TURKISH JOURNAL OF CARDIOVASCULAR NURSING

Official journal of the TURKISH SOCIETY OF CARDIOLOGY

Turkish Journal of Cardiovascular Nursing

Development and Evaluation of Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale

Hemşirelerin İmplante Edilebilir Kardiyak Cihaz Hakkında Bilgi Düzeyi Ölçeğinin Geliştirilmesi ve Değerlendirilmesi

ABSTRACT

Objective: Nurses who work as part of a multidisciplinary team caring for patients with cardiac implantable electronic devices (CIEDs) are required to have sufficient and accurate knowledge regarding CIEDs. This study aimed to develop and evaluate the reliability and validity of a scale designed to measure nurses' CIED-related knowledge.

Method: This cross-sectional descriptive study included 202 nurses who care for cardiovascular patients across four hospitals. The scale's reliability was evaluated using the Kuder–Richardson 20 (KR-20) reliability coefficient, intraclass correlation coefficient, and corrected item–total correlation analysis. Validity was assessed through the content validity index (CVI), predictive validity, and item discrimination index.

Results: Reliability analyses indicated that both the KR-20 reliability coefficient and the intraclass correlation coefficient demonstrated good reliability. Two items with correlation coefficients below 0.20 were removed. The scale-level CVI was 0.99. The item discrimination power ranged from poor to excellent. According to the predictive validity analysis, the type of ward on which nurses worked and the length of experience in the current ward predicted the total score, whereas education level did not.

Conclusion: The scale was found to be a reliable and valid instrument for measuring nurses' CIED-related knowledge in daily practice.

Keywords: Cardiac implantable electronic devices, nurses' knowledge, psychometric testing, reliability, validity

ÖZET

Amaç: İmplante edilebilir kardiyak cihazı olan hastaların bakımı için multidisipliner bir ekibin parçası olan hemşirelerin, cihazlar hakkında yeterli ve doğru bilgiye sahip olmaları gerekir. Çalışmanın amacı, Hemşirelerin İmplante Edilebilir Kardiyak Cihaz Hakkında Bilgi Düzeyi Ölçeği'ni geliştirmek ve geçerliği ile güvenirliğini test etmektir.

Yöntem: Kesitsel tanımlayıcı tipteki çalışmaya, dört hastaneden kardiyovasküler hastalara bakım veren 202 hemşire dahil edilmiştir. Ölçeğin güvenirliği, Kuder Richardson-20 güvenilirlik katsayısı, sınıf içi korelasyon katsayısı ve düzeltilmiş madde-toplam ölçek korelasyon analizi ile değerlendirilmiştir. Geçerlilik, kapsam geçerlilik indeksi, yordayıcı geçerlilik ve madde ayırt edicilik indeksi kullanılarak değerlendirilmiştir.

Bulgular: Güvenilirlik analizleri, Kuder Richardson-20 güvenirlik katsayısının ve sınıf içi korelasyon katsayısının iyi güvenirlik gösterdiğini ortaya koymuştur. Korelasyon katsayıları 0,20'nin altında olan iki madde çıkarılmıştır. Ölçeğin kapsam geçerlilik indeksi 0,99'dur. Madde ayırt edicilik gücü, zayıftan mükemmele kadar değişmektedir. Yordayıcı geçerlilik analizi sonuçlarına göre, hemşirelerin çalıştığı servis türü ve mevcut servisteki deneyim süresi toplam puanı öngörürken, eğitim düzeyi öngörmemiştir.

Sonuç: İmplante edilebilir kardiyak cihazlarla ilgili bilgi ölçeğinin, hemşirelerin günlük pratikte bilgisini ölçmek için güvenilir ve geçerli bir ölçek olduğu bulunmuştur.

Anahtar Kelimeler: İmplante edilebilir kardiyak elektronik cihazlar, hemşire bilgisi, psikometrik testler, güvenilirlik, geçerlilik

ORIGINAL ARTICLE
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Received: August 13, 2024
Accepted: July 30, 2025

Cite this article as: Erünal M, Akbaba A, Mert H, Bektaş M. Development and Evaluation of Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale. *Turk J Cardiovasc Nurs.* 2025;16(41):139-144.

DOI: 10.5543/khd.2025.17894

Introduction

The umbrella term cardiac implantable electronic devices (CIEDs) includes implantable cardioverter defibrillators (ICDs), permanent pacemakers (PPMs), and cardiac

resynchronization therapy (CRT). These are widely used treatments for rhythm disorders, heart failure, and the prevention of sudden cardiac death.[1,2] Patients require comprehensive education at discharge to manage their new devices effectively and to avoid complications such as lead dislodgement,[1] or frozen shoulder,[3] electromagnetic interference (EMI),[4] and psychological effects like anxiety,[5,6] and depression.[7]

Recent guidelines emphasize the importance of educating and monitoring patients with CIEDs, advocating for a multidisciplinary team approach involving electrophysiologists, cardiologists, nurses, psychologists, dieticians, and pharmacists.[1] Nurses are a vital part of this team and must be knowledgeable about the indications for all types of CIEDs, as well as all aspects of living with these devices—including managing shock delivery, physical restrictions, and the clinical care of patients with CIEDs.[8] Enhancing nurses' knowledge contributes to patient safety by helping prevent complications such as inappropriate shocks, frozen shoulders, or lead dislodgement.

In this context, developing a reliable and valid scale to measure nurses' CIED-related knowledge is essential. Such a scale can support both self-assessment and serve as a tool for clinical nurse managers to organize targeted educational programs, address specific knowledge gaps, and ensure the continued competence of nursing staff. Furthermore, nursing education leaders and nurse educators can use the scale to evaluate CIED knowledge in relevant courses and as a guide for curriculum planning.

Therefore, the present study aimed to develop and evaluate the psychometric properties of a scale designed to measure nurses' CIED-related knowledge.

Methods

Scale Development Process

Researchers developed an initial item pool consisting of 84 items based on a literature review, which involved searching electronic databases including PubMed, CINAHL, MEDLINE, and Scopus. The review was conducted using the following keywords: "cardiac implantable electronic devices," "pacemaker," "implantable cardioverter-defibrillator," "cardiac resynchronization therapy," "nurses' knowledge," and "nursing care of patients with CIEDs." This process identified key topics such as indications for CIEDs,[1,2] care of the incision area,[9] restrictions on daily activities,[1] sports and exercise,[10] medical procedures,[11] shock plans,[12] electromagnetic interference (EMI), device ID cards, and follow-up.[1,13]

The item pool was transformed into a draft scale with three response options: "True," "False," and "I don't know," which was used to gather expert opinions and calculate the content validity index (CVI). A True/False design was selected, as the multiple-choice question format offers no significant advantages over it.[14] The "I don't know" option was included to reduce the likelihood of respondents guessing answers inaccurately.

According to Grant and Davis'[15] guidelines, between 2 and 20 expert opinions are recommended when determining a scale's CVI.[16] In this study, the expert panel consisted of eleven professionals: two cardiovascular nurses, three cardiologists, three cardiac device technicians, and three academic experts in cardiovascular nursing. The CVI was calculated using the Davis technique, in which experts rate items on a scale from 1 (not relevant) to 4 (highly relevant).[15] The CVI is determined by dividing the number of experts who selected a rating of 3 or 4 by the total number of experts.

Fifty-four items that were either similar to others or had a CVI below 0.80 were removed, resulting in a 30-item draft scale. This version was then reviewed by another expert panel composed of two cardiovascular nurses, three cardiologists, three cardiac device technicians, and one academic expert in cardiovascular nursing. The panel did not recommend any further changes, and all 30 items were retained.

The finalized 30-item Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale was then used for evaluation (Figure 1).

MAIN POINTS

- Nurses' knowledge about cardiac implantable electronic devices (CIEDs) is typically measured using questionnaires, but no standardized scale currently exists. Therefore, the scale developed in this study contributes to the standardized measurement of nurses' knowledge about CIEDs.
- The scale is both valid and reliable for assessing nurses' knowledge of CIEDs.
- It can be used in daily practice to evaluate nurses' knowledge of CIEDs.

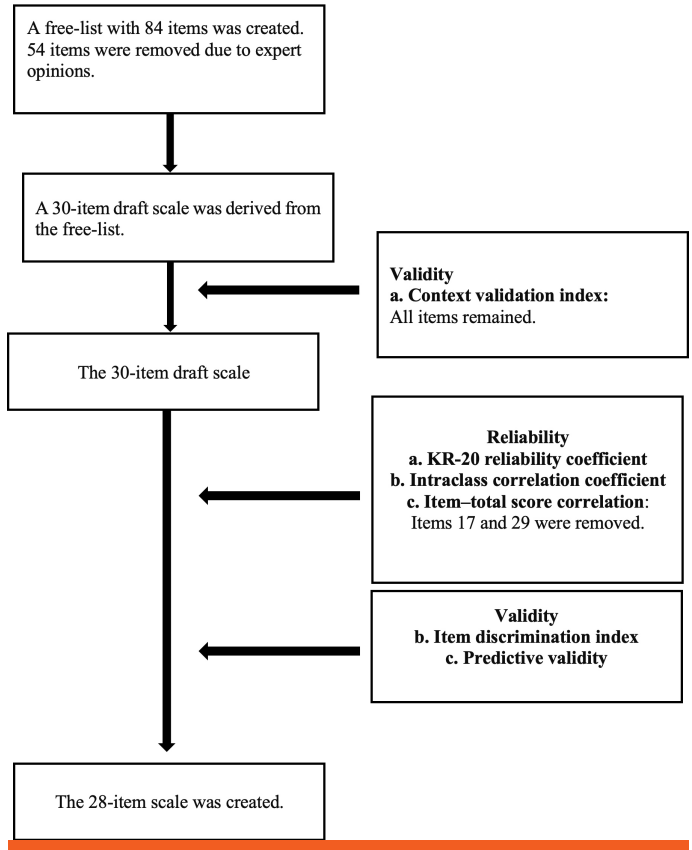

Figure 1. Scale development process.

Design and Sample

This cross-sectional descriptive study was conducted with nurses from four hospitals in the city who met the inclusion criteria. The criteria were current employment in a clinical ward for at least six months, voluntary participation in the study, and no communication difficulties. Participants were recruited from the cardiology ward, coronary intensive care unit, and other units including cardiology outpatient clinics, the emergency department, and the catheterization laboratory. For studies of this nature, a minimum sample size of 200 participants is recommended.[17] In this study, 211 nurses were approached, and 202 who voluntarily agreed to participate were included. The research instruments were administered in the hospitals during working hours, with an average completion time of 20 minutes.

Data Collection Tools

Sociodemographic Characteristics Form

The researchers developed a sociodemographic characteristics form consisting of eight questions on age, gender, education level, income status, marital status, current ward, length of experience in the current ward, and overall nursing experience.

Final Version of the Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale

The final scale included 28 items addressing topics such as CIED indications, wound care, and post-discharge instructions related to daily activity restrictions, EMI, and similar concerns. Participants responded to each statement with one of three options: "True," "False," or "I do not know." One point was awarded for each correct response, and zero points for incorrect or "I do not know" responses. A total score was calculated by summing all responses, with possible scores ranging from 0 to 28. The cut-off scores were determined by quartile analysis of the minimum and maximum scores: 0–14 indicated inadequate knowledge, 15–21 indicated medium knowledge, and 22–28 indicated adequate knowledge.

Data Analysis

Data analysis was conducted using SPSS version 24 (IBM Corp., Armonk, NY, USA). Descriptive data were analyzed using frequency, percentage, mean, and standard deviation. The significance level was set at 0.05. Since the scale included dichotomous variables, reliability was assessed using the Kuder–Richardson 20 (KR-20) reliability coefficient,[15,18] intraclass correlation coefficient (ICC),[19] and corrected item–total correlations.[20] Validity was evaluated using content validity, predictive validity, and the item discrimination index.

Reliability

Internal consistency was assessed with the KR-20 reliability coefficient and the intraclass correlation coefficient (ICC). KR-20 values are interpreted as follows: ≥ 0.70 is acceptable, ≥ 0.80 is good, and ≥ 0.90 is very good.[15,18] ICC values are classified as: < 0.5 = poor, 0.5–0.75 = moderate, 0.75–0.90 = good, and > 0.90 = excellent.[19] The correlation between individual items and the overall scale was determined using corrected item–total correlation analysis, with acceptable values ranging from 0.20 to 0.50.[15,20]

Validity

Content validity was used to evaluate interpretive validity. The content validity index (CVI) was calculated, with values ≥ 0.80 considered valid.[15,16] Predictive validity was assessed to determine whether factors that may influence nurses' knowledge could predict future scale scores. Multiple regression analysis was conducted, with ward type, length of experience in the current ward, and education level as independent variables, and the total knowledge score as the dependent variable.[21,22] Ward type was categorized as either cardiology/coronary intensive care unit or other wards. Education level was coded as follows: high school graduate or associate degree = 0, and bachelor's degree or postgraduate level = 1.

The item discrimination index was calculated to evaluate each item's ability to distinguish between groups. The formula was:

D_i = (GA correct answers – GB correct answers) / N largest group

- D_i: discrimination index of item
- GA correct answers: number of correct responses to item i among participants in the top 27%
- GB correct answers: number of correct responses to item i among participants in the bottom 27%
- N largest group: number of participants in the larger of the two groups (GA or GB)

Interpretation of the item discrimination index values is as follows: > 0.39 = excellent, 0.30–0.39 = good, 0.20–0.29 = mediocre, and 0.00–0.20 = poor.[23]

Ethical Considerations

Ethical approval for the research was obtained from Dokuz Eylül University Non-Interventional Clinical Research Ethics Committee (approval number: 2019/03-14, date: 13.02.2019). Institutional permissions were also secured from the participating hospitals. All participants were provided with sufficient information about the study and gave informed consent. The research was conducted in accordance with the Declaration of Helsinki.

Results

The mean age of the nurses was 33.18 ± 7.29 years. Among the participants, 83.7% were female, 52.5% were married, 88.6% held a bachelor's degree, and 77.2% worked in the coronary intensive care unit or cardiology ward. The mean length of professional nursing experience was 127.4 ± 90.27 months, while the mean length of experience in the current ward was 76.29 ± 74.49 months.

Reliability

Reliability analysis showed that the KR-20 reliability coefficient and the intraclass correlation coefficient of the scale were 0.80. Corrected item–total score correlations ranged from –0.009 to 0.599. Items 17 and 29, which had values below 0.20, were removed. Although items 5, 6, 9, 11, 22, and 30 did not meet the criteria, they were retained because they addressed important issues not covered elsewhere. After these adjustments, the KR-20 reliability coefficient and the intraclass correlation for the 28-item scale were 0.81 (Table 1).

Table 1. Discrimination ability and internal consistency (n = 202)

Ite.	Phase 1 KR-20	Phase 1 ICC (99% CI)	Corrected item-total score correlation	Phase 2 KR-20	Phase 2 ICC (99% CI)	Item Discrimination Index
Total	0.80	0.80		0.81	0.81	
1			0.351			0.56
2			0.340			0.37
3			0.261			0.46
4			0.315			0.46
5			**0.082**			0.22
6			**0.180**			0.33
7			0.468			0.46
8			0.599			0.39
9			0.173			0.26
10			0.521			0.72
11			**0.078**			**0.11**
12			0.453			0.26
13			0.534			0.67
14			0.499			0.65
15			0.403			0.52
16			0.219			0.24
17			0.091			
18			0.339			0.24
19			0.481			0.67
20			0.454			0.76
21			0.364			0.50
22			**-0.009**			**0.02**
23			0.480			0.50
24			0.254			0.31
25			0.271			0.43
26			0.371			0.56
27			0.317			0.24
28			0.365			0.22
29			-0.153			
30			**0.120**			0.20

Ite, Items; ICC, Intraclass correlation; CI, Confidence interval.

Validity

The item-level CVI values ranged from 0.89 to 1.00, while the scale-level CVI for the 30-item draft scale was 0.99. The item discrimination index values ranged from 0.02 to 0.76. Although items 11 and 22 demonstrated poor discrimination power, they were retained because of their importance for nurses' CIED-related knowledge (Table 1). Multiple regression analysis indicated that ward type, length of experience in the current ward, and education level significantly influenced the total score ($P < 0.001$). Together, these three variables accounted for 28% of the variance in total knowledge scores. However, only ward type and length of ward experience were significant predictors of total knowledge, while education level was not (Table 2).

Table 2. The level of prediction of nurses' knowledge level of clinic and working duration (n = 202)

Variables	Beta	SE	β†	T‡	P
Constant	12.204	0.696		17.527	0.000
Ward	5.989	0.702	0.514	8.532	0.000
Length of experience	0.008	0.004	0.124	2.038	0.043
Education level	1.101	0.934	0.072	1.179	0.240
R§	0.533				
R2¶	0.284				
F¥	26.238				
P	0.000				

SE, Standard error; †, Standartized Beta; ‡, t-test value; §, Correlation co-efficient; ¶, R Square; ¥, ANOVA value.

Table 3. Characteristics of participants (n = 202)

Characteristics	X̄	SD
Age (year) (min-max: 20-54)	33.18	7.29
	n	**%**
Gender		
Male	33	16.3
Female	169	83.7
Marital status		
Married	106	52.5
Single	96	47.5
Education level		
Bachelor's degree	179	88.6
Postgraduate	23	11.4
Income status		
Income < Expense	73	36.1
Income = Expense	102	50.5
Income > Expense	27	13.4
Ward		
Coronary ıntensive unit/cardiology ward	156	77.2
Other departments	46	22.8
	X̄	**SD**
Length of experience (month)		
Current ward (min-max: 6-324)	76.29	
Nursing profession (min-max: 6-324)	127.44	
	n	**%**
Scale total score (min-max: 1 - 27)		
Inadequate	43	21.3
Medium	120	59.4
Adequate	39	19.3

SD, Standard deviation; Min, Minimum; Max, Maximum.

The Knowledge Level of the Nurses

The results of the study revealed that 21.3% of the nurses had an inadequate knowledge level, 59.4% had a medium level, and 19.3% had an adequate level (Table 3). Most nurses (80–90%) answered correctly on items related to ICD indications, arm

restrictions, undergoing MRI, and wound care. Fewer correct responses were provided for items concerning shock management, device ID cards, undergoing CT, passing through security systems in shopping malls, and follow-up. Only 52–65% of participants answered correctly on items regarding PPM and CRT indications, daily activities, undergoing chest X-rays, performing CPR on patients with CIEDs, and EMI (cell phones and flights).

Discussion

This study describes the development and evaluation of the Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale, designed to measure nurses' knowledge of CIEDs.

For content validity, expert opinions were obtained. To confirm agreement among experts, it is recommended that the content validity index (CVI) be above 0.80. Fifty-four items that were either redundant or had a CVI below 0.80 were removed, leaving 30 items in the draft scale. The item-based CVI ranged from 0.89 to 1.00, and the scale-based CVI was 0.99 for the 30-item draft.

In this study, the KR-20 reliability coefficient and intraclass correlation coefficient (ICC) of the scale were both 0.80. KR-20 values above 0.80 are considered good,[15,18] and ICC values between 0.75 and 0.90 also indicate good reliability.[19] These results show that the scale had good reliability. Item–total score analysis, which evaluates whether scale items measure the intended concept, recommends a minimum correlation of 0.20.[15,20] Some items had corrected item–total correlations below this threshold; however, they were retained because of their importance for patient education and care. These included items on the shock plan (item 5), ROM exercises (item 9), device ID cards (item 6), swimming alone (item 11), security systems in shopping malls (item 22), and the follow-up schedule (item 30). These issues are critical for nurses' knowledge: developing a shock plan with patients helps prevent anxiety,[6,24,25] informing patients not to swim alone reduces isolation and risk of depression, addressing shopping mall security systems alleviates patient concerns,[26] teaching ROM exercises prevents complications such as frozen shoulder,[1,13] and reinforcing the importance of carrying a device ID card and adhering to follow-up improves patient safety and compliance.[13]

For items to remain in the scale, a discrimination index of at least 0.20 is recommended. In this study, discrimination power was adequate for all items except items 11 (swimming alone) and 22 (shopping malls). Despite their lower discrimination, these items were retained to counter misinformation, increase nurses' awareness, and enhance patient support.

The multiple regression analysis demonstrated that working in cardiology or coronary intensive care units, as well as longer ward experience, positively affected CIED-related knowledge. Experience in these units provides nurses with direct exposure to patients with CIEDs, reinforcing both practical knowledge and care skills. Similarly, longer ward experience increases familiarity with CIED care, thereby improving knowledge.[22,27] By contrast, education level did not affect knowledge scores. This finding suggests that nurses may not update their knowledge regularly, continuing outdated practices that may no longer be optimal.[21,22] It may also indicate that the nursing education curriculum is insufficient in covering CIED-related topics.

The study also revealed that a relatively low proportion of nurses achieved an adequate knowledge level, with about half demonstrating only medium knowledge. Notably, knowledge was limited regarding shock management, device ID cards, undergoing CT, negotiating security systems in shopping malls, and follow-up schedules. In addition, knowledge levels were inadequate in areas critical for clinical management, including PPM and CRT indications, device mechanisms, performing CPR on patients with CIEDs, and chest X-rays. These knowledge gaps suggest that many nurses may not be able to adequately educate or care for patients with CIEDs.[21,22,24]

Strengths and Limitations

A limitation of this study is that the scale was developed based on current knowledge of CIEDs. Future revisions may be required as new scientific and technological knowledge emerges. However, the study also had important strengths, including a large sample size and diversity of participants.

Conclusion

This study demonstrated that the 28-item Nurses' Cardiac Implantable Electronic Devices-Related Knowledge Scale provides reliable and valid evidence for measuring nurses' CIED-related knowledge. The scale can be confidently used for self-assessment in daily practice. Healthcare managers can apply it to identify nurses' knowledge levels and needs when designing training programs, thereby ensuring that nurses are better prepared to provide informed care and education for patients with CIEDs. In addition, the scale can serve as a resource for nursing educators in designing CIED-related components of curricula, helping ensure that future nurses enter the workforce with a strong foundation in this specialized field. Its use in both academic and clinical settings may contribute to standardizing CIED education and fostering a more competent nursing workforce.

Ethics Committee Approval: Ethics committee approval was obtained from Dokuz Eylül University Non-Interventional Clinical Research Ethics Committee (Approval Number: 2019/03-14, Date: 13.02.2019).

Informed Consent: All participants were provided with sufficient information about the study and gave informed consent.

Conflict of Interest: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: Artificial intelligence was not used in the writing of the article.

Author Contributions: Concept – M.E., H.M.; Design – M.E., A.A., H.M.; Supervision – M.E., A.A., H.M., M.B.; Data Collection and/or Processing – M.E., A.A.; Analysis and/or Interpretation – M.E., A.A., M.B.; Literature Review – M.E., A.A., H.M.; Writing – M.E., A.A., H.M., M.B.; Critical Review – M.E., A.A., H.M., M.B.

Acknowledgments: This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors. We want to thank all of the participants who willingly contributed to this research.

Peer-review: Externally peer-reviewed.

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