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Healthcare
Working Group

5th Annual Systems
Engineering in Healthcare
Conference
May 1-2, 2019
Minneapolis, MN

Systems thinking in healthcare quality improvement:

High Level Overview: CASE STUDY

MAY 2nd, 2019

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Agenda

- Introduction
  - Case Study: Developing a Logistic Regression model: to evaluate factors affecting COPD 30-day Readmissions
    1. Analysis
    2. Inference
    3. Limitations
- Conclusion

INTRODUCTION

Why is Quality measurement important ?

What is the role of systems thinking ?

Can we improve care ?

Case Study

Developing a Logistic Regression model: to evaluate factors affecting COPD 30-day Readmissions

"Why are 30-day readmissions important ?"

- Quality metric that spans the care continuum
- Hospital Readmissions Reduction Program (HRRP)
- Chronic Obstructive Pulmonary Disease   (COPD)

COPD: Chronic obstructive pulmonary disease

- Chronic Obstructive Pulmonary Disease is the third leading cause of death in United States
- An estimated number of 28.9 million affected individuals
- High morbidity leads to increased emergency room visits and hospitalizations

Data

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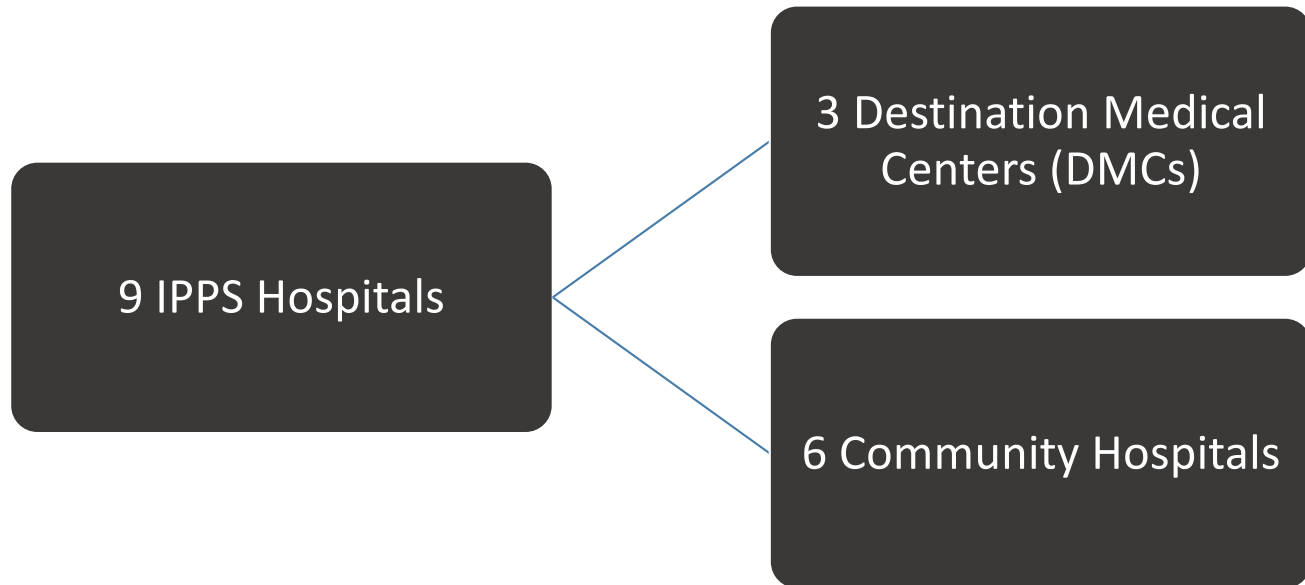Engineering in Healthcare
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30 Day Readmission Flag

Index COPD admission is flagged for 30-day readmission:
- Any cause readmission
- Within 30 days
- To the same facility

Data

3 Destination Medical Centers (DMCs)

9 IPPS Hospitals

6 Community Hospitals

Time Period: Discharge from October 1st 2015 to December 31st 2016

Analysis

essentially,
all models are wrong,
but some are useful

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ANALYSIS

LOGISTIC REGRESSION MODEL

Indicator Variable: **30-day Readmission FLAG**

Predictor Variables

Patient Demographics	Comorbidities	Structural	Process

Examples

Age Sex Race	Pneumonia Heart Failure Diabetes	Payer Hospital	Discharge Disposition

Analysis

Intermediate Iteration of the Model:

```
Iteration 0:    log likelihood = -829.00926
Iteration 1:    log likelihood = -802.77652
Iteration 2:    log likelihood =  -800.9189
Iteration 3:    log likelihood = -800.89667
Iteration 4:    log likelihood = -800.89665
```

```
Logistic regression                        Number of obs   =      1,942
                                           LR chi2(18)     =      56.23
                                           Prob > chi2     =     0.0000
Log likelihood = -800.89665                Pseudo R2       =     0.0339
```

DayReadmissionFlagY	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Age	.9900402	.0065502	-1.51	0.130	.977285	1.002962
MEDICARE	1.35696	.2556738	1.62	0.105	.9379645	1.963123
FacilityID						
	.8004381	.2440832	-0.73	0.465	.4403165	1.455092
	.4766786	.1258657	-2.81	0.005	.284098	.7998031
	.5044396	.1906717	-1.81	0.070	.2404727	1.058163
	.4547163	.1526215	-2.35	0.019	.2355278	.8778874
	.7018999	.2026471	-1.23	0.220	.3985868	1.236026
	.6200196	.2522778	-1.17	0.240	.2792947	1.376411
	.6595593	.2111805	-1.30	0.194	.3521378	1.235365
	.7022641	.2008959	-1.24	0.217	.400865	1.230277
WEEKEND	.7125463	.2358103	-1.02	0.306	.3724913	1.363044
SNFDischarge	4.181531	1.786687	3.35	0.001	1.809812	9.661335
HOMEDischarge	3.757747	1.513847	3.29	0.001	1.706131	8.276425
HomeHealthDischarge	5.122715	2.245184	3.73	0.000	2.169879	12.09386
WeekendHome	1.788996	.6636996	1.57	0.117	.8646139	3.701661
PN	.7755698	.1250909	-1.58	0.115	.5653682	1.063923
HF	1.418516	.1961492	2.53	0.011	1.081763	1.860101
DIAB	1.344474	.198737	2.00	0.045	1.006306	1.796284
_cons	.1049341	.0656597	-3.60	0.000	.0307822	.357712

Analysis

Final Iteration of the Model:

```
. logit DayReadmissionFlagY  HOSPSITE3  SNFDischarge HOMEDischarge HomeHealthDischarge HF DIAB, or

Iteration 0:    log likelihood = -829.00926
Iteration 1:    log likelihood = -810.46247
Iteration 2:    log likelihood =  -809.1942
Iteration 3:    log likelihood = -809.18603
Iteration 4:    log likelihood = -809.18603

Logistic regression                              Number of obs    =        1,942
                                                 LR chi2(6)       =        39.65
                                                 Prob > chi2      =       0.0000
Log likelihood = -809.18603                      Pseudo R2        =       0.0239
```
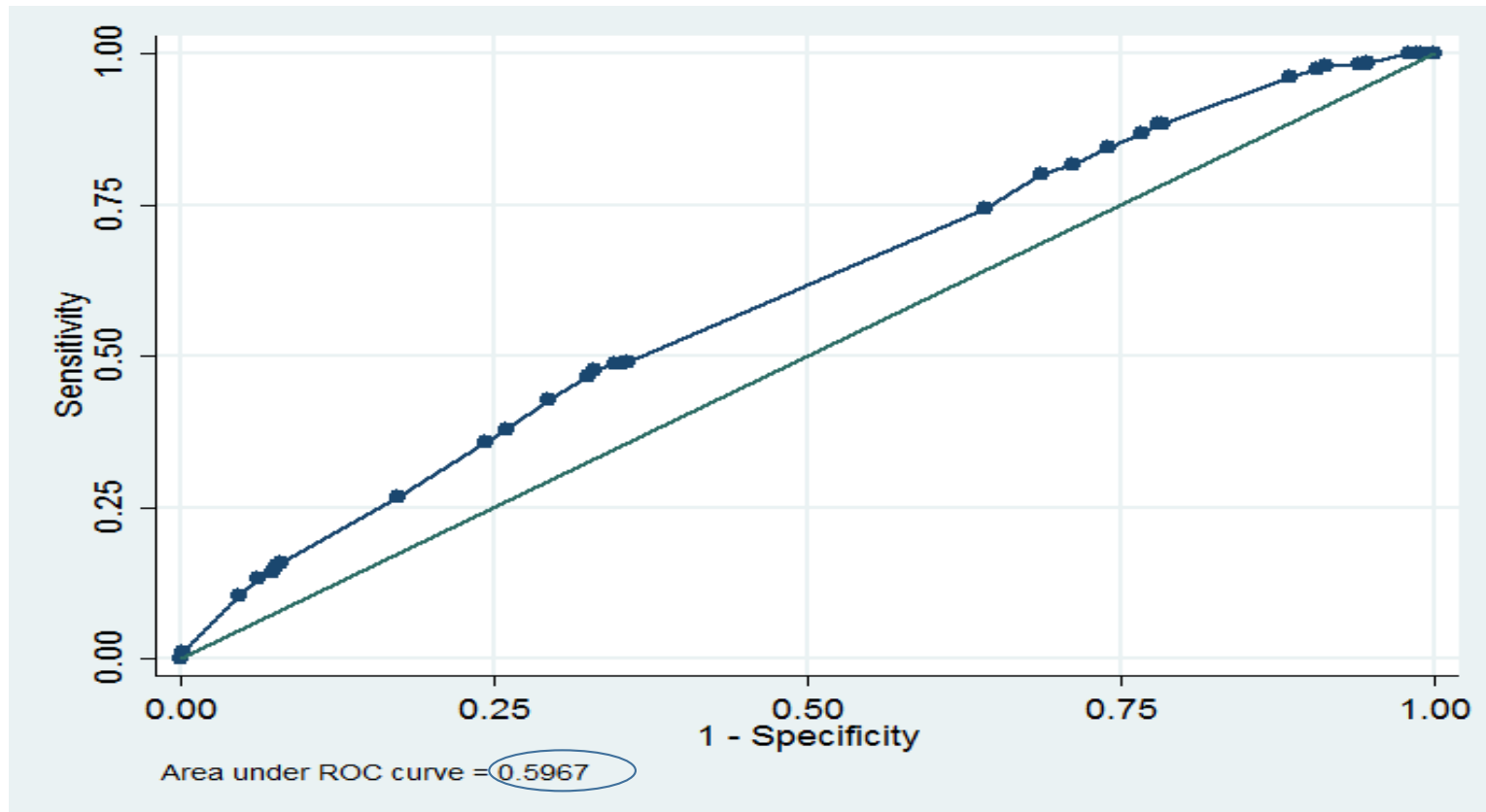
DayReadmissionFlagY	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
HOSPSITE3	.7084607	.1040569	-2.35	0.019	.5312433	.944796
SNFDischarge	4.092502	1.737586	3.32	0.001	1.780687	9.405682
HOMEDischarge	4.404822	1.740916	3.75	0.000	2.030057	9.557592
HomeHealthDischarge	5.618769	2.418671	4.01	0.000	2.416744	13.06327
HF	1.391449	.1851236	2.48	0.013	1.072063	1.805986
DIAB	1.360165	.1976438	2.12	0.034	1.023068	1.808334
_cons	.0388858	.0153443	-8.23	0.000	.0179436	.0842702

```
. lroc

Logistic model for DayReadmissionFlagY
```

ANALYSIS

Area under ROC curve = 0.5967

AREA UNDER ROC CURVE (AUC) : Measure of model fit (1 is best fit, 0.5 is worst fit)

Inference

"What are the odds ratios indicating?"

- Home Health discharge is 5.6 times more likely than a non Home Health discharge to be readmitted

(HIGHER ODDS)

- Patient admitted to Hospital Site 3 (Within Larger System) is 0.7 times as likely to be readmitted than a patient admitted to other Mayo Clinic sites

(LOWER ODDS)

"What are the odds ratios indicating?"

- Home Health discharges are 'sicker' patients
- Patients being discharged home might not have the required support to continue care (transition of care)
- Need to investigate transitions of care to Skilled Nursing Facilities
- Heart Failure and Diabetes are comorbidities that raise the odds of readmission for COPD patients

"What does that lead to ?"

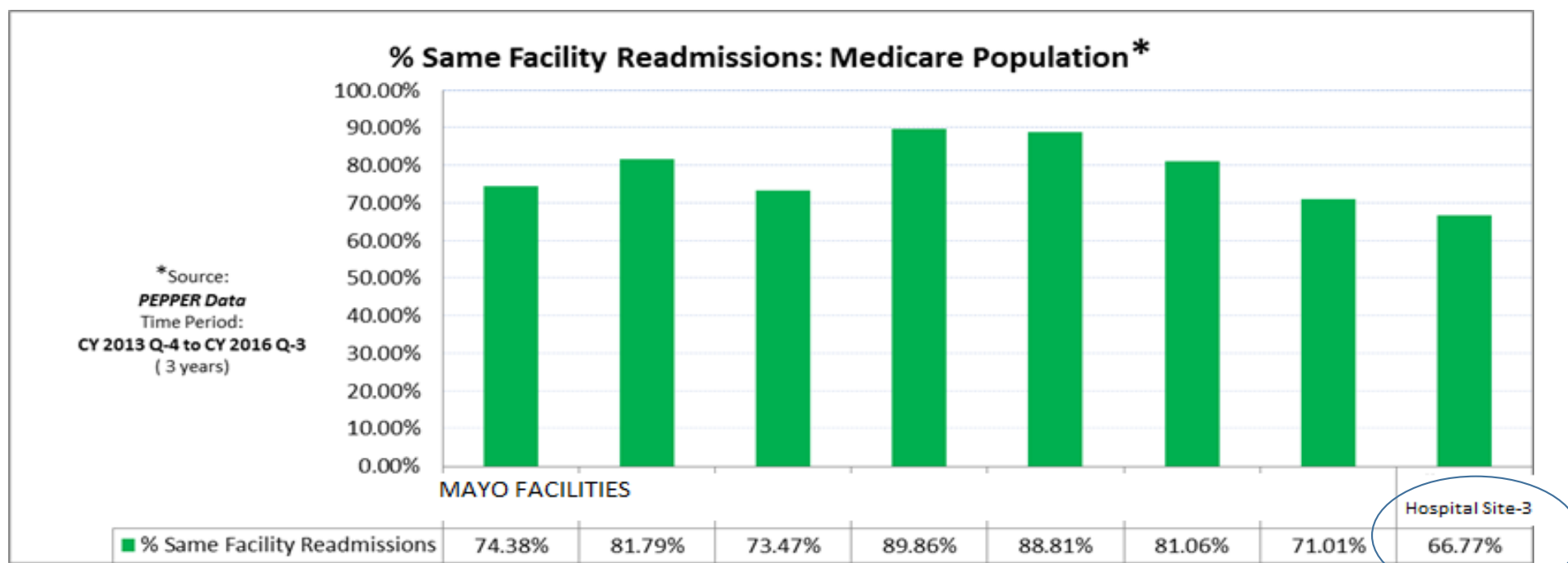- Lowest probability of COPD readmissions at Hospital Site 3

But….

- Data reflects "Readmission to same Facility"

LIMITATION

Only 2 out of 3 readmissions are to the same facility for Site 3

% Same Facility Readmissions: Medicare Population*

*Source:
PEPPER Data
Time Period:
CY 2013 Q-4 to CY 2016 Q-3
(3 years)

MAYO FACILITIES

Hospital Site-3

■ % Same Facility Readmissions	74.38%	81.79%	73.47%	89.86%	88.81%	81.06%	71.01%	66.77%

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Conclusion

- *Utilize a systems thinking approach to understand and improve 'quality' in healthcare*

- *Understand the limitations of the data and subsequent statistical modelling techniques*

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Questions & Discussion