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Research

The Development of the Inadvertent Perioperative Hypothermia Knowledge Test (IPH-KT)

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A B S T R A C T

Purpose: This study aimed to develop the inadvertent perioperative hypothermia knowledge test (IPH-KT) for health care professionals and examine its validity and reliability.
Design: The methodological and cross-sectional study design was used.
Methods: The research was carried out with 326 nursing students in Turkey. Data for the study were collected using a demographic information form and the IPH-KT.
Findings: The item difficulty index and item distinctiveness index of the questions included in the draft form of the 25-item test ranged from 0.03 to 0.81 and from 0.25 to 0.99, respectively. After the analyses, 8 items were excluded from the draft test, and the final version of the test consisted of 17 questions. The item difficulty index of the final test ranged from 0.30 to 0.96, and the item distinctiveness index ranged from 0.33 to 0.81. The reliability of the test was determined using the Kuder-Richardson formula 20 and found to be 0.72, indicating high internal consistency. Therefore, the IPH-KT was accepted as a reliable test.
Conclusions: The study revealed that the questions in the IPH-KT had varying difficulty levels and a high ability to discriminate between individuals with knowledge of IPH and those without. The results demonstrated that the test had good content and face validity and showed high reliability for measuring the IPH knowledge of nursing students.

Inadvertent perioperative hypothermia (IPH) is defined as a decrease in core body temperature below 36 °C (96.8 °F) in patients undergoing surgery, starting from 1 hour before anesthesia induction in the preoperative period, during the intraoperative period and in the postoperative period in the intensive care unit, spanning 24 hours.[1] IPH is a preventable complication; however, it can cause adverse patient outcomes after surgery if adequate precautions are not taken.[1] There are several international evidence-based practice guidelines (National Institute of Health and Clinical Excellence [NICE], American Society of Perianesthesia Nurses [ASPAN], Association of periOperative Registered Nurses [AORN])[2–4] for the prevention and control of hypothermia in the perioperative period. Although the guidelines state that hypothermia can be prevented with some simple and cost-effective measures implemented during the perioperative process,[5] the compliance rate with these practices may be poor in clinical practice. Identification and elimination of these practice barriers by health professionals is key to improving the quality of patient care.

Although a strong body of research characterizes the causes of, risk factors for, and interventions to prevent IPH, the literature lacks recent data concerning health professionals' depth of knowledge regarding perioperative hypothermia. The surgical team plays a primary role in caring for and monitoring patients throughout the perioperative continuum; therefore, a better understanding of their knowledge of perioperative hypothermia is an important part of improving patient outcomes.[5,6]

IPH is a situation that needs to be addressed by the involvement of multiple disciplines (eg, nurses, surgeons, anesthesia personnel) in preoperative, intraoperative, and postoperative patient care processes.[7,8] Some perioperative team members may not be fully knowledgeable about thermoregulation and the prevention of hypothermia. One method of preventing IPH is to improve their knowledge of the condition in order to facilitate a standardized approach to the patient.[7] The first way to prevent IPH is to improve

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knowledge of the condition among team members.[9] All surgical team members should have the same knowledge of IPH to facilitate a standardized approach to patient care. Provision of a systematic approach with standardized protocols designed to prevent IPH can support prevention in surgical clinics (eg in patient care units). Health professionals should be evaluated first. In one study,[10] it was found that IPH can be prevented by increasing the knowledge level of clinicians and that protocols can help maintain normothermia and prevent IPH in newborns. No tool could be identified in the literature review for assessing knowledge regarding the prevention of IPH among healthcare professionals. This study aimed to develop an IPH knowledge test (IPH-KT) for health professionals and to examine its validity and reliability.

Methods

Test Development

This study was conducted in a cross-sectional methodological design to ensure that the IPH-KT is used as a reliable and valid measurement tool by health care professionals. IPH-KT was created by researchers to evaluate the knowledge level of health professionals about IPH. While preparing the items, care was taken to keep them simple and understandable and not to express more than one estimate or perspective per item; only statements containing IPH knowledge were included. Researchers drew on their clinical experience to plot the relevance of test items. A 28-item question pool was created for the IPH-KT, in line with previously published guidelines.[2–4] Study participants selected an answer from three response options (ie, "True," "False," or "I don't know"), and each answer was assigned a value. A value of "1" for a correct answer and "0" for an incorrect answer or unknown were also assigned points. The content and face validity of the test were then evaluated to determine its applicability.

Content and Face Validity of the IPH-KT

The opinions of seven specialists sought to evaluate the language and content validity of the IPH-KT. All of the specialists had doctoral degrees and included one professor surgeon, four full-time nursing professors, and two statistician professors. The language of the test was Turkish. Test items were emailed to the specialists. They evaluated the relevance and intelligibility of sentences (such as grammar and vocabulary), predisposition to Turkish culture, and competence to measure IPH knowledge. As a result of these evaluations, some modifications were made in terms of items, and 3 items that were considered unnecessary were removed from the test, reducing the total number of items from 28 to 25. A form was created to assess the comprehensibility of each item, and then the IPH-KT was piloted with 100 nursing students in their third and fourth grades. All students marked that the items were comprehensible. This means that the test items are comprehensible. The reliability ranges from 0 to 1, and validity ranges from −1 to +1.[11] In this study, the item difficulty index of IPH-KT was found to be between 0.30 and 0.96, and the discrimination index was between 0.33 and 0.81 (Table 3). In the discrimination index below 0.30, 8 items were removed from the measurement tool, which reduced the number of test items from 25 to 17. The items in the first test (28 items) contained an equal number of "true (14 items)" and "false (14 items)" marks. But, initially, it was suggested by specialists that the items should be revised due to their potential to cause confusion in terms of guiding and measuring knowledge. Due to the recommended exclusion of certain items and revisions in others, the final test includes a total of 1 "false" and 16 "true" statements. The analyses conducted to determine the test's reliability resulted in a Kuder-Richardson formula 20 (KR-20) value of 0.72. Substantial and reliability analyses on 100 individuals in a pilot study (third and fourth-grade nursing students), IPH-KT, which was concluded to be valid and reliable, was administered to 326 individuals in the sample group. The highest and lowest IPH-KT scores possible are 17 and 0, respectively. In addition, within the scope of the subproblems of the study, the demographic characteristics of the students and their IPH information were also compared.

Study Sample and Design

The study was conducted with nursing students constituting the test population in Turkey. University education in Turkey consists of eight semesters (two per year). Each semester, a clinical area is taught with 168 hours per course of clinical practice. In Turkey, the fifth and sixth semesters are called third grade, and the seventh and eighth semesters are called fourth grade. The surgical diseases nursing course is offered in the fourth semester (second year), and within the scope of this course, IPH knowledge is also taught. This supports the decision for third and fourth-grade nursing students as the study sample. The universe of this research consisted of 382 nursing school students (third and fourth grade) studying at a university.

The inclusion criteria were to have completed IPH training, volunteer to participate in the study, and to speak, read, and understand Turkish. Information on IPH was given in the second year's Surgical Diseases Nursing course at the center where the study was conducted. Therefore, third and fourth-year nursing students were invited to participate in this study to evaluate their knowledge. According to Tekin,[11] the minimum sample size should be 5 to 10 times the number of items in the test (17 × 10 = 170 participants). In order to increase the validity and power of the test, the sample size (170) was increased by 91.8%, and 326 third and fourth-year nursing students studying at a university in Turkey were obtained. Therefore, the students participating in the research constituted 85% (326/382) of the universe size.

The final test, including 17 items, was administered to the sample group 2 months after the pilot application of the initial 25-item IPH-KT. Students participating in the pilot application were also included in this administration. To determine the reliability of the IPH-KT scale, a confidence interval of 1 to 3 weeks[11] was used to readminister the final version of the test. Thus, the 17-item test was administered to the 326 students 2 weeks after the final application.

Data Collection Tools

The data collected for the study contained information about the demographic form and the IPH-KT (Table 1). The demographic form was created by the researchers based on studies found in the literature.[12,13] The form included data on the gender of the participants and the academic year. Another question asked of the students was whether they encountered and cared for patients with hypothermia during their clinical practice. Five questions about nursing practice regarding IPH and students' self-assessments of IPH knowledge were included: (1) monitoring of patient's body temperature intervals (ie, 15 minutes), (2) covering the patient with a blanket or quilt, (3) putting on the patient's socks, (4) warming the patient with forced air warming, and (5) no application was made. Additionally, students assessed their own IPH knowledge levels as inadequate (lack of knowledge in IPH intervention), moderate (ability to identify and intervene in IPH cases), or sufficient (ability to identify IPH, perform patient assessment, prevent IPH, or ensure normothermia) based on the care and practices they performed after their training.

Table 1
Demographic Characteristics of Participants and Inadvertent Perioperative Hypothermia Knowledge Self Assessments (n = 326)

	n (%)	Mean Rank	Test	*P*
Demographic characteristics				
Gender				
Female	265 (81.6)	164.35	U = 7,592.50	.583
Male	61 (18.4)	157.04		
Academic year				
Third year	184 (56.4)	182.40	U = 9,587.000	**.000**[*]
Fourth year	142 (43.6)	139.01		
Encountering and caring for patients with hypothermia				
Yes	94 (28.8)	156.68	U = 10,262.500	.401
No	232 (71.2)	166.27		
Nursing Practice Self Assessment by Students				
Hypothermic patient's care				
Monitoring the patient's body temperature at intervals (15 min)	62 (19.0)	174.18	χ^2 = 10.077	**.039**[†]
Covering the patient with a blanket or quilt	23 (7.0)	105.93		
Dressing the patient in socks	4 (1.2)	185.25		
Warming the patient with forced air-warming	5 (1.5)	150.20		
No application made	232 (71.2)	166.27		
IPH self-assessments of knowledge				
Inadequate (lack of knowledge in IPH intervention)	65 (19.9)	120.89	χ^2 = 17.551	**.000**[*]
Moderate (ability to identify and intervene in IPH cases)	218 (66.9)	172.06		
Sufficient (ability to identify IPH, perform patient assessment, prevent IPH, or ensure normothermia)	43 (13.2)	184.53		

	n (%)	Min	Max	Mean ± SD
IPH-KT total score	326 (100)	4	17	11.89 ± 2.38

IPH, inadvertent perioperative hypothermia; IPH-KT, IPH knowledge test.
[*] $P < .001$.
[†] $P < .05$.

Written informed consent was obtained from the participants explaining the purpose of the study before starting the study. The forms were completed by the students in approximately 20 to 25 minutes. Data were collected by the researchers between October 10, 2021 and February 10, 2022.

Ethical Approval

Ethics Committee approval (2021-10/51) was obtained from the university prior to the initiation of the study. The students invited to participate could opt out of the study if they desired. They were also told that the confidentiality of data is ensured and that informed consent would be obtained. All procedures performed in studies involving human participants were performed in accordance with the ethical standards of the National Research Committee and the 1964 Declaration of Helsinki.

Data Analysis

All statistical analyses were performed using IBM SPSS version 25.0 (SPSS Inc). First, a normality analysis was performed for each variable. According to the results of the normality analysis, nonparametric Mann-Whitney *U* test was used for the comparison of two independent variables, and the Kruskal Wallis test was used for the comparison of more than two independent variable groups. The statistical significance level was accepted as $P < .05$. To determine the demographic data of the students, mean, standard deviation, frequency, and percentage values were used. During the development process of this test, content and face validity were used to evaluate the validity of the test. Internal consistency reliability analysis and exploratory factor analyses were performed for the validity and reliability analyses of the IPH-KT. Item distinctiveness index and item difficulty index were used for item analysis. The KR-20 was used to test the internal consistency reliability of the IPH-KT. Distinctiveness index value was determined, and items with negative or near zero distinctiveness index values were used in the test.

Results

Item Difficulty Index and Discrimination Index of the IPH-KT

The discrimination index of an item varies between −1 and +1. Discrimination indices of 0.40 or higher are considered to be very good items; between 0.30 and 0.39, it is a fairly good item; between 0.20 and 0.29, it is a weak item; and below 0.19 it is a very weak item.[11] The item difficulty index of IPH-KT was found to be between 0.25 and 0.98, and the distinctiveness index was between −0.14 and 0.70. After the pilot implementation, the items with a distinctiveness index of 0.30 and above were used exactly as written. The eight items (item numbers 1, 3, 6, 7, 10, 17, 20, and 25) removed from the initial 25-item test as described earlier are listed in Table 2. The final 17-item version of IPH-KT is found in Table 3. The IPH-KT applied to the sample was concluded to be valid and reliable. In the 17-item final test, the item difficulty index was between 0.33 and 0.81, and

Table 2
The Items Excluded From Inadvertent Perioperative Hypothermia Knowledge Test

Items
A core body temperature of less than 35.5 °C is defined as hypothermia.
Hypothermia is a common problem in surgical patients.
The duration of the surgical procedure does not affect the development of hypothermia.
Premedicated patients are not in the risk group for hypothermia.
Hypothermia shortens the recovery time from anesthesia.
Passive heating methods are used for hypothermic patients.
In the perioperative period, the body temperature value does not affect the patient transfer.
The patient's peripheral body temperature is most accurately obtained by axillary measurement.

Table 3
Item Difficulty and Item Discrimination Index distribution of the IPH-KT Final Version

No	Test Items	True n (%)	False n (%)	I Do Not Know n (%)	P*	q†
1.	Hypothermia management should begin before the patient is anesthetized and should be continued until the patient is discharged.	283 (86.9)	16 (4.8)	27 (8.3)	.68	0.40
2.	IPH can lead to life-threatening complications.	308 (94.5)	5 (1.4)	13 (4.1)	.79	0.40
3.	The elderly and newborns are at risk for hypothermia.	310 (95.2)	7 (2.1)	9 (2.8)	.96	0.44
4.	Hypothermia causes adverse cardiac problems.	283 (86.9)	7 (2.1)	(11)	.77	0.44
5.	Hypothermia causes suppression of the respiratory center.	270 (82.8)	7 (2.1)	49 (15.2)	.75	0.48
6.	IPH increases the risk of bleeding in patients.	126 (38.6)	106 (32.4)	94 (29)	.48	0.44
7.	Hypothermia causes an increase in surgical site infections.	225 (69)	56 (17.2)	45 (13.8)	.64	0.70
8.	The discharge time is prolonged in patients who develop hypothermia.	308 (94.5)	2 (0.7)	16 (4.8)	.83	0.33
9.	The clinic room (patient room) temperature being between 20 °C and 25 °C prevents the development of hypothermia.	234 (71.7)	34 (10.3)	58 (17.9)	.68	0.48
10.	To prevent hypothermia, the operating room ambient temperature should be above 21 °C.	106 (32.4)	121 (37.2)	99 (30.3)	.40	0.66
11.	Active warming methods are applied for normothermic patients.	123 (37.9)	93 (28.3)	110 (33.8)	.76	0.40
12.	Forced air warming systems, blankets, and clothes with circulating hot water are active heating methods.	263 (80.7)	(6.9)	(12.4)	.70	0.44
13.	Clothes and blankets made of wool or synthetic wool materials, insulation materials are passive heating methods.	263 (80.7)	16 (4.8)	47 (14.5)	.64	0.70
14.	If the patient's body temperature is below 36 °C in the operating room, anesthesia induction should not be started.	182 (55.9)	34 (10.3)	110 (33.8)	.46	0.70
15.	If more than 1,000 mL of intravenous fluid, blood, blood-product will be administered to the patient during the surgery, the temperature should be increased to 37 °C by using special heaters.	146 (44.8)	61 (18.6)	119 (36.6)	.51	0.81
16.	All irrigation fluids to be used during the operation should be heated to 38°C to 40 °C.	65 (20)	115 (35.2)	146 (44.8)	.30	0.51
17.	Body temperature of hypothermic patients should be checked every 15 min.	297 (91)	9 (2.8)	20 (6.2)	.81	0.37

IPH, inadvertent perioperative hypothermia; IPH-KT, IPH knowledge test.
* Item difficulty index.
† Item discrimination index.

the distinctiveness index was between 0.30 and 0.96. The distinctiveness index of 1 item (item 16) in the IPH-KT was "good" in the range of 0.30 to 0.39, and the distinctiveness index of 16 items was rated as "very good" because it was greater than or equal to 0.40 (Table 3). The final version of the IPH-KT had general information about IPH (items 1 and 2), IPH risk factors (items 3 and 6), IPH complications (items 4,5,7 and 8), and IPH prevention methods (items 9, 10, 11, 12, 13, 14, 15, 16, and 17). This final form of the test consisted of 1 "false" (item 11) and 16 "true" items. As a result of the analyses made to determine the reliability of the test, the KR-20 reliability value was 0.72. Given the high internal consistency coefficient of the test (above 0.60),[11] the IPH knowledge test was accepted as reliable.

Scoring of the IPH-KT

Similar to knowledge tests found in academic settings or certification exams, this test allowed for only one answer per item. The highest score that can be obtained from the IPH-KT is 17—no breakpoint specified. The fact that the total score on the scale is close to 17 indicates that the level of knowledge is high.

Table 1 shows the comparison of the participants according to their demographic data. No significant difference was found between gender and IPH knowledge levels of students who encountered and cared for patients with hypothermia during their clinical hours and those who did not ($P > .05$). A significant difference is noted between the students' academic year and their level of knowledge ($P < .05$), the level of knowledge was third graders higher than that of fourth graders. In addition, it was observed that student IPH knowledge level made a statistical difference according to what they encountered in clinical practice for hypothermic patients ($P < .05$). As a result of the Mann-Whitney *U* analysis, a statistical difference was found between "following the patient's body temperature at intervals (15 minutes)" and "covering the patient with a blanket." Covering the patient with a blanket or quilt resulted in a positive outcome or effect. A statistically significant difference was observed between "no application" and "covering the patient with a blanket or quilt." There was a statistically significant difference between the knowledge levels of IPH and the results of self-evaluation ($P < .05$). The result of the Mann-Whitney *U* analysis has determined that this difference originates from individuals with a moderate level of knowledge. The highest score for IPH-KT was 17, the lowest score was 4, and the group mean was 11.89 ± 2.38.

Discussion

Recognition and management of IPH remain important aspects of perioperative patient follow-up in maintaining patient safety, achieving positive surgical outcomes, and patient satisfaction.[14] Body temperature monitoring is a standard of care,[14] but it can still be a clinical challenge.[5] Previous studies reported that 50% to 90% of IPH develops in surgical patients 1 hour after the start of surgery.[14–18]

An IPH test was developed to evaluate the level of knowledge of nursing students during the perioperative process in our study. Until now, there was no valid and reliable IPH knowledge scale in the literature. IPH-KT was created using evidence-based guidelines to identify knowledge gaps so that education can be provided. In nursing students, the item discrimination index of the IPH-KT was found to be high (0.30 and above).[19] In addition, the fact that our test included items with different difficulty levels makes us think about this. As in the IPH-KT, the only answers indicate the quality of the test for practical use.[20] The IPH-KT is a scale reliable and valid in evaluating the knowledge level of nursing students.

Other tests related to IPH have also been developed, but outcomes have been published without conducting validity and reliability analyses of the test. For example, in one study,[12] physicians awareness and practice of IPH were assessed using a questionnaire developed by the researchers that was based on the AORN and NICE perioperative hypothermia guidelines. In another study,[18] a questionnaire containing 19 questions was developed by the researchers to assess IPH and content analysis of the questionnaire items was conducted; however, the construct validity has not been tested, and the questionnaire used has not been proven to be valid and reliable.

The validity and reliability of the IPH-KT developed in our study were tested in a large sample. It is a significant contribution to the literature that can further guide other studies to obtain objective results in the future.

In a study,[18] IPH prevention practices were examined before training, immediately after training, and 1 month after training. In that study, immediately after training, some nurses took preventive measures against IPH, while 1 month after the training, there were nurses who did not take preventive measures in IPH-related practices.[18] Our test results showed that third-grade nursing students have a relatively good level of IPH knowledge (mean: 11.89, SD = ± 2.38) and showed that third-grade nursing students were statistically significantly higher according to fourth graders. This result can be interpreted as a decreased knowledge level of IPH over time due to the prolongation of training and practice of using acquired knowledge in a clinical setting when employed. This indicates that the level of knowledge will continue to decline further over time and is insufficient in the working-period population. Therefore, health care professionals in hospitals should update their knowledge and follow the new literature[21] and need for continuing education (eg, on-the-job training, in-service, staff development sessions), familiarize themselves with various organizational guidelines[22] regarding the prevention of IPH (eg, AORN, ASPAN, NICE)[2–4] and prepare protocols such as policies and procedures in accordance with these guidelines.

Over time (eg, annually), the assessment of the knowledge level of IPH needs to be evaluated as a valid and reliable tool. The IPH-KT was developed using the current needs of nursing students. Knowledge of IPH prevention can positively affect the quality of patient care,[22,23] the level of job satisfaction experienced by health care professionals,[24] and financial costs,[25] institution caused by hypothermia (eg, increased use of supplies and medication, increased length of stay in hospital, among other resources).[23,25] Therefore, IPH-KT can be regarded as a significant tool for assessing future IPH knowledge levels. Currently, as there is no valid and reliable IPH knowledge scale available, this scale can be tested in a hospital setting and subjected to validity and reliability studies. While the statements in the scale encompass nursing care knowledge, their content can be expanded to be applicable to other health care domains. Consequently, in accordance with guidelines, it is evident that applications utilizing IPH-KT will have a positive impact on patient outcomes.

A statistically significant difference was found among nursing students' self-evaluations. Most students stated that they found their level of knowledge to be sufficient; the number of those who find it inadequate is substantial, and it should not be underestimated. This indicates that students' self-assessments do not reflect their excellent IPH-KT scores. It suggests that students may not have been able to objectively evaluate themselves before responding to the test, and they realized that their IPH knowledge levels were actually quite good after providing their answers to the test. Perhaps, initially, students marked "inadequate" in order to be cautious, maybe to avoid raising expectations in front of the educator delivering the course. More study is needed in this area.

Limitations

There are some limitations in the study. First, since the study is voluntary, only those who are interested in the subject can participate in the research. Although this does not introduce bias, it restricts the generalizability of the results to the population. Second, the validity and reliability of IPH-KT were assessed in only one university and one country. Third, the validity and reliability study is not used in a language other than Turkish, and the test is for the nursing discipline, not for other health disciplines such as anesthesiologists and surgeons. Finally, IPH-CT has been evaluated solely among the nursing school population, without inclusion in clinical practice workplaces. Use in patient clinics and evaluation of its reflections on care is important.

Conclusion

Understanding the knowledge of health care professionals involved in the care of surgical patients is important for clinical practice and medical science. In general, the development of valid and reliable knowledge tests to assess whether there is a lack of knowledge will facilitate the determination of objective quantitative data to identify knowledge gaps. Results of our study showed that the 17-item IPH-KT is a valid (content and structure) and reliable test in assessing nursing students' IPH knowledge level. This knowledge measurement tool also covers nursing practices in a clinical setting and can be used to assess IPH-KT after IPH education.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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