

The Influence of Community Pharmacists on Star Ratings: Focus on Diabetes Medication Adherence

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Summary

- Project background
- Objective of this project
- Statistical methods
- Analysis process
- Conclusion of analysis
- Acknowledgements

Background

- The nation's current healthcare system is rapidly evolving from “fee for service” to “pay for performance” reimbursement models to encourage and ensure quality patient care at decreasing costs.
- More specifically, pharmacists may have a considerable impact on ensuring the quality and success of such models by practicing appropriate, safe, effective, and encouraged medication use.

The objectives

- The main objective of this study is to assess the impact of community pharmacist initiated medication therapy management focused on diabetes medication adherence on Part D star ratings evaluated by the Centers for Medicare and Medicaid Services.
- Three questions were raised:
 - Is there difference of PDC score before and after intervention?
 - Do any predictor variables contribute to categorical response variables – PREPDC and POSPDC?
 - Does the PDC change before and after pharmacist intervention correlate with any predictor variables?

Statistical methods

- In order to appropriately answer the three questions above, different statistic methods are used.
- two paired samples t-test and McNemar's Test are applied for examining the difference of PDC score between before and after intervention.
- logistic regression is employed to find which predictor variables have influence on categorical outcomes.
- multiple linear regression is utilized to set up the correlation for predictor variables and PDC change.

Analysis Process

- Accordingly the interest of questions, the analysis process contains three parts
 - Test for the difference of PDC score
 - Logistic regression
 - Multiple linear regression

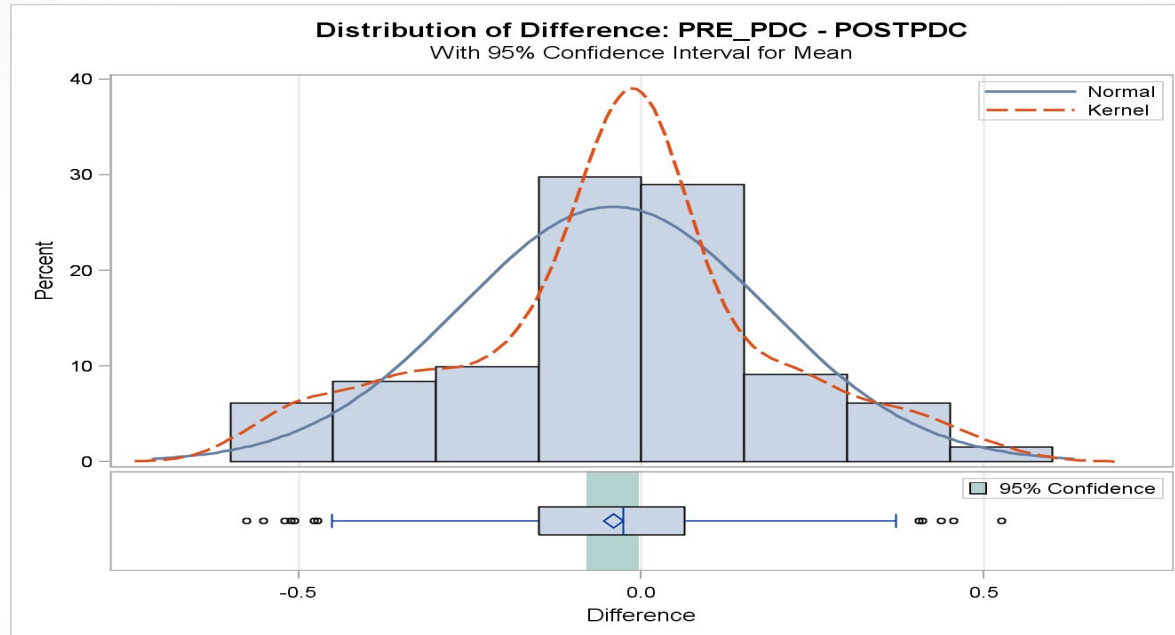
Variables

Variables in the data set			
Variable	Type	X/Y	Label
DUP	1	X	Times of conversation
gender	1	X	Gender of patient
cate-distance	1	X	Categorical variable of distance
Cate-age*	1	X	Categorical variable of age
Intervention*	1	X	Integrated variable
SIG	1	X	Times of taking pills per day for patient
CMR	1	X	Contents of conversation
TIP	1	X	Identified method for patient
distance	2	X	Distance between patient's home and pharmacy
age	2	X	Age of patient
PREPDC	1	Y	Categorical PDC score before intervention
POSPDC	1	Y	Categorical PDC score after intervention
PREPDC_C	2	Y	PDC score before intervention
POSPDC_C	2	Y	PDC score after intervention
PDCdelta	2	Y	The difference of PDC score before and after intervention

1 represents categorical type of variable; 2 represents continuous type variable. X represents the predictor variable; Y represents the response variable. 15 variables are included in the dataset (5 Y and 10 X). Cate-age* and intervention are created in the analysis.

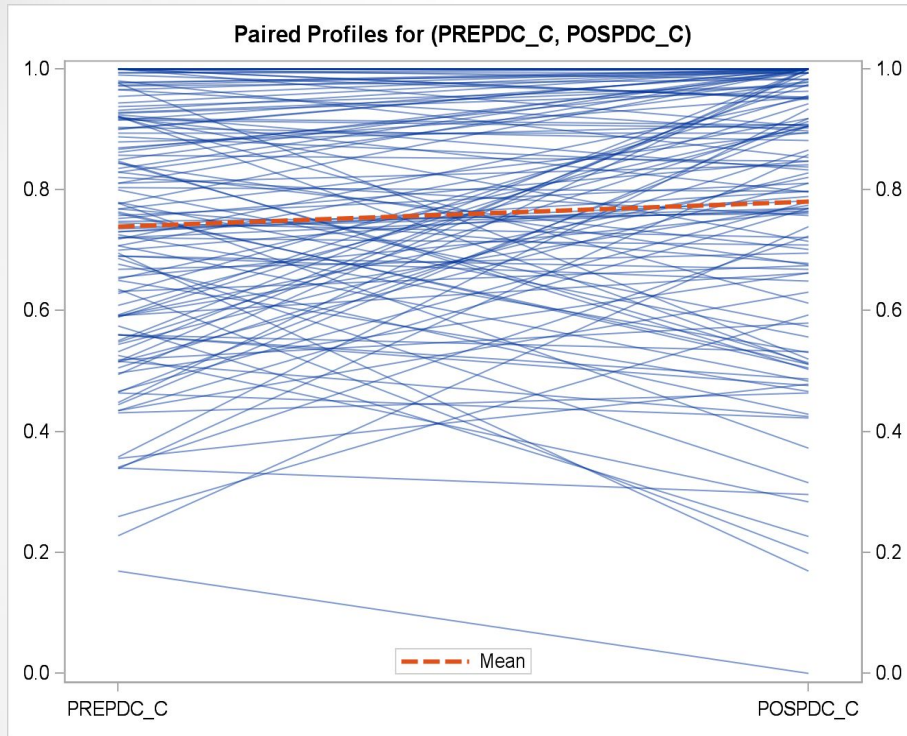
Test the difference of PDC score

two sample paired T-test



The histogram and boxplot of the difference of PREPDC_C and POSPDC_C. The mean, minimum and maximum of the difference of PDC score are -0.0414, -0.5758 and 0.5262, respectively. The 95% confidence interval of mean for the difference is from -0.0802 to -0.00267.

Result of T-test



1. The plot shows paired profiles of PDC score from before to after intervention period. The blue line represents the PDC score for each patient; the red line represents the mean of PDC score from before to after intervention period.
2. The statistic of two sample paired t-test is -2.11 (degree of freedom 130). The P-value (0.0364) slightly less than 0.05 and confidence interval of mean for the difference around 0 suggest a small significance for the difference of PREPDC_C and POSPDC_C, and this test also indicates an increasing trend of the mean of PDC score.

Test the difference of PDC score

McNemar's Test

Table of PREPDC by POSPDC			
PREPDC response	POSPDC response		
Frequency	1	0	Total
1	47	12	72
0	25	47	59
Total	59	72	131

McNemar's Test	
Statistic (S)	4.5676
DF	1
Asymptotic Pr > S	0.0326

- McNemar's Test is used to assess the difference of paired categorical variable PREPDC and POSPDC.
- The results from McNemar's Test suggest that there is a difference between PREPDC and POSPDC, consistent with the results from two samples paired T-test,
- The result also indicates that the number of POSPDC(=1) was slowly increased after intervention.

Logistic Regression

Association test for PREPDC and predictor variables

Variable	Test method	Response	statistics	P-value	The least expect value
cate-distance	Chi-Square	PREPDC	1.7818	0.1819	7
gender	Chi-Square	PREPDC	1.5805	0.2087	19
cate-age	Fisher's Exact	PREPDC		0.0165	1
SIG	Fisher's Exact	PREPDC		2.857E-12	0

Logistic regression for PREPDC

Parameter Estimates and odds ratio								
Parameter		Estimate	95% Confidence Limits		Two-sided p-Value	Odds Ratios	95% Confidence Limits	
Intercept		1.4126	-1.5318	Infinity	0.3916	4.107	0.216	Infinity
cate-age	1	1.7642	-0.3020	5.5940	0.1254	5.837	0	0.083
SIG	2	-4.0515	-Infinity	-2.4920	<.0001	0.017	0	0.047
SIG	3	-5.1014	-Infinity	-3.0535	<.0001	0.006	0	0.679
SIG	4	-3.3322	-Infinity	-0.3878	0.0690	0.036	0.739	268.795

1. The parameter estimates and oddsratio for SIG2 and SIG3 are significant given P-values less than 0.05, and those for SIG4 is marginally significant, but those for age, intercept are not significant.
2. The odds ratio of SIG2 (SIG3, SIG4) means that the odds for patient who takes pills twice (three times, four times) per day has 0.017 (0.006, 0.036) times as low as patient who takes once a day.
3. These results suggest that age maybe not impact outcome, but SIG strongly affect the outcome (PREPDC=1). As the SIG increasing, the PREPDC(=1) decrease.

Logistic Regression

Association test for POSPDC and predictor variables

Variable	Test method	Response	statistics	P-value	The least expect value
cate-distance	Chi-Square	POSPDC	4.4342	0.0352	7
gender	Chi-Square	POSPDC	0.5013	0.4789	17
DUP	Chi-Square	POSPDC	7.5897	0.0059	5
TIP	Chi-Square	POSPDC	3.1574	0.0756	16
cate-age	Fisher's Exact	POSPDC		0.0918	3
CMR	Fisher's Exact	POSPDC		0.6521	2
SIG	Fisher's Exact	POSPDC		5.909E-04	0

Logistic regression for POSPDC

Parameter Estimates and odds ratio								
Parameter		Estimate	95% Confidence Limits		Two-sided p-Value	Odds Ratios	95% Confidence Limits	
Intercept		3.7076	2.1963	Infinity	<.0001	40.758	8.992	Infinity
dup	2	-0.1797	-1.6453	1.1739	1.0000	0.836	0.193	3.235
dup	3	-0.8819	-2.7088	0.5975	0.3283	0.414	0.067	1.818
SIG	2	-4.0699	-Infinity	-2.5156	<.0001	0.017	0	0.081
SIG	3	-4.9355	-Infinity	-2.8868	<.0001	0.007	0	0.056
SIG	4	-3.3556	-Infinity	-0.4111	0.0674	0.035	0	0.663

1. The odds ratio of intercept is 40.758 ($p < 0.0001$), which means the odds of patients who have one conversation with pharmacist (DUP1) and take once pills per day (SIG1) are 40.758 times as high as those who have more conversation and taking more pills per day.

2. These results indicate that the outcome POSPDC (=1) was significantly influenced by one conversation (DUP1) between patients and pharmacists, but not by multiple conversations. Moreover, POSPDC (=1) dramatically decreases as SIG (the frequency of taking pills per day for patients) increasing.

Conditional logistic regression for PREPDC and POSPDC

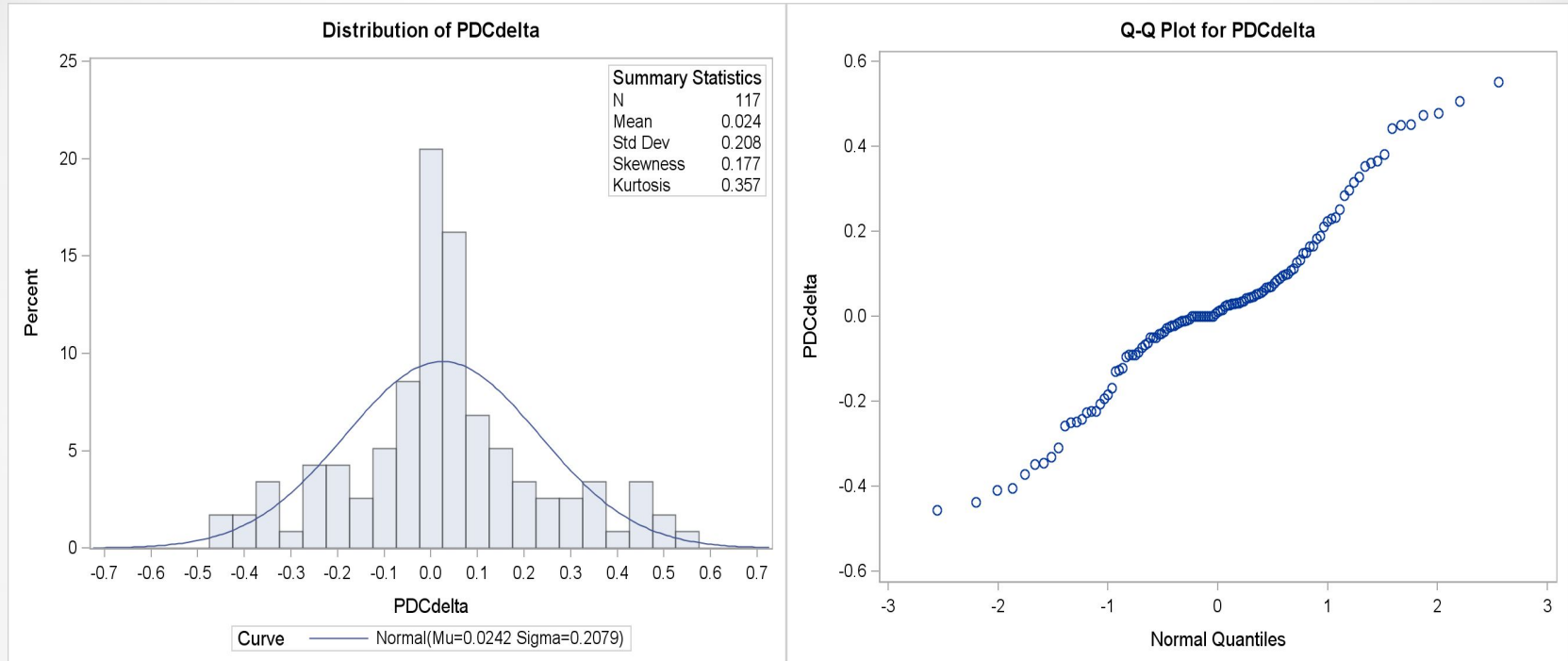
- The goal of POSPDC *v.s.* PREPDC analysis is to determine relative impact for pharmacist intervention

Estimates and odds ratio of parameter									
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Odds ratio	95% Confidence Limits	
intervention	1	1	0.6061	0.3589	2.8528	0.0912	1.833	0.907	3.704

- The estimate of intervention is 0.6061, which is marginally significant ($p=0.0912$) and represents the increment of log odds for POSPDC(=1) after pharmacists intervention.
- The odds ratio estimate of the intervention is 1.833, which is marginally significant ($p=0.0912$). This means the odds of POSPDC(=1) is 1.833 times as high as PREPDC(=1). We conclude that the pharmacist intervention has the relative impact on the POSPDC(=1).

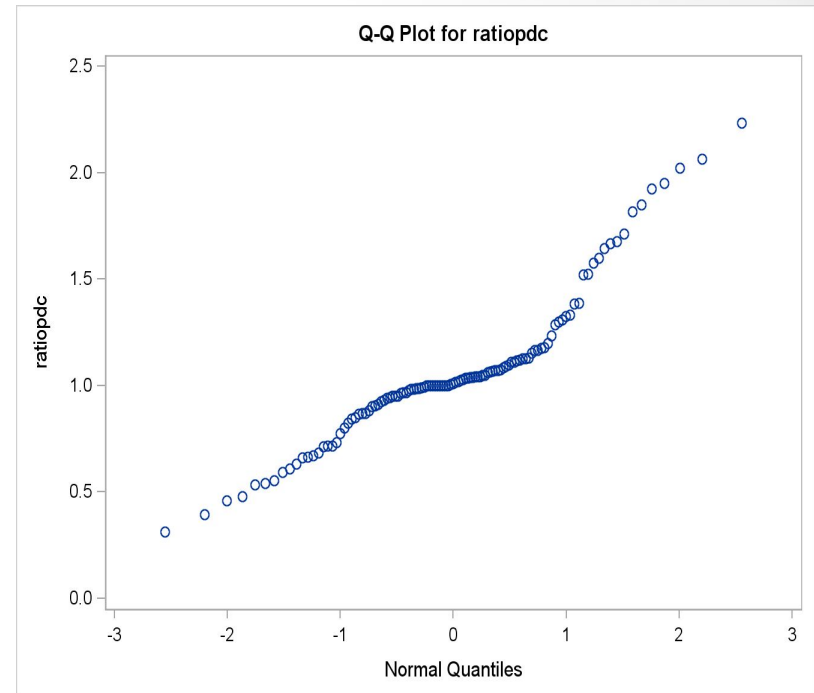
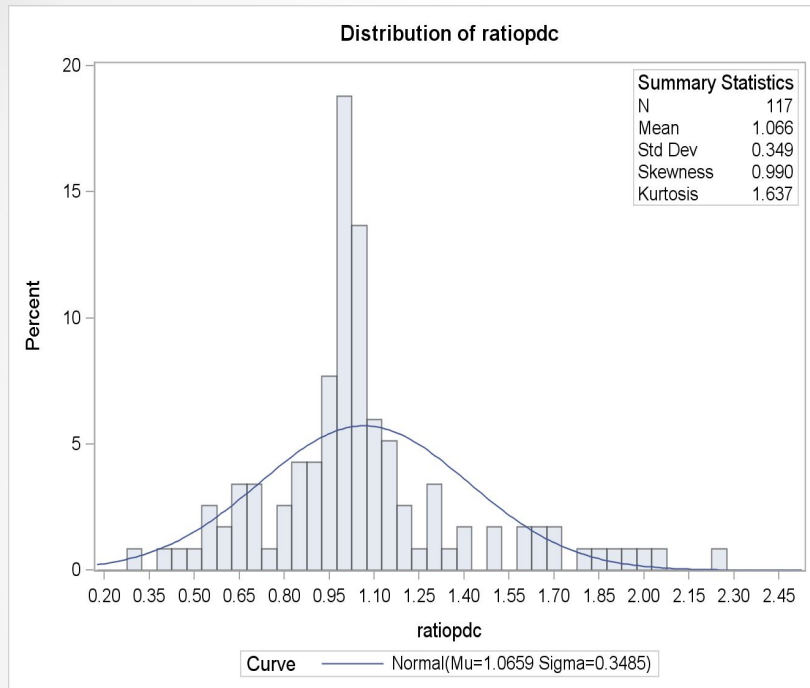
Linear regression

DATA Diagnostics



1. PDCdelta resides between 0.5519 and -0.4560, with a mean value of 0.024.
2. Histogram of PDCdelta shows a high peak around the mean value.
3. Both QQ plot and results from tests for normality uniformly indicate that P-values is less than the significant level 0.05, suggesting that the PDCdelta does not follow normal distribution.

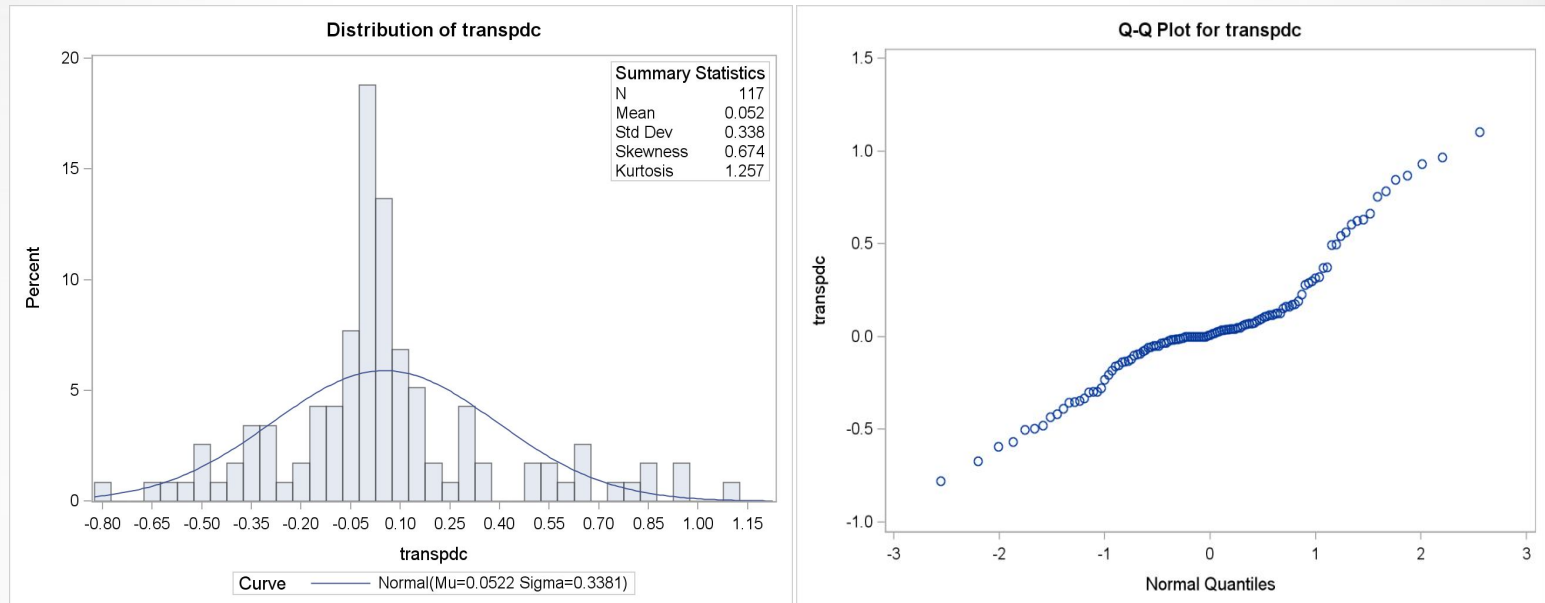
Linear regression



- Response variable ratioPDC (POSPDC_C/PREPDC_C) is created to display the fold-change between POSPDC_C and PREPDC_C.
- RatioPDC resides between 0.311 and 2.231 with a mean value of 1.066.
- RatioPDC distribution displays high kurtosis and skewness.
- The non-normality was also revealed from the QQ plot.

Linear regression

Box-Cox transformation



- RatioPDC fulfills this requirement that all the values of variable before transformation are positive.
- Transformation was performed with an optimized lambda value of 0.75.
- the transformed ratioPDC (transPDC) values reside between -0.779 and 1.1043 with a mean 0.0521.
- QQ plot and test of goodness of fit lead to the conclusion that transPDC does not follow a normal distribution.

Linear regression

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	3.69774	0.92443	10.87	<.0001
Error	111	9.44246	0.08507		
Corrected Total	115	13.14020			

Parameter Estimate					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.00175	0.03624	0.05	0.9616
TIP	1	0.24032	0.06316	3.80	0.0002
CMR	1	0.50522	0.14127	3.58	0.0005
dup2	1	-0.12432	0.07440	-1.67	0.0976
dup3	1	-0.13364	0.08004	-1.67	0.0978

1. Given that the statistic of F test is 10.87 and the P-value is less than 0.001, this mean the covariates should be include in model.
2. The P-values of parameters TIP and CMR are less than significant level 0.05, but DUP2($p=0.0976$) and DUP3(0.0978) are marginally significant.
3. The result shows TIP(=1), CMR(=1) and once time conversation will strongly increase transPDC . But increasing conversation times maybe have weakly negative impact on transPDC score.

Conclusion

- Two-sample paired t-test suggests that there is difference between PREPDC_C and POSPDC_C. Correspondingly, McNemar's Test suggests difference between categorical PDC scores – PREPDC and POSPDC.
- Variable SIG was shown to have strong impact on PREPDC, suggesting that PREPDC(=1) decreases when the frequency of taking pills by patients increases.
- POSPDC was shown to be significantly affected by SIG and DUP(=1), only one conversation between pharmacist and patients. These evidence suggest POSPDC(=1) decreases when the SIG(frequency of taking pills by patients) increases, but outcome has little impact by multiple conversations.
- The influence of intervention on comparing PREPDC and POSPDC was analyzed through conditional logistic regression. The analysis suggests a relative effect from intervention given a P-value of 0.09.
- Linear regression revealed that PDC change is significantly affected by DUP1 (only one conversation), CMR and TIP, but not by DUP2 and DUP3.