DRUGS ARE ~~BAD~~ GOOD!

The Royal Flying Data Service

Catherine: catwang89@gmail.com
Ivan: ivan.liuyanfeng@gmail.com
Max: maxwang427@gmail.com
Michael: michaelpaulhisch@gmail.com
Noah: meng.noah.xiao@gmail.com

Introducing the Compliance Score

Why looking into Compliance Score

- We want to find a standard index to measure drugs efficiency and customer behavior.
- Because of the data quality issue in the given dataset, we find patient compliance and persistence are the most valuable features to dig into.
- We use IPI (Inter-Purchase Interval), which is the time between shopping for particular drugs, to calculate the Compliance Score.
- Drug Companies and the hospital can apply the compliance score on the drug to determine their popularity and effectiveness in the patient.
- Retail pharmacy and GPs can apply compliance score on the patient to see if they adhere to their prescription, identify sales patterns, and provide better follow-up services.

STEP 1: Standard Drug IPI

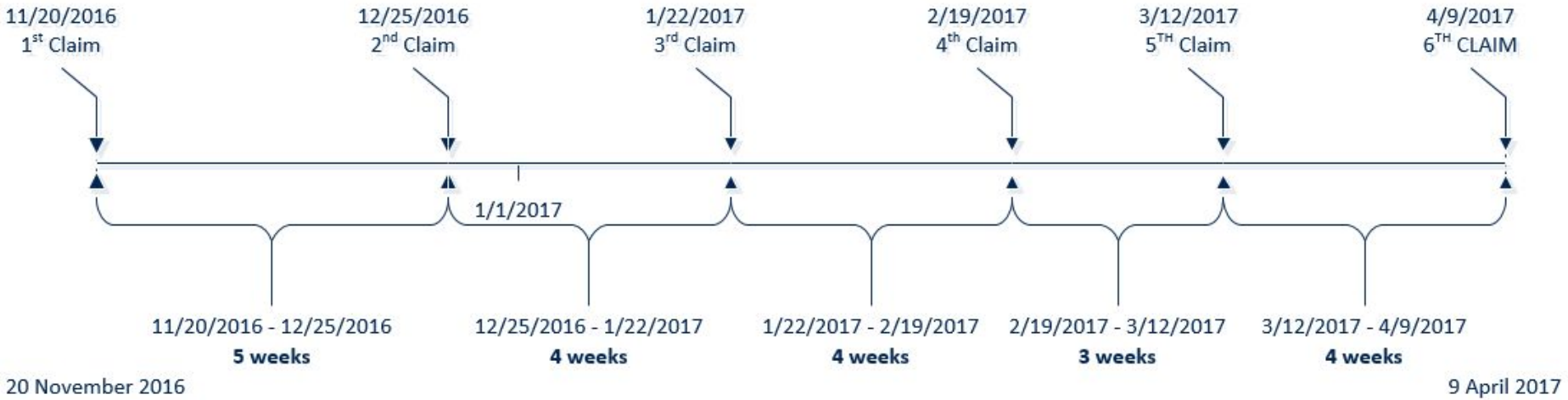
IPI: Inter-Purchase Interval

Say, a drug prescription is like below:

Drug:	**Dytrex**
Pack Size:	**30**
Total Repeats:	**6**
Script Qty:	**60**
…	
Prescriber ID:	1234
Patient ID:	1111
Prescription Week:	23 Nov 2016

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval



STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Dispense Week	20 Nov 2016	25 Dec 2016	22 Jan 2017	19 Feb 2017	12 Mar 2017	9 Apr 2017
Script Qty	60	60	60	60	60	60
Pack Size	30	30	30	30	30	30

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Dispense Week	20 Nov 2016	25 Dec 2016	22 Jan 2017	19 Feb 2017	12 Mar 2017	9 Apr 2017
Script Qty	60	60	60	60	60	60
Pack Size	30	30	30	30	30	30
Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

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Script Qty	60	60	60	60	60	60
Pack Size	30	30	30	30	30	30
Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**
Interval in weeks	5	4	4	3	4	NA

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Dispense Week	20 Nov 2016	25 Dec 2016	22 Jan 2017	19 Feb 2017	12 Mar 2017	9 Apr 2017
Script Qty	60	60	60	60	60	60
Pack Size	30	30	30	30	30	30
Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**
Interval in weeks	5	4	4	3	4	NA
Adjusted Interval	5 / 2 = **2.5**	4 / 2 = **2**	4 / 2 = **2**	3 / 2 = **1.5**	4 / 2 = **2**	NA

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Dispense Week	20 Nov 2016	25 Dec 2016	22 Jan 2017	19 Feb 2017	12 Mar 2017	9 Apr 2017
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Interval in weeks	5	4	4	3	4	NA
Adjusted Interval	5 / 2 = **2.5**	4 / 2 = **2**	4 / 2 = **2**	3 / 2 = **1.5**	4 / 2 = **2**	NA

IPI = median(**2.5**, **2**, **2**, **1.5**, **2**) = **2**

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Calculate the Adjusted Intervals for **all**

- Drugs
- Prescriptions

A **Standard Drug IPI** = median(All **Adjusted Intervals** of that Drug)

E.g. **Dytrex**'s standard IPI = 2

STEP 1: Standard Drug IPI

IPI: Inter-Purchase Interval

Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**
Interval in weeks	5	4	4	3	4	NA
Adjusted Interval	5 / 2 = **2.5**	4 / 2 = **2**	4 / 2 = **2**	3 / 2 = **1.5**	4 / 2 = **2**	NA
Standard IPI	2	2	2	2	2	2

STEP 2: Deviation

Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**
Interval in weeks	5	4	4	3	4	NA
Adjusted Interval	5 / 2 = **2.5**	4 / 2 = **2**	4 / 2 = **2**	3 / 2 = **1.5**	4 / 2 = **2**	NA
Standard IPI	2	2	2	2	2	2
Deviation	2.5 / 2 = **1.25**	2 / 2 = **1**	2 / 2 = **1**	1.5 / 2 = **0.75**	2 / 2 = **1**	NA

STEP 3: Non-Compliance Index

Dosage	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**	60 / 30 = **2**
Interval in weeks	5	4	4	3	4	NA
Adjusted Interval	5 / 2 = **2.5**	4 / 2 = **2**	4 / 2 = **2**	3 / 2 = **1.5**	4 / 2 = **2**	NA
Standard IPI	2	2	2	2	2	2
Deviation	2.5 / 2 = **1.25**	2 / 2 = **1**	2 / 2 = **1**	1.5 / 2 = **0.75**	2 / 2 = **1**	NA

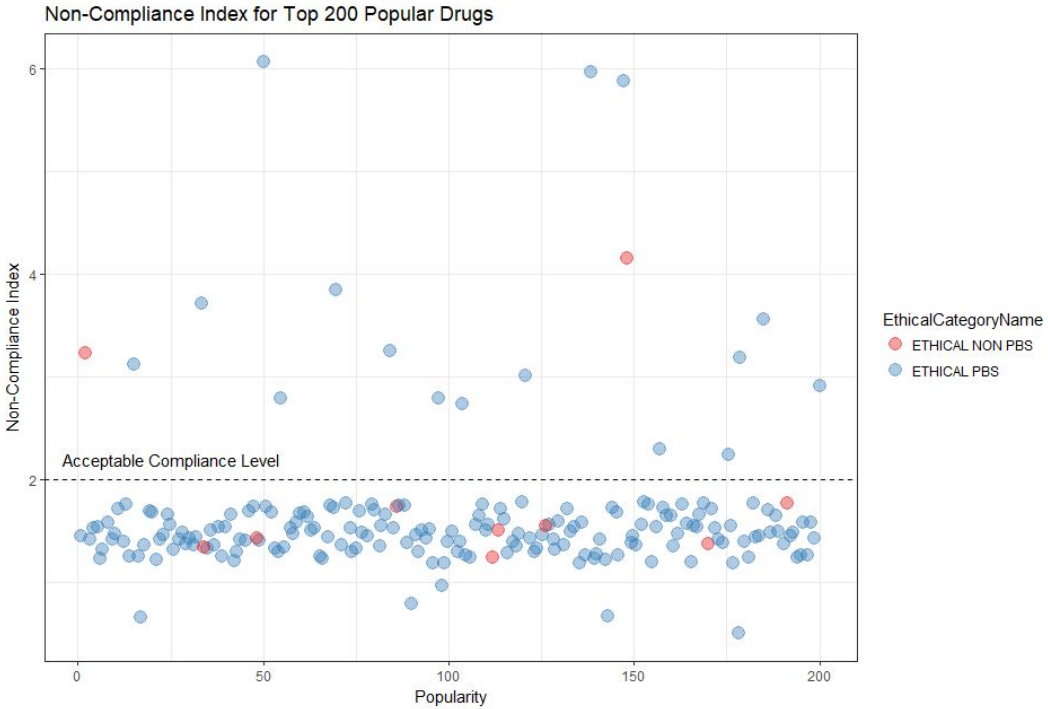
Non-Compliance Index = mean(**1.25**, **1**, **1**, **0.75**, **1**) = 1

STEP 4: Compliance Score

1. Remove Outliers
2. Standardisation
3. **Compliance Score =** 1 - Non-Compliance Index

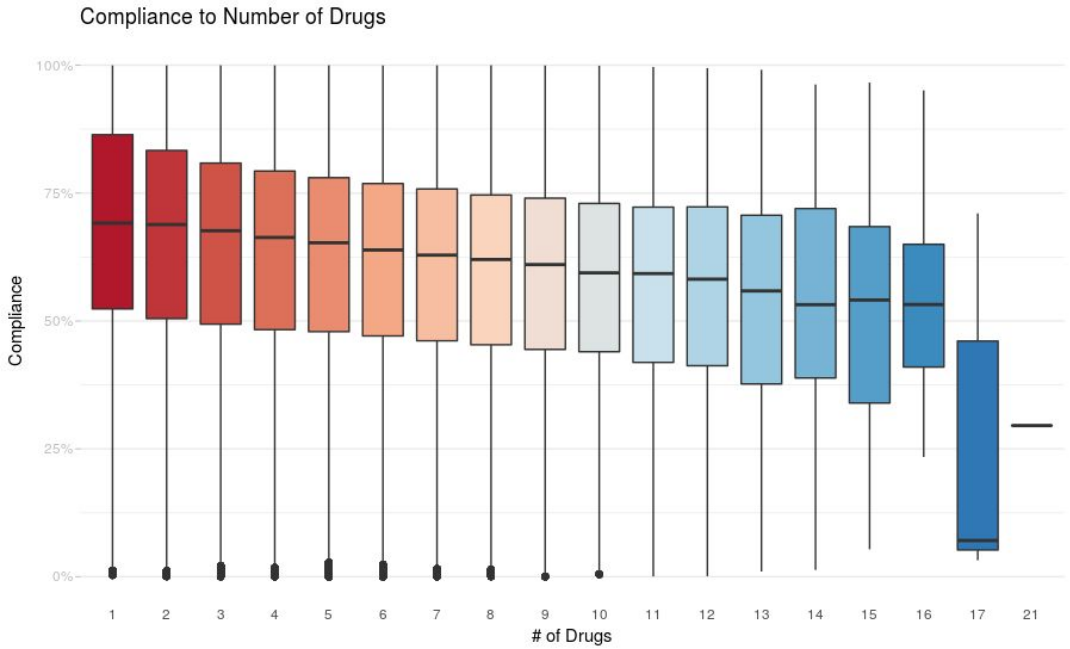
Insights around Compliance Score

Which Drugs should be on PBS but actually aren't



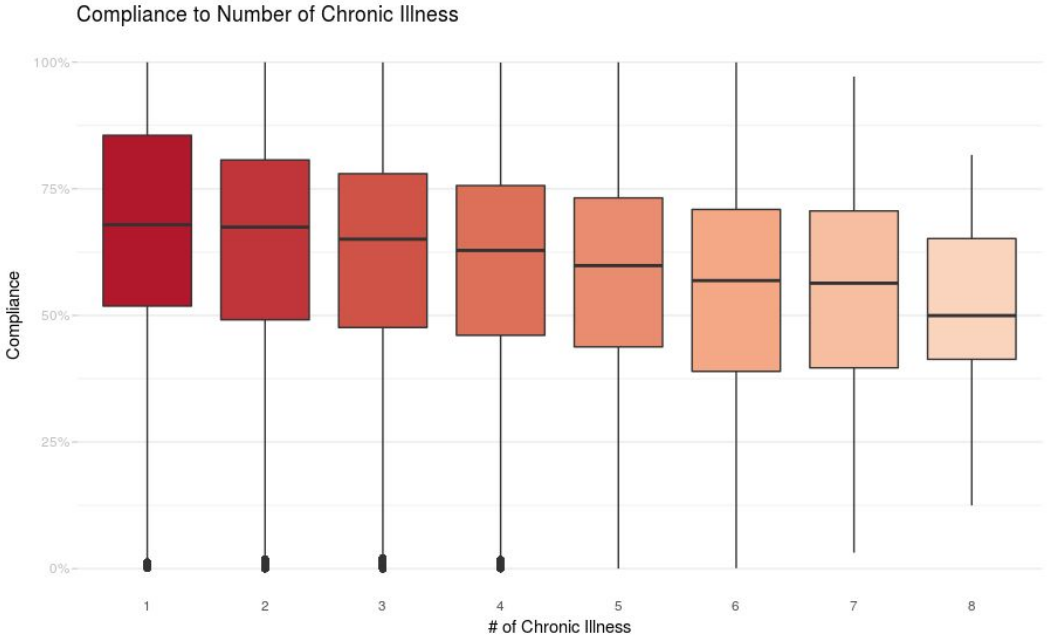
- Drugs have high compliance score indicate they are more effective in relieving patients' symptoms.
- Identify some Drug with high compliance index and high popularity among patient but not in the PBS.
- Drug companies should propose to the government to considering placing those drugs on Ethical PBS.

Compliance vs. How Many Drugs you take



- Patient with fewer drugs on their prescription has higher compliance score.
- The compliance score drops sharply when patient is taking 15 drugs at the same time. (Maybe Chronic disease)
- Prescriber and Doctor should increase their awareness on how many drugs one patient takes at a time.
- The drug company should invest on the drugs that can address multiple symptoms.

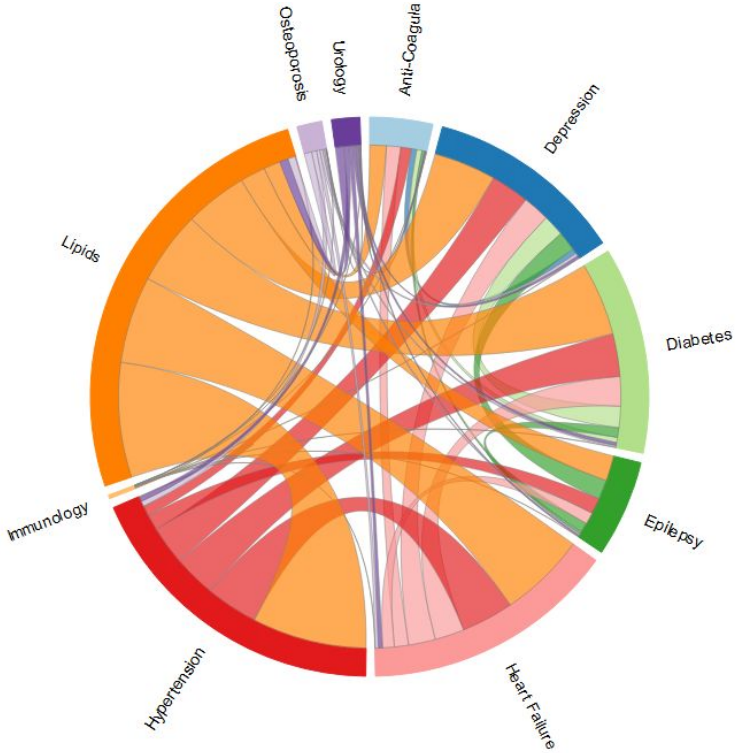
Compliance vs. How Many Chronic Illnesses you have



- Compliance and Chronic are negative correlated.
- Patient with fewer Chronic illness has higher compliance and wider distribution.
- The compliance score drop sharply when the patient has more than 8 chronic diseases.
- The reason why multiple chronic patients have lower compliance could be drug-drug interactions.

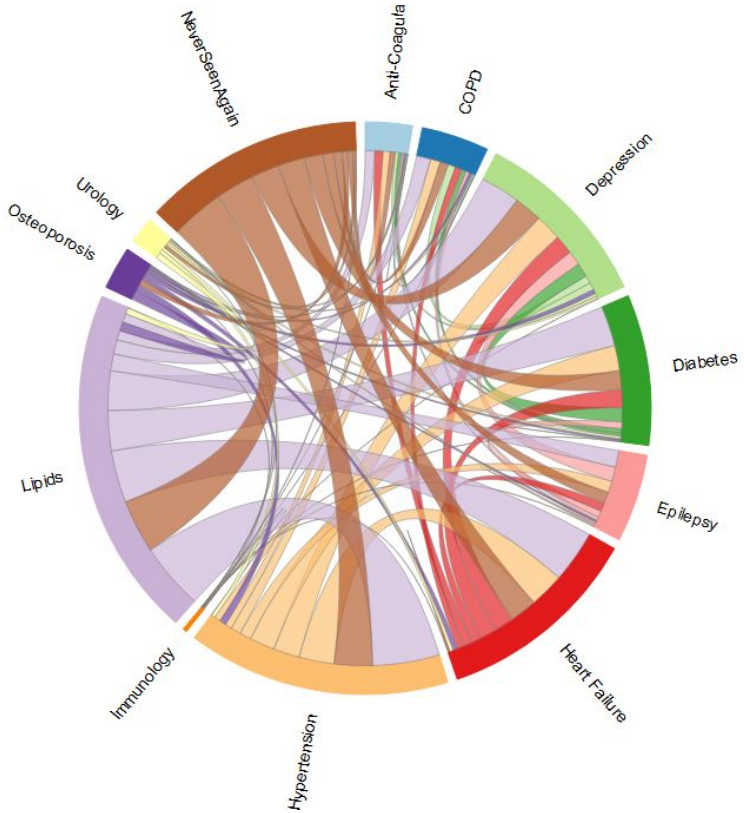
Other Discoveries on Patients & Disease' Pattern

Chronic Disease Connections



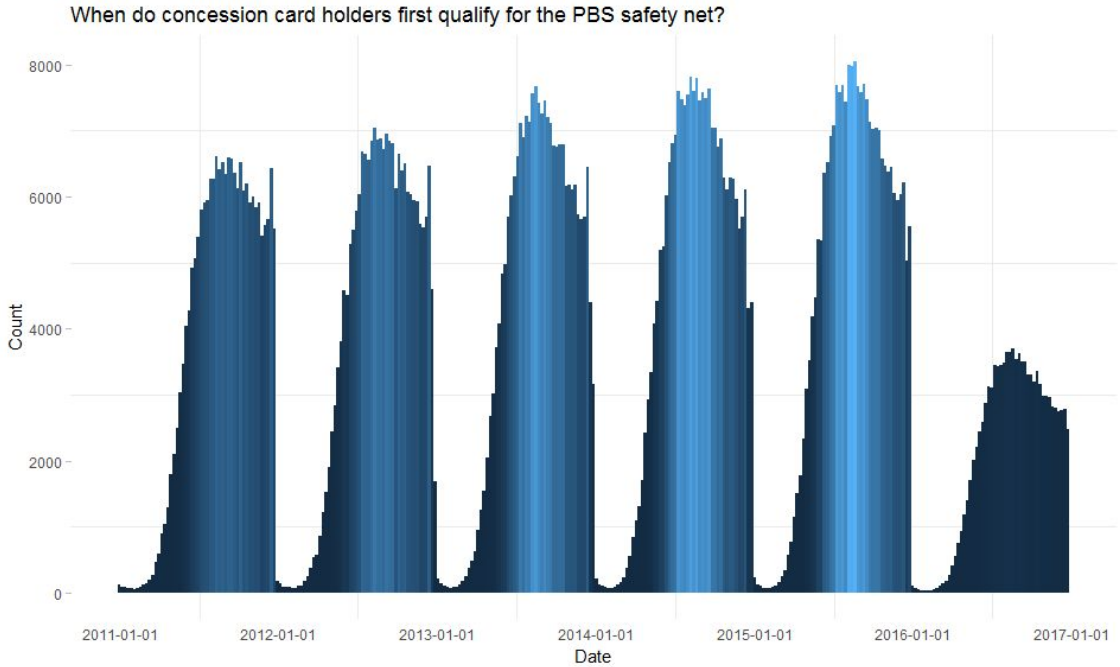
- Likelihood of one patient with present chronic illness showing other chronic syndromes within a year
- Chronic diseases may share underlying causes, such as stress, diet, smoking, and family history, and other socio-economic factors.
- Lipids has the largest shared cooccurence of all illnesses.

Chronic Disease Connections (part II)



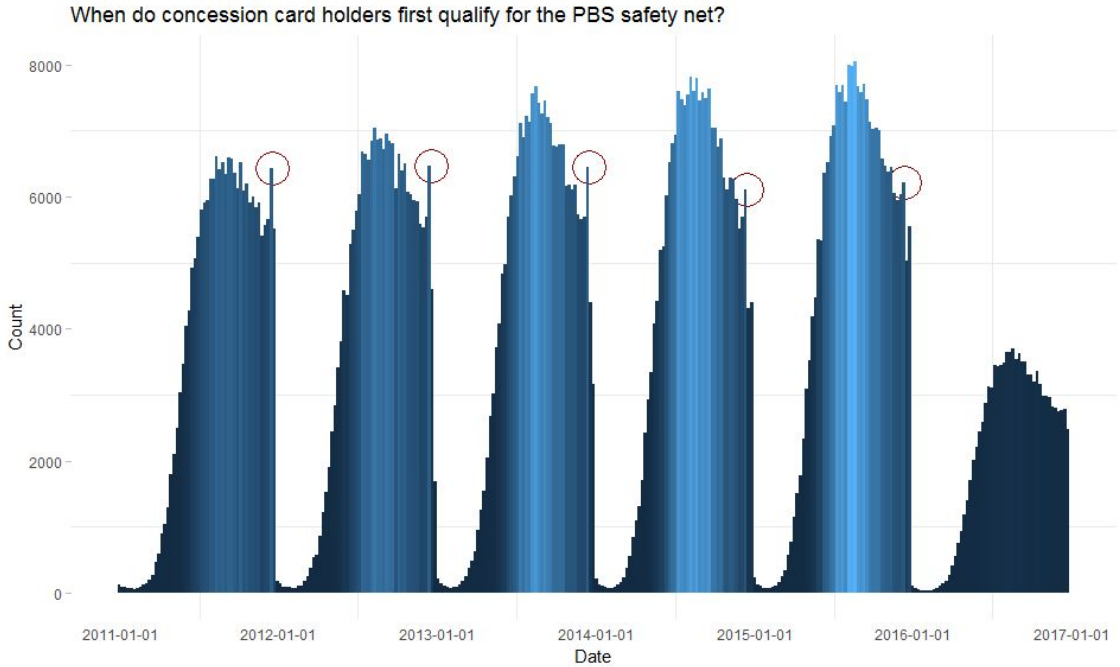
- Includes new field ‘NeverSeenAgain’(patients who stopped buying drugs for treating an illness)
- Majority of patients show multiple chronic illnesses
- NeverSeenAgain may indicate the patient having been cured or having passed away.
- Patient have higher possibilities to show other chronic symptoms than end up in NeverSeenAgain

The PBS Safety Net



Patients start qualifying for the safety net from January and peak in August

The PBS Safety Net



Qualifications for the safety net experience a sharp peak in mid-december presumably as the holiday period approaches

Where are pharmacies needed most?

Where are pharmacies needed most?

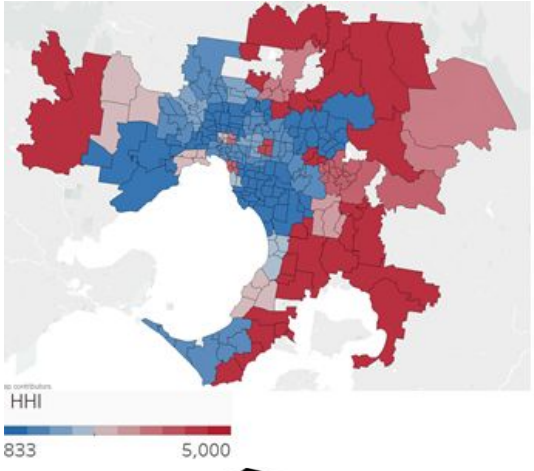
We look at population, pharmacy-suburb spend (as a proxy for demand), and a patient's home suburb

Criteria on finding locations for new stores:

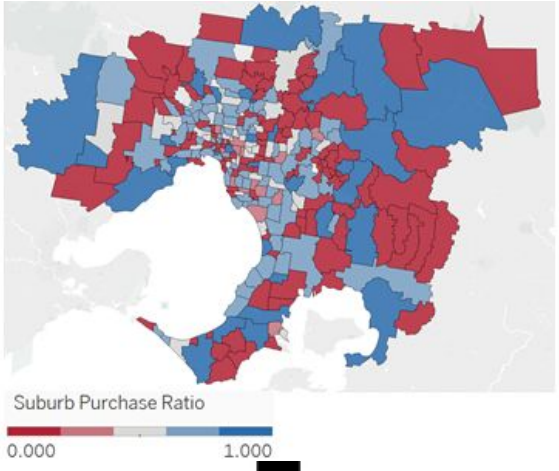
- **Is this suburb highly saturated or sparsely populated by pharmacies?**
  Herfindahl-Hirschman Index (HHI) of stores' revenue (a proxy for demand) in a neighborhood is higher than 2500.
- **Do patients prefer to visit pharmacies nearby their homes?**
  Same-Suburb purchase ratio is lower than 0.5.
- **We target suburbs where the local population fill most of their prescriptions elsewhere**
  This would reduce ease of collecting prescriptions and increase compliance as well.
- **We target high population suburbs as the best candidates for new pharmacies**
  Suburbs with higher populations demonstrate the highest potential for helping patients. We isolate suburbs with population higher than the median of suburbs that have at least one store (14000).

Where are pharmacies needed most?

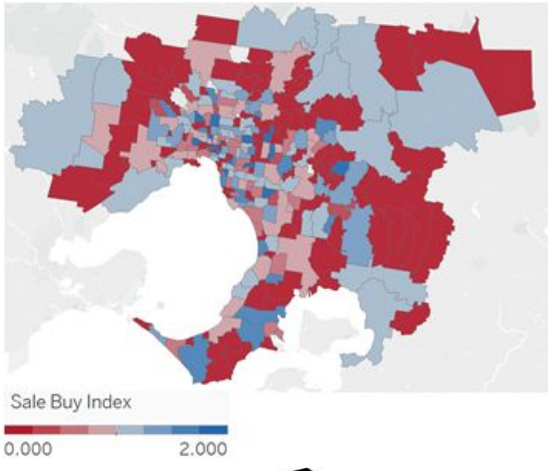
Neighbourhood HHI

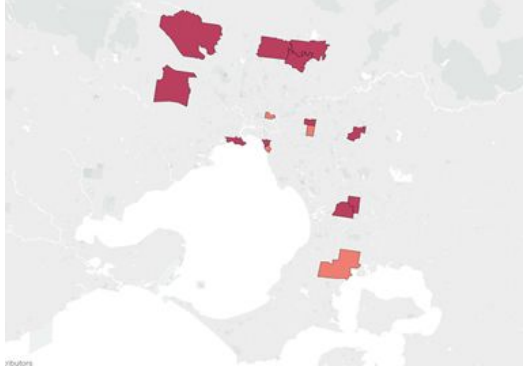


Suburb Purchasing Ratio



Sale Buy Index





These Victorian suburbs are in highest need of a pharmacy considering population, travel times to nearest pharmacies, and the lack of pharmacies already present.

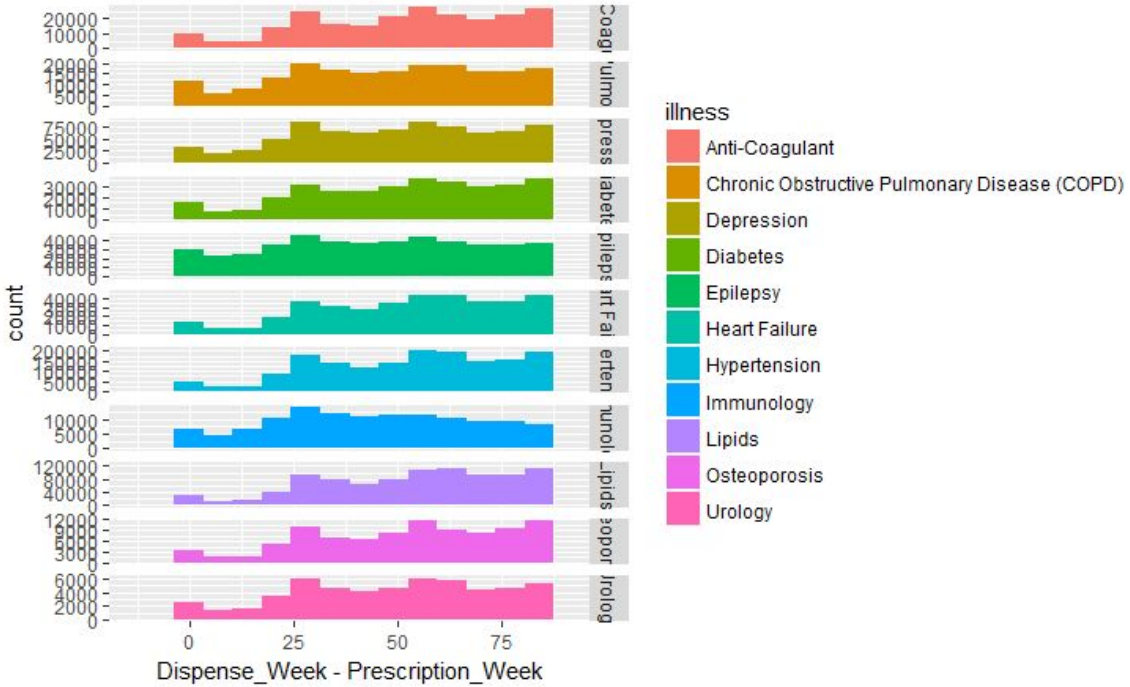
Where are pharmacies needed most?

postcode	suburb	number of store	population	patient_buy ($)	store_sold ($)	buy sale metric	District HHI
3016	Williamstown	1	16578	240008.55	11990.01	0.049957	2608
3068	Clifton Hill	2	21196	437142.13	315929.94	0.722717	3515
3128	Box Hill	3	20122	1016122.71	213239.65	0.209856	4365
3129	Box Hill North	0	18341	213451.66	0	0	4365
3153	Bayswater	2	21487	1029975.54	132011.27	0.128169	5074
3182	St Kilda	0	24570	155432.25	0	0	3816
3184	Elwood	2	17516	87922.89	25904.7	0.29463	3816
3335	Rockbank	0	16547	114666.42	0	0	2836
3429	Sunbury	0	38094	38749.41	0	0	10000
3750	Wollert	0	22091	26524.4	0	0	10000
3752	Soth Morang	1	15601	688546.48	138023.83	0.200457	10000
3754	Doreen	0	49211	243381.54	0	0	10000
3912	Pearcedale	1	15755	57005.57	11910.8	0.208941	10000
3975	Lynbrook	0	17243	134258.69	0	0	5712
3976	Hampton Park	0	32390	101649.43	0	0	5712

Based on visualization of the data and our knowledge on these suburbs, opening big stores in **Box Hill, Bayswater,** and **South Morang** can easily occupy the market and gain profit.

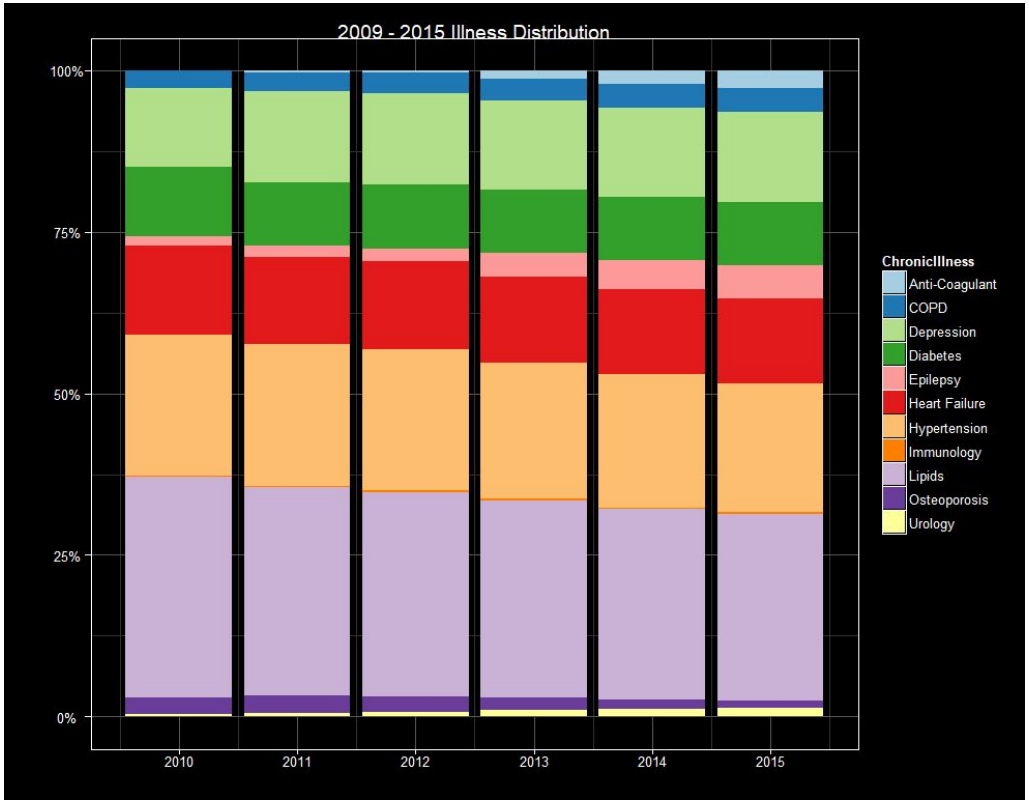
Appendices

How quickly do different patients fill their prescription?



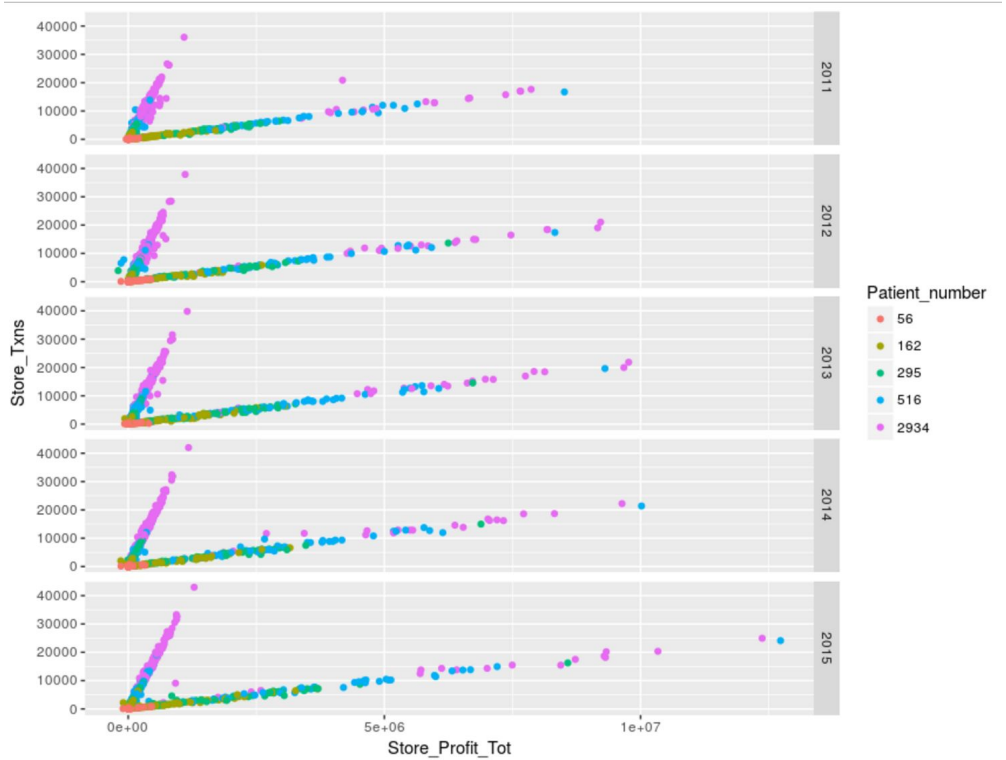
- Epilepsy and Immunology patient fill their prescription sooner than.
- Some symptoms are more urgent
- Diabetes patient need larger dosage to control their symptoms than others.

Yearly Proportion of Illnesses



- Over year, Lipids are decreasing in terms of proportion
- Depression and Epilepsy are increasing in terms of proportion
- Anti-Coagulant is merging and reach the same proportion as COPD in 2015.

Evidence of two types of Stores



- A distinct distribution showing transaction data are coming from two types of source.
- The organization who have fewer transactions and higher profit are the retail pharmacy.
- The organization who have larger transactions and lower profit are the hospital.

Thank you

Q&A