CONTINUING MEDICAL EDUCATION

Postoperative Care and Follow-Up After Coronary Stenting

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SUMMARY

Background: The diagnosis and treatment of coronary heart disease have improved in recent years. Most patients can return to their everyday routine a few days after a successful percutaneous coronary intervention (PCI). How should patients be followed up after the successful implantation of a coronary stent?

Method: Selective review of the pertinent literature, including current practice guidelines and recommendations.

Results: After a PCI, the patient should be followed up both by the primary care physician and by the cardiologist one week after the procedure, and then every three to six months for the first year. Clinical history taking and physical examination, including an assessment of cardiovascular risk factors and of potential evidence of myocardial ischemia, constitute the best way to detect possible progression of coronary heart disease. Diagnostic coronary angiography is not routinely indicated after coronary stent implantation. If progression of heart disease is suspected, a stress test should be performed; patients who develop symptoms or show evidence of ischemia in a stress test should undergo diagnostic cardiac catheterization.

Conclusion: Repeated history taking and physical examination play an important role after PCI. For patients at high risk of restenosis and those with complex coronary morphology, coronary angiography may be indicated regardless of the findings of non-invasive stress tests.

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Diagnostic cardiac catheterization and the catheter-based treatment of coronary stenoses are among the main techniques of modern cardiology. In Germany, in 2008, a total of 845 172 left-heart catheter studies and 303 832 percutaneous coronary interventions were performed in 556 hospitals and outpatient practices and 765 cardiac catheterization laboratories. 89% of these interventions involved stent implantation (1). In proportion to its population, Germany has more sites where cardiac catheterization is performed, and more catheterizations performed per year, than any other country in Europe (2).

The term “percutaneous coronary intervention” (PCI) encompasses balloon angioplasty with or without stent implantation, laser angioplasty, and rotational ablation. The long-term results of PCI change continually as new techniques and materials are introduced, including drug-eluting stents (DES) and drug-eluting balloons (DEB). Restenosis at the site of treatment nonetheless remains a clinical challenge.

The follow-up of patients who have undergone cardiac catheterization is, therefore, an important matter. It can be subdivided into three steps:

1. History and physical examination
2. Tests for functional ischemia (dobutamine stress MRI, myocardial perfusion MRI, stress echocardiography, single photon emission computerized tomography [SPECT])
3. Coronary artery visualization (cardiac catheterization and CT angiography).

The question arises whether patients who have undergone PCI, and coronary stent implantation in particular, should undergo cardiac catheterization, CT angiography, and/or stress testing as part of their routine follow-up. The goal of such studies would be

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The clinical manifestations of CHD

The clinical manifestations of coronary heart disease (CHD) include angina pectoris, myocardial infarction, signs of left-heart failure (e.g., dyspnea, edema), cardiac arrhythmias, and sudden cardiac death.

to relieve these patients' symptoms and/or improve their outcome by detecting restenoses that could then be treated. On the other hand, catheter studies and CT angiography still carry a residual risk, even at their current high state of development, and both techniques involve exposure to ionizing radiation. They are also very costly.

For this article, we selectively reviewed pertinent literature retrieved by a PubMed search as well as the evidence-based guidelines of the American (3), European (4), and German (5) specialty societies and the German National Disease Management Guidelines for Coronary Heart Disease (6). Other guidelines were also consulted (2, 10, 15, 28, 31–33, e5–e9).

Learning objectives

This article is intended to acquaint readers with

- the main elements of patient follow-up by primary care physicians and cardiologists after coronary stent implantation,
- the indications for non-invasive stress testing after coronary stent implantation,
- the critical evaluation of coronary angiography and CT angiography after PCI, and
- implementation of the recommendations found in the guidelines that served as sources for this article.

Coronary heart disease

Coronary heart disease (CHD) is due to arteriosclerosis of the coronary arteries (7, 8), and endothelial dysfunction is the key element in the pathogenesis of arteriosclerosis (9). In the early stage of the disease, symptoms and signs are usually not yet evident; in its advanced stage, high-grade, flow-limiting stenoses cause a mismatch between oxygen supply and oxygen demand, leading to myocardial ischemia. Advanced CHD is often symptomatic, with manifestations including angina pectoris, myocardial infarction, left-heart failure, cardiac arrhythmias, and sudden cardiac death.

The goals of treatment are

- to improve quality of life,
- to lessen the frequency of angina pectoris,
- to improve physical performance,
- to prevent CHD from becoming symptomatic,
- to prevent heart attacks and heart failure in particular, and
- to prevent cardiac death (10).

The achievement of these goals requires a combination of interventional and/or surgical revascularization, drug treatment for secondary prevention, lifestyle changes, and reduction of cardiovascular risk factors (11–13).

Diagnostic and therapeutic cardiac catheterization

CHD can be treated with drugs, interventional procedures, and surgery. This article is concerned only with interventional treatment—in particular, with the follow-up of patients who have undergone coronary stent implantation.

Recent years have seen continual improvement in diagnostic and therapeutic cardiac catheterization with the introduction of better catheter techniques and new-generation stents and with the acquisition of knowledge from large-scale clinical trials (3). Most patients who undergo successful catheter treatment of life-threatening heart disease can now return to their previous daily routine within several days when they are treated in accordance with the current guidelines. The German, European, and American guidelines are regularly updated in the light of new findings (3).

The indications for cardiac catheterization (*Box 1*) do not depend on whether the patient is known to have CHD or merely suspected of having it. The knowledge that CHD is present can, of course, affect the individual patient's risk stratification.

The probability that CHD is present and needs treatment can be estimated on the basis of the totality of the patient's clinical findings. History taking and physical examination, including an assessment of cardiovascular risk factors and of evidence of myocardial ischemia, constitute the best way of detecting possible progression of coronary heart disease and determining whether coronary angiography should be performed (3, 14, 15). The indication for coronary angiography also depends on the patient's overall state of health and on whether he or she would consent to interventions that might be recommended on the basis of the results (e.g., a stent placement or bypass operation). Patients should be told that, in many situations, such an intervention can alleviate symptoms but does not affect life expectancy, unless angiography has revealed main-stem stenosis, proximal RIVA stenosis, or three-vessel disease.

Diagnostic coronary angiography may also be reasonable for patients who present repeatedly with

Risk estimation

History taking and physical examination, including an assessment of cardiovascular risk factors and of evidence of myocardial ischemia, constitute the best way to assess the indication for coronary angiography.

Silent ischemia

Silent myocardial ischemia—which preferably affects e.g. diabetics, the elderly, or women—is not associated with angina or anginal equivalent symptoms.

BOX 1

Inclusion and exclusion criteria for diagnostic cardiac catheterization

● **Diagnostic cardiac catheterization should be performed**

- in patients with typical clinical symptoms, i.e., angina pectoris on mild exercise or at rest; Canadian Cardiovascular Society (CCS) class III/IV; and/or
- when non-invasive tests indicate relevant coronary heart disease, i.e., with clear evidence of ischemia; and/or
- when the patient's symptoms and/or prognosis might be improved by a coronary intervention.

If the patient has no more than mild or atypical anginal symptoms, non-invasive studies should be done first. These will serve to identify patients at high risk, who should then undergo diagnostic cardiac catheterization (2, 14).

● **Patients with any of the following are considered at high risk: (2)**

- ST-segment elevations and/or angina pectoris on ergometry
- markedly impaired left-ventricular (LV) function (<35%) in echocardiography at rest
- markedly impaired LV function (<35%) in stress echocardiography
- wall-motion abnormalities in >2 segments under low-dose dobutamine in stress echocardiography
- stress-induced perfusion defects in myocardial scintigraphy
- stress-induced perfusion defects in an adenosine-stress MRI

[†]modified from (2, 14)

atypical chest symptoms, in either an outpatient or an inpatient setting, even without evidence of ischemia in non-invasive testing. Such decisions should be made on a case-by-case basis, with the involvement of the treating primary care physician/internist and the cardiologist. Angiography is particularly useful when the symptoms have no clearly identifiable, non-cardiac cause, when the previous findings were not completely normal, or when the patient is severely distressed by anxiety about heart disease (14).

So-called silent myocardial ischemia is particularly common among diabetics but also appears in

non-diabetic elderly men and women. These patients do not suffer from typical angina pectoris or equivalent symptoms, but their ECG may show evidence of ischemia at rest or on exercise, and otherwise unexplained arrhythmia can also arise. Because the extent and severity of silent myocardial ischemia are associated with the cardiovascular prognosis (16), an early diagnostic evaluation of the coronary arteries should be performed whenever silent myocardial ischemia is suspected (2).

Restenosis

After balloon dilatation with or without stent implantation, stenoses can form outside the area of intervention; there can also be restenosis in the treated area. Restenosis is defined as an angiographically demonstrated reduction of vessel diameter by at least 50% ("angiographic restenosis"). A somewhat more precise estimate can be made with determination of late lumen loss (quantitative coronary angiography, QCA), intravascular ultrasonography (IVUS), or measurement of fractional flow reserve. Randomized studies have revealed 6-month rates of angiographically demonstrated restenosis ranging from 32% to 42% after balloon angioplasty (17, 18) and from 16% to 32% after the implantation of a non-drug-eluting stent (bare metal stent, BMS) (17, 18); the 6-month rate of restenosis after the implantation of a drug-eluting stent is less than 10% (19, 20). The causes of restenosis after simple balloon angioplasty include the migration and proliferation of smooth-muscle cells, platelet deposition, thrombus formation, elastic recoil (loss of lumen area within a few minutes of balloon dilatation), and negative arterial remodeling (lumen-narrowing changes of the vascular wall). Stent implantation prevents both elastic recoil and negative arterial remodeling. After stent implantation, the most common mechanism of restenosis is neointimal hyperplasia (3).

Less than half of all patients with angiographically documented restenosis develop clinical manifestations (clinically relevant restenosis) within one year (3). This may be because angiographically demonstrable vascular narrowing is not necessarily associated with impaired distal myocardial perfusion. The most common manifestation of clinically relevant restenosis is exercise-induced angina, followed by unstable angina (25%) and acute myocardial infarction (5–10%) (21, 22).

The definition of restenosis

Restenosis is defined as an angiographically demonstrated reduction of vessel diameter by at least 50% at the site of a prior intervention ("angiographic restenosis").

The incidence of symptomatic restenosis

Less than half of all patients with angiographically documented restenosis develop clinical manifestations (clinically relevant restenosis) within one year.

Known risk factors for restenosis are listed in *Box 2* (23, 24). A computational model incorporating these factors can be used to identify patients whose risk of restenosis is low (<2%) or high (>7%); for more information, see reference 23.

Clinical follow-up after discharge

How should patients be followed up after coronary stent implantation? Who should see them in follow-up, and what aspects need to be considered?

In answering these questions, we rely on the recommendations of the European Society of Cardiology (4) and the recommendations made in the German National Disease Management Guidelines for CHD (6).

When patients are discharged from the hospital or outpatient interventional cardiology practice after stenting, the physician tells them to avoid excessive movement of the limb where the puncture was performed for the next two days. To prevent bleeding after femoral artery punctures, patients should avoid carrying heavy objects or taking long automobile or bicycle rides or hikes for two weeks. After radial artery punctures (25), patients should try to rest the affected hand for a few days.

It is recommended that the following ambulatory tests be performed within one week of the intervention as part of post-interventional follow-up by the patient's primary care physician (general practitioner or internist) or other physician responsible for further care (4):

- Physical examination (auscultation of the heart and lungs and of the puncture site, exclusion of inflow obstruction, wet rales, peripheral edema)
- 12-lead ECG at rest
- Blood pressure measurement
- Routine laboratory tests (electrolytes, complete blood count, liver and renal function tests).

Particular attention should be paid to (4):

- Problems at the puncture site (bleeding, hematoma, aneurysm, AV fistula)
- Anemia (Hb value)
- Contrast-induced nephropathy (creatinine value)
- Statin intolerance, if statin treatment has just been initiated (muscle symptoms, liver values)
- Continuation of prescribed drug treatment (4, 26), particularly of dual antithrombotic treatment after stent implantation.

BOX 2

Factors associated with an elevated risk of restenosis¹

- **Clinical situation** (STEMI, acute coronary syndrome)
- **Patient characteristics** (diabetes, age <55 to 60 years, male sex, multiple vessel disease)
- **Type of lesion** (unprotected left coronary main stem, venous bypass vessel)
- **Procedure characteristics** (minimal stent diameter <2.5 mm, total stent length >40 mm)

STEMI, ST-segment-elevation myocardial infarction
¹modified from (23, 24)

As recommended in the National Disease Management Guidelines (6), patients with coronary heart disease and those who have undergone stent implantation should be followed up regularly (every three to six months) by their primary care physicians, independently of any additional visits that may be necessitated by worsening symptoms, comorbidities, or any other tests that need to be done (recommendation grade B, evidence level 2). In these regular follow-up visits, the physician should take a clinical history focusing particularly on current symptoms (specific cardiac symptoms, but also fatigue or diminished performance), endurance level, and functional status, including effects on family life, occupation, everyday activities, sports, and sexual activity (recommendation grade B, evidence level 2). Further questions should be asked about emotional aspects (depression, anxiety, worries, disappointment) and the patient's psychosocial situation, conception of illness, and behavior patterns, e.g., excessive caution. The goal is to communicate an optimistic attitude about the possibilities for treatment (recommendation grade 0, evidence level 3/4). The patient's tobacco use, physical activity, nutrition, and regular taking of medications should be assessed, and, if necessary, the patient should be encouraged to change his or her behavior in health-promoting ways (recommendation grade A, evidence level 1). At each visit, a physical

Clinically relevant restenosis

The most common manifestation of clinically relevant restenosis is exercise-induced angina, followed by unstable angina (25%), and acute myocardial infarction (5–10%).

Patient counseling after discharge

To prevent bleeding after femoral artery punctures, patients should avoid carrying heavy objects or taking long automobile or bicycle rides or hikes for two weeks.

examination should also be carried out, including the heart, lungs, limbs (peripheral pulses, edema), weight (BMI), blood pressure, and heart rate (recommendation grade B, evidence level 2).

In the first year after PCI, the patient should be cared for both by his or her primary care physician/internist in primary care and by a cardiologist (6). The primary care physician should refer the patient to the cardiologist whenever symptoms and signs arise that might be due to CHD and cannot be adequately evaluated by the primary care physician alone (6). Referral to the cardiologist may also be indicated if the primary care physician cannot achieve adequate symptomatic relief or cannot implement the treatments (drugs and other measures) that are indicated to improve the prognosis, e.g., because of adverse effects, interactions, or non-compliance, where a specialist might be able to address these problems more effectively (6). Finally, referral is indicated when preexisting heart failure worsens, when the new onset of heart failure is suspected, or when new, clinically relevant arrhythmia is documented (6).

An algorithm for the care of patients with known CHD by the cardiologist, adapted to the algorithm recommended by the National Disease Management Guidelines, is shown in the *Figure* (6).

Stress test after coronary interventions

The indication for a stress test should be determined by a cardiologist (*Figure*). Routine stress testing after coronary interventions has no proven benefit and is not indicated (3, 4, 6, 27–33).

A stress test (stress ECG) is indicated for patients who have undergone PCI if their symptoms and signs have changed and/or if there is clinical suspicion that their CHD may have become worse ([6], recommendation grade A, evidence level 1). Patients who cannot tolerate physical stress of an adequate intensity to produce a reliable finding on stress ECG should have an imaging study under pharmacologically induced stress instead (stress echocardiography, stress MRI, or SPECT [34]) ([6], recommendation grade A, evidence level 1). Patients with known CHD who develop symptoms again after a symptom-free interval despite treatment and for whom the site of ischemia, the functional relevance of stenosis, and/or cardiac vitality are important questions should undergo an imaging study under physical or pharmacologically

induced stress rather than a stress ECG ([6], recommendation grade B, evidence level 2). No clear recommendation is given for a specific type of imaging study. An imaging modality should be chosen that is locally available and can be carried out with the necessary expertise; the adverse effects of ionizing radiation, contrast media, and pharmacological stressors should also be taken into account (4).

Patients with chronic CHD and any of the following are considered to be at high risk ([6], recommendation grade B, evidence level 2):

- Diminished left-ventricular function
- Multiple diseased vessels
- Proximal RIVA stenosis
- Survived episode of sudden cardiac near-death
- Diabetes
- Prior intervention with a suboptimal result
- Silent myocardial ischemia
- Use of 5-phosphodiesterase inhibitors
- An occupation or hobbies in which a cardiac event would be particularly dangerous (e.g., flying a plane, driving a vehicle, diving).

Such patients should be regularly monitored with imaging studies even if asymptomatic ([6], recommendation grade B, evidence level 2) ([4], class IIa-C recommendation). The appropriate interval between such studies is not stated in either the German National Disease Management Guidelines or the ESC guidelines.

The role of CT angiography after coronary interventions

Multidetector computed tomographic angiography has a low positive predictive value for the detection of significant coronary stenosis. Only about half of all “relevant” (diameter reduction of 50% or more) coronary stenoses detected by CT are hemodynamically significant (35). The indication for treating a stenosis depends on the inducibility of ischemia, rather than on the structural features of the stenosis (28). Thus, routine CT angiography is not indicated after coronary stent implantation.

Cardiac catheterization after coronary interventions

In general, the indications for coronary angiography after PCI are the same as those for primary coronary angiography. The benefits of the study must be weighed against its risks.

The timing of follow-up

As recommended in the German National Disease Management Guidelines, patients with CHD and those who have undergone stent implantation should be followed up regularly (every 3 to 6 months) by their primary care physicians.

Stress tests after coronary interventions

Routine stress testing after coronary interventions has no proven benefit and is not indicated.

FIGURE

Algorithm for patients with known CHD—care by cardiologist. Modified from (6). CHD, coronary heart disease; WPW, Wolff-Parkinson-White; LBBB, left bundle branch block; LVH, left-ventricular hypertrophy; VVi/DDD, single-chamber/double-chamber pacemaker

Stent thrombosis

When a patient with a coronary stent develops acute symptoms, the possibility of stent thrombosis—a life-threatening complication—must always be considered. Its annual incidence is less than 1%.

The consequences of stent thrombosis

As many as 80% of persons with stent thrombosis have a myocardial infarction, and as many as half of these persons die. The risk of stent thrombosis is still present for several years after stent implantation.

Thus, diagnostic cardiac catheterization should be reserved for patients who are symptomatic and/or have evidence of ischemia in a stress test. Symptomatic patients whose findings in a stress test imply low risk (ischemia under intense stress, late-onset ischemia, wall-motion abnormality in a single segment or small reversible perfusion deficits, no evidence of ischemia) should be managed conservatively with optimized drug treatment (4, 36–38) (class I-B recommendation). On the other hand, symptomatic patients whose findings in a stress test imply intermediate or high risk (ischemia under mild stress, early-onset ischemia, wall-motion abnormalities in multiple segments, large reversible perfusion deficits) should undergo coronary angiography ([4], class I-C recommendation). Asymptomatic high-risk patients who have had a stress test should be managed as if they were symptomatic patients with the same stress test findings ([4]), class IIa-C recommendation).

When a patient with a coronary stent develops acute symptoms, the possibility of stent thrombosis—a life-threatening complication—must always be considered. The annual incidence of stent thrombosis is less than 1%, but as many as 80% of persons with stent thrombosis have a myocardial infarction, and as many as half of these persons die. The risk of stent thrombosis is still present for several years after stent implantation (for definitions of stent thrombosis see *Tables 1 and 2*) (39). If stent thrombosis is suspected, cardiac catheterization should be performed without delay, with the option of performing an emergency PCI at the same procedure ([2], class I-C recommendation).

Some centers routinely perform a coronary follow-up study six months after any coronary intervention, whether or not there is any evidence of ischemia in stress testing. The purpose of this is to identify asymptomatic, but angiographically significant stenoses. The six-month interval is based on the observation that neointima formation and vascular remodeling in the area of the stent have generally run their full course by this time. Some intervention studies have shown, however, that patients who undergo routine coronary follow-up studies end up having more coronary interventions than those who have such studies only when they become symptomatic (40). Moreover, an interventional treatment of a non-flow-limiting in-stent stenosis retriggers the remodeling process and might,

therefore, actually lead to a worse result. While uncontrolled studies suggest (as such studies often do) a survival advantage (14) for patients undergoing routine follow-up angiography after balloon dilatation (e1) or stent implantation (e2), randomized controlled trials (e3) show that routine follow-up angiography merely increases the number of interventions to treat irrelevant coronary stenoses, without any improvement of outcome.

The guidelines on coronary interventions that were issued in 2005 by the American College of Cardiology and the American Heart Association (the ACC/AHA guidelines) (31) still contained a recommendation for routine follow-up coronary angiography two to six months after intervention on an unprotected main stem. A similar recommendation is found in the myocardial revascularization guidelines of the European Society of Cardiology (ESC), issued 2010 (28): The authors state that cardiac catheterization may be indicated three to twelve months after a PCI on an unprotected main stem. This recommendation, however, is no longer found in the 2009 update of the ACC/AHA guidelines (e4) or in the joint guidelines of the American College of Cardiology Foundation, the American Heart Association, and the Society for Coronary Angiography and Interventions (the ACCF/AHA/SCAI guidelines), issued in 2011 (3). The change was justified by the good intermediate-term results for main-stem catheter interventions that were found in the SYNTAX trial.

It is also stated in the guidelines of the German Cardiac Society (*Deutsche Gesellschaft für Kardiologie-, Herz- und Kreislaufforschung*) that coronary angiography is not indicated for the routine follow-up of patients who have undergone coronary interventions (2).

These guidelines do, however, contain the statement that “elective follow-up angiography [may] be indicated, regardless of whether non-invasive testing yields any evidence of ischemia, for some patients who are at especially high risk of restenosis or a cardiovascular event” ([2], class I-C recommendation).

This select group of patients is not discussed or defined in any further detail. We recommend follow-up angiography for patients who have had their last patent coronary vessel treated; for those who have undergone complex coronary interventions with long stented segments and suboptimal results, or complex interventions on an unprotected main stem; and for those who have had recurrent in-stent stenoses followed by a myocardial infarction.

Indications for coronary angiography after PCI

In general, “after PCI is before PCI”: That is, the indications for coronary angiography after PCI are the same as those for primary coronary angiography.

No benefit from routine post-PCI angiography

Routine follow-up angiography merely increases the number of interventions to treat irrelevant coronary stenoses, without any improvement of outcome.

Overview

Ideally, a patient who has undergone coronary stent implantation should be cared for by the primary care physician and the cardiologist working closely together. Any progression of coronary heart disease can be reliably detected by means of history taking, physical examination, an assessment of risk factors, and a search for evidence of ischemia. Coronary angiography is not indicated for routine follow-up after coronary stent implantation and should only be performed in special cases.

Conflict of interest statement

The authors state that no conflicts of interest exist.

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TABLE 1

The definitions of definite, probable, and possible stent thrombosis according to the Academic Research Consortium (ARC) (39)

Category of stent thrombosis	Clinical manifestations and test findings
Definite	Angiographic or pathological demonstration of partial or complete thrombosis in the region of the stent, with fulfillment of at least one of the following criteria: – symptoms, e.g., angina pectoris, dyspnea – new ischemic ECG changes – elevated concentration of cardiac biomarkers
Probable	– any unexplained death within 30 days of stent implantation – any myocardial infarction in the territory of the implanted stent, without angiographic demonstration of thrombosis, in the absence of any other obvious cause
Possible	– any unexplained death more than 30 days after stent implantation

TABLE 2

Classification of stent thrombosis by time of occurrence, as proposed by the Academic Research Consortium (ARC)

Interval after PCI ¹	Definition
Up to 1 day	acute stent thrombosis
1 day to 1 month	subacute stent thrombosis
1 month to 1 year	late stent thrombosis
>1 year	very late stent thrombosis

¹ PCI, percutaneous coronary intervention

Angiography indicated in selected cases

Follow-up angiography may be indicated for some patients who are at especially high risk of restenosis or have undergone very complex coronary interventions, regardless of whether the non-invasive studies reveal any evidence of ischemia.

Medical partners in follow-up

Ideally, a patient who has undergone coronary stent implantation should be cared for by the primary care physician and the cardiologist working closely together.

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For eReferences please refer to:
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Further Information on CME

This article has been certified by the North Rhine Academy for Postgraduate and Continuing Medical Education. Deutsche Ärzteblatt provides certified continuing medical education (CME) in accordance with the requirements of the Medical Associations of the German federal states (*Länder*). CME points of the Medical Associations can be acquired only through the Internet, not by mail or fax, by the use of the German version of the CME questionnaire within 6 weeks of publication of the article.

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The CME unit “Competitive Sports and the Heart: Benefit or Risk?” (Issue 1–2/2013) can be accessed until 18 February 2013. For issue 9/2013, we plan to offer the topic “Specific Immunotherapy.”

Solutions to the CME questions in Issue 49/2012:

Wulker: The Treatment of Hallux Valgus. Solutions: 1d, 2a, 3d, 4b, 5a, 6c, 7a, 8e, 9c, 10d

Please answer the following questions to participate in our certified Continuing Medical Education program. Only one answer is possible per question. Please select the answer that is most appropriate.

Question 1

Which of the following is a common clinical manifestation of coronary heart disease?

- a) myocardial infarction
- b) myocarditis
- c) endocarditis
- d) peripheral arterial occlusive disease
- e) pulmonary embolism

Question 2

Which of the following findings make a patient a high-risk patient with respect to the indications for diagnostic cardiac catheterization?

- a) wall-motion abnormality in a single segment under low-dose dobutamine in stress echocardiography
- b) ST-segment depression and/or angina pectoris during ergometric testing
- c) low LV function ($\leq 50\%$) in echocardiography at rest
- d) mild impairment of LV function ($> 60\%$) on stress echocardiography
- e) no stress-induced perfusion defect in myocardial scintigraphy

Question 3

What is the angiographic restenosis rate 6 months after treatment of an uncomplicated stenosis with a drug-eluting stent?

- a) $>50\%$
- b) 50%
- c) $30\text{--}35\%$
- d) $0\text{--}15\%$
- e) $<10\%$

Question 4

What goal has been shown to be achievable by treating chronic CHD with stent implantation?

- a) lowering the frequency of angina pectoris
- b) restoring cardiac performance to the norm for age
- c) preventing heart failure
- d) preventing myocardial infarction
- e) prolonging life

Question 5

What sort of follow-up should patients undergo after having an uncomplicated PCI?

- a) coronary angiography
- b) a stress MRI
- c) stress echocardiography
- d) myocardial perfusion scintigraphy
- e) history and physical examination

Question 6

Which of the following is a well-documented advantage of routinely performed stress tests after coronary interventions?

- a) high sensitivity
- b) improvement of patients' outcomes
- c) there is no such advantage
- d) hemodynamic improvement
- e) enables prophylactic medication

Question 7

What is the annual incidence of stent thrombosis after the implantation of a coronary stent?

- a) greater than 9%
- b) $6\text{--}7\%$
- c) $4\text{--}5\%$
- d) $2\text{--}3\%$
- e) less than 1%

Question 8

Which patients stand to benefit from diagnostic cardiac catheterization after a coronary intervention?

- a) those who are in their first year after bypass surgery
- b) those who have mild coronary artery stenosis
- c) those who refuse PCI
- d) those with complex coronary morphology and those who have undergone complex PCIs
- e) those without evidence of ischemia in non-invasive testing

Question 9

Which of the following elevates the restenosis risk?

- a) intervention in a venous bypass vessel
- b) implantation of a drug-eluting stent (DES)
- c) stent diameter $>3\text{ mm}$
- d) short length of stent
- e) single-vessel coronary heart disease

Question 10

Which patients without evidence of ischemia in non-invasive testing should undergo diagnostic cardiac catheterization?

- a) children
- b) those who have had an infarct with ST elevation
- c) those who have had a non-ST-segment-elevation myocardial infarction (NSTEMI)
- d) those who have undergone an intervention on a bypass vessel
- e) those who have diabetes

CONTINUING MEDICAL EDUCATION

Postoperative Care and Follow-Up After Coronary Stenting

Tienush Rassaf, Stephan Steiner, Malte Kelm

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