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Responding to COVID-19 with real-time general practice data in Australia

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ABSTRACT

Introduction: As SARS-CoV-2 spread around the world, Australia was no exception. Part of the Australian response was a robust primary care approach, involving changes to care models (including telehealth) and the widespread use of data to inform the changes. This paper outlines how a large primary care database responded to provide real-time data to inform policy and practice. Simply extracting the data is not sufficient. Understanding the data is. The POpulation Level Analysis and Reporting (POLAR) program is designed to use GP data for multiple objectives and is built on a pre-existing engagement framework established over a fifteen-year period. Initially developed to provide QA activities for general practices and population level data for General Practice support organisations, the POLAR platform has demonstrated the critical ability to design and deploy real-time data analytics solutions during the COVID-19 pandemic for a variety of stakeholders including state and federal government agencies.

Methods: The system extracts and processes data from over 1,300 general practices daily. Data is de-identified at the point of collection and encrypted before transfer. Data cleaning for analysis uses a variety of techniques, including Natural Language Processing and coding of free text information. The curated dataset is then distilled into several analytic solutions designed to address specific areas of investigation of interest to various stakeholders. One such analytic solution was a model we created that used multiple data inputs to rank patient geographic areas by the likelihood of a COVID-19 outbreak. The model utilised pathology ordering, COVID-19 related diagnoses, indication of COVID-19 related concern (via progress notes) and also incorporated state based actual confirmed case figures.

Results: Using the methods described, we were able to deliver real-time data feeds to practices, Primary Health Networks (PHN) and other agencies. In addition, we developed a COVID-19 geographic risk stratification based on local government areas (LGAs) to pro-actively inform the primary care response. Providing PHNs with a list of geographic priority hotspots allowed for better targeting and response of Personal Protective Equipment allocation and pop-up clinic placement.

Conclusions: The program summarised here demonstrates the ability of a well-designed system underpinned by accurate and reliable data, to respond in real-time to a rapidly evolving public health emergency in a way which supports and enhances the health system response.

1. Introduction

As the SARS-CoV-2 virus spread around the world, Australia was no exception. The first case of COVID-19 was recorded on the 17th January 2020 and the first death on the 5th of March. Australia, like many other parts of the world, initiated a multi factored approach to containment. The response strategy relies on social measures, enhanced testing, contact tracing and controlling outbreaks.

An essential part of the response involves Australian general practice. In Australia, general practice (GP) functions as the gatekeeper for

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secondary and tertiary services (specialists and hospitals). The federal government provides universal health insurance (Medicare) that supports ambulatory services. Medicare funds fixed amounts on a fee for service basis, although individual practitioners are free to accept that fee or charge the patient extra. Public hospitals are funded by the states (and the majority of hospital care, and there is a significant private hospital system. [1,2] Within primary care, there is a long history of *meso*-level organisations to support general practice and to enable primary care. These have gone through many iterations: initially divisions of general practice, then GP networks and Medicare Locals [3,4] – and finally to the current iteration of Primary Health Networks (PHNs). [5,6] In their current form, the PHN mandate emphasises commissioning clinical services, with seven stated priorities (mental health, Aboriginal and Torres Strait Islander health, population health, health workforce, digital health, aged care, and alcohol and other drugs). Their mandate also includes population health planning, and relationships with state health systems and departments [6]. With those foci, PHNs became crucial to supporting the GP response to COVID-19.

The COVID-19 response was supported by a funding package of A $2.4 billion announced by the Australian Federal Government in March 2020, which included $1.1 billion specifically allocated to support the response in primary care. Relevant key components [7] of the primary care response included:

- funding telehealth for the whole community (using telephone or video consultations) – prior to the pandemic, telehealth was restricted to special groups (people outside major cities, aged care residents and people receiving care from Aboriginal Medical Services) and accounted for 0.1% of Medicare Benefits Schedule-funded attendances;[8]
- establishment of call centres to triage people with fever or respiratory symptoms, provide advice and direct them to the most appropriate health services;
- establishment of a nationwide network of respiratory clinics based in the community to complement state and territory-run fever clinics. Many of these were run by Primary Health Networks (PHNs).

The key to informing a successful COVID-19 response at all levels (government, PHNs, individual practices) is good, current data. Data has been used to inform the diagnosis and outcomes of COVID-19 [9], and been an important factor in understanding the consequences of the pandemic on non-COVID-19 care.[10,11]. General practice coding for COVID-19 in software represented a challenge – as GPs were placing diagnoses in their systems in advance of developed coding systems. [12], although work has since been done. [12] GP data has long been recognised as a significant opportunity for research and quality improvement [13] but requires a comprehensive approach to data. [14] The possibilities of using GP systems for influenza like illnesses has been demonstrated in the UK. [15]

At the time of writing, Australia has undergone three significant waves: the first in March/April 2020 which occurred across the country, a second, larger wave in July/August 2020 that occurred primarily in one state, Victoria. [16] Australia is currently in its third and largest wave, caused by the Delta variant. The burden of this wave falls largely in NSW. This paper describes the activities of a large repository of Australian general practice data to reconfigure its processes to deliver benefit to individual practices, population health level information and ultimately to patient care, enabling the primary care sector to rapidly respond to the pandemic.

2. The POLAR program

The Population Level Analysis and Reporting (POLAR) program is part of a suite of activities provided by Outcome Health, a not-for-profit organisation to create an integrated approach to data. The program extracts data from general practices to provide feedback on practice performance at an individual and practice level [17]. It has ethics clearance (The Royal Australian College of General Practitioners National Research and Evaluation Ethics Committee Protocol 17–008) and has undergone an independent privacy assessment. Ethics approval for this specific work was obtained from Monash Health Human Research Ethics Committee (MH Ref: RES-21–0000-013L).

The program has been established over a twelve year period.[17] The system was initially designed to provide QA activities for general practices and population level data for General Practice support organisations - originally divisions of general practice, then GP networks and Medicare Locals [3,4] – and finally to the current iteration of Primary Health Networks [5]. The system currently extracts and processes data daily.

POLAR is compatible with the five most popular GP Electronic Medical Records (EMRs), collectively covering 95% of the sector. Clinical and business insights are presented to general practices via interactive dashboard reports. Data remains identifiable to the practice, assisting practice staff to coordinate and deliver high quality care. Data is de-identified at the point of collection, hashed and encrypted before being transferred to Outcome Health. Data is then coded, mapped and curated. This process involves application of redaction techniques to further strengthen de-identifiability.

It is this transformed and curated dataset which is made available for population health planning and service delivery at the PHN level, and then research and policy [18].

Currently the database contains records from 1,300 practices and around 12 M patients (out of 25 M total population). Areas within Australia that have had the greatest COVID-19 impact are substantially represented by POLAR GP practices, particularly in the major population centres of Sydney and Melbourne. Currently patient activity is tracked within the practice and not across the dataset. This means records are duplicated for patients who attend more than one practice. POLAR is (at the time of writing) applying Bloom filter structures across the dataset, which will create a unique encrypted (and thus privacy preserving) patient key.

The data is used for a mix of clinical care and research under a program known as ‘Aurora’: a research dataset available for collaborative research designed to improve the health of Australians through the medium of primary care. Research can be **data driven** exclusively [19], or **translational** - by partnering with the PHNs to rapidly deliver change to front line care [20]. The dataset and related activity are governed by an independent Data Governance group that provide input into the program as a whole and oversight of the research program. All research proposals are expressly approved by the PHN CEOs. Research has included in-house programs on admissions risk [20] and collaborations with university partners on topics including pathology use [21] and prescribing [22].

3. Method

3.1. Data considerations within the POLAR system

3.1.1. Diagnoses

POLAR captures the diagnosis fields. A limitation is that Australian GP systems do not comply with any given standard for coding (despite SNOMED-CT being the Australian standard) and allows free text diagnoses to be recorded. This provides with some significant challenges. We have approached this with a significant technical process to increase utility and preserve de-identifiability. The free text diagnoses are taken through a series of processes including Natural Language Processing to generate SNOMED codes [23,24]. These codes are then grouped to clinically derived, higher level groupings. In addition, Outcome Health has developed a further grouping around chronic disease. Thus, a free text diagnosis of ‘post-traumatic stress disorder’ is classified in the system as:

- Free Text: PTSD
- SNOMED: 47,505,003 (Post-traumatic stress disorder)
- Higher Level Group: Mental Health
- Chronic Disease Group: Mental Health

Coding for COVID-19 has involved a great deal of work to interpret GP diagnoses in the context of COVID-19. Free text diagnoses encountered are listed in Table 1..

- Each clinical system vendor has released a different set of standard term lists for coding COVID19. These are not consistent and are usually not SNOMED codes. SNOMED codes themselves at that developing stage of the pandemic did not capture the full primary care experience.
- Because of the above – GPs often overwrite the supplied codes and use free text which has been addressed by an additional manual mapping process.
- Extracting a count of numbers of 'COVID' 'Coronav' etc. mentions.

3.1.2. Medication overview

POLAR collects high quality categorical prescribing data from the GP clinical systems, which is then classified according to the Anatomic Therapeutic Chemical (ATC) classification [25]. The ATC advantage from a population health perspective gives us the ability to stratify to: multiple levels, e.g. Cardiac (1st level), Beta Blockers (3rd level) to the individual drug Metoprolol (5th level).

A limitation is that the 'reason for prescription' is not well recorded (and often contains identifiable data), so assumptions of the indication must be taken from either the drug class, or by an association with specific diagnosis in the record. Changes that we see will be mostly in the 'most common indication'. In other words, if 98% of the use of a drug is for indication X, and 2% is for indication Y, we would not be able to discern a 10% increase in the use of the drug for indication Y, as the change in the overall drug use would be too small to be seen in our data,

4. Deliverables

4.1. POLAR data and approaches to prediction

The data we produce has utility not just in after the fact analyses. Significant benefit can be realised if the data can be interpreted as a predictive tool of impact at a population level [20]. Most of the work done has been predictive tools for individual patients in the context of illness, [9], however we believe there is benefit in using these large data sets to inform public health response.

Having developed a realtime reporting framework in response to the 2019 bushfire crisis, we moved to develop a COVID-19 geographic risk stratification to be pro-active in informing the PHN and practice response. The PHNs in the early stages of the pandemic were responsible for the distribution of personal protective equipment (PPE) so having information on the key geographies that were being most impacted was vital. We leveraged several **data streams** to create a geographic early warning of community infection ranking (Geographic Priority Score) of areas within each PHN catchment including:

- Pathology orders;
- GP Diagnosis;
- GP Research for visit – flag;
- State-based Positive Local Government Area (LGA) tracking.

The first 3 indicators are considered leading indicators - they are indicative of potential infection or community concern, akin to the old adage of 'where there's smoke, there's fire'. The last is a lagging indicator, it is a true indicator of community infection and adds weight to the ranking given known community transmission and incubation periods.

Pathology tracks COVID-19 tests being ordered in GP practices. Pathology data is extracted from the GP system. Standard pathology codes related to COVID-19 are largely and somewhat unsatisfactorily not being used by the majority of pathology vendors when sending results back to GPs, so searching test names is being done on a wildcard test name basis. The transfer of pathology results from a Lab and the atomisation within the EMR represents a large gap and missed opportunity within the Australian pathology landscape.

GP **Diagnosis** is what is being seen / entered in a GP practice and is discussed in detail earlier.

Reason for Presentation is extracted from the EMRs using that field. This data returns a flag of any mention of COVID, COVID-19, Coronavirus, etc within the field, but does not extract any context or further text about the use of the word, it is only a count. The use of these key word counts is used to track any overall volume changes rather than as a specific measure for an individual patient.

Active Diagnosis counts are sourced from state health. This data is only available by Local Government Area (LGA) and has been included in the report to assist with Geographic mapping of the COVID-19 spread.

4.2. Prediction Tool

The resulting tool (Fig. 1) ranks either postcodes or LGAs according to standardised population adjusted weighting of the 4 risk indicators described above. Importantly though, the weightings can be tuned based on changes observed in the community – i.e. as GPs get better at recording COVID-19 related diagnoses (increase weighting), or as larger scale community concern grows and results in a greater number of false positive Reason for Visit Flags (Decrease weighting)

We currently allocate a 100% ranking to the state based positive tracking. To see a risk based on GP data and pathology ordering alone, you can adjust the measures and increase the others accordingly to see the impact on the 'priority score' that ranks the highest risk geography. This data also contributed to decision making to inform where pop-up testing clinics should be located.

The risk score was updated and distributed to PHNs daily. The data compiled in Fig. 1 from 20 May 2020 identified Morning Peninsula as the highest risk are for a COVID-19 outbreak.

Given time constraints we made some decisions in constructing the score, emphasising the presence of positive tests in the area, more than

Table 1
Top 10 free text Diagnosis mapped to SNOMED COVID-19.

Diagnosis Text	SNOMED Code	SNOMED Text
COVID-19 INFECTION	840539006	COVID-19 (disorder)
COVID-19 (CORONAVIRUS) INFECTION	840539006	COVID-19 (disorder)
COVID-19 (CORONAVIRUS)	840539006	COVID-19 (disorder)
COVID-19	840539006	COVID-19 (disorder)
CORONAVIRUS INFECTION	840539006	COVID-19 (disorder)
COVID-19 (CORONAVIRUS) SUSPECTED INFECTION	840544004	Suspected COVID – 19 (Situation)
COVID-19 EXPOSURE	840544004	Suspected COVID – 19 (Situation)
COVID-19; SUSPECTED	840544004	Suspected COVID – 19 (Situation)
SUSPECTED COVID-19 INFECTION	840544004	Suspected COVID – 19 (Situation)
AT RISK; COVID-19	840544004	Suspected COVID – 19 (Situation)
COVID-19 TESTING REQUESTED	1454651000168108	COVID-19 Serology (procedure)
COVID-19 TEST NEGATIVE	1454651000168108	COVID-19 Serology (procedure)
TEST;SWAB;COVID-19	1454651000168108	COVID-19 Serology (procedure)

Priority Score	LGA Name	State Health Positive Results	Diagnoses Per 100k	Pathology Per 100k	Progress Notes per 100k
		3,316	28	328	1,305
0.39	Mornington Peninsula (S)	61	96	506	3,078
0.38	Sydney (C)	160	56	421	937
0.35	Casey (C)	57	28	196	1,641
0.34	Waverley (A)	183	25	575	1,183
0.32	Woollahra (A)	93	47	1,139	1,851
0.30	Sutherland Shire (A)	115	32	381	1,184
0.28	Stonnington (C)	91	40	362	1,479
0.28	Banyule (C)	89	24	446	2,372
0.27	Boroondara (C)	66	28	431	1,171
0.27	Glen Eira (C)	50	34	293	1,238

Fig. 1. COVID-19 risk score according to LGA.

ordered pathology tests as the latter could be driven by social rather than symptom factors. To counter those decisions, however, a key feature of the tool was the ability for participants to change the weighting. Although we selected weightings according to our experience and background, the speed of the evolving pandemic did not allow for extensive validation. Thus, sliders were introduced to change the weightings. For example, we weighted positive diagnoses at 100% in the model, but given the time lag between exposure and infection, a valid view was to reduce that weighting to prioritise activity in general practice (people attending with concerns) over actual infections. The ability to change weighting allowed PHNs to modify according to their settings – increasing weightings on GP seen diagnoses for instance, vs state level, that could increase the weighting for pathology testing.

Rapid testing and deployment was also associated with responsiveness to feedback and rapid release management. The makeup of this risk model and changes applied constantly evolved:

- **Activity**: As changes to telehealth rules occurred (several times during the pandemic) the representation of telehealth also changed. The 'timeframe' of the report that originally measured the last seven days NEW POSITIVE changed to look at different timeframes for different measures
- **Diagnosis/Coding**: New 'draft' and then 'official' SNOMED codes were mapped and added to the model. In many cases we found the SNOMED were difficult to map to an Australian general practice context and as such this has had to remain a largely manual rather than machine or NLP driven process. Following on from the end of the first wave, the 'NEW POSITIVE' cases which were very low, no longer became a relevant measure so this was changed to 'ACTIVE CASES'
- **Geography**: We created a 'combined geography' report for PHNs where there were overlapping LGAs or split / partial LGAs that were hiding a full picture. To account for different numbers of 'POLAR patients' in different areas, a 'per 100 k' people measure was introduced to the relevant geography.

4.3. Public health support tools

The prediction tool was not the only information provided to the PHNs. They were given access to a large suite of information about other aspects of the pandemic, from individual drugs through to practice level impacts.

Practices and PHNs have access to a set of COVID-19 reports emailed daily to authorised users as well as online dashboards, which cover a number of areas important for planning response and practice support. They include an estimate of impact over the next few days, monitoring of pathology and diagnostic activity, as well as specific drugs of interest. There are also measures of admission risk according to established protocols [26]. For clarity and ease of interpretation, the data released to PHNs was a mix of high level and detailed data. So whilst the reports included high level prescription data, we also included individual drugs such as Hydroxychloroquine (not indicated but widely used as a preventive agent). Overall the data was organised in headings listed below:

- Key geographic areas likely to be impacted by COVID-19 based on last 7 days
- POLAR LGA geographic priority model (Top 20, Last 7 days)
- Age Groups Impacted and patient population age group change over time
- Top Chronic Disease Category for each schema of data
- Top Diagnosis Group for each schema of data
- Top Mental Health SNOMED for each schema of data
- Hospital Risk scores (based on a national weighting scheme)
- Acuity and Co-morbidity Indicators
- Pathology Data by patient and practice
- Prescriptions of Ivermectin, ACE inhibitors and Hydroxychloroquine 2020 vs 2019
- Comparison by Week of Year for prescriptions, pathology and radiology

Examples of the information available to PHNs are displayed in Fig. 2 and Fig. 3. The data allows PHNs to tailor specific support according to patient and practice needs – assisting practices to adopt telehealth, provide PPE, etc. This information is also important in determining the placement of pop-up respiratory clinics and allowing PHNs to track non-COVID-19 related patient activity. Overall the PHS had access to over 20 different representations.

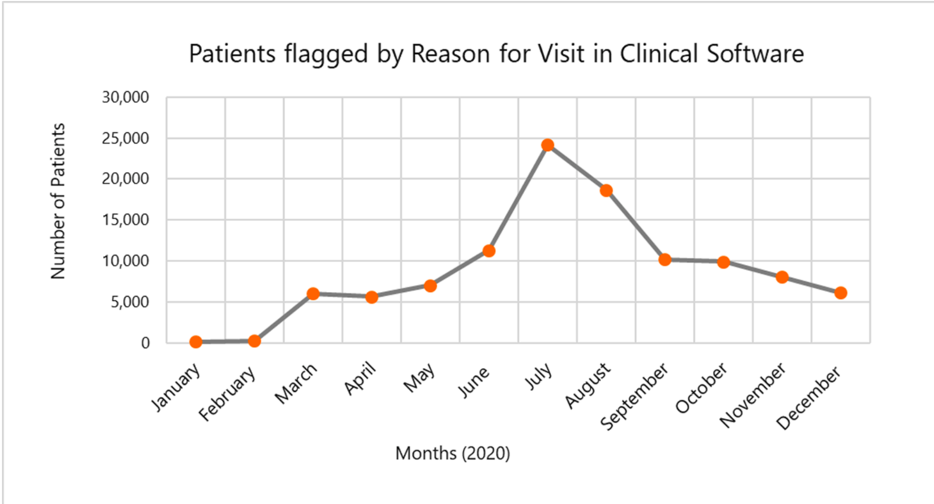

Fig. 2. Time series of presentations with COVID-19 activity POLAR PHNs.

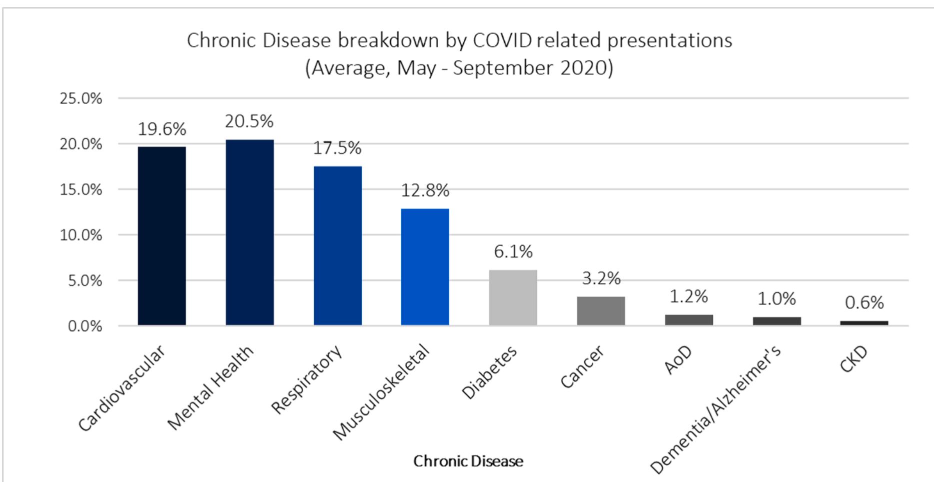

Fig. 3. Monitoring of Chronic Disease Groups in Patients with a COVID-19 Contact.

5. Discussion

The program summarised here demonstrates the ability of a well-designed system underpinned by accurate and reliable data, to respond in real-time to a rapidly evolving public health emergency in a way which supports and enhances the health system response. It is worth emphasising that these reports were available daily, enabling rapid system feedback.

For Gippsland PHN (as an exemplar) the report was used in a variety of ways:

- The report was distributed daily to the region's health services and Public Health Unit as part of summer preparedness planning (and emergency outbreak response over the New Year period) given the high number of tourists in Gippsland.
- It was also distributed to sub-regional GP COVID information meetings to promote understanding of the data and the whole of Gippsland picture for general practice.
- The PHN used the data to understand general practice activity around COVID testing across Gippsland and for reporting purposes to state and Commonwealth COVID response meetings.
- General practices were prompted to review their rising risk patient cohorts from this report to proactively manage patients at risk.

Practices used the data to inform the demand management and to understand the changes happening, particularly in response to the telehealth changes and planning PPE demand, as well as understand the patient cohort risk. At the Health system level, Outcome health provided a series of rapid data reports to inform policy and planning (12) and provided data feeds to state health and national monitoring organisations.

A particular challenge was deciding what represented important data to represent. Regular contact was kept with the PHNs, who in turn were working with the practices. At the same time Outcome health worked with national and state bodies to determine priorities. So whilst COVID diagnoses was an obvious choice, a question from a national expert led us to look at Hydroxychloroquine, and detect a spike in prescribing in advance of national bodies.

The use of data extracted from general practice allows for a whole of system response. In this case, individual practices could assess their performance against local and state markers, PHNs could inform their responses, and state level agencies could monitor the system response (at a primary care level). The rapid evolution of the pandemic means that much of the activities of this type remain unpublished to date – although the UK and parts of Canada have similar programs. The next stage is to further examine the impacts of a data-informed approach and which models work best. This type of model remains worthy of investigation and investment moving forward.

6. Disclaimer

This work was undertaken independent of funding or specific drive other than that of community necessity at the time and the needs of the PHNs. Given resources and time a model that could be independently validated and further enhanced would have been ideal, but resource and time does not necessarily lend itself to fast innovation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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