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# The Association between Age, Anxiety, and Outcomes Following Coronary Artery Bypass Graft Surgery

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Over 81,000,000 American adults have one or more types of cardiovascular disease (CVD). Of those, an estimated 17,600,000 American adults have coronary heart disease (CHD), which is the most common form of cardiovascular disease. CHD is the leading cause of death for both men and women (CDC, 2005) causing one of every six deaths in the United States (American Heart Association, 2006). Individuals who are diagnosed with CHD often have severe narrowing or blockage of the coronary arteries and are recommended for a procedure known as coronary artery bypass grafting surgery (CABG). Approximately 800,000 CABG procedures are performed annually in the U.S. (American Heart Association, 2006).

The aging of the U.S. population has led to an increase number of CABG operations among older adults with CHD (Carney et al., 1995; Luc et al., 1998). Furthermore, recent trends suggest that CABG patients are now generally older and sicker than those a decade ago (Ferguson, Hammill, Peterson, DeLong, & Frederick, 2002). Despite advances in medical care and improvements in surgical procedures, a consistent finding across the literature is that increasing age predicts poor CABG surgical outcomes. For instance, Hannan et al. (2003) found that older age was independently associated with higher readmission rates within 30 days of discharge following a CABG surgery. Rosenfeld et al. (2006) found that patients had increased intensive care length of hospital stay if they were older CABG patients. Similarly, Rosen et al. (1999) found that significant independent predictors of postoperative length of stay for CABG surgery included age with those older than 79 having the longest mean postoperative length of stay. More recently, researchers have found that age was independently associated with increased mortality and morbidity (Gopaldas et al., 2009; Tully et al., 2008).

Recent research suggests that CABG outcomes including length of hospital stay, recurrent cardiac events, and in-hospital mortality cannot be fully explained by traditional risk factors alone such as age, gender, and medical co-morbidities (Saur et al., 2001; Blumenthal et al., 2003). As a result, the role of psychological risk factors in explaining such outcomes has recently emerged. To date, multiple longitudinal and cross-sectional studies have examined the association between CABG outcomes and psychological functioning, including anxiety. Among the psychosocial risk factors, anxiety has been found to be specifically related to poor outcomes in patients undergoing cardiovascular surgery. For instance, Tully et al. (2008) found that preoperative anxiety symptoms were significantly associated with increased mortality risk after adjustment for known mortality risk factors. More recently, Dao et al. (2010) found in a nationwide sample that post traumatic stress disorder (PTSD), a subtype of anxiety disorders, was prevalent in patients undergoing a CABG procedure. Furthermore, having a PTSD diagnosis increased the risk of death by magnitudes comparable to well-established physical health risk factors following CABG surgery.

Anxiety disorders are the most common mental health disorders in adults with 1-year prevalence estimates around 18% (Kessler, Berguland, Demler, Jin, & Waters, 2005). It is estimated that anxiety disorders affect over 40 million adults age 18 years and older. Unlike relatively mild, brief anxiety caused by everyday stressful events, anxiety disorders last at least 6 months and these symptoms can potentially worsen if they are not treated. Research has found that anxiety disorders may affect people at different rates based on age. For instance, Brown, O'Leary, & Barlow (2001) summarized current prevalence estimates of generalized anxiety disorders (GAD) across different age groups, and reported that 17% of elderly men and 21.5% of elderly women experience severe anxiety. Furthermore, the rate of GAD in the elderly may be

the highest of any age group. Likewise, Wittchen (2002) found that generalized anxiety disorder is one of the most frequent anxiety disorders seen in primary care and is particularly prevalent among older adults. Beekman et.al (1998) found that anxiety disorders occur commonly among the elderly, with an overall prevalence of 10.2%. Collectively, these studies suggest that there is a significant association between age and anxiety disorders with the elderly at the greatest risk of having an anxiety disorder of any age group.

Although the relationship between age and adverse CABG outcomes is well established, the mechanism underlying this relationship remains unclear. Thus, the goal of this study was to examine whether clinical levels of anxiety act as a mediator between the age and three CABG outcome variables (length of hospital stay, mortality and patient discharge status). Based on the established relations between increased age and CABG outcomes, increased age and anxiety and anxiety symptoms and CABG outcomes, it was hypothesized that having an anxiety diagnosis will mediate the relationship between increased age and CABG outcomes.

## Methods

### *Data Source*

Data were collected from the Nationwide Inpatient Sample (NIS) 2008 database. The NIS is a part of the Healthcare Cost and Utilization Project (HCUP) and contains about 8 million hospital discharges sampled from 1,000 hospitals. The 2008 NIS database provides demographic, medical, and psychological disease severity measures, postoperative complications, discharge disposition, as well as procedure and diagnostic codes classified according the International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9, CM).

Institutional Review Board approval was obtained from the authors' University Human Subject's Committee. The reported data conform to the data-use agreement for the NIS from the Healthcare Cost and Utilization Project.

### *Patient Selection*

Using the 2008 NIS database, the discharge records of those who underwent primary CABG were identified. Independent variables in this study included age, gender (0=Female, 1=Male), race (0=White, 1=Other), median household income based on patient's zip code (0=$21,000 and above, 1= $0- $20,000) Deyo-Comorbidity-Index ( Deyo, Cherkin, & Ciol, 1992), and a clinical Anxiety diagnosis (1=Clinical Anxiety Diagnosis and 0=No Clinical Anxiety Diagnosis). The Comorbidity Index (Charlson, Pompei, & Ales, 1987) is designed to capture co-morbid conditions recorded in the inpatient setting using ICD-9-CM diagnosis and procedure codes. This index has been widely used in outcome studies with administrative data sets as the principle data source (Needham, Scales, Laupacis, & Pronovost, 2005). The Co-morbidity Index assesses co-morbid medical conditions such as myocardial infarction (MI),

congestive heart failure (CHF), peripheral vascular disease, cerebrovascular disease (CVD), dementia, chronic obstructive pulmonary disease (COPD), rheumatologic disease, mild liver disease, diabetes, diabetes with complications (DWC), hemiphegia or paraplegia, renal disease, malignancy, moderate to severe liver disease, metastatic solid tumors, and acquired immune deficiency syndrome (AIDS/human immunodeficiency virus (HIV). Outcome variables in this study were length of inpatient hospital stay (LOS), disposition of the patient, and in-hospital mortality. Length of inpatient hospital stay (measured in days) is defined as the difference between the hospital admission date and the date of the discharge for the patient. Disposition of the patient is defined as the status of release of the patient, (1=routine and 0= non-routine). Mortality is defined as the status of the patient following surgery, (1= died and 0= did not die.)

## Outcome Variables

The outcome variables in this study were in-hospital length of stay, mortality and patient discharge status (DCS). Because the NIS database contains only inpatient data, deaths occurring after hospital discharge were excluded from analyses. Surgical mortality was defined as death during the index admission (1= died and 0= did not die.). The DCS of each patient was classified into one of two categories (1=routine and 0= non-routine). Routine discharge was defined as normal convalescence without the need for additional support services or any form of home health care from physicians, paramedics, or other trained health care personnel. Non-routine discharges included all other types of patient dispositions (except death): transfers to skilled nursing facilities, hospice facilities, short-term–care hospitals, rehabilitation facilities, intermediate care facilities, and home-bound discharges with any type of additional special care, such as home health nursing, home intravenous administration, and home hospice care.

Discharges to nursing homes were counted only if the patient had not been admitted from a nursing home.

To examine whether having an anxiety disorder mediates the relationship between age and CABG outcomes, two logistic and one multivariate regression mediation analyses were conducted using Kenny and colleagues methods (Baron & Kenny, 1986; Judd & Kenny, 1981; Kenny, Kashy, & Bolger, 1998). According to this method, there are four steps performed with three logistic regression equations in establishing that a variable (i.e., anxiety diagnosis) mediates the relation between a predictor variable (i.e., age) and an outcome variable (i.e., length of stay, mortality or DCS). The first step is to show that there is a significant relation between the predictor and the outcome. The second step is to show that the predictor is related to the mediator. The third step is to show that the mediator is related to the outcome variable controlling for the effects of the predictor on the outcome. The final step is to show that the strength of the relation between the predictor and the outcome is significantly reduced when the mediator is added to the model. Sobel's test (1982) for mediation was used for testing the significance of the mediated effect.

*Results*

Demographics

Table 1 provides demographic and clinical data for the total sample. The sample consisted of mostly Caucasian (58%) males (71%) with mean age of 67 (SD=11.26). The majority of the sample had a median household income of $1-$20,099 (51%). The average Charlson-Comorbidity-Index score was 1.28 (SD=110). Comorbid conditions ranged from 0.0% to 35% for AIDS/HIV and MI, respectively.

Table 2 contains the analyses necessary to examine the meditational hypothesis that a clinical diagnosis of anxiety will mediate the relation between age and outcome variable length of stay. In table 2, following the steps outlined earlier for testing mediation: we first established that age (predictor) was significantly related to length of stay (outcome). The unstandardized coefficient (B= .123) associated with outcome variable length of stay was found to be significant (p<.001). Step 2 indicated that the unstandardized regression coefficient (B= .026) associated with age and having a clinical diagnosis of anxiety was significant as well (p< .001). In Step 3 the unstandardized coefficient (B= 4.420) associated with the relation between having a clinical diagnosis of anxiety (controlling for age) and length of stay was also significant (p<.001). Step 4 requires computing Sobel's T statistics. Based on this statistic, (Sobel's T= 73.72, p=0), the decrease in the unstandardized coefficient between age and length of stay from Step 1 (.123) to Step 3 (.104) is significant and suggests that a clinical diagnosis of anxiety partially mediates the relation between age and length of stay.

Table 3 contains the analyses necessary to examine the meditational hypothesis that a clinical diagnosis of anxiety will mediate the relation between age and outcome variable mortality. In table 3, we first established that age (predictor) was significantly related to mortality (outcome). The unstandardized coefficient (B= .032) associated with outcome variable mortality was found to be significant (p<.001). Step 2 indicated that the unstandardized regression coefficient (B= .026) associated with age and having a clinical diagnosis of anxiety was significant as well (p< .001). In Step 3 the unstandardized coefficient (B= -.385) associated with the relation between having a clinical diagnosis of anxiety (controlling for age) and mortality was also significant. The decrease in the unstandardized coefficient between age and mortality from Step 1 (B=.032) to Step 3 (B=. 030) is significant based on Sobel's T statistics

(Sobel's t= -10.64, p <. 001) and suggests that the presence of a clinical diagnosis of anxiety for those patients undergoing a CABG partially mediates the relation between age and mortality.

In Table 4, it was first established that age (predictor) was related to DCS. The unstandardized coefficient (B= -.049) associated with the effect on age and DCS was significant (p< .001). Step 2 indicated that the unstandardized regression coefficient (B=.026) associated with age and having a clinical diagnosis of anxiety was significant (p< .001). In Step 3, the unstandardized coefficient (B= .336) associated with the relation between having a clinical diagnosis of anxiety (controlling for age) and DCS was also significant. The decrease in the unstandardized coefficient between age and DCS from Step 1 (B= -.049) to Step 3 (B= -. 048) is significant based on Sobel's T statistics (Sobel's t=-19.05, p <. 001) and suggests that the presence of a clinical diagnosis of anxiety for those patients undergoing a CABG partially mediates the relation between age and DCS.

*Discussion*

There has been little systematic effort to investigate the role of psychological factors such as anxiety in explaining outcomes following CABG surgery. This study attempted to determine whether having an anxiety diagnosis is the mechanism through which a predictor influences an outcome variable.

In all three analyses, having an anxiety disorder partially mediated the relation between age and CABG outcomes. More specifically, the predicted length of in-hospital stay for those having an anxiety disorder diagnosis is approximately 4 days longer than those not having an anxiety disorder diagnosis, controlling for other independent variables. As the cost of inpatient hospitalization continues to increase, this finding has both clinical as well as practical

implications. For instance, the total cost associated with the surgery and in-hospital stay is about 38 thousand dollars (about 4 thousand dollars per hospital day). Reducing hospitalization even by one day will decrease cost by several thousand dollars per patient. This will also reduce use of resources such as hospital staff, equipments, beds, etc., which makes them available for other patients in need of care.

Table 3 reflects the results of steps 1-4 to establish anxiety as mediation variable between age and mortality. Step 1 results reflect a significant relation between age and mortality following CABG surgery. Results of Step 1 suggest the odds of dying are 3% greater for every one year increase in age. Results of Step 2 suggest that the odds of having an anxiety disorder diagnosis are 2% greater for every one year increase in age. Step 3 results suggest that having an anxiety disorder diagnosis compared to not having an anxiety disorder diagnosis were seven tenth as likely die. Furthermore, the results in step 4, using the Sobel's test allowed us to conclude that anxiety partially mediate the relationship between age and death following CABG surgery.

Table 4 reflects the results of steps 1-4 to establish anxiety as a mediation variable between age and disposition. The results in Step 1 suggests that  that odds of having a non-routine discharge are 5% less for every one year increase in age. Step 2 results indicate the odds of having an anxiety disorder diagnosis are 3% greater for every one year increase in age.  Step 3 results suggest that the presence of anxiety yields a 40% greater chance of a having non-routine discharge.  In step 4, using the Sobel's test, we were able to conclude that anxiety partially mediate the relationship between age and disposition following CABG surgery.

Findings from the present study suggest that having an anxiety disorder diagnosis is a significant partial mediator between age and CABG outcomes such as length of hospital stay,

mortality and DCS. Within the context of trying to improve patient outcomes following CABG surgery, measuring underlying change mechanism (i.e., mediators) as well as outcomes provides information on which mechanisms are critical for influencing outcomes. This information can enable cardiac surgeons and their surgical team to focus on the effective components of treatments.

*Limitations*

This study has potential limitations that can arise from reliance on the Nationwide Inpatient Sample database (NIS). The NIS database is as accurate at the ICD-9 codes entered by hospital administrators. Furthermore, the findings will be based on the ICD-9-CM diagnosis codes. For instance, a potential limitations associated with using code-based co morbidity indexes, such as the Deyo-index, is the possibility of coding errors.

A statistical regression threat to the internal validity could potentially be a limitation to this study. For example, samples that are selected according to their extreme scores have a tendency to regress towards the mean. Nevertheless, the results from this study provide additional support for the importance of pre-surgery screening for anxiety as well as the development of short-term treatments for anxiety that may facilitate better outcomes following CABG surgeries. These limitations should be addressed prospectively in future investigations.

Table 1. Demographics and Clinical Data of CABG patients

| | |
|---|---|
| Age, years | 67.23± 11.26 |
| Sex | |
| Male | 217271 (71%) |
| Female | 90281 (29%) |
| Race | |
| Caucasian | 179490 (58%) |
| Other | 128160 (42%) |
| Median Household Income Based on Zip Code | |
| $0-20.9K | 157768 (51%) |
| $21K-greater | 142281 (49%) |
| Deyo Index | 1.28 ±1.10 |
| Myocardial Infarction | 107506 (35%) |
| Congestive Heart Failure | 67838 (22%) |
| Peripheral Vascular Disease | 22107 (7%) |
| Cerebrovascular Disease | 17979 (6%) |
| Dementia | 154 (.1%) |
| COPD | 51831 (17%) |
| Rheumatologic Disease | 3766 (1%) |
| Peptic Ulcer Disease | 3141 (1%) |
| Mild Liver Disease | 897 (.3%) |
| Diabetes | 90328 (29%) |
| Diabetes with Chronic Complications | 12545 (4%) |
| Hemiplegia or Paraplegia | 951 (.3%) |
| Renal Disease | 1408 (.5%) |
| Malignancy | 4096 (1%) |
| Moderate or Severe Liver Disease | 231 (.1%) |
| Metastatic Solid Tumor | 320 (.1%) |
| AIDS/HIV | 0 (0) |
| Anxiety | 81087 (26%) |

Notes. Data are presented as number (%) or as mean ± standard deviation. COPD=chronic obstructive pulmonary disease. AIDS/HIV-human immunodeficiency virus/acquired immune deficiency syndrome.

Table 2. Testing Mediator Effects of Anxiety on Length of Stay

| Testing Steps in Mediation Model | B | SE | Odds Ratio | 95% CI | P value |
|---|---|---|---|---|---|
| Testing Step 1 | | | | | |
| Outcome: Length of Stay | | | | | |
| Predictor: Age (years) | .123 | .001 | | | <.001 |
| Testing Step 2 | | | | | |
| Outcome: Anxiety | | | | | |
| Predictor: Age (years) | .026 | .001 | 1.026 | 1.024-1.029 | <.001 |
| Testing 3 | | | | | |
| Outcome: Length of Stay | | | | | |
| Mediator: Anxiety | 4.420 | .048 | | | <.001 |
| Predictor: Age (years ) | .104 | .001 | | | <.001 |

Note. Sobel's t= 73.7; p= 0

Table 3. Testing Mediator Effects of Anxiety on Mortality

| Testing Step 1 | B | SE | Odds Ratio | 95%CI | P value |
|---|---|---|---|---|---|
| Outcome: Mortality | | | | | |
| Predictor: Age (years) | .032 | .001 | 1.033 | 1.031-1.035 | <.001 |
| Testing Step 2 | | | | | |
| Outcome: Anxiety | | | | | |
| Predictor: Age (years) | .026 | .001 | 1.026 | 1.024-1.029 | <.001 |
| Testing Step 3: | | | | | |
| Outcome: Mortality | | | | | |
| Mediator: Anxiety | -.385 | .033 | .681 | .639-.726 | <.001 |
| Predictor: Age (years) | .030 | .001 | 1.031 | 1.028-1.033 | <.001 |

Note. Died=1 No Alive=0 Sobel's t= -10.64, p=0

Table 4. Testing Mediator Effects of Anxiety on Disposition

| | | | | | |
|---|---|---|---|---|---|
| Testing Step 1 | B | SE | Odd Ratio | 95%CI | P value |
| Outcome: Disposition | | | | | |
| Predictor: Age (years) | -.049 | .000 | .952 | .951-.953 | <.001 |
| Testing Step 2 | | | | | |
| Outcome: Anxiety | | | | | |
| Predictor: Age (years) | .026 | .001 | 1.026 | 1.024-1.029 | <.001 |
| Testing Step 3: | | | | | |
| Outcome: Disposition | | | | | |
| Mediator: Anxiety | .336 | .012 | 1.400 | 1.367-1.433 | <.001 |
| Predictor: Age (years) | -.048 | .000 | .953 | .953-.954 | <.001 |
| Note. Non-routine-1; Routine=0 | Sobel's t= | | p=0 | | |

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