Secure SQL database with GRHANITE™ Linkage
Standardised database (CDM) of linked pseudonymised individuals
Data analytics of data repository

Feedback & Data Quality
Cohort studies and RCTs

Health neighbourhood

GP 1, GP 2, GP n...

ED, CHCs & Outpatient Clinics
Hospital admissions

Pseudonymisation & extraction

ePBRN Infrastructure: network of multiple EHRs
Digital health to connect actors

1. Readiness to connect
   Capability maturity/enablers
   Infrastructure: EHR & ePBRN

2. Connect data, systems, tools:
   Common Data Model
   Data linkage, cohorts, continuity of care

3. Connect services & practitioners:
   Acute-primary care continuum
   Chronic disease/cancer mx
   teleHealth & mHealth: apps

4. Connect citizens & community:
   Equitable access: IMPACT, HeLP
   Health Alliances
   Schools: Ashcroft school nurse
   Culturally and clinically appropriate care (WoTWoD)
The curse of interoperability

- Undertaking large scale analysis across multiple sites requires dealing with heterogenous data sources
- Often different types of standard vocabularies used in each source system
OMOP-CDM Vocabulary mapping

- Adopted an iterative approach involving all the team members
- Medical students recruited as mappers
- Mappings are reviewed by the research assistant
Challenges

• Limited coverage of Australian terminologies/concepts

• Vocabulary mapping is very tedious
  ▪ Especially when the source EMRs don’t use standardized vocabularies. MedicalDirector EMR uses DOCLE
  ▪ and subjective, example below

• The standards can be still subjective without appropriate conventions in place. For example, how to handle duplicate diagnoses? What if data is not available in mandatory fields?

• Harmonizing observational EHR data is more complex than harmonizing registry or claims data.

• CDM doesn’t cover many complex aspects observed with secondary usage of EHR data. For example, storing linkage information

• How do we validate the data quality after the ETL process into OMOP-CDM?
Comparison of AMT-ATC mapping in cohort selection
Background & objectives

- AMT is a reference terminology which describes each drug available in Australia.
- ATC is a classification that aims to group drugs based on their properties.
- Classifications provides efficient methods to easily include or exclude groups of patients. It can be used for cohort selection in observational studies or RCT.
- Effectiveness in cohort selection dependent on data quality and mapping accuracy
- Explore the existing mappings from two sources – PBS and OMOP-CDM
  - Identify which mapping performs better for cohort identification.

**AMT = Australian Medicines Terminology**

**ATC = Anatomical, Therapeutic & Chemical classification**
Result summary

<table>
<thead>
<tr>
<th>ATC Group</th>
<th>OMOP Mappings</th>
<th>PBS Mappings</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10</td>
<td>82</td>
<td>84</td>
<td>2 (2.4%)</td>
</tr>
<tr>
<td>N02A</td>
<td>62</td>
<td>141</td>
<td>79 (101%)</td>
</tr>
<tr>
<td>N06A</td>
<td>115</td>
<td>112</td>
<td>3 (2.6%)</td>
</tr>
</tbody>
</table>

ATC Group | OMOP-CDM Mapping | PBS Mapping | ATC Groups
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recall</td>
<td>Precision</td>
<td>F-measure</td>
</tr>
<tr>
<td>A10 (Drugs used in diabetes)</td>
<td>0.943</td>
<td>1</td>
<td>0.970</td>
</tr>
<tr>
<td>N02A (Opioids)</td>
<td>0.389</td>
<td>1</td>
<td>0.561</td>
</tr>
<tr>
<td>N06A (Antidepressants)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Use and misuse of opioids in general practice using observational EHR data
Opioids were initially developed for the treatment of malignancy-related pain but there was a push for its use to treat chronic nociceptive and neuropathic pain in 1995.

Between 1990-2014, there has been a four-fold increase in pharmaceutical opioid (PO) use in Australia and correspondingly, marked increases in rates of PO-related deaths, mostly by accidental overdose.

A group at high risk of opioid-related harm are doctor shoppers as they have twice the risk of drug-related mortality and opioid-related hospital admissions.

Of opioid deaths in 2016:
- 550 mentioned other opioids (includes prescription painkillers such as oxycodone, morphine and codeine)
- 361 mentioned heroin
- 208 mentioned methadone
- 234 mentioned other synthetic narcotics (for example, fentanyl and tramadol).
Study Aim

To use linked routinely collected primary care and general practice data to identify a cohort of opioid users to answer the following research questions:

1. Is EHR a viable source for investigating opioid usage in primary care?

2. Identify the risk factors such as age, gender, co-morbidities of opioid use.

3. Does the continuity of care measured in Usual Provider of Care (UPC)\textsuperscript{16} affect the amount of opioid use?
Methodology

- UNSW electronic practice-based research network (ePBRN)
- Opioids included are oral, sublingual and transdermal formulations of those under the Anatomical Therapeutically Chemical (ATC) classification drug code category NO2A (opioids) and NO7BC (drugs used in opioid dependence).
- Drug amounts converted to oral morphine equivalent dose (oMED) to represent opioid use at the population level instead of Defined Daily Doses (DDD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of opioid</td>
<td>Codeine, Hydromorphone, Morphine, Oxycodone, Oxycodone+Naloxone, Fentanyl, Methadone, Buprenorphine, Aspirin+codeine, Paracetamol+Codeine, Tapentadol, Tramadol</td>
</tr>
<tr>
<td>Prescription Reason</td>
<td>The reason for the prescription.</td>
</tr>
<tr>
<td>Drug Usage</td>
<td>Drug usage in oral morphine equivalent dose</td>
</tr>
<tr>
<td>Date of prescription</td>
<td>Date of prescription</td>
</tr>
<tr>
<td>Prescribed dose of drug</td>
<td>Prescribed dose of drug (mg)</td>
</tr>
<tr>
<td>Prescription period</td>
<td>First to last date of prescription by one prescriber for shared patients only</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean (SD) / Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>52.61 (18.01)</td>
</tr>
<tr>
<td><strong>Sex:</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5920 (53.6%)</td>
</tr>
<tr>
<td>Female</td>
<td>6848 (46.3%)</td>
</tr>
<tr>
<td>No Information / Other</td>
<td>10 (0.1%)</td>
</tr>
<tr>
<td><strong>Alcohol Status:</strong></td>
<td></td>
</tr>
<tr>
<td>Drinker</td>
<td>2418 (18.9%)</td>
</tr>
<tr>
<td>Non-Drinker</td>
<td>30 (0.2%)</td>
</tr>
<tr>
<td>No information</td>
<td>10330 (80.8%)</td>
</tr>
<tr>
<td><strong>Smoking Status:</strong></td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>2575 (20.2%)</td>
</tr>
<tr>
<td>Non-Smoker</td>
<td>5781 (45.2%)</td>
</tr>
<tr>
<td>Ex-Smoker</td>
<td>2490 (19.5%)</td>
</tr>
<tr>
<td>No information</td>
<td>1932 (15.1%)</td>
</tr>
<tr>
<td><strong>Conditions:</strong></td>
<td></td>
</tr>
<tr>
<td>Neuropathic pain</td>
<td>467 (3.7%)</td>
</tr>
<tr>
<td>Cancer related pain</td>
<td>672 (5.3%)</td>
</tr>
<tr>
<td><strong>Shared patients across practices</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>236 (1.8%)</td>
</tr>
<tr>
<td>3</td>
<td>10 (0.1%)</td>
</tr>
<tr>
<td><strong>Mental illness co-morbidities:</strong></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>1726 (13.5%)</td>
</tr>
<tr>
<td>Depression</td>
<td>2252 (17.6%)</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>81 (0.6%)</td>
</tr>
<tr>
<td><strong>Number of mental illness co-morbidities</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2280 (17.8%)</td>
</tr>
<tr>
<td>2</td>
<td>869 (6.8%)</td>
</tr>
<tr>
<td>3</td>
<td>13 (0.1%)</td>
</tr>
<tr>
<td>≥ 1</td>
<td>3163 (24.8%)</td>
</tr>
</tbody>
</table>
Results

Duration Vs age group

DDD vs Age group

DDD vs UPC
Average Number of Visits Per Month

Prevalence and Incidence of Opioid Prescriptions

Patients who received opioid prescriptions (%)
Other On-going projects

- Monitoring quality of care using continuity of care
- Machine learning based patient record linkage
- ETL Validation on Data quality
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Pseudonymisation & ETL

FUTURE: ePBRN Infrastructure: Internet of Things

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OMOP CDM

GP n… Apps Wearables

Hospital admissions

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Feedback & Data Quality

OHDSI cohort studies & RCTs

OMOP CDM
FUTURE: Sydney ePBRN & MedicineInsight
Future CDM work
Acknowledgements

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• Mike Wu (cycle 1-5)
• Su Lynn Yeoh (cycle 5)
• Elizabeth Qian (cycle 5)
• Ning Zhang (cycle 5)

Vendors

• Amazon Web Services
• CGD Health Pty Ltd
• BestPractice
• MedicalDirector

Collaborators

• University of Melbourne
• NPS Medicinewise
• South Western Sydney PHN
• South Western Sydney LHD

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QUESTIONS