Focus
October 2007

Coronary and valvular heart disease revisited
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Introduction

Modern cardiology underwent a period of unique growth in the latter decades of the 20th century, the fruit of close collaboration between doctors and engineers in the conception, development and introduction into clinical practice of new diagnostic and therapeutic techniques. In fact, this technological prowess was founded on centuries of observation and experimentation on the heart and the circulation.

At the beginning of the 20th century, cardiologists began using invasive methods of examining the heart by cardiac catheterisation of which Werner Forssmann was pioneer in 1929. André Cournand and Dickinson Richards greatly contributed to the development of this investigation in the 1950s. Cardiac catheterisation entails the introduction of a thin flexible tube (the catheter) into a peripheral artery and thence to the heart to enable the introduction of a radio-opaque dye for imaging the heart and the vessels. The data so obtained provided a much more accurate assessment of cardiac diseases than was previously possible.

Shortly afterwards, coronary angiography arrived on the scene, used for the first time by Mason Sones for the investigation of diseased coronary arteries, opening up the field of revascularisation of the ischaemic heart, initially by coronary artery bypass surgery performed by Michael DeBakey for the first time in 1964.

Coronary Angiography:

It was only after the work of Andreas Gruntzig in 1977 that revascularisation of these same arteries, situated on the surface of the heart, was possible by a percutaneous approach, opening up a new field of cardiac expertise, coronary angioplasty. The main problem with this technique, entailing balloon dilatation of narrowed arteries, was restenosis of the dilated segment; but in the 1990s, a new and important development overcame this problem with the introduction of endoprostheses for stenting the angioplasty. The results were greatly improved and the number of procedures increased exponentially.

Concurrently, the 1950s saw the invention of the first heart-lung machine which made open heart surgery possible. The first artificial heart valve was inserted by Albert Starr in 1960 and the lives of thousands of patients with previously untreatable valvular heart disease were transformed.

In 1954, a major step was made in non-invasive diagnosis with the use of ultrasound to study the heart. Again, the fruit of close collaboration between an engineer, Hertz, and a doctor, Edler, echocardiography (as it came to be known) developed into a reliable and safe technique for obtaining anatomical and functional data about heart diseases providing cardiologists with the means of better follow-up of their patients and optimal timing of their interventional treatments.

The new diagnostic and therapeutic methods of coronary and valvular heart disease are now widely used.

The improved material made available by the manufacturers and the experience of the physicians with these new techniques have improved the clinical results with the hope of better life expectancy and quality of life.

This is the reason for this brochure regrouping an update in the medical and surgical treatments of coronary and valvular heart diseases based on presentations at SCOR Medical Meetings, the object of which is to inform our clients of medical progress and their impact on our daily practice of underwriting life insurance.

The recent advances presented by our invited medical experts confirm the improvements in the management of these diseases and should enable better medical risk selection with appropriate adjustments of extramortality ratings. We hope you enjoy the brochure.
Focus

Epidemiology and physiopathology of coronary artery disease

Doctor Jean-Philippe COLLET. Institute of Cardiology - Pitié - Salpêtrière Hospital, Paris

The aim of this presentation is to give a general overview of acute coronary syndromes. First of all, I shall review the physiopathology and then, give a classification followed by the modern therapeutic strategies which will be treated in greater depth by Professor FERRARI.

Physiopathology

Acute coronary syndromes are the final expression of a process called atherosclerosis, a progressive transformation of lipid streaks, present in all people as demonstrated by autopsy studies of young American soldiers who died in the Vietnam war, into atheromatous plaques. These plaques bulge into the arterial lumen and progressively narrow its diameter; irrespective of its location, carotid, coronary or lower limb. This transformation is accelerated by two principal factors. The first is hereditary which is being intensively investigated and which manifests itself by the occurrence of coronary artery disease before the age of sixty. In some families, death intervenes very early in life, after the age of thirty. We can now identify some culprit genes, but it is a long and difficult process to establish a causal relationship between a given polymorphism and the clinical expression of atherothrombotic disease. Hereditary factors interact with the second group of factors which are related to the environment. These are the well-known group of cardiovascular risk factors, some of them being acquired, like cigarette smoking, and others mixed, like hypertension, dyslipoproteinaemia (lipid abnormalities), diabetes, abnormalities of blood clotting or hyperhomocysteinemia. The interaction between these risk factors predisposes to the transformation of lipid streaks into atheromatous plaques and then, to the development of acute coronary syndromes.

A progressive process

The size of the plaques increases to limit blood flow in the vessel and thereby reduce oxygen supply to the organ vascularised. In the case of the heart, blood flow in the coronary arteries normally increases on exercise. When the diameter of the coronary arteries is reduced, blood flow cannot increase sufficiently and the heart runs up an oxygen debt. We now know that when the diameter of the coronary artery is reduced by more than 60%, angina pectoris occurs. It is a chronic phenomenon, something like intermittent claudication, which is cramp in the calf muscle coming on after walking a certain distance in patients with peripheral obstructive arterial disease.

Atheromatous plaques grow by cycles with episodes of rupture (Fig.1). Plaque rupture is a random process. When it occurs, the lipid core comes into contact with the circulating blood, triggering blood coagulation. This results in a blood clot which obstructs flow in the vessel. If the blood flow is totally interrupted, it results in a clinical event which is myocardial infarction in the case of the coronary arteries, stroke when the cerebral arteries are involved or critical limb ischaemia, if any of these clinical events, when severe, may lead to death.

Plaque rupture

The three layers of the arterial wall are the adventitia, the media and the intima or endothelium, a thin line of cells separating the blood from the rest of the arterial wall. The endothelium prevents the formation of blood clots in the artery in normal subjects.

Rupture of the cap of a plaque brings the blood into contact with the lipid core and causes a clot to form. Several phenomena predispose to plaque rupture.

Mechanical

The coronary arteries are moving all the time with the motion of the heart. Under increasing stress, the blood pressure rises and may cause plaques to rupture. This is the case in so-called stress-induced myocardial infarction.

Inflammatory

This is a cascade of biological reactions which causes the erosion of the fibrous cap which separates the blood from the lipid core so resulting in blood clot formation.

Vascular

The artery is a living tissue. It is itself supplied with blood by tiny vessels situated in the adventitia called the vasa vasorum which may become obstructed. This causes haematoma formation under the plaque and may cause rupture of its fibrous cap.

Figuratively speaking, the plaque may be likened to a volcano. The lipid core would be the lava. On top of the volcano, you can imagine a lake separated from the lava by a thin cap of rock. When the cap breaks, the volcano erupts leading to complications. The lipid core of the plaque is like a magma containing inflammatory cells and material rich in fatty esters and containing the tissue factor which is the principal activator of the blood clotting system. Any contact between the lipid core and the circulating blood activates blood clotting. Nature has designed things well: in the physiological setting, this phenomenon of coagulation serves to repair any vascular damage. In fact, the endothelium breaks from time to time and the clot in contact with the rupture clots, so closing up the breach.

Some plaques are vulnerable to rupture because the fibrous cap contains inflammatory cells which, at a given moment, may be activated and digest the matrix which keeps the fibres together. The digestion of this matrix brings the lipid core in contact with the vascular lumen and initiates thrombosis. A clot forms to fill in the breach of the fibrous cap. Over 95% of these ruptures are clinically silent because of the harmonious character of the healing process.

In some cases, the healing process oversteps its objective resulting in complete or partial obstruction of the vessel. This results in an acute coronary event, a localised phenomenon in the vessel. Sometimes, the clot disintegrates and pieces break off and embolise to the small distal vessels so obstructing the capillary bed.

Fig. 1: Physiopathology of acute coronary syndromes
The obstruction of the vessel leads to a progressive asphyxiation of the tissues dependent on the vessel for oxygen supply. Myocardial infarction will ensue unless the vessel is reopened. In the absence of intervention, vascular recanalisation will occur spontaneously after an interval during which irreversible damage will have occurred.

In other cases, equilibrium may be established between the forces acting to open the vessel and those acting to obstruct it. There is a physiological thrombolytic system. It prevents clots growing to an inappropriate size. When this physiological thrombolytic system is overwhelmed, the clot continues to develop until the vessel is totally obstructed. When the equilibrium between vessel obstruction and patency is unstable, the clinical syndrome of unstable angina is observed. Muscle damage is not totally established, but there is a high risk of progression to total occlusion of the vessel.

A bipolar disease (Fig. 2)
Atherothrombotic disease is a bipolar condition because it comprises local phenomena at the site of thrombotic occlusion of the artery and distal complications due to embolism of atherothrombotic material into the capillary circulation. In some patients, treated early for myocardial infarction by complete reopening of the culprit artery, reperfusion of the myocardial tissues remains ineffective. They are victims of a capillary blockage in addition to the obstruction of an artery, troponin is liberated into the bloodstream (Fig. 3a). For five years now, we have been able to measure this protein in the blood. When it is detected, myocardial tissue has been damaged.

Biological markers
Certain biological tools are now available for use in acute coronary syndromes. One of these markers is troponin, an intracellular protein involved in the contraction of cardiac muscle. When myocardial tissue dies due to obstruction of an artery, troponin is liberated into the bloodstream (Fig. 3a). For five years now, we have been able to measure this protein in the blood. When it is detected, myocardial tissue has been damaged.

Mechanisms of arterial obstruction
As soon as the platelets come into contact with the ruptured endothelium, they are activated and adhere to the subendothelium to cover the vascular breach by forming a platelet aggregate. They pile up one on top of the other to cover the breach of the endothelium (Fig. 4a) and build a carpet on which clotting is activated.

Coagulation is a process which transforms a soluble blood factor, the fibrinogen, into an insoluble factor, fibrin, which is in fact a polymer of activated fibrinogen molecules. The fibrin forms a network of fibres around the platelets and reinforces the structure of the blood clot (Fig. 4b) which enables the clot to increase in size and progressively occlude the artery.

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The objective of fibrinolysis from the biological point of view is to dissolve the network of fibrin. When there is a disequilibrium between fibrinolysis and clot formation, there is a higher risk of arterial obstruction.

Therefore, it all begins with a lesion of the arterial wall and the formation of a clot. This is followed by a cascade of biological events:

- platelet activation;
- platelet aggregation;
- fibrin formation by the activation of the coagulation system promoted by the presence of thrombin.

Each of these stages is essential and interacts with others with phenomena of retroactivation. For effective therapeutic intervention, drugs must be used to block each of these key stages of clot formation (fig. 4c).

Mechanisms of platelet activation
There are several pathways of platelet activation: the ADP receptor, the thrombin receptor and the thromboxane receptor. All lead to platelet activation which is the keystone of clot formation.

The target of the drugs which we use is to block each of these three metabolic pathways. When one of these pathways is activated, it results in activation of the platelet and in the exhibition of platelet membrane receptors on which a circulating element can adhere and which causes definitive adhesion of the platelets.

At present, there are specific drugs available for each of these three pathways. Cyclooxygenase inhibitors lead to 30% inhibition of platelet aggregation. Clopidogrel, inhibitor of ADP receptors, provides greater efficacy. By associating these two drugs, it is possible to block 60% of platelets.

In the last few years, even more effective antiplatelet drugs have come onto the market, the anti-GP IIb/IIIa. This is called the common final pathway of platelet aggregation. With these molecules, there is no platelet aggregation. They are used for very short periods of time. The use of these molecules may be likened to that of an airbag in a motorcar: they are only used in critical moments in acute coronary syndromes. Their use decreases by about 50% the complications of these events. They are expensive and powerful drugs.

A blood clot is made up of fibrin which forms a matrix with platelet aggregates. The degradation of this matrix is impeded by the platelet aggregates. When GP IIb/IIIa inhibitors are used, the platelet aggregates are removed and thereby make the blood clot more easily degradable.

Epidemiology and classification
The usual clinical presentation of an acute coronary syndrome is chest pain. There are two main types of acute coronary syndrome which may be identified from the surface electrocardiographic recording: myocardial infarction with ST elevation (AMI) and unstable angina (UA). These two clinical entities although closely related, are managed differently.

- AMI results from complete occlusion of the coronary artery requiring emergency measures to reopen the artery (thrombolysis or transluminal angioplasty).
- UA is an intermediary state for which the diagnostic strategy is essential for identifying patients with the highest risk, especially those with a non-Q wave myocardial infarction. UA is different from AMI because there is a higher risk of recurrence and because of the potentially deleterious effect of thrombolytic treatment in this condition.

In France, we do not have accurate data on the incidence of AMI or UA, but nearly 150 000 patients are admitted for AMI with ST segment elevation. These are patients who arrive alive at the hospital, but we estimate that one out of two patients never gets to hospital. Approximately 300 000 patients are admitted for UA. UA is the commonest pathology because of the increasing prevalence of risk factors such as diabetes, the increasing age of the general population (90% of octogenarians have coronary artery disease) and finally, the improved diagnosis of UA with the use of diagnostic tests such as the troponin test.

Management of unstable angina
The primary objective is to confirm the diagnosis, evaluate the risk profile and identify the high risk patients.

Evaluating diagnosis and risk profile
- Clinical examination alone is useful in assessing the diagnostic probability by recensuring the classical risk factors: a patient under 40 years of age admitted for chest pain and who does not smoke or has a positive family history has a probability of less than 2% of having coronary artery disease. Clinical examination should look for a previous myocardial infarction (clinical history, ECG), disease of other arteries, and prescription of drugs for cardiovascular disease (aspirin and beta-blockers).
- Biological markers have become essential tools. The serum troponin can be measured in under ten minutes at the patient’s bedside. It has become an almost invaluable tool for confirming myocardial ischaemia as the cause of chest pain with a negative predictive value of 97%. Moreover, it has been shown to be an independent prognostic factor for morbidity and mortality of coronary artery disease.
- These two stages are used to calculate the TIMI risk score (fig. 5) which allows evaluation of the probability of myocardial infarction and the morbidity and mortality at one month.

TIMI RISK SCORE FOR UNSTABLE ANGINA

<table>
<thead>
<tr>
<th>HISTORY POINT</th>
<th>TIMI RISK SCORE FOR UNSTABLE ANGINA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 65 years</td>
<td>1</td>
</tr>
<tr>
<td>Documented coronary disease</td>
<td>1</td>
</tr>
<tr>
<td>Left of age</td>
<td>1</td>
</tr>
<tr>
<td>PRESENTATION</td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>1</td>
</tr>
<tr>
<td>Radiation and nitrites</td>
<td>1</td>
</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>1</td>
</tr>
<tr>
<td>Risk factors: hypertension (C1)</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 5

- Left ventricular function and renal function are predictive of severe ischaemic events (death or myocardial infarction) which must be evaluated by the Killip stage (fig. 6) and the creatinine clearance. Cardiac failure (Killip stage II or more) and renal failure (creatinine clearance < 30 mlin/min) increase by a factor of 4 the one month coronary morbidity and mortality.

THE KILLIP STAGE

I: normal pulmonary auscultation
II: crepitations to mid region or gallop rhythm
III: crepitations throughout the lung fields
IV: cardiogenic shock

Fig. 6

All these drugs are commercially available: aspirin, which is the first line; clopidogrel (Plavix), which is a new molecule; glycoprotein IIb/IIIa blockers and heparin.

The objective of the treatment of acute coronary syndrome is mainly to block the formation of a blood clot predispose to bleeding.

The most powerful drugs.

The use of these molecules may be likened to that of an airbag in a motorcar: they are only used in critical moments in acute coronary syndromes.
intercurrent disease which must be recognised: pyrexia, anaemia... The permanent or transient alteration of the vital functions (hepatic, renal, cerebral) make these patients high risks both from the ischaemic and haemorrhagic points of view.

Preventing complete coronary occlusion
This step consists of preventing complete coronary thrombosis and progression to acute myocardial infarction with ST segment elevation.

The classical approach
This is based on the results of randomised clinical trials published at the end of the 1990s and which demonstrated the necessity of a period of medical stabilisation with the association aspirin, heparin, betablockers (fig. 8).

Non-fractionated heparin reduces the risk of progression from unstable angina to acute myocardial infarction by over 80% and reduces the incidence of refractory unstable angina by a factor of 3. Interestingly, recurrence of AMI and reactivation of UA after stopping this treatment demonstrated the value of associating heparin with aspirin during the acute phase of UA. Heparin may be stopped after 4 to 6 days of treatment with aspirin which should be continued in the long term in the context of secondary prevention.

Betablockers reduce the morbidity and mortality by preventing serious ventricular arrhythmias and myocardial rupture. Thrombolysis is ineffective and deleterious in unstable angina. The calcium inhibitors have not been shown to be useful with the exception of isopet in the post-infarction period.

The modern approach
The concept of multi-antithrombolytic therapy arose from a better understanding of the physiopathology of unstable angina, opening the way for early revascularisation by angioplasty. Different classes of thrombolytic drugs are associated with the aim of blocking every stage of clot formation including platelet activation and aggregation.

Fig. 8: Evaluation of haemorrhagic risk

Identification of difficult cases
These are high risk patients with an atypical presentation: the elderly, diabetic patients, perioperative environment.

Angina is rarely typical in its presentation in elderly patients. Shortness of breath or decreased cerebral blood flow resulting in a traumatic fall may mask the diagnosis. Unstable angina often emerges during the course of an intercurrent disease which must be recognised: pyrexia, anaemia... The permanent or transient alteration of the vital functions (hepatic, renal, cerebral) make these patients high risks both from the ischaemic and haemorrhagic points of view.

WHAT ARE THE RECOMMENDATIONS OF THE SCIENTIFIC SOCIETIES?

> Associate aspirin and clopidogrel with an anticoagulant (antithrombotic therapy).
> Prefer low molecular weight heparin to non-fractionated heparin because of a better dose-response relationship, less platelet activation and better tolerance.
> Associate a GP IIb/IIIa inhibitor when: coronary angiography is undertaken with the aim of performing angioplasty or in cases of refractory ischaemia or - raised troponin or - other risk factors, in the absence of the angioplasty strategy.

Fig. 7: Evaluation of haemorrhagic risk

EFFECT OF INTERVENTIONS ON THE REDUCTION OF MORTALITY AND INFARCTION IN THE ACUTE PHASE OF UNSTABLE ANGINA

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>NUMBER OF TRIALS</th>
<th>NUMBER OF PATIENTS</th>
<th>% change of risk (with 95% CI) of death or MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>4</td>
<td>2,114</td>
<td>&lt; decrease</td>
</tr>
<tr>
<td>Heparin</td>
<td>4</td>
<td>1,561</td>
<td>&lt; decrease</td>
</tr>
<tr>
<td>Betablockers</td>
<td>5</td>
<td>4,700</td>
<td>&lt; decrease</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>12</td>
<td>2,376</td>
<td>&lt; decrease</td>
</tr>
<tr>
<td>Calcium anticoagulants</td>
<td>3</td>
<td>224</td>
<td>&lt; decrease</td>
</tr>
<tr>
<td>Early Angioplasty</td>
<td>1,473</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results obtained from meta-analysis of randomised clinical trials. Source: Granger CB. In Califf RM (Ed) “Acute Coronary Care”. Mosby, Philadelphia, PA, 1995; Chap. 42.

The value of angioplasty in the acute phase of unstable angina
It is associated with a 20 to 30% reduction of coronary morbidity and mortality. These benefits are even greater in high risk patients and when a GP IIb/IIIa inhibitor is associated to limit early acute complications.

What are the likely future developments?
Good quality randomised medical trials and the assessment of many antithrombolytic strategies have led to the rapid increase in revascularisation procedures by angioplasty which is now employed in about 25 to 30% of patients admitted to hospital for unstable angina. Three lines of development could improve our management of these patients.

First of all, the evaluation of these aggressive strategies in patients excluded from the clinical trials. They include those with renal failure, cardiac failure, the elderly and those with a history of haemorrhage. These groups account for at least 40% of all our patients and have a four-fold increase in morbidity and mortality compared with the other patients. They should, therefore, derive greater benefits from this approach. The tolerance, and especially the haemorrhagic risk, will be the main problem to overcome.

The development and evaluation of rapid management of unstable angina with early revascularisation as in acute myocardial infarction with ST elevation. This type of approach, besides reducing the duration of hospital stay and the duration of aggressive antithrombotic treatment, should reduce the morbidity and mortality of the highest risk patients, those with resting angina, clinical left ventricular dysfunction or serious ventricular arrhythmias.

Finally, the development of tools for biological follow-up to enable titration of the dosages of antithrombotic drugs.

Management of myocardial infarction
The following remarks are only a brief description of this topic. In myocardial infarction, the artery is completely obstructed and, as we sometimes say, “time is myocardium”! The faster the intervention, the greater the amount of myocardium we can save and the better the chances of survival for the patient. The artery must be opened as soon as possible to improve survival. This can be done either by thrombolysis or by angioplasty. Thrombolysis consists of chemically dissolving the clot but without treating the plaque. Angioplasty allows removal of both the clot and the plaque. Unfortunately, angioplasty is only available in specialised centres whereas thrombolysis can be performed in the patient’s home. The earlier the patients are treated, the more lives that are saved. It has been shown that when thrombolysis is performed in the first three hours after onset of symptoms, 80 lives are saved for every 1,000 patients treated. When the treatment is delayed over six hours after onset of symptoms, the benefits are much less. It is therefore extremely important to act early. The same applies to angioplasty: the earlier the intervention, the more myocardium, and, therefore, the more lives we can save.
In real life, out of 100 patients with acute myocardial infarction, about 50 will be treated by thrombolysis, 10 by angioplasty and 40 to 50 will have no treatment at all. The latter group has the greatest risk of developing the complications of myocardial infarction, notably cardiac failure and death. This is the largest problem for the treatment of myocardial infarction over the next ten years. We have made great strides in the science of revascularisation. There have been significant improvements in the technique of angioplasty, but the overall results have stagnated. Only 40% of patients with acute myocardial infarction are revascularised and this figure has not changed over the last decade. This is the real challenge for the years to come.

**Secondary prevention**

What can we do after an acute coronary event? First of all, the cardiac risk factors must be treated to prevent recurrence of the problem. This entails advising patients to stop smoking, to lose weight, to correct their diabetes and high blood pressure. Several types of drug will be prescribed:

**Aspirin**

Aspirin is used as long term therapy to reduce the risk of recurrent thrombosis. It is associated with a reduced risk of sudden death and recurrent myocardial infarction at the price of a slightly higher risk of bleeding complications. The risk of death from myocardial infarction is reduced by 30%. There is a direct relationship between the benefits of treatment and the patient’s risk profile. Patients with a history of unstable angina are at highest risk. This explains the fact that the greatest reduction in morbidity and mortality is observed in this group. When the absolute risk of a coronary event is over 4% per year, the benefits of aspirin increase and the risk/benefit ratio is in favour of the treatment.

**Betablockers**

Betablockers in the acute and chronic phases of myocardial infarction decrease the risk of ventricular arrhythmias, sudden death and cardiac rupture. An association of these four families of drugs should figure on the prescription of all patients with a history of acute coronary events.

**The statins**

These are lipid lowering drugs and their discovery was recognised with a Nobel Prize for medicine. There are six or seven different statins on the market. The results of trials in primary prevention, which is to say before the occurrence of an adverse coronary event, as in secondary prevention after a coronary event show a 30% reduction in coronary morbidity and mortality with these drugs. Moreover, it would appear that the benefits are not only related to lowering the serum cholesterol, but could be related to a direct action on the arterial wall. These drugs are relatively well tolerated and their cost corresponds approximately to that of smoking one pack of cigarettes per day.

**Angiotensin converting enzyme inhibitors**

These drugs were developed for the treatment of hypertension. It was observed that when they were given after myocardial infarction there was a 20 to 30% reduction in mortality and that they decreased the number of complications, especially cardiac failure, by an effect on the infarct scar.

**Conclusion**

Coronary artery disease and its complications are regressing, thanks to advances in primary and secondary prevention and the improved management of the acute complications of coronary atherothrombosis, especially by angioplasty. The limited accessibility of these invasive techniques is problematic for the improvement of the management of acute coronary syndromes. It is, above all, a logistic and educational problem.

The development of a better risk score is also essential for improving the management of acute coronary syndromes. We have biological markers for assessing the prognosis of patients which can be used at the bedside and in the emergency department. One of these markers is the Brain Natriuretic Peptide (BNP) which is released by the myocardial muscle. When the concentration of this marker is raised, the risk of death is very high irrespective of the underlying mechanism of myocardial damage. Other biological markers are predictive of plaque rupture. One of these proteins, present in the atheromatous plaque, is released when the fibrous cap is digested. It is possible to use it to identify patients with a large number of unstable plaques. Some biological markers are candidates for risk stratification before the occurrence of any complication and, after evaluation, could help insurers improve their underwriting strategies.

**Patrick MALAMUD**

With respect to primary prevention, what are the pertinent risk factors for assessing absolute coronary risk? Also, could you explain the value of the arterial intimal medial thickness in primary prevention?

**Jean-Philippe COLLET**

The absolute risk score was established from prospective studies, the best known of which is the Framingham study. Framingham is a small town located to the North-East of Boston, Massachusetts, where the population has been followed up for about 50 years. This is a cohort of twenty to thirty thousand people followed up longitudinally. The clinical characteristics (hypertension, diabetes, etc.) have been identified over the years and the coronary events observed in this group have enabled the investigators to establish a cardiovascular risk score based on the presence of the cardiovascular risk factors. This is called the Framingham score which gives an idea of the overall risk but cannot give an accurate probability for each individual of having an acute coronary event. Therefore, other tools have been developed such as the intimal/medial thickness. This measurement of the arterial wall is performed by ultrasonography of the carotid artery. It has been shown that, in people who have no history of coronary disease, the thickness of the arterial wall is predictive of future coronary and cerebrovascular events. A number of teams use this parameter regularly for screening purposes. In those with an increased intima/ media thickness or in whom atheromatous plaques are detected and who have borderline stress tests, we recommend coronary angiography because there is a higher risk of finding severe coronary artery disease in these patients. This is a risk factor that we use often in young patients who have had a recent myocardial infarction. In fact, people who suffer from a myocardial infarction before the age of 40 years have greatly increased intima/media thicknesses of their femoral arteries. Although the physiopathology is not fully understood, these tools are now used in daily practice.
The atheromatous plaque

Atheromatous plaques may rupture and this process is quite common. Everyday, people have plaques which rupture and are repaired spontaneously. No one in this room has called the Emergency Ambulance Service as yet... Atheromatous plaques of the coronary arteries may be non-obstructive, they may slowly obstruct the coronary artery or suddenly occlude it totally.

When the plaque is non-obstructive, the clinical presentation is usually angina of effort. The patient describes the pain with a closed fist over his chest and often calls it “vice-like” squeezing his chest when he makes the effort of running for a bus, for example. In this situation, the first thing is not to be late for the bus... But when a 50-year old man who smokes describes this type of oppressive chest pain at rest, possibly irradiating to the jaw or the arm, this is a marker of unstable angina. Angina without totally occlusive arterial plaques may progress to cardiac failure due to ischaemia. The reduced blood supply to the cardiac muscle may be compared to inadequate watering of a plant in a heat wave. The plant will wither and the cardiac muscle, likewise, will lose its tonicity.

When coronary obstruction is sudden and the artery totally occluded, myocardial infarction, the death of the cardiac muscle supplied by the artery, will ensue. Myocardial infarction may be clinically silent in diabetic, elderly and hypertensive patients. They feel no chest pain. Sometimes, these patients present 5 to 10 years later with ischaemic cardiac failure. Angina pectoris, the alarm signal, did not occur in their cases.

Consequences of arterial obstruction

Therefore, the same arterial plaque may, by three different mechanisms lead to the different coronary syndromes: angina pectoris, myocardial infarction and, less often, ischaemic cardiac failure.

I find it difficult to define the term “ischaemic heart disease” despite my twenty years’ experience of cardiology. Is it an acute coronary syndrome due to sudden arterial obstruction whereas the patient was perfectly well two minutes beforehand? Or is it a stable coronary state with a non-occlusive plaque which prevents normal cardiac function only when the person requires an increased cardiac output? Or, again, is it documented coronary disease with previous left ventricular damage? I tend to think that ischaemic heart disease corresponds to this last case that I have described. The term ischaemic heart disease is rarely applied to sudden occlusion of a coronary vessel. Even in medicine, where we apply ourselves to classify diseases accurately, everything is not always clear.

Myocardial infarction results from total obstruction of an artery. Without its blood supply, the muscle dependent on the artery will die as any skeletal muscle deprived of oxygen and nutrients. In order to diagnose myocardial infarction, it was thought for many years that two of the following three criteria needed to be present:

- typical constrictive chest pain (vice-like) which persists until the artery is reopened or which can last 24 hours if the artery is not reopened;
- certain ECG changes which a physician, especially a cardiologist, should be able to recognise;
- the presence of a biological marker, troponin, an enzyme which is released by cardiac muscle when it dies; the dead cells rupture their membranes and the cytoplasmic contents are dumped into the blood stream, including this marker of infarction and cell death.

Troponin is one of the biological markers of myocardial necrosis. This is the enzyme whose concentration in the blood rises the earliest and remains elevated the longest (normalisation in 2 to 3 weeks). In some subjects, it is the only biochemical abnormality observed.

Ten years ago, we used to miss the diagnosis of myocardial infarction when the CPK (creatine phosphokinase), another biological marker of infarction, remained within normal limits.

This new definition based on the troponin level is more sensitive and will increase the number of patients labelled "myocardial infarction" that we see in our Coronary Care Units. It is estimated that the incidence of myocardial infarction will increase by about 20% for this reason. Therefore, a patient with chest pain and raised troponin levels alone will be classified in the same group as the patients with raised CPK levels. The hospital discharge summary will label both cases myocardial infarction but the prognosis will be totally different. We will come back to this point later on.

If the troponin levels rise, it is because pieces of the fissured arterial plaque have broken off and embolised distally. They do not occlude the main artery which may have a diameter of 3mm but a small peripheral arteriole which will cause a small area of infarction, detected by the rise in troponin levels.

Can we identify high risk atheromatous plaques

We all have atheromatous plaques on our arterial walls. In some of us, they may lead to obstruction of the artery. In others, they will be of no clinical consequence.

Contrary to what we might think from the visual appearances, it is not the most obstructive plaques which necessarily fissure and occlude the artery. This is one of the "burning subjects" of interventional cardiology. We treat plaques which obstruct 75% of the artery because it decreases blood flow and to prevent angina and ischaemic heart disease. However, it is probably the plaque that only obstructs the arterial lumen by 25% which is at highest risk of causing infarction. But we do not treat these plaques because there are so many of them and we cannot identify those at highest risk.

When we revascularise patients with stable angina, it is not to prevent myocardial infarction, but to stop the chest pain.

When only one artery is affected by atheroma, it is called single vessel disease; when two arteries are affected it is called double vessel disease and when all three coronary arteries are affected, triple vessel disease.

The risk is not strictly correlated to the extent of the coronary disease. There is a progression of the disease which can be followed by biological parameters. When these markers are low, the risk of a patient with triple vessel disease will be lower than that of a patient with single vessel disease with raised markers. This is a new concept in cardiology.

In the future, markers will become available to enable us to better understand the disease than our present visual appreciation and allow us to identify the single vessel diseases with a higher risk than certain triple vessel diseases.

Impact of new techniques of myocardial revascularisation on the prognosis of ischaemic heart disease

Professor Emile FERRARI, Department of Cardiology, Pasteur Hospital, Nice

Coronary artery disease is one of the top two or three causes of mortality in the developed countries and that is where we live! By 2020, it will be the leading cause of mortality in all populations on our planet. It is a serious and common condition.

This presentation will describe the impact of new techniques of revascularisation of ischaemic myocardium on the prognosis of coronary artery disease. The basis, the techniques, the indications of angioplasty and the results compared with another method of revascularisation (bypass surgery) and medical treatment alone will be discussed.

The essentials of myocardial revascularisation

When the question of ischaemic heart disease or myocardial infarction is raised, we are really talking about the left ventricle. The heart comprises four chambers, the two atria and the two ventricles. The primary function of the heart is to pump blood, in particular from the lungs to the systemic arteries. The term infarcted muscle usually refers to the left ventricular muscle. The coronary arteries are like carburettors which nourish this muscle. They arise from the root of the aorta and supply the muscle with oxygen and nutrients. They arise from the root of the aorta and supply the muscle with oxygen and nutrients.

The coronary blood stream, including this marker of infarction and cell death.

When the plaque is non-obstructive, the clinical presentation is usually angina of effort. The patient describes the pain with a closed fist over his chest and often calls it “vice-like” squeezing his chest when he makes the effort of running for a bus, for example. In this situation, the first thing is not to be late for the bus... But when a 50-year old man who smokes describes this type of oppressive chest pain at rest, possibly irradiating to the jaw or the arm, this is a marker of unstable angina. Angina without totally occlusive arterial plaques may progress to cardiac failure due to ischaemia. The reduced blood supply to the cardiac muscle may be compared to inadequate watering of a plant in a heat wave. The plant will wither and the cardiac muscle, likewise, will lose its tonicity.

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Methods of revascularisation

In some clinical situations, it is important to bring the heart some “fresh blood”. One method of attaining this objective is to ask a surgeon to perform bypass surgery. This entails excising some of the superficial leg veins and connecting these “vein grafts” to the aorta and bypassing the diseased artery to bring oxygen-rich blood with its nutrients distal to the narrowed artery and reperfuse the ischaemic muscle.

The surgeon can also use the two internal mammary arteries for bypass surgery. They are located each side of the sternum and have the advantage of already being connected to the subclavian arteries which supply the arms. These arteries do not have any vital function and can be anastomosed to the coronary arteries distal to the obstruction.

Another method of revascularising the coronary arteries consists of passing a 3mm plastic tube, a catheter, up a peripheral artery as far as the coronary arteries to perform a coronary dilatation.

A 0.4 mm guide wire is introduced through the catheter to cross the narrowed segment.

Then, a balloon is pushed over the guide wire which serves as a rail, as far as the narrowed arterial segment put under pressure and inflated. The dilated balloon squashes the plaque against the arterial wall. When the artery has been treated, the balloon is deflated and withdrawn. It is then possible to insert a metallic prosthesis, called a stent, where the plaque used to be before withdrawn. It is then possible to insert a metallic prosthesis, artery has been treated, the balloon is deflated and

One of the prognostic factors after myocardial infarction is the infant size. The prognosis is not the same when a small artery is obstructed leading to infarction of a square centimetre of tissue and when a large artery is obstructed with a loss of a large amount of muscle. The larger the infarct, more the pump function will be affected and, therefore, the greater the risk of cardiac failure.

The primary function of the left ventricle is to pump blood from the lungs into the arterial circulation. Cardiac failure corresponds to a reduction in systemic output. The prognosis of cardiac failure is poor in this setting with a 60-month mortality of 50%. Some cancers have a much better prognosis!

Left ventriculography is a more accurate method. A catheter is introduced into the left ventricle and a radio-opaque dye injected. The contour of the chamber is drawn at the end of filling and at the end of emptying. The difference between the end diastolic and end systolic volumes is the stroke volume. The average end diastolic volume is about 130 cc and the end systolic volume about 45 cc. The stroke volume to end diastolic volume ratio is the ejection fraction which is normally over 60%. When the ejection fraction is reduced to less than 40%, the situation is serious, the dysfunction severe.

The second widely accepted risk factor is the presence of residual ischaemia. This may be in the territory of the culprit artery of the coronary event or in that of another vessel. The stress test allows evaluation of the residual ischaemia in the infarcted territory and detection of ischaemia in other regions of the left ventricle.

The stress test consists of asking the patient to sit on an ergometric bicycle and to pedal at increasing loads with increments of 30 watts in order to accelerate the heart rate as in normal exercise. The patient is exercised to 75 or 80% of the theoretical maximal heart rate (220 – age). The test is only reliable when the target heart rate is achieved. Some patients develop signs of ischaemia or arrhythmias from 60 watts and 85 beats per minute. This indicates a poor prognosis.

Coronary pathologies

Myocardial infarction

Total coronary occlusion with absence of blood flow to the myocardium for more than 4 to 6 hours (8 hours in some cases) results in myocardial cell death.

The mortality of patients with myocardial infarction is over 40% at 30 days. Out of 100 deaths, 50 occur in the first two hours. These are patients who do not even have time to call the Emergency Ambulance service and who die suddenly. If somebody has chest pain, you must call the Emergency service immediately. Seventy to eighty per cent of deaths due to myocardial infarction occur in the first 24 hours. After myocardial infarction, the annual death rate is 5 to 10%. There are not many other conditions associated with such a high sudden death rate.

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Treatment of myocardial infarction: thrombolysis or angioplasty?

In myocardial infarction, the urgency is to reopen the artery. The earlier that this is accomplished, the better the chances of survival. The techniques of primary balloon angioplasty and thrombolysis with a simple intravenous injection of a substance to dissolve the clot obstructing the artery, are in competition.

If thrombolysis is given before the second hour after onset of symptoms, 80 lives are saved for every 1,000 patients treated. This may not seem impressive but, in fact, it is one of the best results in the field of cardiology. When treatment is given at about the sixth hour, the number of lives saved decreases to 20 for every 1,000 patients treated and when treatment is given after the twelfth hour, the patient risks bleeding complications from the drugs used and the benefits are practically nil. The lesson is: the earlier the artery is reopened, the more lives we save.

Thrombolysis can be performed by any doctor anywhere. Angioplasty requires transport of the patient to a specialised centre and these centres are not uniformly distributed throughout the country.

In recent studies in the field comparing the two methods of treatment, the 30 day mortality was the same after primary angioplasty and thrombolysis. One approach was not significantly better than the other. Thrombolysis may be instituted in the pre-hospital period and, as we have seen, has a much higher success rate than an angioplasty and even one hour gained is important. It is better for patients to have thrombolysis if it is started earlier even if intrinsically it is less effective than angioplasty. This is essential in terms of public health.

The disadvantage of medical treatment is that 30 to 40% of patients are non-responders. Moreover, there is a risk of bleeding with these drugs, and finally, the reopened artery may thrombose again in the hours following treatment and this is observed in 10 to 25% of cases.

The advantage of angioplasty initial is that the results are better. The success rate is 95% or more in the best centres. The disadvantage is that patients have to be transported to a specialised centre with medical teams trained to perform this procedure.

The consensus that has been adopted is that the physician who first sees the patient must telephone the nearest centre and, if the time to transport the patient is less than one hour, the patient is sent to the catheter laboratory for primary angioplasty. On the other hand, if there is no room at the centre or if the travelling time is estimated superior to one hour, the physician performs thrombolysis.

Before 1960, the hospital mortality of myocardial infarction was 40%. Then the coronary care units were set up and patients were monitored by ECG for ventricular arrhythmias, the commonest cause of these early deaths. This measure allowed detection and treatment of previously lethal arrhythmias and reduced hospital mortality from 40 to 18%. Thrombolytic therapy has contributed to another spectacular reduction in mortality. Drugs such as beta-blockers and aspirin, followed by angiotensin converting enzyme (ACE) inhibitors have reduced the mortality further to the present rates of 6 to 7%.

It is suggested in the literature that there is no rivalry between interventional cardiologists and thrombolysis, but this is not true. Rather than to squabble over whether to dilate the patient's artery or use thrombolysis, which is costly but can be widely administered, it is more profitable to look at the statistics. The proportion of patients who benefit from any form of revascularisation before one and a half hour after onset of symptoms, when it is most effective, is only 8%. Instead of discussing amongst physicians the pros and cons of the best method of revascularisation, the energies should be directed to ensuring that more people get some form of treatment at an early stage. In myocardial infarction, although primary angioplasty represents a sort of “four star” treatment, thrombolysis is more accessible, easier to perform and, in terms of public health, could save more lives.

Unstable angina

Unstable angina is caused by a non-obstructive thrombus. The atheromatous plaque reduced blood flow and results in ischaemia of some of the heart muscle. There may be rest angina: the patient has chest pain without exercising. There may be angina on minimal exercise. In both cases, it is an emergency situation.

Since 1989, the number of cases of unstable angina has exceeded that of myocardial infarction and the difference continues to increase. Over the last 10 to 15 years, the medical community has been wondering what to do with only partially obstructive coronary plaques which nevertheless threaten the cardiac
muscle. Should a very aggressive strategy be adopted with instrument revascularisation or should we “only” give the appropriate drug therapy? Many clinical trials have been performed to answer this question and the conclusion was that when the diseased vessel is accessible, it is preferable to disobliterate the artery, not with the same urgency as for myocardial infarction, but within 48 hours.

A comparison of the non-invasive (thrombolysis) and invasive (angioplasty or surgery) methods showed that the latter strategy provided better results at 3 months. However, there was a price to pay. The invasive strategy is sometimes complicated by myocardial infarction; in trying to unblock the artery, the operator blocks it. When the patient is protected by the antithrombotic drugs listed by Doctor J.P. COLLET, this complication is prevented.

**Stable angina**

The scenario here is the patient who goes to buy his bread each morning and who, while running for the bus he has just missed, feels a pain in his chest. In this case, the therapeutic options are not just two but three methods: medical, surgical or angioplasty. These methods will now be compared.

The survival of coronary patients who underwent coronary bypass surgery over 18 years previously has been studied in the CASS (Coronary Artery Surgery Survey) study which many insurance companies use to evaluate prognosis.

In patients undergoing coronary bypass, the death rate is higher initially because of the operative mortality. Thereafter, the mortality rate decreases and the 5 year survival is 90%, a very good figure when the age of the patients, their general condition and the operation they have had, are taken into consideration. The 10 year survival is 74% and 15 year survival 56%. Patients who are operated between 65 and 75 years of age have a survival rate comparable to that of the general population of the same age. In fact, a 70 year old patient who survives coronary bypass surgery has a 10 year survival rate of 60%.

If the mortality rate of patients undergoing coronary bypass surgery is slightly higher than that of the general population and the more elderly seem to derive greater benefit, it is because there is a subgroup of patients in whom the mortality is much higher than that of the general population. In fact, young people with coronary artery disease generally have a more complex and progressive form of the disease with many risk factors. The patient may not have stopped smoking or the medication may not have fully corrected the hypertension or hypercholesterolaemia.

Young age at the time of coronary bypass surgery is not a good prognostic factor; similarly, overweight, a past coronary history, diuretic therapy (co-morbidity due to hypertension or cardiac failure), smoking and left main coronary disease carry a worse prognosis. The use of saphenous vein grafts alone without arterial bypass grafts is associated with a higher risk as we know today that mammary artery grafts are more effective.

In some forms of stable angina, medical therapy may be better than revascularisation. Our young doctors sometimes have the impression that treating patients medically alone is not sufficient. The RITA2 trial was carried out in 1,018 patients with stable angina who were randomly allocated to treatment by drugs alone or by angioplasty and followed up for 2 years. The death rate from myocardial infarction was twice as high in the groups who underwent aggressive treatment by angioplasty. The results of this trial were published in 1997 and reflected our techniques dating back to 1994 and 1996 which were less effective than those used today. However, I think that the results are still pertinent, although angioplasty has improved since, so has drug therapy. A meta-analysis, comparing medical treatment with angioplasty, based on 6 trials and 1,000 patients, showed that angioplasty reduced the relative risk of angina by 30% as unblocking the artery allowed reperfusion of the muscle. It also showed that angioplasty was associated with a higher risk of myocardial infarction. There was also an increased risk of death and of repeat angioplasty or coronary bypass surgery. The act of introducing an instrument into an artery that is already diseased may create a certain pathology which has consequences later on for the patients.

The most important medical treatment is not that which makes the angina disappear. On the contrary, it may be valuable to the patient to have this alarm signal. The most important treatment is that which prevents plaque rupture. Treatment should prevent the fissure forming and the volcano from exploding.

When we compare angioplasty with coronary bypass surgery, the subject of a number of trials, angioplasty seems to be better than surgery. There are fewer immediate complications, fewer strokes and infaracts. However, angioplasty has the drawback of an overreaction to the introduction of a prosthesis or stent into the artery. This complication of restenosis is not operator or technique-dependent but occurs in 25 to 30% of cases for which it is possible to repeat the angioplasty to repair this poor result. The advantages of bypass surgery are that the coronary circulation can, a priori, be totally revascularised (up to 5 grafts in the same procedure) and that there are fewer recurrences of angina in the short term. The disadvantages are the operative complications. Moreover, it is estimated that 10% of coronary bypass grafts are occluded when the patient leaves the operating theatre and that 50% of grafts are occluded after 10 years. Therefore, the recurrence rate at 10 to 12 years is high.

There is an important lack of data comparing the different methods. When angioplasty is compared with surgery at 6 months, the success rate is 70% compared with 90% for surgery, making surgery appear to be superior. At 5 years, however, the angioplasty results are the same but, with the occlusion of the bypass grafts, the surgical success rate has decreased to the same as that of angioplasty. At 10 years, angioplasty still has 30% of poor results but the poor results of surgery have increased to 50%. Therefore, this temporal dimension must be taken into account when comparing angioplasty and surgery — bypass surgery will always be superior if the results at 6 months are compared.

In addition, the techniques change. There is an interval of 5 to 8 years between starting a clinical trial and publishing the results. Should the techniques which we wish to compare change in different ways, the result of the trial will only be of historical value. This is what is happening at the moment with angioplasty. The main drawback of the technique has been restenosis and it would seem that this complication can now be prevented with the use of a new type of stent.

Professor FERRARI then shows a video of an angioplasty procedure. The film shows the introduction of the guide wire to the narrowed region of the coronary artery and the introduction of a stent. At the end of the procedure, the diseased segment is completely repaired. The technique only takes 20 minutes compared with 4 to 5 hours for coronary bypass surgery. The patient can be admitted to hospital and leave the next day whereas surgery requires several days of intensive care and a minimum of 15 days’ convalescence.

**From the floor**

Is there any data on the comparison between angioplasty and bypass surgery on the beating heart (without cardiopulmonary bypass)?

Emile FERRARI

One must be fair! There has been progress in the field of coronary surgery as well. Although great strides were made in interventional cardiology over the last 15 years, the surgeons somewhat rested on their laurels because of the large numbers of patients referred for surgery. When they appreciated the success of endovascular revascularisation, they realised that they too had to move forward. More and more surgical teams are revascularising patients without cardiopulmonary bypass. They open the chest and locate the internal mammary artery, the vessel that the Almighty created for bypass surgery, and anastomose it to the coronary artery without diverting the circulation. It is a much less invasive procedure than classical bypass surgery but, unfortunately, cannot be employed in all cases. In particular, the technique is not applicable in patients with diffuse disease or with arteries of poor quality. Nevertheless, it is an advance and when we compare different techniques, these improvements must be taken into account.

**From the floor**

From the statutory point of view, angioplasty can only be performed when there is cardiac surgery cover with the possibility of cardiopulmonary bypass.

Emile FERRARI

This is an old regulation which is no longer valid. It is true that the legal text stipulates that the patient must be within one hour’s transport of a centre with cardiac surgery. In our region of France, there are so many centres that the problem never arises. In Corsica, on the other hand, it is an issue. It is a serious problem because the number of patients is decreasing. As a result, we are losing these patients to the north of the country. The solution is for the French government to make an effort.
Focus

hand, this is an issue and coronary angioplasty can only be performed in an emergency. This rule does not limit the indications of angioplasty.

John EVANS
One of the new technical advances is the use of drug-eluting stents to prevent intrastent restenosis. What is the science on this point?

Emile FERRARI
The main drawback of uncovered stents is intimal proliferation restenosis. It would seem that we have found the method of avoiding this excessive reaction with an anti-mitotic drug which limits cellular proliferation. After an operation a keloid scar may form – a bulging excess of fibrous tissue. You have to imagine a similar process after treatment of coronary artery stenosis. The first results of the use of these new stents were published in the New England Journal of Medicine (Dr MC MORICE) and reported no cases of restenosis after one year’s follow-up. We have been trying for nearly ten years to solve this problem and it would seem that we now have the solution with these anti-cancer drugs.

Patrick MALAMUD
What about repeat angioplasty? Many patients need treatment of coronary artery disease and better survival of patients with the disease. After the other hand, in the Eastern European countries, Czechoslovakia being a flagrant example, the tendency was completely inverted with a 75% increase in mortality in men and a 48% increase in women.

Michel DUFOUR
Time off work is a major preoccupation in disability insurance. From your presentation, I imagine that the duration of sick leave is not the same after angioplasty as after surgery.

Emile FERRARI
It all depends on the context of angioplasty. After myocardial infarction, it is not the angioplasty procedure which is responsible for the disability but the underlying infarct. From the moment that the patients have chest pain and the time of arrival in the cardiology department, the infarct size progresses. As soon as treatment is started, the process is aborted but we cannot reverse the damage already caused to the cardiac muscle. It avoids the massive infarct but the patient will nevertheless have had a myocardial infarction. After any myocardial infarction, patients usually require several months off work. On the other hand, when a patient with effort angina or even resting angina consults on the Monday, is admitted for angioplasty on the Tuesday, he may return to work only three days later. Some patients may “swing the lead” but it is not necessarily justified to prescribe 3 months’ sick leave after angioplasty, far from it.

The reduction of mortality from coronary artery disease

The mortality due to coronary artery disease was in constant progression in the United States of America from the Second World War until the beginning of the 1970s when, for the first time, it began to fall. This sparked off a WHO large scale epidemiological study in 21 countries which was launched at the beginning of the 1980s. The MONICA project (Monitoring Trends and Determinants in Cardiovascular Disease) confirmed this observation, at least in the developed Western countries by showing a significant fall in prevalence of the disease and better survival of patients with the disease. On the other hand, in the Eastern European countries, Czechoslovakia being a flagrant example, the tendency was completely inverted with a 75% increase in mortality in men and a 48% increase in women.

Another observation to come out of this study was the presence of a geographic gradient in the mortality rates which were higher in Northern European countries than in the Mediterranean regions. This phenomenon was implicated in the coining of the term “the French paradox”, a term often inadmissibly used because we observe the same gradient between the participating centres in the North of France with respect to the Southern centres. Nevertheless, the mortality rates are much lower in the three French centres than those in the North of the United Kingdom.

During the last ten years, much research has been done to improve our understanding of coronary artery disease and our treatment of this condition. The paradigm of the fatal cascade of events from the initiation of the atherosclerotic process in patients with a genetic predisposition, its aggravation by environmental factors to the advent of adverse clinical events with aggravating factors resulting in the death of patients, has been brought under question.

The object of medical intervention of primary prevention is to prevent coronary events by treating the risk factors. Modern interventional methods of revascularisation in the acute phase of complications reduce the hospital mortality and preserve the myocardium to improve the long term outcome. Finally, secondary prevention seeks to prevent recurrence with the use of modern drugs which have been shown to improve the quality of life and longevity.

Underwriting life insurance

This occasion was a good opportunity of taking a new look at our underwriting methods without completely changing our basis. The postponement of applications for life insurance received after an acute coronary event, is not under question. In fact, it is an essential part of our approach. Whether the applicant has had angina of recent onset, unstable angina, myocardial infarction, revascularisation by angioplasty or by bypass surgery, a six month delay for stabilisation of the disease process is important before insuring the risk. This time interval should enable the insurers to avoid the high mortality rate of acute myocardial infarction in the hospital period and improve risk selection with the follow-up control investigations.

Principles of underwriting

For a long time, coronary artery disease was associated with an unpredictable outcome. Data has now become available to stratify the risk. The first predictive factor is the severity of the coronary disease. Longitudinal studies of patients treated in the 1980s, such as the Coronary Artery Surgery Survey, showed better long term survival in patients with single vessel disease compared with those with double or triple vessel disease. Although surgery seems to confer short term benefits in sub groups of patients with triple vessel disease or left ventricular dysfunction, the long term results seem to be the same whether the patients are treated surgically, by angioplasty or by drugs alone. The annual death rate is about 2%. The exception of this rule is disease of the left main coronary artery. This is a medical emergency and requires immediate revascularisation. We would not accept the risk of untreated left main coronary stenosis.

The second factor for consideration is left ventricular function. The left ventricular ejection fraction is the usual index and it is derived from the ratio of left ventricular stroke volume to left ventricular end diastolic volume. The normal value is higher than 50% and anything under 45% is abnormal with a value of 35% indicating significant left ventricular dysfunction. The survival of patients with ejection fractions lower than 35% is poor and they should generally be declined for life insurance. It may be possible to insure some patients with ejection fractions between 35 and 50% but with a high surcharge.
The third step of this evaluation is based on functional capacity after the coronary event which is usually evaluated by exercise stress testing.

The result of the stress test is an essential clinical tool. The duration of effort, the maximal heart rate attained and the work load are important parameters as is the observation of anginal chest pain or ECG changes suggestive of poor myocardial perfusion.

The stress electrocardiogram is the most commonly used test but exercise myocardial scintigraphy is sometimes used as its predictive value is better in some patients. These tests help improve risk stratification with differences in relative risk of death varying by a factor of 1.4 between the groups with the best results and those with poor functional status.

There is, of course, an interaction between these 3 criteria of evaluation as patients with triple vessel disease are more likely to have left ventricular dysfunction and poor exercise capacity although this is not invariable.

After obtaining the basic rating, we advise using certain prognostic factors before reaching a final decision. Co-morbid conditions, especially diabetes, hypertension or dyslipidaemia should be taken into account. We also debit applicants who continue to smoke even moderately and a family history of coronary artery disease before the age of sixty. Some treatments have been shown to be effective in secondary prevention and a credit may be considered when the medical follow-up is well organised.

Underwriting disability riders

This type of insurance is a permanent worry for both the insurer and the insured. The risks of temporary and permanent disability have to be assessed case by case. Many factors come into consideration, some related to the disease and others to the socio-economic environment.

Clearly, the nature of the disease plays a role through recurrent symptoms, but, even in their absence, the disease may progress through so-called silent ischaemia. However, it is obvious that an applicant who has had a long period off work after myocardial infarction which required coronary bypass surgery is at much greater risk of permanent disability than a person who has had a short hospital stay for angioplasty and then returned to work, even if the risk of recurrent disease is higher in the short term.

Functional capacity must be assessed, usually by exercise stress testing. Cardiac rehabilitation can significantly improve the results.

Therefore, the results in terms of duration of exercise, maximum work load, occurrence of chest pain and ECG changes or isotopic defects on scintigraphy are decisive. Functional capacity depends on left ventricular function and so the left ventricular ejection fraction must be taken into account.

Personal and psycho-social factors may be more important than the purely medical factors in the decision to return to work. Age, particularly, is a critical factor; will the person return to work when he or her is near retirement age? The answer may depend on the amount of the pension. The level of education and the training received are factors which influence aptitude for retraining for another job.

The type of job itself and the working environment are essential factors. Is the work physically strenuous or psychologically stressful? In such cases, the risk of disability is high. The conditions of work in extreme temperatures, in a dusty atmosphere or at altitude, for example, are other poor prognostic factors.

The nature of the job and safety of other persons have to be taken into consideration in bus drivers or airline pilots in whom the risk of malaise could be fatal.

Patients with arrhythmias or conduction defects would be poor risks. Then, finally, we should mention pacemaker patients and their protection from magnetic fields which could affect the pacemaker function.

This list of factors is not complete. However, another important parameter is the conditions of the insurance contract, the amount of benefit and its duration and, above all, the waiting periods before payment of benefits.

Therefore, before accepting these risks, the overall risk of disability must be taken into account, as we said earlier, case by case.

Long-term care

On the other hand, the long-term care insurance risk of coronary artery disease is not particularly high, providing the applicants have not already lost their autonomy at the time of subscription. Although not standard risks, the duration of dependency is usually short after the loss of the activities of daily living through coronary disease.

Conclusion

SCOR Global Life has an underwriting schedule for coronary artery disease based on analysis of the latest coronary angiogram, left ventricular function and exercise stress test reports and the prognostic risk factors. We hope this approach will provide more appropriate underwriting decisions which reflect the true risks that these lives represent to the insurer.
Valvular heart disease: our overview of files referred to SCOR Global Life

Doctor Patrick MALAMUD. Associate Medical Director, SCOR Global Life

Native valvular disease

These pathologies represent a significant number of files over a 10 year period with a distribution comparable to that observed in clinical medicine. The male/female ratio is neutral.

The oldest age observed was 85 (probably a long-term care proposal), but the average age was in the 45 to 49 year old histogram.

Mitral regurgitation was the commonest valvular disease in the substandard group. In this population, there were only 20 propositions declined for 50 postponements (only 3 of which for administrative reasons). The files referred to SCOR Global Life were therefore quite complete. Co-morbid conditions were a significant factor in the underwriting decisions with a predominance of arrhythmias and hypertension. There were relatively few cases of associated coronary artery disease.

Mitral valve prolapse was declared in 302 files: 232 of them were underwritten and there were few declinations (7% of all propositions). In this condition, the minimum and average ages were lower than observed in common mitral regurgitation and co-morbid conditions were generally less severe.

There were relatively few files of mitral stenosis: only 31 proposals in 10 years. It was not possible to make a statistical analysis on such a small number.

Similarly, the number of files of mixed mitral valve disease was low, only 37 cases. Again, it was not possible to make a statistical analysis either for age or for associated pathologies.

On the other hand, there were many proposals with aortic valve disease (560 files). The majority of applicants also had co-morbid conditions. Most of them had aortic regurgitation. The number of postponements was high (23.2%). This was striking, but only a very few postponements were for administrative or non-medical reasons.

Aortic regurgitation was observed in 333 files, 15 of which were declined and 61 postponed. The sex ratio was characteristic given the bias in the number of men applying for life insurance. Two or even three subgroups could be identified. There were fewer very elderly applicants with this pathology. Co-morbid conditions were common: dyslipidaemia, hypertension. There were also 16 applications from people with associated congenital heart disease. On the other hand, arrhythmias were very rare.

Besides, aortic stenosis was a feature of 67 applications. Their distribution was quite similar to that of aortic regurgitation. Co-morbid degenerative conditions were common, especially hypertension and dyslipidaemia, but there were very few congenital lesions.

Mixed aortic lesions were uncommon in the files received. Many applications were declined and the sex ratio was also heavily weighted in favour of men.

The association of aortic and mitral valve disease was observed in 75 files, 30 of which were postponed for complementary medical information, and we will come back to this point.

The average age was 48; the sex ratio was neutral. Again, it was not possible to analyse co-morbid conditions because of the small number of cases.

Prosthetic cardiac valves

Our review of proposals of applicants with prosthetic cardiac valves identified two groups: those with bioprostheses and those with mechanical valves.

Rather surprisingly, the larger group (686 applicants) had bioprostheses whereas more mechanical valves are implanted in clinical practice. Mechanical valves were declared in 382 applications and concerned 201 mitral and 181 aortic valves. The lowest and average ages of these applicants were quite low. In this group, the sex ratio was again heavily weighted in favour of men. The age distribution was banal but the co-morbid conditions were commoner and more serious than in the group with bioprostheses. In particular, there were:

- 18 cases of dyslipidaemia;
- 15 cases of diabetes.

We concluded that the health of these applicants was not as good as in those who had benefited from valve replacement with a bioprosthesis.

Postponements were mainly due to a lack of medical information. What was the data which was most commonly missing from applicants with valvular heart disease? Without question, the results of Doppler echocardiography. This investigation provides information concerning the function of the artificial valve and, in addition, about left ventricle function. Apart from this cause of postponement, the greater amount of information available should allow evaluation of a greater number of cases in the future. Patients with cardiac valve prostheses are followed up once or twice a year by their cardiologist in France.

Consequently, the number of postponements could be reduced. When the results of a recent Doppler echocardiography are provided, evaluation of an application becomes possible.
Doppler echocardiography: the key investigation in valvular heart disease

Doctor John EVANS. Associate Medical Director, SCOR Global Life

Echocardiography is of capital importance in the assessment of valvular heart disease and in organising treatment strategies, although this is not always recognised.

Sound is a vibratory phenomenon. For example, the mechanism of sound production by the human voice is a vibration of the vocal chords which is transmitted to the air by cycles of compression and dilatation. These cycles are quantifiable by their frequency measured in Hertz, the name of a famous German physicist. One Hertz corresponds to one cycle per second. In ultrasound, the range of frequencies is in the millions of cycles per second or Megahertz. The upper limits of human audition are about sixteen to twenty thousand cycles per second or Kilohertz.

Echocardiography

High frequency sound may be pointed towards a target like a beam of light from an electric torch. This is a very valuable property. The ultrasound obeys the same laws of reflection and refraction when they cross a medium of different density. The waves reflected by the physical interfaces are most valuable because they allow analysis of the anatomy and of the function of the heart.

A piezoelectric transducer is placed on the chest wall. The echocardiograph sends a brief electric signal to the transducer which causes it to vibrate at high frequency. The ultrasound produced by these vibrations is transmitted through the chest to the heart and echoes are reflected at each interface of different density. The reflected echoes return to the transducer and the vibrations are transformed back into an electric signal for treatment and conversion into an image. In the same way as sailors use sonar for depth ranging, the cardiologist uses the echocardiograph for visualising the heart. When the velocity of ultrasound and the time between emission and reception of the signal are known, it is possible to calculate the distance between the transducer and the reflecting interface. Cardiologists use a sectorial beam to reflect a single line of one-dimensional analysis which we call time-mode (TM) echocardiography. In this mode, the resolution is better and measurements of chamber dimensions are more accurate.

Two-dimensional and time-mode echocardiography provide much information about:

- chamber dimensions in systole and diastole;
- indexes of left ventricular systolic function;
- wall thicknesses;
- valvular morphology.

The view of the left ventricle enables quantification of wall motion and the systolic and diastolic dimensions are used to calculate the ejection fraction. This parameter is essential in choosing treatment.

The doppler effect

When sound waves are reflected by an object in movement towards the source of emission, they are compressed and therefore the frequencies of the echoes are higher than those reflected in the other direction. On the other hand, when the echoes return from an object moving away from the source, the waves are rarefied and the returning frequencies are lower.

This is the Doppler effect, so-called after a 19th century Austrian astro-mathematician. It is also used by highway police to control speed of cars on the roads. In medicine, instead of targeting cars on the road, we aim at the blood cells moving in the heart. Blood cells moving away from the transducer will shift the frequency of the returning ultrasound to a lower value whereas those approaching the transducer will increase the frequency of the echoes. Christian Doppler was the first to understand that this shift in frequency was related to the velocity of the reflecting object. Thanks to his formula we are able to measure the velocity of blood flow within the heart:

\[ V = \left( \frac{c}{2F°} \times \cos \theta \right) \times F_d \]

Where:

- \( V \) = blood velocity;
- \( c \) = constant;
- \( F° \) = emission frequency;
- \( \cos \theta \) = cosine of the incident angle of the ultrasound beam and;
- \( F_d \) = the Doppler shift.

Apart from the velocity of blood flow, the only other unknown in the equation is the angle between the blood flow and the incident ultrasound beam (\( \theta \)).

The cardiologist aligns the ultrasound so that the angle between the beam and blood flow is minimal and so that blood flows either directly towards or directly away from the transducer and the value of \( \cos \theta \) is 1 and, therefore, negligible.

When the velocity of blood flow is known and it is possible to measure the surface of the section at which it is measured, we can calculate the volume of blood flow. These volumes are deduced from a number of physical laws of hydraulics.

The continuity equation states that the blood flow is the same wherever it is measured in a closed circuit. Therefore, by knowing the surface area and the blood velocity at one point, and by measuring the blood velocity at another, it is possible to deduce the surface area at the second point. This principle is used everyday for measuring the severity of valvular stenosis: the smaller the surface area of a valve, the more severe the stenosis.

Another application of blood velocity measurement is the study of the difference of pressures over a stenotic valve. This is what we call the pressure gradient. As blood crosses a stenotic valve, its velocity increases as the kinetic energy is transformed into potential energy. An Italian scientist, Bernoulli, deduced that the pressure gradient was related to the square of the velocity. The more severe the stenosis, the higher are the pressure gradients.

Using these Doppler techniques, we are able to obtain valuable haemodynamic information about flow in the heart. Therefore, by using echocardiography, we obtain anatomical information by measuring valve areas by planimetry and chamber dimensions. In the case of mitral stenosis, it is possible to demonstrate the limitation of leaflet motion and observe left atrial dilatation. Another example shows planimetry of the surface area.

The Doppler provides the pressure gradients and functional surface area. In addition, Doppler echocardiography enables assessment of pulmonary artery pressures in mitral valve disease.

An example of mitral stenosis is shown in which the diastolic blood flow velocity across the valve attains two metres per second whereas it is normally less than one meter per second. By measuring the surface under the velocity curve, we obtain the velocity time integral and the value of the mean pressure gradient. In this particular example, it is raised to 12mmHg.

In regurgitant lesions, the cardiologist examines the same anatomical parameters by 2D and TM echo. The left ventricle and left atrial dimensions are of particular interest because these chambers undergo volume overload by mitral and aortic regurgitation.

Most of the Doppler information is semi-quantitative and the severity is classified by a number of grades. This investigation is very useful for the study of valvular disease, especially in patients with prosthetic valves.

The value of Doppler echocardiography in medical practice is unquestioned. The investigation is rapid, non-invasive, reproducible and relatively economical. It is not without its limitations: the results of the procedure depend on the experience of the operator, the echogenicity of the patient and the quality of the material used. You cannot expect good results when the machine is out of date.
Epidemiology and factors of morbidity and mortality in valvular heart disease

Epidemiology of valvular heart disease

Anatomically, the heart is a collection of chambers from which vessels leave and to which vessels arrive; other vessels, the coronary arteries, supply blood to the cardiac muscle. The different heart chambers are separated from each other by valves. The heart is a pump and so the chambers fill and empty and each of these periods is associated with opening and closing of the valves.

There are two types of valvular disease: narrowing of the valves (aortic and mitral stenosis) and incompetence of the valves (aortic and mitral regurgitation). The latter type of lesion is characterised by leaking of the valve, the consequences of which may be minimal or very serious. The mitral valve is situated between the left atrium and the left ventricle whilst the aortic valve is located between the left ventricle and the aorta.

The epidemiology of valvular heart disease has changed. There are few studies of the subject, but one of them, conducted by the European Society of Cardiology in 2001, the Euro Heart Survey (EHS), should be mentioned. The study included 5,001 patients from 25 European countries and 92 different cardiological centres. The distribution was quite uniform between the southern and northern regions of Europe. The patients included in the study were either in hospital or followed up in out-patient clinics.

Approximately one quarter of the study population was followed up after valvular heart surgery and the remainder had native valve disease. The average age of the population was high. Indeed, generally speaking, the remainder had native valve disease. The average age of patients in the EHS was 64 years. Nearly one third of patients were smokers and one third had hyperlipidaemia. Moreover, nearly half of these subjects were hypertensive. One quarter of the EHS population had a family history of early coronary artery disease and this was one of the strongest risk factors for the occurrence of an adverse cardiovascular event.

Co-morbidity was quite common in this population with myocardi al infarction observed in 13% of cases, neurodegenerative disease in 7% and chronic obstructive airways disease in 15%. As patients get older, they tend to have polyopathy. These co-morbidities must be taken into account in the prognostic assessment.

Aortic stenosis is a surgical indication when the re is no aortic regurgitation. In mitral stenosis, for example, about a third of patients are treated by percutaneous valve dilatation which has replaced surgical commissurotomy.

In mitral regurgitation, mitral valve repair is often the treatment of choice, performed in 46% of cases in the EHS. In good surgical centres, this percentage is continually increasing and the native valve is preserved.

The long-term outcome of this procedure is quite different to that of valve replacement.

The mortality related to cardiac surgery is progressively decreasing. In the early days of the 1960s, valve replacement surgery carried a 30% to 40% mortality.

Nowadays, this figure is down to 2 to 3% for aortic valve replacement and 5 to 6% for mitral valve replacement. In addition, the patient population is generally older. Co-morbid conditions may increase the individual operative risk. Each case poses specific surgical and medical problems.

The data of the EHS shows that aortic stenosis, the commonest lesion, is now principally a degenerative disease, way ahead of rheumatic aortic stenosis. There is a slight underestimation because congenital bicuspid aortic stenosis is not taken into account separately. Aortic regurgitation is mainly due to degenerative or dystrophic diseases.

Mitral stenosis remains nearly always caused by rheumatic fever. Mitral regurgitation, the second most common lesion, is primarily caused by degenerative disease.

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Aortic regurgitation

The decisive parameter in aortic regurgitation is the volume of regurgitation. The prognosis of major aortic regurgitation due to the common aetiologies is poor. At ten years, the patient develops multiple complications such as aneurysm and cardiac failure, which is observed in nearly half the cases. Nearly 2/3 of the patients will have surgery and cardiac symptoms reappear in over 80% of cases 10 years after surgery. This is only true for severe aortic regurgitation and not for mild or moderate aortic regurgitation.

The natural history of chronic severe aortic regurgitation starts without symptoms and normal left ventricular systolic function. Only 4% of persons at this stage of the disease have any symptoms or left ventricular dysfunction. Sudden death being very rare, there is no need to operate these patients at this stage.

On the other hand, when there are signs of left ventricular dysfunction, surgery should be considered, otherwise the patient will rapidly become symptomatic. Echocardiography allows detection of these ventricular abnormalities. The essential prognostic factor of aortic regurgitation is the cardiac contractility.

After surgery, even without complications, survival is not as good as that of the general population of the same age. It is the same for the first years, but then falls off. If, in addition, surgery was performed on a patient with left ventricular dysfunction, the long-term survival is even worse compared with that of a control group.

Mitral regurgitation

In terms of frequency, mitral regurgitation is the second most common valvular lesion. As in aortic regurgitation, the severity of the regurgitation is intrinsically related to the volume of the regurgitation. The patient may live tens of years if the regurgitation is mild. Therefore, there should not be an additional increased risk.

The expression "mitral valve prolapse" is really a term used to describe very variable clinical situations. Diagnosis of mitral valve prolapse has been made even in patients without a cardiac murmur. A diagnosis of valvular heart disease was therefore made in patients without any major pathology.

The degree of regurgitation and the causal mechanism are the determinant factors of the outcome of mitral regurgitation. When the regurgitation is severe there is a strong argument for surgery. It is in the patient's interest to be operated without delay, especially when the valve can be repaired.

Mitral stenosis

This condition is nearly always due to rheumatic fever. Some rare degenerative causes have been reported but are purely anecdotal. Acute rheumatic fever is generally observed in children between 5 and 10 years of age. There follows a long latent period before the appearance of clinical signs. Rheumatic valvular heart disease remains endemic in developing countries (South East Asia, Africa, South America…). In these regions, acute rheumatic fever is a major cause of death of young women.

Globally, survival is related to the severity of symptoms. When patients become symptomatic, the data of life expectancy is relatively catastrophic. This condition is progressive: the degree of stenosis slowly increases. The prognosis of symptomatic disease without treatment is poor.

Mitral stenosis has one particularity: as it progresses, blood pools in the left atrium which dilates and predisposes to the formation of blood clots. This leads to a serious complication: systemic thrombo-embolism. It can cause hemiplegia, which is always dramatic, especially in a young woman of 25 years of age. In 25% of cases of mitral stenosis, the inaugural symptom is an ischaemic stroke. This risk is an argument in favour of a therapeutic intervention in patients who are still asymptomatic but have tight stenosis. Anti-coagulant therapy in these patients is associated with a risk of bleeding. It certainly reduces the incidence of thrombo-embolic events, but does not altogether prevent them.

The modern treatment of mitral stenosis is by a percutaneous approach. It consists of introducing a device for dilating the valve through a peripheral vein. The catheter is advanced through the inter-atrial septum to the left atrium, a communication which only usually exists in the foetal period. A balloon is positioned across the stenotic valve and then inflated. This opens up the commissures between the leaflets and results in an enlarged mitral orifice. A pressure gradient between the left atrium and the left ventricle decreases. The splitting of the commissures may be observed by Doppler echocardiography.
In conclusion, we have observed a significant reduction in is effective and improves the prognosis.

The results of percutaneous mitral commissurotomy when performed at an early stage are excellent. This procedure is effective and improves the prognosis.

From the floor
In aortic regurgitation, it is important to determine the regurgitant volume. What are the Doppler echocardiographic criteria for this measurement?

Pierre-Louis MICHEL
I really like my echocardiographers. Each year, one of them thinks that he has found the answer to this question with a new definitive index better than all the others. Year after year a “better index” is announced. Therefore, the literature is full of echocardiographic parameters. None of them are perfect.

A good echocardiographer must therefore be a good cardiologist. The parameters of analysis are many and only an intelligent synthesis provides a reliable diagnosis. Sometimes I compare echocardiographers to a perverted Saint Thomas. Saint Thomas affirmed “I only believe what I see”. The echocardiographer sees and therefore he believes. However, sometimes he may be induced into error by certain images which are difficult to interpret. Doppler echocardiography is therefore very operator-dependant.

From the floor
What are the criteria of a good surgical result in mitral regurgitation?

Pierre-Louis MICHEL
There should be no residual regurgitation or stenosis, even minimal, at the end of the operation. Ninety-five per cent of patients operated for mitral regurgitation by a good surgeon such as Professor Christophe Acar, have no residual regurgitation or stenosis.

We now have a 30 year follow-up for the assessment of conservative mitral valve surgery since the first procedures performed by Professor Carpenter. Nowadays, these operations are effective and the results are sustained in the long-term.

The long-term results are such that we can justifiably talk of a cure of the valvular pathology. Certainly, the patient has a sternotomy scar, but his heart should be considered as normal.

This point must be remembered.

John EVANS
After percutaneous mitral commissurotomy, does the valvular pathology continue to progress with time as in mitral stenosis?

Pierre-Louis MICHEL
We observe the same process as in previous years when a surgical commissurotomy was performed. The valve has been affected by rheumatic fever 15 or 20 years beforehand.

It is not possible to imagine that we can restore a normal valve. The stenosis progresses at a variable speed with respect to age. Mitral stenosis, a relatively uncommon disease, does not have a good prognosis. Once operated, the valve continues to be affected by the underlying disease process. In rheumatic valvular disease, the physician may be confronted with previously operated mitral stenosis with recurrence. The operative procedure simply gains a little time. Cardiac diseases require long-term management. Remember the state of the heart in the treatment of coronary artery disease. Considerable progress has been made with the development of stents, but this does not signify that the disease has been cured. The potential for developing atheroma in the coronary artery continues.

In some ways, the best chance for the patient presenting with coronary symptoms is when he already has known coronary artery disease.

From the floor
As a rheumatologist, I would like to know whether anklyosing spondylitis worsens the prognosis of aortic regurgitation.

Pierre-Louis MICHEL
Anklyosing spondylitis is a relatively uncommon cause of aortic regurgitation. All depends on the nature of the regurgitation and the associated problem. Atrial ventricular conduction defects may require a pacemaker. A person may have a valve prosthesis and a pacemaker.

From the floor
How often should patients with valvular heart disease be followed up?

Pierre-Louis MICHEL
If the lesion is minimal, annual or bi-annual follow-up is sufficient. When the lesion is significant, follow-up must be more frequent from once a year to every six months.
The impact of new surgical techniques on immediate and long-term morbidity and mortality

Professor Christophe ACAR, Department of Cardiothoracic Surgery, Institute of Cardiology - Pitié-Salpêtrière Hospital, Paris

Open heart cardiac surgery is a young specialty, dating back only to the 1960s. It has only recently begun to grow compared with other specialties. Every year, 38,000 open heart operations are performed in France. This is about average for industrialised countries. Eleven thousand of these procedures are performed in the Ile de France region, which is about a third of all operations carried out in France per year.

The number of operations has remained about the same over the last 10 years. In France, 291,000 surgical operations are carried out every year, which is the average in Europe.

What are the pathologies which we encounter in our Departments of Cardiac Surgery? Roughly speaking, half the operations are performed for coronary disease and half for valvular heart disease. A number of patients undergo both coronary and valvular surgery. The surgeon may have to operate for congenital heart disease. Cardiac transplantation is only a marginal activity: only 136 cardiac transplantations are performed annually in the Paris region.

Two types of prostheses are available for valvular replacement: mechanical and biological.

Mechanical valves present the considerable advantages of longevity and being easy to insert. Their industrial fabrication has not stopped progressing.

Bioprostheses do not require anticoagulant treatment contrary to the mechanical valves. They are very safe because of their compatibility with blood which prevents blood clotting. These organic valves do not have the same defects as valves produced industrially.

What types of valve are implanted in France? A recent inquiry recenssed 38% of mechanical prostheses and 39% of bioprostheses. Out of the 38,000 operations performed annually in France, 17,000 are for valvular surgery. Globally, half of the valves are replaced by mechanical prostheses and half by bioprostheses.

In addition, we must mention surgery of mitral valve repair. This represents 21% of operations of cardiac valves.

This statistic is based on the number of prosthetic valve rings sold by the manufacturers. Only a small minority of patients benefit from valvular homografts (2%).

Mechanical valves

The mechanics of these prostheses have considerably evolved despite the fact that the basic principle of a valve between two chambers is very simple. The number of models available continues to increase. The first example is a ball and cage prosthesis which has a remarkable performance. It is very solid and nearly free of wear and structural alteration. It is slightly obstructive because the blood must flow around the obstacle of the ball.

The second example is the disk prosthesis. The disk is made of pyrolytic carbon and is attached by a hinge to tilt through nearly 90°. This type of prosthesis is still slightly obstructive because of the space required for the disk to open. This is why the engineers designed the latest model: the bileaflet prosthesis. In this example, the disk is separated into two halves fixed to the valve ring by a hinge. These valves are also made of pyrolytic carbon.

The major disadvantage of mechanical prostheses is their incompatibility with the blood. The risk is that the patient has to be placed on anti-coagulant therapy all his life. In order to monitor this, the patient must have a regular blood testing in order to maintain an International Normalised Ratio (INR) of between 2 and 3 for an aortic valve replacement. The anticoagulation must be more intense for mitral valve replacement with values of INR of between 3 and 5.

Bioprostheses

These valves are made of animal tissue fixed by glutaraldehyde which makes these tissues remarkably well tolerated. There are almost no reactions of rejection. The only drawback with these valves is that they tend to wear and progressively degrade, which in the long-term leads to a reoperation.

There are two types of bioprostheses:

- porcine prostheses made from pig aortic valves inserted on a ring to facilitate their implantation;
- the other prostheses: made of calf pericardium which is industrially mounted on a structure for implantation.

Comparison of the two types of prosthesis

The essential complication of mechanical valves is the risk of thrombus formation. A large thrombus impedes the movement of the leaflets and so prevents the prosthesis from functioning correctly. The clinical presentation is that of an acute stenosis requiring reoperation. Sometimes, the thrombus is smaller, but when badly situated, it may still block the movements of the two leaflets. This complication is always serious because of the important haemodynamic consequences.

Some rare cases of fibrous sheathing may be observed in the long-term, again a cause of stenotic malfunction. Structural defects are rare. One example is that of the fracture of the ball of a mechanical prosthesis.

The major drawback of bioprostheses is the risk of reoperation due to the wear and degeneration of the valve, but they do not have the risk of thrombus formation. One example is tearing of the leaflets with calcification on the valve preventing the valve from opening and requiring valve replacement.

Statistically, it is interesting to compare the long-term results of these two types of prostheses. In the large series, the average age of implantation of mechanical prostheses is about 62 years whereas that of the bioprostheses was 75 years.

The commonest complication observed was thrombosis giving rise to systemic embolism in both types of prostheses. In one very large series, the risk of thrombosis was identical (22% of patients affected) with mechanical and biological prostheses. This result is quite surprising. Hemiplegia, with the major handicap that it causes, is a serious complication. However, these figures are not entirely comparable because of the age difference between the two groups. The thrombo-embolic events in the group with bioprostheses were not valve related, but due to the age of the patients and the higher prevalence of cerebral vascular disease. Finally, the problem is not that of the type of prosthesis, but of the age of the patients. The series which I mentioned had a patient population undergoing aortic valve replacement whereas it is well known that thrombosis is much more common after mitral valve replacement. Clearly, the risk of thrombosis is much higher after mitral valve replacement with a mechanical valve than with a bioprosthesis.

Haemorrhagic complications are commoner after valve replacement with mechanical prostheses than with bioprostheses which do not require anti-coagulant therapy. Bleeding complications were observed in 13% of patients with mechanical valves compared with only 5% of patients with bioprostheses.

On the other hand, the risk of reoperation for valve degeneration is much higher in the bioprosthetic group of patients. It was 11% at 10 years compared with only 4% in the group with mechanical prostheses for which reoperation is very rare.

Homografts

This is a rather special group of patients in whom the valve is replaced by a homograft. Historically, the first procedure was carried out by Donald ROSS in London in 1962. More than 25,000 operations of this type have been carried out since, mainly between 1962 and 1974. Their number has decreased with the increased use of mechanical valves and the progress achieved in valve manufacture. The regain of interest for this technique is due to the observation of degenerescence of bioprostheses.

Homografts are obtained by excision on patients who have died from extra-cardiac causes. These cadaveric valves are usable provided they are obtained very soon after death. It is a large source of valves in the United States, Canada, and the United Kingdom.
Since laws on bioethics were passed in 1994, valves cannot be taken from cadavers but only from patients in a state of brain death. If the heart cannot be used for transplantation, then it may be possible to just use the valves. The heart is sent to the tissue bank. The cardiac valves are often functional and can be used for valvular replacement. Cardiac transplantation may also be used to the same end, but when the myocardium is damaged, the valves alone may be used.

Once they have been recovered, the valves undergo a process of decontamination with antibiotics. Then they are cryo-preserved in a tissue bank, the temperature being lowered to - 60°C. They are preserved and available for reimplantation. The conditions of donation are clearly defined:

- the person must be under 60 years of age;
- there must be no systemic disease such as cancer or infectious disease;
- patients having been treated with hypophysal hormones are also excluded.

Homografts are mainly used for treating aortic valve disease (stenosis or regurgitation due to congenital bicuspid valve or acute rheumatic fever).

The long-term results of homograft valve replacement depend on the age of the operated patients. Twenty years after undergoing this procedure, 42% of patients are still alive. Homograft valve replacement is contra-indicated in patients under 20 years of age because of these long-term results. Infectious endocarditis is one of the diseases for which homograft valve replacement is particularly valuable. This condition may occur on a prosthesis valve with vegetations developing on the valve itself. Homograft valves do not have any synthetic material and therefore may be used to replace the valve without risking recontamination by the endocarditis. It must be remembered that infectious endocarditis is a very serious complication and may give rise to systemic embolism with renal, splenic and cerebral infarct which may be very extensive.

Autografts

The other operations which remain to be described are marginal by their number. The autograft valve replacement, also known as the Ross procedure, consists of replacing the diseased valve by the healthy neighbouring valve. For example, the surgeon dissects part of the pulmonary valve to place it in an aortic position and the native pulmonary valve is itself replaced by a homograft.

In the example shown, the pulmonary valve which is the anatomic twin of the aortic valve, is reimplanted in the aortic position explaining the term autograft. This procedure is very valuable, for example, in the case of young athletes requiring valvular heart surgery. The characteristics of the autograft are remarkable with no obstruction after its implantation. The operated athlete is able to reproduce the same efforts as a normal individual.

The life expectancy is very good with a 72% survival rate at 20 years. However, cases of reoperation have been reported, such as the example shown of a stenosis on the conduit of the homograft.

The Ross procedure is also very valuable in children: normal growth can be expected, and it is the technique of choice for aortic valve replacement in this population.

Choice of valvular replacement

According to the circumstances and clinical context, which is the best valve for an elderly patient? Should a mechanical prosthesis or a bioprosthesis be used?

The choice is made by comparing the patient’s life expectancy and the result hoped for by replacing the valve. Necessarily, a bioprosthesis will degenerate with time but this process is much slower in the very elderly from 70 years of age onwards. The first signs of bioprosthesis degeneration only appear after 10 years. Therefore, there is little chance of having to reoperate a patient over 70 years of age in whom a bioprosthesis is implanted.

Age is therefore a crucial factor. The national demographic data shows that men aged 70 have a life expectancy of 13 years. This figure increases to 16 years for a 70-year-old woman. The use of a bioprosthesis in this age group would expose a man and even more so a woman, to the risk of reoperation of the valve. On the other hand, the life expectancy of a 75-year-old man is 9 years and that of a 75-year-old woman 13 years. Our practice is to use bioprostheses in men over 70 years of age and in women over 75 years of age.

Other factors than age have to be taken into consideration in the choice of a prosthesis. Some are related to the causal cardiac disease. A patient with aortic stenosis does not have the same life expectancy as a normal subject. This is even more the case when there is associated coronary artery disease. I underline the fact that life expectancy was different according to gender. But whereas there is associated coronary artery disease, it must be remembered that women have a much worse prognosis than men. Their coronary arteries are smaller and the disease progresses more rapidly. Of course, in subjects with normal coronary arteries, the life expectancy of women is better than that of men.

In addition, the more serious the cardiac lesion, and the more advanced the clinical stage, the greater the risk of secondary death. In these conditions, the surgeon would usually use a bioprosthesis because of the limited life expectancy.

Finally, there are socio-economic parameters to take into consideration. A patient aged 80 has a life expectancy of 7 years. If this patient has aortic stenosis, the life expectancy is reduced to 2 years. The potential benefit is to increase life expectancy by 5 years, and in order to obtain it, the patient will be exposed to the risk of operative death (10%) and to a certain number of complications including certain serious neurological morbidity. The cost of valvular replacement is 23 000 €. Therefore, the decision is not only medical but also socio-political.

We will now consider mitral valve replacement in young patients. In principle, these procedures use mechanical prostheses. However, a mechanical valve in the mitral position is not as good as when it is used for aortic valve replacement because of the five-fold increase in the risk of thrombosis. The risks of anti-coagulant therapy also have to be born in mind. At 10 years, 83% of patients have an event-free survival. Seventy-one per cent of patients with an average age of 51 years at the time of operation are still alive ten years later. The implantation of a mechanical prosthesis is not, therefore, an ideal solution in young patients. However, bioprostheses are no better because 52% of patients aged under 60 have to be reoperated within the first 10 years after surgery. The risk of degeneration of the bioprosthesis in the mitral position is much higher than in the aortic position after the results observed in a series of 232 young women with an average age of 24 years. The 10 year survival was only 84% for such a young age group. Therefore, alternatives have been developed and our department proposes a method of homograft of the mitral valve.

The results of this homograft method for mitral valve replacement were comparable to those of the use of a bioprosthesis in a group of 104 patients. The incidence of reoperation was comparable and, in addition, this method was associated with a risk of early degeneration of the valve with a high reoperation rate during the first post-operative year. Consequently, this method of mitral valve replacement is not considered optimal. The results are no better than mechanical valve replacement.

Therefore, the choice of prosthesis is again largely dependant on the age of the patient. Patients over 70 years of age are usually offered mitral valve replacement with a bioprosthesis with the exception of the special case of a woman with moderately advanced disease and without associated coronary disease. For this exception, a mechanical valve would be proposed.

In patients between 40 and 70 years of age, cardiac surgeons usually propose mechanical prostheses. A contra-indication to anti-coagulant therapy constitutes an exception and, in this case, a bioprosthesis or a homograft would be proposed. If the patient has infectious endocarditis, the homograft is the valve of choice for correcting the disease.

When patients are under 20 years of age, the method of choice is the Ross procedure or, if need be, a mechanical valve replacement.

Finally, the choice between valve replacement and valve repair must be considered. The latter is to be preferred whenever possible.

Mitril valve repair

This method which avoids valve replacement was pioneered by Alain Carpentier at the end of the 1960s. It consists of implanting a prosthetic ring at the site of the diseased valve.

There are different forms of mitral regurgitation based on the movements of the abnormal valve: increased (prolapse) or decreased (valve restriction). A functional classification in three types guides the surgeon throughout the procedure and it is imperative that he knows which functional type is being operated. Echocardiography is the best investigation for determining the type of mitral regurgitation. In the example shown, the surgeon dissects part of the pulmonary valve to place it in an aortic position explaining the term autograft. This procedure is very valuable, for example, in the case of young athletes requiring valvular heart surgery. The characteristics of the autograft are remarkable with no obstruction after its implantation. The operated athlete is able to reproduce the same efforts as a normal individual.

The life expectancy is very good with a 72% survival rate at 20 years. However, cases of reoperation have been reported, such as the example shown of a stenosis on the conduit of the homograft.

The Ross procedure is also very valuable in children: normal growth can be expected, and it is the technique of choice for aortic valve replacement in this population.
there is mitral valve prolapse and it is necessary to transpose the chordae tendineae to avoid the leaflet ballooning into the left atrium.

How does mitral valve repair compare with other procedures? This depends mainly on the clinical situation and the experience of the surgeon. In our department, we perform many mitral valve repairs. Between 2/3 and 3/4 of patients who are referred for mitral valve surgery undergo mitral valve repair. This is worth mentioning because 1/4 of these patients were candidates for valve replacement.

The operative mortality depends very much on the aetiology of the mitral valve disease. It is very low for degenerative lesions, which are the most common, and for post-rheumatic valvular disease. It is much higher in coronary pathology or infectious endocarditis in which the mortality rates reach 9%.

Now let us compare the results of mitral valve repair and mitral valve replacement. Long-term survival after mitral valve repair is incontestably better than that after mitral valve replacement. Mitral valve repair is the best surgical option when it is technically possible in patients with mitral valve disease.

The long-term results are strongly influenced by the aetiology of the valvular pathology. The mortality is higher for a rheumatic lesion than for a degenerative lesion. Ninety-three per cent of patients are free from reoperation at 15 years in degenerative aetiologies compared with only 75% for rheumatic valvular lesions.

The use of modern methods of investigation has improved the results of surgical procedure. Echocardiography is widely used in the operating theatre which should now be equipped with echocardiographs and probes for transoesophageal imaging.

Basically, the possibilities of conservative surgery of the aortic valve are much less than those for the mitral valve. In fact, only a few cases can be managed in this way and aortic valve replacement is the rule.

However, in Marfan’s syndrome associating disease of the aortic valve with aortic aneurysm, especially of the ascending aorta, the mechanism of aortic regurgitation is traction on the valve by the aneurysm. If this traction is relieved by restoring a normal diameter to the aortic valve, it is possible to re-establish its competence.

The long-term results in 158 patients showed almost 60% survival at 15 years. The reoperation rate is finally very low in this particular group of patients.

The Euroscore registry allows comparison of data obtained from Southern Europe, including France, and Northern Europe. In Southern Europe, 65% of patients were operated for aortic valve disease and 35% for mitral valve disease. These figures were respectively 73% and 27% for Northern Europe. This is explained by the fact that acute rheumatic fever is relatively rare in Northern Europe. The ratio of valvular repair to valvular replacement is interesting to compare. There were 25% valve repairs in Southern Europe versus 19% in Northern Europe (with 81% of valvular replacements).

The association of valvular replacement and coronary artery surgery was reported in 16% of patients in Southern Europe compared with 31% in Northern Europe, where the patients were usually a little more elderly. The global mortality of patients operated for coronary bypass is 3.4%. This figure is almost doubled when there is associated aortic valve surgery (6%). Mortality is even higher when there is an associated mitral valve procedure.

When there are no associated risk factors, the surgical mortality for valvular procedures is much lower. The clinical context is therefore very important. Each associated risk factor has to be considered to assess the operative risk. About 15 hospital mortality risk factors have been identified.

Finally, as a last resort, cardiac transplantation can be considered in the rare cases where the valvular pathology has reached a terminal stage. The patient is placed on cardiopulmonary bypass while the new heart is grafted. At the end of the operation, the suture lines on the atrium and great vessels are clearly visible. However, the prognosis of patients transplanted for valvular heart disease is not as good as that of patients transplanted for other cardiac pathologies. There is a risk of developing ischaemic cardiomyopathy and dilated cardiomyopathy.

A final case is presented of a patient who underwent mitral valve repair. There were few symptoms, as it is sometimes the case of patients referred to the surgeon. In fact, there was severe regurgitation associated with mild shortness of breath. Echocardiography had diagnosed severe mitral regurgitation. The leak was due to ruptured chordae. The damaged part of the valve was resected and sent for histological study. The operation in itself consisted of repairing the defect created by the valvular resection. At the end of the procedure, the repair was completed by the insertion of a prosthetic ring calibrated for the valvular orifice. This restored the normal form and dimensions of the valve.

<table>
<thead>
<tr>
<th>Type of valve</th>
<th>Number</th>
<th>Age</th>
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<td>Mechanical</td>
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<td>St Jude</td>
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Focus

John EVANS
There have been reports of percutaneous aortic valve replacement by an endoprosthesis. Is this procedure still at the research stage?

Christophe ACAR
This procedure is the result of an enthralling research project. Professor Alain CRIBIER of Rouen is the pioneer of this technique which consists of implanting a valve percutaneously. It has been carried out in four or five patients with variable results. The object is to replace the valve without having to open the chest and without exposing the patient to the risks of cardiopulmonary bypass. Technically, the procedure is ready to rival the reference method of valve replacement through a median sternotomy.

From the floor
What is the value of homograft valve replacement in Libman Sachs endocarditis?

Christophe ACAR
Libman Sachs endocarditis is an exceptionally rare condition. This type of surgery has been carried out, but more experience is needed. Valve repair is the technique of choice for this problem whenever technically possible.

From the floor
After valvular heart surgery, to what degree are patients able to return to a normal lifestyle? Do they remain heavily handicapped?

Christophe ACAR
In general, they return to a normal life. However, all depends on the conditions under which they underwent surgery. If the patient’s condition is good at that time and the operative indications are appropriate, no major complications are expected for everyday activities. A period of rehabilitation may be necessary for a breathless patient who needs crutches for walking. On the other hand, this would not be required in a young patient of 30 years of age who has undergone mitral valve repair.

Doctor John EVANS
When you look at the mortality curves, the greatest risk seems to be in the first year following valve replacement. Thereafter, the survival curve is practically parallel to that of the general population.

Christophe ACAR
The post-operative period is the period of highest risk. None of the surgical procedures is risk-free and the complications such as thrombosis are commonest in the first six post-operative months. In the long-term, everything depends on the pre-operative condition of the patient. If the patient is not breathless and has no advanced cardiac disease, the life expectancy should be normal.

John EVANS
What is the prognosis of a young patient who has undergone valve replacement without complications? What percentage returns to work and how many remain disabled?

Christophe ACAR
The type of work of the patient is the determining factor. If the work requires strenuous physical activity, the patient may require retraining because of a cardiac disease.

Risk evaluation of valvular heart disease

Drawing the consequences of the modern medical management of valvular heart disease

We now enter the specific field of insurance medicine to carry out the synthesis of the data which has been exposed at this meeting. Our aim is to provide reliable methods of underwriting applicants with valvular heart disease or a history of valvular replacement.

We are dealing with substantial risks as these are serious conditions which are submitted for analysis.

However, the art of medicine has progressed and diagnosis has considerably improved with the use of echocardiography.

This technique has also enabled cardiologists to improve the follow-up of patients who have undergone valvular replacement. Moreover, the prevention of infectious endocarditis has become systematic from the moment that a pathological cardiac murmur has been detected.

Valvular lesions should not be operated too soon or too late. The insurance applications of patients whose heart is in the best condition at the time of surgery are the easiest to assess.

From a technical point of view, the bileaflet carbon prostheses have replaced the old models. Valve repair is another technical advance, especially in surgery of the mitral valve.

The follow-up of patients is again facilitated by echocardiography and for insurance purposes, underwriters must take into account the results of this investigation. Doppler echocardiography is used not only for diagnosis but also for surveillance of valvular heart lesions, in general every six months.

It enables the cardiologist to determine the optimal timing of surgical intervention.

Insurers and reinsurers should now review their approach to risk assessment of valvular heart disease requiring valvular heart replacement. The risk may be reduced if medical selection is appropriate.

Methods of analysis

Medical selection is based on the medical questionnaire. A cardiac murmur may be the sign of valvular disease. In the presence of cardiac failure requiring medical treatment with diuretics and ACE inhibitors, the underlying valvular disease is severe and most applications should be declined.

The declaration of breathlessness is a red flag which usually justifies complementary investigation. In all cases, with underlying valvular disease, the underwriter would require the latest follow-up results, especially those of echocardiography. A specific “valvular heart disease” questionnaire may help improve analysis and give a more appropriate rating.

How do we proceed with underwriting? We use clinical and echocardiographic data.

For the clinical evaluation, the NYHA Classification is useful:

- Class I corresponds to normal exercise capacity;
- Class II corresponds to breathlessness on moderate exercise. Professor MICHEL emphasised the relative objectivity of this classification which depends on the physical activity of the individual;
- Class III corresponds to breathlessness at the least exertion;
- Class IV corresponds to pulmonary oedema.

Applicants in Classes III and IV should have their applications postponed or declined.

For echocardiographic evaluation, we have seen that the diagnostic criteria change regularly but there is no common consensus of classification. In everyday practice, valvular lesions are classified as:

- Grade I or minimal;
- Grade II or mild;
- Grade III or moderate;
- Grade IV or severe.

Again, the underwriter has to decide the Grade of the valvular lesion and in general, Grades III and IV would be postponed or declined. Particular attention must be paid to chamber dilatation, wall hypertrophy and abnormal ejection fractions.
Therefore, the underwriter will look for clinical and echocardiographic information to assess these proposals. Insurable candidates are relatively asymptomatic with no breathlessness or syncopal attacks. Surgery is not usually envisaged in this category of patient with Grade I or II lesions on echocardiography.

The proposals postponed or declined are from applicants with:

- very symptomatic valve disease in the NYHA Classes III or IV;
- moderate to severe, Grades III or IV, echocardiographic lesions;
- surgery programmed in the near future.

Patients with valvular heart disease have a natural history of a long asymptomatic period before surgery, the preoperative period and the postoperative period when the valve disease is once again stabilised. The essential high risk period is that surrounding surgical operation.

To simplify, for many years potential applicants will present the following clinical characteristics: cardiac murmur, no shortness of breath and good echocardiographic indices. As the operative period approaches, they develop symptoms and the echocardiographic parameters begin to deteriorate. Underwriters have to decide if the operative period is near as this is the crucial time of high risk. Then follows the postoperative period when the clinical condition is once again stabilised.

Antiselection is highest in the immediate preoperative period. We do not advise issuing life insurance just before such an event as common sense would indicate.

Before valvular surgery, the main risks are:

- Infectious endocarditis;
- Cardiac failure;
- Arrhythmias;
- Sudden death;
- Angina.

The problem of angina is explained by the fact that patients, often elderly, may have an association of valvular and coronary artery diseases.

The operative risk of valvular surgery, as presented by Professors Michel and Acar, is between 3 and 5%.

After surgery, the major risks are:

- Thrombosis or dehiscence of the prosthesis;
- Complications of anti-coagulant therapy;
- Artificial valve endocarditis;
- Infection of the valve.

Finally, applications received in the period which surrounds the surgical operation should be postponed or declined. The same decision would also apply if:

- The applicant presents symptoms corresponding to the NYHA Classes III or IV or there are signs of cardiac failure;
- Echocardiography reports Grades III or IV valvular lesions;
- Surgery programmed in the near future.

In such cases, it is possible to review the proposal after the applicant has undergone valvular surgery.

**Examples of underwriting**

We will now review specific aspects of underwriting using concrete examples.

For applications received well before the operative period, when the applicant is asymptomatic or in Classes I or II and the echocardiographic data shows Grades I or II lesions, the extra-mortality ratings will range from 50 to 250%.

After valvular surgery, when the patient is once again asymptomatic with a follow-up echocardiographic examination showing good function of the prosthesis and of the left ventricle, the extra-mortality ratings will range from 25 to 150%.

**RATING SCHEDULES**

After surgery, the major risks are:

- Thrombosis or dehiscence of the prosthesis;
- Complications of anti-coagulant therapy;
- Artificial valve endocarditis;
- Infection of the valve.

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- Surgery programmed in the near future.

In such cases, it is possible to review the proposal after the applicant has undergone valvular surgery.

The following example shows a significant change in our underwriting assessment taking into account the progress of conservative mitral valve surgery. Isolated prolapse of the mitral valve without complications is now considered to be a standard risk.

Mitrail valve prolapse with an audible murmur and mitral regurgitation will be underwritten as common mitral regurgitation.

Applicants who have two valve lesions (for example, aortic stenosis and mitral regurgitation) will be assessed individually and no systematic declination is advised.

Here is a series of clinical cases.

A 50 year old man presenting asymptomatic mitral regurgitation with normal left ventricular function would receive a rating of:

- 75% extra-mortality for life cover;
- 125% extra-premium for temporary and permanent disability cover;
- 25% extra-premium for long-term care, the risk being minor in this case.

A 50 year old man with aortic regurgitation, shortness of breath on climbing one flight of stairs, under treatment with diuretics and ACE inhibitors, who is unable to provide a Doppler echocardiographic result, will be declined.

It is not worth recovering the Doppler echocardiographic results as the applicant will probably have to undergo surgery.

If the decision is contested, then further information can be requested including the Doppler echocardiography results.

A 35 year old woman with mitral stenosis and shortness of breath on moderate exercise such as jogging, and providing echocardiographic evidence of mild mitral stenosis (valve surface area of 2cm²) would be rated:

- 200% extra-mortality for life cover to take into account the risks of arrhythmias, systemic embolism and a probable future surgical procedure;
- 250% extra-premium for temporary and permanent disability;
- 100% extra-premium for long-term care.

The fact of having a scar on the chest wall after correction of mitral regurgitation should not therefore lead to systematic declination of a proposal by the insurer.

**SCOR Global Life’s underwriting schedules reflect the advances in clinical and hospital practice. Even though our decisions may seem a little conservative with respect to some of the data that has been presented, we must remember that surgery is performed not only in the Paris region and that not all practitioners are as experienced and technically accomplished as our invited guests.**

Besides, infectious endocarditis is always a danger. What are the risks of this complication?

**Pierre-Louis MICHEL**

The risk is constant; the incidence is low but stable in the developed countries with 25 new cases per million population per year. The same percentage is observed in France with 1,500 new cases each year. The mortality remains between 15 and 20%. The risk of early operation is about 50%. This is a dreaded condition and the consequences are severe. The epidemiology of this infection has changed with fewer cases due to buccal streptococci. Antibiotic prophylaxis has been successful. However, there are greater numbers of endocarditis due to gastrointestinal streptococci especially in the aged with degenerative diseases. The risks are major in patients with prosthetic valves and in native aortic regurgitation.

On the other hand, there is no theoretical reason to apply an extra-mortality rating in a person with mitral stenosis.
The mortality related to cardiovascular disease is falling progressively in the so-called industrialised countries. Unfortunately, this is not the case everywhere, especially in the third world countries where much remains to be done in the management of these conditions.

However, as we have just seen, thanks to the contributions of our guest speakers, the progress made in the diagnosis, treatment and prevention of coronary artery and valvular heart diseases enable those patients with access to health services to hope for longer and better quality lives.

These medical advances must be translated into better terms for patients with these conditions who seek cover for life and disability insurance.

At SCOR Global Life, we believe that it is possible to provide better conditions of insurance providing we receive the necessary medical information to establish an objective assessment of the risk. Our methods of risk selection and underwriting must advance in parallel with medical progress so that the large majority of patients suffering from these conditions can realise their future social and professional projects.
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