

## Medicare FFS Readmission Rate Predictive Models

**Model 1: Average Annual Change: (16 over 15; 15 over 14; 14 over 13; averaged)**

**Model 2: Most Recent Annual Change: (17 YTD over 16YTD)**

**Model 3: 12MMA: 12-Month Moving Average**

**Model 4: 24MMA: 24-Month Moving Average**

**Model 5: Proc Forecast: Predictive Function in SAS**

The method implemented using SAS Proc FORECAST combines a deterministic time trend model with an autoregressive model, where the trend model is used to capture long-term behavior and the autoregressive model is appropriate for capturing short-term fluctuations. Specifically, the autoregressive parameters included in the model for the time series are selected by a stepwise auto-regression (STEPAR) procedure, so that autoregressive parameters are only included at those lags at which they are statistically significant. The stepwise autoregressive method is fully automatic. As a note, the STEPAR method assumes that the long-term trend is stable; that is, the time trend regression is fit to the whole series with equal weights for the observations.

The deterministic trend is probably the biggest drawback of this method. It essentially fits one, fixed trendline through all of the data, giving each data point equal weight. So that means the downward trends observed in the earlier periods gets as much weight as the “flat” trends in more recent years. This is why this method yields the lowest predicted 2018 rate – that lower predicted rate reflects older downward trends in the data.

**Model 6: ARIMA: Auto-Regressive Integrated Moving Average**

The autoregressive integrated moving average (ARIMA) model is a parametric statistical model to characterize the time series data. The ARIMA model is quite flexible with as many as six parameters to specify the model. In particular, these are the order of the autoregressive model, the degree of the differencing, and the order of the moving average model for both non-seasonable and seasonable part of the model. The auto.arima function in R implements an algorithm that combines multiple evaluation criteria (unit root tests, minimization of the second-order Akaike’s Information Criterion (or AICc), and maximum likelihood estimate (or MLE)) to automatically derive an optimal ARIMA model with recommended model coefficients. The key takeaway is that this fits structural models. While this means that trend forecasting is more flexible than in PROC FORECAST, the overall approach is less flexible than STL (see below)

**Model 7: STL: Seasonal and Trend decomposition using Loess**

The Seasonal and Trend decomposition using Loess (STL) is a versatile and robust method to explicitly divide a time series into three components – the seasonal component, the trend cycle, and the remainder component. Compared to other decomposition methods and the ARIMA models, STL has the advantages of allowing flexible seasonal component that can change over time, controllable smoothness for the trend component, as well as robustness to outliers. Its nonparametric approach allows a wider range of seasonal and trend effects and nonlinearity.