**VA Risk Scores**

Background of VAPD database: 2014-2017 VA nationwide inpatient data. For the VA risk score, we selected only hospital day 1 (at admission) of each hospitalization.

**Section 1: Risk adjustment**

Our goal was to adjust for hospitalization- and hospital-level covariates to account for differences in case-mix. Using the dataset that contains all hospitalizations, we used a severity of illness score for each hospitalization at the time of admission. The severity of illness score is defined as the predicted probability of 30-day mortality (from admission) using a logistic model that adjusts for hospitalization-level risk factors at the time of admission. Our model for severity of illness includes the following hospitalization-level covariates (see Table 1A for more details):

**Demographics**: Age, gender, race, Hispanic ethnicity

**Diagnoses**: all granular diagnosis groups and the top 20 most frequent specific diagnoses. The granular diagnosis groups are the level 1 diagnoses from Healthcare Cost and Utilization (HCUP)1 multilevel Clinical Classification Software (CCS) and the specific diagnoses groups are the single-level CCS diagnosis groups.

**Laboratory** **values**: Acute Physiology and Chronic Health Evaluation (APACHE) III scores2 for labs drawn on the first calendar day of admission. These labs include albumin, bilirubin, blood urea nitrogen, creatinine, glucose, hematocrit, PaO2, partial pressure of carbon dioxide (PaCO2) and pH, sodium, and white blood cell.

**Comorbidities**: Indicators for 30 comorbidities (included in Elixhauser4)

We used the APACHE III scores for labs instead of the raw lab values to consider the nonlinear relationships that some labs have with 30-day mortality. The overall c-statistic of our illness severity measure is 0.849. The top 20 single-level diagnoses accounted for 49.8% of hospitalizations.

The SAS code used to generate illness severity score:

/\*Predicted mortality using logistic regression\*/

proc logistic data=HAVE plots(maxpoints=none)=all;

class gender (ref="M") /\*use Male as the reference group \*/

race (ref="WHITE") /\*use White as the reference group \*/

hispanic (ref="1")) /\*Hispanic as the reference group \*/

chf\_nonhp sepsis alcohol dysrhythmia pneumonia

copd coron\_athero osteoarthros skin\_infection chestpain

complic\_devi uti diabmel\_w\_cm complic\_proc acute\_ren\_fail

backproblem acute\_mi adlt\_resp\_fl gi\_hemorrhag Fluid\_elc\_dx

Infect\_parasitic\_dis Neoplasms Endocrine blood\_dis Mental\_Illness nervous\_dis circulatory respiratory

digestive genitourinary pregnancy skin musculoskeletal Congenital\_anomalies perinatal Injury\_poisoning

illdefined\_conditions unclassified;

model mort30\_admit /\*30-day mortality is the outcome\*/ (event='1') =

/\*patient characteristics\*/

AGE gender race hispanic

/\*lab scores\*/

wbc\_sc albval\_sc bili\_sc bun\_sc glucose\_sc

hct\_sc na\_sc pao2\_sc ph\_sc creat\_sc

/\*comorbodities indicators at bedsection, n=30\*/

htn chf cardic\_arrhym valvular\_d2 pulm\_circ pvd paralysis neuro pulm dm\_uncomp dm\_comp

hypothyroid renal liver pud ah lymphoma cancer\_met cancer\_nonmet ra coag obesity wtloss

fen anemia\_cbl anemia\_def etoh drug psychoses depression

/\*top 20 diagnosis groups of single level and all of 18 multi-level CCS\*/

chf\_nonhp sepsis alcohol dysrhythmia pneumonia

copd coron\_athero osteoarthros skin\_infection chestpain

complic\_devi uti diabmel\_w\_cm complic\_proc acute\_ren\_fail

backproblem acute\_mi adlt\_resp\_fl gi\_hemorrhag Fluid\_elc\_dx

Infect\_parasitic\_dis Neoplasms Endocrine blood\_dis Mental\_Illness nervous\_dis circulatory respiratory

digestive genitourinary pregnancy skin musculoskeletal Congenital\_anomalies perinatal Injury\_poisoning

illdefined\_conditions unclassified;

output out=WANT

predicted=va\_risk\_score; /\*predicting the probability of 30-day mortality\*/

run;

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| --- | --- | --- |
| **Table 1A: Patient-level variables included in the risk adjustment/reliability adjustment models** | | |
| Severity of illness | VA risk score | Predicted probability of 30-day mortality from a logistic regression model that includes demographics, diagnoses, laboratory values and comorbidities at time of admission. |
| Demographics | age  gender  race  Hispanic | Age in years at admission  Male as reference group  Indicator for race, use White as reference group  Indicator for Hispanic, use Hispanic as reference group |
| Diagnoses | Indicators for all level 1 diagnoses from multi-level CCS; n=18  Indicators for the top 20 most frequent single-level CCS diagnoses | There are 18 level 1 multilevel CCS variables which group the diagnoses into broad categories. See Table 3 for the full list.  The top 20 most frequent single-level CCS diagnoses are re-generated each year. |
| Laboratory values | Scores for labs drawn on the first calendar day of admission. | albumin, bilirubin, blood urea nitrogen, creatinine, glucose, hematocrit, PaO2, partial pressure of carbon dioxide (PaCO2) and pH, sodium, and white blood cell |
| Comorbidities | Indicators for the 30 comorbidities included in Elixhauser | Congestive Heart Failure, Cardiac Arrhythmia, Valvular Disease, Pulmonary Circulation Disorders, Peripheral Vascular Disorders, Hypertension, Paralysis, Other Neurological Disorders, Chronic Pulmonary Disease, Diabetes Uncomplicated, Diabetes Complicated, Hypothyroidism, Renal Failure, Liver Disease, Peptic Ulcer Disease excluding bleeding, AIDS/HIV, Lymphoma, Metastatic Cancer, Solid Tumor without Metastasis, Rheumatoid Arthritis/collagen, Coagulopathy, Obesity, Weight Loss, Fluid and Electrolyte Disorders, Blood Loss Anemia, Deficiency Anemia, Alcohol Abuse, Drug Abuse, Psychoses, Depression |

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| --- | --- |
| **Table 3: Diagnoses included in the risk adjustment model** | |
| Level 1 of the multilevel CCS diagnoses | Top 20 single-level CCS diagnosis |
| 1. Infectious and parasitic diseases 2. Neoplasms 3. Endocrine; nutritional; and metabolic diseases and immunity disorders 4. Anemia 5. Mental illness 6. Diseases of the nervous system and sense organs 7. Diseases of the circulatory system 8. Diseases of the respiratory system 9. Diseases of the digestive system 10. Diseases of the genitourinary system 11. Complications of pregnancy; childbirth; and the puerperium 12. Diseases of the skin and subcutaneous tissue 13. Diseases of the musculoskeletal system and connective tissue 14. Congenital anomalies 15. Certain conditions originating in the perinatal period 16. Injury and poisoning 17. Symptoms; signs; and ill-defined conditions and factors influencing health status 18. Residual codes; unclassified; all E codes [259. and 260.] | 1. Congestive heart failure; non-hypertensive 2. Nonspecific chest pain 3. Coronary atherosclerosis and other heart disease 4. Cardiac dysrhythmias 5. Alcohol-related disorders 6. Septicemia (except in labor) 7. Chronic obstructive pulmonary disease and bronchiectasis 8. Pneumonia 9. Skin and subcutaneous tissue infections 10. Osteoarthritis 11. Complication of device; implant or graft 12. Complications of surgical procedures or medical care 13. Diabetes mellitus with complications 14. Respiratory failure; insufficiency; arrest (adult) 15. Urinary tract infections 16. Acute and unspecified renal failure 17. Spondylosis; intervertebral disc disorders; other back problems 18. Acute myocardial infarction 19. Fluid and electrolyte disorders 20. Gastrointestinal hemorrhage |

**References:**

1. HCUP. Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality. <www.hcup-us.ahrq.gov/home.jsp>. Published March 2019. Accessed 3/25/2019.

2. Render ML, Welsh DE, Kollef M, et al. Automated computerized intensive care unit severity of illness measure in the Department of Veterans Affairs: preliminary results. SISVistA Investigators. Scrutiny of ICU Severity Veterans Health Sysyems Technology Architecture. *Crit Care Med.* 2000;28(10):3540-3546.

3. Harrell FE, Jr., Lee KL, Mark DB. Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. *Statistics in medicine.* 1996;15(4):361-387.

4. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Med Care.* 2009;47(6):626-633.