MEDICINEINSIGHT

HbA_{1c} testing for MedicineInsight patients newly diagnosed with, or with a history of diabetes in 2018–2019

Prepared for the Australian Government Department of Health

December 2020

Independent, not-for-profit and evidence-based, NPS MedicineWise enables better decisions about medicines, medical tests and other health technologies.

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Suggested citation

NPS MedicineWise. MedicineInsight report: HbA_{1c} testing in MedicineInsight patients newly diagnosed, or with a history of diabetes in 2018–2019. Sydney: NPS MedicineWise, 2020.

Acknowledgments

We are grateful to the patients, general practitioners and general practices who allow the use of de-identified information for MedicineInsight.

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EXECUTIVE SUMMARY

The aim of this study is to provide information on the prevalence of type 1, type 2 and gestational diabetes among Australian general practice patients and to explore aspects of their care, with a particular focus on glycated haemoglobin (HbA_{1c}) testing. It also explores the impact of the COVID-19 pandemic on rates of general practice visits (also referred to as clinical encounters) and HbA_{1c} testing.

These analyses will be used to inform the Diagnostic Imaging and Pathology Branch and the Quality Use of Medicines Branch of the Department of Health. It may also be used in the development of general practitioner (GP) educational interventions on management of diabetes by NPS MedicineWise.

Prevalence

Among regularly attending MedicineInsight patients (three or more GP visits between January 2018 and December 2019), the prevalence of recorded type 1 diabetes was 0.6% and the prevalence of recorded type 2 diabetes was 6.4%. During this two-year period, 0.6% of all regularly attending patients and 11.6% of patients with a record of type 2 diabetes, appeared to have been newly diagnosed with type 2 diabetes.

Patients with recorded type 1 diabetes were younger (52.5 years), on average, than those with recorded type 2 diabetes (67.7 years). Consistent with other national datasets, the prevalence of recorded type 2 diabetes increased with age and social disadvantage.

Among regularly attending patients aged 15–49 years who were recorded as being pregnant during 2019, 8.0% had a record of gestational diabetes.

Comorbidities

Almost a quarter of patients with a record of type 2 diabetes also had a record of cardiovascular disease (CVD) or chronic kidney disease (CKD). Approximately a fifth of patients with a record of type 1 diabetes also had a record of CVD or CKD.

Half of patients with type 2 diabetes had a record of dyslipidaemia and almost two-thirds had a record of hypertension. These risk factors were also commonly reported among patients with type 1 diabetes.

GP visits and testing

Over the course of the 2019 calendar year, patients with a record of type 2 diabetes visited their general practice more frequently (a mean of 11.1 and a median of 8.3 consultations) than those with a record of type 1 diabetes (mean 9.8; median 6.4) or patients without any record of diabetes (mean 5.7; median 3.5). Some of this variation may be due to differences in age, gender or comorbidity burden.

As expected, the mean number of HbA_{1c} tests recorded was higher among patients with a record of type 1 diabetes (1.3 tests in 2019) or type 2 diabetes (1.4) compared to those without a record of diabetes (0.1). Almost three-quarters of patients (73.1%) with a record of type 2 diabetes and two-thirds of patients (66.0%) with a record of type 1 diabetes had at least one HbA_{1c} test recorded in

2019. It is possible that patients who had no record of an HbA_{1c} test recorded in 2019 may have had testing undertaken in the specialist setting or in another general practice.

More than 70% of MedicineInsight patients with type 2 diabetes had at least one record of an estimated glomerular filtration rate (eGFR) test and a cholesterol test in 2019, consistent with guidelines. However, only half had a record of urine albumin to creatinine ratio (ACR). This suggests that monitoring for albuminuria and potential kidney damage may not be optimal in general practice.

Among patients who appeared to have been newly diagnosed with type 2 diabetes in 2018–19, half did not have any record of HbA_{1c} testing in the 30 or 90 days prior to their first recorded diagnosis. Among those who did have a record of testing, the majority (> 95%) only had one record of an HbA_{1c} test prior to diagnosis. As Australian guidelines recommend that a diagnosis of type 2 diabetes in asymptomatic patients should be based upon two abnormal blood glucose tests, this could indicate that confirmatory testing is being conducted in a setting other than general practice (such as in hospitals or by specialists), or that a combination of HbA_{1c} and fasting/random blood glucose tests are being used during diagnosis (possibly in response to Medicare Benefits Schedule [MBS] restrictions on claiming for more than one diagnostic HbA_{1c} test), or that patients are being diagnosed with type 2 diabetes on the basis of a single HbA_{1c} test. Establishing which of these explanations is the most likely requires further research, possibly including linkage to MBS data.

COVID

To explore the impact of COVID-19 on attendance at a general practice and HbA_{1c} testing among people with type 2 diabetes, the 6 months of March to August 2020 (COVID period) were compared with the 6 months of March to August 2019 (pre-COVID period).

Patients with a record of type 2 diabetes had a mean number of 6.4 general practice consultations over 6 months in both the pre-COVID and COVID period. However, the mean number of consultations per patient among patients without a record of diabetes increased from 2.98 over 6 months to 3.11 over 6 months during the COVID period. This may have been due to the introduction of telehealth MBS items in March 2020 that allowed GPs to be reimbursed for phone and video consultations.[1] Confirming this as an explanation would require further investigation.

The rate of HbA_{1c} testing decreased for patients with a record of type 2 diabetes during the COVID period. This was despite the rate of clinical encounters with patients with a record of type 2 diabetes remaining similar in both time periods. The average monthly rate of HbA_{1c} testing among patients with a record of type 2 diabetes fell from 126.1 per 1000 clinical encounters to 109.0 tests per 1000 clinical encounters during the COVID period and suggests that patients with type 2 diabetes were less likely to have an HbA_{1c} test after a GP consultation during the pandemic period. It is possible that this may be due to a lower likelihood of HbA_{1c} testing being requested during telehealth consultations or it could reflect a reluctance by patients to visit pathology collection centres to have their blood taken during the pandemic.

When the data were explored on a month-by-month basis, there was a sharp drop in April 2020 in rates of encounters and HbA_{1c} testing for all patients and for patients with type 2 diabetes. The proportion of encounters in which the patient had a record of type 2 diabetes fell from 80 to 59.6 per

1000 encounters in April 2020 before increasing to approximately 80 per 1000 encounters in subsequent months. This may have been due to increasing restrictions on movement in response to the pandemic. However, from June 2020 onwards, the rate of encounters with people with a record of type 2 diabetes had risen to approximately 80 per 1000 clinical counters and was higher than that in the same months of 2019. This could be due to a number of factors including patients with type 2 diabetes making up a higher proportion of all patients seen by practices, the easing of social distancing restrictions or the increasing use of telehealth consultations from March 2020 onwards.

1. BACKGROUND

Type of diabetes

The term diabetes refers to several conditions in which a person has a higher-than-normal level of glucose in their blood. This may be caused by the inability of the body to produce insulin, to use insulin effectively, or both.[2]

Type 1 diabetes

Type 1 diabetes is an autoimmune condition that occurs more frequently more frequently among children or young adults but can present at any age. Its causes are currently unclear. In type 1 diabetes, the cells that produce insulin in the pancreas are destroyed and the body can no longer produce insulin.[2-4]

In 2018, 2,800 new cases of type 1 diabetes were identified in Australia and almost 50,000 new cases have been identified since 2000.[2-4]

Type 2 diabetes

Type 2 diabetes is the most common form of diabetes, seen in about 90% of people with diabetes. It occurs when the body becomes resistant to insulin and the amount of insulin produced is inadequate to meet the body's needs. It is often associated with lifestyle factors including physical inactivity, poor diet and being overweight or obese.[2-4]

Early in the disease, blood glucose levels can often be maintained at normal levels through lifestyle modification and/or oral blood glucose-lowering medicines, but insulin may eventually be required if the disease progresses.[2-4]

Gestational diabetes

Gestational diabetes (GDM) is a form of diabetes that can develop during pregnancy, generally in the second or third trimester, for patients not previously diagnosed with other forms of diabetes. It affects about 15% of pregnancies each year and arises because the action of insulin is blocked, probably by hormones produced by the placenta. The resulting high blood glucose levels can lead to complications for mother and baby. Although GDM usually disappears after the baby is born, it can recur in later pregnancies and is a marker that that person is at increased risk of developing type 2 diabetes later in life. Some cases of GDM are managed with changes to diet and exercise, and some require insulin treatment. The incidence of GDM has been rapidly increasing in Australia over the last 20 years although some of this increase is thought to be related to changes in diagnostic guidelines.[2-5]

Glycated haemoglobin (HbA_{1c})

Glycated haemoglobin (HbA_{1c}) is a measure of the average of blood glucose levels during the previous 2 to 3 months.[6] For this reason, HbA_{1c} is used to monitor long-term blood glucose control. Since November 2014, it has also been reimbursed via the Medicare Benefits Schedule (MBS) for diagnosing type 2 diabetes.[7,8]

Other ways to measure blood glucose that are less convenient than HbA_{1c} are via:

- a fasting blood glucose (FBG) test which uses blood drawn after the patient has not eaten for 8–12 hours; or.
- an oral glucose tolerance test (OGTT) which involves taking an FBG from the patient, asking them to drink a glucose drink to 'challenge' their system and then performing another two blood glucose tests one and two hours after the drink is consumed.

MBS data on HbA_{1c} testing

Using MBS data to investigate the use of HbA_{1c} testing among Australian patients is difficult because a proportion of HbA_{1c} tests will be subject to episode coning. Episode coning occurs when more than three MBS items are requested for a patient in the same day or using the same specimen. In these situations, there is an upper limit to the amount paid to conduct all of the requested tests. Medicare only pays laboratories for the three most expensive MBS items and no information about other cheaper MBS items is recorded. As HbA_{1c} tests are relatively cheap, and often requested as part of a suite of other tests, this means that MBS data will underestimate HbA_{1c} testing undertaken for patients with diabetes or at risk of diabetes.

HbA_{1c} and screening and/or diagnosis

The Royal Australian College of General Practitioners (RACGP) guidelines for the management of diabetes in general practice recommend asymptomatic patients considered to be a risk of developing diabetes* be screened using FBG or HbA_{1c}. If HbA_{1c} is used as the initial test, and if the result is ≥ 48 mmol/mol (6.5%), the HbA_{1c} test should be repeated. If the second HbA_{1c} test is also ≥ 48 mmol/mol then a diagnosis of diabetes is confirmed.[9]

Currently, one HbA_{1c} test is subsidised on the MBS for the diagnosis of diabetes in asymptomatic patients at high risk in a 12-month period. Therefore, even though guidelines recommend that the test be repeated in asymptomatic patients, the second confirmatory HbA_{1c} test would not be subsidised under the MBS.

In contrast, symptomatic patients can be diagnosed with a single fasting blood glucose, HbA_{1c} or random blood glucose under the MBS.[9]

HbA_{1c} and monitoring

In people with diagnosed type 2 diabetes, the recommended frequency of HbA_{1c} is:[9]

- 3-monthly in newly diagnosed patients, patients undergoing therapeutic changes or those whose HbA_{1c} is outside their individualised target range
- less frequently, if appropriate, in stable patients who have reached agreed targets. The guidelines suggest a 6-month interval may be appropriate and at least yearly is required to meet the minimum MBS diabetes cycle of care requirements.

* AUSDRISK score of ≥12; or all people with a history of a previous cardiovascular event (acute myocardial infarction or stroke); or women with a history of gestational diabetes mellitus; or women with polycystic ovary syndrome; or patients on antipsychotic drugs

The RACGP guidelines recommend, and the MBS diabetes cycle of care minimum requires, that the following tests be conducted at least annually[9]:

- total cholesterol, triglycerides and high-density lipoprotein (HDL) cholesterol
- a urine albumin-to-creatinine ratio (ACR) to check for microalbuminuria
- estimated glomerular filtration rate (eGFR) to check for kidney disease.

HbA_{1c} in people with type 1 diabetes is recommended at least every 3 to 4 months.[10]

HbA_{1c} and gestational diabetes

For gestational diabetes, national Australian guidelines and RACGP guidelines recommend all women at risk of hyperglycaemia be screened in the first trimester. This may be HbA_{1c} or fasting blood glucose. If this is normal, then women at high risk should be retested between week 24 and week 28 gestation, as should all pregnant women not previously tested.[9,11]

However, HbA_{1c} is NOT recommended for testing for gestational diabetes in the second or third trimester because it is less accurate in these stages of pregnancy. Exceptions are if the area is remote and an oral glucose tolerance test (OGTT) may be logistically difficult or if a woman cannot tolerate OGTT.[9-11]

Monitoring of women with hyperglycaemia in pregnancy is via a glucose point of care monitor with a fingerprick test, not HbA_{1c}. An OGTT is recommended after giving birth, not HbA_{1c}.[10].

Point of care HbA_{1c} testing

In March 2020, the Medical Services Advisory Committee recommended that a point of care (POC) HbA_{1c} test be listed on the MBS for people with established diabetes. The POC testing must be done in a general practice. Once listed, this MBS item will allow a maximum of three POC HbA_{1c} tests per year. Should POC HbA_{1c} testing be performed for a patient three times during the year, only one MBS-subsidised laboratory HbA_{1c} will be funded in the same 12-month period.[12]

This test has not yet been added to the MBS. It could be looked at in the future to see if it is being billed by MedicineInsight practices and to look at the sociodemographics of patients who have been tested using this item.

MedicineInsight program

MedicineInsight is a large-scale primary care data set of longitudinal de-identified electronic health records (EHR) in Australia. MedicineInsight was initially established by NPS MedicineWise in 2011, with core funding from the Australian Government Department of Health, to collect general practice data to support quality improvement in Australian primary care and post-market surveillance of medicines. The monthly collation of collected data can be analysed for the purposes of improving patient care, quality improvement and evaluation, performing population health analysis, research and developing health policy.

MedicineInsight utilises third-party data extraction tools which extract, de-identify, encrypt and securely transmit whole-of-practice data from the clinical information systems of over 700 general practices.

Patient level data are de-identified ‘at source’ meaning patients’ personal identifiers such as name, date of birth and address are not extracted by the tool (although year of birth and postcode are extracted, enabling the calculation of age and Socio-Economic Indexes for Areas [SEIFA]). However, each patient is assigned a unique number which allows all the records (clinical, prescription, referral etc) held in the database to be linked to the associated patient number. The process of collecting patient data achieves a data collection that meets the definition of non-identified data in the NHMRC National Statement on Ethical Conduct in Human Research. [chapter 3.2, p.27].

Further information is available online: https://www.nps.org.au/medicine-insight

Representativeness

As of March 2020, there were 5199 active GPs participating in the MedicineInsight program representing 14% of the national GP workforce. MedicineInsight has national coverage across all states and territories and remoteness areas. Practices in South Australia are underrepresented and practices in Tasmania are overrepresented, but otherwise the distribution of MedicineInsight practices in each state is similar to the distribution of all practices in each state or territory. Compared to MBS data, patients in MedicineInsight are representative of the Australian patient population in terms of age and gender. Of the patients in the MedicineInsight cohort, 3.0% had been identified as Aboriginal or Torres Strait Islander people, similar to the 2.9% rate reported in MBS statistics for total GP non-referred attendances.[13] Further information about MedicineInsight is available elsewhere[13,14] and online: https://www.nps.org.au/medicine-insight.

Ethics approval for MedicineInsight

In December 2017, NPS MedicineWise was granted ethics approval for the standard operations and uses of the MedicineInsight database by NPS MedicineWise. This program approval was given by the Royal Australian College of General Practitioners (RACGP) National Research and Evaluation Ethics Committee (NREEC 17-017).

The use of MedicineInsight data for the purposes of this report was approved on 14 October 2020 by the independent Data Governance Committee (2020–028).

2 AIMS AND METHODS

Aims

The aim of this study is to provide information on:

- the average number of clinical encounters (general practice visits) per year among patients with a recorded diagnosis of diabetes (all types).
- the type and number of selected comorbidities commonly associated with diabetes (all types)
- HbA_{1c} testing undertaken for people with type 1, type 2 and gestational diabetes
- HbA_{1c} testing performed around the period of diagnosis of type 2 diabetes
- information on other relevant tests undertaken for people with type 2 diabetes (defined as urine ACR, eGFR and lipids testing).

These analyses will be used to inform the Diagnostic Imaging and Pathology Branch and the Quality Use of Medicines Branch of the Department of Health. It may also be used in the development of GP educational interventions on management of diabetes by NPS MedicineWise.

Research questions

The specific research questions are presented in Table 1.

Table 1: **LIST OF STUDY OBJECTIVES AND RESEARCH QUESTIONS**

Objectives	Questions*
1. Estimate the prevalence of diagnosed diabetes	a. What is the prevalence of type 1 diabetes among MedicineInsight patients?
	b. What is the prevalence of type 2 diabetes among MedicineInsight patients?
2. Explore the sociodemographics of MedicineInsight patients with diagnosed diabetes	a. What are the sociodemographics of patients with diagnosed type 1 diabetes?
	b. What are the sociodemographics of patients with diagnosed type 2 diabetes?
3. Explore the prevalence of common comorbidities of patients with diagnosed diabetes	a. What is the prevalence of common comorbidities among patients with type 1 diabetes?
	b. What is the prevalence of common comorbidities among patients with type 2 diabetes?
	c. What proportion of people with type 1 diabetes have more than one comorbidity recorded?
	d. What proportion of people with type 2 diabetes have more than one comorbidity recorded?
4. Explore how often patients with diabetes visit a general practice (for any reason) and explore testing	a. What are the average number of clinical encounters (GP visits) for any reason per year?
	b. What are the average number of HbA_{1c} test results received per year
	c. What proportion of patient with diagnosed type 1 diabetes have nil, 1, 2, 3, 4 or more HbA_{1c} results recorded in a year?
	d. What proportion of patient with diagnosed type 2 diabetes have nil, 1, 2, 3, 4 or more HbA_{1c} results recorded in a year?
	e. What proportion of patient with diagnosed type 2 diabetes have at least one of the selected test results recorded in a year?

Objectives	Questions*
6. Explore use of HbA_{1c} testing around the time of diagnosis of type 2 diabetes	a. What is the incidence of type 2 diabetes in the study period?
	b. What proportion of patients had an HbA_{1c} test performed in the 90 days prior to the first record of type 2 diabetes?
	c. How many HbA_{1c} tests did patients newly diagnosed with type 2 diabetes have in the 90 days prior to the first record of type 2 diabetes?
7. Explore gestational diabetes	a. What proportion of regularly attending patients have a record of pregnancy during the study period?
	b. What is the prevalence of gestational diabetes among female MedicineInsight patients during the study period?
	c. What are the sociodemographics of patients with diagnosed gestational diabetes?
	d. What is the prevalence of common comorbidities among patients with gestational diabetes?
	e. What proportion of patients had a record of a glucose test request?
	f. What proportion of patients with a record of gestational diabetes had a record of a glucose test?
8. Explore the impact of COVID-19 on care provided to people with type 2 diabetes	a. Has the average number of clinical encounters per patient changed during the COVID-period when compared with the same period in 2019?
	b. Has the rate of type 2 diabetes encounters changed during the COVD period when compared with the same period in 2019?
	c. Has the rate of HbA_{1c} testing per 1000 clinical encounters changed during the COVID period when compared with the same month in 2019?

Study design and period

This was a descriptive analysis, using Australian general practice data from MedicineInsight.

The main study used data from a 2-year period (1 January 2018 to 31 December 2019), inclusive, unless otherwise specified. A second study period which included the 6 months from 1 March 2020 to 31 August 2020, inclusive, was used to explore the impact of COVID-19 on attendance and HbA_{1c} testing among people with type 2 diabetes.

Historical records up until the end of the relevant study period were included when identifying patient demographics, and when assessing the presence of specified comorbidities.

Study cohort

General practice sites

De-identified patient data were obtained from 441 individual general practices which met the standard data quality criteria in the MedicineInsight October 2020 download. A general practice site is used to describe one or more practices that share the same general practice database, either because they are operating within a common administrative system (eg, the same corporate entity) or in the same geographical area.

These standard data quality criteria were applied:

- the site had been established for at least 2 years, and
- had no significant interruptions of longer than 2 months in the 2 years prior to their practice data, and
- met the minimum threshold of clinical activity for at least 50 patients in the last 2 years.

Patient population

The study population were patients who met the following inclusion criteria:

- have visited a practice site that contributed data to MedicineInsight and meets specific MedicineInsight data quality requirements
- have valid information for age and gender (0–112 years as at 1 July 2019)
- had at least three clinical encounters during the study time period (regularly attending patients) – ie, 1 January 2018 to 31 December 2019.

For analyses undertaken among people newly diagnosed with type 2 diabetes, patients had to have met the above criteria, have been recorded as having a diagnosis of type 2 diabetes for the first time between January 2018 and December 2019, and have at least one clinical encounter recorded between January 2015 and December 2016 (to allow a look-back period of at least a year prior to the new diagnosis).

The study population for study period 2 (COVID study) had to:

- have visited a practice site that contributed data to MedicineInsight and meets specific MedicineInsight data quality requirements
- have valid information for age and gender (0–112 years as at 1 July 2019)
- have had at least three clinical encounters during the study time period (regularly attending patients) – ie, 1 September 2018 to 31 August 2020.

Definitions

Clinical encounters

A clinical encounter, or any professional exchange between a patient and a healthcare professional, was defined as all encounters at the practice site with a GP or a nurse that were: a) not identified as administrator entries nor encounters that have been transferred/imported from another practice and b) were not identified by predefined ‘administration-type’ terms found in the ‘reason for encounter’ field such as ‘administrative reasons’, ‘forms’, and ‘recall’*.

Defining sociodemographics

Sociodemographics included in the analysis are: age, gender, Socio-economic Indexes for Areas (SEIFA), concession card status, state and rurality, as described in Table 2**.**

* Please note that in this instance, this term denotes that the reason for contact was to ask the patient to return to the practice, and it does not refer to the encounter itself.

Table 2: **SOCIODEMOGRAPHIC DEFINITIONS**

Characteristic	Definition
Age	Age was calculated at 1 July 2019 based on the patient's date of birth (defined as 1 July in the patient's year of birth) and presented as 10-year age groups. Valid age will be defined as 0–112 years.
Gender	As recorded in the clinical information system (CIS) (Male or Female only)
Aboriginal and Torres Strait Islander status	As recorded in the CIS
State in Australia	State will be assigned based on each patient's postcode of residence. If patient postcode is missing, the practice postcode will be used as a proxy.
Rurality/remoteness	Rurality will be assigned based on a mapping of each patient's postcode of residence using the Australian Bureau of Statistics (ABS) mapping of Postcode 2016 to the Australian Statistical Geography Standard (ASGS) Remoteness Areas 2016 data
Modified Monash Model locality	Remoteness will be assigned by mapping each patient's postcode of residence using the Modified Monash Model (MMM). **NB: this information has been provided for information only in Appendix 2.**
Socio-economic status (SEIFA)	SEIFA will be assigned based on a mapping of each patient's postcode of residence using the Australian Bureau of Statistics (ABS) mapping of Postcode 2016 to the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD).

Identifying patients with diabetes

MedicineInsight 'condition flags' were used to identify patients with diabetes. The flags identified patients using an algorithm that looks at relevant coded (Docle, Pyefinch) or free text entries in one of the three diagnosis fields – diagnosis, reason for encounter or reason for prescription – recorded at any time from the patient's earliest record up to the download date (ie, ever recorded in the medical history) or, in the case of gestational diabetes, between January 2019 and December 2019. The terms that are used in each of these flags are shown in Table 3.

Records identified by a free text string alone are not automatically flagged but are individually reviewed by a clinical coder to determine whether the text string actually refers to the condition indicated or is present in another context (eg, a search for 'cancer' may identify 'partner died from cancer'). Each record is flagged accordingly. Records indicating 'suspected', 'query' or '?' records of the condition are not flagged as the condition, unless otherwise specified.

Table 3: **DEFINITIONS OF DIABETES THAT WILL BE USED IN THIS STUDY**

Condition	Definition
Type 1	Relevant terms include: diabetes mellitus (IDDM or juvenile onset or type I or type 1), IDDM, insulin dependent diabetes mellitus, juvenile onset diabetes
Type 2/unspecified	Relevant terms include: diabetes, diabetes (controlled or cortisone induced or unstable), diabetes mellitus, diabetes mellitus (NIDDM, or type ii or type 2 or type 3c), latent autoimmune diabetes of adults, NIDDM, non-insulin dependent diabetes mellitus, pancreatogenic diabetes, t2dm, t11, tii, type two, unstable diabetes
Gestational	Relevant terms include: gestational (diabetes or diabetes mellitus)

A similar strategy to that described above was used to identify patients who have been pregnant at some point between January 2019 and December 2019. However, in addition to the three fields mentioned, the reason for test field was also searched.

Patients were assigned into four mutually exclusive groups using the above flags in the following priority order:

- patients with a record of type 1 diabetes were assigned to the type 1 diabetes group
- patients without a record of type 1 diabetes but who had a record of type 2 diabetes or unspecified diabetes were assigned to the type 2 diabetes group
- patients without a record of type 1, type 2 or unspecified diabetes but with a record of gestational diabetes were assigned to the gestational diabetes group
- patients with no record of any of the above were assigned to the non-diabetes group.

Some of the patients included in each group will have more than one type of diabetes recorded – for example, patients assigned to the type 1 diabetes group may also have a record of type 2 diabetes or gestational diabetes. However, these numbers are small in comparison the cohort of all patients and, for ease of analysis and reporting, they have been grouped into four mutually exclusive groups.

Test definitions

The study looked at HbA_{1c} tests in people with type 1, type 2 and gestational diabetes. It also collected data on eGFR, lipids testing. alanine aminotransferase (ALT) and urine ACR among people with type 2 diabetes (Table 4).

Table 4: **TESTS OF INTEREST**

Observation or test	Definition
Urine ACR	A record of a urine ACR result in the atomised pathology table
eGFR	A record of eGFR result in the atomised pathology table
Total cholesterol (proxy for lipids)	A record of a total cholesterol result in the atomised pathology table
HbA_{1c}	A record of an HbA_{1c} result in the atomised pathology table
ALT (proxy for LFT)	A record of an ALT result in the atomised pathology tables
Blood glucose	A record of a fasting blood glucose or a random blood glucose result in the atomised pathology table
OGTT (pregnant women and gestational diabetes only)	A record of an OGTT result in the atomised pathology table

Comorbid condition definitions

The various comorbidities investigated in this study are shown in Table 5.

MedicineInsight 'condition flags' were used to identify patients with all conditions, with the exception of chronic kidney disease (CKD). The flags identify patients using an algorithm that looks at relevant coded (Docle, Pyefinch) or free text entry in one of the three diagnosis fields – diagnosis, reason for encounter or reason for prescription – recorded at any time from the patient's earliest record up to the

end of the study period (31 December 2019). The terms that are used in each of these flags are shown in Table 4.

Previous studies have indicated that CKD is often not documented as a diagnosis in the fields available to MedicineInsight. Therefore, for the purposes of this analysis, CKD is defined using both the CKD flag and pathology results (as defined in Table 5) during the 24-month period (ie, 1 January 2018 to 31 December 2019).

Table 5: **CLINICAL DEFINITIONS USED TO IDENTIFY COMMON COMORBIDITIES AMONG MEDICINEINSIGHT PATIENTS WITH DIABETES**

Comorbid condition	Included terms
Chronic kidney disease (CKD)	Based upon both pathology results and condition flags For pathology results: patients will be defined as having 2–5 CKD if they have two or more eGFR values ≥ 60 mL/min/1.73m^2, or ≥ 2 ACR values ≥ 3.5 mg/mmol for females or ≥ 2.5 mg/mmol for males, at least 90 days apart Relevant terms used to develop the condition flag include: anaemia – chronic renal failure, CAPD, catheterisation of peritoneum, chronic kidney disease or CKD (all stages), chronic renal disease (all stages), chronic renal failure, chronic renal failure – hyperparathyroidism, chronic renal insufficiency, continuous ambulatory peritoneal dialysis, CRF, dialysis, haemodialysis, hemodialysis, peritoneal catheterisation for dialysis, peritoneal dialysis renal dialysis or surgery – abdomen – dialysis – catheterisation
Chronic liver disease	Relevant terms include: alcohol or alcoholic (fatty liver disease or hepatitis or induced hepatitis or liver disease or steatohepatitis), CLD, cirrhosis, cirrhosis (hepatic or liver or alpha1 antitrypsin deficiency or acute renal failure or renal failure), copper storage disease, hepatorenal syndrome, hepatic (coma or encephalopathy or failure or fibrosis or pre-coma or steatosis or transplant), hepatolenticular degeneration, liver (disease or failure or fatty or fibrosis), NAFLAD, non-alcoholic fatty liver disease, polycystic liver disease, steatohepatitis, Wilson's (degeneration or disease or syndrome), viral hepatitis
Cardiovascular disease*	Relevant terms include: atherosclerosis, coronary heart disease (including myocardial infarction and angina), peripheral vascular disease, stroke and transient ischaemic attack
Dyslipidaemia	Relevant terms include: dyslipidaemia, dyslip, familial (hypercholesterolaemia or hypercholesterolemia), HDL, high cholesterol, high cholest, high lipids, hypercholesterolaemia, hyperlipidaemia, hyperlipoproteinaemia (type 2 or type IV or type IIa), hypertriglyceridaemia, hypercho, hyperlip, hypertr
Hypertension	Relevant terms include:(blood pressure or bp) and (labile or review or unstable), HBP, high blood pressure, HT, H/T, hypertension, hypertension (controlled or diastolic or essential or isolated systolic or labile or lifestyle management or malignant or pregnancy or primary or renal or renovascular or review or unstable), PIH, pregnancy induced hypertension or severe refractory hypertension
Polycystic ovary syndrome	Relevant terms include: - PCOS, polycystic (ovarian syndrome or ovary or polycystic ovary syndrome), Stein-Leventhal syndrome

*Excluding atrial fibrillation

Data analysis plan

Analysis of the data was conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Measures included are descriptive statistics, frequencies, proportions and odds ratios, as appropriate. To indicate the reliability of the estimates of prevalence and proportion, 95% confidence intervals (CI)

and p-values were included as needed. Non-overlap of 95% CIs (adjusted for clustering by practice site) determined if there were significant differences between groups when appropriate.

For the analyses investigating the impact of COVID on HbA_{1c} testing rates and patient attendance at GP practices, the unit of analysis was clinical encounters. For these analyses clinical encounters were capped at one per day per patient and records of HbA_{1c} results were capped at one record per day per patient.

If a particular result was only reported in 1–4 patients, this result has been reported as < 5 in order to preserve the privacy of individuals (with the exception of missing variables).

3. TYPE 1 AND TYPE 2 DIABETES SNAPSHOT

- Among regularly attending patients the prevalence of recorded type 1 diabetes was 0.6%.
- Among regularly attending patients the prevalence of recorded type 2 diabetes was 6.4%.
- The median age of patients with recorded type 1 diabetes (52.5 years) was younger than for those with recorded type 2 diabetes (67.7 years).
- Just over half of all patients with recorded type 1 or type 2 diabetes were male.
- The prevalence of recorded type 2 diabetes increased with age and social disadvantage.
- The prevalence of recorded type 1 diabetes was higher among the most disadvantaged patients (0.8%) than among the most advantaged (0.5%).
- Almost a quarter of patients with a record of type 2 diabetes and almost a fifth of patients with a recorded diagnosis of type 1 diabetes also had a record of CVD or CKD.
- Almost half of regularly attending patients with a record of type 2 diabetes had a record of dyslipidaemia and almost two-thirds had a record of hypertension.
- Half of all patients with a record of type 2 diabetes had a record of two or more comorbidities.

Study questions

- What is the prevalence of recorded type 1 or type 2 diabetes among MedicineInsight patients?
- What are the sociodemographics of patients with recorded type 1 or type 2 diabetes?
- What is the prevalence of common comorbidities among patients with type 1 or type 2 diabetes?
- What proportion of patients with type 1 or type 2 diabetes have more than one comorbidity?

Of the 1,764,223 patients regularly attending MedicineInsight practices who were included in this study, 7.0% were recorded as having either type 1 or type 2 diabetes. As expected, type 2 diabetes (6.4%) was more commonly recorded than type 1 diabetes (0.6%).

The prevalence of type 2 diabetes among MedicineInsight patients is higher than that reported in the 2017–18 National Health Survey (NHS).[15] The NHS reported a prevalence of 4.1% for type 2 diabetes in the general population. The differences in prevalence are partly a reflection of the different populations from which the data are drawn (regularly attending general practice patients compared with the general population) and the different collection methods (self-reported data compared with secondary use of electronic health records).

Table 6: **PATIENTS RECORDED AS HAVING TYPE 1 OR TYPE 2 DIABETES (N= 1,764,223)**

	Number	**% (95% CI)**
Type 1 diabetes	11,089	0.6 (0.6, 0.7)
Type 2 diabetes	112,784	6.4 (6.1, 6.7)

The prevalence of type 2 diabetes in this report is higher than that reported for the 2018–19 General Practice Insights Report (GPIR) which reported an unweighted prevalence of 5.5%.[13] This reflects

differences in study populations as the GPIR population is comprised of all patients who attended a general practice. This includes patients who visited their GP infrequently and who are more likely to be younger and less likely to have a chronic condition.[16] In contrast, the prevalence of type 1 diabetes in this report and in the GPIR was the same (0.6%). This suggests that patients with type 1 diabetes are likely to visit their GP at least once a year.

Sociodemographics of patients with type 1 or type 2 diabetes

Table 7 shows the demographics of patients who have been identified as having either type 1 or type 2 diabetes. As expected, the median age of patients with type 1 diabetes (52.5 years) was younger than that of those with type 2 diabetes (67.7 years). Similarly, while 52.0% of patients with type 1 diabetes were aged 54 years or younger, only 18.5% of those with type 2 diabetes were aged 54 or younger. For both types of diabetes, just over half of the patients were male and just under 4.0% were identified as being of Aboriginal or Torres Strait Islander origin.

Additional breakdowns of the socio-economic characteristics of patients with a record of type 1 or type 2 diabetes, including region of residence and socio-economic status, can be found in Appendix 1.

Table 7: **SOCIODEMOGRAPHIC CHARACTERISTICS OF PATIENTS WITH RECORDED TYPE 1 OR TYPE 2 DIABETES IN MEDICINEINSIGHT**

Characteristic	Type 1 diabetes (N=11,089)		Type 2 diabetes (N=112,784)	
	No.	% (95% CI)	No.	% (95% CI)
Gender				
Female	5282	47.6 (46.6, 48.7)	51,914	46.0 (45.4, 46.6)
Male	5807	52.4 (51.3, 53.4)	60,870	54.0 (53.4, 54.6)
Age, mean (95% CI)	51.1 (50.1, 52.1)		66.8 (66.3, 67.3)	
Age, median (Q1–Q3)	52.5 (Q1 33.4, Q3 68.0)		67.7 (Q1 57.6, Q3 76.2)	
Age group (years)				
0–12	358	3.2 (2.8, 3.6)	107	0.1 (0.1, 0.1)
13–17	358	3.2 (2.8, 3.6)	75	0.1 (0.1, 0.1)
18–44	3484	31.4 (29.7, 33.1)	7422	6.6 (5.9, 7.2)
45–54	1580	14.2 (13.5, 15.0)	13,213	11.7 (11.1, 12.3)
55–64	1819	16.4 (15.6, 17.2)	24,252	21.5 (21.0, 22.0)
65–74	1839	16.6 (15.6, 17.6)	33,039	29.3 (28.7, 29.9)
75+	1651	14.9 (13.6, 16.1)	34,676	30.7 (29.5, 32.0)
Indigenous status				
Aboriginal and/or Torres Strait Islander	404	3.6 (3.0, 4.3)	4246	3.8 (3.1, 4.4)
Other Australian	9261	83.5 (80.9, 86.1)	94,835	84.1 (81.8, 86.3)
Not known	1424	12.8 (10.2, 15.5)	13,703	12.1 (9.8, 14.5)

Q1, quartile 1 (25th percentile); Q3, quartile 3 (75th percentile).

Prevalence of type 1 and type 2 diabetes by sociodemographics

The prevalence of both type 1 and type 2 diabetes was significantly higher among males than females (Table 8). As expected, the prevalence of type 2 diabetes increased with increasing age. Among 45–54-year-old patients, 5.8% had a record of type 2 diabetes compared with 19.5% of patients aged 75 or older. The prevalence of type 2 diabetes among patients identified as Aboriginal or Torres Strait Islander people (8.1%) was also significantly higher than among patients who were not identified as being Aboriginal or Torres Strait Islander people (6.8%).

The prevalence of type 2 diabetes was lower in metropolitan areas than in some regional areas when classified according to ASGS Remoteness Areas. Information on the prevalence of type 1 or type 2 diabetes according to the Modified Monash Model can be found in Appendix 2.

The prevalence of recorded type 1 diabetes was higher among the most disadvantaged patients (0.8%) than among the most advantaged (0.5%). The prevalence of type 2 diabetes progressively increased with greater social disadvantage.

Table 8: **PREVALENCE OF RECORDED TYPE 1 DIABETES AND TYPE 2 DIABETES BY SOCIODEMOGRAPHIC STATUS**

Characteristic	Type 1 diabetes (n=11,089)		Type 2 diabetes (n=112,784)	
	n	% (95% CI)	n	% (95% CI)
Gender				
Female	5282	0.5 (0.5, 0.6)	51,914	5.2 (5.0, 5.5)
Male	5807	0.8 (0.7, 0.8)	60,870	7.9 (7.6, 8.2)
Age group (years)				
0–12	358	0.1 (0.1, 0.1)	107	0.0 (0.0, 0.0)
13–17	358	0.5 (0.4, 0.5)	75	0.0 (0.1, 0.1)
18–44	3484	0.6 (0.6, 0.6)	7422	1.3 (1.2, 1.4)
45–54	1580	0.7 (0.6, 0.7)	13,213	5.8 (5.4, 6.1)
55–64	1819	0.8 (0.8, 0.9)	24,252	10.8 (10.3, 11.2)
65–74	1839	0.9 (0.8, 1.0)	33,039	16.3 (15.8, 16.9)
75+	1651	0.9 (0.8, 1.0)	34,676	19.5 (18.8, 20.1)
Remoteness (missing=2)				
Major city	6855	0.6 (0.6, 0.6)	67,658	5.9 (5.5, 6.3)
Inner regional	2750	0.7 (0.6, 0.7)	28,095	7.1 (6.6, 7.5)
Outer regional	1301	0.7 (0.6, 0.8)	14,819	7.7 (7.2, 8.2)
Remote or very remote	182	0.6 (0.3, 0.8)	2211	6.8 (5.6, 8.0)
Indigenous status				
Aboriginal and/or Torres Strait Islander	404	0.8 (0.7, 0.9)	4246	8.1 (7.5, 8.8)
Other Australian	9261	0.7 (0.6, 0.7)	94,835	6.8 (6.4, 7.1)
Not known	1424	0.5 (0.4, 0.5)	13,703	4.4 (4.1, 4.8)
State/Territory				
ACT	128	0.6 (0.4, 0.8)	1002	4.7 (3.0, 6.4)
NSW	4358	0.7 (0.6, 0.7)	43,186	6.6 (6.1, 7.1)
NT	127	0.4 (0.3, 0.5)	2016	6.1 (5.0, 7.3)
QLD	2013	0.6 (0.5, 0.6)	20,380	5.9 (5.3, 6.6)
SA	422	0.8 (0.5, 1.0)	4279	7.8 (5.6, 9.9)
Tas	810	0.8 (0.7, 1.0)	7327	7.5 (6.6, 8.3)
Vic	2027	0.6 (0.5, 0.7)	21,337	6.4 (5.7, 7.1)
WA	1204	0.5 (0.5, 0.6)	13,257	5.9 (5.1, 6.7)
Socio-economic status (SEIFA) (missing=2)				
1 (most disadvantaged)	2246	0.8 (0.7, 0.9)	24,644	8.9 (8.5, 9.3)
2	2331	0.7 (0.6, 0.8)	24,780	7.5 (7.1, 7.9)
3	2432	0.6 (0.6, 0.7)	25,255	6.5 (6.1, 6.9)
4	1908	0.6 (0.5, 0.6)	18,654	5.4 (4.9, 5.8)
5 (most advantaged)	2171	0.5 (0.5, 0.6)	19,450	4.6 (4.2, 5.0)

SEIFA, Socio-economic Index for Areas; Q1, quartile 1 (25th percentile); Q3, quartile 3 (75th percentile). NB: Practices were recruited to MedicineInsight using non-random sampling, and systematic sampling differences between regions cannot be ruled out. Tasmania is overrepresented whereas South Australia is underrepresented in MedicineInsight. Comparisons between regions should be interpreted with caution.

Comorbidities

As expected, there were high rates of CVD and CKD among patients with a record of diabetes (Table 9 and Figure 1). Almost a quarter of patients with a record of type 2 diabetes also had a record of CVD or CKD. Approximately a fifth of patients with a recorded diagnosis of type 1 diabetes also had CVD or CKD.

These high rates of cardiovascular disease and CKD are consistent with other national data sources. In the NHS, 28.6% of respondents who reported that they had diabetes (of any kind) reported that they also had CKD while 22.6% reported that they also had a heart condition or had had a stroke.

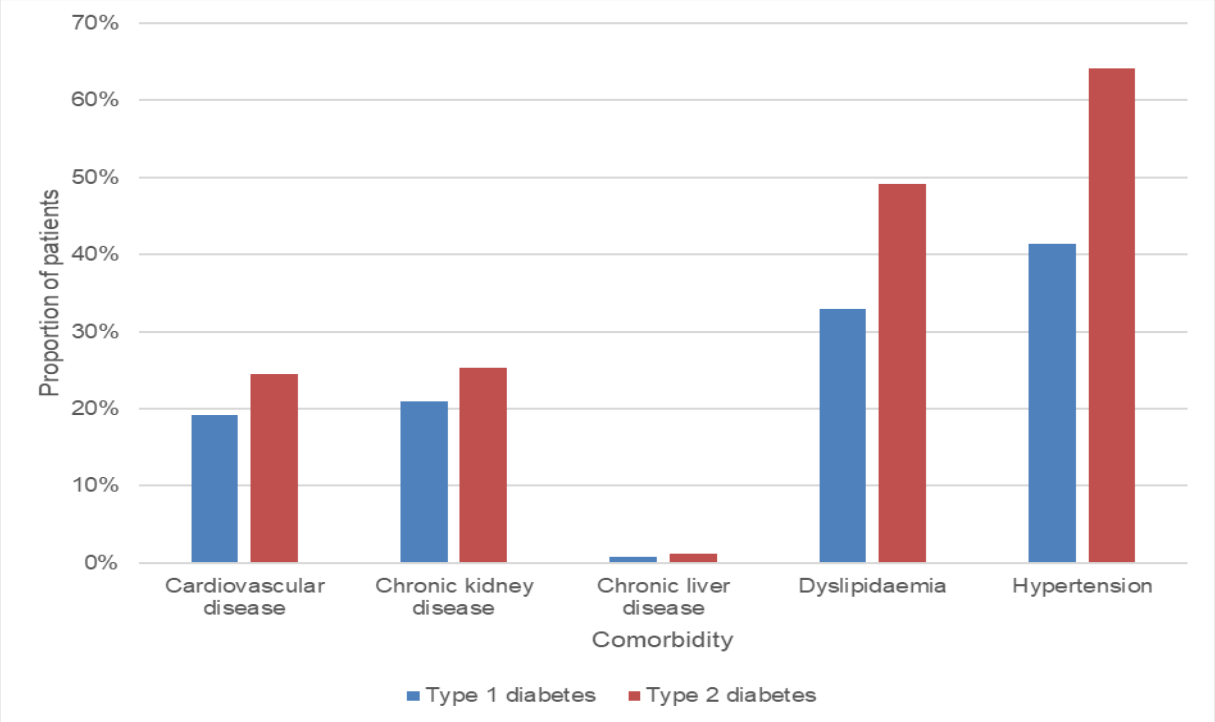
Almost half of regularly attending patients with type 2 diabetes had a record of dyslipidaemia and almost two-thirds had a record of hypertension. These risk factors were also commonly reported among patients with type 1 diabetes.

In contrast, few patients with records of either type of diabetes also had a record of chronic liver disease.

Table 9: **PREVALENCE OF COMMON COMORBIDITIES (EVER) AMONG PATIENTS WITH TYPE 1 OR TYPE 2 DIABETES IN MEDICINEINSIGHT**

Comorbid condition	Type 1 diabetes		Type 2 diabetes	
	No.	% (95% CI)	No.	% (95% CI)
Cardiovascular disease	2117	19.1 (17.8, 20.4)	27,619	24.5 (23.7, 25.3)
Chronic kidney disease	2333	21.0 (19.7, 22.4)	28,539	25.3 (24.4, 26.2)
Chronic liver disease	89	0.8 (0.6, 1.0)	1328	1.2 (1.1, 1.3)
Dyslipidaemia	3655	33.0 (30.9, 35.0)	55,387	49.1 (47.6, 50.6)
Hypertension	4590	41.4 (39.4, 43.3)	72,407	64.2 (63.2, 65.2)

FIGURE 1: PREVALENCE OF COMMON COMORBIDITIES AMONG PATIENTS WITH TYPE 1 DIABETES AND TYPE 2 DIABETES



As can be seen in Table 10, patients with a record of type 2 diabetes were more likely to have another comorbidity than patients with type 1 diabetes. This is likely to be because the group of patients with a record of type 1 diabetes are a younger group of patients.

Half of all patients with a record of type 2 diabetes had a record of two or more comorbidities.

Table 10: **NUMBER OF COMMON COMORBIDITIES WITH TYPE 1 OR TYPE 2 DIABETES IN MEDICINEINSIGHT**

Number of comorbid conditions	Type 1 diabetes		Type 2 diabetes	
	No.	% (95% CI)	No.	% (95% CI)
Nil	4774	43.1 (41.0, 45.1)	19,426	17.2 (16.4, 18.1)
1	2350	21.2 (20.4, 22.0)	32,729	29.0 (28.5, 29.6)
2	2045	18.4 (17.4, 19.5)	35,282	31.3 (30.8, 31.8)
3	1343	12.1 (11.1, 13.1)	19,475	17.3 (16.6, 17.9)
4	570	5.1 (4.5, 5.8)	5798	5.1 (4.8, 5.5)
All	7	0.1 (0.0, 0.1)	74	0.1 (0.0, 0.1)

4. HEALTH SERVICE UTILISATION AND TESTS

- Patients with a record of type 2 diabetes visited their general practice on average 11.1 times in 2019, significantly more frequently than patients with a record of type 1 diabetes (9.8 consultations) or patients without any record of diabetes (5.7 consultations). Some of this variation may be due to differences in age, gender or comorbidity burden.
- The mean number of HbA_{1c} tests for people with type 1 or type 2 diabetes in 2019 was 1.3 and 1.4, respectively ,compared to 0.1 among people without a record of diabetes.
- Almost three-quarters of patients (73.1%) with a record of type 2 diabetes and two-thirds of patients (66.0%) with a record of type 1 diabetes had at least one HbA_{1c} test recorded in 2019.
- Approximately 70% of patients with a record of type 2 diabetes had at least one record of an eGFR, ALT or total cholesterol test during 2019. In contrast, urine ACR testing was only recorded for half these patients.
- Among regularly attending patients, 0.6% of all patients and 11.6% of patients with a record of type 2 diabetes appeared to have been newly diagnosed with type 2 diabetes between January 2018 and December 2019.

Study questions

- What are the average numbers of GP visits (clinical encounters) per year?
- What are the average numbers of HbA_{1c} test results received per year?
- What proportion of patient with a record of type 1 diabetes or type 2 diabetes have nil, 1, 2, 3, 4 or more HbA_{1c} results recorded in a year?
- What proportion of patients with diagnosed type 2 diabetes have a record of at least one of the guideline-recommended (non-HbA_{1c}) monitoring test results per year?
- What is the incidence of type 2 diabetes in the study period?
- What proportion of patients had an HbA_{1c} test performed in the 90 days prior to their first record of type 2 diabetes?
- How many HbA_{1c} tests did patients newly diagnosed with type 2 diabetes have in the 90 days prior to their first record of type 2 diabetes?

General practice visits and testing

Table 11 shows the number of general practice visits (clinical encounters) in 2019 for patients with a record of type 1 or type 2 diabetes compared to patients without a record of diabetes. As expected, patients with a record of either type 1 or type 2 diabetes visited their general practice significantly more often than patients who did not have any record of diabetes. Some of this variation may be due to differences in age, gender or comorbidity burden.

It should be noted that patients may visit GP for multiple reasons and for reasons other than to manage their diabetes. Therefore Table 11 does not provide information on the number of times that

patients visited their general practice specifically for the purpose of diabetes management, but rather on how often they visited their general practice for any reason.

Table 11: **NUMBER OF GP VISITS AND RECORDED HbA_{1c} TESTS DURING THE 2019 CALENDAR YEAR AMONG REGULARLY ATTENDING PATIENTS WITH AND WITHOUT TYPE 1 OR TYPE 2 DIABETES**

	Patients without diabetes	Patients with type 1 diabetes	Patients with type 2 diabetes
Number of patients	1,627,921	11,089	112,784
Mean (95% CI) visits	5.7 (5.6, 5.8)	9.8 (9.4, 10.1)	11.1 (10.9, 11.4)
Median (IQR) visits	3.5 (Q1 1.4, Q3 6.9)	6.4 (Q1 2.6, Q3 12.8)	8.3 (Q1 3.9, Q3 14.7)
Mean (95% CI) HbA_{1c} tests	0.1 (0.1, 0.1)	1.3 (1.3, 1.4)	1.4 (1.4, 1.5)
Median (IQR) HbA_{1c} tests	0.0 (Q1 0.0, Q3 0.0)	0.6 (Q1 0.0, Q3 1.7)	0.8 (Q1 0.8, Q3 1.7)

Also as expected, the mean number of HbA_{1c} tests was higher in people with a record of type 1 or type 2 diabetes. The mean number of HbA_{1c} tests for people without a record of diabetes was 0.1. This is likely to reflect the use of HbA_{1c} tests as a screening test for patients at high risk of developing diabetes as per Australian guidelines. In contrast, the mean number of HbA_{1c} tests for people with type 1 or type 2 diabetes was 1.3 and 1.4, respectively. Of those patients with either type 1 or type 2 diabetes who were tested at least once during 2019, the majority of patients had one or two HbA_{1c} tests recorded (Table 12).

Table 12: **PROPORTION OF REGULARLY ATTENDING PATIENTS WITH TYPE 1 OR TYPE 2 DIABETES WITH RECORDS OF NIL, ONE OR UP TO 5+ HbA_{1c} TESTS DURING THE 2019 CALENDAR YEAR**

Number of recorded HbA_{1c} tests	Type 1 diabetes		Type 2 diabetes	
	No.	% (95% CI)	No.	% (95% CI)
Nil	3772	34.0 (32.6, 35.4)	30,312	26.9 (25.9, 27.9)
1	2903	26.2 (25.1, 27.2)	33,254	29.5 (28.7, 30.3)
2	2315	20.9 (19.9, 21.8)	28,741	25.5 (24.8, 26.2)
3	1350	12.2 (11.3, 13.0)	14,019	12.4 (11.7, 13.1)
4	564	5.1 (4.4, 5.7)	4991	4.4 (3.9, 4.9)
5 or more	185	1.7 (1.3, 2.1)	1467	1.3 (0.9, 1.7)

Just over a quarter (26.9%) of patients with a record of type 2 diabetes had no record of HbA_{1c} testing during 2019 (Table 12). The MBS Cycle of Care for people with type 2 diabetes requires HbA_{1c} be undertaken at least yearly so this may indicate that some patients are not being monitored frequently enough. However, some of these patients will also be seeing specialists and testing undertaken in this setting may not be identified in MedicineInsight if the results are not provided to the general practice in a manner that allows data extraction (eg, results are recorded in progress notes or in a letter from the specialist). Patients may also be attending other general practices.

Just over a third of patients with a record of type 1 diabetes had no record of HbA_{1c} testing during 2019. The Therapeutic Guidelines recommend HbA_{1c} testing for these patients at least every 3 to 4 months.[10] Once again, it is possible that this testing may be done in a specialist setting but it could also indicate that some patients are not being monitored frequently enough.

Because HbA_{1c} testing measures average blood glucose levels in the previous 2–3 months, it is typically recommended no more frequently than every 3–4 months. Table 12 shows that there is a small number of patients with recorded type 1 or type 2 diabetes who appear to have been tested

more frequently than recommended. It is possible that some of these patients may have been tested in both primary care and specialist settings.

Other testing in type 2 diabetes

The RACGP guidelines recommend cholesterol, urine ACRs and eGFR testing at least annually for people with type 2 diabetes. During 2019, approximately 70% of patients with recorded type 2 diabetes had a record of at least one eGFR or total cholesterol. However, only half had a record of a urine ACR. This suggests that monitoring for albuminuria and potential kidney damage may not be optimal in general practice.

Alanine aminotransferase (ALT) testing is part of the panel of liver function tests, and for this reason it was used as a proxy measure to estimate the proportion of liver function tests ordered for patients with type 2 diabetes. The RACGP guidelines do not recommend routine ALT testing for patients with diabetes but it was frequently recorded (72.0%) for MedicineInsight patients with a record of type 2 diabetes. This may reflect that liver function tests are considered by some GPs to be a routine part of annual testing and so are commonly requested at the same time as blood tests that are part of the diabetes Annual Cycle of Care such as full blood counts and cholesterol checks.

Patients with a record of type 2 diabetes also frequently had a record of a fasting or random blood glucose test suggesting that it is still commonly used to monitor glucose control.

Table 13: **PATIENTS WITH TYPE 2 DIABETES WHO HAVE HAD AT LEAST ONE OF THE LISTED TESTS IN THE 2019 CALENDAR YEAR**

Number of recorded HbA_{1c} tests	No	% (95% CI)
eGFR	84,848	75.2 (74.1, 76.4)
urine albumin-to-creatinine ratio (ACR)	55,071	48.8 (47.3, 50.3)
total cholesterol	78,157	69.3 (68.2, 70.4)
alanine aminotransferase (ALT)*	81,197	72.0 (70.8, 73.1)
fasting or random blood glucose (FBG or RBG)	67,859	60.2 (58.1, 62.2)

*Proxy test for identifying liver function tests

Testing for newly diagnosed patients

Among regularly attending patients with a record of type 2 diabetes, 11.6% appeared to have been newly diagnosed between January 2018 and December 2019 (Table 14). When expressed as a proportion of all regularly attending patients, 0.6% were newly diagnosed between January 2018 and December 2019. Of these, 48.1% had a record of an HbA_{1c} test in the 30 days prior to diagnosis and 55.3% had a record of an HbA_{1c} test in the 90 days prior to diagnosis.

Table 14: **PROPORTION OF PATIENTS WITH A RECORD OF HbA_{1c} TESTS IN THE 30-DAY AND THE 90-DAY PERIODS PRIOR TO BEING NEWLY DIAGNOSED WITH TYPE 2 DIABETES**

Number of recorded HbA_{1c} tests	30 days prior to diagnosis		90 days prior to diagnosis	
	No.	%	No.	%
Newly diagnosed patients	10,262	11.6		
At least one HbA_{1c} test in the period prior to diagnosis	4939	48.1	5671	55.3
Only one HbA_{1c} test in the period prior to diagnosis	4836	47.1	5443	53.0
Two HbA_{1c} tests in the period prior to diagnosis	<103*	1.0	222	2.2
Three or more tests in the period prior to diagnosis	<5*	-	6	0.1

*Complementary cell suppression due to small numbers.

Almost half of the MedicineInsight patients did not have any record of HbA_{1c} testing in the 30- or 90-day periods prior to their first recorded diagnosis of type 2 diabetes. Among those who did have a record of testing, the majority (> 95%) only had one record of an HbA_{1c} test prior to diagnosis. Given that RACGP guidelines recommend that diagnoses of type 2 diabetes in asymptomatic patients be based on two abnormal blood glucose tests, this could indicate a number of things:

- confirmatory testing is being conducted in a specialist or hospital setting
- most patients diagnosed with type 2 diabetes in general practice are symptomatic and therefore only require one confirmatory test
- a combination of HbA_{1c}, fasting/random blood glucose tests and point of care tests are being used during diagnosis (possibly because of restrictions on claiming more than one HbA_{1c} test for diagnosis under the MBS)
- patients are being diagnosed with type 2 diabetes on the basis of a single HbA_{1c} test.

Establishing which of the above explanations is the most likely would require further research, possibly including linkage to MBS data.

5. GESTATIONAL DIABETES

- Among regularly attending pregnant patients aged 15–49 years, 8.0% had a record of gestational diabetes
- The prevalence of polycystic ovary syndrome among patients with gestational diabetes was 7.7%
- Just over a quarter of patients with a record of gestational diabetes had a record of an HbA1c test and just under a third had a record of an oral glucose tolerance test (OGTT).

Study questions

- What proportion of regularly attending female patients have a record of pregnancy during the study period?
- What is the prevalence of gestational diabetes among pregnant MedicineInsight patients during the study period?
- What are the sociodemographics of patients with diagnosed gestational diabetes?
- What is the prevalence of common comorbidities among patients with gestational diabetes?
- What proportion of female patients had a record of a glucose test request?
- What proportion of patients with a record of gestational diabetes had a record of a glucose test?

Prevalence

During 2019, 6.3% of regularly attending female patients aged 15 to 49 years had an entry in their diagnosis or test request field that indicated they were pregnant at some point. Of these 8.0%, (0.5% of all regularly attending female patients aged 15–49 years), also had a record of gestational diabetes.

Table 15: **NUMBER AND PROPORTION OF REGULARLY ATTENDING FEMALE PATIENTS AGED 15–49 YEARS WITH A RECORD OF PREGNANCY AND GESTATIONAL DIABETES DURING 2019**

	No.	%	(95% CI)
Record of pregnancy	28,537	6.3	(5.9, 6.7)
Patients with a record of pregnancy and gestational diabetes	2294	0.5	(0.5, 0.6)

Please note that we identified patients as pregnant using a combination of searches for references to pregnancy in the diagnosis and test request fields. While there is much more detailed pregnancy-specific data recorded in the clinical information software, this information has not yet been imported into MedicineInsight. The first tranche of this kind of pregnancy-related data will begin to become available from January 2021 onwards.

Sociodemographics

Table 16 shows the sociodemographics of patients identified as having gestational diabetes in 2019. Patients with a record of gestational diabetes had an average age of 33 years.

Table 16: **SOCIODEMOGRAPHIC CHARACTERISTICS OF FEMALE PATIENTS WITH GESTATIONAL DIABETES RECORDED AT LEAST ONCE DURING THE 2019 CALENDAR YEAR**

Characteristic	Gestational diabetes	
	No.	% (95% CI)
Total	2294	
Age, mean (SEM)	33.6 (0.17)	
Age, median (Q1–Q3)	33.1 (Q1 29.3, Q3 36.9)	
Age group (years)		
15–19	10	0.4 (0.2, 0.7)
20–24	113	4.9 (3.7, 6.1)
25–29	411	17.9 (16.0, 19.8)
30–34	753	32.8 (30.5, 35.2)
35–40	660	28.8 (26.7, 30.9)
40–45	274	11.9 (10.3, 13.6)
45+	73	3.2 (2.4, 3.9)
Remoteness (missing n=1)		
Major city	1598	69.7 (63.0, 76.4)
Inner regional	425	18.5 (13.5, 23.6)
Outer regional	233	10.2 (5.9, 14.5)
Remote or very remote	37	1.6 (0.3, 2.9)
Indigenous status		
Aboriginal and/or Torres Strait Islander	85	3.7 (2.3, 5.1)
Other Australian	1884	82.1 (78.4, 85.9)
Not known	325	14.2 (10.5, 17.8)
Current smoker (missing n=160)		
Yes	184	8.6 (7.0, 10.3)
No	1950	91.4 (89.7, 93.0)
State/Territory		
ACT	87	3.8 (0.0, 7.6)
NSW	924	40.3 (32.3, 48.2)
NT	27	1.2 (0.0, 2.5)
QLD	433	18.9 (12.7, 25.1)
SA	78	3.4 (0.6, 6.2)
Tas	96	4.2 (2.0, 6.3)
Vic	438	19.1 (12.1, 26.0)
WA	211	9.2 (5.0, 13.4)
Socio-economic status (SEIFA) (missing n=1)		
1 (most disadvantaged)	340	14.8 (11.1, 18.5)
2	430	18.8 (14.6, 22.9)
3	523	22.8 (18.3, 27.4)
4	497	21.7 (17.0, 26.3)
5 (most advantaged)	503	21.9 (16.7, 27.2)

SEIFA, Socio-economic Index for Areas; Q1, quartile 1 (25th percentile); Q3, quartile 3 (75th percentile). NB: Practices were recruited to MedicineInsight using non-random sampling, and systematic sampling differences between regions cannot be ruled out. Tasmania is overrepresented whereas South Australia is underrepresented in MedicineInsight. Comparisons between regions should be interpreted with caution.

Prevalence of gestational diabetes by sociodemographics

The prevalence of gestational diabetes was higher in pregnant patients aged 30–39 years than among other age groups (Table 17). The prevalence of gestational diabetes was higher in the ACT than in other states or territories. This could be a chance finding but it is also consistent with national data that suggests the incidence of gestational diabetes is higher in the ACT than in other states.[17]

Unlike other datasets we found no significant differences in prevalence of gestational diabetes according to socioeconomic status, remoteness or Aboriginal or Torres Strait Islander status.[17]

Table 17: **PREVALENCE OF GESTATIONAL DIABETES BY AGE GROUP AND STATE OF RESIDENCE**

Characteristic	Gestational diabetes	
	No.	% (95% CI)
Age group (years)		
15–19	10	0.0 (0.0, 0.0)
20–24	113	0.2 (0.1, 0.2)
25–29	411	0.6 (0.5, 0.6)
30–34	753	1.0 (0.9, 1.0)
35–39	660	0.9 (0.8, 0.9)
40–44	274	0.4 (0.4, 0.4)
45+	73	0.1 (0.1, 0.1)
State/Territory		
ACT	87	1.4 (0.8, 2.1)
NSW	924	0.6 (0.5, 0.6)
NT	27	0.3 (0.1, 0.5)
QLD	433	0.5 (0.4, 0.6)
SA	78	0.6 (0.3, 0.9)
Tas	96	0.4 (0.3, 0.5)
Vic	438	0.5 (0.4, 0.6)
WA	211	0.4 (0.3, 0.4)

Prevalence of comorbidities among patients with gestational diabetes

The prevalence of recorded dyslipidaemia and hypertension among women with a record of gestational diabetes was low when compared with the prevalence of recorded dyslipidaemia among patients with type 1 or type 2 diabetes (Table 18).

The prevalence of polycystic ovary syndrome (PCOS), which can place women at higher risk of complications during pregnancy, including high blood pressure and gestational diabetes,[18] was 7.7%. Among all female patients (of any age), the prevalence of PCOS was 1.8%.

Table 18: **PREVALENCE OF RECORDED COMORBIDITIES AMONG PATIENTS WITH GESTATIONAL DIABETES IN 2019**

Comorbid condition	No.	%	(95% CI)
Dyslipidaemia	99	4.3	(3.4, 5.2)
Hypertension	171	7.5	(6.4, 8.5)
Polycystic ovary syndrome (PCOS)	177	7.7	(6.5, 8.9)

Blood glucose testing for patients with gestational diabetes

National Australian guidelines and RACGP guidelines recommend that all women at risk of hyperglycaemia be screened in the first trimester using either HbA_{1c} or fasting blood glucose, and that women considered to be at high risk who had a normal result on the first test should be retested between week 24 and week 28 gestation.[9,11] Just over a quarter of women with a record of gestational diabetes had a record of an HbA_{1c} test (Table 19).

An oral glucose tolerance test (OGTT) is typically used to test for gestational diabetes in the second or third trimester.[9-11] Almost a third of women with a record of gestational diabetes in 2019 had a record of this test. This test is often performed in hospital maternity services.

Table 19: **PREVALENCE OF BLOOD GLUCOSE TESTING AMONG PATIENTS WITH GESTATIONAL DIABETES IN 2019**

Comorbid condition	No.	%	(95% CI)
HbA_{1c} result	664	28.9	(26.2, 31.7)
OGTT request	699	30.5	(25.5, 35.4)

Pregnancy-specific data (including the dates that pregnancy started or ended) were not available in time for this report but will become available from early 2021. It may be worthwhile looking further into issues around gestational diabetes once this data is available.

6. IMPACT OF COVID-19

- Over the 6-month COVID period, the mean number of clinical encounters per patient among patients without a record of diabetes increased when compared with the pre-COVID period. However, there was no significant change in the mean number of clinical encounters per patient among patients with a record of type 2 diabetes.
- The monthly rate of encounters where the patient had a record of type 2 diabetes fell to 59.6 per 1000 encounters in April 2020 before increasing to approximately 80 per 1000 encounters in subsequent months.
- The rate of HbA_{1c} testing among patients with a record of type 2 diabetes fell during the COVID period despite the rate of type 2 diabetes encounters remaining similar in both time periods. In the pre-COVID period the rate of HbA_{1c} tests was 126.1 per 1000 clinical encounters compared with 109.0 tests per 1000 clinical encounters in the COVID period.

Study questions

- Has the average number of clinical encounters per patient changed during the COVID period compared with the same period in 2019?
- Has the average rate of type 2 diabetes encounters changed during the COVID period compared with the same period in 2019?
- Has the average rate of HbA_{1c} testing per 1000 clinical encounters changed during the COVID period compared with the same period in 2019?

Patients eligible for inclusion in this cohort were those who regularly attended a general practice (ie, three or more clinical encounters) between 1 September 2018 and 31 August 2020 and who had been diagnosed with type 2 diabetes prior to 31 August 2018.

The monthly number of clinical encounters at MedicineInsight practices was used as the denominator for rates of HbA_{1c} testing and clinical encounters with patients with a record of type 2 diabetes.

It should be noted that patients may consult GPs for multiple reasons and for reasons other than to manage their diabetes. Therefore, the information in this chapter does not provide information on the number of times that patients consulted their GP specifically for the purpose of diabetes management, but rather on how often they consulted their GP for any reason.

Average number of clinical encounters per patient

When comparing the entire 6-month pandemic period to the corresponding 6-month period in 2019, it does not appear that patients with type 2 diabetes limited their general practice consultations in response to the pandemic. Other regularly attending patients appear to have increased their regularity of consultations. This may have been due to the introduction of the new MBS items in March 2020 that allowed GPs to be reimbursed for phone and video (ie, telehealth) consultations with patients.[1] Confirming this as an explanation would require further investigation.

The mean number of general practice visits per patient among all regularly attending patients increased from 3.17 visits in the 6-month pre-COVID period to 3.29 visits in the 6-month COVID period (Table 19). This seems to be due to a significant increase in the mean number of general practice visits by patients who did not have a record of type 2 diabetes. In contrast, there was no significant increase in the mean number of clinical encounters per patient among patients with a record of type 2 diabetes in the COVID period. This may be because in the pre-COVID period they were already visiting their general practice on average every month.

Table 20: **MEAN NUMBER OF CLINICAL ENCOUNTERS PER PATIENT IN THE 6 MONTHS FROM 1 MARCH 2019–AUGUST 2019 AND THE 6 MONTHS FROM 1 MARCH 2020–31 AUGUST 2020**

	1 March–31 Aug 2019 (mean, 95% CI)	1 March–31 Aug 2020 (COVID period; mean, 95% CI)	p-value
All regularly attending patients	3.17 (3.10, 3.23)	3.29 (3.22, 3.37)	< 0.001
Patients without any type of diabetes	2.98 (2.92, 3.03)	3.11 (3.04, 3.18)	< 0.001
Patients with type 2 diabetes	6.36 (6.21, 6.51)	6.44 (6.29, 6.58)	0.22

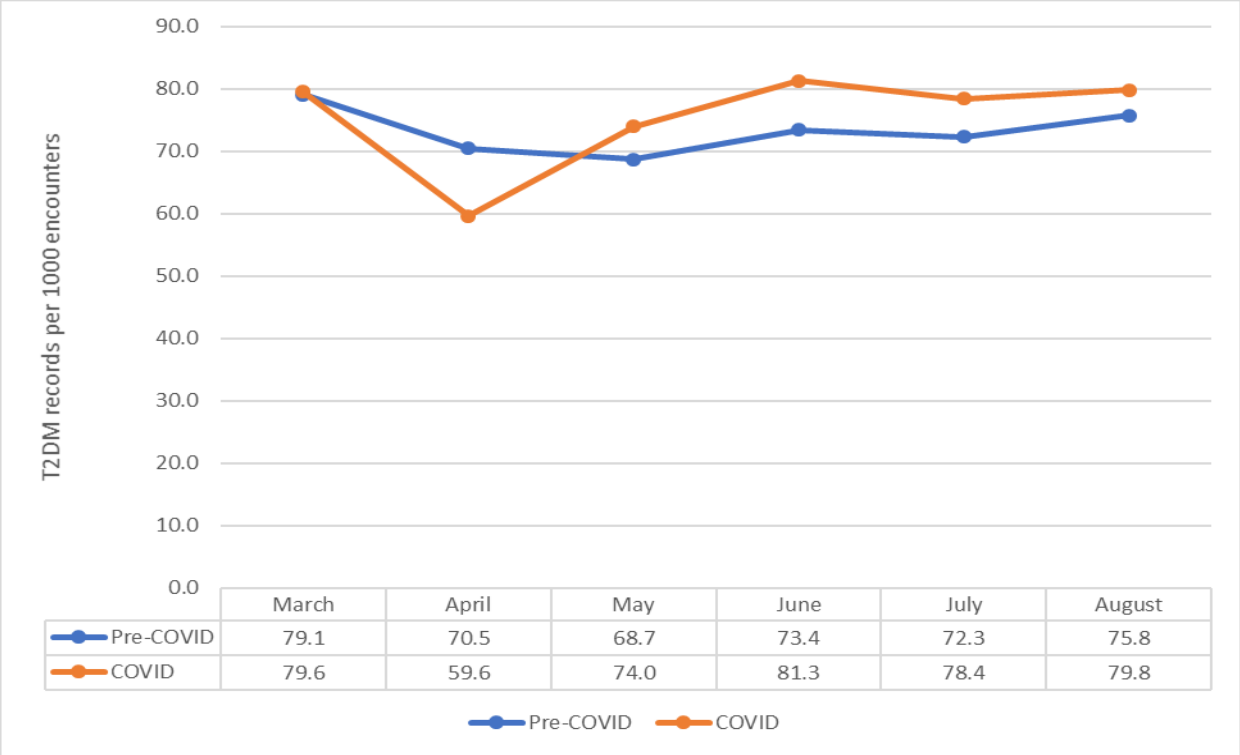
Proportion of encounters per month in which the patient had a record of type 2 diabetes

When explored on a month-by-month basis, the proportion of encounters in which the patient had a record of type 2 diabetes fell sharply in April 2020, shortly after the imposition of social distancing requirements and the closure of 'non-essential services' that began around 22 March 2020 (Figure 2).[19] The proportion of clinical encounters in which the patient had a record of type 2 diabetes was 70.5 per 1000 encounters in April 2019 compared with 59.6 per 1000 encounters in April 2020.

However, by May 2020 the number of encounters in which the patient had a record of type 2 diabetes was higher than in the same months of 2019 (Figure 2). This could result from a number of factors, including:

- patients with type 2 diabetes making up a higher proportion of all patients seen in practices
- the easing of social distancing restrictions
- the introduction of telehealth consultations from March 2020 onwards.[1]

FIGURE 2: MONTHLY MEAN NUMBER OF CLINICAL ENCOUNTERS IN WHICH THE PATIENT HAD A RECORD OF TYPE 2 DIABETES BETWEEN 1 MARCH 2020 – 31 AUGUST 2020 (COVID PERIOD) COMPARED WITH 1 MARCH 2019 – 31 AUGUST 2019 (PRE-COVID PERIOD) PER 1,000 CLINICAL ENCOUNTERS*



*Clinical encounters have been calculated using a maximum of one encounter per patient date.

HbA_{1c} testing rates

The rate of HbA_{1c} testing over the 6-month period from 1 March 2020 to 31 August 2020 was not significantly different from the pre-COVID period, when looking at all regularly attending patients (Table 21). However, the rate of HbA_{1c} testing did fall significantly among regularly attending patients with a record of type 2 diabetes, despite the rate of type 2 diabetes encounters remaining similar in both time periods. In the pre-COVID period, the average monthly rate of HbA_{1c} testing among patients with a record of type 2 diabetes was 126.1 per 1000 clinical encounters, which fell to 109.0 tests per 1000 clinical encounters in the COVID period. This suggests that patients with type 2 diabetes were less likely to have an HbA_{1c} test when they consulted their GP during the pandemic period. It is possible that this reflects reluctance by patients to visit pathology collection centres to have their blood taken during the pandemic, or it may be due to a lower likelihood of HbA_{1c} testing being ordered if a patient is seen as part of a telehealth consultation.

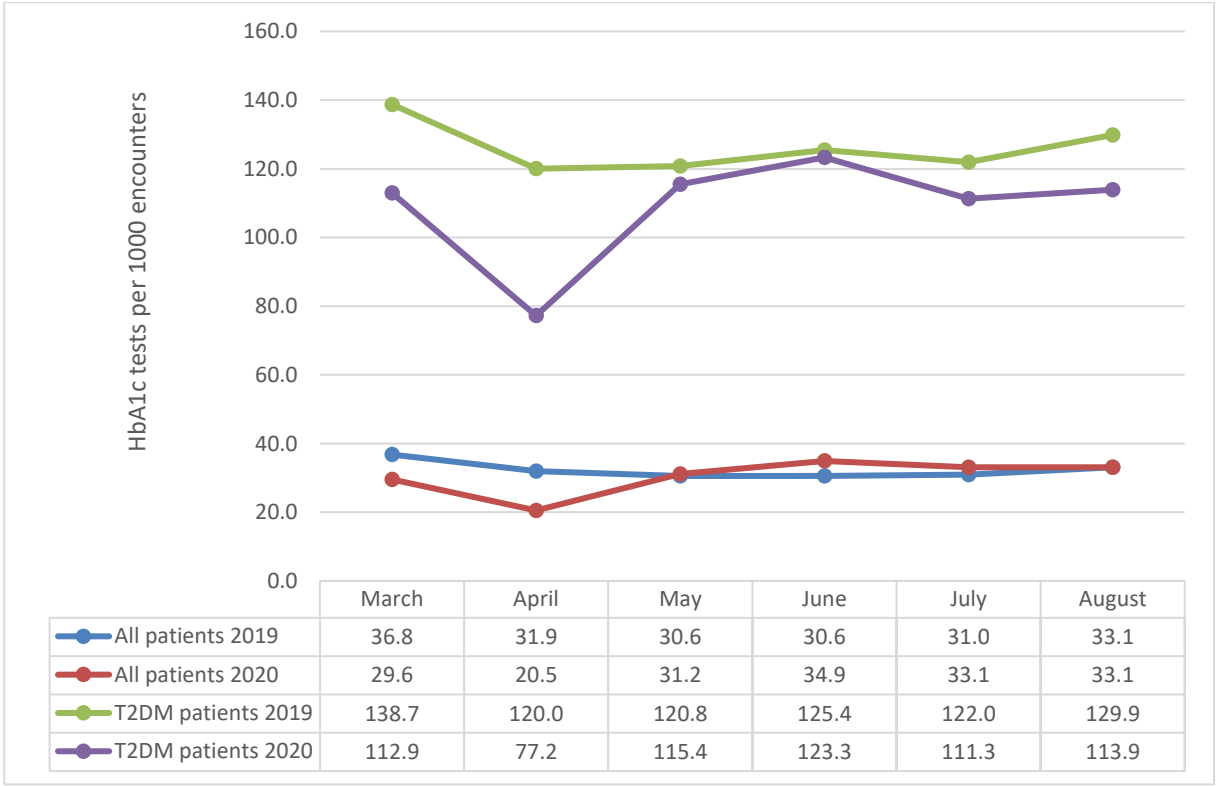
Table 21: **RATE OF HbA_{1c} TESTING AND DIABETES ENCOUNTERS PER 1000 CLINICAL ENCOUNTERS IN THE COVID PERIOD COMPARED WITH THE SAME PERIOD IN 2019**

	1 March–31 Aug 2019 (pre-COVID period)*	1 March–31 Aug 2020 (COVID period)*	p-value
Rate of HbA_{1c} testing (all patients)	32.3 (29.8, 34.8)	30.4 (25.0, 35.8)	0.43
Median all pts	31.5 (Q1 30.6, Q3 33.1)	32.1 (Q1 29.6, Q3 33.1)	-
Rate of HbA_{1c} testing (type 2 diabetes patients)	126.1 (118.6, 133.7)	109.0 (92.1, 125.9)	0.04
Median	123.7 (Q1 120.8, Q3 129.9)	113.4 (Q1 111.3, Q3 115.4)	-
Rate of type 2 diabetes encounters	73.3 (69.4, 77.2)	75.4 (66.9, 84.0)	0.57
Median	72.9 (Q1 70.5, Q3 75.8)	79.0 (Q1 74.0, Q3 79.8)	-

* Reported as the mean [per 1000 encounters] (95% CI); or median (quartiles)

There was a significant drop in the number of HbA_{1c} tests performed per 1000 clinical encounters in April 2020 when compared to April 2019 for both all patients and patients with a record of type 2 diabetes (Figure 3). Among all patients the rate of HbA_{1c} testing per 1000 encounters largely returned to pre-COVID levels in the subsequent months. However, for people with a record of type 2 diabetes, the number of HbA_{1c} tests per 1000 clinical encounters remained lower than in the same months pre-COVID and began to fall again in July and August 2020 as the second wave hit, and Victoria went back into lockdown.

FIGURE 3: **MONTHLY NUMBER OF HbA_{1c} RESULTS REPORTED PER 1000 CLINICAL ENCOUNTERS BETWEEN 1 MARCH 2020 AND 31 AUGUST 2020 (COVID PERIOD) COMPARED WITH 1 MARCH 2019 AND 31 AUGUST 2019 (PRE-COVID)**



	March	April	May	June	July	August
All patients 2019	36.8	31.9	30.6	30.6	31.0	33.1
All patients 2020	29.6	20.5	31.2	34.9	33.1	33.1
T2DM patients 2019	138.7	120.0	120.8	125.4	122.0	129.9
T2DM patients 2020	112.9	77.2	115.4	123.3	111.3	113.9

7. GUIDE TO INTERPRETING THE DATA

When interpreting the information presented in this report, readers should note the following caveats and/or assumptions related to the MedicineInsight data.

- MedicineInsight data are dependent on the accuracy and completeness of data recorded in, and available for extraction from, general practice clinical systems.
- Identification of conditions is dependent on GPs recording these items in their clinical software systems. Conditions may be underreported in MedicineInsight data depending on GPs' recording practices.
- Information on procedures, diagnoses and imaging tests from non-MedicineInsight practices and specialist / hospital settings are not necessarily available to MedicineInsight, depending on GPs' recording practices. Information from other settings provided to GPs in PDF format (such as discharge summaries, letters, faxes etc) are not extracted by MedicineInsight.
- Calculation of the relative proportion of different indications assumes that non-recording of conditions occurs at random.
- Medicines prescribed or tests requested at non-MedicineInsight practices or by specialists will not routinely be available to MedicineInsight and may lead to an underestimate of the true history of prescribing and monitoring/reviews.
- Identification of risk factor information is dependent on whether this information has been recorded in fields from which data can be extracted and analysed.
- Due to confidentiality issues we do not have access to progress notes, which may contain further information on symptoms, family history, reasons for encounters and diagnoses.
- Patients are free to visit multiple other practices. We do not have data on patients from non-MedicineInsight clinics. Currently we cannot identify patients who have attended multiple MedicineInsight practices.

GLOSSARY

95% CI	95% confidence interval – a range of values that are likely to encompass the true value
ABS	Australian Bureau of Statistics
ACR	urine albumin-to-creatinine ratio – a measure of kidney function
AF	atrial fibrillation
ALT	alanine aminotransferase – a measure of liver function
ASGS	Australian Statistical Geography Standard Remoteness Areas 2016
CI	confidence interval – a range of values that are likely to encompass the true value
CIS	clinical information system
CKD	chronic kidney disease
COVID-19	disease caused by the novel coronavirus, SARS-CoV2
CVD	cardiovascular disease
EHR	electronic health record
episode coning	Episode coning occurs when more than three MBS items are requested for a patient in the same day or using the same specimen. In these situations, there is an upper limit to the amount paid to conduct all of the requested tests.
eGFR	estimated glomerular filtration rate – a measure of kidney function
FBG	fasting blood glucose – a measure of blood glucose levels
GDM	gestational diabetes
GP	general practitioner
GPIR	2018–19 General Practice Insights Report
HbA_{1c}	glycated haemoglobin – a measure of the average of blood glucose levels during the previous 2 to 3 months
HDL	high-density lipoprotein cholesterol
IRSAD	ABS Index of Relative Socioeconomic Advantage and Disadvantage
MBS	Medical Benefits Schedule
MMM	Modified Monash Model
NHS	2017–18 ABS National Health Survey
NHMRC	National Health and Medical Research Council
OGTT	oral glucose tolerance test
OR	odds ratio – a measure of the strength of association between a risk factor and an outcome
PCOS	polycystic ovarian syndrome
POC	point of care
p-value	a test of statistical significance
RACGP	Royal Australian College of General Practitioners
RBG	random blood glucose – a measure of blood glucose levels
SAS	a statistical software package
SEIFA	ABS Socio-Economic Indexes for Areas

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APPENDIX 1: ADDITIONAL TABLES

Table 22: **SOCIODEMOGRAPHICS OF ALL REGULARLY ATTENDING MEDICINEINSIGHT PATIENTS**

Characteristic	Baseline study population (N=1,764,223)	
	No.	% (95% CI)
Gender		
Female	994,516	56.4 (55.9, 56.8)
Male	769,707	43.6 (43.2, 44.1)
Age group (years)		
0–12	269,425	15.3 (14.6, 15.9)
13–17	78,776	4.5 (4.3, 4.6)
18–44	582,835	33.0 (31.8, 34.2)
45–54	228,030	12.9 (12.7, 13.2)
55–64	224,743	12.7 (12.4, 13.1)
65–74	202,166	11.5 (10.9, 12.0)
75+	178,248	10.1 (9.4, 10.8)
Remoteness (missing n=144)		
Major city	1,141,510	64.7 (59.4, 70.0)
Inner Regional	397,654	22.5 (18.0, 27.0)
Outer Regional	192,536	10.9 (7.9, 13.9)
Remote or very remote	32,379	1.8 (0.8, 2.9)
Indigenous status		
Aboriginal and/or Torres Strait Islander	52,317	3.0 (2.5, 3.4)
Other Australian	1,403,685	79.6 (76.6, 82.5)
Not known	308,221	17.5 (14.4, 20.5)
State/Territory		
ACT	21,300	1.2 (0.2, 2.3)
NSW	656,301	37.2 (31.4, 43.0)
NT	32,939	1.9 (0.5, 3.2)
QLD	343,283	19.5 (14.9, 24.1)
SA	55,134	3.1 (1.2, 5.0)
Tas	98,338	5.6 (3.0, 8.2)
Vic	333,714	18.9 (14.0, 23.8)
WA	223,214	12.7 (8.4, 16.9)
SEIFA (missing n=144)		
1 (most disadvantaged)	277,609	15.7 (12.8, 18.7)
2	328,917	18.6 (15.6, 21.7)
3	388,014	22.0 (18.7, 25.3)
4	346,669	19.7 (16.6, 22.7)
5 (most advantaged)	422,870	24.0 (20.0, 28.0)
Concession card holder (missing n=283,279)		
Yes	565,858	38.2 (35.7, 40.7)
No	915,086	61.8 (59.3, 64.3)

SEIFA, Socio-Economic Index for Areas. NB: Practices were recruited to MedicineInsight using non-random sampling, and systematic sampling differences between regions cannot be ruled out. Tasmania is overrepresented whereas South Australia is underrepresented in MedicineInsight. Comparisons between regions should be interpreted with caution.

Table 23: **SOCIODEMOGRAPHICS OF PATIENTS IDENTIFIED AS HAVING TYPE 1 DIABETES OR TYPE 2 DIABETES**

Characteristic	Type 1 diabetes (N=11,089)		Type 2 diabetes (N=112,784)	
	No.	% (95% CI)	No.	% (95% CI)
Gender				
Female	5282	47.6 (46.6, 48.7)	51,914	46.0 (45.4, 46.6)
Male	5807	52.4 (51.3, 53.4)	60,870	54.0 (53.4, 54.6)
Age, median (Q1–Q3)	52.5 (Q1 33.4, Q3 68.0)		67.7 (Q1 57.6, Q3 76.2)	
Age group (years)				
0–12	358	3.2 (2.8, 3.6)	107	0.1 (0.1, 0.1)
13–17	358	3.2 (2.8, 3.6)	75	0.1 (0.1, 0.1)
18–44	3484	31.4 (29.7, 33.1)	7422	6.6 (5.9, 7.2)
45–54	1580	14.2 (13.5, 15.0)	13,213	11.7 (11.1, 12.3)
55–64	1819	16.4 (15.6, 17.2)	24,252	21.5 (21.0, 22.0)
65–74	1839	16.6 (15.6, 17.6)	33,039	29.3 (28.7, 29.9)
75+	1651	14.9 (13.6, 16.1)	34,676	30.7 (29.5, 32.0)
Remoteness (missing=2)				
Major city	6855	61.8 (56.1, 67.5)	67,658	60.0 (54.3, 65.7)
Inner regional	2750	24.8 (19.8, 29.8)	28,095	24.9 (20.0, 29.9)
Outer regional	1301	11.7 (8.4, 15.1)	14,819	13.1 (9.6, 16.7)
Remote or very remote	182	1.6 (0.7, 2.6)	2211	2.0 (0.9, 3.0)
Indigenous status				
Aboriginal and/or Torres Strait Islander	404	3.6 (3.0, 4.3)	4246	3.8 (3.1, 4.4)
Other Australian	9261	83.5 (80.9, 86.1)	94,835	84.1 (81.8, 86.3)
Not known	1424	12.8 (10.2, 15.5)	13,703	12.1 (9.8, 14.5)
State/Territory				
ACT	128	1.2 (0.1, 2.2)	1002	0.9 (0.1, 1.7)
NSW	4358	39.3 (33.1, 45.5)	43,186	38.3 (32.3, 44.2)
NT	127	1.1 (0.3, 2.0)	2016	1.8 (0.4, 3.2)
QLD	2013	18.2 (13.5, 22.8)	20,380	18.1 (13.6, 22.5)
SA	422	3.8 (1.2, 6.4)	4279	3.8 (1.5, 6.1)
Tas	810	7.3 (4.0, 10.6)	7327	6.5 (3.5, 9.5)
Vic	2027	18.3 (13.3, 23.2)	21,337	18.9 (13.9, 23.9)
WA	1204	10.9 (7.1, 14.6)	13,257	11.8 (7.7, 15.8)
Socioeconomic status (SEIFA) (missing=2)				
1 (most disadvantaged)	2246	20.3 (16.3, 24.2)	24,644	21.9 (18.0, 25.7)
2	2331	21.0 (17.5, 24.6)	24,780	22.0 (18.4, 25.6)
3	2432	21.9 (18.5, 25.3)	25,255	22.4 (18.9, 25.9)
4	1908	17.2 (14.4, 20.0)	18,654	16.5 (13.8, 19.3)
5 (most advantaged)	2171	19.6 (16.0, 23.2)	19,450	17.2 (14.1, 20.4)

SEIFA, Socio-Economic Index for Areas. NB: Practices were recruited to MedicineInsight using non-random sampling, and systematic sampling differences between regions cannot be ruled out. Tasmania is overrepresented whereas South Australia is underrepresented in MedicineInsight. Comparisons between regions should be interpreted with caution.

APPENDIX 2: MODIFIED MONASH MODEL

This is the first time that MedicineInsight data has been analysed using the Modified Monash Model (MMM) and we are still exploring this data. Information on remoteness using the MMM has been provided for information only.

Table 24: **PROPORTIONS OF REGULARLY ATTENDING PATIENTS BY MODIFIED MONASH MODEL**

Characteristic	Baseline study population (N=1,764,223)	
	No.	% (95% CI)
Remoteness (Modified Monash)		
Metropolitan (MM1)	1,138,696	64.5 (59.3, 69.8)
Regional centre (MM2)	248,596	14.1 (10.5, 17.6)
Large rural town (MM3)	155,481	8.8 (5.7, 11.9)
Medium rural town (MM4)	72,950	4.1 (2.4, 5.9)
Small rural town (MM5)	116,959	6.6 (4.8, 8.5)
Remote/very remote communities (MM6-7)	31,541	1.8 (0.8, 2.8)

Table 25: **PROPORTIONS OF PATIENTS WITH A RECORD OF TYPE 1 OR TYPE 2 DIABETES BY MODIFIED MONASH LEVEL**

Characteristic	Type 1 diabetes (N=11,089)		Type 2 diabetes (N=112,784)	
	No.	% (95% CI)	No.	% (95% CI)
Remoteness (Modified Monash)				
Metropolitan (MM1)	6861	61.9 (56.2, 67.6)	67,624	60.0 (54.3, 65.6)
Regional centre (MM2)	1581	14.3 (10.5, 18.0)	15,969	14.2 (10.5, 17.8)
Large rural town (MM3)	1116	10.1 (6.5, 13.7)	11,662	10.3 (6.6, 14.1)
Medium rural town (MM4)	446	4.0 (2.3, 5.7)	5453	4.8 (2.7, 7.0)
Small rural town (MM5)	903	8.1 (5.5, 10.8)	9915	8.8 (6.3, 11.3)
Remote/very remote communities (MM6-7)	182	1.6 (0.7, 2.6)	2161	1.9 (0.9, 3.0)

PREVALENCE OF RECORDED TYPE 1 OR TYPE 2 DIABETES BY MODIFIED MONASH MODEL LEVEL

Characteristic	Type 1 diabetes (N=11,089)		Type 2 diabetes (N=112,784)	
	No.	% (95% CI)	No.	% (95% CI)
Remoteness (Modified Monash)				
Metropolitan (MM1)	6861	0.6 (0.6, 0.6)	67,624	5.9 (5.9, 6.3)
Regional centre (MM2)	1581	0.6 (0.6, 0.7)	15,969	6.4 (6.4, 6.8)
Large rural town (MM3)	1116	0.7 (0.7, 0.8)	11,662	7.5 (7.5, 8.2)
Medium rural town (MM4)	446	0.6 (0.6, 0.7)	5453	7.5 (7.5, 8.5)
Small rural town (MM5)	903	0.8 (0.8, 0.9)	9915	8.5 (8.5, 9.0)
Remote/very remote communities (MM6-7)	182	0.6 (0.6, 0.8)	2161	6.9 (6.9, 8.1)

Table 26: **PROPORTION OF PATIENTS WITH GESTATIONAL DIABETES BY MODIFIED MONASH MODEL**

Characteristic	Gestational diabetes (N=2294)	
	No.	% (95% CI)
Remoteness (Modified Monash)		
Metropolitan (MM1)	1594	69.5 (62.8, 76.2)
Regional centre (MM2)	271	11.8 (7.4, 16.2)
Large rural town (MM3)	170	7.4 (4.0, 10.8)
Medium rural town (MM4)	104	4.5 (1.9, 7.1)
Small rural town (MM5)	118	5.1 (3.0, 7.3)
Remote/very remote communities (MM6-7)	37	1.6 (0.3, 2.9)