

CBE 0369: Standardized Mortality Ratio for Dialysis Facilities

5.4.4a Risk/Case-mix Adjustment Modeling and/or Stratification Specifications

The methods for development of the risk factor models have been published and documented previously (Wolfe 1992; Wolfe 2001). The final risk adjustment is based on a Cox or relative risk model. In this model, covariates are taken to act multiplicatively on the death rate and the adjustment model is fitted with facility defining strata so as to provide valid estimates even if the distribution of adjustment variables differs across facilities. Relevant references are Cox (1972) and Kalbfleisch and Prentice (2002). All analyses are performed using SAS.

The denominator of SMR for a facility is the expected number of deaths from the patient-records meeting the inclusion criteria, based on the number of days attributed to that facility (the assignment rule will be detailed later), if the facility conforms to the national norm. Specifically, the expectation is calculated using a two-stage model. At Stage 1, we fit a Cox model [1] stratified by facility and adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, prevalent comorbidities, body mass index (BMI) at incidence, Medicare Advantage status, and calendar year. This stratified model allows each facility to have a distinct baseline survival function while retaining the same regression coefficients of all the adjusters across all the facilities. Stratification by facility avoids estimating facility effects directly and also reduces computational burden. A linear predictor using the estimates of regression coefficients will be computed for each patient and will be used as the offset term in the Stage 2 modeling. At Stage 2, we fit an unstratified Cox model, which includes the offset term from Stage 1 model as well as the race-specific age-adjusted state population death rates. The baseline hazard or survival function of this model has national norm interpretations. With the fitted model at Stage 2, we compute the expected probability of death for each patient based on the aforementioned adjusters and the number of days assigned to a facility. The denominator of SMR for a facility is then the summation of expected probabilities of death from all the patients assigned to that facility.

The patient characteristics included in the stage 1 model as covariates are:

- Age: Age is included as a piecewise continuous variable with different coefficients based on whether the patient is 0-13 years old, 14-60 years old, or 61+ years old.
- Sex
- Race: White, Black, Asian/PI, Native American or other
- Ethnicity: Hispanic, non-Hispanic or unknown
- Diabetes as cause of ESRD
- Duration of ESRD:
 - Less than one year
 - 1-2 years
 - 2-3 years
 - 3+ years

- Nursing home status in previous 365 days:
 - None (0 days)
 - Short term (0-89 days)
 - Long term ≥ 90 days)
- BMI at ESRD incidence:
 - BMI < 18.5
 - $18.5 \leq \text{BMI} < 25$
 - $25 \leq \text{BMI} < 30$
 - BMI ≥ 30
- Comorbidities at ESRD incidence:
 - Atherosclerotic heart disease
 - Cardiac disease
 - Diabetes other than as primary cause of ESRD (all types including diabetic retinopathy)
 - Congestive heart failure
 - Inability to ambulate
 - Chronic obstructive pulmonary disease
 - Inability to transfer
 - Malignant neoplasm, cancer
 - Peripheral vascular disease
 - Cerebrovascular disease, CVA, TIA
 - Tobacco use (current smoker)
 - Alcohol dependence
 - Drug dependence
 - No Medical Evidence (CMS-2728) Form
 - At least one of the comorbidities listed
- A set of prevalent comorbidities based on Medicare inpatient claims (individual comorbidities categorized into 90 groups – see below)
 - Includes an adjustment for Less than 6 Medicare covered months in prior calendar year
- Calendar year
- Medicare Advantage coverage

Beside main effects, two-way interaction terms between age, race, ethnicity, sex, duration of ESRD and diabetes as cause of ESRD are also included:

- Age and Race: Black
- Ethnicity and Race: Non-White
- Diabetes as cause of ESRD and Race
- Diabetes as cause of ESRD and Duration of ESRD
- Duration of ESRD: less than or equal to 1 year and Race
- Sex and Race: Black