Same-day discharge coronary interventions: How to succeed?

Aleksandra Gąsecka[1], Karol Sadowski[1], Weronika Ploch[1], Jakub Michał Zimodro[1], Łukasz Gabryel[2], Arkadiusz Pietrasik[1], Łukasz Kołtowski[1], Robert J Gil[2], Janusz Kochman[1], Tomasz Pawłowski[2]

[1]1st Chair and Department of Cardiology, Medical University of Warsaw, Warszawa, Poland
[2]Department of Cardiology, National Institute of Medicine of the Ministry of the Interior and Administration, Warszawa, Poland

Correspondence to:
Assist. Prof. Aleksandra Gąsecka, MD, PhD,
1st Chair and Department of Cardiology,
Medical University of Warsaw,
Banacha 1a, 02–097 Warszawa, Poland,
phone: +48 22 599 19 51,
e-mail: aleksandra.gasecka@wum.edu.pl

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ABSTRACT

Percutaneous coronary interventions (PCI) are the cornerstone of treatment in patients with coronary artery disease, generating substantial costs for the healthcare system. Considerable improvements in PCI technique, stent technology, and antiplatelet therapy led to a complication rate of <5%, a success rate of >95%, and lack of routine cardiothoracic surgical support. Thereby, the concept of same-day discharge following PCI has been proposed due to comparable efficacy, safety, and socioeconomic benefits of inpatient PCI. Although single-vessel disease was the primary indication for outpatient (OP) PCI, more complex scenarios such as multivessel disease, left main disease, and chronic total occlusions were also shown to be feasible and safe in the OP setting. Currently, available data show that OP PCI leads to cost optimization, increased capacity of PCI centers, decrease in the nosocomial infections rate, and increased patient satisfaction, along with good clinical outcomes. Although OP PCI seems promising in a subset of well-prepared and compliant patients without severe comorbidities, there are some challenges to overcome before its routine implementation. To prevent unnecessary hospitalization and unsafe same-day discharges, interventional cardiology teams should be trained to perform reliable risk-benefit assessments. Standardized forms should be created to obtain informed consent and instruct OP PCI patients and their relatives about postprocedural management. Here, we summarize the available data on OP and inpatient PCI outcomes, discuss the opportunities and challenges of OP PCI, and propose a periprocedural patient management checklist to facilitate the implementation of OP PCI in interventional cardiology centers.

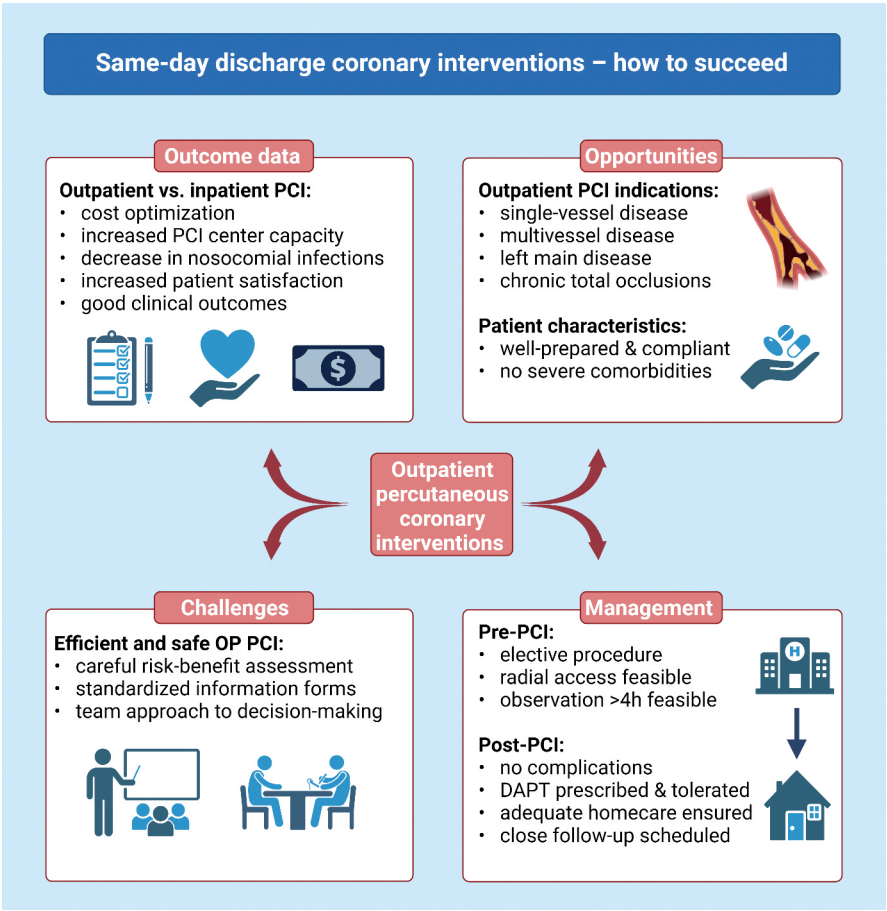
Key words: coronary artery disease, outpatient percutaneous coronary interventions, same-day discharge

INTRODUCTION

Percutaneous coronary interventions (PCI) are the cornerstone of treatment in patients with coronary artery disease (CAD) [1], generating substantial costs for the healthcare system [2–4]. Traditionally, PCI was associated with overnight hospitalization, often extended over 24 hours. However, considerable improvements in PCI technique, stent technology, and antiplatelet therapy led to a low PCI complication rate of approximately 4.5%, lack of routine cardiothoracic surgical support, and a high success rate in more than 95% of cases. Thereby, the concept of same-day discharge following PCI has been proposed [1–4].

Outpatient (OP) PCI is a feasible alternative to inpatient (IP) PCI due to comparable efficacy, safety, and socioeconomic benefits. Currently, the choice of OP or IP strategy depends on characteristics and experience of PCI centers. OP PCI is becoming increasingly popular worldwide [5, 6], but it remains a rare procedure in many experienced high-volume centers [5]. Considering the post-COVID-19 debt, routine implementation of OP PCI in specific subgroups of patients would benefit both the patients and the healthcare system.

Here, we summarize the available data on OP and IP PCI outcomes, discuss opportunities and challenges of OP PCI, and describe periprocedural OP PCI management to facilitate OP PCI implementation in interventional cardiology centers. The aspects of OP PCI discussed in this article are summarized in the Central Figure.



Central Figure. The aspects of outpatient percutaneous coronary intervention (PCI) discussed in the manuscript, including data on outpatient (OP) and inpatient PCI outcomes, discuss the opportunities and challenges of OP PCI, and describe periprocedural OP PCI management, with the goal of facilitating OP PCI implementation interventional cardiology centers

Abbreviations: DAPT, dual antiplatelet therapy

OUTPATIENT VS. INPATIENT PERCUTANEOUS CORONARY INTERVENTIONS

Efficacy and safety

Numerous studies investigating OP and IP PCI outcomes reported consistent results [7]. In a randomized clinical trial including 800 patients, the rate of major adverse cardiac and cerebral events within 24 hours from the index procedure was comparable between the OP and IP PCI groups (0.6% vs. 0.3%; $P = 0.09$, respectively) [8]. Moreover, low readmission rates (3.4%) were reported in OP PCI patients [9]. Importantly, overnight hospitalization did not prevent adverse events, as these were mainly observed either within 6 hours or over 24 hours from the index procedure [10, 11]. Considering long-term outcomes, no significant differences were found between OP and IP PCI patients at 1-year follow-up [9, 12–15]. In addition, OP PCI may be associated with a diminished risk of nosocomial infections compared to IP PCI, as overnight hospitalization was shown to result in an 11.1% infection rate [16]. Accordingly, an increase in OP PCI rate was observed during the COVID-19 pandemic to prevent the risk of SARS-CoV-2 infection associated with the hospital stay [17].

Single- vs. multivessel disease

Although single-vessel disease was the primary indication for OP PCI [18], more complex CAD have been investigated in this setting as well. Although multivessel disease is generally considered a contraindication for OP PCI [18], in previous studies, patients with multivessel disease constitute nearly 50% of all patients referred to OP PCI [19], with confirmed safety of this strategy at 1-month follow-up [12]. Nevertheless, treatment of ≥3 vessels was predominantly performed in the IP PCI regimen [20].

Similarly, patients with left main CAD were initially excluded from OP PCI due to high ischemic risk [21]. However, no significant differences in the rates of major adverse cardiac events (MACE) and readmissions were identified between the OP and IP groups undergoing left main PCI at 1-month follow-up [22]. Comparable results were also reported in OP and IP PCI patients at 5-year follow-up, confirming the long-term safety of OP PCI in treating the left main coronary artery [23]. Furthermore, a growing number of patients with calcified lesions are being treated using rotational atherectomy in OP PCI regimen, without a significant increase in 1-month mortality rate (0.50% vs. 0.35%; $P = 0.409$ for OP and IP PCI, respectively) [24].

Table 1. Outcomes of outpatient (OP) vs. inpatient (IP) percutaneous coronary interventions (PCI) in randomized trials

Reference	OP (n)	IN (n)	Follow-up	Primary endpoint	Outcomes
Heyde et al., 2007 (EPOS) [8]	326	312	24 hours and 30 days	MACCE (cardiac death, myocardial infarction, stroke, coronary artery bypass grafting, and repeat PCI) Severe access site complications with the need of blood transfusion Repeat access site compression	No difference in primary endpoint: hours: 1 OP patient (0.3%), 2 IP patients (0.6%) 30 days: 1 OP patient (0.3%) 5 IP patients (1.6%) Similar frequency of readmissions
Rinfret et al., 2010 (EASY) [28]	504	501	30 days	MACCE (death, myocardial infarction, urgent revascularization, major bleeding, repeat hospitalization, access site complications, severe thrombocytopenia)	No difference in primary endpoint: 20.4% in OP group 18.2% in IP group
Clavijo et al., 2016 [40]	50	50	1 year	MACCE (all-cause death, myocardial infarction) Unplanned coronary revascularization Vascular access complication	No difference in primary endpoint: 1 IP patient (2%) 2 IP patients (4%)
Gaba et al., 2021 (EXCEL) [23]	100	835	30 days and 5 years	MACCE (death, stroke, or myocardial infarction)	No difference in primary endpoint: 30 days: 4.0% OP patients 5.0% IP patients 5 years: 20.6% OP patients 22.1% IP patients

Abbreviation: MACCE, major adverse cardiovascular and cerebrovascular events

Table 2. Patients satisfaction after outpatient (OP) vs. inpatient (IP) percutaneous coronary interventions (PCI)

Reference	Location	OP (n)	IN (n)	Follow-up	Outcomes
Ziakas et al., 2004 [31]	Jubilee Hospital, Victoria, British Columbia, Canada	811	0	Phone interview at 30 days	88.6% satisfied OP patients, higher satisfaction if no complications occured
Heyde et al., 2007 [8]	Academic Medical Centre, Amsterdam, Netherlands	326	312	Satisfaction questionnaire at 3 days and 1 year	Mean satisfaction higher in OP setting ($P = 0.001$): 78.6/100 for OP 73.6/100 for IP No difference in patient's level of knowledge and opinion on PCI effectiveness and care quality 73% of OP patients would repeat it 32% of IN patients would prefer OP setting
Glaser et al., 2009 [13]	Division of Cardiovascular Medicine, PA, US	19	20	Satisfaction questionnaire at hospital discharge and 30 days	Mean satisfaction comparable in OP and IP PCI ($P = 0.68$): 89.6/100 for OP 90.7/100 for IP
Ciszewski et al., 2020 [32]	Institute of Cardiology, Warsaw, Poland	92	78	Phone interview at 30 days	96.7% OP patients found it safe and convenient

Similarly, OP PCI of chronic total occlusions with a J-CTO score ≤2, performed *via* forearm access, was shown to be feasible and safe [25].

Data on OP vs. IP PCI outcomes in randomized trials are summarized in Table 1. Overall, currently available data show that OP and IP PCI are similarly safe and efficient regarding both short-term and long-term outcomes. Although OP PCI showed promising results in the treatment of both single and multivessel disease, including left main lesions, further studies are required to identify potential contraindications for OP PCI and establish dedicated guidelines.

Impact on the healthcare system

Considering the socioeconomic aspects, OP PCI implementation may lead to cost optimization, which is crucial regarding the substantial increase in healthcare expenditure across Europe in the last decade [26]. Compared to IP PCI, OP PCI reduced the cost of a single procedure by 5.5% in Denmark [8] and 18.5% in the United States [13]. Similarly, Canadian authors reported 3-fold higher costs associated with an IP PCI compared to OP PCI, predominantly due to overnight hospitalization [27, 28].

Currently, radial access is preferred over femoral access in most PCI cases, which is a safer and more cost-efficient strategy [28]. To support the latter, conversion from femoral to radial access and same-day discharge in 30% of PCI cases was shown to reduce the annual expenditure by 300 million United States dollars [29]. Furthermore, OP PCI may result in a considerable decrease in hospital bed occupancy, leading to increased PCI center capacity [30]. Finally, OP PCI patients reported a higher level of satisfaction compared to those undergoing IP PCI [31]. In the Polish population, patients and their relatives considered OP PCI a safe and convenient strategy [32]. Moreover, most patients preferred OP PCI over IP PCI in the case of subsequent procedures [8]. Data on OP vs. IP PCI patient satisfaction and cost-effectiveness are summarised in Table 2 and Table 3, respectively.

Table 3. Comparison of percutaneous coronary interventions (PCI) costs per patient between outpatient (OP) and inpatient (IP) settings

Title	Location	Cost per patient	Access
Heyde et al., 2007 [8]	Academic Medical Centre, Amsterdam, Netherlands	OP: 4 675 € IN: 4 933 € Mean difference: 258 €	Femoral
Glaser et al., 2009 [13]	Division of Cardiovascular Medicine, PA, US	OP: 8 604 USD IN: 10 565 USD Mean difference: 1 961 USD	Femoral
Rinfret et al., 2010 (EPOS) [28]	Laval University, Quebec, Canada	OP: 1 117 ± 1 554 USD IN: 2 258 ± 1 328 USD Mean difference: 1 141 USD, mainly due to the costs of overnight hospitalization	Radial
Clavijo et al., 2016 [40]	University of Southern California, CA, US	Mean benefit OP vs. IP: 1 200 USD	Femoral
Amin et al., 2017 [29]	Washington University School of Medicine, MO, US	OP: 12 449 USD IN 15 909 USD Mean difference: 3 460 USD	Radial and femoral
Madan et al., 2019 [27]	University of Toronto, Ontario, Canada	Mean benefit OP vs. IP: 1 200 Canadian dollars	Femoral

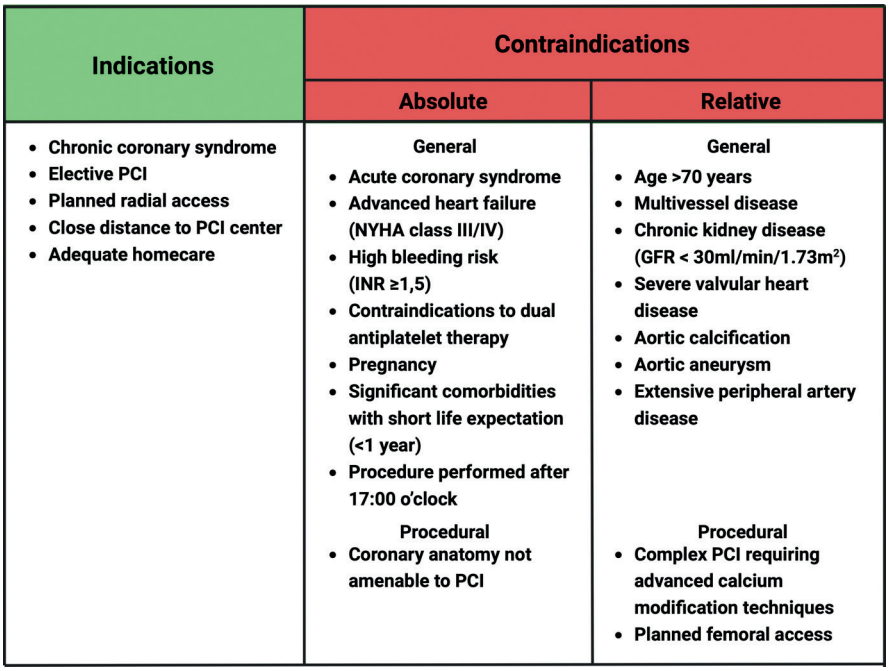


Figure 1. Indications and contraindications for outpatients coronary intervention

Abbreviations: GFR, glomerular filtration rate; INR, international normalized ratio, NYHA: New York Heart Association; PCI, percutaneous coronary intervention

Altogether, OP PCI implementation may be beneficial regarding cost-effectiveness, PCI center capacity, and patient satisfaction, along with good clinical outcomes, compared to IP PCI.

PERIPROCEDURAL MANAGEMENT

Careful risk-benefit assessment is crucial for choosing between OP and IP PCI. Various factors must be considered at every treatment stage to ensure patient safety. The summary of indications and contraindications for OP PCI is presented in Figure 1. The periprocedural patient management checklist is shown in Figure 2.

Preprocedural phase

While qualifying a patient for PCI, medical history must be obtained to identify individuals at high risk of procedural complications. Unstable patients or patients with suspected acute coronary syndrome are obviously unsuitable for OP PCI [33–36]. However, some centers do practice an immediate transfer of patients to their originating hospitals after the primary PCI procedure [37]. In patients with heart failure and class III and IV symptoms in the New York Heart Association classification, IP PCI is recommended [38]. Other cardiovascular disorders that might be associated with unfavorable OP PCI outcomes include severe valvular heart disease, aortic calcification or aneurysm, and extensive peripheral artery disease. Furthermore, patients with uncontrolled diabetes mellitus and impaired renal function, especially end-stage kidney disease, might be unsuitable for OP PCI. Generally, the estimated glomerular filtration rate in patients undergoing OP PCI should be ≥30 ml/min/1.73m^2, with some authors proposing higher

Pre-PCI considerations			
Elective PCI in chronic coronary syndrome	Yes ↓	No →	Monitor overnight
Radial access feasible	Yes ↓	No →	
Close distance to the hospital & adequate homecare	Yes ↓	No →	
Patient willing to be discharged the same day	Yes ↓	No →	
Patient scheduled early enough to be observed for >4 hours post-PCI	Yes→OP PCI	No →	
Post-PCI considerations			
Complication during the procedure or observation period (stroke, bleeding, vascular complications, allergic reaction, arrhytmia, other)	No ↓	Yes →	Monitor overnight
Unresolved severe chest pain or persistent ischemic ECG changes	No ↓	Yes →	
Exacerbation of an underlying disease (e.g. heart failure, hypertension, diabetes, COPD)?	No ↓	Yes →	
Altered mental status compared to baseline presentation	No ↓	Yes →	
Patient willing to stay in the hospital and/or the personnel responsible feels the patient should stay	No ↓	Yes →	
Pre-discharge considerations			
Action	**Check**	**Personnel responsible**	
No vascular access complications			
DAPT and other drugs prescribed			
Patient educated on access site monitoring, the importance of DAPT and risks of premature discontinuation			
Phone call number provided to patient and/ or caregiver in case of emergency			
Phone call 1 day following PCI scheduled			
Follow-up visit at 1 and 3 months after PCI scheduled			

Figure 2. Periprocedural management checklist in patients undergoing outpatient percutaneous coronary interventions (PCI)

Abbreviations: COPD, chronic obstructive pulmonary disease; DAPT, dual antiplatelet therapy; ECG, electrocardiogram; OP, outpatient

cut-off values, ranging from 40 to 60 ml/min/1.73 m^2 [20, 36, 39, 40]. Regarding the age cut-off, the proposed values differ between studies, ranging from 60 to 80 years [35, 39–42]. Since heparin and dual antiplatelet therapy administration are inevitably associated with bleeding risk following arterial puncture, pre-existing coagulopathies and anemias also constitute contraindications to OP PCI. Consequently, the baseline international normalized ratio ≥1.5 has been proposed to ensure the safety of OP PCI [38, 40]. The use of anticoagulants and thrombolytic agents before the procedure favors the choice of IP PCI. Furthermore, pregnancy is a sex-specific contraindication for OP PCI due to alterations in cardiovascular physiology [38, 40]. Other comorbidities, including respiratory, neurological, hepatic, and immunological disorders, as well as the past medical history of MACE, should be considered when choosing the optimal PCI setting [43].

Attention should also be paid to social history, as transportation options and adequate home care after OP PCI are of paramount importance. Patients qualified for OP PCI should generally stay at a close distance from the PCI center to ensure prompt medical intervention if necessary. Both patients and caregivers should be aware of the possible complications and instructed to inform medical services in case of emergency [7, 8, 38, 39, 41, 44–46]. Informed consent must be collected, and patient preference must be considered in the decision-making process [8].

Finally, cardiovascular and periprocedural risk should be assessed using standard diagnostic tools, including (1) laboratory tests, (2) electrocardiography, and (3) imaging modalities, e.g., echocardiography or cardiac magnetic resonance in patients with poor echocardiographic visualization, according to the current European Society of Cardiology guidelines.

Periprocedural phase

In patients qualified for OP PCI, periprocedural complications may require hospitalization. As radial access allows immediate mobilization and is associated with lower risk of MACE and lower mortality compared to femoral access, it is preferred in OP PCI [47–49]. However, complex anatomical variations may require conversion into femoral access, leading to hospitalization. Correspondingly, in cases when femoral access is a primary strategy, e.g., due to inadequate radial pulse, IP PCI should be considered [30], especially in the presence of (1) severe femoral calcification, (2) small (<5 mm) femoral artery diameter, and (3) vascular graft puncture. Further complications associated with vascular access that favor IP PCI include (1) closure device non-deployment, (2) ipsilateral artery puncture, and (3) hematoma, pseudoaneurysm, or arteriovenous fistula present before sheath removal [40]. Nevertheless, even in the case of femoral access, successful use of a vascular closure device could promote OP PCI if the PCI procedure is performed in the morning.

PCI technique may also lead to strategy modification. IP PCI should be considered following implantation of ≥2 stents, treatment of ≥2 vessels, or use of advanced calcium modification techniques. However, the decision on OP vs. IP setting should always be tailored to the individual clinical situation. For example, even if rotational atherectomy is required, the PCI result is optimal, as per the operator's judgment, OP PCI is a feasible solution (Figure 3).

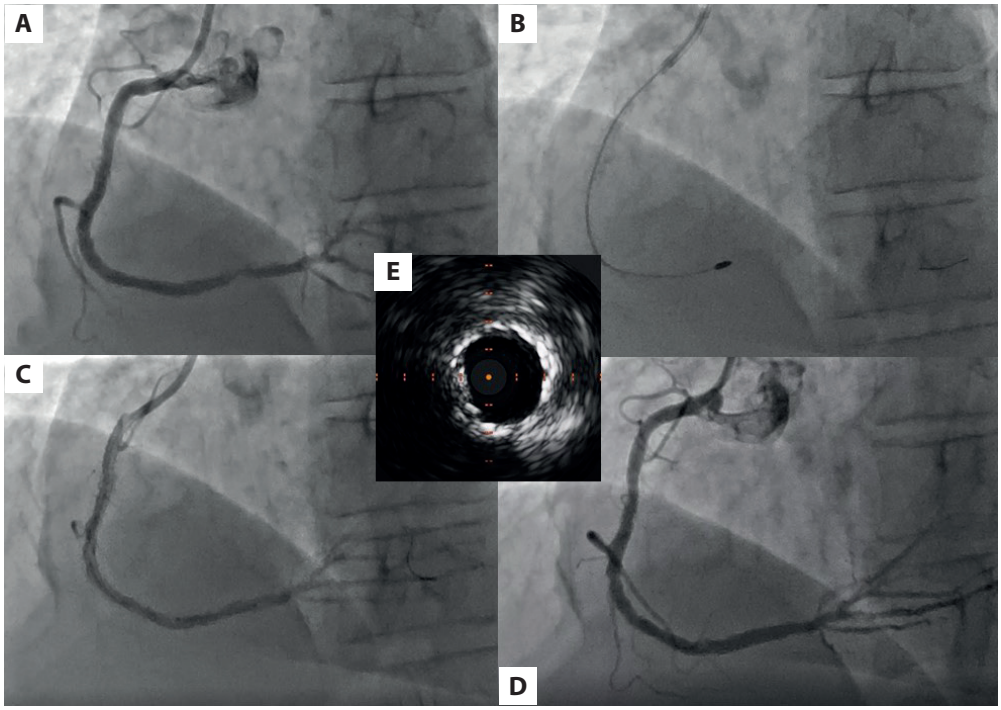


Figure 3. Case example of one-day complex percutaneous coronary intervention (PCI) of right coronary artery which required rotational atherectomy in a 68 years woman with chronic coronary syndrome class 2 anginal symtoms. Atherectomy burr of 1.5 mm was used, followed by lesion pre-dilatation with a 3.0 mm non-compliant balloon. Ultimaster Tansei stent 3.5 × 21 mm was deployed under intravascular ultrasound (IVUS) guidance. Panels A–D represents subsequent PCI stages. Panel E shows final IVUS result with minimal stent area of 7.2 mm^2. The patient was discharged home 5 hours after the procedure

Procedural complications favoring hospitalization include coronary artery dissection or chest pain after the procedure [36]. Furthermore, conversion from OP into IP PCI regimen may be necessary in cases of challenging target lesion characteristics, e.g., total occlusion, large thrombus burden, complex bifurcation, severe calcification, or tortuosity [38, 40, 43]. Although a study reported no MACE in patients undergoing OP PCI for treatment of complex lesions [50], subjective assessment of lesion complexity depending on the PCI center and the operator's experience might affect outcomes. Implementing novel online tools to calculate Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) II score might help to improve consistency in PCI risk stratification [51, 52].

Postprocedural phase

Considering postprocedural management, most PCI complications occur within the first few hours or after 24 hours following the procedure. Thereby, a hospital stay ranging from 2 to 8 hours after OP PCI is recommended to ensure OP PCI safety [53]. It has been proposed that OP PCI should finish at the latest at 5 p.m. to ensure the appropriate monitoring time before discharge [45]. The required monitoring time depends on the diameter of the radial sheath, with smaller sheath sizes (≤6 French) being recommended in the OP PCI setting [54]. A large increase in the number of radial accesses and OP PCI rate (2.3% vs. 51.2%) was observed following the implementation of "a radial lounge", a space dedicated to patients undergoing OP PCI *via* radial access. In a study including 726 patients undergoing elective PCI, 60% of the procedures were followed by radial lounge stay, 85% of which resulted in same-day discharge, leading to increased hospital capacity. Although the radial lounge improved the logistics of OP PCI, its introduction did not decrease the rate of in-hospital MACE [30].

Following same-day discharge, short-term follow-up should be collected in all patients (e.g., a phone call by a medical assistant within 24 hours after the procedure) to identify potential complications. Subsequent ambulatory follow-up visits should be scheduled at 1 and 3 months following OP PCI. Secondary prevention does not differ between OP and IP PCI patients and includes (1) lifestyle modification, (2) pharmacotherapy, and (3) regular follow-up appointments to optimize cardiovascular risk management according to the current guidelines of the European Society of Cardiology [55].

CHALLENGES IN THE IMPLEMENTATION OF OUTPATIENT PCI SETTING

Although OP PCI seems promising in a subset of well-prepared and compliant patients without severe comorbidities (Figure 1), there are some challenges to overcome before its routine implementation. First, to prevent unnecessary overnight hospitalization and unsafe same-day discharges, healthcare professionals should be trained to perform efficient risk-benefit assessments (Figure 2). Second, to avoid delayed interventions, standardized

information forms should be created to obtain informed consent and instruct OP PCI patients and their relatives about postprocedural management. Third, appropriate duty allocation and team approach to the decision-making process in PCI centers are crucial for the efficiency and safety of OP PCI.

Overall, OP PCI management comprises pre-, peri- and postprocedural phases. Upon patient qualification, cardiovascular and procedural risk must be stratified regarding medical and social history, along with the results of cardiological diagnostics. During the periprocedural phase, PCI technique, vascular access, and target lesion characteristics might be potential indications for conversion into IP PCI regimen. Eventually, following OP PCI, a hospital stay of up to 8 hours and short-term follow-up are recommended. To overcome difficulties associated with OP PCI implementation, training healthcare professionals and using standardized protocols are crucial to ensure efficient workflow and patient safety.

CONCLUSION

Altogether, OP PCI seems to be a safe and efficient strategy that may improve the performance of healthcare systems both in terms of medical and socioeconomic aspects. Nevertheless, further studies are needed to validate the available data and establish clear guidelines regarding the choice between OP and IP PCI regimens. Decisions should be based on individual patient and lesion characteristics, logistic aspects, and the patient's preference. To ensure maximal patient safety, risk-benefit assessment should be performed at every stage of the treatment. There should be a low threshold to convert the OP into an IP PCI setting in the case of any changes in the clinical or social situation. Finally, implementing institutional standards for OP PCI seems crucial to providing high-quality healthcare, maximizing patient safety, and ensuring the highest quality care in both OP and IP PCI settings.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/polish_heart_journal.

Article information

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