2.11)	11.94 (2.87)		15.84 (2.26)	18.21 (2.67)	2.36 (1.70)	
6-10	21.66 (2.06)	32.66 (1.21)	11.00 (1.67)		18.00 (0.00)	16.00 (0.00)	-2.00 (0.00)	
11-15	18.00 (2.86)	29.57 (2.94)	11.57 (3.59)		17.33 (1.27)	17.33 (1.93)	0.00 (0.83)	
16 and ↑	19.30 (3.15)	30.65 (2.55)	11.34 (2.86)		19.51 (3.88)	19.86 (4.45)	0.34 (1.90)	
Wound care experience (year)								
0-1	18.71 (4.02)	30.53 (2.61)	11.81 (2.24)	>0.05**	16.65 (3.71)	17.25 (4.25)	0.59 (1.93)	>0.05**
1-5	18.90 (2.92)	29.79 (2.22)	10.88 (3.16)		16.83 (1.86)	17.09 (1.71)	0.25 (1.33)	
6-10	19.30 (4.00)	30.90 (3.34)	11.60 (2.96)		21.39 (2.71)	22.15 (2.98)	0.75 (2.25)	
11-15	19.78 (2.86)	31.92 (1.77)	12.14 (3.34)		20.50 (3.63)	20.00 (4.15)	-0.50 (0.51	
16 and ↑	20.05 (2.58)	32.35 (1.18)	12.30 (2.38)		20.70 (2.61)	20.85 (4.40)	0.15 (2.88)	

*Independent samples t-test of difference for pretest and post test data with normal distributions; **One-way Anova test of difference for pretest and post test data with normal distribution.

ature studies showed that the deficiencies in practice were addressed and awareness increased when the nurses were involved in the training.

Tegegne et al reported that 66.8% of nurses gave correct information when asked about taking a swab culture for wound infection.[18] When the results of our study were compared with the results of the study in the literature, it was found that the mean pre-test knowledge scores of the nurses on the topics related to the method of taking culture from the wound (53.6%) and the method of taking culture specific to the wound (57%) were in parallel with the literature; in addition, it was found that the mean knowledge scores of the nurses increased by approximately 32% and 35%, respectively, after the training. The fact that the nurses' pre-test knowledge levels were lower than those found in the literature was an unsatisfactory finding and demonstrated the need for training in this area. However, after the training intervention it was observed that this rate significantly improved and exceeded the knowledge rates reported in the literature.

Kingsley and Winfield-Davies' study found that nurses took a culture from a wound based on infection signs, wound size, pain, inflammation, or doctor's request.[21] In this study, 55.3% of nurses correctly answered when to take a wound culture increasing to 83.3% after training. Another study in the literature investigating nurses' knowledge and practice of wound care found that before training, 25% of nurses routinely took cultures from wounds, and after training, no

TABLE 6: Comparison of the scores for knowledge and attitudes towards wound infection and wound culture.

		Wound infection & culture attitudes	
		Pre-test	**Post-test**
Wound infection & culture knowledge	Pre-test	r=0.088	r=0.069
		p=0.277	p=0.397
	Post-test	r=0.047	r=-0.016
		p=0.562	p=0.841

r: Pearson correlation analysis; **Correlation is significant at the 0.01 level (2-tailed).

cultures were taken unless clinical signs and symptoms were observed.[22] The low level of knowledge in the pre-test was interpreted as a reflection of the nurses' low level of knowledge about the definition of clinical signs/symptoms of wound infection and the method of taking cultures from the wound. The increase in the post-test was interpreted as an important finding because it showed that the nurses' professional skills could be improved after the training.

Again, in the study by Kingsley and Winfield-Davies, when nurses were asked whether they paid attention to the steps involved in taking wound culture samples, the answer was quite consistently "no", and the rate of nurses not answering ranged from 63-81% depending on the unit they worked in.[21] Again in the same study reported that only 25% of the nurses recorded clinical information about the patient on the culture forms after taking a wound culture, and detailed information about the patient was significantly missing.[21] In this study, the nurses answered the questions asked about the culture sampling process correctly at a high rate in the pre-test, and the average score increased after the training. In addition, nurses answered the questions asked about the wound culture sample delivery process correctly at a high rate in the pre-test, and the average score increased after the training. Although nurses had a low level of knowledge about the definition of wound infection and the method of taking a culture from the wound, their high rate of correct answers to the steps in the process of taking a wound culture sample shows that the procedures and steps involved are well defined in the units where they work and that nurses observe the procedures well when other healthcare professionals take a wound culture. This difference in study results may also be related to the broad nature of these studies. They were not primarily focused on wound infection and the method of taking a culture from the wound.

NURSES' ATTITUDES TOWARDS WOUND INFECTION AND WOUND CULTURE

A study conducted with nurses on ensuring tissue viability in wound care found that 59% of the participants had a positive attitude, and their attitude scores increased after the training.[23] Our study found that the nurses' mean attitude scores towards wound infection and wound culture increased after training.

A study found 80% of respondents rated their wound infection assessment skills poor to fair in knowledge and management of wound infections. In the same study, 77% of participants reported low attitudes towards assessing patient-centred symptom findings that may indicate wound infection, such as pain.[24] In this study, nurses' attitude scores towards wound infection and wound culture were significantly higher after training. The mean nurse attitude score for defining the clinical signs and symptoms of wound infection was 77% of the total score, and this increased to 81% in the post-test. In line with this finding, nurses' high attitudinal scores on the components of assessing clinical signs and symptoms of wound infection may help to prevent inappropriate treatment decisions, prevent delays in wound healing, improve quality of life and reduce healthcare costs.

Buksh et al. study revealed only 27% of participants knew the time to take wound cultures, 54% correctly answered wound culture recommendations, and 22% knew about the kind of information from

the results of wound culture.[25] In our study, in parallel with the literature, it was found that the participants had low scores in terms of attitudes before and after the training in terms of interpreting the time to take a wound culture in wound infection, which microorganisms can be found as a result of wound culture. The attitude of healthcare professionals is an important quality that helps to understand how issues or processes in clinical care are perceived and to decide what is appropriate for the health of patients. The low attitudinal scores obtained in the study may be due to nurses believing that the issues of assessing wound infection and taking wound cultures are only the responsibility of doctors, not nurses.

RELATIONSHIP BETWEEN NURSES' DEMOGRAPHIC CHARACTERISTICS, WOUND INFECTION AND WOUND CULTURE KNOWLEDGE AND ATTITUDE SCORES

A study found a significant relationship between nurses' knowledge and their nursing profession duration and wound care experiences. Higher knowledge scores were found in nurses with 1 to 5 years of experience in wound care. However, no significant relationship was found between knowledge, gender, age, or professional qualification.[26] In the study conducted by Uba et al, a significant relationship was found between the knowledge scores of nurses and the duration of their profession.[27] On the other hand, there are studies in the literature that did not find statistical significance between nurses' knowledge and the duration of the nursing profession and found that nurses with more years of experience in the profession had lower knowledge scores.[28,29]

Our study results showed an increase in the knowledge and attitude scores of nurses who had been in the profession for 0-1 and 1-5 years and who had worked in wound care for 11-15 and 16 years or more, and an increase in the attitude scores of nurses who had worked in wound care for 0-1 and 6-10 years after training. This result, which is in line with the literature, reflects that nurses at the beginning of their professional experience have a more comprehensive knowledge of nursing principles. It also reflects the efforts of experienced nurses to update their knowledge. Considering that all nurses in the study group worked in surgical wards, the fact that these nurses had more clinical exposure to wound care due to the high frequency of patients requiring wound care may have influenced this result.

Our study found a statistically significant difference between the pre-test and post-test mean score differences in wound infection/culture knowledge, attitudes and gender ($p<0.05$). However, Bilal et al. reported that no statistical significance was found between nurses' gender, wound care experience, and attitude scores.[26] It can be thought that the fact that the majority of the nurses who constitute the study population are of the female gender influenced this result.

RELATIONSHIP BETWEEN WOUND INFECTION AND WOUND CULTURE KNOWLEDGE AND ATTITUDE SCORES

Our study found that increasing the knowledge level of nurses did not affect their attitudes and there was no statistically significant relationship between knowledge scores and attitudes scores consistent with the study of Bilal et al.[26] However, Beeckman et al. found a relationship between nurses' knowledge and attitudes that did not overlap with the results of our study and some studies indicated an inverse relationship.[15,17,30] This finding from our study demonstrates the limited usefulness of current training in influencing nurses' attitudes towards changing practices in routinely handled clinical protocols. This situation highlights the need for effective interventions to improve attitudes and clinical practice.

LIMITATIONS OF THE STUDY

The nurses participating in this study received the training via the online platform. The participants represent a group of nurses from a single center. Strategies to overcome perceived barriers due to time constraints and short-term accessibility of educational materials should be explored in further research. Despite potential limitations, this study identifies nurses' knowledge and attitudes, gaps and learning needs in relation to wound infection and wound culture. It is clear that nurses would benefit from educational programme to improve their care of chronic wounds. Therefore, we recommend the initiation of future multicenter studies to obtain a global result.

CONCLUSION

This study showed nurses' knowledge of wound infection and culture increased post-training, but not affecting attitudes. While nurses' knowledge scores were found to be low, particularly in relation to timing of wound culture collection and process of obtaining wound culture samples, they were found to have low scores in relation to attitudes before and after training in relation to the timing of wound culture collection and interpretation of what microorganisms could be found as a result of wound culture. It was found that nurses' knowledge and attitude scores were not affected by years in the profession and experience of wound care, but their gender was significantly affected. It was concluded that there was no practical agreement on wound infection and wound culture, that nurses were deficient in this regard and that training was needed. Therefore, a comprehensive educational programme focusing on evidence-based practice is needed to ensure positive attitudes and better clinical practice. Opportunities for nurses to participate in research activities should be included in evidence-based protocols for wound infection and culture taking, and nurses should be informed about the importance of evidence-based practice in clinical practice for wound infection and culture taking.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

This study is entirely author's own work and no other author contribution.

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