Using Machine Learning to Predict Survival Following Prostatectomy

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INTRODUCTION

Tissue biopsy and the Gleason scale remain the standard care to predict the aggressiveness of prostate cancer. Recent studies have shown that other clinical factors including comorbidities and genes may play significant roles in determining overall survival. [1] Existing nomograms including Memorial Sloan Kettering Cancer Center's (MSKCC) prostate cancer nomograms do not incorporate comorbidities when predicting survival. This study aimed to use comorbidities to predict survival for prostate cancer patients following radical prostatectomy.

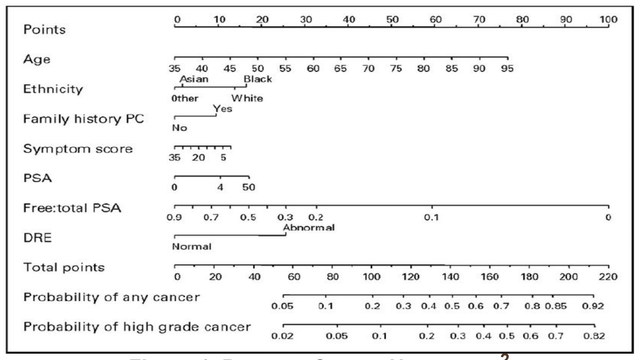

Figure 1. Prostate Cancer Nomogram[2]

METHODS

This study used electronic health record data from MIMIC-III (Medical Information Mart for Intensive Care III), a database containing de-identified data associated with forty thousand patients in critical care units of Beth Israel Deaconess Medical Center between 2001 and 2012.[3] International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes corresponding to comorbidities were mapped onto the broader Clinical Classifications Software codes from patients diagnosed with prostate cancer using the ICD-9-CM code 185. Using age as an indicator for survival, linear regression models from the PredictMD machine learning pipeline were applied to determine comorbidities that impacted survival prediction.[4] P-values less than .05 were considered significant.

RESULTS

Electronic health record data on 608 patients were analyzed. Certain comorbidities play significant roles in determining survival for patients in emergency care who had previously underwent prostatectomies. The most significant comorbidities include cognitive disorders, intestinal infections, fractures, surgical and medical care complications, and respiratory tract infections. Some of these comorbidities were common to predicting survival in all patients in emergency care based on a separate study [5]. Others including cognitive disorders, intestinal infections, fractures, and surgical and medical care complications were unique to those who underwent prostatectomies.

Figure 2. Unified Modeling Language Diagram

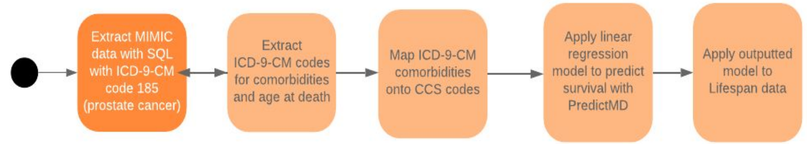

Table 1. Comorbidities Determining Survival in Prostatectomy Patients in Emergency Care

Comorbidity	P-value
Delirium, dementia, cognitive disorders	0.0026
Intestinal Infection	0.0094
Fracture of Lower Limb	0.0103
Complications of Surgical Procedures or Medical Care	0.0293
Acute Bronchitis	0.0359
Spinal Cord Injury	0.0386
Poisoning by Other Medications and Drugs	0.0436
Respiratory Tract Infection	0.0483
Chronic Ulcer of Skin	0.0524
Shock	0.0547
Fracture of Neck of Femur	0.0579
Calculus of Urinary Tract	0.0621
Nephritis, Nephrosis, Renal Sclerosis	0.0645

Table 2. Comorbidities Determining Survival in All Patients in Emergency Care

Comorbidity
Non-Infectious Lung Disease
Renal Disease
Ischemic Heart Disease
Neoplasms
Diseases of the Blood
Major Injuries
Infectious/Parasitic Diseases
Pneumonia
Endocrine, Nutritional, Immunity, Metabolic Disorders
Cerebrovascular Disease
COPD
CHF
Other Respiratory Diseases

DISCUSSION

In emergency care, patients who underwent prostatectomies and have comorbidities such as cognitive disorders, intestinal infections, and fractures are at especially high risk of mortality. Thus, physicians should treat these patients with extreme care. Based on the comparison to all patients in emergency care, these comorbidities are uniquely linked to patients who underwent prostatectomy. These findings support the notion that certain comorbidities may help predict overall survival in patients following prostatectomy and should be incorporated into existing nomograms. Next steps will be to analyze data on a cohort of patients outside of the emergency care setting as well as use the time between prostatectomy and death as a marker of survival instead of age.

CONCLUSION

The findings of this study demonstrate that comorbidities play a significant role in determining overall survival in patients following prostatectomy. The integration of comorbidities into nomograms should offer physicians a better tool to predict survival for their patients following prostatectomy.

References

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