Epic data Results

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0.1 Methods

Data from 2018-08-31 to 2020-12-30 were queried from the Epic 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, CVA_Stroke, cancer status, 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. # (need to check with Ryan) # 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(need to check with Ryan)

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 8315 distinct patients with 8950 hospitalizations. Characteristics of the cohort and overall outcome rates are given in Table 1. AD8 was abnormal ($>=2$) in 3.7 percent of included patients; SBT was abnormal ($>=5$) in 17.8 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, CHF = Congestive heart failure, Diabetes = Diabetes mellitus, COPD = Chronic obstructive pulmonary diseae, CKD = chronic kidney disease, CVA_Stroke = history of stroke or transient ischemic attack, dc_home = discharge to home, readmit = readmission within 30 days, los = postoperative hospital length of stay computed from first qualifying procedure, death = death in hospital or within 30 days of surgery

	normal	impaired cognition	p
n	7128	1822	
Sex = 2 (%)	3530 (49.5)	993 (54.5)	<0.001
RACE (%)			NA
-1	48 (0.7)	17 (0.9)	
0	6392 (89.7)	1436 (78.8)	
1	637 (8.9)	357 (19.6)	
2	45 (0.6)	11 (0.6)	
3	6 (0.1)	1 (0.1)	
CAD (%)	1856 (26.0)	639 (35.1)	<0.001
CHF (%)	830 (11.6)	379 (20.8)	<0.001
Diabetes (%)	2115 (29.7)	684 (37.5)	<0.001
COPD (%)	1189 (16.7)	423 (23.2)	<0.001
CKD (%)	1646 (23.1)	603 (33.1)	<0.001
CVA_Stroke (%)	447 (6.3)	276 (15.1)	<0.001
cancerStatus (%)			NA
0	4646 (65.2)	1224 (67.2)	
2	901 (12.6)	193 (10.6)	
3	1388 (19.5)	339 (18.6)	
4	193 (2.7)	66 (3.6)	
age (median [IQR])	72 [68, 76]	74 [69, 79]	<0.001
dc_home (%)	1139 (16.0)	662 (36.3)	<0.001
readmit (%)	318 (4.5)	90 (4.9)	0.379
death (%)	164 (2.3)	109 (6.0)	<0.001
ICU (%)	1228 (17.2)	426 (23.4)	<0.001
los (median [IQR])	4 [2, 9]	5 [2, 11]	<0.001

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'.
```

Table 2: Number of Procedures by Type

Surgery Type	N
AV fistula	7
VATS	49
lap hiatal hernia	56
cholecystectomy	81
cystectomy	92
nephrectomy	156
gastric	168
pancreatic	174
prostatectomy	294
lumbar fusion	406
total hip	417
total knee	480
hysterectomy	491
total shoulder	491
intestinal	662

```
## 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 home (odds ratio 2.50, 95% CI 2.21 to 2.83, p = <0.001). For readmission in 30 days, impaired cognition was not a significant predictor (odds ratio 0.92, 95% CI 0.66 to 1.27, p = 0.167). Similarly for near-term death, impaired cognition was a significant predictor (odds ratio 1.94, 95% CI 1.49 to 2.52, p = <0.001). Similarly, impaired cognition was not a significant predictor of length of stay (duration ratio 1.04, 95% CI 0.91 to 1.06, p = 0.647).

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 0.446 A forest plot is presented in Figure 1.
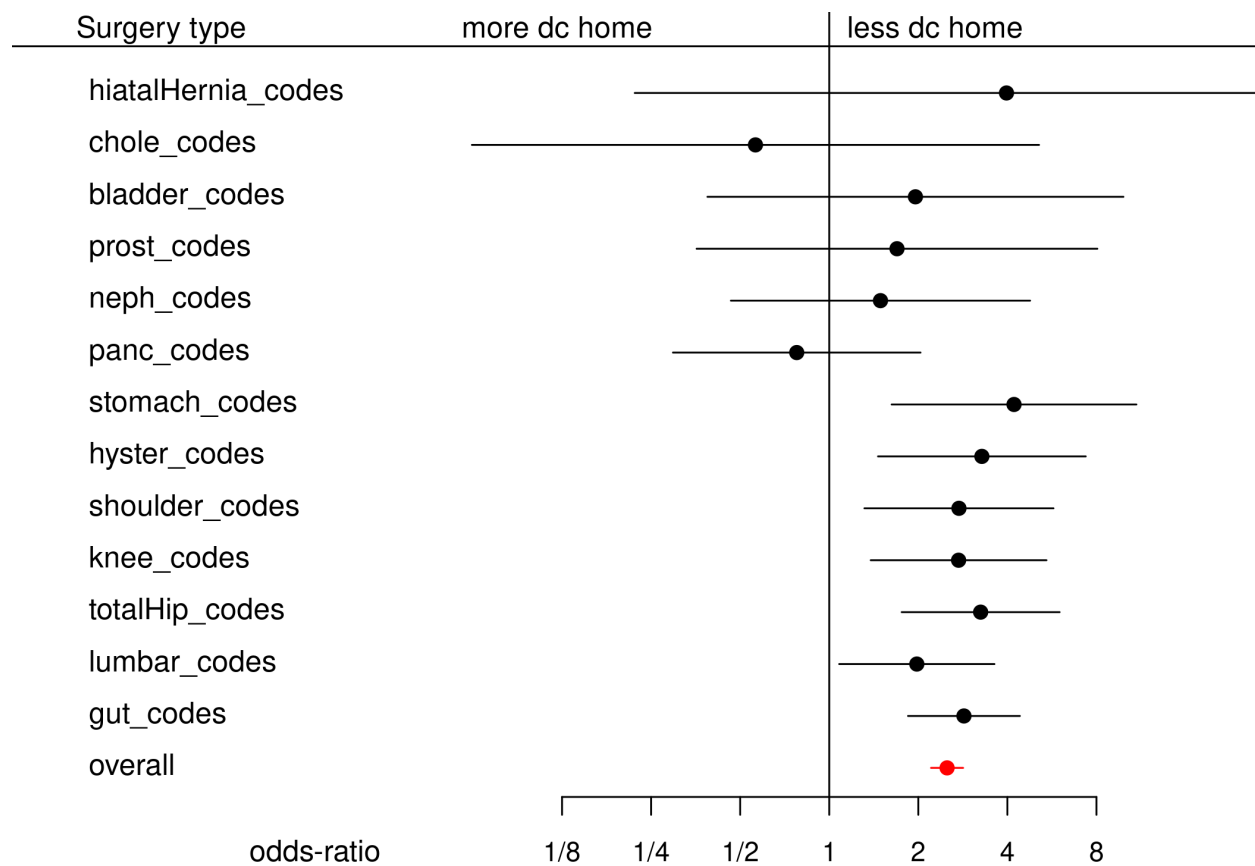
Figure 1: Odd-ratio for discharge to home with impaired cogition by surgery type. Dot = point estimate, lines 95 % confidence intervals