



Innovating patient care delivery: DSRIP's interrupted time series analysis paradigm

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ARTICLE INFO

Keywords:

Impact of DSRIP on Preventable Hospitalization Rates
Interrupted Time Series Regression Analysis
DSRIP Policy
Macro- and Micro- care delivery environmental factors on DSRIP policy
Preventable Hospitalization Rate Change:
DSRIP and PH rates

ABSTRACT

Introduction: Adoption of Medicaid Section 1115 waiver is one of the many ways of innovating healthcare delivery system. The Delivery System Reform Incentive Payment (DSRIP) pool, one of the two funding pools of the waiver has four categories viz. infrastructure development, program innovation and redesign, quality improvement reporting and lastly, bringing about population health improvement.

Background: A metric of the fourth category, preventable hospitalization (PH) rate was analyzed in the context of eight conditions for two time periods, pre-reporting years (2010–2012) and post-reporting years (2013–2015) for two hospital cohorts, DSRIP participating and non-participating hospitals. The study explains how DSRIP impacted Preventable Hospitalization (PH) rates of eight conditions for both hospital cohorts within two time periods.

Methods: Eight PH rates were regressed as the dependent variable with time, intervention and post-DSRIP Intervention as independent variables. PH rates of eight conditions were then consolidated into one rate for regressing with the above independent variables to evaluate overall impact of DSRIP. An interrupted time series regression was performed after accounting for auto-correlation, stationarity and seasonality in the dataset.

Results: In the individual regression model, PH rates showed statistically significant coefficients for seven out of eight conditions in DSRIP participating hospitals. In the combined regression model, the coefficient of the PH rate showed a statistically significant decrease with negative p-values for regression coefficients in DSRIP participating hospitals compared to positive/increased p-values for regression coefficients in DSRIP non-participating hospitals.

Conclusion and implications: Several macro- and micro-level factors may have likely contributed DSRIP hospitals outperforming DSRIP non-participating hospitals. Healthcare organization/provider collaboration, support from healthcare professionals, DSRIP's design, state reimbursement and coordination in care delivery methods may have led to likely success of DSRIP.

Level of evidence: IV, a retrospective cohort study based on longitudinal data.

1. Introduction

Texas was one of six states to receive approval for Medicaid Section 1115 waiver for which federal payments were being used to innovate patient care delivery methods.^{1,2} Funding for Medicaid Section 1115 waiver comes from two pools, Uncompensated Care (UC) pool and Delivery System Reform Incentive Payment (DSRIP) pool. The UC pool

was designed to provide reimbursement to cover hospital costs for uncompensated care rendered to medically needy and uninsured patients. On the other hand, the DSRIP pool was designed to reform and innovate patient care delivery methods through DSRIP projects that was funded by healthcare organizations and subsequently reimbursed by the state.^{2,4,5}

The DSRIP pool that funded DSRIP projects functioned in the

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<https://doi.org/10.1016/j.hjdsi.2017.11.004>

Received 19 April 2017; Received in revised form 29 October 2017; Accepted 28 November 2017

Available online 08 December 2017

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following four Categories:^{2–7}

1. Category I: Infrastructure Development,
2. Category II: Program Innovation and Redesign,
3. Category III: Reporting outcomes derived from patient care programs or Reporting Quality Improvement, and lastly
4. Category IV: Population Health Improvement

DSRIP's Category IV comprises of five domains namely, potentially preventable admissions, 30 day readmissions, potentially preventable complications, patient centered healthcare, and emergency department outcomes.⁸ A metric of the first domain essentially, potentially preventable admissions includes Preventable Hospitalizations (PH) that are known to be “costly” and reflect upon “system ineffectiveness”.^{9,10}

The following paper is an econometric research study that evaluates the association of PH rates with DSRIP implementation in nine counties of southeast Texas employing an interrupted time series methodology. The study aims to fulfill the gap in existing literature where there no quantitative studies have been performed to evaluate DSRIP's impact on PH rates of eight diagnostic conditions as stipulated by the program with the help of an interrupted time series regression method. The study then spotlights how DSRIP adoption may have helped the participating hospital cohort to likely outperform the non-participating hospital cohort during implementation years.

2. Methods

2.1. Study design overview

The study is a retrospective observational cohort study based on data obtained from the Texas Healthcare Information Collection (THCIC) public use database. Data was provided by the University of Texas Health Science Center at Houston's School of Public Health following approval by the Institutional Review Board. The interrupted time series (ITS) study design was employed to investigate the association of PH rates with DSRIP implementation in the analyzed nine county region of southeast Texas.

2.2. Sampling elements and sampling time frame

Sampling elements were PH rates of eight conditions as stipulated by DSRIP. The sampling time frame comprised of 22 quarters of years 2010 through mid-2015. A non-probability based convenience sampling model was used.

2.3. DSRIP hospitals - Target and Study Population

The target population included all hospitals located in nine southeastern counties of Texas as listed in the THCIC database. The study population consisted specifically of acute care, general medical and surgical, children's general and cancer care hospitals in the analyzed counties. The list of 18 DSRIP participating hospitals was concluded by referring to the Texas Health and Human Services (TX HHSC) Tableau website.¹¹

2.4. Non-DSRIP hospitals - Target and Study Population

The target population included all hospitals in the analyzed counties as those listed on the THCIC database. The names of DSRIP hospitals were deleted from the list to sieve target non-DSRIP hospitals. In the process, 16 non-DSRIP hospitals were identified from hospitals that were not listed on the TX HHSC Tableau website but were located in the analyzed counties as hospitals specializing in acute care, general medical and surgical, children's general and cancer care.

2.5. Exclusion criteria for DSRIP/Non-DSRIP hospital cohorts

The selection criteria excluded hospitals fulfilling the following conditions:

1. Those hospitals that were present in counties other than the ones analyzed
2. Those conditions other than the ones stipulated by DSRIP
3. Those hospitals with specialties other than acute care, general medical and surgical, children's general and cancer care.
4. Those PHs occurring in quarters of years other than the ones for 2010 through mid-2015

2.6. Statistical analysis model

The interrupted time series regression method was used to evaluate DSRIP based on two hospital cohorts within two time periods. DSRIP participating hospitals reported their quality improvement outcomes to the State Department of Health Services in the early months of 2013. The two time periods were pre-reporting time quarters of years spanning 2010 through 2012 and post-reporting time quarters of years spanning 2013 through mid-2015. The interruption in the regression model was created in the first quarter of 2013 to stratify pre/post reporting time frames.

2.7. Regression equations

The interrupted time series regression equation below is the combined equation model for DSRIP participating/non-participating hospital cohorts to determine association of PH Rates with DSRIP implementation:

$$Y_{PH} = B_0 + B_1(\text{Time})_{PH} + B_2(\text{Intervention})_{PH} + B_3(\text{Time post-DSRIP Policy Intervention})_{PH} + E_{PH}$$

The equation above was further stratified into the following equations for each DSRIP participating/non-participating hospital cohort:

$$Y_{PH \text{ DSRIP Hospitals}} = B_0 + B_1(\text{Time})_{PH \text{ DSRIP}} + B_2(\text{Intervention})_{PH \text{ DSRIP}} + B_3(\text{Post-DSRIP Intervention})_{PH \text{ DSRIP}} + E_{PH \text{ DSRIP}}$$

$$Y_{PH \text{ non-DSRIP Hospitals}} = B_0 + B_1(\text{Time})_{PH \text{ non-DSRIP}} + B_2(\text{Intervention})_{PH \text{ non-DSRIP}} + B_3(\text{Post-DSRIP Intervention})_{PH \text{ non-DSRIP}} + E_{PH \text{ non-DSRIP}}$$

Where,

Y_{PH} = PH rate or outcome of interest known as the dependent variable

B_0 = intercept at the base level;

B_1 = coefficient of the independent variable - time;

B_2 = coefficient of the independent variable - Intervention;

B_3 = coefficient of the independent variable - Post-DSRIP Intervention;

E = error term

The above interrupted time series equations were individually regressed for eight conditions. Thereafter, eight PH rates were consolidated into one rate so as to examine the overall impact of DSRIP implementation on PH rates of both cohorts of DSRIP participating/non-participating hospitals.

2.8. Statistical analysis

Statistical analysis required extensive data calibration, preparation of variables and testing using estimators in a series of the following five steps:

- I. Testing for auto-correlation:
First, Durbin-Watson test statistic was used to detect if there was an autocorrelation in the dataset. The ‘estat dwatson’ command analyzed and detected autocorrelation.
- II. Combining PH rates and Accounting for Moving Average and Non-linear Smoothing:
Second, the ‘egen-rowmax’ command combined eight PH rates into one PH rate each for DSRIP participating/non-participating hospital cohorts. ‘Egen-ma’, ‘tssmooth-ma’, and ‘tssmooth-nl’ commands accounted for moving average, time series smoothening in the combined PH rate variable.
- III. Testing for Stationarity and Seasonality:
Third, stationarity is important and required in a time series dataset. If the series is non-stationary, all typical results of the classical interrupted time series regression analysis are invalid. Time series regressions with non-stationary time series data set have no meaning and lead to “spurious” results.¹² For an interrupted time-series to be stationary, it should have a fixed mean, a constant variance and a constant autocovariance, also called autocorrelation. Mean, variance and autocovariance do not change over time in a stationary time series.¹² The Dickey Fuller’s test statistic was used whether to examine if there was stationarity in the analyzed time series dataset.^{13,14}
- IV. Generating Intervention and post-DSRIP Intervention variables to indicate Interruption in the Regression Model:
Fourth, the ‘generate’ command was used to create ‘Intervention’ variable column in the dataset. ‘Intervention’ variable was coded 0 for pre-reporting time quarters and 1 for post-reporting time quarters.¹⁴ A new variable was created to analyze the effect of DSRIP implementation on PH rates that was named ‘Post-DSRIP_Intervention’ independent variable. ‘PostDSRIP_Intervention’ variable was coded 0 for all pre-intervention time quarters and then was sequentially coded in serial order from 1 to 10 for ten post-intervention time quarters.¹⁴
- V. Interrupted Time Series Regression Command:

‘Arima’ command is used for analyzing time series datasets with more than 100 time points.¹⁴ ‘Arima’ command wasn’t applicable in this dataset because there were 22 time points. The presence of 22 time points was the reason to perform an interrupted time series regression with the Prais-Winston test statistic, ‘prais’.^{13–15} Therefore, ‘prais’ command was used to regress individual and consolidated PH rates as the dependent variable with time, intervention and post-DSRIP_intervention as the independent variables. This was the final statistical step in the regression.

Summarizing, Durbin-Watson test statistic detected autocorrelation. Dickey Fuller’s test statistic detected stationarity in the dataset because the calculated z-score was outside the 1–10% confidence interval limits. ‘Prais’ command regressed individual and consolidated PH rates with Time, Intervention and Post-DSRIP_Intervention as independent variables.

Software used for statistical analyses was STATA^(R) that is a statistical/data analysis software package copyrighted for StataCorp LP, 4905 Lakeway Drive, College Station, Texas 77845 USA. STATA version 14.1.

3. Results

Table 1 displays results of the interrupted time series analysis on eight PH rates as the dependent variable regressed individually with

Table 1 Results of the Interrupted Time Series Analysis for the DSRIP Participating Hospital Cohort - Individual Regression Models.

Prais-Estimator of PH Rates (Individual)	Regression Model Validation and Parameter Estimation				Statistical Testing				Tests for Stationarity/Seasonality (Dickey-Fuller’s unit test)				
	Intercept (B ₀)		Time (B ₁) (Baseline)		Intervention (B ₂) (Change in Level)		Post-DSRIP_Intervention (B ₃) (Change in Tend)			Autocorrelation (AC) Check (Durbin-Watson test)			
	Value	P-value	Value	P-value	Coefficient	95% CI	P-value	R ²		D-value (before)	D-value (after)	Z-value	Result
BH/SA	7.36	0.00*	-0.02	0.02*	-0.48 (-0.70 -0.26)	0.00*	-0.04 (-0.04 0.03)	0.04*	0.90	0.25	0.74	-0.27	Stationary
HT	2.71	0.01*	-0.01	0.01*	-0.01 (-0.10 -0.08)	0.81	-0.01 (-0.03 0.03)	0.1*	0.41	0.64	0.76	-1.84	Stationary
Diabetes	0.21	0.03	-0.02	0.05*	-0.03 (-0.05 -0.01)	0.005*	-0.02 (-0.05 0.01)	0.01*	0.83	1.20	0.89	-0.78	Stationary
COPD	-0.52	0.00*	0.02	0.00*	-0.08 (-0.09 -0.08)	0.00*	-0.03 (-0.04 -0.02)	0.00*	0.92	0.44	0.79	-1.03	Stationary
CHF	-0.30	0.05	0.01	0.02*	-0.02 (-0.04 0.01)	0.001*	-0.06 (-0.02 -0.08)	0.00*	0.87	0.30	0.92	-0.21	Stationary
Influenza	-0.20	0.31*	0.01	0.02*	-0.04 (-0.07-0.02)	0.00*	-0.01 (-0.05 0.02)	0.04*	0.73	0.12	0.54	-1.37	Stationary
BP	-1.52	0.21*	0.07	0.10*	-0.07 (-0.19 0.35)	0.16*	-0.01 (-0.03 -0.06)	0.10*	0.16	0.51	0.73	-1.79	Stationary
Asthma	-0.04	0.20*	-0.05	0.32*	-0.05 (-0.01 0.05)	0.30*	-0.04 (-0.03 0.05)	0.05*	0.29	0.57	0.90	-3.82	Stationary

* BH/SA: Behavioral Health/Substance Abuse conditions; HT: Hypertension; COPD: Chronic Obstructive Pulmonary Disorder; CHF: Congestive Heart Failure; BP: Bacterial Pneumonia.

Table 2
Results of the Interrupted Time Series Analysis for the DSRIP Non-participating Hospital Cohort - Individual Regression Models.

Rates (Individual)	Regression Model Validation and Parameter Estimation										Statistical Testing			
	Prais-Estimators of PH		Time (B ₁) (Baseline)		Intervention (B ₂) (Change in Level)		Post-DSRIP_Intervention (B ₃) (Change in Trend)		Autocorrelation (AC) Check (Durbin-Watson test)		Tests for Stationarity/Seasonality (Dickey-Fuller's unit test)			
	Value	P-value	Value	P-value	Coefficient 95% CI	P-value	Coefficient 95% CI	P-value	R ²	D-value (before)	D-value (after)	Z-value	Result	
	Intercept (B ₀)		Time (B ₁) (Baseline)		Intervention (B ₂) (Change in Level)		Post-DSRIP_Intervention (B ₃) (Change in Trend)		R ²	D-value (before)	D-value (after)	Z-value	Result	
BH/SA	0.12	0.70	0.07	0.6	0.03 (-0.03 0.03)	0.5*	0.02 (-0.09 0.04)	0.40*	0.47	0.23	0.59	-3.12	Stationary	
HT	2.24	0.04*	0.08	0.1*	-0.06 (-0.12 0.11)	0.91	0.02 (-0.01 0.22)	0.88	0.51	0.51	0.84	-3.33	Stationary	
Diabetes	0.16	0.50*	0.04	0.05*	0.09 (-0.19 0.03)	0.5*	0.01 (-0.05 0.03)	0.05*	0.11	0.22	0.69	-4.91	Stationary	
COPD	-0.11	0.50*	0.05	0.5*	0.02 (-0.04 -0.02)	0.03*	0.03 (-0.05 0.06)	0.05*	0.21	0.32	0.59	-4.37	Stationary	
CHF	-0.07	0.30*	0.06	0.72	0.01 (-0.01 0.05)	0.34*	0.03 (-0.08 0.02)	0.22*	0.13	0.26	0.71	-5.03	Stationary	
Influenza	0.47	0.11*	0.02	0.1*	0.07 (-0.04 0.02)	0.6	0.02 (-0.02 0.07)	0.4*	0.23	0.34	0.52	-3.95	Stationary	
BP	0.36	0.01	0.01	0.01*	0.04 (-0.01 0.01)	0.5*	0.01 (-0.05 0.05)	0.1*	0.49	0.64	0.79	-4.86	Stationary	
Asthma	0.30	0.09	0.02	0.98	0.02 (-0.06 0.01)	0.18*	0.03 (-0.06 0.12)	0.25*	0.03	0.35	0.91	-4.98	Stationary	

time, intervention (change in level) and post-DSRIP intervention (change in trend) as independent variables in the DSRIP participating hospital cohort. In this cohort, seven out of eight PH rates displayed a statistically significant decrease in coefficients of p-values within 95% confidence interval limits as observed from the Intervention variable column. Similarly, in this cohort, seven out of eight PH rates displayed a statistically significant decrease in coefficients of p-values within 95% confidence interval limits as observed from the Post-DSRIP_Intervention variable column. PH rates displayed a statistically significant decrease in coefficients of p-values within 95% confidence interval limits for the Post-DSRIP_Intervention variable due to the likely presence of DSRIP implementation in this cohort.

Table 2 displays results of the interrupted time series analysis on eight PH rates as the dependent variable regressed individually with time, intervention (change in level) and post-DSRIP intervention (change in trend) as independent variables in the DSRIP non-participating hospital cohort. In this cohort, six out of eight PH rates displayed statistically significant increase in coefficients of p-values within 95% confidence interval limits as observed from the Intervention variable column. Similarly, in this cohort, seven out of eight PH rates displayed a statistically significant increase in coefficients of p-values within 95% confidence interval limits as observed from the Post-DSRIP_Intervention variable column. PH rates displayed a statistically significant increase in coefficients of p-values within 95% confidence intervals for the Post-DSRIP_Intervention variable likely due to the absence of DSRIP implementation in this cohort.

Tables 3 and 4 display results of the interrupted time series regression with the consolidated PH rate for each cohorts. In Table 3, results of the interrupted time series regression with the consolidated PH rate showed a statistically significant decrease in coefficients of p-values within 95% confidence interval limits for Time, Intervention (change in level) and Post-DSRIP_Intervention (change in trend) independent variables in the DSRIP participating hospital cohort.

In Table 4, results of the interrupted time series regression with the consolidated PH rate showed a statistically significant increase in coefficients of p-values within 95% confidence interval limits for Intervention (change in level) and Post-DSRIP_Intervention (change in trend) independent variables in DSRIP non-participating hospital cohort. The statistically significant increase in the coefficient values within 95% confidence interval limits of the consolidated PH rate likely suggests that DSRIP hospitals may have outperformed non-DSRIP hospitals likely because of policy participation.

4. Discussion

In the light of the DSRIP program, this is the first study that has employed an interrupted time series regression study design for evaluating the association of PH rates with DSRIP implementation. Results of the interrupted times series regression on pre/post DSRIP years of analysis showed a marked decrease in PH rates within post-intervention time quarters thereby likely answering the question: Did DSRIP adoption decrease PH rates for eight diagnostic conditions in the analyzed nine county region of southeast Texas?

At the macro-level, a likely explanation for the detected decrease in PH rates may point towards the fact that DSRIP participating hospitals established regional health care partnerships, conducted regional needs assessments, developed and implemented projects thus addressing local gaps in service. Furthermore, they augmented service in high demand areas. These activities constituted DSRIP projects that were selected from menus supplied by the Texas State Health and Human Services Commission (TX HHSC) and the Centers for Medicare and Medicaid Services (CMS).

At the micro level, there may have been many factors that could have interplayed in the success of decreasing PH rates. First, DSRIP policy adopted in the analyzed counties of southeast Texas was geared towards having healthcare organizations and providers in lead roles

Table 3
Results of the Interrupted Time Series Analysis for the DSRIP Participating Hospital Cohort - Consolidated Regression Model.

Regression Model Validation and Parameter Estimation										Statistical Testing				
Prais-Estimators of PH	Intercept (B ₀)		Time (B ₁) (Baseline)		Intervention (B ₂) (Change in Level)		Post-DSRIP_Intervention (B ₃) (Change in Tend)			R ²	Autocorrelation (AC) Check (Durbin-Watson test)		Tests for Stationarity/Seasonality (Dickey-Fuller's unit test)	
	Value	P-value	Value	P-value	Coefficient	P-value	Coefficient	95% CI	P-value	R ²	D-value (before)	D-value (after)	Z-value	Result
PH Rate (Consolidated)	7.57	0.005*	-0.03	0.02*	-0.44 (-0.63 -0.26)	0.00*	-0.08 (-0.05 0.37)		0.5*	0.92	0.86	1.32	-0.11	Stationary

that gave both of them the capacity to manage care independently and at a pace at which they could combine DSRIP's goals while simultaneously innovating delivery of patient care programs. Their mutual partnership likely improved efficiency in creating patient health outcomes and thus may have likely resulted in the decreased PH rate attesting to the findings of another study that explains "healthcare improvement cannot happen without better management".¹⁶ Second, community health workers and ancillary staff provided beneficial support in obtaining patient volume needed to achieve and in some cases even supersede set milestones carved out for DSRIP projects. This is consistent with the finding that 72% of DSRIP projects in the analyzed nine county region of southeast Texas achieved the set targets in DSRIP.^{3,4} Third, DSRIP's inner workings had a highly developed information exchange system that allowed participating hospitals communicate its success to the Texas State Department of Health to be eligible for reimbursement by the state for executing DSRIP projects.¹ Following receipt of state reimbursement, DSRIP hospitals leveraged those fiscal incentives to achieve their targets for the next DSRIP Category in the ascending order of DSRIP Categories.³ In certain cases where hospitals weren't able to achieve targets, the state allowed them to carryforward the remainder of the allocated reimbursement amount so that they had more time to further plan and execute DSRIP projects. Fourth, DSRIP projects engaged/educated patients and their families thus coordinating care between hospitals, patients and their families. This coordination likely strengthened patients' transition from hospitals to their homes after discharge. The coordination may have aided recovery likely tapering PH rates for 30 day readmissions thus likely decreasing overall PH rates. And lastly, the Affordable Care Act (ACA) policy that penalizes hospitals for 30 day readmissions may have also likely interplayed in the detected PH rate decrease during those years.¹

DSRIP Categories I through IV spanning over five years progressed in ascending order over the five year period from developing infrastructure, innovating/redesigning patient care programs, reporting outcomes in quality improvement and improving overall health. Infrastructure development was initiated in the first year to retrieve overall health improvement outcomes in the final year of the program in an organized systematic/step-wise manner. Healthcare organizations and providers were reimbursed by the state for planning projects and achieving metrics for executing DSRIP projects in each project

category.^{3,6}

DSRIP projects have been classified into eight project cohorts. These project cohorts are behavioral health, primary care, specialty care, emergency care, chronic care, disease prevention and wellness, navigation/case management and general. DSRIP project cohorts have in turn have been classified into a singular or a combination of project outcome measures, namely, health service use, health status, behavior change, satisfaction, health service use/health status, health status/satisfaction, health service use/satisfaction and general. In DSRIP, out of the 175 total projects, the maximum number of project outcomes achieved were reported for health service use (78) and the least were reported for general (2) categories. State-reimbursed healthcare entities and providers achieved each of these outcomes over the five-year program demonstration period, from October 2011 through September 2016.^{3,4} A comprehensive list of 175 DSRIP projects implemented in nine counties of southeast Texas is provided in [Appendix A](#) for reference.

In support of DSRIP's Behavioral Health project cohort, the Mental Health and Mental Retardation Authority (MHMRA) of Houston executed DSRIP's behavioral health projects one of which was implementing technology-assisted services (telehealth, telemonitoring, telementoring, or telemedicine) to support, coordinate, or deliver behavioral health services. The MHMRA developed behavioral health crisis stabilization service as an alternative to hospitalization. Their HelpLine made follow-up calls and texts to clients who were released from Psychiatric Emergency Services (PES), Mobile Crisis Outreach Team (MCOT), HCPC and Chronic Consumer Stabilization Initiative (CCSI) to ensure they are following through on their discharge plans, taking medications and being connected to the next level of patient care. The target population were individuals who were discharged from Comprehensive Psychiatric Emergency Programs (CPEP) or Harris County Psychiatric Center (HCPC) and who were provided referrals for ongoing patient treatment and those in the community seeking information about crisis care trying to avoid emergency department visits.

In support of DSRIP's primary care project cohort, Memorial Hermann Northwest Hospital created neighborhood centers that integrate all ambulatory services in a highly coordinated, efficient and accessible manner for the greater Houston Metropolitan Service Areas

Table 4
Results of the Interrupted Time Series Analysis for the DSRIP Non-participating Hospital Cohort - Consolidated Regression Model.

Regression Model Validation and Parameter Estimation										Statistical Testing				
Prais-Estimators of PH	Intercept (B ₀)		Time (B ₁) (Baseline)		Intervention (B ₂) (Change in Level)		Post-DSRIP_Intervention (B ₃) (Change in Tend)			R ²	Autocorrelation (AC) Check (Durbin-Watson test)		Tests for Stationarity/Seasonality (Dickey-Fuller's unit test)	
	Value	P-value	Value	P-value	Coefficient	P-value	Coefficient	95% CI	P-value	R ²	D-value (before)	D-value (after)	Z-value	Result
PH Rate (Consolidated)	2.34	0.05*	-0.09	0.10*	0.06 (-0.08 0.09)	0.5*	0.01 (-0.02 0.02)		0.04*	0.68	0.81	1.49	-1.71	Stationary

(MSA). The target population were patients in the greater Houston MSA that would benefit from seeking ambulatory care at ambulatory facility rather than the acute care facility. Furthermore, they increased the number of school-based primary care sites in low-income communities for people with limited access and expanded Memorial Hermann Health Centers for Schools program by three health centers & a mobile dental van.

In support of DSRIP's specialty care project cohort, Texas Children's Hospital increased access to pediatric neurology services by utilizing advanced practice providers to see lower acuity pediatric neurology patients, thereby allowing neurosurgeons to see more complex pediatric spine and epilepsy patients thus expanding services to fetal, craniofacial and trauma cases. The target population were pediatric neurosurgery patients. Additionally, they increased access for children to pediatric subspecialty services in the Orthopedic Surgery clinic at Texas Children's Hospital and aimed at enhancing its sub-specialization in areas of Sports Medicine, Orthopedic Oncology, Leg and Limb Deformity, and Hand/Upper Extremity.

In support of DSRIP's emergency care project cohort, Harris Health System improved emergency center throughput and reduce inappropriate use of emergency centers in the system through implementation of a provider-in-triage model. Memorial Medical Center supported DSRIP's emergency care initiatives through research, design and implementation of an effective a hospitalist model to increase productivity and access to care for patients involving both physicians and mid-level providers.

For DSRIP chronic care projects, the University of Texas Health Science Center at Houston implemented a chronic disease management registry to enter data into a unique chronic disease registry that will be used to proactively contact, educate, and track patients by disease status, risk status, self-management status, community and family need. Records from the registry will then be used to develop and implement targeted quality improvement plans for diabetes, hypertension, asthma, COPD and CHF.

In support of DSRIP's case management/navigation projects, the City of Houston's Department of Health and Human Services developed care management function that integrated primary and behavioral health needs of individuals specifically that provided care management services that integrated primary and behavioral health needs of released ex-offenders, parolees and probationers in Houston, Harris County. Their Community Re-Entry Network Program (CRNP) integrated a project that provided a multi-dimensional clinical approach to assess and address the mental, physical and psychosocial needs of ex-offenders released from prison and probationers in Houston, Harris County.

In support of DSRIP's health promotion, disease prevention and wellness initiatives, the UT MD Anderson Cancer Center implemented an evidence-based disease prevention Program for tobacco control called Ask Advise Connect (AAC) to deliver to four Federally Qualified Health Centers (FQHCs) in Harris County. They implemented clinical practice guidelines and promoted health system supports in electronic health records. Then, based on questions asked by adult patients regarding smoking, connections to the QuitLine were made by clicking an automated link in the electronic health record (EHR) that sent patient concern to QuitLine within 24 h. QuitLine then contacted patients within 48 h of receipt of their contact information to address their concerns.

In the broad sense, seven out of eight projects cohorts not only achieved but also superseded the their targets, the eight project type being specialty care. Each projects in each project type were reimbursed based on measures that were either Pay for Performance (P4P) or Pay for Reporting (P4R), collectively known as Quantifiable Patient Impact (QPI) factors.³ P4P is a measure indicating that reimbursements were paid by the state based on improving health of the target population with regard to the increasing quality of life and decreasing disease intensity. On the other hand, P4R is another measure where

reimbursements were paid by the state based on the number of individuals served.⁶ For example, individuals who were immunized, had adolescent and adult patients enrolled in a smoking cessation program, have screenings for depression and mentally needy population, target and reduce teen pregnancy and STI infection rates in clinics and decrease the number of low acuity ED visits. These project goals were met in reality with the help of the DSRIP program and in the broad sense, for improvement in overall health. For the very few number of projects that were not able to meet and achieve the target QPI measures, the state let the providers and healthcare entities carry forward⁴ their reimbursement amount to the next year.

DSRIP projects having met its QPI baselines and in some cases superseding its yearly QPI targets were collectively approved for \$2,045,008,846⁴ to be reimbursed under P4P and/or P4R financial models to bring about overall health improvement in southeast Texas. DSRIP as a program by itself is "budget-neutral"^{1,5} in nature being an offshoot of the Medicaid Section 1115 waiver. A comprehensive list of funding allocations for DSRIP project cohorts and project types within each cohort is provided in [Appendix B](#) for reference.

There are some important limitations to consider for this research study setting. The study focused only on PH rates while the scope of DSRIP is much broader, encompassing the IHI's Triple Aim functions^{1,3,5} while at the same time maintaining "budget neutrality".^{1,5} The variation in involvement of DSRIP participating hospitals, resource inputs and time investment couldn't be considered in the study. Another study that employs a survey instrument to examine the degree of varying involvement may overcome this limitation. The strength of the study lies in the interrupted time series methodology. This research design helps in obtaining more valid estimates of the impact of DSRIP has on PH rates compared to a pre-post analysis of means. Additionally, this research methodology has the ability to measure the outcome of interest, in this case, PH rates of eight diagnostic conditions.

5. Conclusion and implications

PH rates for the set of eight diagnostic conditions may have decreased in the DSRIP participating hospital cohort likely due to provider and hospital participation in DSRIP program during the first three Categories of adoption. Funds invested in DSRIP's Categories were reimbursed by the state following which funds were further leveraged to operationalize funding for the next Category of the program.

Hospitals and healthcare settings leveraged their state-reimbursed fiscal resources right in the beginning to build infrastructure and develop innovative healthcare programs that may have step by step likely resulted in realizing goals of DSRIP's final category - Category IV - Improving Population Health in the implemented counties. DSRIP participating hospital/provider collaboration in DSRIP projects may have had the capacity to likely decrease overall PH rates. The likely decrease in PH rates may have had a significant impact in likely improving overall health outcomes in nine counties of southeast Texas. Conclusively, decreased PH rates may have likely accomplished DSRIP's goal of improving health outcomes in counties where the policy was implemented from the broader point of view.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.hjdsi.2017.11.004>.

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