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Marriage and mortality after noncardiac surgery



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ABSTRACT

Background: Marriage is linked to substantial societal and economic benefits, and it has been associated with improved outcomes following acute illness. However, it is not known if being married confers benefit to patients undergoing noncardiac surgical procedures.

Materials and methods: Patients undergoing any noncardiac surgical procedure were included over a period of 19 months. All-cause mortality at 2 years was determined by linking patient records to the National Death Index. Risk adjustment was performed using Cox modeling and the Cleveland Clinic risk stratification index.

Results: Of the 11,588 patients included, 7830 (68.0%) were married at the time of surgery. There was a significant interaction between sex and marital status ($P = 0.03$), so the remainder of the analysis was performed separately by sex. Among men, not being married was associated with significantly worse survival (hazard ratio [HR]: 1.31, 95% confidence interval [CI]: 1.06, 1.63), whereas among women, there was no significant association between marital status and survival (HR: 0.94, 95% CI: 0.77, 1.15). Furthermore, divorced men (HR: 1.76, 95% CI: 1.25, 2.51) and never married men (HR: 1.53, 95% CI: 1.14, 2.05) had significantly worse survival than married men, whereas there was no significant difference between widowed men and married men, nor when comparing widowed, divorced, or never married women to married women.

Conclusions: Among a diverse group of surgical patients, being married at the time of surgery is associated with significantly improved survival only among men. Focused efforts to improve social support for unmarried male patients may improve outcomes.

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Introduction

The institution of marriage has been a central topic in national and international news over the past decade, especially within the context of political, judicial, and legislative activities. Previous studies have demonstrated that marriage can lead to substantial psychologic, economic, and social benefits.^{1–3} In this light, there is growing concern about decreasing

rates of marriage.⁴ According to the Centers for Disease Control and Prevention in the United States, the national marriage rate decreased from 0.82% in 2000 to 0.69% in 2014.⁵ This was associated with a decrease in the percentage of married men from 57.9% to 53.8% and the percent of married women from 54.7% to 51.4% over the same period.⁶ Given the importance of this topic there is considerable interest in understanding whether marriage is beneficial to health related outcomes.

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As early as 1913, an editorial published in the *Journal of the American Medical Association (JAMA)* raised the question of the association of marital status and long-term survival, especially among men.⁷ Since that time, multiple studies have investigated the impact of marital status on financial and emotional well-being.^{2,3} For example, a recent analysis by the National Bureau of Economic Research found that among retirement age individuals, married households had nearly 10 times the amount of savings as a single-person household.¹ Furthermore, married individuals have been found to have a reduced overall risk of mortality as compared to single individuals, and this gap appears to be increasing.⁸⁻¹¹ Another study found that married patients presented with less severe illnesses, were less likely to be discharged to a nursing home, and were less likely to have longer hospital lengths of stay and reduced hospital charges.¹² In addition, a national study demonstrated that marital status is significantly associated with long-term survival among patients being treated for cancer.¹³

It is not known, however, if marital status is associated with survival following a diverse group of surgical procedures. With nearly 51.4 million inpatient procedures being performed per year in the United States, small changes in pre-procedural risk can lead to substantial variations in outcomes.¹⁴ Therefore, we sought to determine the association of marital status and long-term survival among patients undergoing a diverse group of general surgical procedures. We also wished to study how this association varies by patient sex and whether this association is stable by type of unmarried status (never married, divorced, or widowed).

Materials and methods

Patient population

Adult patients (≥ 18 years of age) undergoing a non-cardiothoracic surgical procedure at Duke University Medical Center between January 2007 and September 2008 were included using a database compiled in a previously published analysis.¹⁵ This previous analysis focused on a different topic (acute hemodynamic effects of the sedative dexmedetomidine) and did not include any information about marriage or long-term mortality. Patients who did not have an electronic history and physical examination and electronic anesthesia record on file were excluded, as were patients who had a surgical procedure lasting less than or equal to 60 minutes. Finally, patients with a subsequent same-day surgery were also excluded. This study was approved by the Duke University Institutional Review Board.

Variables

Patient demographics were retrieved from the patient's electronic history and physical. Diagnosis and procedure codes recorded according to the International Classification of Diseases, ninth edition coding system were also retrieved from patient medical records. The 1-year Cleveland Clinic risk stratification index (RSI) was used to adjust for patient comorbidities and procedural severity. As previously described, the Cleveland Clinic RSI was created from a random

sampling of half of the 2001-2006 Medicare Provider Analysis and Review files, including 17,589,824 patient records and validated on a similarly sized validation cohort as well as a single-institution registry of 103,324 patients to develop models which predicted hospital length of stay, in-hospital mortality, 30-day mortality, and 1-year mortality.¹⁶ From an initial model including all possible International Classification of Diseases, ninth edition diagnostic and procedural codes, the final Cleveland Clinic RSI for 1-year mortality incorporated 503 diagnostic and procedural codes.¹⁶ The Cleveland Clinic RSI has been found to be a better predictor of 1-year mortality than the Charlson-Deyo comorbidity index, perhaps one of the most commonly used methods to adjust for patient comorbidities (c-statistic for 1-year mortality: 0.83 versus 0.77 for Cleveland Clinic RSI versus Charlson-Deyo comorbidity index).¹⁶

Mortality within 2 years of the index procedure was determined by linking patients with the National Death Index (NDI) based on name, date of birth, and social security identification number. The NDI is a centralized database of death record information compiled by the National Center for Health Statistics with the aid of state vital statistics offices. Updated yearly, the NDI contains death records from 1979 through 2013.¹⁷ Of the available national mortality databases, the NDI has been demonstrated to have the highest sensitivity for recording mortality.¹⁸

Statistical analysis

All analyses were performed by the study's statistician (WDW; co-author). Patients were grouped based on marital status (yes versus no). Patient demographics and the 1-year Cleveland Clinic RSI was compiled by group. Continuous variables were compared using the Wilcoxon rank sum test. Categorical variables were compared using Fisher's exact test or the chi-squared test as appropriate. In addition, the type of procedure was categorized by surgical specialty based on the first current procedural terminology code of the index procedure.

A Cox proportional hazards regression model taking into account age, sex, and the 1-Year Cleveland Clinic RSI was used to determine the adjusted association between marriage status and overall survival. Initially, based on clinical concerns that there may be an interaction between marital status and sex, an interaction term was included in the model between these variables. If found to be significant, the sample was then split by sex, and the models were rerun in these subgroups. In addition, a secondary analysis in which unmarried patients were divided by single status including never married, widowed, and divorced was performed to determine if the effect of marital status was similar among these subgroups.

The proportional hazards assumption was tested for all Cox models. A *P*-value of 0.05 was used to define statistical significance. All analyses were performed using SAS Version 9.1 (SAS Institute, Cary, North Carolina.)

Results

A total of 11,588 patients were enrolled, of whom 7830 (67.6%) patients were married at the time of the procedure. Among

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