Preoperative Cognition and Surgical Outcomes Results

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June 14, 2022

0.1 Methods

Data from 2013-04-22 to 2018-05-18 were queried from the MetaVision electronic health record. Patients were matched to hospital admission, discharge, billing and mortality data. Records were filtered to include those with preoperative clinic visits with AD8 and SBT measured, surgery within 90 days of that clinic visit, and matching billing and discharge records. A subset of surgical procedures were included into the analytical dataset, procedure codes for which are in the appendix. This restriction was intended to reduce confounding due to surgical complexity. That is, we suspect that patients with impaired cognition may be selectively referred to medical vs surgical management of their conditions, and that patients with impaired cogition will be referred for surgeries with less physiologic stress. These procedures were felt to be ones with little variation in overall surgical complexity which would contribute to this selection bias.

Because our principal outcomes (readmission, discharge to home) and inclusion critereon (procedure codes) are generated at the hospitalization level, we treat that as the unit of analysis. Readmission in 30 days and length of stay was only considered for patients with discharge to home.

Association between preoperative cognitive impairment (defined as a Short Blessed Test >= 2 or a AD8 >= 5) was assesed using logistic regression models adjusting for surgical procedure type, sex, age using a 5 degree of freedom cublic spline, indicator variables for history of diabetes, chronic kidney disease, chronic obstructive pulmonary disease, stroke or transient ischemic attack, active cancer, and congestive heart failure.
Each hospitalization can have procedures qualifying in multiple categories; we created indicator variables for each procedure category and assumed additivity for hospitalizations with more than one type of procedure. Logisitic regression models with the same adjustment startegy were considered for readmission and near-term death. A log-link generalized linear model (quasipoisson) with the same set of adjusting variables was used for length of stay.

Heterogeneity of association between abnormal cognition and outcomes was assessed using an expanded model with an interaction term and a score-test.

To compare the predictive value of AD8 and SBT, we used two approaches. First, we used a k-fold cross-validation method (K=100) fitting logistic regression models predicting each outcome using AD8 or SBT, then assessing the accuracy by area under the receiver operating characteristic curve in the hold-out sample. Each 100 pairs of accuracy metrics are then compared by a paired t-test. Second, we used the Vuong test for non-nested models https://doi.org/10.2307/1912557 implemented by the "nonnest2" package version 0.5-5.

All analysis was conducted using R 4.1.2. A repository containing the analysis code is available at https://github.com/cryanking/cognition_discharge

0.2 Notes from CRK

1. Gyn-onc cases are a little problematic. We detect that they have e.g. a hysterectomy in them, but they are also giant resections.
2. I replaced "lobectomy" (which is uncommon) with VATS. I think it might be a good idea to break the SB/CR and hysterectomy procedures into open vs not.
3. I do not have an easy way to scan for reason for readmission

4. Some of the exploratory outcomes are difficult: reoperation is hard to define, sepsis is not cleanly defined, troponins are not well recorded
5. None of the exploratory outcomes are meaningfully associated. I am happy to put that in an appendix.

0.3 Results

The filtered dataset included 6118 distinct patients with 6665 hospitalizations. Characteristics of the cohort and overall outcome rates are given in Table 1. AD8 was abnormal (>=2) in 3.5 percent of included patients; SBT was abnormal (>=5) in 14 percent of included patients.

Table 1: Descriptive statistics stratified by Cognition status. P-values for quantitative variables by Mann-Whitney U, factor variables by Fisher's exact test. CAD = Coronary artery disease, low barthel = Barthel Index < 100, CHF = Congestive heart failure, AF = Atrial fibrillation or flutter history, DM = Diabetes mellitus, low functional capacity = functional capacity estimated < 4 METs, HTN = hypertension, COPD = Chronic obstructive pulmonary diseae, CKD = chronic kidney disease, CVA = history of stroke or transient ischemic attack, BMI= body mass index, dc home = discharge to home, readmit 30 = readmission within 30 days, LoS = postoperative hospital length of stay computed from first qualifying procedure, death = death in hospistal or within 30 days of surgery

	normal	impaired cognition	p
n	5388	1277	
sex = 2 (%)	3143 (58.3)	717 (56.1)	0.156
race (%)			<0.001
White	4172 (77.4)	878 (68.8)	
Black	261 (4.8)	130 (10.2)	
Other	215 (4.0)	82 (6.4)	
Missing	740 (13.7)	187 (14.6)	
low_barthel (%)			<0.001
FALSE	3896 (72.3)	709 (55.5)	
TRUE	1313 (24.4)	519 (40.6)	
(Missing)	179 (3.3)	49 (3.8)	
CAD (%)	971 (92.7)	326 (92.4)	0.814
CHF (%)	341 (6.3)	135 (10.6)	<0.001
AF (%)	589 (95.3)	185 (93.9)	0.455
DM (%)	1215 (22.6)	353 (27.6)	<0.001
HTN (%)	3873 (96.7)	998 (96.3)	0.631
COPD (%)	444 (8.2)	182 (14.3)	<0.001
CKD (%)	754 (86.8)	282 (92.5)	0.007
CVA (%)	508 (9.4)	209 (16.4)	<0.001
Current_cancer (%)	1018 (18.9)	297 (23.3)	0.001
low_functional_capacity (%)	2268 (42.1)	795 (62.3)	<0.001
Age (median [IQR])	71 [68, 75]	74 [69, 79]	<0.001
BMI (median [IQR])	29 [26, 34]	29 [25, 33]	<0.001
dc_home (%)	4660 (86.5)	1002 (78.5)	<0.001
readmit_30 (%)	637 (11.8)	185 (14.5)	0.011
death (%)	36 (0.7)	8 (0.6)	1.000
ICU (%)	402 (7.5)	111 (8.7)	0.144
LoS (median [IQR])	3 [2, 5]	3 [2, 6]	<0.001

Table 2: Number of Procedures by Type

Surgery Type	N
total knee	1328
total hip	1130
total shoulder	986
hysterectomy	599
lumbar fusion	527
intestinal	510
nephrectomy	272
prostatectomy	257
VATS	255
pancreatic	252
AV fistula	205
cystectomy	106
gastric	94
cholecystectomy	91
lap hiatal hernia	53

The frequency of each type of surgery is displayed in 2. The frequencies do not add up to the number of hospitalizations because of multiple procedures per hospitalization.

```
## Warning: The ‘x‘ argument of ‘as_tibble.matrix()‘ must have unique column names if ‘.name_repair‘ is
## Using compatibility ‘.name_repair‘.
## This warning is displayed once every 8 hours.
## Call ‘lifecycle::last_lifecycle_warnings()‘ to see where this warning was generated.
```

We found that impaired cognition was significantly associated with discharge to other than home (odds ratio 1.55, 95% CI 1.31 to 1.83, p = <0.001). For readmission in 30 days, impaired cognition was not a significant predictor (odds ratio 1.06, 95% CI 0.86 to 1.31, p = 0.109). Similarly for near-term death, impaired cognition was not a significant predictor (odds ratio 0.66, 95% CI 0.28 to 1.40, p = 0.308). Similarly, impaired cognition was not a significant predictor of length of stay (duration ratio 1.05, 95% CI 0.98 to 1.18, p = 0.102).

We found modest evidence of heterogeneity by type of surgery, although power for this question is limited by small sample sizes in some surgery types. A score test comparing models with and without interaction terms yielded a p-value of 0.073 A forest plot is presented in Figure 1.

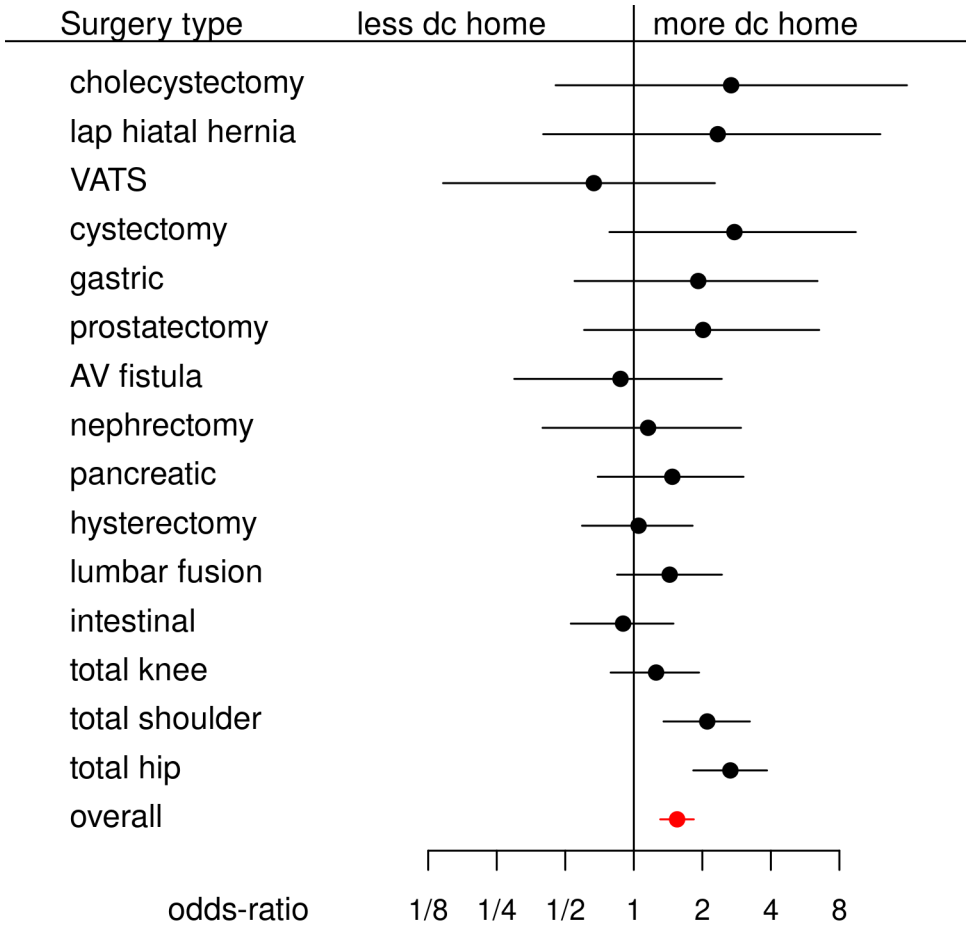

Figure 1: Odd-ratio for discharge to other than home with impaired cogition by surgery type. Dot = point estimate, lines 95 % confidence intervals