Caring of patients after PCI

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A brief history of PCI

PCI revolutionized CAD outcome

- Percutaneous Transluminal Coronary Angioplasty (PTCA) 1980
- Balloon Angioplasty with Permanent Metallic Stents 1985
- Drug-Eluting Stents (DESs) 1990
- Cypher 1995
- Taxus 2000
- Biopolymeric Stents 2005
- 2.5 Million Implanted 2010
POBA < Stent < DES / India leading the world
PCI is more complex than it appears!

Pre procedure issues

- Patient selection
- Lesion selection
- Timing
- Emergency/Elective
Intra-procedure

Drugs/Anticoagulation protocol
Vascular access
Hardware
Special devices
Post procedure

Sheath removal
Monitoring /Hemodynamics
ECG/ACT
Anticoagulation protocol
Success is not angiographic . . .

It is in the follow up and it starts right from the point the patient is wheeled out of cath lab . . .
Post PCI

First 24 hours: Most of patients can be discharged
Chest pain/Mild hypotension are common in the immediate post PCI. Usually due to medications, hypovolemia/NPO
Contrast induced diuresis
Responds to supportive treatment
Persistent hypotension/Angina
Vasovagal can be dangerous

First week:
Symptoms settle down. Usually not procedure related

First month
Events unrelated to procedure

6 months

1 year
“Real success is achieved only when the patient is followed up without any complication and **favorable impact** in the clinical outcome”

Currently long term means $> 1$ YEAR
Why special care required for post PCI patients?

PCI is a focal treatment of systemic problem. It is usually done only to flow limiting lesions.

All physiologically insignificant (<70%) lesions are left alone.

To be taken care of medical management.
What happens to the non PCI vessels?

It is estimated, every patient who has undergone a PCI has at least a few coronary lesions that has a potential to cause ACS in the same vessel or the remote vessel.
What is the risky period?

The concept of stent healing

How long will it take?
What looks like a simple metal coil outside...
Post PCI patients

Are not conventional medical patients who have CAD

All have a baseline risk profile

“They carry a metallic transplant”

They should be considered a special group like a prosthetic valve and pacemaker patient.
Who should follow up the patient? and where?

Who?
- General practitioners
- Physicians
- Cardiologists

Where?
- Clinics
- Nursing homes
- Tertiary centres
Post PCI follow up

Follow up done 10, 20, 30 days

Standard drugs

Aspirin/ACEI/Beta blockers as indicated

Clopidogrel : Platelet count /TC

Statin : SGOT /SGPT /CPK
Clinical examination
ECG
Echocardiogram
Stress testing
CAG
Post PCI high risk subset

Patients with complex lesion morphology, multivessel stenting, Left main, underlying severe LV dysfunction

Primary PTCA/PCI in cardiogenic shock

Need more intensive and frequent follow up ideally by the same team that performed the procedure
PCI after CABG

Graft occlusions
Complex lesions
Recognition &
Management
requires
Special competence
What to watch for? Short & Long term

Annual cardiac events reach up to 6-8% at 1 year

<table>
<thead>
<tr>
<th>Cardiac events</th>
<th>Non Ischemic events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable angina</td>
<td>Drug related</td>
</tr>
<tr>
<td>Recurrent ACS</td>
<td>Anticoagulant issues</td>
</tr>
<tr>
<td>STEMI</td>
<td>Non cardiac surgery</td>
</tr>
<tr>
<td>Progression of LV dysfunction</td>
<td></td>
</tr>
<tr>
<td>SCD</td>
<td></td>
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</tbody>
</table>
Post PCI follow up

- Routine asymptomatic
- Chest pain
- Recurrent ACS
- Cardiac failure
Approach a patient with chest pain following PCI?

- Noncardiac
- Atypical
- Anginal

- TMT
- TMT/CAG

General guidelines applicable except Exercise stress testing.
### Table 49G-1
American College of Cardiology/American Heart Association System for Risk Stratification of Patients with Unstable Angina

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Risk At Least One of the Following Features</th>
<th>Intermediate Risk No High-Risk Feature but Must Have One of the Following Features</th>
<th>Low Risk No High- or Intermediate-Risk Feature but May Have Any of the Following Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Accelerating tempo of ischemic symptoms in preceding 48 h</td>
<td>Prior MI, peripheral or cerebrovascular disease, or CABG, prior aspirin use</td>
<td>New-onset or progressive CCS Class III or IV angina the past 2 wk without prolonged rest pain but with moderate or high likelihood of CAD</td>
</tr>
<tr>
<td>Character of pain</td>
<td>Prolonged ongoing (&gt;20 min) rest pain</td>
<td>Prolonged rest angina, now resolved, with moderate or high likelihood of CAD</td>
<td></td>
</tr>
<tr>
<td>Clinical findings</td>
<td>Pulmonary edema, most likely due to ischemia</td>
<td>Age &gt;70 yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New or worsening MR murmur</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S₃ or new worsening rales</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hypotension, bradycardia, tachycardia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age &gt;75 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECG</td>
<td>Angina at rest with transient ST segment changes &gt;0.05 mV</td>
<td>T wave inversions &gt;0.2 mV</td>
<td>Normal or unchanged ECG during an episode of chest discomfort</td>
</tr>
<tr>
<td></td>
<td>Bundle branch block, new or presumed new</td>
<td>Pathological Q waves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sustained ventricular tachycardia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac markers</td>
<td>Elevated</td>
<td>Slightly elevated</td>
<td>Normal</td>
</tr>
</tbody>
</table>

CABG = coronary artery bypass graft; CAD = coronary artery disease; CCS = Canadian Cardiovascular Society; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; NTG = nitroglycerin.

Post PCI angina – Always high or intermediate Risk / Never Low risk
When post PCI patient require coronary angiogram?

Rarely indicated in an asymptomatic patient

TMT positive

Left main stenting routine CAG after 6 months
# PCI issues in specific clinical situations

<table>
<thead>
<tr>
<th>Chronic stable angina</th>
<th>Bare metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA</td>
<td>DES</td>
</tr>
<tr>
<td>Following AMI</td>
<td>CSA</td>
</tr>
<tr>
<td>CSA</td>
<td></td>
</tr>
</tbody>
</table>
Post PCI: Follow up issues

Drug related

Stent related

Restenosis

Subacute / Late stent thrombosis

Overall risk profile reduction

DM

HT

Lipids

Stress reduction
Time Frame of Stent Thrombosis

1 month

1 year

Early \( \leq 1 \) month

Late \( > 1 \) month - 1 year

Very late \( > 1 \) year

Acute \( \leq 1 \) day

Subacute \( > 1 \) day to 1 month

\( \leq 1 \) day

to 1 month

1 month

1 year

Acute stent thrombosis

Subacute stent thrombosis

Late stent thrombosis

Very late stent thrombosis
Stent thrombosis
Endothelium: Unfriendly DES

Figure 1 Angioscopic images show the grading for neointimal stent strut coverage. Neointimal coverage was more complete with bare-metal stents compared with sirolimus-eluting stents (p < 0.0001).
Bare metal

Healing is complete with fibromuscular neointimal covering struts

Paclitaxel stent.

At site of struts where the drug is present, healing is not complete.
Long term dual antiplatelet therapy

Main strategy in post PCI risk reduction

Within the stent

Beyond the stented segment

Non PCI vessels

Systemic vascular events
<table>
<thead>
<tr>
<th></th>
<th>Plain balloon</th>
<th>Baremetal</th>
<th>DES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sirolimus</td>
</tr>
<tr>
<td>Clopidogrel 75mg</td>
<td>-</td>
<td>1 month</td>
<td>3 months</td>
</tr>
<tr>
<td>Aspirin 162-325mg</td>
<td>Indefinite</td>
<td>Indefinite</td>
<td>Indefinite</td>
</tr>
</tbody>
</table>
All PCI patients are medical patients by default!

### Table 2. Cardiac Rehabilitation After Percutaneous Coronary Intervention*

<table>
<thead>
<tr>
<th>Cardiac risk factor</th>
<th>UA/NSTEMI guideline recommendations(^{54})</th>
<th>STEMI guideline recommendations(^{55})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>Blood pressure goal of $&lt;130/85$ mm Hg (class Ib)</td>
<td>Blood pressure goal of $&lt;140/90$ mm Hg or $&lt;130/80$ mm Hg if kidney disease or diabetes present (class Ib)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>Initiate statin if LDL-C $&gt;$130 mg/dL (class Ia)</td>
<td>Initiate statin if LDL-C $&gt;$100 mg/dL (class Ia)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Tight control of hyperglycemia (class Ib)</td>
<td>Hypoglycemic therapy initiated to achieve hemoglobin $A_{1c}$ $&lt;$7% (class Ib)</td>
</tr>
<tr>
<td>Smoking</td>
<td>Cessation (class Ib)</td>
<td>Cessation (class Ib)</td>
</tr>
<tr>
<td>Obesity</td>
<td>Maintenance of optimal weight (class Ib)</td>
<td>BMI goal of 18.5-24.9 (class Ib)</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>Maintenance of daily exercise (class Ib)</td>
<td>Daily goal of at least 30 min of exercise (class Ib)</td>
</tr>
<tr>
<td>High-fat diet</td>
<td>Maintenance of appropriate diet (class Ib)</td>
<td>Switch to a low-fat diet; increase fresh fruit and vegetable intake (class Ia)</td>
</tr>
</tbody>
</table>

*BMI = body mass index; LDL-C = low-density lipoprotein cholesterol; NSTEMI = myocardial infarction without ST-segment elevation; STEMI = myocardial infarction with ST-segment elevation; UA = unstable angina.
V. Secondary Prevention and Long-Term Management
Diabetes management

Goal: HbA1c less than 7%

Appropriate hypoglycemic therapy to achieve near-normal fasting plasma glucose, as indicated by HbA1c.

Treatment of other risk factors (e.g., physical activity, weight management, blood pressure, and cholesterol management).
## Hypertension

<table>
<thead>
<tr>
<th>Blood pressure control</th>
<th>If blood pressure is 120/80 mm Hg or greater:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal: Less than 140/90 mm Hg or less than 130/80 mm Hg if chronic kidney disease or diabetes</td>
<td>■ Initiate lifestyle modification (weight control, physical activity, alcohol moderation, moderate sodium restriction, and emphasis on fruits, vegetables, and low-fat dairy products) in all patients.</td>
</tr>
</tbody>
</table>

If blood pressure is 140/90 mm Hg or greater or 130/80 mm Hg or greater for individuals with chronic kidney disease or diabetes:

■ Add blood pressure reducing medications, emphasizing the use of beta-blockers and inhibitors of the renin-angiotensin-aldosterone system.
**Lipid management**

**Lipid management (TG 200 mg/dL or greater)**

**Primary goal:**

Non-HDL-C* substantially less than 130 mg/dL

If TGs are greater than or equal to 150 mg/dL or HDL-C is less than 40 mg/dL:

- Emphasize weight management and physical activity.
- Advise smoking cessation.

If TG is 200–499 mg/dL:

- After LDL-C-lowering therapy,† consider adding fibrate or niacin.‡

If TG is greater than or equal to 500 mg/dL:

- Consider fibrate or niacin‡ before LDL-C-lowering therapy.†
- Consider omega-3 fatty acids as adjunct for high TG.

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Lipid management (TG less than 200 mg/dL)

**Primary goal:**

Start dietary therapy in all patients (less than 7% of total calories as saturated fat and less than 200 mg/dL cholesterol).

Promote physical activity and weight management. Encourage increased consumption of omega-3 fatty acids.
## Smoking

<table>
<thead>
<tr>
<th>Goals</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smoking</strong></td>
<td>Assess tobacco use. Strongly encourage patient and family to stop smoking and to avoid secondhand smoke. Provide counseling, pharmacological therapy (including nicotine replacement and bupropion), and formal smoking cessation programs as appropriate.</td>
</tr>
<tr>
<td><strong>Goal: Complete cessation</strong></td>
<td></td>
</tr>
</tbody>
</table>
Weight management

**Goal:**

- **BMI 18.5-24.9 kg/m²**
  
  Calculate BMI and measure waist circumference as part of evaluation. Monitor response of BMI and waist circumference to therapy.

  Start weight management and physical activity as appropriate. Desirable BMI range is 18.5–24.9 kg/m².

**Waist circumference:**

- **Women: less than 35 inches**
- **Men: less than 40 inches**

  If waist circumference is greater than or equal to 35 inches in women or greater than or equal to 40 inches in men, initiate lifestyle changes and treatment strategies for metabolic syndrome.
Mental stress  Emotional stability:

Stented and worried?

When will I have the second heart attack?

Anti-depressants and anti-anxiety drugs useful.

Anxiety can trigger an event

Selective, patient specific information
Ignorance still a bliss?

Should we disclose all complications and potential side effects to the patients?

One of the health web site describes a DES tickling time bomb.

Is too much information harming the patients?
Special situations post PCI patients
Exercise & Physical activity following PCI

Indications

Contraindication
Coronary stent occlusion following strenuous exertion: is the risk actual? Is it preventable?

A total of four cases of stent occlusion between 2 days and 3 months.

Stent occlusion ranged from up to 2 h after the stress test.

*Int J Cardiol.* 2000;74:249–251 Meurin
SES and PES show exercise-induced vasoconstriction proximal and distal to the stent, whereas BMS maintain exercise-induced vasodilatation of the respective segments. Adapted from Togni et al., 61 copyright © 2005, and Togni et al., 62 copyright © 2007, with permission from Elsevier.
When exercise stress testing to be avoided?

Who is at risk for stent thrombosis?

Within 3 months

PCI following UA

Improper stent deployment

? DES
Exercise prescription for Post PCI patients

### Exercise Prescriptions for CAD Patients

<table>
<thead>
<tr>
<th>Patients</th>
<th>Intensity</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>General CAD</td>
<td>70%–85% peak HR</td>
<td>3 Times weekly</td>
<td>≥20 min per session</td>
</tr>
<tr>
<td>With asymptomatic ischemia</td>
<td>70%–85% Ischemic HR</td>
<td>3 Times weekly</td>
<td>≥20 min per session</td>
</tr>
<tr>
<td>With angina</td>
<td>70%-85% Ischemic HR or angina onset</td>
<td>3 Times weekly</td>
<td>≥20 min per session</td>
</tr>
<tr>
<td>With angioplasty±stent</td>
<td>As for general CAD patient</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>With claudication</td>
<td>Walking to pain tolerance</td>
<td>3 Times weekly</td>
<td>≥30 min per session</td>
</tr>
<tr>
<td>With NYHA class I–III HF</td>
<td>As for general CAD patient</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>For most CAD patients</td>
<td>30%–50% RM</td>
<td>2–3 Times weekly</td>
<td>12–15 Repetitions</td>
</tr>
</tbody>
</table>

RM indicates 1-repetition maximal weight.
Non cardiac surgery in patients with PCI

Elective
Emergenc

Peri-operative Clopidogrel

When to stop?
When to resume?

Withhold clopidogrel for 5-7 d before CABG, unless the urgency of revascularization outweighs the risks of excess bleeding; aspirin should not be withheld before elective or nonelective CABG after STEMI; aspirin, 75-325 mg/d, should be prescribed within 24 h of CABG unless contraindicated.
Emergency non cardiac surgery in post PCI patients

How safe to withdraw clopidogrel?
Spinal anesthesia /GA

Neuro axial blockade on a patient in whom you suspect abnormal platelet function, you should perform platelet function testing and correct the platelet function as guided by the test result or, if testing is unavailable, transfuse platelets before you proceed.

Dual Antiplatelet therapy and non-cardiac surgery risk; what are the anaesthetists and surgeons doing? Eur Heart J 2006; 27: 380-1
Point of care platelet function testing
Imaging Intra coronary stents

Should we need to visualize the stent?

64 slice CT
IVUS
MRI
64 slice CT intra stent view
Direct visualisation of stent
Newer imaging modalities

Have great potential

Imaging stents in the routine follow up

Is generally neither advised nor required
Is MRI safe in patients with stent?
AHA Scientific Statement

Safety of Magnetic Resonance Imaging in Patients With Cardiovascular Devices

An American Heart Association Scientific Statement From the Committee on Diagnostic and Interventional Cardiac Catheterization, Council on Clinical Cardiology, and the Council on Cardiovascular Radiology and Intervention: Endorsed by the American College of Cardiology Foundation, the North American Society for Cardiac Imaging, and the Society for Cardiovascular Magnetic Resonance

Glenn N. Levine, MD, FAHA; Antoinette S. Gomes, MD, FAHA; Andrew E. Arai, MD, FAHA; David A. Bluemke, MD, FAHA; Scott D. Flamm, MD; Emanuel Kanal, MD; Warren J. Manning, MD, FAHA; Edward T. Martin, MD, FAHA; J. Michael Smith, MD; Norbert Wilke, MD; Frank S. Shellock, Ph
MRI post PCI is generally safe!

Old generation Stents:
Better to wait for 6 weeks for stent anchoring.
(Migration/heating reported)

Newer generation Stents/DES are MRI safe

Weakly ferromagnetic platinum cobalt alloy, gold, tantalum,

Non-ferromagnetic: Titanium, titanium alloy, or nitinol
Post PCI care: Logistics

Telemetry

Access to emergency services
Who will take care?

Insuring post PCI patients
PCI follow up: Future directions...

- Non invasive Imaging
- Newer drugs
- Maintenance free stents?
- Bio degradable stents
Caring after PCI

Caring does not mean caring for
The stent!
The coronary artery!
The heart!

“Percutaneous coronary intervention is a focal treatment of a systemic disease process. And patients require lifelong caring.”

It is caring for the whole patient...
Thank you
Personal perspective . . .

While we take every pain to reduce the conventional risk factors and reduce a coronary event we should always remember

Is PCI by itself a coronary risk factor?
Variability of response to clopidogrel administered in the cath lab
- As measured by aggregometry

Variability of residual response after cessation of clopidogrel therapy
- As measured by VerifyNow