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Review article

Surgical outcomes for patients diagnosed with dementia: A coarsened exact matching study

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ABSTRACT

Background: An increasing number of elderly patients with dementia are undergoing surgical operations. Little is known about the differential impact of dementia on surgical outcomes. We investigated whether demented patients undergoing surgical operations have worse outcomes than their non-demented counterparts.

Methods: We performed a cohort study of all patients undergoing a series of surgical operations who were registered in the New York Statewide Planning and Research Cooperative System (SPARCS) database from 2009 to 2013. We examined the association of dementia with inpatient case-fatality, discharge to a facility, and length of stay (LOS). Coarsened exact matching was used to balance comorbidities among the comparison groups, and mixed effect methods were used to control for clustering at the hospital level.

Results: During the study period, 342,075 patients underwent surgical operations that met the inclusion criteria. Multivariable logistic regression models, after coarsened exact matching, demonstrated that demented patients were not associated with higher case-fatality (OR, 0.43; 95% CI, 0.13–1.36), but were associated with higher rates of discharge to a facility (OR, 1.71; 95% CI, 1.26–2.31) and longer LOS (Adjusted difference, 31%; 95% CI, 26%–36%). These persisted in pre-specified subgroups stratified on particular operations.

Conclusions: Using a comprehensive all-payer cohort of surgical patients in New York State we identified an association of dementia with increased rate of discharge to rehabilitation and longer LOS. No difference was identified in the case fatality of the two groups. Policy makers, payers, and physicians should take these findings into account when designing new policies, and when counseling patients.

1. Introduction

As the US population is aging [1], and safer surgical and anesthetic techniques are developed, older and more debilitated patients are now undergoing surgery [2,3]. In this setting, patients with dementia are increasingly undergoing surgery for a wide variety of conditions [3,4]. Although some studies suggested that individuals with dementia are healthier than age-matched controls [5], more recent evidence reveals greater comorbidity in demented patients [1,4,6]. Management of comorbid conditions is more challenging in the presence of dementia due to the often-limited ability of the patient to communicate, or adhere to treatment recommendations [7]. Clinicians therefore need to coordinate medical care through surrogates. Additionally, presence of dementia may affect health professionals' care decisions, especially about surgical indications [6]. In this context, concerns have been raised about the surgical outcomes of this population in comparison to their non-demented counterparts [3].

The impacts of dementia on surgery are complex. Most previous studies focused on specific procedures, such as hip surgery, or minor procedures, such as cataracts or hernia repair, and had limited general applicability because of the single center retrospective study design [8,9]. Other multi-center investigations lack appropriate control for confounding factors – most specifically, matching

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comparison groups based on their comorbidities so that similar patients (outside of dementia status) are compared [3]. There has been no previous study addressing this question in a comprehensive, all-payer, appropriately matched cohort of surgical patients.

We used the New York Statewide Planning and Research Cooperative System (SPARCS) [10] to study the association of dementia with case-fatality, discharge to a facility, and length of stay (LOS) for patients undergoing surgery. Following coarsened exact matching, a multivariable analysis was used to control for confounders and minimize differences between the comparison groups.

2. Methods

2.1. New York Statewide Planning and research Cooperative System (SPARCS)

This study was approved by our institutional Committee for Protection of Human Subjects. This study is based on de-identified data and therefore the consent process was waived by the committee. All patients who were hospitalized for a series of surgical operations and registered in the SPARCS (New York State Department of Health, Albany, NY) [10] database between 2009 and 2013 were included in the analysis. For these years, SPARCS contains patient-level details for every hospital discharge, ambulatory surgery, and emergency department admission in New York State as coded from admission and billing records. More information about SPARCS is available at https://www.health.ny.gov/statistics/sparcs/.

2.2. Cohort definition

To establish the cohort of patients, we used *International Classification of Disease-9-Clinical Modification* (ICD-9-CM) codes to identify adult (18 years and older) patients in the database, who were hospitalized after abdominal aortic aneurysm (AAA) repair, carotid endarterectomy (CEA), coronary artery bypass graft (CABG), cardiac valve replacement, cystectomy, esophagectomy, lung resection, pancreatic resection, craniotomy, and spine surgery (Table S2) between 2009 and 2013.

2.3. Outcome variables

The primary outcome variable was case-fatality during the initial hospitalization after the surgical operations above. Secondary outcomes were length of stay (LOS) during the initial hospitalization, and discharge to a facility. The latter included all locations of disposition other than the patient's home.

2.4. Exposure variables

The primary exposure variable was whether the patient was diagnosed with dementia. This was defined as *International Classification of Disease-9-Current Modification* (ICD-9-CM) codes 290.xx, 331.0–331.2 at the time of admission to the hospital for the operation.

Covariates (Table S1) used for risk-adjustment were age, gender, race (African-American, Hispanic, Asian, Caucasian, other), insurance (private, Medicare, Medicaid, uninsured, other), and the specific type procedure performed.

The comorbidities used for risk adjustment were diabetes mellitus (DM), smoking, chronic lung disease, hypertension, hypercholesterolemia, peripheral vascular disease (PVD), congestive heart failure (CHF), coronary artery disease (CAD), history of ischemic stroke, history of transient ischemic attack (TIA), alcohol abuse, obesity, chronic renal failure (CRF), and coagulopathy. Only variables that were defined as "present on admission" were considered part of the patient's comorbidity profile.

2.5. Statistical analysis

The association of dementia with our outcome measures was examined in a multivariable setting.

A logistic regression was used for the categorical outcomes (case-fatality, discharge to a facility), and a linear regression for the linear outcomes (LOS). The values of LOS were positively skewed and therefore were log transformed for the purpose of the analysis. The covariates used for risk adjustment in these models were: age, gender, race, insurance, the specific type of surgery performed and all the comorbidities mentioned previously. Fixed effects were used for surgery type.

In an alternative way to control for confounding in differences between the two groups (demented, non-demented) we utilized coarsened exact matching methods [11,12]. Matched patient cohorts were created after balancing the covariates to reduce the risk of confounding by indication. The *MatchIt* package [13] in the 64-bit version of R.3.1.0 was used. Our data set was matched across the following variables: age, gender, race, insurance status, and specific procedure performed. Cohorts were matched using coarsened exact matching using the *MatchIt* package [13]. Balance among the covariates after coarsened exact matching was assessed with numerical diagnostics, quantile-quantile plots, histograms, and jitter plots. The dataset underwent matching, the matched cohort was imported into the Zeilig package and used in a logistic regression (logit) model with the same variables as our prior logistic regression.

In order to demonstrate the robustness of our data in a sensitivity analysis, we used standard techniques to account for measured confounding, while accounting for clustering at the hospital level. For categorical outcomes we used a logistic regression model with hospital ID as a random effects variable, while controlling for all the covariates mentioned previously. For continuous outcomes, we performed similar analyses using linear models. Finally, we repeated the above analyses in pre-specified subgroups, specific to the procedure performed. The direction of the observed associations did not change and therefore these results are not reported further.

Regression diagnostics were performed for all models. All results are based on two sided tests, and the level of statistical significance was set at 0.05. This study, based on 342,075 patients, has sufficient power (80%) at a 5% type I error rate to detect differences in case-fatality as small as 7.8%.

3. Results

3.1. Patient characteristics

In the selected study period there were 342,075 patients hospitalized after surgery who were registered in SPARCS. The mean age was 60.8 years, with 44.3% females. 1313 were diagnosed with dementia preoperatively, and 340,762 were not. The characteristics of the two cohorts at baseline can be seen in Table 1.

3.2. Inpatient case-fatality

Overall, 54 (4.11%) inpatient deaths were recorded among patients with preoperative diagnosis of dementia and 6623 (1.94%) among those without. Dementia was not associated with higher case-fatality (OR, 1.13; 95% CI, 0.86–1.50) in unadjusted analysis. Likewise, using a logistic regression model after coarsened exact matching, we identified that patients with dementia

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