
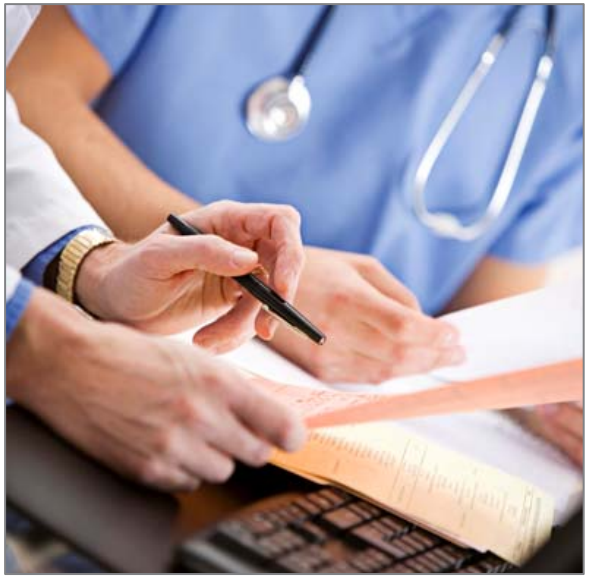


Profiling Future Mental Health and Substance Abuse Risk by Disease-Specific Models

Ogi Asparouhov, PhD
Chief Scientist, LexisNexis

Agenda

Presentation Goals

Introduction: future complications' cost trends

Future Complications of Depression:

- Comparison of utilization models with Disease-specific model

Profiling of Future MHSA Risk by Disease-specific Models

Conclusions

Questions & Opinions

Presentation Goals

1. To compare a group of disease-specific versus legacy overall cost and utilization models in terms of future Mental Health and Substance Abuse (MHSA) risk profiling.

2. Pilot study of some new MHSA claim-based PM to identify members with the greatest opportunity of being positively impacted both clinically and financially.

3. To initiate the exchange of opinions and experiences on the topic within this wider predictive modelling & clinical analytics audience.

Introduction

Identification of High Risk Members is the critical initial activity in Population Health Management / Disease and Case Management

High Risk Member identification is usually based on predictions of overall future utilization (Total Cost, Hospitalization likelihood / LOS, Emergency Room likelihood / ER visits, Rx Cost, etc.)

However, identification is rarely helpful in clarifying *what is driving the predicted risk*; therefore, significant effort is needed to develop associated risk drivers which can guide clinical intervention plans

Moving forward, risk profile must focus on identification of predicted drivers of high risk/cost in addition to High Risk Member identification

The addition of risk drivers to High Risk Member identification empowers personalized, targeted, and prioritized clinical intervention programs

Cost Trends Relative to the Presence of Future Complications

Trends on commercial population of ~ 1M health plan members, 24 months enrollment

YEAR1 DISEASE	COUNT	YEAR2 COMPLICATIONS	YEAR2 COMPLICATIONS - NO			YEAR2 COMPLICATIONS - YES		
			%	YEAR2$	DELTA	%	YEAR2$	DELTA
Asthma - Yes COPD - No Pneumonia – No	44,287	Pneumonia	91.4%	$ 6,224	-7.2%	8.6%	$ 8,834	17.3%
COPD - Yes Pneumonia – No	10,585	Pneumonia	92.5%	$ 11,544	-11.0%	7.5%	$ 27,194	32.2%
Diabetes - Yes CAD, CVA - No Renal Failure – No	54,130	CAD, CVA or Renal Failure	94.2%	$ 7,595	-1.1%	5.8%	$ 28,069	157.3%
Depression - Yes Drug and/or Alcohol Dependence – No	77,323	Drug and/or Alcohol Dependence	96.1%	$ 7,158	-3.4%	3.9%	$ 14,758	53.4%

Obviously, future complications and acute events lead to high cost and risk and this is what Population Health Management & Disease Management professionals are interested in.

Future Complications of Depression: Comparison of utilization models with disease-specific model

We analyzed the following three future depression complications:

1. Psychoactive Drug Dependence
   - opioid or barbiturate dependence
   - cocaine or amphetamine dependence
2. Alcohol Dependence
   - acute alcohol intoxication
   - alcohol dependence
3. Other Drug Dependence

Future Complications of Depression: Comparison of utilization models with disease-specific model

Data

- 24 months of medical and pharmacy claims for **77,323** members from commercial health plan; all of them with *Depression* and **none** of the listed *Depression* complications during Year1
- 24 months of medical and pharmacy claims for **4,786** members from commercial health plan; all of them with *Depression* and **at least one** of the listed *Depression* complications during Year1

Future Complications of Depression: Comparison of utilization models with disease-specific model

Members	Without Year1 Complications				With Year1 Complications			
	Count	%	Year1$	Year2$	Count	%	Year1$	Year2$
All members	77,323	100%	$ 7,498	$ 7,456	4,786	100%	$ 16,305	$ 12,657
Y2 Complications	3,039	3.9%	**$ 9,623**	**$14,758**	1,759	36.8%	$ 18,940	$ 17,947
No Y2 Complications	74,284	96.1%	$ 7,411	$ 7,158	3,027	63.2%	$ 14,774	$ 9,583
Y2 *Psychoactive Drug Dependence*	304	0.4%	$14,496	$21,996	494	10.3%	$ 19,627	$ 19,810
Y2 *Alcohol Dependence*	433	0.6%	$10,729	$17,094	310	6.5%	$ 21,227	$ 20,642
Y2 *Other Drug Dependence*	2,467	3.2%	$ 9,085	$14,207	1,209	25.3%	$ 19,043	$ 18,531

Future Complications of Depression: Comparison of utilization models with disease-specific model

Data on 77,323 members with *Depression* without listed complications in Year1 were randomly split into train and test sets. This model used 95 measures.

We also applied the following three utilization predictive models:

- Prediction of future total cost
- Prediction of future LOS
- Prediction of future Emergency Room visits

The three utilization models were developed using a multimillion life repository. They are very sophisticated models - using many clusters and more than 300 measures/predictors.

Future Complications of Depression: Comparison of utilization models with disease-specific model

The Comparison is based on the test set only. PPV – Positive predicted value.

Model		Disease Specific Complications		Utilization						Lift
				LOS		Total Cost		ER visits		
Top %	Count	PPV	Sensitivity	PPV	Sensitivity	PPV	Sensitivity	PPV	Sensitivity	
1	388	26.8%	6.8%	13.4%	3.4%	9.3%	2.4%	5.4%	1.4%	2.00
2	776	24.7%	12.6%	11.0%	5.6%	9.8%	5.0%	5.3%	2.7%	2.26
3	1165	22.5%	17.2%	9.8%	7.5%	9.0%	6.9%	6.2%	4.7%	2.30
4	1553	20.5%	20.9%	9.1%	9.3%	8.4%	8.5%	6.3%	6.4%	2.26
5	1939	19.9%	25.3%	8.8%	11.2%	8.1%	10.4%	6.7%	8.5%	2.26
10	3879	15.0%	38.3%	7.8%	19.8%	7.0%	17.7%	6.2%	15.8%	1.93

Conclusion

The Complication model is about two times (100%) better than the best utilization model in identification of depression's complications irrespectively of the fact that the utilization models are significantly more sophisticated and advanced from any point of view (predictive modeling, clinical, disease management, size of the data – the utilization models were developed using a multimillion life repository).

Profiling of Future MHSA Risk by Disease-specific Models

We built one *utilization model (UM)* and four *disease-specific models (DSM)*:

***UM Model 1*:** *TotalCost* for Year 2 & Year 3 (regression model)
Data: 1,640,691 users; two clusters: men, women; the final model contained 269 original/transformed variables and interactions.

***DSM Model 2*:** *MentalCost* for Year 2 & Year 3 (regression model)
Data: 446,557 members with mental problems; the final model contained 94 original/transformed variables and interactions.

DSM Model 3: *Mental cost progression* (classification model)
The target class (10.3% out of 446,557 members with mental problems) contains members with mental problems and two consecutive years of MHSA cost's increase (MHSA$_Year3>MHSA$_Year2>MHSA$_Year1). The final model contained 225 original/transformed variables and interactions.

Profiling of Future MHSA Risk by Disease-specific Models

***DSM Model 4*:** *Chronic mental drug compliance*: medication adherence or medication possession ratio (MPR) which measures the percentage of time a patient has access to medication (regression model). *Target*: Year 2 MPR. *Data*: 165,605 members with chronic psychological drugs. The final model contained 129 original/transformed variables and interactions.

***DSM Model 5*:** *Alcohol dependency for both – Year 2 & Year 3* for patients with alcohol dependency during Year 1 (classification model)
Data: 12,421 members with Year 1 Alcohol Dependency diagnosis, 18.4% (2,284) of which had the same diagnosis during next two years (target class). The final model contained 82 original/transformed variables and interactions.

Predictive modeling procedure: we used GLM like procedure (based on linear regression for regression purposes and on logistic regression for classification purposes) with backward variable selection and clinical approval of the final selected set of variables and interactions.

Profiling of Future MHSA Risk by Disease-specific Models

Overall statistics of the models (based only on the test set)

Positive Predicted Value (PPV): the percentage of the true positive results;
Sensitivity – the percentage of actual positives which are correctly identified as such

Model	Truncation/ Target Class %	R^2 / Accuracy (%)	Sensitivity		
			Top 2%	Top5%	Top 10%
TotalCost	250K	0.41	40.5%	44.1%	50.6%
MentalCost	30K	0.45	49.5%	54.8%	58.7%
MentalCost Progression-Y2&3	10.30%	83.93%	27.4%	25.1%	22.3%
Alcohol Dependency	18.40%	78.42%	52.5%	45.1%	38.4%
Medication Adherence (MPR)	63.6% with MPR ≥80%	0.205	PPV=85.7% (% of members with predicted MPR ≥80% & actual Year 2 MPR ≥80%)		

Profiling of Future MHSA Risk by Disease-specific Models

Comparison of utilization vs. disease-specific cost (Year 2 & Year 3) model

Future mental events (diagnoses, cost, drugs)	Total Cost Model		Mental Cost Model		Top 5% Lift
	Top 2%	Top 5%	Top 2%	Top 5%	
Depression_Y2	40.7%	32.3%	41.0%	41.9%	1.29
Depression_Y3	40.7%	32.5%	37.3%	39.2%	1.21
Schizophrenia_Y2	3.1%	2.7%	17.0%	10.5%	3.93
Schizophrenia_Y3	2.8%	2.6%	17.3%	10.5%	4.02
Drug Dependence_Y2	11.0%	9.5%	15.2%	14.4%	1.52
Drug Dependence_Y3	10.6%	9.9%	16.3%	14.2%	1.44
Alcohol Dependence_Y2	3.1%	2.7%	5.6%	5.2%	1.93
Alcohol Dependence_Y3	3.1%	2.9%	5.9%	5.1%	1.76
Neuroses_Y2	13.2%	11.0%	22.2%	18.8%	1.70
Neuroses_Y3	14.8%	11.2%	20.9%	18.4%	1.64

Profiling of Future MHSA Risk by Disease-specific Models

Comparison of utilization vs. disease-specific cost (Year 2 & Year 3) model

Future mental events (diagnoses, cost, drugs)	Total Cost Model		Mental Cost Model		Top 5% Lift
	Top 2%	Top 5%	Top 2%	Top 5%	
Anxiety_Y2	25.4%	20.5%	24.4%	25.3%	1.23
Anxiety_Y3	26.0%	21.5%	24.7%	26.0%	1.21
Total Cost_Y2	$ 63,918	$ 36,703	$ 19,586	$ 15,829	0.43
Total Cost_Y3	$ 64,237	$ 37,117	$ 19,855	$ 16,290	0.44
MHSA Cost_Y2	$ 3,407	$ 2,497	$ 10,592	$ 6,862	2.75
MHSA Cost_Y3	$ 3,107	$ 2,414	$ 9,701	$ 6,476	2.68
PsychRxCompliance_Y2	61%	49%	80%	71%	1.45
PsychRxCompliance_Y3	59%	47%	75%	67%	1.43
AntiDepressants_Y2	8.04	6.33	10.10	8.85	1.40
AntiDepressants_Y3	7.39	5.85	9.38	8.27	1.41
Tranquilans_Y2	3.95	3.15	10.98	7.44	2.36
Tranquilans_Y3	3.60	2.98	10.24	7.00	2.35

Profiling of Future MHSA Risk by Disease-specific Models

Mental Progression Model (two consecutive years of MHSA Cost increase).
Target class: 10. 3%; Overall accuracy: 84%

Model	Positive Predicted Value		
	Top 2%	Top 5%	Top 10%
Mental Progression	27.4%	25.1%	22.3%
Mental Cost	16.6%	15.8%	14.9%
Total Cost	9.7%	11.3%	11.3%

Profiling of Future MHSA Risk by Disease-specific Models

Alcohol Dependency Model (alcohol dependency diagnosis during future two consecutive years). Target class: 18.4%; Overall accuracy: 78.4%

Model	Positive Predicted Value		
	Top 5%	Top 10%	Top 18%
Alcohol Dependency	52.5%	45.1%	38.4%
Mental Cost	28.5%	26.8%	27.2%
Total Cost	24.1%	26.8%	25.8%
Mental Progression	21.5%	24.3%	22.8%

Conclusions

Disease-specific predictive models are definitely better (higher accuracy) than any utilization predictive model in identification of future drivers for MHSA risks\costs

Disease-specific models complement utilization models and empower Population Health, Disease & Case Management with additional useful information not provided by conventional utilization models

Development of more sophisticated and advanced disease-specific models based on larger populations, specific clusters & more clinically meaningful predictors will significantly increase their accuracy

The Population Health, Disease & Case Management sectors must begin to use more disease-specific models to personalize, target, and prioritize clinical intervention plans for each High Risk MHSA Member

Questions and Opinions

Ogi Asparouhov, PhD

Chief Scientist, LexisNexis

800.869.0751

healthcare@lexisnexis.com

Twitter: @LexisHealthCare

LinkedIn: LexisNexisHealthCareSolutions