

STATISITCAL ANALYSIS

Monthly counts of avoidable stent were also extracted between January 2020 to June 2022. To estimate the intervention effect, an interrupted time series (ITS) with segmented regression analysis was performed to determine if the change was statistically significant. 'A time series is a continuous sequence of observations (values) on a population, taken repeatedly over time'¹. When an intervention is introduced in a defined time period, it interrupts the time series, allowing for the identification of change in level (the value at the beginning of the segment in series) and trend (slope of the line) before and after an intervention¹⁻⁴. Statistical analysis was performed using SAS Enterprise Guide 8.3 and AUTOREG procedures for ITS analysis. The approach used was to estimate the shifts in avoidable stent counts before and after the intervention.

RESULTS

Test statistics for the regression model suggested that the data had positive autocorrelation (Durbin-Waston (DW)=1.623, P-value<DW=0.0472 & P-value>DW=0.95), and data was stationary (p-value (Dickey-Fuller test) =0.0127). Autocorrelation function (ACFs) and Partial autocorrelation function (PACF) were used to identify the number of significant lags, where a lag is the number of time points between an observation and its previous values. As a result, AR (1) model was employed for this analysis. Table 7 shows the parameter estimates from ITS regression. Before the beginning of the observation/intervention period, the number of avoidable stents was 6.3. During pre-intervention period, the regression slope was -0.03 and showed no significant month-to-month change (p-value=0.825). The post intervention timeframe showed that immediately following the intervention, counts of avoidable stents significantly dropped by 6.1 (p-value=0.0088). The post-intervention timeframe indicated no significant change in the month-to-month trend/slope after intervention (p-value=0.3051) suggestive of sustained reduction.

Table 1. ITS Regression Estimate

Variable	Estimate	SE	t Value	P-value
Intercept (Level)	6.29	1.49	4.22	0.0003
Pre-Intervention (Slope)	-0.03	0.15	-0.22	0.8250
Intervention (Level)	-6.13	2.16	-2.84	0.0088
Post-Intervention (Slope)	0.26	0.24	1.05	0.3051

ITS using Segmented Regression Analysis

- Level change(immediate effect)
- Trend/Slope change(sustained effect)
- $y = \beta_0 + \beta_1 T + \beta_2 X + \beta_3 XT + \varepsilon$

y-dependent variable; β -coefficient; X-independent variable (study phase-intervention); T-Time; ε -residual/random error (or deviation from linear relation)

Impact model for segmented regression analysis of ITS data with one interruption

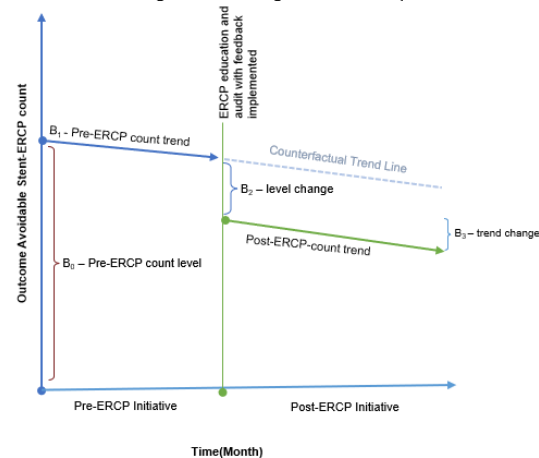


Figure 1: Impact model for single series segmented regression analysis

Reference

1. Bernal L, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a Tutorial. *Intl J Epidemiol* 2017;46:348–55.
2. Chatfield, C. (2003). *The Analysis of Time Series: An Introduction*, Sixth Edition (6th ed.). Chapman and Hall/CRC. <https://doi.org/10.4324/9780203491683>
3. Linden A. Conducting interrupted time-series analysis for Single- and multiple-group comparisons. *The Stata Journal* 2015;15:480–500.
4. Ramsay CR, Matowe L, Grilli R, et al. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *Int J Technol Assess Health Care* 2003;19:613:613–23.:
5. Wagner AK, Soumerai SB, Zhang F, et al. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther* 2002;27:299–309.

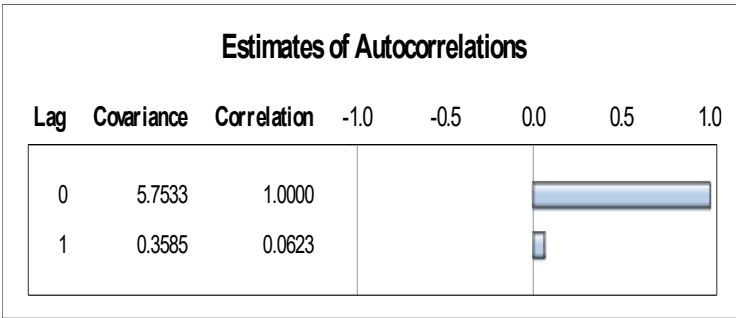
Appendix SAS Output:

Dependent Variable	counts
	counts

Ordinary Least Squares Estimates			
SSE	172.600372	DFE	26
MSE	6.63848	Root MSE	2.57652
SBC	151.234548	AIC	145.629759
MAE	1.82709976	AICC	147.229759
MAPE	50.6682563	HQC	147.422779
Durbin-Watson	1.6234	Total R-Square	0.5133

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	1.6234	0.0472	0.9528

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.



Preliminary MSE	5.7310
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Estimates of Autoregressive Parameters			
Lag	Coefficient	Standard Error	t Value
1	-0.062311	0.199611	-0.31

Algorithm
converged.

AR(1) Model

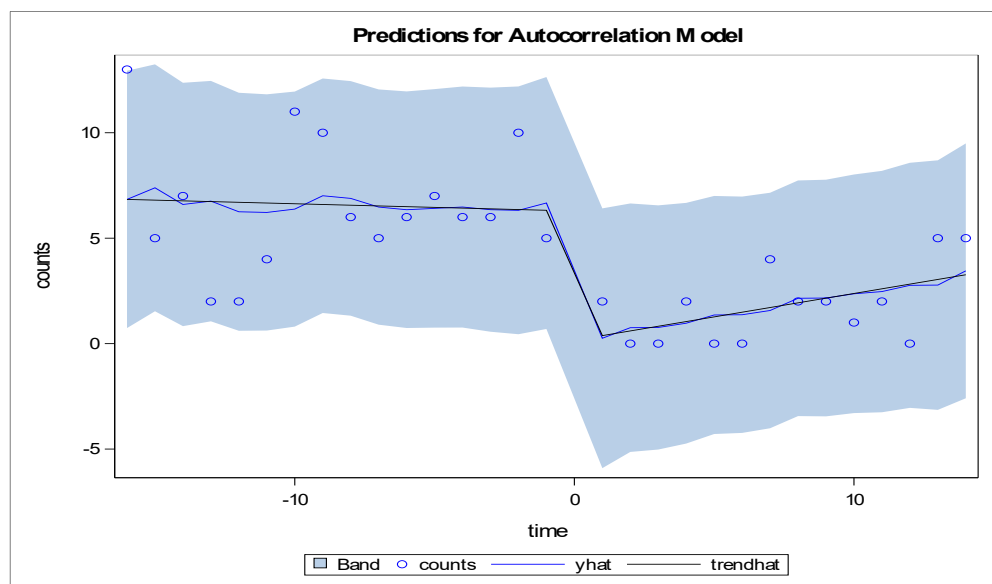
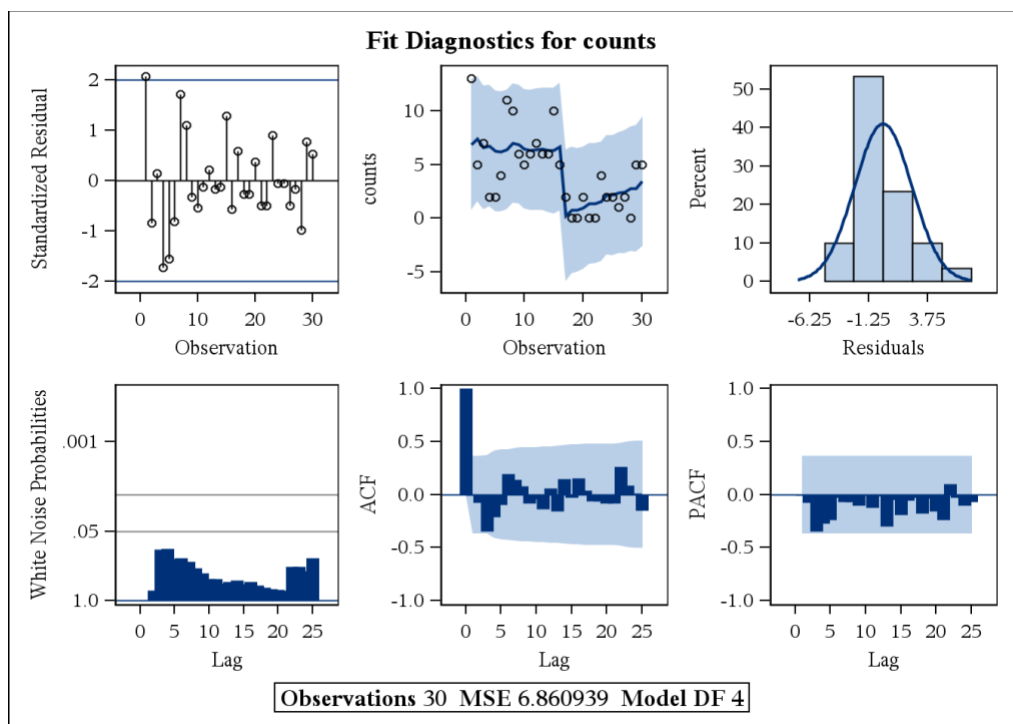
Maximum Likelihood Estimates			
SSE	171.523487	DFE	25
MSE	6.86094	Root MSE	2.61934
SBC	154.457021	AIC	147.451034
MAE	1.84597371	AICC	149.951034
MAPE	50.8629907	HQC	149.69231
Log Likelihood	-68.725517	Transformed Regression R-Square	0.4699
Durbin-Watson	1.7785	Total R-Square	0.5164
		Observations	30

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	1.7785	0.1119	0.8881

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > t	
Intercept (Level)	1	6.2891	1.4952	4.21	0.0003	
Pre-Intervention (Slope)	1	-0.0344	0.1541	-0.22	0.8253	
Intervention (Level)	1	-6.1309	2.1632	-2.83	0.0090	
Post-Intervention (Slope)	1	0.2563	0.2452	1.05	0.3058	
AR1	1	-0.0949	0.2019	-0.47	0.6426	

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > t
Intercept (Level)	1	6.2891	1.4914	4.22	0.0003
Pre-Intervention (Slope)	1	-0.0344	0.1538	-0.22	0.8250
Intervention (Level)	1	-6.1309	2.1588	-2.84	0.0088
Post-Intervention (Slope)	1	0.2563	0.2448	1.05	0.3051



Name of Variable = counts	
Mean of Working Series	4.333333
Standard Deviation	3.438346
Number of Observations	30

Autocorrelation Check for White Noise									
To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	16.02	6	0.0136	0.499	0.294	0.090	0.145	0.166	0.259

Dickey-Fuller Unit Root Tests							
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau	F	Pr > F
Zero Mean	0	-6.8847	0.0614	-2.48	0.0150		
Single Mean	0	-14.5339	0.0256	-3.57	0.0127	6.52	0.0113
Trend	0	-17.8645	0.0501	-3.57	0.0504	7.07	0.0420

