Breast Cancer Diagnosis and Advanced Imaging

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Choosing Wisely Recommendation

On April 4, 2012, the American Society of Clinical Oncology's Choosing Wisely initiative advised against using PET, CT, or radionuclide bone scans to stage patients with early stage breast cancer at a low risk of metastasis.

Research Questions

- Did the rate of scans change after the Choosing Wisely recommendation?
- What variables can explain why patients are getting scanned when they should not be, or are not getting scanned when they should be?

MiBOQI Dataset

The Michigan Breast Oncology Quality Initiative was a multi-center collaborative effort to improve and standardize the care of breast cancer in Michigan. From 2006 to 2015, up to 25 cancer centers participated in recording data on their breast cancer patients.

Stage	Before	After	Total
Stage 0, I, II	19404	14674	34078
Stage III, IV	2491	1706	4197
NA	585	404	989
Total	22480	16784	39264

Table 1: Sample sizes by stage and time relative to the recommendation at diagnosis. Diagnoses occurring before or during 2012 are considered to occur before the recommendation.

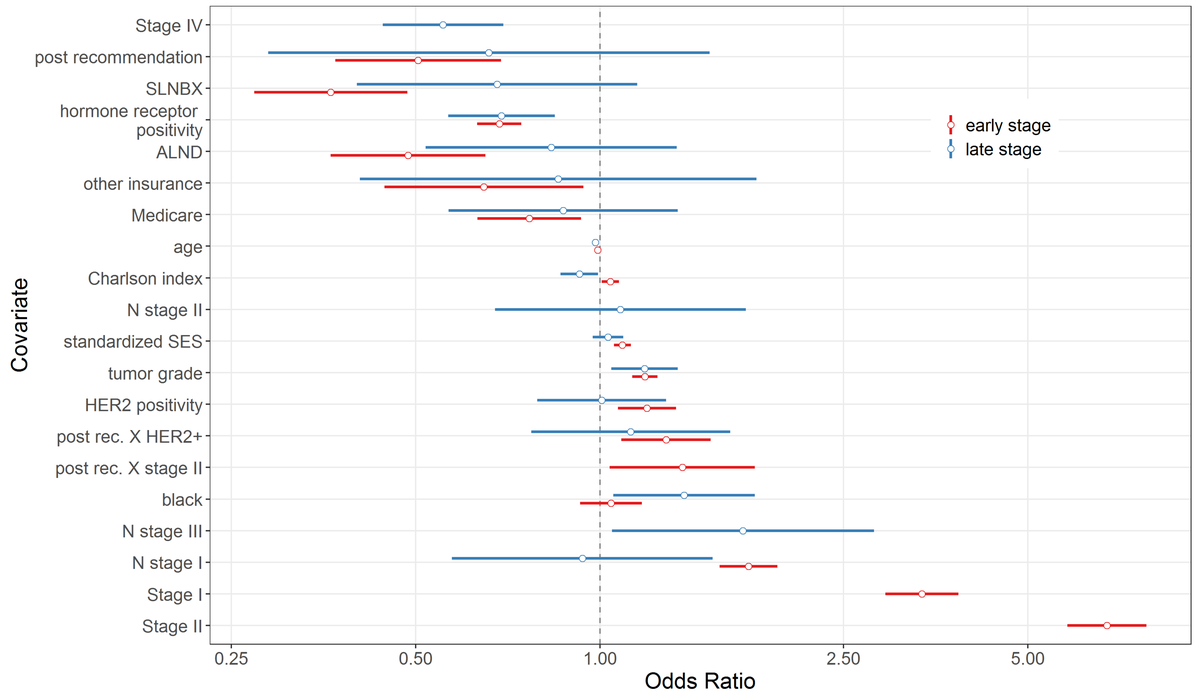

Figure 1: 95% confidence intervals of coefficients that are significant in at least one model. Models are fit to a baseline of a white, pre recommendation, N stage 0 patient on Medicaid. Early stage model baseline is Stage 0; late stage model baseline is Stage III. Standardized SES is inversely related to actual SES. N stage II is significant in the early stage model (interval (7.4, 247.8), point estimate 42.9) but omitted for space.

Missing Data

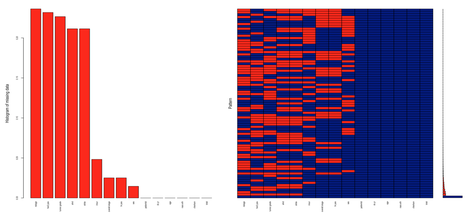

Figure 2: Missing Data Pattern

There is a large proportion of missing data (less than 60% of the data are complete cases) and there is evidence of MAR, especially for HER2 positivity. Therefore, there is a need to do multiple imputation to guarantee the validity of our analysis.

Multiple Imputation

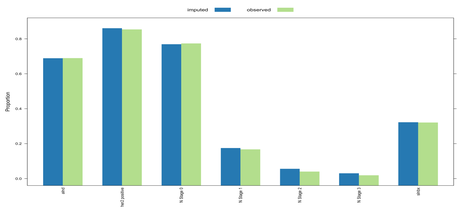

Figure 3: Comparison of Imputed and Observed Data

Using the mice package in R, we generated five imputed datasets by setting the number of iterations to 15. The bar plot above shows that the distribution of the variables in imputed dataset is close to the observed data.

Logistic Regression

The probability of receiving a scan within 90 days of diagnosis is modeled as a function of baseline covariates using logistic regression. Separate models are fit for early stage (Stage 0, I, or II) and late stage (Stage III, IV) patients.

All covariates are considered to have fixed effects with the sole exception of the random effects of zip codes of patient residences. The early stage model estimates this random effect has a variance of 0.25 and the late stage model estimates a variance of 0.10.

Conclusion

In the early stage model, the odds of receiving a scan after the recommendation are about 0.50 times the odds of receiving a scan before the recommendation. In the late stage model, that odds ratio is lower in magnitude and is not significant. The evidence suggests that after the Choosing Wisely recommendation, the likelihood of women with early stage breast cancer getting scanned decreased, moreso than the likelihood for late stage women.

Of the other characteristics associated with likelihood of receiving scans, N Stage II is remarkably highly associated with early stage women receiving scans. The significant effects of SES and primary insurer are also notable. While the effect of Medicare may be due to confounding by age, the association between lower SES and lower odds of receiving a scan may indicate a concerning lack of standardization of patient care.