DOI: 10.12923/pielxxiw-2025-0016

Nursing care process for a patient after PCI CTO procedure using PulseCath iVAC 2L based on the ICNP® classification

Proces pielęgnowania pacjenta po zabiegu PCI CTO z wykorzystaniem PulseCath iVAC 2L na podstawie klasyfikacji ICNP®

Filip Miłosz Tkaczyk[A-B,D-G,K-L]

Doctoral School, Collegium Medicum, Jan Kochanowski University, Poland

CORRESPONDING AUTHOR:
Filip Miłosz Tkaczyk
Doctoral School, Collegium Medicum, Jan Kochanowski University
ul. Żeromskiego 5, 25-317 Kielce, Polska
e-mail: filip1193@onet.pl

A – Development of the concept and methodology of the study/Opracowanie koncepcji i metodologii badań; B – Query - a review and analysis of the literature/Kwerenda – przegląd i analiza literatury przedmiotu; C – Submission of the application to the appropriate Bioethics Committee/Złożenie wniosku do właściwej Komisji Biotycznej; D – Collection of research material/Gromadzenie materiału badawczego; E – Analysis of the research material/Analiza materiału badawczego; F – Preparation of draft version of manuscript/Przygotowanie roboczej wersji artykułu; G – Critical analysis of manuscript draft version/Analiza krytyczna roboczej wersji artykułu; H – Statistical analysis of the research material/Analiza statystyczna materiału badawczego; I – Interpretation of the performed statistical analysis/Interpretacja dokonanej analizy statystycznej; K – Technical preparation of manuscript in accordance with the journal regulations/Opracowanie techniczne artykułu zgodne z regulaminem czasopisma; L – Supervision of the research and preparation of the manuscript/Nadzór nad przebiegiem badań i przygotowaniem artykułu

STRESZCZENIE

PROCES PIELĘGNOWANIA PACJENTA PO ZABIEGU PCI CTO Z WYKORZYSTANIEM PULSECATH IVAC 2L NA PODSTAWIE KLASYFIKACJI ICNP®

Cel pracy. Celem pracy było przedstawienie procesu pielęgnowania nad pacjentem po zabiegu PCI CTO z użyciem urządzenia PulseCath iVAC 2L, opartego na klasyfikacji Międzynarodowej Klasyfikacji Praktyki Pielęgniarskiej (ICNP®).

Materiał i metody. Badanie opierało się na studium indywidualnego przypadku, z zastosowaniem wywiadu pielęgniarskiego, obserwacji, analizy dokumentacji medycznej oraz pomiaru podstawowych parametrów życiowych. Zostało przeprowadzone w czerwcu 2024 roku w warunkach szpitalnych, po uzyskaniu zgody pacjenta. Obserwacja trwała 5 dni.

Wyniki. Pacjent, 79-letni mężczyzna z chorobą wieńcową, przeszedł PCI CTO z zastosowaniem urządzenia PulseCath iVAC 2L. Procedura zakończyła się sukcesem, a pacjent nie doznał poważnych powikłań. Po zabiegu pacjent był monitorowany, a jego stan zdrowia uległ poprawie. Przed i po zabiegu obserwowano poprawę parametrów hemodynamicznych.

Wnioski. Wykorzystanie klasyfikacji ICNP® pozwoliło na holistyczne podejście do procesu opieki nad pacjentem, zapewniając systematyczne diagnozowanie i planowanie interwencji pielęgniarskich. Kluczową rolą personelu pielęgniarskiego było monitorowanie stanu pacjenta, zarządzanie bólem oraz zapobieganie powikłaniom, co przyczyniło się do poprawy jakości życia pacjenta po zabiegu.

Słowa kluczowe: opieka pielęgniarska, przezskórna interwencja wieńcowa (PCI), przewlekła całkowita okluzja (CTO), PulseCath iVAC2L

ABSTRACT

NURSING CARE PROCESS FOR A PATIENT AFTER PCI CTO PROCEDURE USING PULSECATH IVAC 2L BASED ON THE ICNP® CLASSIFICATION

Aim. The aim of the study was to present the nursing process of a patient after PCI CTO using the PulseCath iVAC 2L device, based on the International Classification of Nursing Practice (ICNP®) classification.

Material and methods. The study was based on an individual case study, using a nursing interview, observation, analysis of medical records and measurement of basic vital signs. It was conducted in June 2024 in a hospital setting, after obtaining the patient's consent. The observation lasted 5 days.

Results. The patient, a 79-year-old man with coronary artery disease, underwent PCI CTO using the PulseCath iVAC 2L device. The procedure was successful and the patient did not experience any serious complications. The patient was monitored after the procedure and his health condition improved. Before and after the procedure, an improvement in haemodynamic parameters was observed.

Conclusions. The use of the ICNP® classification allowed for a holistic approach to the patient care process, providing systematic diagnosis and planning of nursing interventions. The key role of the nursing staff was to monitor the patient's condition, manage pain and prevent complications, which contributed to improving the patient's quality of life after the procedure.

Key words: nursing care, percutaneous Coronary Intervention (PCI), Chronic Total Occlusion (CTO), PulseCath iVAC2L

INTRODUCTION

Coronary artery disease (CAD) is one of the leading causes of death worldwide. In 2020, the global total of death from CAD reached 8.95 million, while the number of people affected by this disease grew to 244.11 million, with the highest prevalence rates observed in North Africa, the Middle East, Central and South Asia, and Eastern Europe. According to 2021 data from the American Heart Association (AHA), CAD caused 5.12 million deaths in men and 4.09 million deaths in women [1,2].

Percutaneous coronary intervention (PCI) is a highly specialized medical procedure aimed at reopening narrowed coronary arteries using a balloon catheter or stent. Chronic total occlusion (CTO) refers to a condition where a coronary artery is completely blocked, hindering blood flow [3,4]. Epidemiological data indicate that CTO is diagnosed in 16% to 20% of patients with coronary artery disease who undergo coronary angiography [5,6]. PCI CTO accounts for approximately 5% of all PCI procedures performed globally. In the DECISION-CTO study, the success rate of PCI CTO was 90.6%, but during a 4-year follow-up, no significant differences were observed in major endpoints between PCI and no revascularization (22.3% vs. 22.4%; HR: 1.03; P=0.86) [7]. Despite the challenges of this procedure, such as longer duration, greater use of equipment resources, and higher risk of complications, PCI for CTO can significantly improve patients' clinical outcomes [8].

Mechanical circulatory support with the PulseCath iVAC 2L system utilises pulsatile blood flow technology to temporarily relieve the left ventricle during cardiac procedures, such as PCI. The device consists of three components:

- a membrane pump,
- a bidirectional flow catheter, and
- a dual-axis rotary valve.

The 40 mL membrane pump contains blood and air chambers separated by an flexible membrane, with a maximum stroke volume of 21 mL. A 95 cm long, 17 Fr polyurethane catheter reinforced with nitinol connects the pump to the circulatory system. It consists of a steel inlet tip and a dual-axis rotary valve. The catheter is inserted via the femoral artery into the left ventricle, synchronized with the cardiac cycle, allowing effective left ventricular unloading and improved organ perfusion while stabilizing hemodynamic parameters in patients with severe heart dysfunction [9].

A study conducted by den Uil CA et al. evaluated the PulseCath iVAC 2L device in 14 patients undergoing PCI. The median age of participants was 74 years (range 56–84 years). Successful implantation of the PulseCath iVAC 2L system was achieved in 13 out of 14 patients (93%). The average flow generated by the device was 1.4 L/min (range 1.1–2.0 L/min), with an average support duration of 67 minutes (range 23–149 minutes). No serious adverse events were reported during the three-month follow-up [10].

The nursing team plays the key role in the care of patients following PCI CTO with the PulseCath iVAC 2L device. Specialised tasks performed by the nursing team include monitoring vital signs and ECG recordings, pain management, medication administration, assessment of the puncture site, prophylaxis, health education, and preparing the patient for self-care. Through a holistic approach and close collaboration with other members of the therapeutic team, nursing staff contribute to improved treatment outcomes and quality of life for patients post-PCI CTO [11,12].

AIM

The aim of this study is to present the patient care process for patients after a PCI CTO procedure using the PulseCath iVAC 2L devices, with consideration of the ICNP® classification.

MATERIALS AND METHODS

The research method employed in this study is the individual case study method, based on the care process using the reference terminology of the International Council of Nurses – ICNP® [13].

The following research techniques wereimplemented:

- Nursing interview;
- Unstructured and structured observation;
- Analysis of medical documentation and information provided by other healthcare professionals caring for the patient;
- Measurement of basic vital signs.

The study incorporated the following research tools:

- Medical history;
- Diagnostic test results;
- Nursing interview questionnaire;
- Individual patient care record;
- Patient observation chart (sphygmomanometer, stethoscope, pulse oximeter);
- Peripheral catheter observation chart;
- Body mass index (BMI) tool (medical scale with height meter);
- Numeric Rating Scale (NRS);
- New York Heart Association Scale (NYHA).

Organization and course of the study

The study was conducted in June 2024 in a hospital setting after obtaining written consent from the medical institution and the patient. The consent covered conducting a nursing interview, accessing medical documentation, and performing basic diagnostics of the patient's general condition. The patient provided informed consent to participate in the study.

The patient under observation was informed about the anonymity of the study, which is intended only for scientific purposes. Patient observation was carried out over a period of 5 days.

Case report

The patient, a 79-year-old male, was admitted electively to the invasive cardiology ward due to worsening symptoms of coronary artery disease, significantly reducing his quality of life. The patient was diagnosed with chronic total occlusion (CTO) in the left anterior descending artery (LAD). He was qualified for a PCI CTO procedure, which uses PulseCath iVAC 2L technology to improve myocardial perfusion and support circulation. Comprehensive diagnostic workup, including imaging (coronary angiography), laboratory tests, and monitoring of basic vital parameters, were performed prior to the procedure. The patient had comorbidities, including hypertension. Diagnostic data collected on the functioning of individual anatomical systems were as follows:

- Cardiovascular system: Heart rate: 84 bpm—regular and steady, with no signs of tachycardia. Blood pressure: 130/85 mmHg. No lower limb edema or heart murmurs upon auscultation. The patient did not report chest pain at rest but experienced exertional chest discomfort rated as 7/10 on the NRS scale. Left ventricular ejection fraction (LVEF) was 24%. NYHA Class III.
- Respiratory system: Respiratory rate: 18/min, normal breathing pattern, abdominal breathing. Oxygen saturation: 94%. The patient reported no dyspnea or breathing difficulties at rest, no pulmonary edema, and no signs of hyperventilation.
- Nervous system: Fully conscious, normal verbal communication, logical thinking, and orientation in time, place, and situation. No neurological symptoms; the patient did not complain of headaches or dizziness.
- Sensory function: Normal vision (uses reading glasses). Normal hearing. Normal tactile and temperature sensation.
- Digestive system: Normal appetite and thirst. Oral feeding with a low-sodium diet. No abdominal pain or other gastrointestinal complaints. Normal peristaltic activity, no bloating or constipation.
- Urinary and reproductive system: Normal urination with no signs of dysuria. Nycturia within normal limits (1-2 times per night).
- Skin: Good hygiene, normal body temperature of 36.8°C.
- Nutritional status: Normal body structure. Height: 175 cm, weight: 88.2 kg, BMI = 28.8 kg/m² (overweight). Physical activity was limited due to symptoms of coronary artery disease; a low-sodium diet was maintained.

The patient underwent percutaneous coronary angioplasty of the left anterior descending artery (LAD) using a retrograde approach, which allowed the therapeutic team to cross the coronary artery occlusion. Due to the inability to pass the balloon catheter through the stenosis, rotational atherectomy with a Rotapro system and a 1.25 mm burr was performed. After removing calcified and resistant atherosclerotic plaques, predilation with a balloon catheter was carried out, followed by implantation of a drug-eluting stent (DES) Orsiro (2.5 x 40 mm) at a pressure of 14 atm. Transesophageal echocardiography (TTE) was used multiple times during the procedure to monitor the patient's condition, with no evidence of pericardial effusion observed at any stage. Vascular access was obtained via the radial arteries (both right and left). Additionally, a vascular sheath was placed in the right femoral artery under ultrasound guidance by a vascular surgeon. The vascular access sites were regularly monitored by the interdisciplinary team. During the patient's hospitalization, no significant bleeding, hematomas, signs of infection or complications in the form of a pseudoaneurysm were observed. The condition of the vessels was monitored using point-of-care ultrasound. The patient reported periodic pain in both upper limbs above the vascular access, resulting directly from irritation of the radial arteries. 4/10 on the NRS scale. Painkillers were administered as needed and the pain was systematically assessed.

The procedure was completed without complications, and the LAD occlusion was successfully revascularized, restoring effective blood flow to areas supplied by the left anterior descending artery. After the procedure, the patient was transferred to the intensive cardiac care unit for close monitoring of vital signs and hemodynamic status. The main results before and after the PCI CTO procedure using the PulseCath iVAC 2L systems are presented in Tab. 1.

Tab. 1. Key Outcomes Before and After PCI CTO procedure using PulseCath iVAC 2L Devices

Parameter	Before the procedure	After the procedure
Blood Pressure (mmHg)	155/90 mmHg	130/75 mmHg
Heart Rate (beats per minute)	95/min	78/min
LVEF Ejection Fraction (%)	24% Severe Heart Failure	33%
Degree of LAD Stenosis (%)	100%	<10% Effective Flow Restoration
TIMI Scale (Flow)	TIMI 0 (No Flow)	TIMI 3 (Full Flow)
Troponin (ng/mL)	0,15 ng/mL	0,08 ng/mL
BNP/NT-proBNP (Natriuretic Peptides) (pg/mL)	3000 pg/mL	1700 pg/mL
NYHA (Heart Failure Class)	III	I
LVEDV (Left Ventricular End-Diastolic Volume) (mL)	200 mL	160 mL

The total hospitalization duration was 5 days. The patient was discharged in good general condition and referred to a cardiology outpatient clinic. Follow-up results at 1, 3, and 6 months post-procedure are shown in Tab. 2.

Tab. 2. Follow-Up results (1, 3, and 6 months post-procedure)

Parameter	1 Month	3 Months	6 Months
LAD Patency	Patent[1]	Patent[1]	Patent[1]
LVEF Ejection Fraction (%)	36%	41%	44%
Complications	None[2]	None	None
BNP/NT-proBNP (pg/mL)	1500 pg/mL	1200 pg/mL	1000 pg/mL
NYHA Class	II	I	I
LVEDV (Left Ventricular End-Diastolic Volume) (mL)	160 mL	155 mL	140 mL

[1]The term „Patent" refers to maintained vessel patency, as confirmed by angiographically and by the absence of flow restrictions (TIMI 3).
[2]No major complications: only minor events were reported, such as transient cardiac arrhythmias (without clinical significance) and hematomas at the vascular access site, but resolved without intervention.

ICNP Nursing Process

The International Classification for Nursing Practice (ICNP®) was followed in the care process, enabling healthcare professionals to formulate nursing diagnoses based on a holistic assessment of the patient's clinical condition, considering the hierarchy of priorities for life and health. This classification, through the use of standardized terminology, ensures consistency in presenting nursing diagnoses and interventions on a global level, facilitating comparability and the exchange of information worldwide [14,15,16]. Specific nursing diagnoses and interventions are presented in Tab. 3.

Tab. 3. Patient Care Process After PCI CTO Procedure Using PulseCath iVAC 2L Devices and ICNP® Classification

ICNP® Diagnosis 1	**ischemic pain [10010896] heart [10008822]**
ICNP® Interventions	• monitoring cardiac status [10034285] • pain monitoring [10038929] • observation [10013474] • pain medication administration [10023084] • medication billing [10036549] • providing a medication schedule [10043185] • pain management [10011660] • teaching about pain management [10019489] • identifying attitudes to pain [10009654] • evaluating pain management responses [10034053] • assessing knowledge about the disease [10030639] • reinforcing adherence to recommendations [10024562] • documenting [10006173]
ICNP® Result of care	reduced pain [10027917]
ICNP® Diagnosis 2	dyspnea [10006461] functional dyspnea (exertional) [10008268] resting dyspnea [10017117] respiratory system [10016970]
ICNP® Interventions	• observation [10013474] • assessing respiratory status using monitoring device [10002799] • monitoring blood oxygen saturation with pulse oximeter [10032047] • monitoring respiratory status (efficiency) [10012196] • monitoring tissue perfusion [10035335] • monitoring respiratory therapy [10037092] • assisting with self-care [10035763] • teaching about respiratory rate measurement [0044772] • teaching about oxygen therapy [10044786] • respiratory therapy [10037085] • oxygen therapy [10039369] • assessing knowledge about the disease [10030639] • reinforcing adherence to recommendations [10024562] • documenting [10006173]
ICNP® Result of care	no dyspnea [10029255] effective airway clearance [10027964] positive respiratory process [10028156]
ICNP® Diagnosis 3	vascular pain [10020612] wound pain [10021243] forearm [10008164] leg [10011298]
ICNP® Interventions	• pain monitoring [10038929] • pain medication administration [10023084] • medication billing [10036549] • nurse-controlled pain management [10039798] • pain management [10011660] • teaching about pain management [10019489] • identifying attitudes to pain [10009654] • evaluating pain management responses [10034053] • monitoring medication side effects [10043884] • ensuring adherence [10030298] • documenting [10006173]
ICNP® Result of care	reduced pain [10027917]

cont. Tab. 3. Patient Care Process After PCI CTO Procedure Using PulseCath iVAC 2L Devices and ICNP® Classification

ICNP® Diagnosis 4	bleeding [10003303] forearm [10008164] leg [10011298]
ICNP® Interventions	• wound assessment [10030799] • observation [10013474] • controlling symptoms [10025812] • identifying the risk of hemorrhage [10009696] • technique for stopping bleeding [10008965] • wound care [10033347] • changing the dressing on a wound [10045131] • cooling compress [10004519] • interdisciplinary teamwork in wound care [10043995] • compliance with therapeutic regimen [10030365] • monitoring response to treatment [10032109] • teaching about wound dressing changes [10045149] • assessing adherence [10024185] • assessing knowledge of wound care [10046598] • assessing knowledge of wound healing [10046607] • following recommendations [10030298] • documenting [10006173]
ICNP® Result of care	without bleeding [10028806]
ICNP® Diagnosis 5	risk of infection [10015133]
ICNP® Interventions	• assessing susceptibility to infection [10002821] • assessing signs and symptoms of infection [10044182] • using aseptic technique [10041784] • preventing infection [10036916] • documenting [10006173]
ICNP® Result of care	without infection [10028945]
ICNP® Diagnosis 6	altered blood pressure [10022954]
ICNP® Interventions	• observing [10013474] • performing the test [10007256] • monitoring blood pressure [10032052] • measuring blood pressure [10031996] • administering medication [10025444] • accounting for medication [10036549] • providing a medication schedule [10043185] • monitoring response to treatment [10032109] • ensuring adherence [10030298] • documenting [10006173]
ICNP® Result of care	blood pressure within normal range [10027647]

cont. Tab. 3. Patient Care Process After PCI CTO Procedure Using PulseCath iVAC 2L Devices and ICNP® Classification

ICNP® Diagnosis 7	obesity [10013457] overweight [10013899] body weight [10021034] lack of knowledge about diet regimen [10021939] non-adherence to diet regimen [10025143] impaired nutrition [10023009]
ICNP® Interventions	• physical examination [10032243] • monitoring food intake [10036614] • assessing tolerance to physical activity [10037945] • assessing dietary needs [10037875] • assessing readiness to learn [10002781] • assessing quality of life [10040658] • assessing attitude towards health status [10040636] • improving diet regimen [10036447] • teaching about health-promoting behaviors [10032956] • teaching about nutrition [10024618] • teaching about eating patterns [10032918] • teaching about effective body weight [10033001] • teaching about dietary needs [10046533] • teaching about exercise [10040125] • promoting exercise [10040834] • reinforcing adherence to recommendations [10024562] • monitoring treatment adherence [10043878] • accompanying the patient [10042613] • documenting [10006173]
ICNP® Result of care	nutrition within normal limits [10037572] positive ability to manage regimen [10014800] adherence to the diet regimen [10030159] adherence to recommendations [10030298] knowledge about diet regimen [10023772]
ICNP® Diagnosis 8	risk of impaired cardiac function [10037314] arterial blood flow [10030504] aardiovascular system [10003936]
ICNP® Interventions	• observing [10013474] • assessing attitude towards illness [10024192] • assessing attitude towards therapy regimen [10024205] • monitoring cardiac status [10034285] • assessing cardiac status [10036738] • evaluating cardiac status post-operation [10007078] • reinforcing positive behaviors [10036176] • reinforcing adherence to recommendations [10024562] • collaborating with interdisciplinary team [10039416] • collaborating with family [10035887] • ensuring coordination of nursing care [10046465] • providing health promotion services [10032522] • teaching about the disease [10024116] • teaching about recurrence prevention [10038668] • teaching about self-care [10045014] • documenting [10006173]
ICNP® Result of care	ability to care for health [10023452] without complications [10028834] effective cardiovascular function [10028380]

CONCLUSIONS

- Effectiveness of the applied interventions – Holistic nursing care, including hemodynamic monitoring, pain management, and assessment of the vascular access site, contributed to a safe hospitalization and the absence of severe complications.
- Personalized pain management – An individualized approach to pain assessment and appropriate adjustment of analgesic therapy effectively alleviated discomfort, improving the patient's comfort and well-being.
- Patient health education – Education on lifestyle modifications, adherence to dietary recommendations, and the need to control risk factors (such as hypertension and overweight) significantly increased the patient's awareness of coronary artery disease prevention.
- Interdisciplinary therapeutic approach – Collaboration among the therapeutic team (nurses, physicians, and physiotherapists) ensured comprehensive patient care, positively influencing a faster recovery.
- Absence of significant complications – Despite the complexity of the PCI CTO procedure with the PulseCath iVAC 2L system, the patient did not experience any life-threatening or severe health complications, which demonstrates the effectiveness of the applied therapeutic approach.
- Need for further research – The findings of this case study suggest the necessity for further research on optimizing nursing care for patients after PCI CTO, particularly in the context of long-term monitoring of treatment outcomes.

CONCLUSIONS

The nursing care process for a patient following PCI CTO with the use of PulseCath iVAC 2L devices requires a holistic approach by the nursing team. This approach includes monitoring hemodynamic status, management of pain , and providing support in health education. Key activities involve observing the patient's general condition, preventing potential complications, and assisting the patient in adapting to new therapeutic recommendations and lifestyle changes. Implementing appropriate preventive measures and regularly evaluating the effectiveness of interventions are crucial to ensuring patient safety and improving quality of life post-procedure.

The ICNP® classification was utilized in this care process, which is universal in nature and enables a comprehensive approach to patient care. This included accurately defining nursing problems as well as planning and implementing personalized interventions.

ORCID

Filip Miłosz Tkaczyk https://orcid.org/0000-0003-4847-8858

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Manuscript received: 22.01.2025
Manuscript accepted: 03.04.2025

Translation: Filip Miłosz Tkaczyk