International Journal of Medical and Health Research
ISSN: 2454-9142
www.medicalsciencejournal.com
Volume 4; Issue 7; July 2018; Page No. 96-101

Clinical outcomes of coronary artery bypass graft surgery

Mohammed Al-harthi[1], Obai Mesawa[2], Abrar Abdullah[3*], Reem Al-tarouti[4], Abdullah Almarzoug[5], Hassnah Hawsawi[6]
[1, 2] King Abdulaziz University, Jeddah, Saudi Arabia
[3, 4, 5] Ibn Sina National College, Jeddah, Saudi Arabia
[6] Al-Maarefa Colleges, Jeddah, Saudi Arabia

Abstract
This review article summarizes the major studies performed to show the clinical outcomes of coronary artery bypass graft surgery (CABG), including the history of CABG, indications, measurement of quality of life after CABG in addition to complications to surgery such as life prolongation, physical functioning which can be tested through relief of angina and dyspnea and improvement of physical activity.. We are also going to discuss the mortality and morbidity outcomes following CABG.
We should know that, the literature demonstrates that the outcomes of CABG have been measured in terms of mortality and morbidity; however, it has now been well recognized that adjustment to CABG is a multidimensional phenomenon that is not fully explained by medical factors. Therefore, in addition to studying mortality and morbidity outcomes following CABG, many recent studies have identified that it is important to investigate various physical, psychological, and social variables that have a significant impact on post-operative adjustment to CABG.
Coronary artery bypass graft surgery is increasingly common in patients of age ≥80 years. We are going to discuss the use and outcomes of bypass surgery in the very elderly.

Keywords: clinical outcomes, coronary artery, CABG

Introduction
According to the American Heart Association, coronary artery bypass graft (CABG) surgeries are the most commonly performed major operations advised to be carried out for selected groups of patients with significant narrowing and blockages of the heart arteries (coronary artery disease).
CABG surgery creates new routes around narrowed and blocked arteries so that it allows sufficient blood flow to deliver oxygen and nutrients to the heart muscle.
CABG surgery is performed to relieve symptoms of angina in patients who have failed medical therapy and are not good candidates for angioplasty (PCI) or percutaneous transluminal coronary angioplasty (PTCA). CABG surgery is ideal for patients with multiple narrowing in multiple coronary artery branches which is often seen in patients with diabetes.
It can improve long-term survival in patients with significant narrowing of the left main coronary artery, and in patients with significant narrowing of multiple arteries, especially in those with decreased heart muscle pump function.
The cardiac surgeon makes an incision down the middle of the chest and then saws through the breastbone (sternum) this procedure is called a median (middle) sternotomy (cutting of the sternum). The heart is cooled with iced salt water, while a preservative solution is injected into the heart arteries. This process minimizes damage caused by reduced blood flow during surgery and is referred to as "cardioplegia." Before bypass surgery can take place, a cardiopulmonary bypass must be established. Plastic tubes are placed in the right atrium to channel venous blood out of the body for passage through a plastic sheeting (membrane oxygenator) in the heart lung machine. The oxygenated blood is then returned to the body. The main aorta is clamped off (cross clamped) during CABG surgery to maintain a bloodless field and to allow bypasses to be connected to the aorta [2].
CABG surgery takes about four hours to complete. The aorta is clamped off for about 60 minutes and the body is supported by cardiopulmonary bypass for about 90 minutes. The use of 3 (triple), 4 (quadruple), or 5 (quintuple) bypasses are now routine. At the end of surgery, the sternum is wired together with stainless steel and the chest incision is sewn closed. Plastic tubes (chest tubes) are left in place to allow drainage of any remaining blood from the space around the heart (mediastinum) [1].
Overall mortality related to CABG is 3-4%. During and shortly after CABG surgery, heart attacks occur in 5 to 10% of patients and are the main cause of death.
Also about 5% of patients require exploration because of bleeding. This second surgery increases the risk of chest infection and lung complications. Mortality and complications increase with:

- Age (older than 70 years),
- Poor heart muscle function,
- Disease obstructing the left main coronary artery,
- Diabetes,
- Chronic lung disease, and
- Chronic kidney failure.

Mortality may be higher in women, primarily due to their advanced age at the time of CABG surgery and smaller coronary arteries.
In this article we are going to determine the clinical outcomes of CABG in different patients and how does CABG affect the mortality and morbidity rates in these patients.

Through the first study we have noticed that CABG improves prognosis in the early post-surgical years in patients with symptomatic left main coronary artery stenosis or stenosis of the three main coronary vessels, although this advantage is not thought to be significant after 10–12 years (Cundiff 2002; Hlatky *et al*. 2004).

However, for the majority of patients with less severe pathology, the prognosis is good without surgery (Kirklin *et al*. 1991; Caines *et al*. 2004). Furthermore, cardiac surgery has advanced to a point where mortality rates have declined dramatically (Ferguson *et al*. 2002). Thus, with such low death rates, selection among alternative courses of cardiac therapy is increasingly being based on measures of quality of life (QOL), including minimization of pain and disability [2].

The idea of CABG started when a cardiac surgeon named Sabiston conducted the first unsuccessful saphenous vein graft from the ascending aorta to the distal right coronary artery and the patient died 3 days later in 1962. But this technique was then pioneered by Argentinian René Favaloro and others at the Cleveland Clinic in the late 1960s.

And the next major development was in 1970, when the internal mammary artery was used as a bypass conduit to the coronary arteries.

In 1989, the number of procedures performed per 100 000 people was: 26.6 in the United Kingdom, 62.9 in Australia, and 141.8 in the United States (Wise and Graham-Clarke 1994). In Australia, following a tentative start in 1969, CABG is now one of the most common major elective surgical procedures.

Indications for CABG

The CABG procedure is indicated mainly for the relief of symptoms (primarily angina) that is unresponsive to medical treatment or percutaneous transluminal coronary angioplasty (PTCA), particularly when it is likely that this operation will delay unfavorable events (death, myocardial infarction, angina recurrence) longer than other forms of treatment [1].

For angina relief, surgery has often succeeded where medical or interventional therapy has failed or is not recommended but for survival, it is more complex. There is general agreement that CABG improves prognosis in the early post-surgical years in those patients with symptomatic left main coronary artery stenosis or stenosis of the three main coronary vessels, but this advantage is not thought to be significant after 10–12 years according to (Cundiff 2002; Hlatky *et al*. 2004).

However, for the majority of patients with less severe pathology, the prognosis is good without surgery (Kirklin *et al*. 1991; Caines *et al*. 2004). Furthermore, cardiac surgery has advanced to a point where mortality rates have declined dramatically (Ferguson *et al*. 2002). Thus, with such low death rates, selection among alternative courses of cardiac therapy is increasingly being based on measures of quality of life (QOL), including minimization of pain and disability [1].

Objectives

The first article includes a review of the literature in the areas of: history of CABG; indications for CABG; and measurement of quality of life following CABG, including prolongation of life, physical functioning (relief from angina and dyspnea, physical activity, as well as complications of surgery and re-hospitalization), psychological functioning, and social functioning.

While the second study was performed to discuss the use and outcomes of CABG in very elderly patients with age ≥80 years.

Review

Although the literature demonstrates that the outcomes of CABG have historically been measured in terms of mortality and morbidity, it has now been well recognized that adjustment to CABG is a multidimensional phenomenon that is not fully explained by medical factors and for that reason many recent studies have identified that it is important to investigate various physical, psychological, and social variables that have a significant impact on post-operative adjustment to CABG.

Discussion

Outcomes are always been evaluated in terms of mortality, and complications or recurrence of symptoms and performed after cardiac intervention, as they are easy to measure (Caine *et al*. 1991; Wenger *et al*. 1995; Chocron *et al*. 1996). However, these measures do not provide a complete assessment of an individual's capabilities at home, at work, or in the community (McCarthy *et al*. 1995).

Methodology

It was performed through electronic databases and searches were done without language restriction, from January 1966 to January 2006.

The databases used included the Cochrane Database of Systematic Reviews, MEDLINE(R), CINAHL, and PsychINFO. Using the key search terms: revascularization; coronary artery bypass graft surgery; CABGS; CABG; coronary bypass surgery; percutaneous transluminal coronary angioplasty; PTCA; percutaneous coronary intervention; PCI; mortality; morbidity; quality of life; angina; dyspnea; physical activity; complications; rehospitalization; vocational status; physical functioning; psychological functioning; social functioning; and outcomes [1].

Results

Measurement of quality of life following CABG

It is important to measure the outcomes of CABG in terms of mortality and morbidity so as to help the modern scientific medicine to improve it and continue to perform these operations if they are improving quality of life. The importance of treatment outcome is recognized throughout clinical practice, particularly when innovative, invasive or costly treatments are evaluated, and the mortality rate is too low to affect decision making (Caine *et al*. 1991). However, there is no universal agreement of the meaning of QOL or how it should be measured (Wenger *et al*. 1995).

Although clinical outcomes and cardiac interventions are measured in terms of mortality, and complications or recurrence of symptoms, as they are easy to measure (Caine *et al*. 1991; Wenger *et al*. 1995; Chocron *et al*. 1996), these measures do not provide a complete assessment of an individual's capabilities at home, at work, or in the community (McCarthy *et al*. 1995). So we need some changes in the

questions asked in evaluation, changes in the technologies used to answer these questions, and changes in the sources of assessment information [1].

That leads to classification of clinical outcomes of CABG into categories that reflect the expected goals of CABG such as: prolongation of life, reduction of symptoms, improvement in physical, psychological and social functioning, and improvement in vocational status (Duits *et al*. 1997) and we are going to discuss each of them separately.

1) Prolongation of life

In which CABG was initially addressed in three major randomized clinical trials that compared CABG with medical therapy. They include the Veterans Administration Study (VAS), (Grover *et al*. 1990) the European Coronary Artery Surgery Study (ECASS), (European Coronary Surgery Study Group 1982) and the Coronary Artery Surgery Study (CASS) (CASS PI 1983; Serruys *et al*. 2005).

- The VAS recruited 1015 patients from 13 centers between 1970 and 1974. The study revealed no significant difference in mortality 4 years after CABG in patients with one-, two- or three-vessel disease, although a highly significant increase in survival rate was observed in a subset of patients who underwent CABG for left main coronary artery obstruction. The 4-year mortality for CABG patients was 7% (n = 46), compared with 33% for medical treatment (n = 44) (Hampton 1984).
- While the ECASS recruited 768 men under 65-years between 1973 and 1976. And they randomized the participants to medical or surgical treatment, the main weakness of this trial was that nothing was known about the original population from which the trial patients were drawn. There was significant improvement in survival for the total CABG population, and for patients with three-vessel disease, with stenosis in the proximal third of the left anterior descending artery, or with left main coronary disease. After 5 years of follow up, 30 deaths were reported among the 395 patients treated surgically (7.6%), and 61 deaths among the 373 patients using medical treatment (16.3%) (European Coronary Surgery Study Group 1982; Hampton 1984) [1].
- The CASS recruited 780 patients under 65 years allocated to medical or surgical treatment between 1975 and 1979 (90% male). Noticing the cumulative survival rates was found in the medically assigned group to be (92%) and the surgically assigned group to be (95%) and they were similar.

  No significant differences in survival were found between medically and surgically treated groups at baseline in extent of coronary heart disease (CHD) or in ventricular function. In patients with three-vessel disease and low ejection fractions, a distinct (but not significant) trend for improved 5-year survival was observed in patients treated surgically (90%) compared with those treated medically (80%). This difference persisted and reached statistical significance when the 7-year cumulative survival was 88% in the surgically assigned group and 65% in the medically assigned group (CASS PI 1983; Hampton 1984).

Since these early randomized studies it has become clear that there were a number of methodological issues with these trials. First, there were few females in the early trials, which is concerning as there appears to be a gender difference in outcome following surgery. Second, the results cannot be extrapolated to the entire population since patients included in these studies represented only 20% of the total coronary artery disease population (Pollick 1993).

Finally, the CABG procedure has advanced significantly over the years to a point where operative mortality is now much lower than reported in the early trials, at less than 3% for routine CABG (Pollick 1993; Senes-Ferrari 1999; Ferguson *et al*. 2002) [1].69-

One such procedural change in CABG has been routine use of the internal mammary artery as a conduit for revascularizing the coronary arteries, as 10 years after CABG three quarters of vein conduits are blocked or severely diseased (Fitzgibbon *et al*. 1996), whereas more than 90% of internal thoracic artery grafts are patent and disease free (Pollick 1993; Damgaard *et al*. 2005).

Vein graft failure leads to reduced survival, recurrent angina, late myocardial infarction, and the need for further intervention (Eagle *et al*. 1999), so that by 10–15 years after the initial operation up to 40% of patients may require redo CABG at increased risk and cost (Weintraub *et al*. 1994; Kaul *et al*. 1995; Lytle *et al*. 1999). Thus, recent studies suggest that the use of the left internal thoracic artery to the left anterior descending coronary artery is the most important factor for survival and reduction of late cardiac events after CABG (Loop *et al*. 1986; Yusuf *et al*. 1994; Cameron *et al*. 1996).

Furthermore, while there have been no randomized trials of total arterial revascularization compared with conventional surgery, several large studies have reported that multiple arterial revascularization offers survival advantages over a single internal thoracic artery graft (Pick *et al*. 1997; Schmidt *et al*. 1997; Buxton *et al*. 1998; Lytle *et al*. 1999; Calafiore *et al*. 2000; Dion *et al*. 2000). In a meta-analysis of almost 16 000 patients comprising 11 269 single and 4693 bilateral internal thoracic artery patients matched for age, gender, left ventricular function, and diabetes, the bilateral internal thoracic artery group had significantly better survival (hazard ratio for death 0.81, 95% confidence interval 0.70–0.94) (Taggart *et al*. 2001).

More recently, up to 25% of CABG operations are being performed without the use of a heart-lung pump—"off-pump CABG". A number of non-randomized studies have shown off-pump CABG is as safe as on-pump surgery, and in experienced hands offers less early complications, particularly in those patients with significant comorbidity. In high-risk groups, particularly those with renal impairment, off-pump surgery makes the need for postoperative renal support less likely, and in groups over 70 years of age, there is a reduction in the incidence of cerebral injury when an off-pump technique is employed [1].

In parallel with the progress of the revascularization techniques for patients with stable angina, several randomized trials have also been performed comparing: medical management with surgery; medical management with PTCA or percutaneous coronary intervention (PCI); and PCI with surgery (Spargias and Cokkinos 2004; Bakhai *et al*. 2005).

In a review of seven trials, survival was greater in high risk

patients following CABG compared with medical therapy, where patient risk was defined by severity of ischemia, number of diseased vessels, and left ventricular dysfunction. In low-risk patients, a strategy of initial medical therapy has been shown to be effective (Solomon and Gersh 1998). Despite the difficulty of drawing conclusions from trials comparing outperformed treatments, a recent article tried to outline the comparative efficacy of the available treatment strategies (Spargias and Cokkinos 2004).

Finally about three early major randomized trials indicated that CABG is beneficial in patients with narrowing of the left main coronary artery, or triple-vessel disease and subnormal left ventricular functioning and that they have a particularly poor prognosis when treated medically.

Also recent studies suggest that the use of the left internal thoracic artery to the left anterior descending coronary artery, and potentially multiple arterial revascularization, improves survival and reduces late cardiac events after CABG (Loop *et al*. 1986; Yusuf *et al*. 1994; Cameron *et al*. 1996) [1].

The off-pump CABG may offer fewer early complications, particularly in those patients with significant comorbidity (Pepper 2005). Data are less clear for patients with single- or double-vessel disease, or with normal left ventricular functioning. For these patients, many other variables must be taken into account when assessing the benefits of surgery including the patient's level of physical functioning, psychological functioning, social functioning, and vocational status (Allen 1990) [2].

2) Physical functioning

The main goal of CABG is to improve the patients' functions and return to pre-morbid through the relief of angina and dyspnea, improve the level of physical activity, minimize the complications of surgery, and prevent re-hospitalization and they are all been investigated when assessing physical functioning (Jenkins *et al*. 1983; Herlitz *et al*. 2001).

a) Relief from angina

Relief of disabling angina is the most common indication for CABG. Results of observational studies and randomized controlled trials of medical versus surgical treatment have demonstrated that in patients with disabling angina pectoris, and it was fulfilled through surgery and decreased the need for anti-anginal medication (Herlitz *et al*. 2001).

A review of 14 controlled clinical trials demonstrated that the likelihood of becoming angina-free was approximately 40% greater in the surgical group than the group on medications (Wortman and Yeaton 1985). A more recent study found that 80% of CABG patients were angina-free up to 5 years after surgery (Fihn *et al*. 2001).

b) Relief from dyspnea

Another important symptom is investigated which is breathlessness, or dyspnea, following CABG (Jenkins *et al*. 1983; Mayou and Bryant 1987; Sjoland *et al*. 1997b; Herlitz *et al*. 2001).

- A study in which 60% of patients experienced dyspnea before CABG, 54% of these were completely relieved of dyspnea, 22% reported some improvement, and 18% had no improvement 6 months after the surgery. ' Nine percent of the total patient group reported more dyspnea following surgery, with more than 50% of these reports being from patients without dyspnea pre-surgery (Jenkins *et al*. 1983).
- Another study found that: 71% of patients experienced dyspnea before surgery whilst 39% reported it 12 months post-surgery (Mayou and Bryant 1987).
- In a later study, 63% of CABG patients complained of dyspnea pre-surgery, with the proportion falling to 30% at three months and 33% at 12 months. The level of exertion at which these symptoms developed was also greater after surgery (Caine *et al*. 1991) [1].

More recently, symptoms of chest pain and dyspnea were significantly reduced in both male and female patients following CABG (Sjoland *et al*. 1997b; Herlitz *et al*. 2001). So we can say that angina and dyspnea had been improved following CABG.

3) Physical activity

We are going to discuss some studies performed some of them to show that there was no change and others to show the increase in exercise performance after CABG (Jenkins *et al*. 1983; Caine *et al*. 1991; Chocron *et al*. 1996; Sjoland *et al*. 1997a; Herlitz *et al*. 2001).

- One study found that 6 months after CABG, usual daily physical activity had increased, with a sharp reduction in the number of days participants were unable to carry out usual activities, or were confined to bed, due to their heart condition (Jenkins *et al*. 1983).
- An investigation of usual activity levels at home, at leisure, and socially, found that these were improved 1 year following surgery (Caine *et al*. 1991).

  An assessment of QOL before and 3 months after heart surgery found that physical mobility was improved in 77% of patients (Chocron *et al*. 1996). One study developed a physical activity score containing six questions for the self-estimation of physical abilities and limitations. The score improved over time, with the major improvement observed at 3 months, and further slight improvement at 2 years (Sjoland *et al*. 1997a) [1].

In contrast, other researchers have found no change, or a decrease, in physical functioning following CABG.

- One study found that 17% of previously active CABG patients reported a significant decrease in leisure and social activities up to 2 years after surgery (Wilson-Barnett 1981). Investigators in the CASS found that 68% of patients had a moderate activity level pre-surgery with no change in activity during the 5-year follow-up period (CASS PI 1983).
- More recently, an investigation of exercise behavior at 6 and 24 months post-surgery found that 67% of CABG patients had become long-term regular exercizers by 2 years post-surgery (Jue and Cunningham 1998). These results support the view of Allen (1990) that physical functioning improves for some patients following CABG, while pre-operative inactivity continues or physical activity levels deteriorate following surgery for other patients (Allen 1990).

4) Complications of surgery and re-hospitalization

There are some surgical complications and medical problems

that have resulted in hospitalization following CABG.

- In an early study, 23% of CABG patients were re-hospitalized in the first 6 months following surgery due to:
  - ✓ Cardiac problems in 32% of these hospitalizations.
  - ✓ Complications of surgery (including cardiac complications) includes: 14%, gastrointestinal difficulties for 9%, and a wide variety of problems in other organ systems for 45% of hospitalizations (Jenkins *et al*. 1983).
- More recently, 33% of CABG patients were re-hospitalized in the first 2 years after surgery, with the most common reasons for re-admission being acute myocardial infarction, arrhythmia or angina (Geissler and Aggestrup 2002).

That taught us the most common risk factors for re-hospitalization and they include

- The length of stay in intensive care.
- Severe non-cardiac complications.
- Duration and severity of pre-operative cardiac symptoms
- Intra-aortic balloon insertion.
- Pre-operative resting angina.
- Female gender; age; diabetes; and surgical procedure (patients with left internal mammary artery graft or multiple arterial grafts are less likely to be re-hospitalized) (Jenkins *et al*. 1983; Stanton *et al*. 1985; Fasken *et al*. 2001; Damgaard *et al*. 2005).

5) Psychological functioning

There are many reports and studies to assess the rates of psychological difficulties following CABG and they vary widely (Tienari *et al*. 1982; Raja *et al*. 2004), we found that:

- Studies assessing anxiety levels of CABG patients have generally shown that anxiety levels are raised prior to surgery but drop rapidly post-surgery which is a positive effect of CABG psychologically (Jenkins *et al*. 1983; Gardner and Worwood 1997; Boudrez and Backer 2001).
- Another study found that the anxiety of CABG patients pre-operatively was more severe than the reference population of general medical and surgical patients, although anxiety levels significantly improved post-surgery [1].

It has been suggested that such rises in anxiety levels may reflect the fear of the patient from the forthcoming procedure (Jenkins *et al*. 1983). However, some patients appear to suffer severe anxiety for extended periods of time after surgery, which is often associated with substantial depression (Gardner and Worwood 1997).

Research indicates that a number of CABG patients are depressed immediately following surgery, with a return to pre-operative levels at discharge.

- One study found that 50% of patients were significantly depressed 8 days post-surgery, but this declined substantially with time to 24% 8 weeks post-surgery, and 22% at 12 months (Timberlake *et al*. 1997).

The reasons for depression following CABG

1. The post-operative period may result in discomfort and pain, with patients being isolated from family, friends, and the familiarity of home and that may produce depression (Timberlake *et al*. 1997).
2. Pre-operative mood appears to contribute to the prediction of depression appears post-surgery (Jenkins *et al*. 1983; Timberlake *et al*. 1997; Boudrez and Backer 2001).
   So some studies found that patients unable to cope with stressful events, or those already suffer from neurotic personality traits, are likely to have psychological outcomes following surgery (Magni *et al*. 1987; Timberlake *et al*. 1997).
   Pre-operative depression scores were shown to account for 34% of the variation in depressed mood post-operatively (Magni *et al*. 1987). More recently, pre-operative levels of depression were shown to be the best predictors of depression at 8 days, 8 weeks and 12 months post-surgery (Timberlake *et al*. 1997). These results emphasize the value of examining patients' levels of anxiety and depression prior to surgery.
3. It is also recognized that CABG may be a risk factor for subtle cognitive decline or psychological abnormalities (Raja *et al*. 2004; Phillips-Bute *et al*. 2006).
   - From the neurological complications following CABG we found: stroke (5%–6% of patients); and ophthalmologic abnormalities such as retinal infarction, retinal embolization and reduction in visual acuity (13%–29% of patients) (Van Dijk *et al*. 2002).
   - From the cognitive decline symptoms we could notice: short-term memory loss, psychomotor slowing, or executive dysfunction.

The proposed mechanisms explaining these conditions, was that they are because of surgical-related trauma, microembolization, genetic susceptibility (eg, apolipoprotein E4 allele), other vascular or ischemic changes, and temperature during surgery.

Showing that the etiology for cognitive decline is most likely multifactorial and includes a synergistic effect of microemboli, hypo-perfusion, and other variables associated with major surgery. Non-pharmacologic (eg, emboli reduction, temperature, or glucose management) and strategies to prevent post-CABG cognitive deficits are currently under investigation (Raja *et al*. 2004).

To sum up, there are many studies that explained that a significant proportion of CABG patients experience psychological difficulties post-surgery, and there appears to be a range of possible reasons for these difficulties.

6) Social functioning

The emphasis on treating patients as social beings who live in a complex social context has permeated many branches of medicine. This approach changed the aim of the medical care not only to treat the medical symptoms but also to reintegrate the individual to the society and to be a productive person (McDowell and Newell 1996).

Many studies have highlighted the importance of social support in attenuating the effects of stressful events and thereby reducing the incidence of disease, although there is substantial variability in the manner in which social support has been conceptualized and measured (Orth-Gomer *et al*. 1998; Lett *et al*. 2005) [1].

We can identify the social support in terms of the availability of trusted, reliable people who make the individual feel cared

for and valued. The emphasis in related sociomedical indices lies with assessing the quality, rather than the number or type, of relationships (McDowell and Newell 1996; Lett *et al*. 2005).

Some studies of social functioning following CABG have shown little change in social activities (CASS PI 1983; Jenkins *et al*. 1983), while others have reported an increase in social interaction (Mayou and Bryant 1987; Ross and Ostrow 2001) [1].

- An investigation of social interactions of CABG patients found a stable level of interaction for 48% of patients, an increase for 28%, and a decrease for 24% of patients 6 months after surgery (Jenkins *et al*. 1983).
- Another study reported a general increase in leisure activities, social activities, and satisfaction post-surgery (Mayou and Bryant 1987).

Thus, it seems that CABG patients are able to perform their usual undemanding activities more comfortably following surgery, but may have little desire to dramatically change the pattern of their lives and we have to help them (Mayou and Bryant 1987; Pollick 1993) [1].

7) Vocational status

An important goal of CABG is the resumption of gainful employment in employment-eligible patients (Allen 1990).

- In a review of 15 studies, 80% of patients were less likely to be employed after CABG, while for 20% there was no change or an improvement which is a large percentage and needs to be fixed and changed.
- The percentage of patients employed after CABG ranged from 38% to 81% (average 62%) (Allen 1990).

In the CASS study, a consistent annual decline in employment was observed, with 76% employed at baseline and 52% at 5 years (CASS PI 1983).

A more recent study found that employment rates pre-surgery, 6 and 12 months post-surgery were 36%, 34%, and 21% respectively, although these results were not controlled for age (Skinner *et al*. 1999).

It was found that patients may also experience a decline in income post-surgery as a result of employment changes (Jenkins *et al*. 1983) [1].

Some variables consistently appear to predict employment after CABG, although investigators have used different CABG populations, employment definitions, end points, and follow-up times. There have also been methodological limitations.

The major predictor of post-operative employment is pre-operative work status, which accounts for more than 40% of the total variance in post-operative employment (Hlatky *et al*. 1998; Geissler and Aggestrup 2002). Patients who expect to return to work post-surgery are also more likely to do so (Allen 1990; Skinner *et al*. 1999).

While the predictors of failure to return to work have included: older age; more severe CHD; more chronic medical conditions; persistent angina; female gender; co-morbidities; pre-operative fatigue; blue-collar workers; higher income; and negative communications from physicians and family regarding return to work which prevemt most of them from returning to work actually (Allen 1990; Mittag and Schwarzer 1993; Hlatky *et al*. 1998; Skinner *et al*. 1999).

- There are other variables influencing return to work and they are: prolonged waiting time for surgery; the economic environment; the availability of disability payments; and the increasing age of the population (Skinner *et al*. 1999).

Conclusion

CABG (coronary artery bypass graft surgery) is considered as an established therapy for coronary artery disease that is a group of different procedures performed for multiple vessel disease. Knowing that PCI has had a dramatic effect on CABG, arresting the dramatic growth of surgery in the 1980s and shifting the attention of surgeons to patients with more advanced coronary disease and extensive coexisting conditions.

Most of CABG outcomes are measure in terms of mortality and morbidity which enhanced surgeons to refine coronary revascularization techniques that maximize clinical effectiveness and limits the costs and reduces invasiveness.

Coronary artery bypass surgery remains an established form of treatment for coronary artery disease, and the majority of coronary surgical procedures are performed for multiple vessel disease.

As for the mortality rates: It was found that the mortality rate of coronary artery surgery is low, at around 2%–3% (Keogh and Kinsman 2004), although this benefit is offset by a complication rate of 20%–30%.

Regarding the neurological function: The post-surgical neurocognitive impairment is of concern (Wolman *et al*. 1999; Newman *et al*. 2001). PCI has had a dramatic effect on CABG, arresting the dramatic growth of surgery in the 1980s and shifting the attention of surgeons to patients with more advanced coronary disease and extensive coexisting conditions. This has motivated surgeons to refine coronary revascularization techniques in order to maximize clinical effectiveness, limit costs, and reduce invasiveness.

Acknowledgement

In the second study: This study was supported by research grants HS-06503 and HS-05635 from the Agency for Health Care Policy and Research, Rockville, MD; by research grant HL-17670 from the National Heart, Lung, and Blood Institute, Bethesda, MD; and a grant from the Robert Wood Johnson Foundation, Princeton, NJ.

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