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Psychiatric Factors Which Impact Coronary Heart Disease and Influence Outcomes Post-Coronary Artery Bypass Grafting Surgery

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1. Introduction

1.1 Coronary Artery Bypass Grafting defined

It has been reported that over 13 million individuals in the United States have been diagnosed with Coronary Artery Disease (Morrow & Gersh, 2008), and it is the leading cause of death in the United States with more than 650,000 deaths in 2005 (Centers for Disease Control and Prevention, 2009). One of the most effective and common methods of treating Coronary Artery Disease is Coronary Artery Bypass Grafting surgery (Niles et al., 2001). Typically, those patients with severe narrowing of the left main coronary artery and/or those with disease in at least 3 coronary arteries are candidates for Coronary Artery Bypass Grafting Surgery.

1.2 Comorbidity with Coronary Artery Disease

There is also a high comorbidity between Peripheral Vascular Disease and Coronary Artery Disease (Brandt et al., 2004; Eagle et al., 1994; Hertzer et al., 1984). While several studies have reported short-term adverse outcomes in Coronary Artery Bypass Grafting patients that also have Peripheral Vascular Disease (Gersh et al., 1989; Grover et al., 1990; Higgins et al., 1992; Kunadian et al., 2007; Magovern et al., 1996; O'Connor et al., 1992; Rosenthal et al., 2003; Sutton-Tyrrell et al., 1998) the long-term outcomes have not been thoroughly investigated. To address this gap in the literature, Chu et al. (2008) conducted a study investigating the long-term impact of Coronary Artery Bypass Grafting surgery in patients who concurrently had Peripheral Vascular Disease. After comparing 370 Peripheral Vascular Disease and 794 non-Peripheral Vascular Disease patients, Chu and colleagues determined there were no significant group differences in 30 day mortality or major cardiac adverse events; however, patients with Peripheral Vascular Disease had a significantly worse 9 year survival rate (i.e., almost twice the risk of mortality) when compared to those without Peripheral Vascular Disease. While the short-term outcomes of this study are contradictory to previous studies, the long-term outcomes suggest that those with Peripheral Vascular Disease have poorer outcomes over time when compared to those without Peripheral Vascular Disease.

1.3 Variations of Coronary Artery Bypass Grafting Surgery

Typically Coronary Artery Bypass Grafting surgery is performed via Cardiopulmonary Bypass; however, there are several drawbacks associated with Cardiopulmonary Bypass which may lead to complications following or during surgery (Edmunds et al., 2003). As a result of these complications, a technique utilizing an Off-Pump Coronary Artery Bypass procedure was developed. The Off-Pump Coronary Artery Bypass technique has recently gained popularity and can also be performed without involving Cardiopulmonary Bypass (Benetti et al., 1995; Buffolo et al., 1996; Calafiore et al., 1996; Dewey et al., 2001; Guler et al., 2001; Guru et al., 2007;Magee et al., 2001; Puskas et al., 1998; Trehan et al., 2001). While Off-Pump Coronary Artery Bypass has gained notoriety, some surgeons have opted out of using the technique due to suspicions that Off-Pump Coronary Artery Bypass may compromise patient outcomes. To help clarify these suspicions, researchers have turned their focus to investigating the effectiveness of Off-Pump Coronary Artery Bypass for treating patients with Coronary Artery Disease. The results of such studies have often been counter indicative. Some studies suggest that Off-Pump Coronary Artery Bypass has similar outcomes to conventional Coronary Artery Bypass Grafting surgery with respect to length of hospital stay, morbidity, and neurological deficiencies (Halkos et al., 2008; Puskas et al., 1998; Puskas et al., 2001) as well as comparable graft patency and hospitalization costs (Puskas et al., 2004). Conversely, other studies have reported less favorable Off-Pump Coronary Artery Bypass patient outcomes (e.g., lower graft patency rates and less complete revascularization) when compared to Coronary Artery Bypass Grafting patient outcomes (Khan et al., 2004). Still several other studies report no difference in early mortality, morbidity and hospitalization costs between the two procedures (Bull et al., 2001; Cheng et al., 2005; Cheng et al., 2002; Marasco et al., 2008; Takagi et al., 2007). Clearly, the studies to date comparing the Off-Pump Coronary Artery Bypass and Coronary Artery Bypass Grafting procedures present an unclear picture of potential differential outcomes for patients. In order to further investigate the difference between these two methods, Chu and colleagues (2009a) conducted a study using a nationwide database of over 63,000 Coronary Artery Bypass Grafting and Off-Pump Coronary Artery Bypass patients. The results revealed that the Off-Pump Coronary Artery Bypass and Coronary Artery Bypass Grafting procedures had similar in-hospital mortality, post-operative stroke incidences, and routine discharge rates. However, Off-Pump Coronary Artery Bypass patients had comparatively longer hospital stays and higher hospital costs than Coronary Artery Bypass Grafting patients.

2. Coronary Artery Bypass Grafting and medical/demographic predictors

2.1 Coronary Artery Bypass Grafting and obesity

The accepted medical model for outcomes following Coronary Artery Bypass Grafting Surgery can be found in Figure 1. Falling second to Coronary Artery Disease, obesity is the second leading cause of death in the United States (Mokdad et al., 2000). It is well-known that patients categorized as obese are at unique risk for developing various cardiovascular diseases, including Coronary Artery Disease. Due to the general increased morbidity and reduced life expectancy of obese patients (Fontaine et al., 2003), many researchers have hypothesized that obesity should be linked to poorer outcomes post-Coronary Artery Bypass Grafting surgery. Yet, current research investigating the association between obesity (e.g., body mass index, BMI) and cardiac surgery outcomes has been contradictory. Some studies report no difference in short-term outcomes post-Coronary Artery Bypass Grafting between obese and non-obese patients (Engel et al., 2009; Engelman et al., 1999; Potapov et al., 2003; Rahmanian et al., 2007; Reeves et al., 2003; Schwann et al., 2003; Syrakas et al.,

2007). Others have found that morbid obesity independently predicts perioperative complications as well as operative mortality (Prabhakar et al., 2002). One study by Syrakas and colleagues (2007) even found that normal weight patients had a higher 30-day mortality rate than their obese peers post-surgery. In fact, overall, research seems to suggest that morbid obesity does not increase short-term mortality risk for Coronary Artery Bypass Grafting patients (Baslaim et al., 2008; Shirad et al., 2009; Syrakas et al., 2007). Since research regarding the association between obesity and cardiac surgery has included mostly short-term outcomes, Del Prete and associates (2010) investigated the independent effect of obesity on long-term survival in patients (472 obese and 691 non-obese) who had Coronary Artery Bypass Grafting surgery. Results revealed obese and non-obese patients had similar intraoperative characteristics (e.g., cardiopulmonary bypass time, aortic cross-clamp time, and number of vein and IMA grafts) and post-operative outcomes. Of particular interest was that the rates of mortality and major adverse cardiac events after 30 days were not significantly different between the two groups. Most interestingly, the researchers determined that obese Coronary Artery Bypass Grafting patients demonstrated long-term survival (9 years follow-up) similar to non-obese Coronary Artery Bypass Grafting patients. While these findings are counterintuitive, these results combined with results of studies examining short-term outcomes seem to indicate that obesity is not a significant risk for patients undergoing Coronary Artery Bypass Grafting surgery.

2.2 Coronary Artery Bypass Grafting and age

Due to improvements in medical care, the average life expectancy has increased significantly in recent years. Subsequently, there has been an increase in the number of geriatric patients with cardiac disease that need surgical intervention such as Coronary Artery Bypass Grafting surgery. In addition, this population also tends to have multiple comorbidities which may cause complications; however, Coronary Artery Bypass Grafting procedures in octogenarian patients (those over the age of 80), have demonstrated improved morbidity and mortality outcomes (Alexander et al., 2000; Kolh et al., 2001; Shigemitsu et al., 2001). However, while most of these Coronary Artery Bypass Grafting surgeries are technically successful, they may cause significant physiological adverse events, potentially deconditioning them substantially. Unfortunately, there has not been a wealth of literature investigating these physiological outcomes which may affect the health and well-being of these patients. As a result, Gopaldas et al. (2010) conducted a study investigating the disposition of octogerians following Coronary Artery Bypass Grafting surgery.

Gopaldas identified 5,731 patients over age 80 who underwent Coronary Artery Bypass Grafting surgery. It was discovered that the surgical mortality rate was 7%, and 21% of patients had a routine hospital discharge. Those that did not have a routine discharge had home health care (27%) or were transferred to another care facility (45%). In addition, several predictors of surgical mortality and nonroutine discharge were found: older age, females, a higher comorbidity index, and referral from the emergency room were all found to be independent predictors of these unfavorable outcomes. Thus, it is clear that while mortality rate in octogenarians is low, there are several circumstances that need to be considered to ensure more favorable outcomes following discharge.

2.3 Coronary Artery Bypass Grafting and gender

Women are particularly affected by heart disease, and coronary heart disease has consistently been reported as the leading cause of morbidity and mortality of women in most developed countries (Center for Disease Control and Prevention, 2010; Lloyd-Jones et

al., 2010; Stoney et al., 2003). In 2006, 1 in 6 reported female deaths were due to Coronary Artery Disease (Januzzi et al., 2000), and research suggests that being female is related to poorer Coronary Artery Bypass Grafting outcomes (Blankstein et al., 2005; Culler et al., 2008; Kim et al., 2007; Sawatzky et al., 2009). Women have higher mortality rates, remain in the hospital longer (Dao, 2010b), experience a more difficult recovery (Sawatzky et al., 2009), and self-report being less satisfied with health status after Coronary Artery Bypass Grafting surgery (Sawatzky et al., 2009).

Dao and colleagues (2011c) conducted a study investigating gender differences and outcomes following Coronary Artery Bypass Grafting surgery. It was reported that being female and having an anxiety disorder diagnosis independently and collectively contributed to in-hospital length of stay and non-routine discharge following a Coronary Artery Bypass Grafting surgery. In addition, significant differences were found between groups in age, gender, race, median household income, medical comorbidities, and having an anxiety disorder diagnosis. Specifically, patients with non-routine discharges were more likely to be older, female, non-Caucasian, have more medical comorbidities, and have an anxiety disorder diagnosis.

2.4 Autonomic Nervous System dysregulation

As mentioned previously, the association between depression and cardiac events, particularly Coronary Artery Disease, has been validated consistently in research; yet, the mechanism behind this relationship is unclear. One proposed underlying factor in this relationship is altered autonomic nervous system (Autonomic Nervous System) activity. Altered Autonomic Nervous System activity has been suggested to contribute to elevated mortality risk (and poorer general outcomes) in patients with Coronary Artery Disease, and individuals with Major Depressive Disorder often have Autonomic Nervous System dysregulation (Barnes et al., 1983; Esler et al., 1982; Lake et al., 1982). In addition, research suggests that depressed individuals have higher baseline heart rates (Lake et al., 1982; Siever et al., 1985; Veith et al., 1994), increased heart rate response to stressors (Carney et al., 1988a; Guinjoan et al., 1995), and decreased heart rate variability (HRV) (Appelhans et al., 2006; Carney et al., 1988b; Dallack et al., 1990; Rechlin et al., 1994) when compared to similar peers. In particular, increased Heart Rate Variability has been associated with greater abilities to regulate stress, arousal, and attention, while decreased Heart Rate Variability has been associated with inadequate parasympathetic modulation and increased cardiac sympathetic modulation (Task Force of the European Society of Cardiology and the North American Society for Pacing and Electrophysiology, 1995). Most relevant to this chapter, studies suggest that Heart Rate Variability is lower in Coronary Artery Disease patients with comorbid depression than those with Coronary Artery Disease alone (Krittayaphong et al., 1997; Stein et al., 2000). Taken together, this literature suggests that depressed individuals may not only have an elevated initial heart rate and higher heart rate in reaction to stressors, but they may also have lower Heart Rate Variability that makes it more difficult to manage these other elevated heart rate situations.

Another factor not previously understood was whether patients with Autonomic Nervous System dysregulation also have increased mortality with these concurrent disorders. Dao and colleagues (2010a) proposed a study investigating three variables (heart rate, Heart Rate Variability, and plasma norepinephrine levels) in the following groups: 1) Patients with Coronary Artery Disease and depression, 2) Patients with Depression alone, 3) Patients with Coronary Artery Disease alone, and 4) Patients without neither Coronary Artery Disease nor depression. The focus of the study was to compare the association of heart rate, Heart

Rate Variability, and plasma norepinephrine levels with depression and Autonomic Nervous System activity in addition to their relationship to Coronary Artery Bypass Grafting outcomes. In addition, a second analysis was conducted investigating the 3 aforementioned variables in cardiac patients (Coronary Artery Disease and Depression versus Coronary Artery Disease alone) and surgery outcomes (length of hospital stay, routine versus non-routine discharge status) while controlling for other factors (medical factors such as diabetes and demographic factors such as age). It was hypothesized that patients with Coronary Artery Disease and Depression would have the greatest amount of Autonomic Nervous System dysregulation while the group without Coronary Artery Disease or depression would have the least Autonomic Nervous System dysregulation. In addition, it was hypothesized that the aforementioned variables would predict outcomes following Coronary Artery Bypass Grafting surgery. Analyses revealed that patients with Coronary Artery Disease and Depression had greater Autonomic Nervous System dysregulation when compared to those that had either Coronary Artery Disease or depression alone. Also, it was determined that depression, as well as elevated heart rate and depressed Heart Rate Variability, predicted increased length of hospital stay and non-routine discharge.

2.5 Diabetes

It has been found that systematic disease may increase the risks associated with Coronary Artery Bypass Grafting surgery. Several studies have reported that diabetes is a critical factor and mortality rates are two to three times higher than in non-diabetics (Johnson et al., 1982; Lawrie et al., 1986; Salomon et al., 1983). In addition, patients with diabetes tend to have more post-CABG surgery complications which reduce long-term survival.

3. Coronary Artery Bypass Grafting and psychological predictors

3.1 Depression and Post-Traumatic Stress Disorder

A proposed psychological model for outcomes following Coronary Artery Bypass Grafting Surgery is proposed in Figure 1. Research has demonstrated that medical and demographic factors such as age, gender, diabetes, etc. cannot fully explain the outcomes following Coronary Artery Bypass Grafting surgery (Blumenthal et al., 2003; Saur et al., 2001). Several studies have been published investigating the association between Coronary Artery Disease and psychological functioning, primarily depression (Bankier et al., 2004; Oxland et al., 2006). It has been reported that up to 60% of patients with Coronary Artery Disease have comorbid depression which has a significant impact on the outcomes of Coronary Artery Disease (Blumenthal et al., 2003; Connerney et al., 2001; Krannich et al., 2007; Tully et al., 2008). Those with depression have higher rates of mortality as well as an overall risk of major cardiac events (Blumenthal et al., 2003; Carney et al., 1988; Connerney et al., 2001). Specifically, depressive symptoms also significantly predict mortality 2 to 5 years after Coronary Artery Bypass Grafting surgery, independent of medical and operative factors (Blumenthal et al., 2003; Burg et al., 2003a; Burg et al., 2003b. Unlike depression, the impact of other psychological conditions, such as Post-traumatic Stress Disorder on outcomes after Coronary Artery Bypass Grafting surgery has received less attention in research.

The gap in the literature investigating the relationship between Post-traumatic Stress Disorder on outcomes after Coronary Artery Bypass Grafting surgery needs to be examined independently from depression for several reasons. Specifically, studies have demonstrated

that both depression and Post-traumatic Stress Disorder involve increased secretion of corticotropin-releasing factor. However, patients with Post-traumatic Stress Disorder have hypocortisolemia due to the increased secretion, whereas severe depression is associated with hypercortisolemia, showing that the pathophysiology of the 2 disorders might be different (Lyons et al., 2001). In addition, the psychiatric comorbidities of Post-traumatic Stress Disorder and depression may potentially affect cardiac prognosis adversely. Thus, by treating only depression and not the Post-traumatic Stress Disorder, cardiac outcomes may be adversely affected.

Dao et al (2010c) proposed a study examining the effect of clinical depression, PTSD, and comorbid depression and PTSD on outcomes following Coronary Artery Bypass Grafting surgery. It was hypothesized that depression, PTSD, and comorbid depression and PTSD would independently contribute to an increased risk for mortality following Coronary Artery Bypass Grafting surgery. In addition, it was hypothesized that comorbid depression and PTSD will have the greatest effect on mortality rates and outcomes in general. It was determined that, depression, posttraumatic stress disorder, and comorbid depression and posttraumatic stress disorder are prevalent in patients undergoing Coronary Artery Bypass Grafting surgery. In addition, depression, posttraumatic stress disorder, and comorbid depression and posttraumatic stress disorder increased the risk of mortality following Coronary Artery Bypass Grafting surgery.

3.2 Geographic status

Another topic that has received limited focus in literature to date is the impact geographic status may have on Coronary Artery Bypass Grafting outcomes. While death rates due to heart disease have decreased in recent decades (Cooper et al., 2000), vulnerable populations (e.g., individuals in rural areas) persist (Barnett et al., 2000; Pearson et al., 1998). In fact, recent reports indicate that Coronary Artery Disease is 1.3 times more prevalent in rural areas than in urban areas (McCrone et al., 2007). Another recent survey revealed that Coronary Artery Disease was the second health priority for those residing in rural areas (Gamm et al., 2002). Given that individuals who reside in rural areas are more likely to experience circumstances and situations that could compromise their physical and mental health (Healthcare Cost Utilization Project, 2001), it makes sense that health concerns such as Coronary Artery Disease are such a persistent issue. These circumstances include poverty, physical inactivity, and alcohol abuse and dependence (Miller et al., 1987). Furthermore, the lack of rural health services and difficulties of traveling long distances to larger hospitals, increase the possibility that these rural residents will not receive the best preventative, medical, and psychological care (Wallace et al., 2006). Overall, the clear association between geographic status and Coronary Artery Disease leads to questions regarding whether geographic status may actually be a predictor of adverse outcomes following Coronary Artery Bypass Grafting surgery. Since depression is associated with adverse Coronary Artery Bypass Grafting outcomes (discussed previously), depressive symptomatology must also be taken into account in these investigations. This is particularly important because those who reside in rural areas experience the stressors mentioned above (poverty, alcohol abuse, etc.) and are likely to endorse some symptoms of depression as a result of these (or similar) situations.

In an attempt to address some of the above questions, Dao and colleagues (2010b) proposed a study investigating the relationships between depression, geographical status, and outcomes following Coronary Artery Bypass Grafting surgery. The primary focus was to determine the relationship between Coronary Artery Bypass Grafting outcomes, depression, and geographical status while controlling for medical and sociodemographic factors.

Secondarily, the study was designed to assess whether geographic status would serve as a moderating variable that would subsequently affect the relationship between depression and Coronary Artery Bypass Grafting surgery outcomes. The colleagues hypothesized that those living in the rural areas would have increased depression and that depression and geographical status would contribute to outcomes following Coronary Artery Bypass Grafting surgery (mortality and length of hospital stay). The results of the study indicated that rural patients were more likely than urban patients to have a concurrent depression diagnosis. In addition, both depression and living in rural areas combined were associated with less favorable outcomes (i.e., increased length of hospital stay) following Coronary Artery Bypass Grafting surgery. Similarly, those living in rural areas and having a depression diagnosis had an elevated probability of in-hospital mortality.

3.3 Anxiety as a moderator/mediator

Compared to depression and PTSD, there has been limited research on the influence of clinical anxiety in the relationship between psychological distress and outcomes following Coronary Artery Bypass Grafting surgery. The evidence that does exist suggests that anxiety in Coronary Artery Bypass Grafting patients contributes to post-surgery complications and elevated risk of sudden cardiac death (Rozanski et al., 1999; Stengrevics et al., 1996). In addition, it has been reported that up to 50% of patients undergoing Coronary Artery Bypass Grafting surgery have elevated anxiety scores (Januzzi et al., 2000; Rymaszewska et al; 2003; Krannich et al., 2007). Yet, there had been no previous evidence that those with anxiety would have better outcomes post-Coronary Artery Bypass Grafting surgery than those with depression and/or PTSD. In an effort to address this literature gap, Dao et al. (2011c) conducted a study investigating the relationship between anxiety and outcomes following Coronary Artery Bypass Grafting surgery. Results indicated that 27% of patients undergoing Coronary Artery Bypass Grafting surgery had a comorbid anxiety diagnosis, and patients who had non-routine discharge were more likely to have comorbid anxiety diagnoses compared to patients who had a routine discharge. Thus, for this study sample it was largely concluded that anxiety disorders are prevalent in patients who are undergoing a Coronary Artery Bypass Grafting surgery. Further, for this sample, anxiety was a significant independent predictor of both length of hospital stay and non-routine discharge for patients receiving Coronary Artery Bypass Grafting surgery.

It is expected that the number of octogenarians will increase from 6.9 million to 25 million by 2050 (Spencer, 1989). While there is a clear relationship between age and adverse Coronary Artery Bypass Grafting outcomes, the mechanism(s) underlying this relationship are not fully understood. There are two lines of evidence suggesting that psychosocial risk factors might mediate this relationship. Recent studies have suggested that Coronary Artery Bypass Grafting outcomes (e.g., mortality and patient disposition) cannot be fully explained by factors such as age, gender, and medical co-morbidities (Blumenthal et al., 2003). It has been reported that depression and anxiety can independently predict mortality and patient disposition following Coronary Artery Bypass Grafting surgery (Dao et al., 2010c). The second line of evidence has been shown in studies which have demonstrated the relationship between increased age with depression and anxiety disorders. The most common geriatric psychiatric disorders among the elderly are generalized anxiety disorder and depression (Beekmanet al., 1998). By simply looking at the relationship between age and Coronary Artery Bypass Grafting outcomes as linear, we may limit the understanding of potential critical mechanisms (i.e., mediators) influencing Coronary Artery Bypass Grafting outcomes.

Dao and colleagues (2011c) constructed a study to examine whether clinical levels of anxiety and depression act as a mediator between patient age and mortality and patient discharge status among octogenarian patients following Coronary Artery Bypass Grafting surgery. It was hypothesized that clinical anxiety and depression levels would mediate the relationship between increased age and Coronary Artery Bypass Grafting outcomes. This hypothesis was based on the established relationships between increased age and adverse Coronary Artery Bypass Grafting outcomes (Blumenthal et al., 2003), as well as the relationship between increased age and prevalence of anxiety and depression symptoms. Study results indicated that patients with an anxiety/depression diagnosis had a 6% higher postoperative mortality rate and had an 18% greater likelihood of having postoperative complications. In addition, it was found that an anxiety/depression diagnosis served as a partial mediator of the relationship between age and post-Coronary Artery Bypass Grafting outcomes for both postoperative mortality and discharge status.

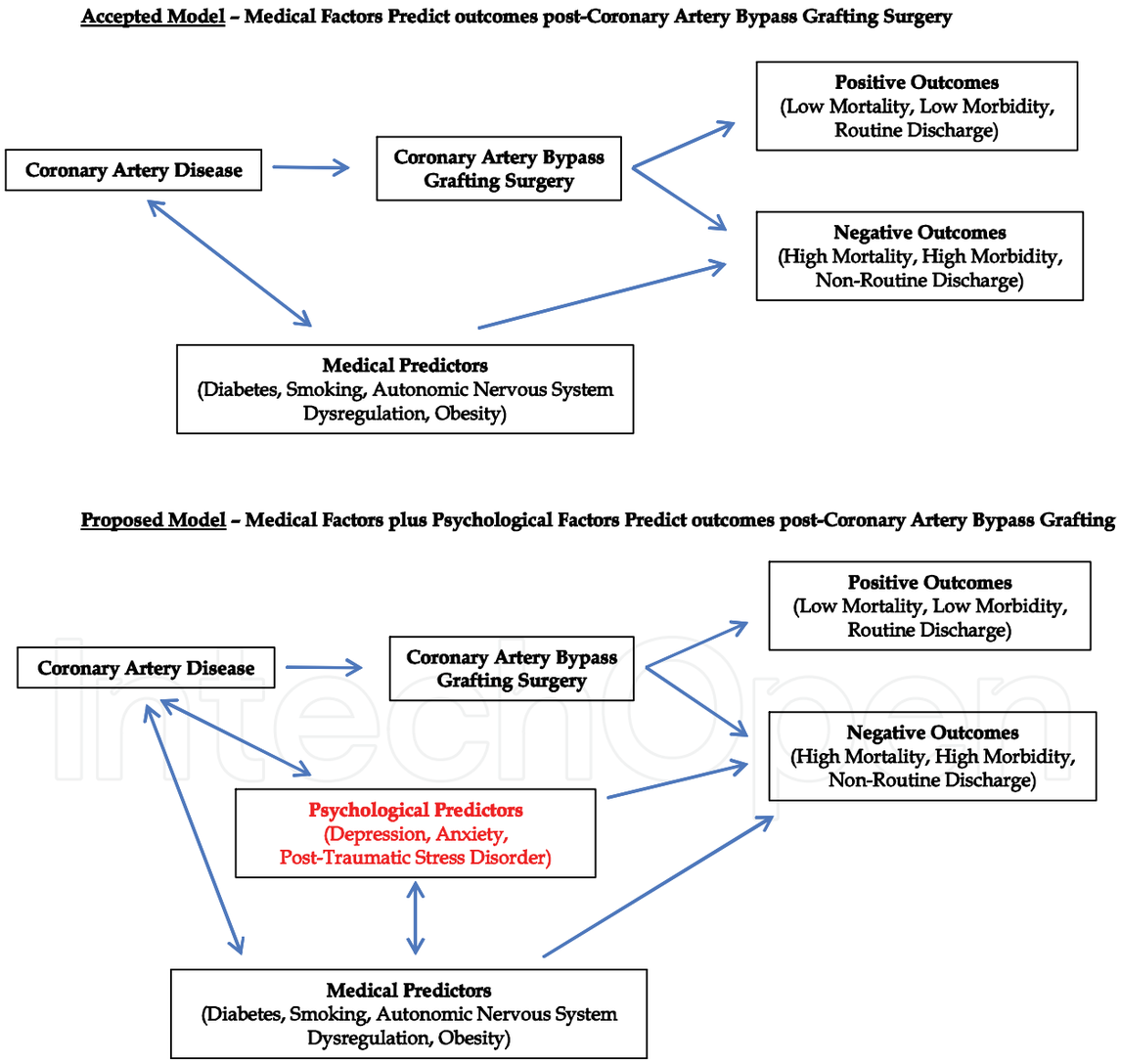


Fig. 1. Proposed Model of Psychological Factors Predicting Outcomes following Coronary Artery Bypass Grafting Surgery Versus the Traditional Medical Model

4. Treatments for comorbid psychological factors prior to Coronary Artery Bypass Grafting surgery

4.1 Treatment using Heart Rate Variability

Over the past several years, the relationship between emotional states and outcomes in cardiac patients has been the subject of increased scrutiny by researchers and clinicians (Doering et al., 2005). In particular, post-traumatic stress symptoms have been reported in up to 15 percent of Coronary Artery Bypass Grafting patients (Doerfler et al., 1994; Stoll et al., 2000). Similar to Coronary Artery Bypass Grafting patients with depression, higher levels of post-traumatic stress symptoms are related to increased mortality (Oxlad & Wade, 2006), lower health-related quality of life (Rothenhausler et al., 2010), and increased length of post-operative hospital stay (Oxlad et al., 2006). While several treatments for Post-Traumatic Stress Disorder have been proven to be effective, one of the primary drawbacks of these interventions is that they can be very lengthy and take weeks or months for treatment. Specifically, long term treatments are unrealistic and unfeasible given the sudden onset of Coronary Artery Bypass Grafting surgeries (Doerfler et al., 1994). Since there is evidence that patients suffering from Post-Traumatic Stress Disorder have an increased likelihood of mortality following Coronary Artery Bypass Grafting surgery (Dao et al., 2010a), in combination with length of treatment necessary for effective Post-Traumatic Stress Disorder care, there is a necessary need for an effective, short term treatment for improving outcomes following Coronary Artery Bypass Grafting surgery.

As mentioned earlier, Heart Rate Variability is a measure which examines the interplay between the parasympathetic and sympathetic influences on heart rate and represents the psychophysiological mechanism of emotion regulation (Appelhans & Luecken, 2006). In addition, increased Heart Rate Variability has been correlated with the increased capability of regulating stress, arousal, and attention (Bornstein et al., 2002). Recent research has demonstrated that the emotion regulation characteristics of patients with Post-Traumatic Stress Disorder have been associated with low Heart Rate Variability (Tan et al., 2010). Also, the physiological profile of a Coronary Artery Bypass Grafting patients with Post-Traumatic Stress Disorder may be complicated given purported research that low Heart Rate Variability is related to cardiovascular disease (van der Kolk, 2006). As previously discussed, it has been reported that patients with Coronary Artery Disease and a diagnosis of Post-Traumatic Stress Disorder have lower Heart Rate Variability than those patients with Coronary Artery Disease alone (Dao et al., 2010a; Krittayaphong et al., 1997; Stein et al., 2000). Since Post-Traumatic Stress Disorder and cardiovascular disease are associated with decreased Heart Rate Variability and Autonomic Nervous System dysregulation, Heart Rate Variability biofeedback training may reduce complications post-surgery. This has been supported by previous reports demonstrating that biofeedback training can increase Heart Rate Variability (Cohen et al., 2002; Tan et al., 2009). Other research has shown that Heart Rate Variability biofeedback training may be effective in reducing psychiatric symptoms associated with trauma (Karavidas et al., 2007; Zucker et al., 2009). Heart Rate Variability biofeedback training entails determining an individual's heart rate resonance frequency at baseline, calculating the optimal resonance frequency, and then providing specific breathing techniques to maximize his/her Heart Rate Variability (Lehrer et al., 2000).

Tan and colleagues (2010) reported that veterans with Post-Traumatic Stress Disorder exhibited significantly lower Heart Rate Variability compared to those without Post-Traumatic Stress Disorder. It was also discovered that those individuals receiving Heart Rate Variability biofeedback along with treatment as usual (TAU) had a significant reduction in Post-Traumatic Stress Disorder symptoms when compared to those receiving TAU alone (Tan et al.,

2010). Thus, evidence exists in support of the use of biofeedback as a potential, beneficial treatment for Post-Traumatic Stress Disorder. However, it remains unclear as to whether this treatment would be beneficial in reducing Post-Traumatic Stress Disorder symptoms in patients with Coronary Artery Disease or if it might improve outcomes post-Coronary Artery Bypass Grafting surgery. Incorporating Heart Rate Variability biofeedback training may result in Autonomic Nervous System regulation and subsequently improve outcomes post-surgery by reducing Post-Traumatic Stress Disorder symptoms.

Dao et al (2011b) proposed a study examining the efficacy of a Heart Rate Variability biofeedback treatment in 65 patients with Post-Traumatic Stress Disorder symptoms prior to Coronary Artery Bypass Grafting surgery. This study was designed to assess the impact of the Heart Rate Variability biofeedback intervention on Post-Traumatic Stress Disorder symptoms and in-hospital length of stay. It was hypothesized that symptoms associated with Post-Traumatic Stress Disorder would decrease following Heart Rate Variability biofeedback training and that their length of inpatient hospital duration would decrease following their Coronary Artery Bypass Grafting surgeries. The results from the study suggested that Heart Rate Variability biofeedback treatment can cause improvement in Post-Traumatic Stress Disorder symptoms in patients undergoing Coronary Artery Bypass Grafting surgery. It was also suggested that this treatment pre-surgery might improve patient quality of life and decrease the length of hospital stay.

4.2 Treatment using brief Cognitive Behavioral Therapy

While there have been some studies investigating the benefits of treating depression or anxiety in Coronary Artery Bypass Grafting patients postoperatively (Freedlandet al., 2009a; Freedlandet al., 2009b; Lie et al., 2007; Rollman et al., 2009), there has been little published investigating the impact of cognitive–behavioral approaches in treating depression or anxiety on Coronary Artery Bypass Grafting patients prior to surgery. Specifically, the SADHART (Sertraline Anti-Depressant Heart Attack Trial) study found a trend toward reduced cardiovascular mortality and morbidity when utilizing selective serotonin reuptake inhibitors. However, this trial had too small of a sample size and a too brief treatment duration to draw useful conclusions (Levin et al., 2005). Another study, the ENRICoronary Artery Disease (Enhancing Recovery in Coronary Heart Disease) trial found that cognitive behavioral therapy (CBT) after myocardial infarction had an effect on depression (Berkmanet al., 2003), but did not affect cardiac events such as nonfatal infarction, death from any cause, and cardiac death.

To further address questions stemming from the previous trials, Dao et al (2011a) proposed a study to examine the feasibility of a brief, tailored Cognitive Behavioral Therapy intervention entitled “Managing Anxiety and Depression using Education and Skills” (MADES), for treating patients with Coronary Artery Disease and symptoms of depression or anxiety prior to Coronary Artery Bypass Grafting surgery. The specific focus of this study was to assess the impact of this brief intervention on depression/anxiety symptoms and in-hospital length of stay. This study demonstrated that brief, tailored Cognitive Behavioral Therapy was not only feasible, but was successful in improving depressive/anxiety symptoms and quality of life while simultaneously reducing in-hospital length of stay.

5. Conclusion

5.1 What we still don’t know

The studies reviewed in this chapter are important for several reasons (for a brief synopsis of each article, please refer to Table 1). First, these studies highlight the importance of

psychological risk factors such as depression and anxiety in predicting adverse Coronary Artery Bypass Grafting outcomes. Second, the relations were more pronounced for certain groups of patients (e.g., rural versus non-rural and females versus males), which could help explain why females often seem to derive less functional benefit from Coronary Artery Bypass Grafting surgery than men. Third, while the treatment of presurgical and postsurgical depression and anxiety have not been extensively studied to date, the results thus far are somewhat promising. The aforementioned studies, however, do not fully explain the nature of psychological risk factors and outcomes following Coronary Artery Bypass Grafting surgery. In other words, are psychological risk factors such as depression and anxiety causal factors, directly related to adverse outcomes following Coronary Artery Bypass Grafting surgery? Or, are psychological risk factors risk markers, indirectly related to outcomes following Coronary Artery Bypass Grafting surgery through behavioral variables?

As pointed out by Rumsfeld and Ho (2005), the relations between psychological factors and adverse Coronary Artery Bypass Grafting outcomes may be mediated by behavioral mechanisms that are well documented in the literature to be associated with psychological symptoms. For instance, symptoms such as low energy or fatigue, loss of interest in activities, diminished ability to concentrate or indecisiveness, and psychomotor retardation are common in individuals diagnosed with depression. Thus, it is not surprising that these individuals are significantly less likely to adhere to prescribedmedications, follow lifestyle recommendations (e.g., exercising), practice self-management (e.g., monitor weight), and even follow up or receive recommended cardiac testing compared to those with no depression.

Overall, no studies to date have concurrently examined the physiological mechanisms (elevated plasma norepinephrine levels, cortisol, heart rate variability) and behavioral mechanisms (not following through with medication suggestions, lack of exercise, etc.) to determine which mechanisms (if any) are more responsible for adverse outcomes following Coronary Artery Bypass Grafting surgery.

Author	**Year**	**Sample Size**	**Sample Characteristics**	**Primary Outcome**	**Result**
Choi	2009	49,357	Pts who underwent CABG surgery	Compare outcomes of CABG surgery in VA versus non-VA hospitals	Pts who underwent CABG surgery at VA hospitals had significantly lower mortality rate than those at non-VA hospitals
Chu	2008	1,164	Pts who underwent CABG surgery	Compare outcomes of those with concurrent PVD with those that did not	PVD was a predictor of poor long-term survival among pts undergoing CABG surgery
Chu	2009	63,047	Pts who underwent on-pump CABG surgery or off-pump surgery	Compare outcomes of on-pump CABG surgery versus off-pump surgery	Off-pump did not produce lower mortality or stroke rates when compared to on-pump. Off-pump was associated with longer hospital stays and higher hospital costs

Table 1. Review of Research Reporting Predictors of Outcomes Following Coronary Artery Bypass Grafting Surgery

Author	Year	Sample Size	Sample Characteristics	Primary Outcome	Result
Dao	2010b	63,061	Pts who underwent CABG surgery	Compare outcomes and examine relationships between depression and geographic status following CABG surgery	Rural pts were more likely than urban pts to have a depression diagnosis Depression was a predictor of mortality and length of stay following CABG surgery Rural pts had increased lengths of hospital stays and increased mortality rates when compared to urban pts
Dao	2010c	62,665	Pts who underwent CABG surgery	Examine relationship between depression and PTSD on outcomes following CABG surgery	Depression and PTSD were prevalent in pts undergoing CABG surgery Depression and PTSD (and in combination) increased the risk of mortality as well as physical health risk factors following CABG surgery
Dao	2011a	100	Pts who were scheduled for CABG surgery	Examine the efficacy of a brief CBT for pts prior to CABG surgery	The intervention improved depressive and anxiety symptoms and quality of life and reduced length of hospital stay
Dao	2011b	65	Pts who underwent CABG surgery	Examine the efficacy of HRV biofeedback treatment for patients with PTSD prior to CABG surgery	HRV biofeedback training results in improvement in PTSD symptoms in patients undergoing CABG surgery, improves the quality of life, and decreases the length of hospital stay
Dao	2011c	17,885	Rural pts who underwent CABG surgery	Examine the effect of and anxiety and gender on outcomes following CABG surgery	Anxiety disorders are prevalent in rural patients who are undergoing a CABG operation Anxiety was a significant independent predictor of both length of hospital stay and non-routine discharge for patients receiving CABG surgery Females with an anxiety disorder seemed to have more aversive outcomes than males with an anxiety disorder

Table 1. Review of Research Reporting Predictors of Outcomes Following Coronary Artery Bypass Grafting Surgery (continuation)

Author	Year	Sample Size	Sample Characteristics	Primary Outcome	Result
Gopaldas	2009	5,731	Pts who were > 80 years of age that underwent CABG surgery	To examine outcomes and predictors of discharge status in pts> 80 years of age	27% were referred to home health care, 45% were transferred to another facility, 21% had normal discharge While those older than 80 years of age have acceptable mortality risk, these pts require further specialized care at discharge
Gopaldas	2010	614,177	Pts who underwent CABG surgery	Compare outcomes pre-work reform versus post-work reform	Work-hour reform did not affect mortality rates Work-hour reform was associated with increased morbidity
Mahoney	2011	51,266	Pts who were > 80 years of age that underwent CABG surgery	Investigate whether anxiety/depression mediates the relationship between age and outcomes following CABG surgery	Anxiety/depression diagnosis actsas a mediator through which age influences mortality and patient discharge status

Table 1. Review of Research Reporting Predictors of Outcomes Following Coronary Artery Bypass Grafting Surgery (continuation)

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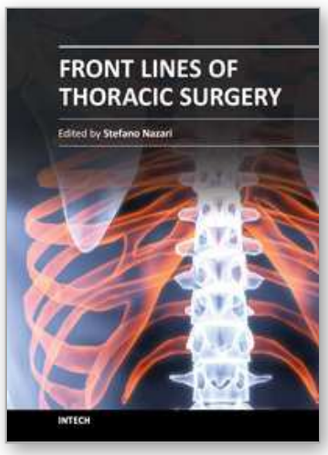
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Front Lines of Thoracic Surgery collects up-to-date contributions on some of the most debated topics in today's clinical practice of cardiac, aortic, and general thoracic surgery,and anesthesia as viewed by authors personally involved in their evolution. The strong and genuine enthusiasm of the authors was clearly perceptible in all their contributions and I'm sure that will further stimulate the reader to understand their messages. Moreover, the strict adhesion of the authors' original observations and findings to the evidence base proves that facts are the best guarantee of scientific value. This is not a standard textbook where the whole discipline is organically presented, but authors' contributions are simply listed in their pertaining subclasses of Thoracic Surgery. I'm sure that this original and very promising editorial format which has and free availability at its core further increases this book's value and it will be of interest to healthcare professionals and scientists dedicated to this field.

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