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Development of a scale for nursing practices for the prevention of surgical site infection

Abstract

Background: Surgical site infections are still a problem despite advances in sterilisation methods, surgical techniques and antibiotic prophylaxis. There is a need for measurement tools with confirmed validity and reliability to assist nurses to control and prevent surgical site infections, as nurses have the most contact with patients.

Method: This study used a descriptive cross-sectional design, with methodology in accordance with the Strengthening the reporting of observational studies in epidemiology (STROBE) guidelines, and was carried out in three phases. In the first phase, a draft scale consisting of 38 items was prepared. In the second phase, the draft scale was reviewed by ten experts and applied to 70 nurses in a pilot study. Three items were removed based on the expert evaluation and two more items were removed after analysis of the data from the pilot study, leaving the final scale with 33 items. In the third phase, the 33-item scale was applied to 320 nurses working in university hospitals and teaching and research hospitals. The reliability and validity of the scale were evaluated by data analysis and a test–retest analysis was carried out on 30 nurses.

Results: The 33-item Nursing practices for the prevention of surgical site infections (NPPSSI) scale, with items scored using a 5-point Likert-type scale, was found through factor analysis to include two sub-dimensions – 'asepsis-related practices' and 'patient-related practices'. Cronbach's alpha was 0.88 for the scale as a whole, 0.87 for the 'asepsis-related practices' sub-dimension and 0.86 for the 'patient-related practices' sub-dimension. The mean total score was 187.43 ± 54.14 and the mean subscale scores were 107.21 ± 37.23 for asepsis-related practices and 80.22 ± 16.91 for patient-related practices.

Conclusion: As a result of analysis and evaluation, the reliability and validity of the NPPSSI scale were confirmed. This scale can be used to determine nursing practices in the surgical area and to prevent surgical site infections.

Impact: The scale developed with this research will contribute to increasing patient safety, standardising clinical practices and facilitating education and quality improvement studies on infection control by enabling nurses to evaluate their practices aimed at preventing surgical site infections.

Keywords: surgical site infection, nursing practice, scale development, evidence-based practice

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Summary

What does this paper contribute to the wider global clinical community?

- **Opportunity for international comparison:** If validity–reliability studies of the scale in different languages are conducted, it will be possible to compare nursing practices between countries. This contributes to the development of global health quality indicators and infection control standards.
- **Dissemination of evidence-based practices:** The scale guides training and interventions by revealing which practices are not performed adequately in clinics.
- **Development of education and policies:** Health ministries, hospitals and educational institutions can update their policies and curricula using this scale. The role of nurses in infection control becomes more visible.
- **Support for global infection control goals:** The scale indirectly contributes to the goals of institutions such as the World Health Organization (WHO) and the Centres for Disease Control and Prevention (CDC) to reduce surgical infections.
- **Reduction of health expenditure:** Surgical site infections prolong hospital stay and increase costs. Preventing these infections provides great economic benefits for health systems; this is especially important in resource-limited countries.
- **Preparation for intercultural nursing research:** The use of the scale in different cultures and health systems can reveal similarities and differences in nursing care.

Introduction

Health care–associated infections (HAIs) are defined as infections that develop in a patient who is not in the incubation period and does not have symptoms of infection while hospitalised in a healthcare institution[1–4]. HAIs, also known as nosocomial or nosocomial infections, are infections that occur in a patient 48 to 72 hours after hospitalisation, or in individuals who come to see the patient or caregivers of the patient within ten days after leaving the hospital[3–5]. HAIs, which cause increased mortality and morbidity rates and prolonged hospitalisation and treatment of patients, are one of the most common problems of all healthcare institutions both in Turkey and in the rest of the worlld[6,7]. HAIs also cause functional deficiencies, anxiety, deterioration in quality of life, reduction in labour force, excessive use of medication, need for isolation and additional costs, for example from the use of laboratory tests and radiological techniques in individuals receiving treatment[8–10].

In Turkey, the most common HAIs are urinary tract infections (40%), followed by ventilator-associated pneumonia (30.3%) and surgical site infections (20.1%). Surgical site infection (SSI) is defined by the Centers for Disease Control and Prevention (CDC) as an infection in the surgical site that develops within 30 to 90 days (or within one year if an implant is placed in an organ) after the intervention[3]. SSI is observed at a rate of 8.2 per cent in developed countries and 10.4 per cent in developing countries[1,4,8–10].

Surgical site infections are one of the major problems of surgery despite the advances in hygiene practices, sterilisation techniques, patient ventilation, surgical methods and prophylactic drug therapy[11–13]. It is known that a range of factors play a role in the occurrence of infection, including age, gender, chronic diseases, smoking and alcohol use, infection occurring in a different part of the body, lack of immune system defence, obesity, poor eating and drinking status, use of corticosteroid drugs, increased duration of hospital treatment, surgical method and non-compliance with asepsis techniques[14–18]. SSI occurs in two to five per cent of surgical interventions, and approximately a quarter of all HAIs are SSIs; to prevent SSI, it is vital to fully fulfil the principles of surgical asepsis[1,5,13,19,20].

Nurses are the people involved in making the most interventions for patients receiving treatment during hospitalisation. In relation to infection prevention, nurses working in the surgical field have the most important role compared to other surgical personnel because they have the power to significantly reduce SSI by implementing evidence-based practices during surgery[13,21–23]. Furthermore, nurses have great responsibility throughout the perioperative period to reduce SSI as they provide care before, during and after surgery. Nurses have responsibilities in the pre-operative period (controlling infections in different areas, removing hair from the surgical site, bathing, shortening the duration of surgery, performing antibiotic treatment for the microorganism), during surgery (surgical hand washing with the current method, and wearing gowns, masks, bonnets and gloves in the surgical area) and after surgery (dressing with aseptic technique, regular reporting of disease cases and regular follow-up of the patient)[20–26].

Today, the importance of evidence-based practice is increasing in relation to favourable treatment outcomes for patients, creating a safe environment in patient care, improving quality of care and patient satisfaction. Nurses, who are the healthcare personnel most frequently encountered by patients receiving treatment, need to develop reliable and valid measurement tools that reduce HAIs in order to control SSI[27–34].

In the literature, there are scales which evaluate the knowledge level of nurses in order to prevent HAIs – the Infection control measures scale, the Catheter associated urinary tract infections scale and the scale related to evidence-based practices in the prevention of ventilator associated pneumonia – but it was found that there was no scale related to SSI used by nurses in the surgical field[29,31,32,35,36]. In addition, there are many scales related to general infection control but there is a paucity of scales that separately address practice behaviours specific to the incision site and practices to reduce the risk of infection during the patient's preparation for surgery

(e.g. antiseptic bathing, hair removal, prophylactic antibiotic timing).

While most scales focus on post-operative practices, specific nursing practices of the pre-operative period are not measured. Similarly, meta-cognitive dimensions, such as the nurse's questioning of their own practices, awareness of errors and desire for self-improvement, are not present in behaviour-based classical scales but are key for professional development. Most scales focus only on clinical practice, neglecting critical steps such as patient education or discharge planning; however, post-operative infections often occur after hospitalisation. Existing scales often question standard practices (e.g. sterile technique and hand washing); however, risk identification and proactive prevention behaviour are often ignored. Many scales only assess knowledge or behaviour, not reflecting current evidence-based approaches. Guidelines are frequently updated and practices should be shaped accordingly.

The Nursing practices for the prevention of surgical site infections (NPPSSI) scale, developed during this study, aims to determine surgical nurses' knowledge about SSI and the practices they use to control and prevent SSI, and also provide a comprehensive assessment that reflects the multidimensional nature of nursing practices by overcoming the limitations of existing measurement tools. Existing scales in the literature mostly focus on knowledge level, compliance with standard protocols and basic infection control practices; however, contextual variables, decision-making processes and patient-centred care behaviours encountered by nurses in clinical reality are mostly ignored. In this context, the NPPSSI scale aims to evaluate nurses' situational awareness of infection risk, communication and leadership roles within the team, levels of compliance with evidence-based practice and contribution to preventive strategies such as patient education. The NPPSSI scale can assess the evidence-based knowledge, attitudes and practices of nurses who undertake the care of individuals receiving treatment in surgical departments and identify deficiencies, thus allowing the quality of nursing care to be improved by eliminating those deficiencies. The NPPSSI scale is a tool with great theoretical depth and application validity that can be used in both research and clinical quality improvement studies.

Aims

The study aimed to develop a scale to determine nurses' knowledge about the prevention of surgical site infections and the evidence-based practices they use.

Materials and methods

Study design

This study used a descriptive, cross-sectional and methodological design. The data of the study were collected between February 2022 and November 2022.

Recruitment and consent

Participants were verbally informed about the purpose of the study, the procedure, possible risks and discomforts, confidentiality, participation in the study and ability to withdraw from the study. The 'informed voluntary consent' form was used to obtain written informed consent from the participants who agreed to participate in the study. The questionnaires were administered to the nurses participating in the study by the researcher using a face-to-face interview technique.

Population and sample

The population of the study consisted of nurses working in surgical intensive care and surgical wards in a university hospital and a training and research hospital in Antalya province, Turkey. After all permissions were obtained (Ethics committee, institutional permission), the population of the study consisted of approximately 1500 nurses who had been working for more than one year in the institutions where the study would be conducted.

There were 420 participants overall, in three samples, who volunteered for the study and fulfilled the inclusion criteria. Phase 2 had a sample of 70 nurses who participated in the pilot study, Phase 3 had two samples – 320 nurses who participated in the main study and 30 nurses who participated in the test–retest analysis to determine the invariance against time.

Inclusion and exclusion criteria

Nurses who agreed to participate in the study after being informed about the study were included if they spoke Turkish, if they were working during the duration of the study (i.e. not on leave or report) and if they had worked in surgical intensive care and surgical wards for at least one year or more.

Nurses were excluded from the study if they were employed in a position other than nursing, if they were working in internal services, if they had been working in surgical services for less than one year and if they had a psychiatric disorder.

Instruments

Individual introduction form

The Individual introduction form consisted of 11 questions and was used to collect demographic data including age, gender, marital status, educational status, length of time working in the profession, unit of work, position in the unit, status of receiving SSI training after graduation and the place of training.

Nursing practices for the prevention of surgical site infections (NPPSSI) scales

The draft NPPSSI scale (35 items) was used to collect data during Phase 2 and the final NPPSSI scale (33 items) was used to collect data during Phase 3. The items of the scale were written in the present tense and participants reported their degree of agreement using a 5-point Likert-type scale of 1 to 5 (1 = 'never agree', 2 = 'rarely agree', 3 = 'sometimes agree', 4 = 'often agree', 5 = 'always agree'). There was no reverse expression used.

The lowest score that can be obtained from the 33-item final version of the scale is 33 and the highest score is 165. In the evaluation of the scale, an increase in the total mean score (approaching 100) is interpreted as knowing the nursing practices related to SSI, and a mean score of 40 and below is interpreted as a lack of knowledge related to nursing practices related to surgical SSI.

Study phases

Phase 1: Literature review and creation of an item pool

The process of creating the items of the scale developed in this study was carried out based on both literature review and expert opinions. Literature published between 2018 and 2024 was scanned, and evidence-based clinical practice guidelines for the prevention of SSI[37–45], published by authoritative institutions such as Association of periOperative Registered Nurses (AORN), American Society of PeriAnesthesia Nurses (ASPAN), National Institute for Health and Care Excellence (NICE) and World Health Organization (WHO), as well as the enhanced recovery after surgery (ERAS) protocol, were consulted. The items of the scale were designed to overlap with the standards of practice in these guidelines.

In addition, in line with the findings obtained from systematic reviews, clinical guidelines and empirical studies published in the last five years, the areas in which nursing practices are concentrated were analysed[14,25,26–29,36]. For example, pre-operative antiseptic shower, timing of antibiotic prophylaxis, hand hygiene standards, principles of creating a sterile field, incision dressing techniques and patient education about monitoring post-discharge infection symptoms are practices directly recommended in the relevant guidelines and were reflected in the scale items.

Based on the literature, clinical practice guidelines and expert opinion, an item pool of 38 items was created after reviewing the literature and consulting clinical practice guidelines. Each item was evaluated by a panel of expert nurse academics and infection control nurses in terms of its ability to reflect evidence-based practices and edited according to content validity.

This process provided the scale with a strong foundation in terms of both content and scientific accuracy. Each item assesses how often a particular practice is carried out by the nurse and thus measures the extent to which the practice is reflected in the clinic. Thanks to this structure, the scale not only measures behaviour but also provides data on the level of integration of clinical guidelines into the field. In this respect, the scale is a unique measurement tool for the evaluation of the evidence-based approach in nursing practice.

To ensure the scale fully represented the theoretical structure, during the item development process care was taken to comprehensively analyse all basic areas of nursing practices related to the prevention of surgical site infections. Guidelines were systematically analysed and an item pool was created based on the nursing interventions recommended in these sources. Each of the building-block practice areas – such as hand hygiene, surgical asepsis, antisepsis, sterilisation, use of personal protective equipment, environmental control, patient information, post-operative follow-up and multidisciplinary cooperation – was reflected in the scale with at least a few items. Thus, the item pool consisted of various behavioural statements developed to represent not only certain types of practice but also all dimensions of the construct – both technical skills and patient-centred nursing roles were included in a balanced manner. As a result of the content validity assessments based on expert opinions, it was confirmed that the items relating to each sub-field were in sufficient number and content.

Phase 2: Expert evaluation and pilot study

Ensuring scale validity

The 38 items of the draft scale were evaluated by ten experts using an 'expert evaluation form' via face-to-face interviews and email. The experts were people related to the object of the study – linguist, infectious diseases physician, infectious diseases nurse, surgical nursing faculty members, surgical unit nurse, surgical intensive care nurse in charge.

The experts were asked to evaluate the items as 'necessary', 'useful but insufficient' and 'unnecessary'. The content validity ratio (CVR) was calculated for each item using the Lawshe method[46–49] which is based on a minimum of five experts and a maximum of 40[50–53]. For ten experts and using a one-tailed test (α = 0.05), the minimum acceptable CVR is 0.51[4,51–54]. Items with CVR below this value were removed, some items were rearranged according to language appropriateness, and the item pool consisting of 38 questions was converted into a 35-item scale.

Preliminary pilot study

The pilot application was carried out using the 35-question scale with a sample of 70 nurses, who met the inclusion criteria, based on the sample having at least twice the number of people as the number of items in the scale. The scale was administered by face-to-face interview.

In addition to data analysis, the pilot study evaluated the scale in terms of appearance, readability, style and clarity of the language used. For this purpose, attention was paid to validity of meaning, language and appearance, and it was ensured that the items in the scale were relevant and in a language that the target audience could understand.

A face-to-face interview technique was used to apply the scale, and the opinions of participating nurses about the clarity, comprehensibility and difficulty level of the items were recorded. At this stage, no questions that were difficult to understand and required detailed explanation were identified.

After the data were collected, item analysis was applied to all items deemed psychometrically appropriate to determine whether there was a problem in terms of item–total correlation and internal consistency.

Phase 3: Application and testing of the final scale

When assessing the reliability and validity of a scale, it is recommended to work with a sample of five to ten times the number of items that make up the scale in order to perform factor analysis and to have at least 30 pairs of data with which to perform the test–retest method used to examine the invariance against time[50–59]. In this context, the minimum sample size should be 165 nurses and the maximum sample size should be 330.

The scale developed in this study was applied to 320 nurses who had been working in surgical intensive care and surgical wards of two different hospitals for at least one year or more. The scale was administered by face-to-face interview.

Data analysis

The data of the study were transferred to the computer environment and analysed by SPSS® 21 (Statistical Package for the Social Sciences 21) and LISREL 8.5 (linear structural relations 8.5) programs.

In order to measure the construct (concept) validity of the scale, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were performed to determine the adequacy of the sample analysis. The minimum value for KMO value should be 0.70 and the p value for Bartlett's test should be less than 0.05[50–52]. The KMO value of the developed scale was 0.963 and the Bartlett's test value was less than 0.05. According to these values, it was accepted that the sample size was 'perfectly adequate' and the developed scale was suitable for exploratory factor analysis (EFA).

EFA results provided the factor loading of scale items and identified when factor loadings of an item were found to be overlapping on two different factors. Two items with factor loading less than 0.40 or that had overlapping factor loadings were removed and analysed. According to the analysis, it was determined that there were two components with eigenvalues above 1 for 33 items[4,50,51,58].

Confirmatory factor analysis (CFA) was performed to determine the compatibility of the items with each other and test the accuracy of the obtained factor structure. Goodness of fit was evaluated by calculating fit indexes – chi-squared (χ^2 and χ^2/SD), root mean square error of approximation (RMSEA), comparative fit index (CFI), goodness-of-fit index (GFI), standardised root mean square residual (SRMR) and non-normed fit index (NNFI) or Tucker–Lewis index (TLI). In addition, Cronbach's alpha coefficient was calculated to determine the internal consistency of the scale.

Ethical considerations

Before the start of the study, Ethics Committee Approval, dated 17.01.2022 and numbered 78017789/050.01.04/1882508, and written permission from the hospital were obtained from the Clinical Research Ethics Committee. Before data collection, all participants were informed about the purpose and scope of the study and the principles of voluntary participation, and their verbal and written consent was obtained.

Table 1: Participant characteristics (N = 320)

		n (%)
Age in years (mean = 37.25±7.52)	18–25	65 (20.3)
	26–35	208 (65.0)
	35 and older	47 (14.7)
Gender	female	271 (84.7)
	male	49 (15.3)
Marital status	single	158 (49.3)
	married	162 (50.7)
Highest level of education	high school	59 (18.4)
	associate degree	38 (11.9)
	bachelor degree	197 (61.6)
	master's degree or doctorate	26 (8.1)
Professional experience in years	1–3	79 (24.7)
	4–6	46 (14.4)
	7–10	56 (17.5)
	10 or more	139 (43.4)
Working unit	surgical intensive care units for adults	131 (41)
	surgical units (neurosurgery, general surgery, thoracic surgery)	122 (38.1)
	operating rooms	26 (8.1)
	emergency department	41 (12.8)
Mode of work	day shift	88 (27.5)
	night shift	232 (72.5)
Training in prevention of SSI received after graduation	yes	227 (71.0)
	no	93 (29.0)
Type of SSI prevention training	print and visual media	11 (4.8)
	institutional in-service training	207 (91.2)
	Ministry of Health training program	3 (1.3)
	conferences and symposia	6 (2.7)

In this study, great care was taken to protect the confidentiality and privacy of the participants. The data were collected in such a way that they did not contain any name, institution name, contact information or personal data that could be directly identified. Only demographic and professional information such as age and years of professional experience were included in the questionnaire forms; this information was anonymised and used in the analysis. All data were coded and stored securely in electronic media and protected so that data could only be accessed by the research team. Participants' responses were organised so that they could not be matched with any individual or institution and were presented at the level of aggregated data in reporting.

Since the study had an observational and low-risk design, there was no serious risk or harm for the participants. However, in order not to cause possible psychological discomfort or professional anxiety, it was clearly stated that all participants were free to respond and that they could withdraw from the study at any time. The data collection process was carried out in accordance with ethical rules and by observing the principles of voluntary participation and confidentiality.

Results

Participant characteristics

Table 1 summarises the sociodemographic and occupational characteristics of the 320 nurses who participated in the main study. The mean age of the participants was 37.25±7.52 years and the majority (65%) were between 26 and 35 years of age. Most (84.7%) were female, about half (50.7%) were married, nearly two thirds (61.6%) had bachelor degrees and a minority (8.1%) had master's or doctoral qualifications.

Less than half (43.4%) of participants had ten years or more experience in the profession, about a third had between three and ten years' experience (17.5% for seven to ten years, 14.4% for three to seven years) and a quarter (24.7%) had one to three years' experience. Participants worked in surgical intensive care units for adults (41.0%), surgical units (38.1%), emergency (12.8%) and operating rooms (8.1%), the majority (72.5%) of them on call.

Most (71%) of the participants stated that they received SSI prevention training after graduating, and nearly all (91.2%) of those who received training stated that the training was institutional in-service training.

Scale validity and reliability

Analysis of the data indicated that the scale is a reliable and valid measurement tool.

Content validity was performed and a minimum CVR value of 0.51 at a significance level of α=0.05 for 10 experts was deemed acceptable[50–54]. The items below this value were removed, some items were rearranged according to language appropriateness, and the draft scale of 38 items was revised to 35 items. Finally, the content validity index (CVI) was determined by calculating the total CVI average of the items. A CVI of higher than 0.67 is considered acceptable[50,51]. The CVI value of the scale items was calculated as 0.83 indicating the scale is valid.

Exploratory factor analysis

Results of the KMO test (0.963, >0.8) and statistical significance of Bartlett's sphericity test (X^2 = 1015.118, p = 0.000, p<0.05)[47,63–65] indicated that the data were suitable for EFA[50,51,54,56,57] (see Table 2). EFA was applied to determine the construct validity and factor structure of the scale. Factor loading values of 0.40 and above were determined as acceptible[4,50,51,58].

Table 2: Kaiser-Meyer-Olkin (KMO) and Bartlett test factor structure of the 35-item scale

KMO		0.963
Bartlett	X^2	1015.118
	p	0.001

Based on the EFA results, two items with factor loadings below 0.40 and an eigenvalue above 1 were removed. The remaining 33 items were found to have two sub-dimensions – asepsis-related practices and patient-related practices. The results of the factor analysis of the 33 items and the new reliability analyses values (Cronbach's alpha and KMO) are given in Table 3.

The contribution of two items to the total variance is 63.76 per cent. The contribution of the first sub-dimension (items associated with asepsis-related practices) to the total variance was 33.16 per cent and the contribution of the second sub-dimension (items associated with patient-related practices) was 30.60 per cent. Considering that 40 to 60 per cent of the total variance explained in multifactor models is considered sufficient and 50 to 75 per cent is considered a valid and strong analysis, the variance values obtained confirm the scale is valid and strong[57,58].

Internal consistency analysis

As shown in Table 3, Cronbach's alpha value was 0.878 for items associated with asepsis-related practices, 0.865 for items associated with patient-related practices and 0.880 for the whole scale (33 items). Cronbach's alpha value above 0.70 is sufficient for reliability[41,50,51]; accordingly, it was determined that the reliability of the scale as a whole and each sub-dimension was high.

Confirmatory factor analysis

The values of the fit indexes calculated for the 33-item NPPSSI scale and acceptable fit indexes are shown in Table 4 (χ^2/sd = 2.664, GFI 0.912, CFI = 0.943, RMSEA = 0.032, SRMR = 0.027).

Path analysis was performed to examine the relationship systems between the variables performed for the items of the NPPSSI scale. The factor loadings for the scale are presented as a path diagram (see Figure 1), and the model was accepted as it was in its original structure without any modification. It was seen that the factor loadings of the model varied between 0.55 and 0.90. Based on the diagram, the items were grouped by sub-dimension and renumbered for the final NPPSSI scale (see supplement). Data were shown for the NPPSSI scale with 19 items in the sub-dimension of asepsis-related practices and 14 items in the sub-dimension of patient-related practices, totalling 33 items.

Test–retest analysis for reliability

The NPPSSI scale was administered to 30 individuals twice, two weeks apart, using the intermittent method. The mean scores obtained from the test and retest

Table 3: Factor loadings and analyses as a result of exploratory factor analysis of the 33-item scale

Item number	Factor load value	Load values after varimax		Cronbach's alpha when item removed
		Sub-dimension 1: Items associated with asepsis-related practices	Sub-dimension 2: Items associated with patient-related practices	
1	0.863	0.876		0.890
2	0.811	0.861		0.891
3	0.764	0.837		0.891
4	0.817	0.829		0.882
5	0.756	0.800		0.882
6	0.847	0.800		0.891
7	0.685		0.805	0.890
8	0.786		0.804	0.891
9	0.701		0.774	0.885
10	0.766	0.788		0.882
11	0.750	0.786		0.891
12	0.802		0.602	0.882
13	0.820		0.592	0.881
14	0.763		0.554	0.885
15	0.736	0.780		0.891
16	0.724	0.769		0.871
17	0.702	0.752		0.876
18	0.794	0.733		0.881
19	0.710		0.721	0.881
20	0.639		0.622	0.881
21	0.753	0.688		0.870
22	0.791	0.681		0.870
23	0.716	0.636		0.871
24	0.754	0.654		0.871
25	0.640	0.649		0.872
26	0.745		0.572	0.871
27	0.831		0.907	0.874
28	0.654		0.680	0.873
29	0.616	0.608		0.872
30	0.763		0.778	0.872
31	0.712		0.752	0.875
32	0.774	0.587		0.871
33	0.708		0.789	0.872
Total explained variance		Sub-dimension 1: 33.16%	Sub-dimension 2: 30.60%	Two removed items: 63.76%
KMO test		0.885		
Bartlett's sphericity test		Approximate chi-square: 1015.118 (SD 381), p<0.001		
Cronbach's alpha		Sub-dimension 1: 0.878	Sub-dimension 2: 0.865	Whole scale: 0.880

SD = standard deviation

Table 4: Confirmatory factor analysis fit indices for the NPPSSI scale

Statistic	Acceptable fit indices	Calculated fit indices
X^2/SD	< 5	2.664 (1015.118/381)
P	< 0.001	0.000
GFI	> 0.90	0.912
CFI	> 0.90	0.943
RMSEA	< 0.08	0.032
SRMR	< 0.08	0.027

χ^2/SD = chi-squared, p = probability, GFI = goodness-of-fit index, CFI = comparative fit index, RMSEA = root mean square error of approximation, SRMR = standardised root mean square residual

Table 5: Comparison of repeated measurements of the NPPSSI scale (n = 30)

	First application	Second application	Mean difference	t*	p
NPPSSI scale score	197.57±45.17	187.43±39.59	10.14	0.554	0.671

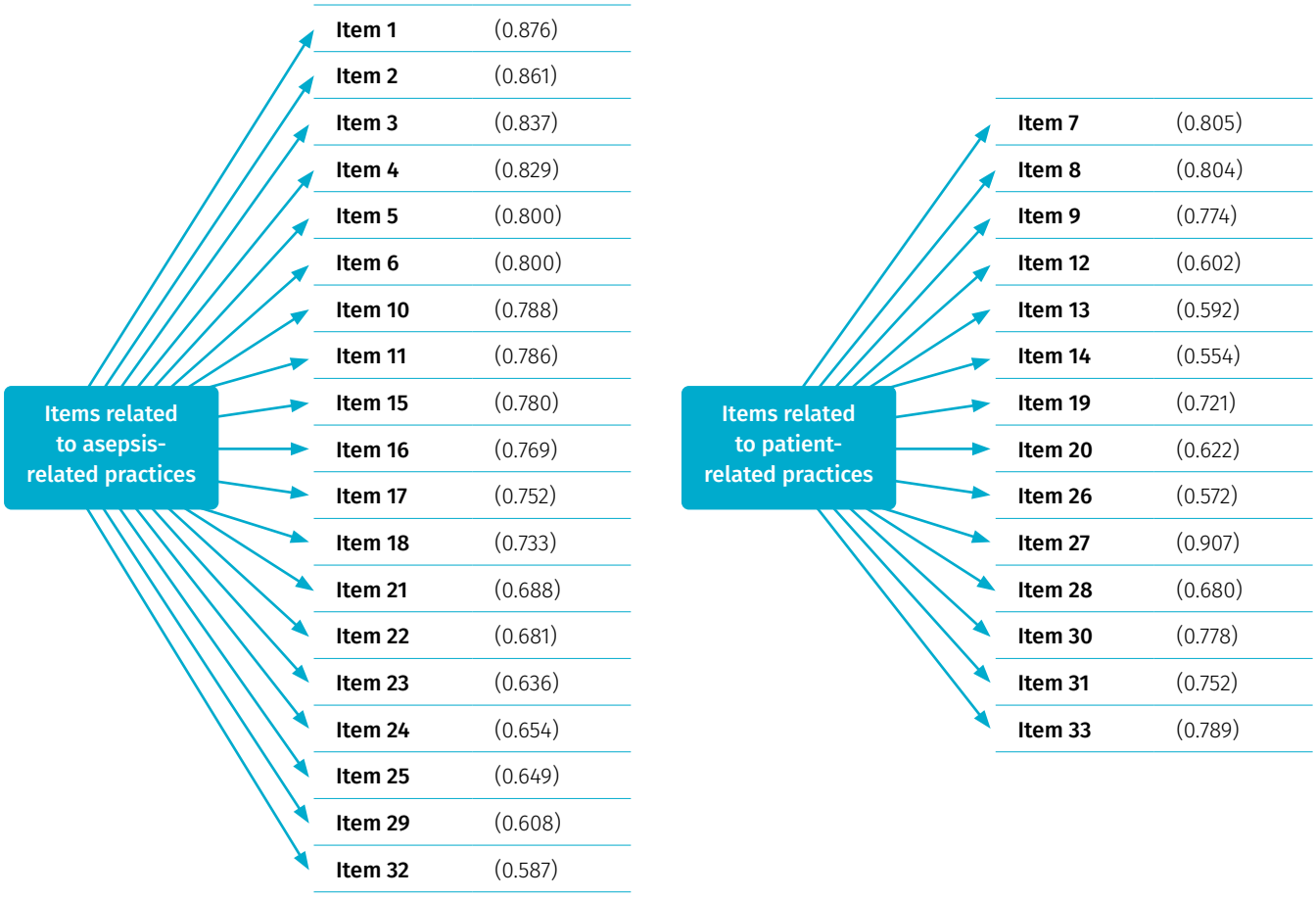

Figure 1: Confirmatory factor analysis path diagram for items (and factor load value) of the NPPSSI scale

were compared by t test (see Table 5) and it was determined that there was no statistically significant difference between the mean scores of the two measurements made two weeks apart ($t = 0.554$, $p = 0.671$, $p>0.05$).

Findings related to the application of the scale

Scoring and evaluation of the scale

As a result of item analysis after the pilot study, the Cronbach alpha coefficient was calculated as 0.91. As a result of the pilot application, all items were accepted as understandable and applicable for nurses.

Discussion

Discussion of the findings related to scale development

In our study, a question pool of 38 items was created after a literature review. Three items were removed after the expert evaluation and two items after the pilot study leaving 33 items in the scale used in the main study.

Each item in the scale was designed in line with the recommendations of relevant evidence-based guidelines. The item content and the main evidence-based clinical guidelines on which these items are based are described below.

- **Surgical asepsis and hand hygiene practices** (items 2–6, 13–17, 21, 22): These items measure compliance with the principles of surgical asepsis and hand hygiene standards. The items are based on CDC hand hygiene guidelines and WHO recommendations for surgical hand hygiene[3,4].
- **Sterilisation and material safety** (items 18, 19, 20, 27): These items assess practices related to sterilisation and control of surgical instruments and materials. The items were developed in light of CDC sterilisation standards[3] and the ERAS protocol implementation checklist[44].
- **Pre-operative preparation and patient information** (items 1, 23–26, 33): These items cover pre-operative patient preparation practices and information provided to patients. The items are consistent with pre-operative practices specified in WHO, ASPAN, NICE and CDC guidelines[3,4,41,42].
- **Invasive interventions and antisepsis** (items 7–12): These items focus on antiseptic application and use of protective equipment before invasive procedures. They are based on AORN, CDC and WHO antisepsis protocols[3,4,37–40].
- **Post-operative follow-up and wound care** (items 28–32): These items measure practices such as monitoring of post-operative infection findings, wound care and use of drains. ERAS, ASPAN, WHO and CDC post-operative care protocols were taken as reference[3,4,41,44].

Each item of the scale targets a critical area of practice for breaking the chain of infection; for example, principles of surgical asepsis, hand hygiene techniques, sterilisation processes, antisepsis practices in invasive procedures, pre-operative preparations and patient education. Thus, the scale is based on a solid foundation in terms of both theoretical framework and clinical practice standards. In particular, the high level of overlap of the items with the methods and practice standards recommended in current guidelines has enabled the scale to be strong in terms of both validity and reliability.

Items that are compatible with evidence-based guidelines measure the behaviours that healthcare professionals are expected to implement in practice, allowing for an objective assessment of field practices and providing guidance in training and quality improvement processes. In this context, the scale items serve as a reliable assessment tool that will contribute to the prevention of surgical site infections by systematically and comprehensively measuring evidence-based nursing practices.

Factor analysis of the data revealed that the scale was composed of two sub-dimensions, namely 'asepsis-related practices' (19 items) and 'patient-related practices' (14 items). This was consistent with the theoretically predicted structure at the beginning of the scale development process. Nursing practices for the prevention of surgical site infections are generally classified under two main headings in the literature: first, aseptic practices based on direct technical skills and standard practices; and, second, patient-oriented practices including more holistic approaches such as patient-centred care, patient education and post-operative follow-up[3,4,37–45].

When the item pool was screened, in the early stages of scale development, this dual structure was taken into consideration and items were created to evaluate nursing practice in the context of technical skills (e.g. hand hygiene, sterilisation, antisepsis etc.) and approaches to patient processes (e.g. smoking cessation education, pre-operative bath recommendation, interpretation of culture results etc.). Therefore, the emergence of these two sub-dimensions as a result of the factor analysis is not only a statistical finding, but also important evidence of construct validity showing the consistency of the theoretical basis of the study. Similarly, it is observed that such thematic distinctions are made in other scales related to nursing practices[30,31,32,34–36]. This finding supports both the theoretical and practical validity of the scale; it also shows that the developed measurement tool is field-specific, functional and based on scientific foundations.

The asepsis-related practices sub-dimension consisted of 19 items with factor loadings ranging from 0.876 to 0.587. This sub-dimension explained 33.16 per cent of the total variance and the reliability coefficient was 0.878. The patient-related practices sub-dimension consisted of 14 items with factor loadings ranging from 0.805 to 0.789. This sub-dimension explained 30.60 per cent of the total variance and the reliability coefficient was 0.865.[46,56,57,60,61] Accordingly, it can be said that the reliability levels of the sub-dimensions are very high.

In our study, confirmatory factor analysis was additionally performed to determine the compatibility of the items with each other. Since the p value of the chi squared (χ^2) statistic was significant ($p<0.001$) in the sample of 320 people, the chi squared over standard deviation (χ^2/SD) was within the acceptable limit. This result was found to be consistent with the literature[47–49,62–64].

When the other fit indices were analysed, it was found that GFI, NFI, NNFI (TLI) and SRMR indices were acceptable, while CFI and RMSEA fit indices were within the limit of perfect fit values. GFI, CFI values higher than 0.90 indicate a good model[47,62,65,66]. The SRMR value was found

to be within the acceptable value limits specified in the literature (<0.09)[61,67]. The RMSEA value, which is an important value examined in all studies, provides an evaluation of the fit of the model. While an RMSEA value of less than 0.08 indicates an acceptable fit, an RMSEA value of 0.032, as found in our study, indicates perfect fit[61,62,66,67,69,47,63,65,66,68]. This result was found to be consistent with the literature[50–53,59,61].

An internal consistency analysis resulted in a Cronbach alpha coefficient of 0.91, and a 'test–retest' analysis found no statistically significant difference between the mean scores of measurements taken two weeks apart. The results of these analyses show that the NPPSSI is a 'highly reliable' scale'[50,59].

Discussion of findings related to demographic data

The mean age of the nurses in our study was 37.25 ± 7.52 years, nearly two thirds (61.6%) had a bachelor's degree as their highest qualification, and the majority (70.1%) worked in surgical units. This is similar to a study by Tank et al.[70] who found that the mean age of nurses was 38.29 ± 9.00, nearly two thirds (63.2%) had a bachelor's degree as their highest qualification, and most (77.2%) worked in surgical units.

The proportion of nurses who report receiving SSI prevention training after graduating varies in the literature. Tank et al.[70] reported that all nurses received training on preventing SSI, while Çelebi[71] and Arli and Bakan[72] reported that about one third received SSI prevention training. In contrast, nearly three quarters (71%) of the nurses in our study reported receiving SSI prevention training after graduating.

Of the participants in our study who received SSI prevention training after graduating, nearly all (91.2%) received in-house training. Similar results were reported by Tank et al.[70]. In-house training is very important in terms of updating the knowledge of nurses; however, it would be appropriate to include more education about the control and prevention of SSI in undergraduate curricula and to update this knowledge through in-service training programs.

Limitations

This study was carried out in a university hospital and a training and research hospital and the results may not be generalisable to other settings. There was some difficulty obtaining data from certain busy clinics and the data collection process took quite a long time. Although the scale aimed to collect data objectively, some data may be subjective.

Conclusion

The NPPSSI scale was developed and found to have two sub-dimensions, important evidence of construct validity and consistency of the theoretical basis of the scale. The reliability, validity and internal consistency of the scale were confirmed to be high through data analysis and evaluation. We therefore conclude that the NPPSSI scale is a valid and reliable scale that can be used to determine nursing practices in the surgical area and to prevent surgical site infections.

Relevance to clinical practice

The NPPSSI scale can contribute to the reduction and prevention of infections by determining the evidence-based SSI prevention practices used by nurses and preventing the occurrence of infection in the practices performed. By using this scale to determine nursing practices, more effective and evidence-based practices can be provided in hospitals.

Conflict of interest and funding statement

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