Informatics Here and Now to Support Efficient Care Coordination

Translating what we learn from

Linked Data into practice

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The Context:

Increasing Demand on Hospitals and Emergency Departments (ED)

- ► *Increased Life Expectancy (Older population)*
- ► *Ever improving surgical survival rates*
  - ► *Survivors require ongoing Hospital and ED services*
- ► *Dominant modes in Lifestyle and Health Behaviour (More food, less exercise)*
  - ► *More prevalent chronic conditions (e.g. Diabetes)*

We are engaged in Data Science to increase Healthy Life Expectancy

Overview

Support for Integrated and Collaborative Initiatives

Care Coordination

► Bridging the Gap between Primary (GP) Care, and Hospital Care (GP Linkage)

Integrated Care

► System level insights to evaluate / guide early intervention (*Has it worked?*)

► Improved quantification of likely benefit from Intervention (*For whom will it work?*)

► Assisting Scale-Up of successful programs (*What does demand look like at state level?*)

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NSW Health – GP Linkage Data

Bridging the Gap between Primary (GP) Care, and Hospital Care

Linking Primary Health and Hospital Data
- GP visits, ED Presentations, Hospital Admissions

► First of its kind in Australia ($11 million funding to go statewide)

► 150,000 Patients observed over a 5 (GP) to 8 year (ED, Hospital Admissions) period.

► Excellent coverage of Socioeconomic (via ABS Geocoding) and sociocultural factors

► Rich with potential Lead Indicators

  ► Undiagnosed chronic conditions

  ► Well managed chronic conditions

  ► Medication history

  ► GP visits, diagnosis

► Improvements since early tranches

  ► Geocoding is now more refined (SA1)

  ► Tried and tested data quality

  ► Medication & diagnoses time records now more comprehensive

Impact of conditions not diagnosed in Primary Care

▶ What can we use to identify _well managed_ chronic conditions?

GP_Diagnosis	APDC_Diagnosis	Test Results	Medication
Diabetes_GP	Diabetes_Hospital	Hba1c (diabetes)	Antidiabetics

▶ What does the data show?

Diagnosis	Hospital No	Hospital Yes
GP No	67,740	1,660
GP Yes	914	4,372

GP Antidiabetics NO	Hospital No	Hospital Yes
GP_No	67,176	1,369
GP_Yes	323	786

GP Antidiabetics YES	Hospital No	Hospital Yes
GP_No	564	291
GP_Yes	591	3,586

▶ $\frac{1369}{(1660+914+4372)}$ = ~20% of patients with diabetes are _not_ flagged, not medicated by GP.

Impact of Unrecognised Diabetes on Risk of Unplanned Hospital Admission

- Controlled factors (over preceding 4+ years) :
  - ED Presentations
  - Planned Admissions
  - Unplanned Admissions
  - GP visits
  - Socio-economic status (SES)
  - BMI, diagnostic tests
  - Chronic, Acute, Mental conditions

- Risk of unplanned hospitalisation in subsequent 12 months.
  - (A) Non smoker, 40s, pattern of GP visits, median SES, no Chronic or Mental conditions, no admissions or ED presentations ; 2.8%
  - As (A), but with GP flagged Diabetes; 4.6% (Risk Ratio 1.6)
  - As (A), but with Unrecognized Diabets: 8.2 % (Risk Ratio 2.9)

	Reference (A)	Diabetes (GP)	Diabetes (Unrecognized)
Risk (Unplanned Admission)	2.8%	4.6%	8.2%
Mean LOS	.4 Days	2 Days	2.7 Days

Hospital Cost (Unrecognized Diabetes) > 2 *(GP managed Diabetes)

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HbA1c Test / Diabetes Flag

Practice	GPflag_No	GPflag_Yes	% Misflagged	SEIFA
10	1	34	2.86	1139
8	5	193	2.53	1133
14	6	132	4.35	1133
6	14	136	9.33	1108
19	9	238	3.64	1058
9	4	93	4.12	1055
17	5	160	3.03	1031
13	6	201	2.90	1028
3	22	551	3.84	1019
15	19	147	11.45	1019
16	34	219	13.44	1019
1	35	478	6.82	1008
5	54	269	16.72	1008
4	0	71	0.00	965
18	52	258	16.77	965
12	14	163	7.91	950
7	54	283	16.02	935
11	4	297	1.33	892
2	22	197	10.05	883

▶ **Percentage of patients per GP, who have tested positive (Hb1Ac) but are not flagged as diabetic.**

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Hb1Ac test / Diabetes Flag

Factors associated with being Flagged as Diabetic following a positive HbA1c test:

```
Call:
glm(formula = Diabetes ~ Gender + CALD_FLAG + age + SEIFA_Stan +
    Antidiabetics + APDC_CVD_F + APDC_CKD_F + APDC_diabetes +
    COUNT_GP + Total_Planned_Readmissions + Total_Unplanned_Readmissions,
    family = binomial, data = HB1AC_testedm2_FilteredData)

Deviance Residuals:
    Min      1Q   Median      3Q      Max
-3.0162  0.1933  0.2383  0.3155  1.4635

Coefficients:
                               Estimate Std. Error z value Pr(>|z|)
(Intercept)                    0.104526   0.393147   0.266 0.790338
GenderMale                     0.192935   0.153126   1.260 0.207678
CALD_FLAGUnknown               0.838996   0.852454   0.984 0.325011
CALD_FLAGYes                   0.178928   0.154732   1.156 0.247528
age                            0.003756   0.005316   0.706 0.479879
SEIFA_Stan                     0.002820   0.001183   2.384 0.017115 *
AntidiabeticsYes               2.209648   0.159702  13.836  < 2e-16 ***
APDC_CVD_FYes                 -0.298749   0.198290  -1.507 0.131907
APDC_CKD_FYes                 -0.187116   0.256031  -0.731 0.464882
APDC_diabetesNo               -0.652229   0.250783  -2.601 0.009302 **
APDC_diabetesYes               0.663532   0.254896   2.603 0.009237 **
COUNT_GP                       0.008116   0.002354   3.447 0.000566 ***
Total_Planned_Readmissions     0.004505   0.005750   0.783 0.433381
Total_Unplanned_Readmissions -0.015852   0.038048  -0.417 0.676942
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1633.9  on 3201  degrees of freedom
Residual deviance: 1284.6  on 3188  degrees of freedom
```

- ► Being on medication (!)
- ► Having a positive diagnosis at hospital
- ► Visiting the GP
- ► Socioeconomic advantage

Impact of Unrecognised CKD (3+) on Risk of Unplanned Hospital Admission

	Reference (A)	CKD (GP)	CKD (Unrecognized)
Risk (Unplanned Admission)	2.8%	3.5%	7.3%
Mean LOS	.4 Days	3.5 Days	5.5 Days

Hospital Cost (Unrecognized CKD) > 3 *(GP managed CKD)

eGFR test / CKD Stage 3+

Practice	GPflag_No	GPflag_Yes	% Misflagged	SEIFA
1	200	122	62.1	1008
2	77	76	50.3	883
3	89	53	62.7	1019
4	26	35	42.6	965
5	117	33	78.0	1008
6	50	17	74.6	1108
7	125	28	81.7	935
8	92	44	67.6	1133
9	37	17	68.5	1055
10	24	6	80.0	11.39
11	160	81	66.4	892
12	77	27	74.0	950
13	71	89	44.4	1028
14	22	39	36.0	1133
15	54	35	62.8	1019
16	138	37	78.9	1019
17	107	37	74.3	1031
18	134	26	83.8	965
19	108	76	58.7	1058

► **Percentage of patients per GP, who have tested positive (eGFR) for Stage 3+ CKD but are not flagged.**

► **Misflagged figures also reflect changing disease classification**

► **Not cross checked against medication**

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Importance of Early diagnosis

- ▶ **Proactive Primary Care**

- ▶ **Screening programs with optimised timing and breadth**

- ▶ **Health education suited to SES levels**

Cost of condition

Cost of diagnosis
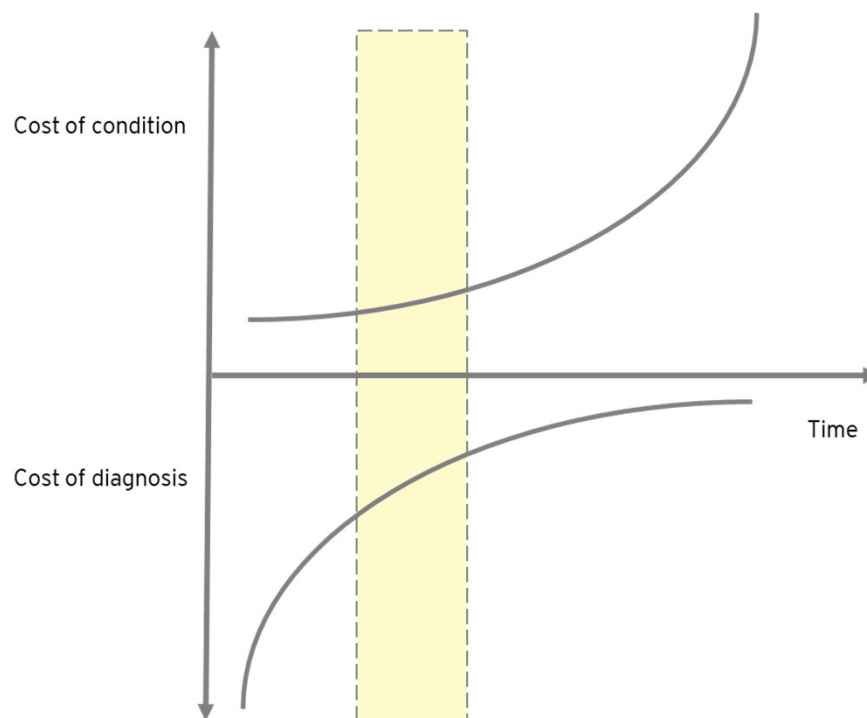
Time

- ▶ **Understand the 'right' dose of primary care** – cost of identifying the disease (GP visits, tests) compared to burden of the disease over time

Assisting Scale-Up of successful programs

What does demand look like at state level?

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ED to Community

Cohort selection

- Applying the propensity score matching algorithm from NBM Checkpoint program on state-wide linked data

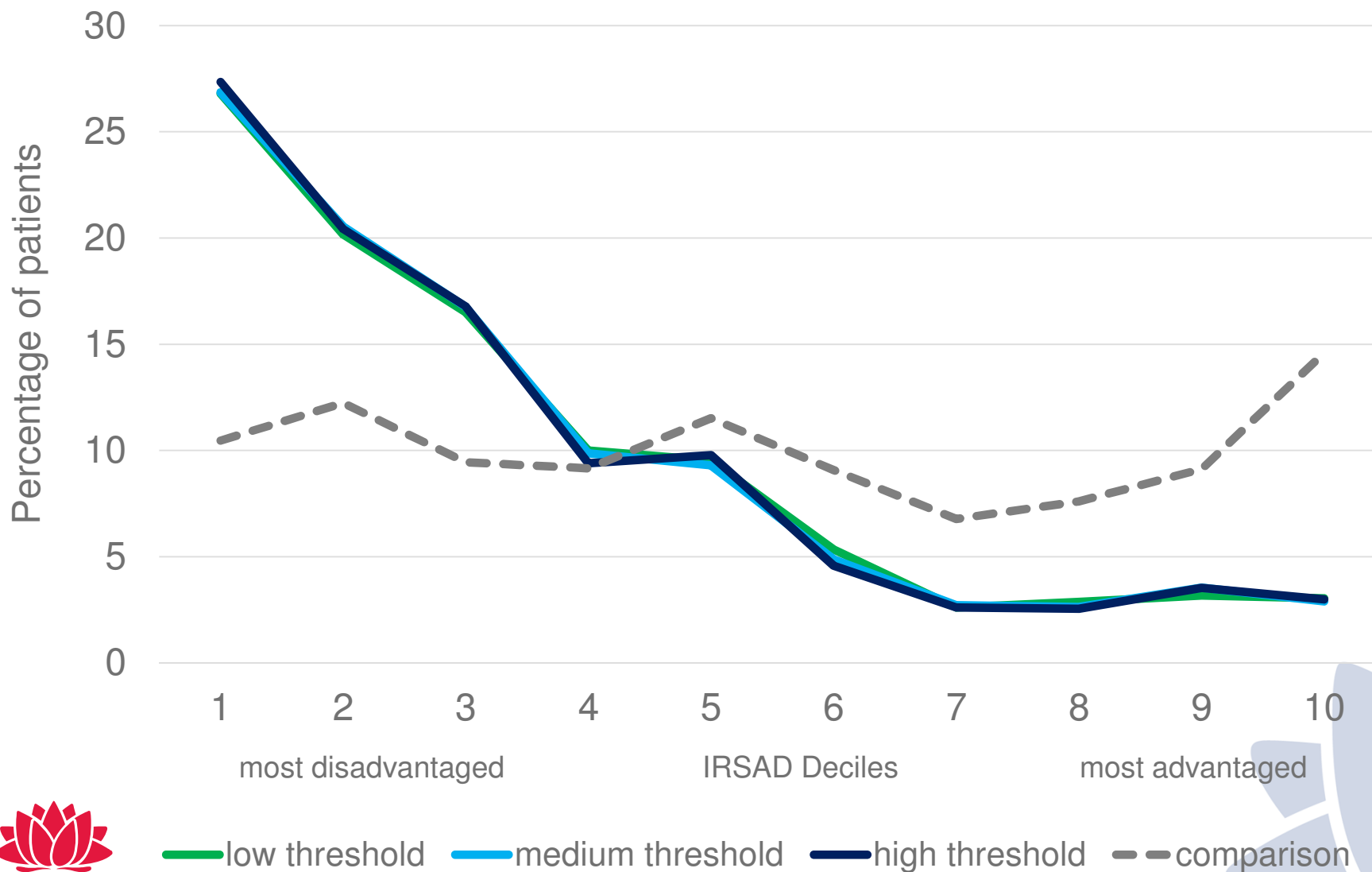- Potential cohorts suited for the ED to Community Program are identified and compared at different threshold levels
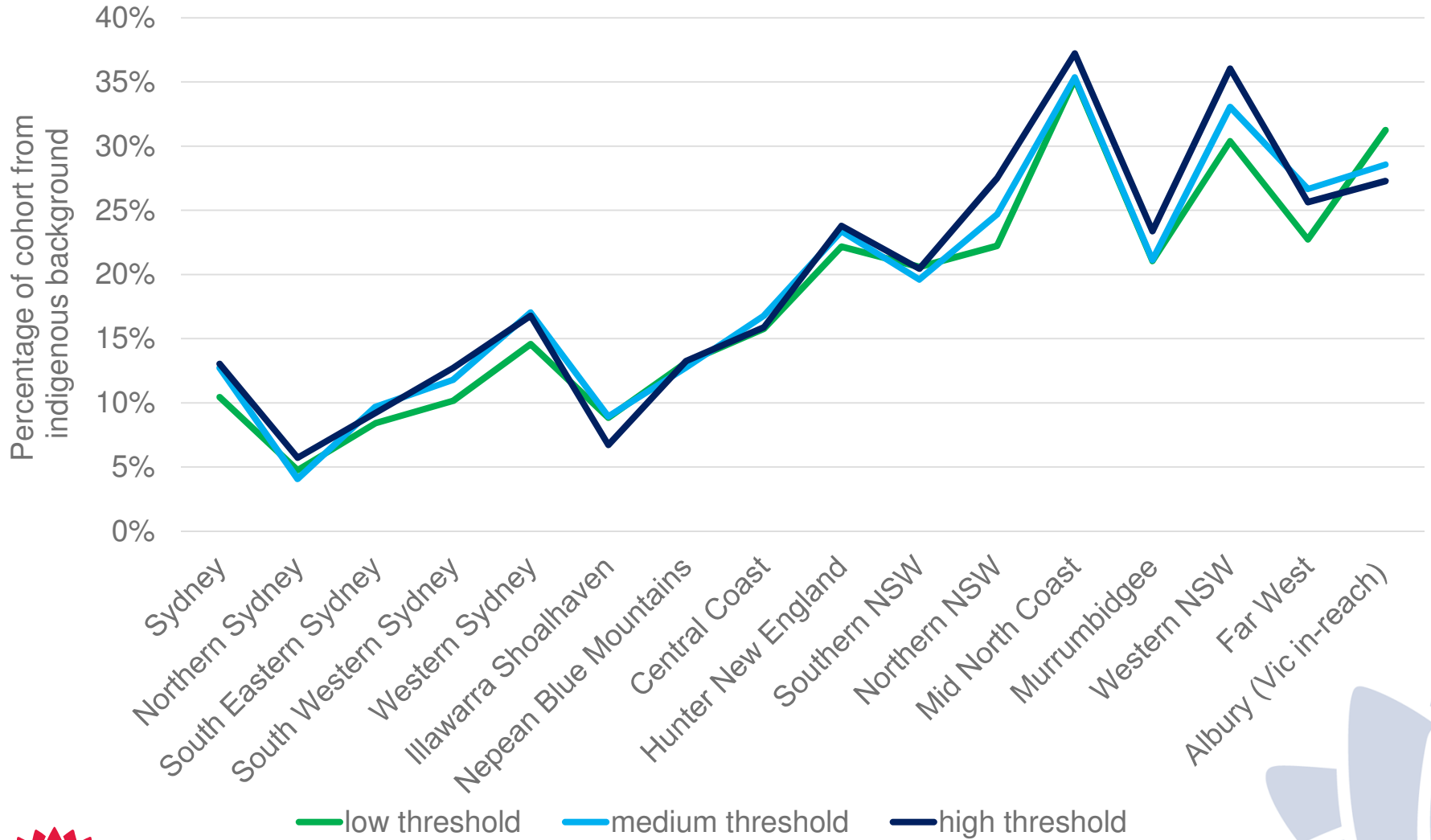
Patient characteristics

Thresholds	Cohort size	Mortality rate	Indigenous	CALD	Gender (male)
Low	3,031	15%	18%	7.7%	46%
	2,594	15%	19%	7.7%	46%
Medium	2,279	15%	19%	7.5%	45%
	2,052	16%	19%	7.7%	46%
High	1,840	16%	20%	7.8%	45%
comparison	**6 million**	**1.25%**	**3%**	**20%**	**49%**

Socio-economic status

Indigenous status

Top 10 Diagnosis for Unplanned Admissions

Low threshold				Medium threshold				High threshold			
Primary	**%**	**Secondary**	**%**	**Primary**	**%**	**Secondary**	**%**	**Primary**	**%**	**Secondary**	**%**
Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4
Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3
Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Type 2 diabetes mellitus without complication	2
Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Other and unspecified abdominal pain	3	Personal history of tobacco use disorder	1
Emotionally unstable personality disorder, borderline type	2	Personal history of tobacco use disorder	1	Emotionally unstable personality disorder, borderline type	2	Nausea and vomiting	1	Emotionally unstable personality disorder, borderline type	2	Mental and behavioural disorders due to use of alcohol, harmful use	1
Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Personal history of tobacco use disorder	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1
Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1
Schizophrenia, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1
Pain localized to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Emotionally unstable personality disorder, borderline type	1
Urinary tract infection, site not specified	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Mental and behavioural disorders due to use of alcohol, withdrawal state	1

Top 10 APDC diagnoses – alcohol, tobacco

Low threshold				Medium threshold				High threshold			
Primary	**%**	**Secondary**	**%**	**Primary**	**%**	**Secondary**	**%**	**Primary**	**%**	**Secondary**	**%**
Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4
Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3
Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Type 2 diabetes mellitus without complication	2
Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Other and unspecified abdominal pain	3	Personal history of tobacco use disorder	1
Emotionally unstable personality disorder, borderline type	2	Personal history of tobacco use disorder	1	Emotionally unstable personality disorder, borderline type	2	Nausea and vomiting	1	Emotionally unstable personality disorder, borderline type	2	Mental and behavioural disorders due to use of alcohol, harmful use	1
Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Personal history of tobacco use disorder	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1
Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1
Schizophrenia, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1
Pain localized to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Emotionally unstable personality disorder, borderline type	1
Urinary tract infection, site not specified	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Mental and behavioural disorders due to use of alcohol, withdrawal state	1

Top 10 Diagnosis for Unplanned Admissions – Mental health

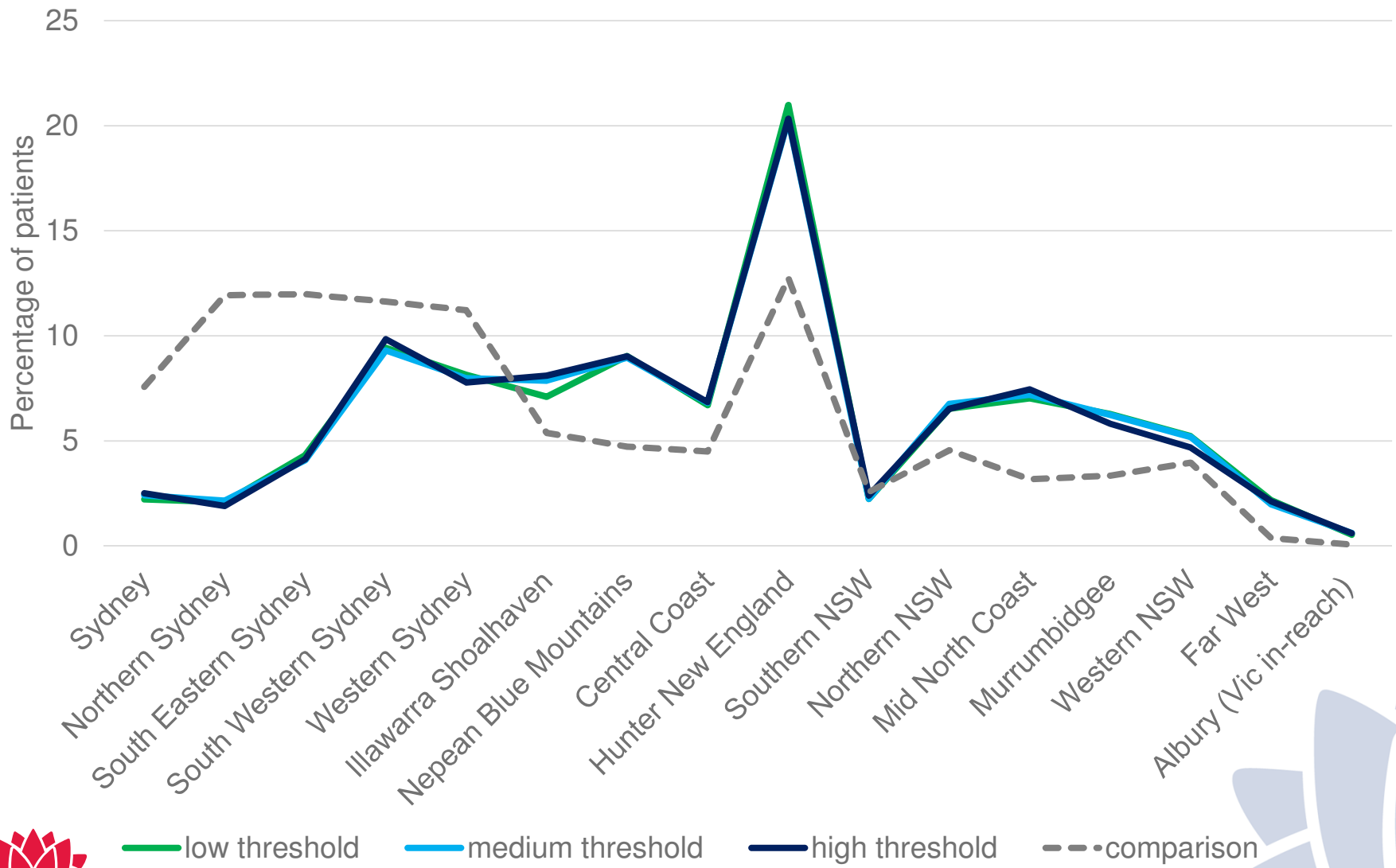| Low threshold				Medium threshold				High threshold			
Primary	%	Secondary	%	Primary	%	Secondary	%	Primary	%	Secondary	%
Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4
Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3
Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Type 2 diabetes mellitus without complication	2
Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Other and unspecified abdominal pain	3	Personal history of tobacco use disorder	1
Emotionally unstable personality disorder, borderline type	2	Personal history of tobacco use disorder	1	Emotionally unstable personality disorder, borderline type	2	Nausea and vomiting	1	Emotionally unstable personality disorder, borderline type	2	Mental and behavioural disorders due to use of alcohol, harmful use	1
Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Personal history of tobacco use disorder	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1
Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1
Schizophrenia, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1
Pain localized to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Emotionally unstable personality disorder, borderline type	1
Urinary tract infection, site not specified	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Mental and behavioural disorders due to use of alcohol, withdrawal state	1

Top 10 Diagnosis for Unplanned Admissions – Chronic conditions

Low threshold				Medium threshold				High threshold			
Primary	%	Secondary	%	Primary	%	Secondary	%	Primary	%	Secondary	%
Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4	Chest pain, unspecified	4	Tobacco use, current	4
Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3	Mental and behavioural disorders due to use of alcohol, acute intoxication	3	Mental and behavioural disorders due to use of alcohol, dependence syndrome	3
Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Other and unspecified abdominal pain	3	Type 2 diabetes mellitus without complication	2	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Type 2 diabetes mellitus without complication	2
Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Chronic obstructive pulmonary disease with acute lower respiratory infection	3	Mental and behavioural disorders due to use of alcohol, harmful use	1	Other and unspecified abdominal pain	3	Personal history of tobacco use disorder	1
Emotionally unstable personality disorder, borderline type	2	Personal history of tobacco use disorder	1	Emotionally unstable personality disorder, borderline type	2	Nausea and vomiting	1	Emotionally unstable personality disorder, borderline type	2	Mental and behavioural disorders due to use of alcohol, harmful use	1
Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Personal history of tobacco use disorder	1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	2	Nausea and vomiting	1
Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1	Other chest pain	2	Volume depletion	1
Schizophrenia, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1	Asthma, unspecified	1	Personal history of noncompliance with medical treatment and regimen	1
Pain localized to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Mental and behavioural disorders due to use of alcohol, acute intoxication	1	Pain localised to upper abdomen	1	Emotionally unstable personality disorder, borderline type	1
Urinary tract infection, site not specified	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Essential (primary) hypertension	1	Pain localised to other parts of lower abdomen	1	Mental and behavioural disorders due to use of alcohol, withdrawal state	1

Distribution by LHDs

LHD of residence	Frequency Low threshold	Percent Low threshold	Frequency Medium threshold	Percent Medium threshold	Frequency High threshold	Percent High threshold
Sydney	67	2%	55	2%	46	3%
South Western Sydney	**286**	**9%**	**212**	**9%**	**181**	**10%**
South Eastern Sydney	131	4%	93	4%	76	4%
Illawarra Shoalhaven	**215**	**7%**	**179**	**8%**	**149**	**8%**
Western Sydney	**247**	**8%**	**182**	**8%**	**143**	**8%**
Nepean Blue Mountains	**274**	**9%**	**204**	**9%**	**166**	**9%**
Northern Sydney	63	2%	49	2%	35	2%
Central Coast	203	7%	155	7%	126	7%
Hunter New England	**636**	**21%**	**462**	**20%**	**374**	**20%**
Northern NSW	198	7%	154	7%	120	7%
Mid North Coast	213	7%	164	7%	137	7%
Southern NSW	68	2%	51	2%	44	2%
Murrumbidgee	190	6%	142	6%	107	6%
Western NSW	158	5%	118	5%	86	5%
Far West	66	2%	45	2%	39	2%
Albury (Vic in-reach)	16	1%	14	1%	11	1%

Distribution by LHDs

Adjusted rate by LHDs
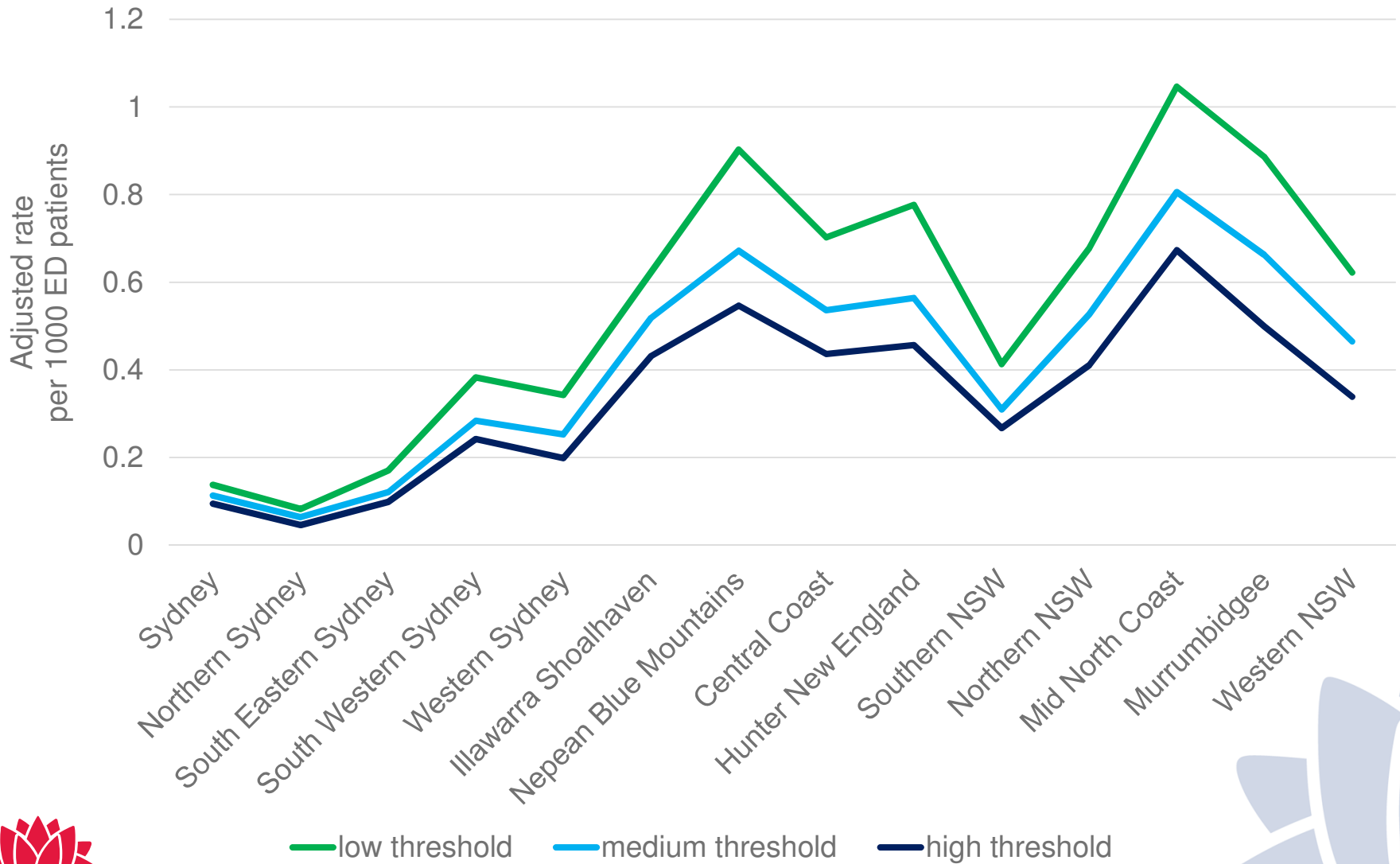
Summary

With Data Science …

Answers to critical business questions:

- Disease Specific Optimised Population Health Strategies
- Has IC intervention worked?
- If so, for whom does it work? (30-40% cost reduction)
- *What does demand look like at state level?*

With IC dataset linked to Primary Care Data,

- *Better understanding of the role Primary Care plays in IC efficacy*
- *Better planning of resources to meet demand at scale-up*

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