Assessment of medication appropriateness using the Medication Appropriate Index (MAI) in Aboriginal and Torres Strait Islander patients with chronic disease receiving integrated pharmacist support within Aboriginal Community -Controlled Health Services (IPAC project)

REPORT TO THE PHARMACEUTICAL SOCIETY OF AUSTRALIA FOR THE IPAC PROJECT

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Integrating Pharmacists within Aboriginal Community Controlled Health Services (ACCHSs) _to improve Chronic Disease Management_ (IPAC) Project.

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ABSTRACT

Objective
Suboptimal prescribing quality is a barrier to achieving equitable health outcomes for Aboriginal and Torres Strait Islander peoples who experience a higher burden of chronic disease than other Australians. The study objective was to assess the effect of an integrated non-dispensing pharmacist on medication appropriateness in Aboriginal and Torres Strait Islander adults with chronic disease compared with usual care pre-intervention.

Design and participants
Participants attended Aboriginal Community Controlled Health Services (ACCHSs) and were enrolled in the *Integrating Pharmacists within* ACCHSs *to improve chronic disease management* (IPAC) project- a non-randomised, prospective, pre and post quasi-experimental, community-based, participatory, and pragmatic study. Consented participants were recipients of integrated pharmacist care within ACCHSs that also included a prescription quality review as part of 10 core pharmacist roles. Prescribing quality (medication appropriateness and overuse) was assessed by pharmacists with the medication appropriateness index (MAI). Deidentified participant data was electronically extracted from health records.

Outcome measures
A subset of the enrolled cohort was assessed for change in prescribing quality: summated mean MAI scores per participant and per medication, and the proportion of: medications rated inappropriate according to ten MAI criteria; participants receiving ≥1 medication rated inappropriate and/or unnecessary (≥ 1 overuse MAI criteria); and prescribed medications with an inappropriateness rating by medication type.

Results
Of participants (n=1,456) from 18 ACCHSs involving 26 integrated pharmacists, 390 were selected (non-probabilistic) for MAI assessments at baseline and at the end of the study. Loss to follow-up (n=33 without repeat MAI) left 357 participants for paired data analysis (median interval of 270 days). Participants had cardiovascular disease (CVD), Type 2 diabetes mellitus (T2DM), chronic kidney disease (CKD), or other chronic disease, and 93% were Aboriginal and/or Torres Strait Islander [mean age 57 years (SD 14.4)]. Chronic disease co-morbidity was present in 87.4%. MAI participant characteristics differed little from the remaining cohort (n=1,099). The median number of medications taken by MAI participants at baseline was 7.0 (IQR 5-9). MAI evaluations each took 60 minutes (median) to complete. A total of 2,804 and 2,963 medications were evaluated at baseline and at the end of the study respectively. At baseline, 67.8% (n=242) of participants were prescribed ≥1 medications rated as inappropriate in at least one MAI criterion; 23.1% of all medications had ≥1 inappropriateness rating; the mean MAI score per participant was 6.02 (SD±23.6); and the mean MAI score per medication was 0.76 (SD±8.5). The most common reason for medication inappropriateness was incorrect dosage. The intervention significantly reduced mean MAI scores per participant (to 3.20, SD ±11.7, p=0.003); the mean MAI score per individual medication (to 0.39, SD ±4.4, p=0.004); the proportion of participants receiving medications rated as inappropriate (to 44.5% n=159, p<0.001), and the proportion of medications with the following prescribing risks: incorrect dosage, impractical directions, unacceptable therapy duration, drug-disease interactions; and unnecessary medications due to absent clinical indications, or lack of clinical effectiveness (all p <0.05). There was a 34.1% relative reduction in the number of participants with medications meeting ≥ 1 medication overuse criteria. Significant reductions in participant numbers prescribed medications with an inappropriateness rating was observed for: cardiovascular (-19.9% absolute reduction, p<0.001), endocrine (-11.2%, p<0.001), and respiratory conditions (-4.5%, p=0.019). Quality prescribing improved for participants with medications for hypertension, diabetes and/or dyslipidaemia (absolute reductions of -5.3%, p=0.01; -9.5%, p<0.001 and -9.8%, p<0.001 respectively).

Conclusion
Nearly two-thirds of participants were prescribed a medication that was rated as inappropriate pre-intervention. Prescribing quality improved significantly for participants following the integrated pharmacist intervention within ACCHSs. Improvements were significant in participants challenged by chronic disease comorbidity and polypharmacy and within a short follow-up period. Prescribing quality improvements are generalisable to the broader subset of IPAC participants, and potentially to other Aboriginal peoples and Torres Strait Islanders in receipt of pharmacist services integrated within primary health care settings such as ACCHSs.

INTRODUCTION

Inappropriate prescribing is defined as the 'use of medications with the potential for risks that outweigh the benefits to the patient'.[1] It refers to pharmaceutical prescribing that does not agree with accepted medical standards or poses more risks than benefits to the patient. Quality prescribing is judicious, patient-centred, and evidence-based so that the use of medicines with no clinical need or dubious efficacy is reduced to a minimum.[2] In Australia, this is fostered through a health systems approach known as the quality use of medicines (QUM).[3] Substantial benefits in healthcare services and the wider community can be realized with improvements in QUM,[4] with national health programs now developed to support better prescribing decisions.[5] Quality prescribing is particularly pertinent for Aboriginal and Torres Strait Islander peoples who concurrently experience health system access constraints[6] as well as much higher levels of co-morbidity than other Australians.[7] There is evidence that prescribing quality is suboptimal in this population,[8] and this serves to worsen already significant systems barriers to equitable health outcomes and resource use.[9]

A range of strategies to reduce inappropriate prescribing have been reported (mainly for the elderly) and these include the integration of pharmacists in multidisciplinary teams, pharmacist interventions alone, computerized systems, audit and feedback, and other strategies.[10] [11] [12]

The addition of pharmacists to healthcare teams has been found to enhance quality prescribing,[13] biomedical outcomes,[14] and to reduce hospitalisation.[15] [16] Whilst co-location of pharmacists within general practice has enabled greater communication, collaboration and relationship building among health professionals,[17] this intervention has never been evaluated in Aboriginal health settings before. Moreover, the quality of prescribing is not systematically examined for Aboriginal peoples and Torres Strait Islanders with chronic disease. National key performance indicators for health services to this population encourage regular clinical audit to improve activity,[18] but are lacking indicators of prescribing quality. The National Prescribing Service supports general practices to undertake small prescribing audits,[19] but it is unclear if this reduces inappropriate prescribing.

In order to investigate the potential gains in health outcomes arising from integrated models of care within Aboriginal health settings, the *Integrating Pharmacists within Aboriginal Community Controlled Health Services* (ACCHSs) *to improve Chronic Disease Management* (IPAC) Project was developed. The IPAC project was a community-based, participatory, pragmatic, non-randomized, prospective, pre and post quasi-experimental study (Trial Registration Number and Register: ACTRN12618002002268) that integrated a registered non-dispensing pharmacist within the primary healthcare team of ACCHS for up to a 15-month period. The project explored if this intervention led to improvements in the quality of the care received by Aboriginal and Torres Strait Islander peoples with chronic diseases. It was anticipated that pharmacists integrated within Aboriginal primary health care settings would facilitate increased access to medication-related expertise and assessments, which when coupled with increased engagement with participants, staff and other stakeholders, would result in improved services and quality use of medicines.

This project commenced in 2018 and measured the medication appropriateness index (MAI) of a subset of enrolled adult patients with chronic diseases (participants) at baseline and at the end of the study. Pharmacists functioned within existing and usual primary health care service delivery systems and focused on pre-determined core roles that included providing medication management reviews, assessing participant adherence and medication appropriateness, providing medicines information and education and training, collaborating with healthcare teams, delivering preventive care, liaising with stakeholders, providing transitional care, and undertaking a drug utilisation review. [20] The study explored changes to the proportion of study participants with inappropriateness ratings to their medications according to the MAI criteria as assessed by pharmacists.

METHOD
Study setting and Intervention
IPAC pharmacists delivered non-dispensing clinical medication-related services within ACCHSs through a coordinated, collaborative and integrated approach to improve the quality of care of patients with chronic diseases. Their intervention targeted consented

patients and practice-specific activities directed to health professionals and systems within the service. Pharmacists were integrated within these services with identified positions, having shared access to clinical information systems, providing continuous clinical care to patients, receiving administrative and other supports from primary health care staff, and adhering to the governance, cultural, and clinical protocols within ACCHSs as part of their shared vision. A full description of the intervention, participant and service recruitment, and pharmacist training is described elsewhere.[21] In short, this project was conducted in 18 ACCHSs across 22 service settings located in urban, rural, and remote Australian regions in three jurisdictions: Queensland, Northern Territory, and Victoria.

Study Participants

The study adopted a non-probabilistic, pragmatic sampling method where health service staff and pharmacists invited IPAC participants into the study from patients attending ACCHSs for usual care. The study enrolled adult participants (≥18 years) with cardiovascular disease, type 2 diabetes mellitus, chronic kidney disease or other chronic conditions at high risk of developing medication-related problems. Pharmacists selected a sample of enrolled participants for MAI assessment according to their clinical need for a medication review. The MAI was undertaken as a comprehensive prescribing quality review of participants medications assessing for medication appropriateness. The clinical need for such a review was reflective of usual care and based on criteria such as for Home Medicines Review where the patient must have 'a chronic medical condition or a complex medication regimen, and not [have] their therapeutic goals met'.[22] The study did not formally randomize the selection of participants for MAI audit in order to reflect usual care clinical processes and services consistent with a pragmatic trial.[23] Pharmacists used the MAI assessment findings to inform medication management plans and recommendations for prescribers, as needed.

For feasibility reasons, for every full-time equivalent (FTE) pharmacist position, at least 30 MAI assessments of IPAC participants were required. The numbers of participants to be audited for medication appropriateness was adjusted pro-rata to be consistent with the level of pharmacist appointment within the ACCHS. Given 12.57 FTE pharmacist positions within all ACCHSs, the project goal was to complete 377 MAI's in total. This goal was set due to the length of time usually required for pharmacists to undertake the MAI assessment and

the large number of participants expected to be enrolled into the study.[24] Pharmacists were instructed to complete the assessments within the first three months after participant recruitment into the study (baseline), and again prior to the end of the study (set as the 31st October 2019). The attendance of the patient was not required to undertake the assessment.

Medication Appropriateness Index

Medication appropriateness in this study was measured by assigning a Medication Appropriateness Index (MAI) weighted score to each medicine based on an internationally validated tool[25][26] that assesses the potential for medicine-related risks that outweigh the benefits to the patient. The MAI criteria inform on the potential for prescribing quality improvements and can be used to measure changes in quality over time.

Instructions on the use of the index and how to assign scoring were sourced from the author in Canada.[27] The MAI has 10 items investigating measures of medication appropriateness, each rated as 'appropriate' (A), 'neutral' (B), 'inappropriate' (C), or 'unknown' (Z) and weighting is applied to the 'C' rating which generates a score that can then be summated per patient (Table 1). The 10 items include medication indication, effectiveness, correct dosage, correct direction, practical direction, drug–drug interaction, drug–disease interaction, drug duplication, duration of therapy, and cost. Pharmacists reviewed each participant's medical record containing their currently prescribed medications and assigned the 10 -item ratings to each medication. The assessed ratings were then entered by pharmacists into an electronic logbook. Pharmacists used this medication review and other assessments related to their core role to formulate recommendations for the prescriber.

Higher MAI scores indicate increasing inappropriateness of prescribed medicines. A score of 18 represents maximal inappropriateness with regard to a single medication and refers to a 'C- rating' for every one of the 10 MAI criteria. A total score for the participant was derived by summating all the scores assigned for each medication.

Overuse of medications, defined as participants' medications deemed to be 'unnecessary', was measured by assigning a MAI score[28] to three items. Items 1,2,8 of the MAI tool specifically informed on the overuse of medications measuring if the prescribed medicine was clinically indicated, effective, or if there was unnecessary duplication of a medicine. The assessment of medication overuse defined by polypharmacy (five or more medications per patient) was not used as an outcome measure as some polypharmacy can be appropriate when this number of medicines is clinically indicated.[29] [30]

An analysis of mean MAI scores per participant, the mean total MAI score per medication, and the number and proportion of participants receiving inappropriate medications was assessed at baseline and at the end of the study. Pharmacists were blinded to the results of the MAI assessment as scores were only measured by the research team. Ratings that were assigned to 'A' or 'B' or 'Z' categories were weighted as zero for scoring, meaning that medications assigned this rating were considered 'appropriate'.

IPAC Pharmacist training

There were 26 registered pharmacists who were recruited into the study and appointed to ACCHS sites, with 20 accredited to offer a Home Medicines Review (HMR) during the intervention phase of the study. Pharmacists were trained by the Pharmaceutical Society of Australia (PSA) to evaluate each medicine using the MAI tool in the ACCHS context at the time of their induction into the project. Attention was paid to the MAI instructions provided by Hanlon et al.[31] The aim was to adopt a standardised approach to rating each medicine to enable individual pharmacists to use the tool accurately, consistently and reliably. Examples of how to assess each item in the MAI were developed by the PSA with input from the project team and adapted to Australian pharmaceuticals (Appendix A). The training also explored the reasons for allocating A, B, C or Z responses.

For each question, the use of Australian evidence-based references to assist assessment was recommended. For example, for MAI question 1, the Australian Medicines Handbook[32] was used to detail how a drug may have an 'accepted' use, as opposed to an 'indication for use'. Pharmacists were also instructed to ensure MAI assessments took account of clinical information such as laboratory results when assessing medications. Pharmacists were

expected to communicate the findings of the MAI assessment to prescribers so that appropriate clinical action was considered, and to follow-up participants as per usual clinic processes.

Training aimed to minimise intra-rater errors (the same person interpreting the same data differently). To minimise inter-rater errors (different observers reporting the same information differently), the same pharmacist was instructed to conduct the end of study MAI assessments they initially completed at baseline. Reliability testing was conducted with a small sample of pharmacists. For intra-rater reliability testing, pharmacists in six services repeated their MAI assessment of the same randomly selected participant, whilst inter-rater testing required two pharmacists to reassess three of each other's participants.

Classification of medicines

Pharmacists were required to classify the type of each MAI-rated medication when entering data into the logbook. For pragmatic study purposes, medicines were classified as per the Australian Medicines Handbook (AMH) as IPAC pharmacists used the AMH in their daily activity. The AMH has 20 main groups, most of which are anatomical, and others are pharmacological/therapeutic groups such as vaccines, and psychotropic drugs. A classification was assigned for 17 of the 20 groups included in the AMH. Categories of medicines excluded were: anaesthetics, antidotes and antivenoms, and obstetrics and gynaecological drugs, as these medicines are less relevant in the management of the chronic diseases investigated in this study.

Participant and service characteristics

Data was collected on health service and participant characteristics, as well as their self-assessed health status and self-report on medication adherence. The participants primary place of residence was not collected for privacy reasons, and so the location of the health service providing the intervention was used instead.

Remoteness and Indigenous disadvantage

The geographical location of IPAC sites was defined to the Australian Statistical Geography Standard-Remoteness Area (ASGS-RA, 2016) which is a classification based on the physical

distance of a location from the nearest urban centre.[33] The Indigenous Relative Socioeconomic Outcomes (IRSEO) index was used to define the relative advantage or disadvantage of geographical areas based on nine socioeconomic measures such as education, employment, housing and income for the Aboriginal and Torres Strait Islander population. The measure is Indigenous-specific and assigns a score of one (1) for the most advantaged area and a score of 100 for the most disadvantaged area.[34] IRSEO data was sourced from publicly available datasets.[35]

Health systems assessment

Health service information was sourced directly from each site through a 'health systems assessment' (HSA) survey completed by two project officers each visiting individual sites. The aim was to identify if incidental changes to health service systems during the IPAC intervention may confound the interpretation of study outcomes. The baseline site visits were conducted between 12th June 2018 and 13th September 2018, whilst the end of study site visits were conducted at least 12 months later between 6th September 2019 and 22 October 2019. Respondents to the HSA survey included the Chief Executive Officer, practice or clinic manager, human resources manager, quality manager and/or clinical staff. On most occasions, interviewees comprised at least two different service representatives, whilst interviewees at the end of the study may not have been the same person/s interviewed at baseline. To minimise bias, the same project officer conducted the site interview on both occasions. Information was collected on service and client population size, number of episodes of care (annualised number of client contacts with the service, where all contacts with the same client on the same day are counted as one episode), number and types of staff, access to on-site specialist and allied health services, engagement with and the support received from community pharmacy, and systems for clinical management and chronic disease care.

Health systems assessment information was collected using a form adapted from a Systems Assessment Tool (SAT) to assist ACCHSs to self- audit their capacity for continuous quality improvement.[36] The SAT was based on the 'chronic disease care model' which is a systematic approach to delivering chronic disease care within primary health care settings.[37] [38] This approach explores delivery system design; information systems and decision support; self-management support; linkages with other services; and organisational influence and

integration. Whilst permission to use the SAT tool for the IPAC project was provided by the developers,[39] a shortened and more context-specific survey was developed that was also informed by the Kanyini Audit Health Assessment Form used with ACCHSs to explore organisational barriers to improved quality care. [40 41] Permission to adapt and use the Kanyini form was provided by Prof Alex Brown from the South Australian Health and Medical Research Institute (SAHMRI).[42]

The items subsequently included in the IPAC HSA form were agreed by the project team and evaluation committee to significantly reduce the time required to collect site information yet still retain elements of the key chronic disease care model domains (Appendix B). For these items, respondents were asked to score them on a scale from 1-10 where 10 represented 'routine or established' activity and 1 represented 'minimal or absent activity'. Items with 'Yes' or 'No" answers were scored 10 for 'yes' and 1 for 'no'. The overall score for each domain was derived for each service, and the median and interquartile range was reported per domain.

The use of point of care (POC) pathology testing within health services was also assessed to ensure the reliability of the biomedical markers describing participant characteristics. Services using POC testing were asked if they were participating in the Australian Government supported *Quality Assurance for Aboriginal and Torres Strait Islander Medical Services* (QAAMS) program. The QAAMS program supports participating ACCHSs to ensure that testing is conducted under a quality management framework, delivering analytically sound performance.[43]

Self-assessed health status

Self-assessed health status was determined using the first question of the Short Form (SF)-36 health related quality of life instrument that asks: '*In general, would you say your health is excellent, very good, good, fair, poor, or very poor?'*. An extra response option – 'very poor' – was added (as in the SF-8 survey) to reduce the potential for respondents to overstate their health status.[44] Responses to this single-item (SF-1) question have been shown to correlate well with multi-item tools measuring the same construct,[45] and are used in the National Aboriginal and Torres Strait Islander Social Survey.[46]

Medication adherence

The extent of medication adherence for each participant was assessed using a self-reported indirect method of assessment with a single-item question: '*How many days in the last week have you taken this medication?*' This was asked for each medication the participant was taking. Pharmacists were trained to express the score as a proportion of the number of days the participant took the correct doses of the medication as prescribed in the preceding week. For example, if the patient took half the doses prescribed for the preceding week, this would be expressed as 50% of the days in the previous 7 days. An 'adherent day' was defined as not missing any doses of prescribed medicines on that day.[47] The mean number of adherent days in the preceding week ranged from 0-7 days, based on the mean score for all medications. This informed on the proportion of days with the correct number of doses taken, which is a frequent summary statistic used for reporting medication adherence.[48] If the mean number of adherent days for participants was least 6 of 7 days, this approximated medication adherence for at least 80% of the days indicated.

This single question and its variations have been used in the Kanyini study involving Aboriginal and Torres Strait Islander peoples in Australia[49] and internationally.[50, 51, 52] Even though self-report adherence measures have significant limitations, one study of medication non-adherence measured objectively by gaps in prescription fills was significantly associated with self-reported non-adherence defined by at least 'two days missed' taking medicines over the past week.[53] Multi-item internationally developed psychometric tools for assessing medication adherence were not used as they lacked validation for use within the ACCHS context,[54] used inappropriate language, and placed substantial data burdens on pharmacists and participants.

Data collection

A bespoke online database (pharmacist logbook) was developed for pharmacists to record the medication appropriateness findings and other pharmacist activity. The logbook was a secure password protected online database, accessible from any device connected to the internet, with dual recording and reporting functionality. The electronic interface was intuitive and user-friendly to minimise the burden of data entry and reporting.

Participant characteristics were sourced from two existing clinical information systems (CIS) used to store patient electronic health records and were used by participating ACCHSs (Best Practice and Communicare). Deidentified participant data was extracted from these systems

using an electronic tool called GRHANITE that required remote installation and regular extraction from IPAC sites for the term of the project.[55] GRHANITE extracted data only for consented patients and copied it to a JCU SQL server database employing internationally recognised point-to-point encryption (P2PE) mechanisms to protect data in transit.

The scope of the data extractions was agreed based on IPAC-specific data requirements and extract definitions for GRHANITE XML's (site interfaces) to ensure they were fit-for-purpose. All ACCHSs consented to the installation of GRHANITE and the de-deidentified data extractions required for the project. Each ACCHS successfully completed 'site acceptance testing' that confirmed the extraction of fit-for purpose data. The integrity of the data extraction process was monitored through weekly uploads. XML interface maintenance ensured that any software vendor upgrades to the CIS were aligned with data extract definitions.

The deidentified CIS participant identification numbers in the GRHANITE extractions linked with participant data recorded by pharmacists in the logbook. For assessed participants, pharmacists also recorded in the CIS that the MAI had been completed in order to assist with their follow-up.

Private laboratories conducted all pathology testing for IPAC sites as per usual care and were all accredited for testing by the National Association of Testing Authorities. Point of care testing by some sites for particular biomedical measures complied with QAAMS requirements. A laboratory diagnosis of dyslipidaemia was defined as one or more of the following four measures: low density lipoprotein (LDL) >=3.5mmol/L; total cholesterol (TC) >= 5.5mmol/L; triglycerides (TG) > =2.0mmol/L; high density lipoprotein (HDL) < 1.0 mmol/L for men and <1.3 mmol/L for women.[56] A participant missing the result of any of these measures, even with the remainder within the normal range, was excluded from the diagnosis. Albuminuria was defined as a urinary albumin:creatinine ratio (ACR) >2.5 mg/mmol for males and >3.5mg/mmol for females. [57] [58] Estimated glomerular filtration rate (eGFR) as reported in CISs was used without derivation from serum creatinine measures.

Patients already at a clinically high risk for a CV event were those with any of the following: diabetes mellitus and age >60 years, diabetes mellitus and microalbuminuria (urinary ACR >2.5 mg/mmol for males and >3.5 mg/mmol for females), eGFR <45 mL/min per 1.73 m^2,

systolic blood pressure (BP) ≥180 mm Hg, diastolic BP ≥110 mm Hg, and serum total cholesterol >7.5 mmol/L.[59]

Data analysis

All participants with less than 90 days of follow-up were removed from the analysis due to their short length of stay in the study (n=90). Health Care Homes (HCH) participants who were also concomitantly enrolled in another program- the '*Community Pharmacy in Health Care Homes Trial* '[60] - were also removed from the analysis (n=47).

Participant characteristics data was extracted from the JCU SQL Server database using the Navicat 15 for SQL Server (PremiumSoft) database management tool; MAI data was extracted from the pharmacist logbook as Microsoft Excel files; and health services data was sourced from HSA survey. All data was subsequently analysed using a number of statistical tools including the SPSS Statistics Premium version 24 (IBM) statistical package, Stata/MP 13.0 (StataCorp LP), and Microsoft Office 2016 (Microsoft). Nominal variables are presented as absolute and relative frequencies. Depending on their distribution, continuous variables are presented as mean and standard deviation (SD) or median and interquartile range (IQR) as indicated accordingly.

The characteristics of participating ACCHSs were described and compared for changes between baseline and end of the study using the Wilcoxon test (median values) or the McNemar test (paired proportions).

The study design of IPAC involved cluster sampling using ACCHSs as the primary sampling units. As a consequence, statistical analyses were cluster-adjusted for the design effect of ACCHSs (one-stage) for comparisons at the level of participants and were cluster-adjusted for the design effects of ACCHS and participant (two-stage) for comparisons at the level of medications.

The percentages of participants with improvements in outcomes were compared to determine the absolute and relative change pre and post intervention. P-values for changes in numerical MAI outcome variables for participants (paired data) were derived from the cluster-adjusted confidence interval (ACCHS cluster) of the differences as this is equivalent to a paired t-test. P-values for comparisons between baseline and end of the study for

changes in medications (unpaired data, nominal variables) were determined using logistic regression analyses that were cluster-adjusted for ACCHSs and participants. P-values for comparisons between baseline and end of the study for changes in participants and the type of medications prescribed for them (paired data, nominal variables) were determined using conditional logistic regression analyses that were cluster-adjusted for ACCHSs. Statistical significance was assumed at the conventional 5% level.

Ethics approval

Ethics approval for the project was received from four ethics committees in the three jurisdictions including St Vincent's Hospital Melbourne (SVHM) Human Research Ethics Committee (HREC), Victoria (HREC/17/SVHM/280), James Cook University HREC (mutual recognition of SVHM HREC, approval HREC/H7348), Menzies School of Health Research (HREC/2018-3072) and the Central Australian HREC (HREC/CA-18-3085).

RESULTS

The total IPAC project cohort comprised 1,456 participants who remained in the study until the end. From this, 390 participants had a baseline MAI, with a loss to follow-up of 33 participants, meaning the final MAI subset comprised 357 (24.5%) participants with both a baseline and follow-up MAI from 18 ACCHSs (Figure 1). MAI assessments were completed by pharmacists at each of these ACCHSs. The mean time from participant enrolment to the completion of the baseline MAI was 22 (SD± 96) days, with 94% completed within 100 days, consistent with the project protocol. Follow-up MAIs were completed within a median of 270 days (IQR: 218-316) from the baseline assessment. The median length of stay in the study for MAI participants was 329 (IQR: 289-364) days.

Health service characteristics

The majority of services were located in outer regional and remote locations of Australia, and in IRSEO regions of relative greater disadvantage for Indigenous Australians (Table 2). Services were mostly large in size with a median of 2,066 regular clients per service at baseline, of which 88% were Aboriginal and/or Torres Strait Islander. At baseline, services that used the Communicare CIS software provided more patient services (based on episodes of care) than those using Best Practice software. Only about half of all services were able to

offer on-site access to a cardiologist, with fewer providing on-site endocrinology support. However, 72% and 83% of services were able to offer diabetes educator and podiatry support to patients on-site (respectively).

Two-thirds of services (12) conducted POC pathology testing and all were participating in the QAAMS program. The remaining IPAC services (6) did not utilise point-of-care testing for biomedical measures assessed in the IPAC project.

Half of the services engaged with two or more community pharmacies at baseline. Almost all services that reported receiving community pharmacy support did so for dose administration aids. Medicines dispensing and response to queries about medications were other forms of support given to services by community pharmacy. Only 50% of services received support for an HMR.

At baseline, eight services reported that pharmacists had provided on-site support prior to the IPAC intervention. In these settings, the pharmacist's role was to provide medication support for the section 100 remote-area Aboriginal health services program,[61] or to undertake HMRs. Only one service reported employing a pharmacist prior to IPAC, but their role was predominantly related to medicines policy and governance and did not involve delivering the intervention defined by the IPAC study [*Personal communication, NACCHO*].

By the end of the study, the vast majority of the broad health service level factors explored in the IPAC study had not changed (p>0.05, Table 2). There were still six services eligible for remote area support from community pharmacy through the Section 100 Pharmacy Support program, and one additional service participated in the Health Care Homes (HCH) program designed to better coordinate the health care of patients with chronic disease,[62] with all located in the NT. Most of the access to specialists and allied health staff did not change during the study.

Health systems assessment

IPAC services had high performing systems for chronic disease management at baseline with median scores across all domains ranging from 7-9. By the end of the study, no score change was evident with three domains ('organisational influences and integration', 'information system and decision support', 'self-management'), but two domains

significantly improved ('delivery system design', and 'links with community and other health services', Table 3, Figure 2).

Participant characteristics

At baseline, the mean age of participants was 57 years (SD±16.4), 93% were of Aboriginal and/or Torres Strait Islander origin, and 57% were female (Table 4). One third of participants attended ACCHSs in major cities or inner regional areas, one-third in outer regional, and the remaining third in remote or very remote locations. The vast majority were attending ACCHSs in locations outside major cities. Most participants were pensioners or had concessional eligibility status (83%). Half of all MAI participants were prescribed 7 or more medications, consistent with the definition of polypharmacy (≥ 5 medications). Despite this large number of per patient medications, only 11.5% of participants had an HMR (MBS item 900) completed in the 12 months prior to study enrolment.

Only a small proportion of participants assessed for the MAI were also engaged in the Health Care Homes program (10.6%), whilst most were registered with the Close the Gap (CTG) Pharmaceutical Benefits Scheme (PBS) co-payment measure (75%). The remainder of this cohort were mostly likely patients of remote-area health services with access to PBS medicines under the section 100 medicines supply scheme,[63] who did not need to be registered with CTG.

Most MAI participants self-assessed as having 'good to very poor' health status (82%) with only 18% of MAI subgroup participants defining their health as 'very good to excellent'. Almost all had evidence of comorbidity or multimorbidity (up to 87%) with a median of 2 chronic diseases per participant. Diabetes, hypertension, dyslipidaemia, chronic kidney disease, and obesity (BMI>30) were highly prevalent.

Overall, the vast bulk of participant characteristics at baseline were similar between those who were MAI assessed or not (n=1,099) (Table 4). Similarities were observed in age, sex, Aboriginality, geographical location, pensioner status, number of medications, CTG script eligibility, Health Care Homes enrolment, prior HMR, self-assessed health status, clinical diagnoses, type of chronic disease, degree of comorbidity or multimorbidity, obesity, glycaemic control, or prevalence of eGFR levels. The proportion of participants who self-reported as adherent to medications was similar between cohorts. MAI participants had

more doctors' visits per 12 months at baseline than the remainder of the IPAC cohort with a median of 7 visits compared with 5 respectively (p<0.001).

Medication appropriateness index

The total number of medications used by participants increased between assessments to 2,963 medications by the end of the study with a mean 8.3 medications- an increase of 0.45 medications per participant or 5.7% increase to the end of the study although this change was not statistically significant (p=0.147, Table 5).

At baseline, 67.8% of participants had at least one medication that was rated as inappropriate in any of the 10 criteria, but this reduced significantly to 44.5% of participants by the end of the study (p<0.001). Compared to baseline, this is a relative reduction of 34.3% in the number of participants with at least one inappropriate medication. By the end of the study, 83 fewer participants were prescribed one or more medications with an inappropriateness rating than at baseline. To achieve this result, 4.3 participants needed to be assessed by a pharmacist so that one less participant was prescribed a medication rated as inappropriate.

When the outcome was assessed by change in the mean MAI score per participant, the score reduced significantly by 47% from 6.02 (SD ±23.6) to 3.20 (SD ±11.7) (p=0.003). The mean MAI score per medication also reduced significantly by 48.7% from 0.76 (SD ±8.5) to 0.39 (SD ±4.4), (p= 0.004).

Of 2,804 medications, 23.1% were rated as inappropriate in any of the 10 criteria at baseline compared with just 12% at the end of the study - a significant reduction in the proportion of medications that were rated inappropriate by 48% (p= 0.008). On average, 1.8 medications per participant were rated inappropriate at baseline and this reduced significantly to 1.0 medications per participant (p= 0.001).

Clinical examples of the medication type and the reason for the inappropriateness rating given by IPAC pharmacists are shown in Table 6. Of all the medications prescribed at baseline, the most common reason for an inappropriateness rating was for 'incorrect dosage' affecting 7% of all medications (Table 7). Unacceptable therapy duration, significant drug-drug interactions, and the drug lacking an indication were the next most common reasons according to ratings. Only a small proportion of medicines were rated as

inappropriate due to the medicine not being the least expensive option for the patient (1.5%).

By the end of the study, the proportion of medicines with incorrect dosage reduced significantly by 55% with an absolute change of -3.81% (p<0.001). A significant reduction in medication inappropriateness was also evident for most other MAI criteria (Table 7). Participants were prescribed significantly fewer medications that were ineffective for the condition, or had incorrect dosage, impractical directions, significant drug to disease interactions, or unacceptable therapy duration compared with baseline (p<0.05). Although reductions in medication inappropriateness were also evident with regard to incorrect directions, significant drug to drug interactions, unnecessary duplication of drugs, and the use of a more expensive drug than necessary, these changes did not reach statistical significance (p>0.05) after cluster adjustment.

Overall, the number of participants with any medication that met at least one overuse criteria was reduced significantly with an absolute decline of 12.6% (p<0.001, Table 5) and 34.1% relative reduction compared to baseline. This suggests that 8 participants needed to be assessed for one less participant to be prescribed an unnecessary medication (Table 5). There was a statistically significant decline in medication overuse according to two of three MAI criteria for medication overuse with a -2.29%, and -1.95% absolute decline in the number of prescribed medications that were either not indicated, or ineffective for the condition (p<0.05, Table 7). Very few medications fulfilled all three criteria for overuse. The mean number of medications (per participant) that met at least one overuse criteria was significantly reduced by 41.4% (p=0.016, Table 5)

The proportion of medications with a Z-rating at baseline was negligible for all MAI questions at baseline (0.2-2.2% of all medications), except for question 8, which was one of the three questions that explored the overuse of medications (Table 8). Question 8 rated if the medication was an unnecessary duplication of other drugs. For 16% of all medications (446/2,804), pharmacists could not rate if the medicine was an unnecessary duplication. By the end of the study, the proportion of medications with Z-ratings reduced for every MAI criterion compared with baseline. The reduction in the degree of pharmacist uncertainty was only significant with regard to whether the prescribed medication was the least expensive.

Type of medications assessed by MAI

Of 2,963 medications assessed by IPAC pharmacists at the end of the study, 35.6% were cardiovascular (CV) medications, with antihypertensives (16%) and medications for dyslipidaemia (10%) being the most commonly prescribed (Table 9). Medications for endocrine disorders were the next most common type (21%), of which the vast majority were for the management of diabetes (17%). Respiratory medications comprised about 9% of all medication types.

The relative distribution of medication types prescribed for participants stayed the same throughout the study, with the exception of those for dyspepsia contributing a significantly smaller proportion of all types (Table 9). Of all medications rated as inappropriate in any criterion, the medication type did not change from baseline to the end of the study (Table 10). Most of the medications that were inappropriate in any one or more MAI criteria were for cardiovascular and endocrine conditions.

There were significant reductions in the proportion of medication-types that had an inappropriateness rating (Table 11). Medications for cardiovascular conditions were significantly less likely to have an inappropriateness rating by the end of the study when compared to baseline. This was particularly evident for medications used to treat dyslipidaemia (p=0.008). For cardiovascular conditions, 16.2% of medications were rated inappropriate at baseline, reducing to 7.3% by the end of the study (-8.9% absolute, p=0.013). Significant reductions in inappropriateness was also seen with medications for endocrine conditions and especially for diabetes (-12.9% absolute reduction, p<0.001).

By the end of the study, nearly all participants were prescribed medications for cardiovascular conditions (91%), most of them for hypertension (77%) and predominantly using angiotensin-converting enzyme (ACE) inhibitors (53%). More participants were prescribed antihypertensives (+3.6% absolute change, p=0.048), at the end of the study than at baseline with a significant increase in prescribed sartans (p=0.014) and beta-blockers (p=0.012), but no change in the proportion prescribed ACE inhibitors (p=0.312, Table 12). There was no change in the proportion of participants prescribed medications for dyslipidaemia (p=0.143), but prescribing for 'blood and electrolyte' conditions (a category that includes anti-platelet medications) was significantly increased (p=0.006). The number of participants on endocrine medications (72%), and on analgesics (26%) did not change.

Significantly fewer participants were prescribed gastrointestinal, musculoskeletal, and antidepressant medications by the end of the study (-5.0%, p=0.009; -5.0%, p=0.009; -3.6%, p=0.014, respectively), compared with baseline.

For many clinical conditions, fewer participants were prescribed medications rated as inappropriate by the end of the study (Table 13). Significant reductions in the number of participants prescribed medications with an inappropriateness rating were observed for the following conditions: cardiovascular (-19.9% absolute reduction, p<0.001), endocrine (-11.2%, p<0.001), 'blood and electrolyte' conditions (-7.0%, p=0.0034), respiratory conditions (-4.5%, p=0.019), for dyspepsia (-4.5%, p=0.02), and psychotropic use (-3.4%, p=0.031). The number of participants with medication for hypertension, diabetes and/or dyslipidaemia that was inappropriate in one or more MAI criteria reduced significantly by the end of the study (absolute reductions of -5.3%, p=0.01; -9.5%, p<0.001 and -9.8%, p<0.001 respectively). The proportion of participants prescribed non-opioid medications that had an inappropriateness rating also reduced significantly (-2.8%, p=0.035, Table 13).

Reliability testing

The majority of the follow-up MAIs (79%) were completed by the same pharmacist who completed the baseline MAI. The remaining follow-up MAI assessments were completed by a different pharmacist due to pharmacist turnover in some sites.

Inter-rater reliability testing was conducted with a sample of two pharmacists, each assessing three participant MAI's completed by the other pharmacist. This involved an assessment of 31 medications (310 MAI questions) from 6 participants within a mean 3 (range 0-6) days between assessments. Only 4 of 310 questions (1.3%) generated discordant answers with regard to C-ratings. A discordant C-rating for medications applied to only one MAI criterion (drug to drug interactions) and to 4 of 31 medications, indicating 87.1% concordance (Table 14).

Intra-rater reliability testing was conducted with a sample of six pharmacists reassessing 6 participant MAIs they had completed earlier (totalling 43 medications). This sample made up 6% of their combined 101 participants within a mean 8 (range of 6-14) days between assessments. Only 2 responses (from one pharmacist) from 430 MAI questions were discordant based on C-ratings indicating 99.5% concordance overall. The two discordant C-ratings for 43 medications indicated 95.3% concordance in ratings amongst pharmacists.

DISCUSSION

Integrating a pharmacist within 18 ACCHSs led to significant improvements in prescribing appropriateness by reducing the number of participants with medications rated as inappropriate or that met medication overuse criteria, amongst adult study participants with chronic disease and polypharmacy. Improvements were evident in Aboriginal and Torres Strait Islander participants following a median of 270 days (approximating 9 months) between repeat prescribing quality assessments. The intervention significantly reduced summated mean MAI scores per participant; the mean MAI score per individual medication; and the number and proportion of medications rated as inappropriate due to one or more of the following prescribing risks: incorrect dosage, impractical directions, unacceptable therapy duration, drug-disease interactions; and unnecessary medications due to absent clinical indications, and/or lack of clinical effectiveness. There was a 34.3% relative reduction in the number of participants with at least one medication rated as inappropriate, and a similar relative reduction in the number meeting at least one overuse criteria.

These significant improvements occurred within a context where most study participants (68%) at baseline were prescribed medications that were rated inappropriate in at least one prescribing risk criterion, and 37% had evidence of at least one medication that was potentially unnecessary. Almost all participants were Aboriginal peoples and/or Torres Strait Islanders with substantial chronic disease comorbidity, polypharmacy, chronic kidney disease, glycaemic control above the recommended target level for most of those with T2DM with available results, but only 11.5% had an HMR prior to the study intervention. As the presence of chronic disease was a participant inclusion criterion, at baseline, participants self-rated their health at worse levels than reported in the National Aboriginal and Torres Strait Islander Social Survey (2014-15).[64] Of respondents to the national survey, the proportion aged 15 years or older who self-rated their health as 'excellent or very good' was 40%, whereas only 18% of adult IPAC participants rated their health to this level. In a separate study, 22% of remote North Queensland Aboriginal and Torres Strait Islander adults with poorly controlled T2DM reported 'excellent or very good' self-assessed health.[65]

Only 4.3 participants needed to be assessed by a pharmacist to result in one less participant with suboptimal prescribing, and 8 participants needed to be assessed to result in one less

participant with an unnecessary medication. The proportion of medications that were rated as inappropriate reduced by half for most of the prescribing risk criteria. Moreover, there was an almost 4% absolute decline in the number of medications with incorrect dosage by the end of the study (p<0.001), indicating that the assessment of just 25 medications would result in one less medication with an incorrect dosage.

Improvements in appropriate prescribing were particularly evident with medications used for cardiovascular conditions and for diabetes. By the end of the study, significantly fewer participants were prescribed cardiovascular medications that had met an inappropriate criterion. With 71 participants no longer in receipt of cardiovascular-type medications with an inappropriateness rating, only five needed to receive the intervention for one to benefit.

Baseline MAI assessments were repeated with the same participants by predominantly the same pharmacists. There were very few discordant MAI results within and between pharmacists when participant samples were investigated for inter and intra-rater reliability. Pharmacist uncertainty in assigning MAI criteria (Z-rating) was also shown to be consistently very low. The only criterion for which change was not found pertained to the use of a more expensive drug in the presence of cheaper alternatives. This is one of the most commonly identified problems when reported in other international studies,[66][67] but was the least problematic medication issue in this study. This is likely because the PBS caps a patient co-payment for medications, the co-payment is reduced or waived for at-risk Aboriginal people and Torres Strait Islanders, and the PBS includes medicines specifically listed for health issues disproportionately affecting this population. For these reasons, prescribers were unlikely to prescribe a medication not listed on the PBS.

The characteristics of participants assessed for medication appropriateness were similar to the remaining IPAC study cohort. If we infer the same degree of prescribing quality improvements to the whole cohort of 1,456 participants, there would be 339 fewer patients with suboptimal prescribing and 183 fewer patients with medication overuse from pharmacist integration within ACCHSs in a median 9-month period. Being a pragmatic study, changes in prescribing quality occurred from a baseline representing usual care. Integrated pharmacists functioned within existing and usual service delivery systems delivering pre-determined core roles in flexible ways to suit their context. For this reason,

we believe outcomes of the magnitude described would be generalisable to other patients who have a clinical need for a medication review, within a broader ACCHS context.

To our knowledge, assessing prescribing quality using the MAI has never been reported from participants who are predominantly Aboriginal and/or Torres Strait Islanders. Multiple studies have evaluated change in prescribing quality using MAI quality indicators with pharmacist interventions.[68] [69] The MAI relies on pharmacist judgement supported by context-specific prescribing guidelines to assess medication appropriateness (implicit criteria). The MAI is not drug nor disease specific, and scores vary depending on the number and individual circumstances of the medications being prescribed making scoring time-consuming and dependent on clinical expertise.[70] Each assessment in the IPAC project took a median of 60 minutes to complete. In return, assessments were very patient-centric and changes in the quality of prescribing over time were clinically meaningful.

The implicit criterion-based MAI contrasts with the explicit Beers criteria[71] that define potentially inappropriate prescribing in older populations (≥ 65 years of age). Beers criteria lists 88 medications (USA) that pose a potentially higher risk for harm or unnecessary increase in drug-related costs and this list can be used to evaluate changes in prescribing quality to reduce medication-related problems.[72] [73] [74] [75] These criteria were not suitable for the IPAC project as participants were much younger than the population for which Beers criteria were designed; the listed medications did not reflect the disease burden of the Aboriginal and Torres Strait Islander population; criteria did not take into account patient preferences and their unique situation; and many criteria were irrelevant given Australia's PBS system that offers a more controlled scope of prescribing than in other countries.

The only study to explore prescribing appropriateness in Aboriginal Australians was an audit of the medication records in remote Western Australia (WA). This study found that 20% (54/273) of patients (54% were aged less than 60 years) had potentially inappropriate prescribing based on selected Beers criteria for older people. An example of potentially inappropriate prescribing was if patients were prescribed non-steroidal anti-inflammatory drugs, glibenclamide, sulphonamide-trimethoprim combinations or other medications that were relatively contraindicated in older people.[76]

When compared with other studies using implicit criteria such as the MAI, the observed improvement in the summated MAI score per IPAC patient was similar to that reported for

much older participants in systematic reviews,[77] [78] in rural patients older than 50 years attending family practices in Canada,[79] and in participants discharged from hospital aged 58 years (mean) in Sri Lanka.[80]

Even though improvements in MAI scores have been validated to represent improvement in prescribing quality, it is unclear what quantum of change can impact clinically on patient outcomes.[81] One estimate is a 9% increase in the risk of medication-related hospital admission for every one point increase in MAI score (mean score per patient), as was shown for patients older than 80 years.[82] Nevertheless, it is well known that overuse, underuse, and inappropriate use of medications resulting in adverse drug events from dosage errors or interactions, leads to increased health system costs largely because of potentially preventable hospitalisations in the elderly.[83] Few studies have explored the impact of inappropriate prescribing on hospitalisation or work capacity in younger populations burdened with chronic disease.

The IPAC study showed that for those who have a disproportionately high chronic disease burden at a younger age, like many Aboriginal peoples and Torres Strait Islanders, and have a clinical need for a medication review, integrating a pharmacist within the primary health care team can significantly improve appropriate prescribing. This clear benefit was observed despite the many challenges influencing optimal prescribing for this population, such as: remoteness, healthcare professionals turnover, lack of integrated care, difficulty with managing medications in those with complex health problems, and unsuccessful existing strategies for medication management reviews.[84] [85] Achieving improvements in prescribing quality and health outcomes in this context depends on health systems change to optimise health workforce skills, support for an expanded scope of practice for pharmacists, integrated services so that patients with significant comorbidity have a joined-up experience of care, patients are assisted to overcome medication adherence challenges, are empowered to self-manage, have access to healthcare professionals they can trust, and can afford these services.

This study showed significant prescribing quality improvements despite these substantial health system challenges and the potential to deliver further downstream health gains. Improvements in quality prescribing are important goals for all healthcare providers and health systems.

LIMITATIONS

A potential bias is that pharmacists may have assessed the appropriateness of medications more favourably in the follow-up MAI given this was a pre-post study without a control group. However, pharmacists were blinded to the results of the baseline MAI assessment and were not responsible for calculating the MAI scores. Pharmacists were neither prescribers, nor dispensers of medications. Post-testing was conducted a lengthy time after initial baseline testing reducing familiarity with the instrument to bias responses. The standardised training received by pharmacists and the continuity of their assessments also served to enhance the pharmacist implicit criteria-based assessments of the MAI. Favourable outcomes from reliability testing, although it comprised only a small sample of pharmacists, also supported the reproducibility of these assessments. Nevertheless, more comprehensive reliability testing of MAI assessments within the ACCHS context would have strengthened confidence in the reproducibility of study outcomes.

Without a control group, it is possible that prescribing quality improved irrespective of this intervention. However, this outcome is highly unlikely. Firstly, maturation effects suggest that prescribing quality would deteriorate over time in patients with substantial multimorbidity where chronic disease worsens over time, and polypharmacy increases with age.[86] Secondly, in qualitative analysis, clinicians and participants reported that the intervention had considerably enhanced health status and prescribing quality.[87] Thirdly, pharmacists had access to participants medical records which is a key success factor in other studies reporting enhanced prescribing quality following pharmacist interventions.[88] Fourthly, changes in prescribing quality favoured high-value care improvements such as for cardiovascular disease and diabetes. Finally, the quantum of improvement we observed is consistent with that reported in a systematic review of other studies using the MAI.[89]

There was little change in health systems assessment within participating sites from baseline to the end of the study that might otherwise explain prescribing improvements (such as from non-IPAC related service activity). Moreover, the health system changes that were observed were most likely explained by improvements generated by integrated pharmacist activity. For example, ACCHSs had more accessible on-site pharmacists at the end of the study than at baseline (Table 2), which is explained by integrated pharmacists

working within sites. By the end of the study, six services received community pharmacy support for educational sessions, but no services reported this activity at baseline. The local community pharmacy employed the IPAC pharmacists in five of these six services which likely explains this increased activity. The remaining service reported increased collaborative activity with community pharmacy as a result of the project. Other perceptions of community pharmacy support to ACCHSs did not change during the study (Table 2).

Although the median total number of staff (clinical and non-clinical) employed within IPAC participating ACCHSs increased during the study, the proportion of services with staff numbers above or below this median did not change. The median (annual) number of 'episodes of care' per service also increased although the median number of regular clients per service did not change, suggesting that services expanded the number of contacts with clients (rather than the number of clients) during the study period. This increase may be a result of integrated pharmacist patient follow-up activity or expanded service activity for other reasons. Alternatively, a change in counts may have been due to variations in the reporting of health services data as has been noted by the Australian Institute of Health and Welfare for episodes of care.[90] The latter is likely given that the number of episodes of care did not change for Communicare users in this project.

Health systems improvements in two domains were also observed during the study (Appendix B). The 'delivery system design' domain explored the quality of communication between the service, hospitals and specialists regarding patient hospitalisation and discharge, their discharge medications, and patient attendance at hospital outpatient services. The domain also explored care planning activity, whether patient follow-up is routine, the provision of translators, cultural orientation and training to staff, appointment systems, and transport support to patients. Based on qualitative analysis of service activity,[91] it is likely that integrated pharmacists influenced some improvement in this domain.

The 'links with community and other health services' domain (Appendix B) explored health service partnership with, and mechanisms for, using support available from other community groups; partnerships with Primary Health Networks; and routine use of patient feedback surveys to ascertain the patient experience, or other forms of seeking community feedback on the quality of care. Whether improvement in this domain acted as a

confounder to reduce prescribing errors independent of the intervention is unclear. This however is unlikely since published evidence is not indicative of an association between social, economic, or political interventions and the willingness of individuals (like healthcare workers) to reduce medication errors.[92]

Only a few participants (n=23) were assessed at baseline more than 100 days after enrolment into the study. These participants may have received pharmacist services prior to the baseline assessment thereby influencing prescribing quality assessments for usual care. If so, this would serve to minimise change over time, biasing study outcomes towards the null.

The selection of MAI participants by pharmacists is unlikely to impact generalisability (external validity) of the findings since the vast bulk of participant characteristics for the MAI assessed and remaining participants were similar. MAI participants were more likely to have more doctor visits, which suggests either they were more compliant with follow-up or had more complex disease. Neither of these possibilities were suggested with regard to other examined characteristics, and it is unclear how this particular characteristic could have increased prescribing quality independent of other factors.

Another potential confounder to the relationship between the intervention and prescribing quality was the HCH program. However, all participants concurrently enrolled in the *Community Pharmacy in Health Care Homes* (HCH) Trial program (undertaken in the NT around the same time as the IPAC project[93]) were removed from the IPAC analysis (Figure 1). The IPAC participants concurrently enrolled in the broader HCH program were not in receipt of additional community pharmacy support beyond usual care and comprised only 10.6% of MAI subjects. Moreover, the IPAC pharmacist was integrated within the HCH site meaning that the HCH intervention could not have acted as a confounder independently of the pharmacist.

The study was pragmatic, adopting a quasi-experimental design across a large sampling frame of 18 services as the goal was to evaluate real-life outcomes affecting an unselected population with chronic disease to enhance the external validity of the quality improvements expected from the intervention.[94] Fidelity to community-based participatory principles were vital for study participants to benefit from the community trust this

supported. These goals favoured the study design that was adopted combined with efforts to minimise bias as have been outlined.

CONCLUSION

Pre-intervention, nearly two-thirds of participants were prescribed medications assessed as being inappropriate posing potential risks that may outweigh benefits. Prescribing quality improved significantly following interventions received by participants from non-dispensing pharmacists integrated within ACCHSs. Participant risks associated with medication errors from inappropriate prescribing such as incorrect dosage, and unnecessary medications was significantly reduced. Only 4.3 participants needed to be assessed by a pharmacist to result in one less participant with a medication rated as inappropriate. Improvements occurred in participants challenged by substantial chronic disease comorbidity and polypharmacy at a relatively younger age than other Australians and within a short follow-up period. These improvements are generalisable to the broader subset of IPAC participants who have a clinical need for a medication review, and potentially to other similar Aboriginal peoples and Torres Strait Islanders in receipt of pharmacist services integrated within primary health care.

Table 1. Medication Appropriateness Index (MAI) and scoring

MAI Question	Assessment			Weighting for C-score
*1. Is there an indication for the drug?	A_____ Indicated	B_____	C_____ Not Indicated	3
*2. Is the medication effective for the condition?	A_____ Effective	B_____	C_____ Ineffective	3
3. Is the dosage correct?	A_____ Correct	B_____	C + or C - Incorrect	2
4. Are the directions correct?	A_____ Correct	B_____	C_____ Incorrect	2
5. Are the directions practical?	A_____ Practical	B_____	C_____ Impractical	1
6. Are there clinically significant drug-drug interactions?	A_____ Insignificant	B_____	C_____ Significant	2
7. Are there clinically significant drug-disease/condition interactions?	A_____ Insignificant	B_____	C_____ Significant	2
*8. Is there unnecessary duplication with other drug(s)?	A_____ Necessary	B_____	C_____ Unnecessary	1
9. Is the duration of therapy acceptable?	A_____ Acceptable	B_____	C_____ Not acceptable	1
10. Is this drug the least expensive alternative compared to others of equal utility?	A_____ Least expensive	B_____	C_____ Most expensive	1

The total score is aggregated (per medicine) to determine the total MAI score for the patient (the total result can range from 0-infinity). Scores in columns A and B are weighted zero. The maximum score per medicine =18.

* Rows represent the MAI ratings for medication overuse (combined MAI scores for question, 1, 2, 8)[95]

Figure 1: Flow-diagram for the Medication Appropriateness Index MAI subset of participants in the IPAC Project.
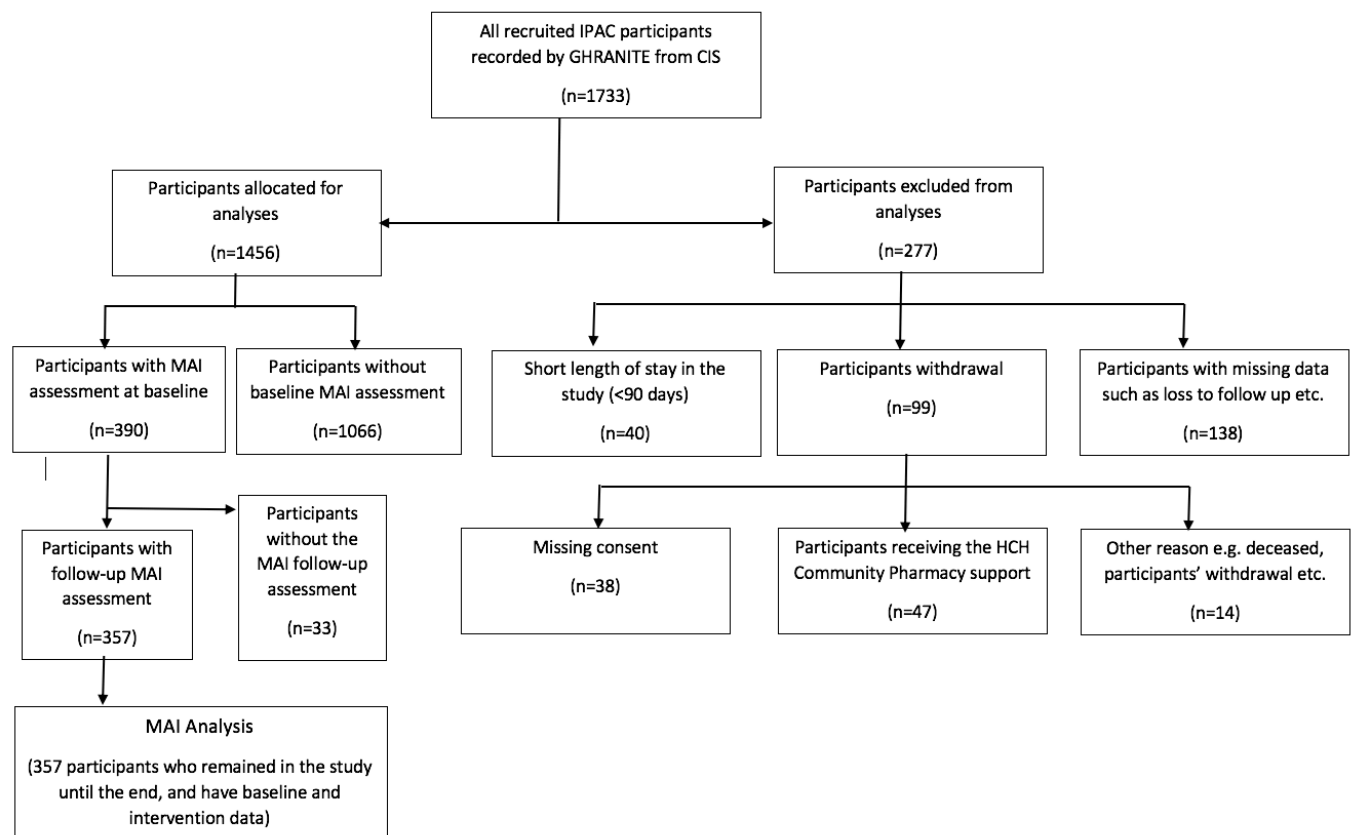
Table 2: The characteristics of Aboriginal Community-controlled health services (ACCHS) that participated in Medication Appropriateness Index MAI assessments at baseline and at the end of the study (n=18).

Health service characteristics	Baseline	End of the study	P-value
State (n %)			
Northern Territory	5 (27.8%)	5 (27.8%)	-
Queensland	7 (38.9%)	7 (38.9%)	-
Victoria	6 (33.3%)	6 (33.3%)	-
Location classified by ASGS-RA* (n, %)			
Major city	1 (5.6%)	1 (5.6%)	-
Inner regional	4 (22.2%)	4 (22.2%)	-
Outer regional	7 (38.9%)	7 (38.9%)	-
Remote	3 (16.7%)	3 (16.7%)	-
Very remote	3 (16.7%)	3 (16.7%)	-
Median IRSEO~ score (IQR)	60.5 (45-81)	60.5 (45-81)	> 0.999
Service size characteristics			
Median number of regular (active) clients per service (IQR)**	2,066 (1,251-5,209)	2,563 (1,614-3,477)	0.50
Median % Indigenous clients per service (IQR)**	88 (77-94)	83 (77-93)	0.17
Median number of episodes of care[a] per service (IQR)**	32,347 (9,836-47,207)	33,670 (12,072-43,444)	**0.04**
Median number of episodes of care[a] per service that uses *Communicare* (IQR)**	32,347 (8,023-42,559)	33,670 (11,977-41,051)	0.10
Median number of episodes of care[a] per service that uses *Best Practice* (IQR)**	14,456 (10,964-22,077)	N/A	N/A
Median total number of staff per service (IQR)**	30 (14-81)	37 (28-100)	**0.025**
Number of services with total number of staff (n,%):			
< Median	7 (38.9%)	7 (38.9%)	> 0.999
>= Median	11 (61.1%)	11 (61.1%)	> 0.999
Median total number of staff per service who are Aboriginal/TSI (IQR)**	14 (7-25)	16 (13-53)	0.20
Median number of staff per service by type (IQR)**			
Nurses	5 (3-9)	6 (3-8)	0.50
GP	4 (3-6)	5 (3-9)	0.17
Aboriginal health workers	4 (3-6)	4 (4-12)	0.64
Allied health	1 (0-5)	4 (1-9)	**0.04**
Administration	6 (4-16)	8 (4-13)	0.76
Number of ACCHS with access to specialists and allied health on-site (n, %)			
Paediatrician	11 (61.1%)	12 (66.7%)	0.56
Cardiologist	9 (50.0%)	10 (55.6%)	0.56
General physician	7 (38.9%)	6 (33.3%)	0.56
Endocrinologist	4 (22.2%)	5 (27.8%)	0.56
Psychiatrist	5 (27.8%)	6 (33.3%)	0.32
Nephrologist	5 (27.8%)	3 (16.7%)	0.16
Ophthalmologist	4 (22.2%)	4 (22.2%)	>0.999

ENT surgeon	3 (16.7%)	3 (16.7%)	> 0.999
General surgeon	2 (11.1%)	0 (0%)	0.16
Diabetes Educator	13 (72.2%)	13 (72.2%)	> 0.999
Podiatrist	15 (83.3%)	15 (83.3%)	> 0.999
Optometrist	12 (66.7%)	13 (72.2%)	0.71
Audiologist	12 (66.7%)	13 (72.2%)	0.66
Dentist	8 (44.4%)	12 (66.7%)	0.05
Social worker	8 (44.4%)	7 (38.9%)	0.66
Pharmacist	8 (44.4%)	15 (83.3%)	**0.02**
Median number of community pharmacies engaged with ACCHS (IQR**)	2 (1-4)	2 (2-5)	0.16
Community pharmacy support received by ACCHS (n, %)	16 (88.9%)	17 (94.4%)	0.18
Dose administration aids	18 (100.0%)	17 (94.4%)	0.32
Dispensing of medicines	14 (77.7%)	15 (83.3%)	0.71
Home Medicines Reviews	8 (44.4%)	6 (33.3%)	0.48
Response to queries about medications	15 (83.3%)	15 (83.3%)	>0.999
Educational sessions to staff within the clinic	6 (33.3%)	6 (33.3%)	>0.999
Educational sessions to community groups/your patients	0 (0.0%)	6 (33.3%)	**0.01**
Home delivery of medicines to patients	7 (38.9%)	9 (50.0%)	0.16
Delivery of medicines to the clinic	11 (61.1%)	11 (61.1%)	>0.999
Quality control of medicines stock onsite	6 (33.3%)	8 (44.4%)	0.32
Assistance with script collection	8 (44.4%)	8 (44.4%)	>0.999
Participation of ACCHS in QAAMS^ for point of care testing (n, %)	12 (66.7%)	12 (66.7%)	> 0.999
ACCHS with remote area access to medicines (Section 100) (n, %)	6 (33.3%)	6 (33.3%)	> 0.999
ACCHS engaged in Health Care Homes initiative (n, %)	4 (22.2%)	5 (27.8%)	0.32

Bold p-value implies statistically significant change at the 0.05 level. The paired groups were compared (baseline versus end of the study) and P-values determined using the Wilcoxon test (median values) or the McNemar test (proportions).
N/A= not available; ACCHS= Aboriginal Community Controlled Health Service.
*Australian Statistical Geography Standard-Remoteness Area (ASGS-RA, 2016)[96]
**IQR = inter-quartile range; ***SD = standard deviation;
^QAAMS= Quality Assurance for Aboriginal and Torres Strait Islander Medical Services program.
~IRSEO= Indigenous Relative Socioeconomic Outcomes index. The IRSEO reflects relative advantage or disadvantage at the Indigenous Area level, where a score of one (1) represents the most advantaged area and a score of 100 represents the most disadvantaged area.[97]
[a] Episodes of care are defined as the number of contacts between an individual client and an Aboriginal and Torres Strait Islander health service, within a calendar day, in the provision of health care. The figure is annualized for the 12-month period in the most recent services reporting to the Australian Institute of Health and Welfare.[98] All contacts with the same client on the same day are counted as one episode of care.

Table 3: **Description of composite systems assessment scores from the IPAC Health Systems Assessment (HSA) Form for health services (ACCHS) that participated in Medication Appropriateness Index (MAI) assessments at baseline (n=18).**

Health system assessment according to five chronic care model domains	Baseline	End of study	P-value
Median **delivery system design** score (IQR)	8.5 (8.0-9.0)	9.5 (9.0-10.0)	**0.002**
Median **links with community, other health services and services** score (IQR)	8.3 (6.0-9.0)	9.0 (8.0-9.5)	**0.027**
Median **organisational influence and integration** score (IQR)	8.0 (7.8-10.0)	8.0 (8.0-10.0)	0.58
Median **information system and decision support** score (IQR)	8.0 (7.0-9.0)	8.0 (7.4-10.0)	0.39
Median **self-management support** score (IQR)	8.0 (6.0-8.0)	8.0 (7.0-8.3)	0.09

Bold p-value implies statistically significant change at the 0.05 level. The paired groups were compared (baseline versus end of the study) with P-values determined using the Wilcoxon test (median values).
IQR = inter-quartile range.
ACCHS= Aboriginal Community Controlled Health Service

Figure 2. Radar plot of the composite systems assessment scores from the IPAC Health Systems Assessment (HSA) Form for health services (ACCHS) that participated in Medication Appropriateness Index (MAI) assessments at baseline (n=18).
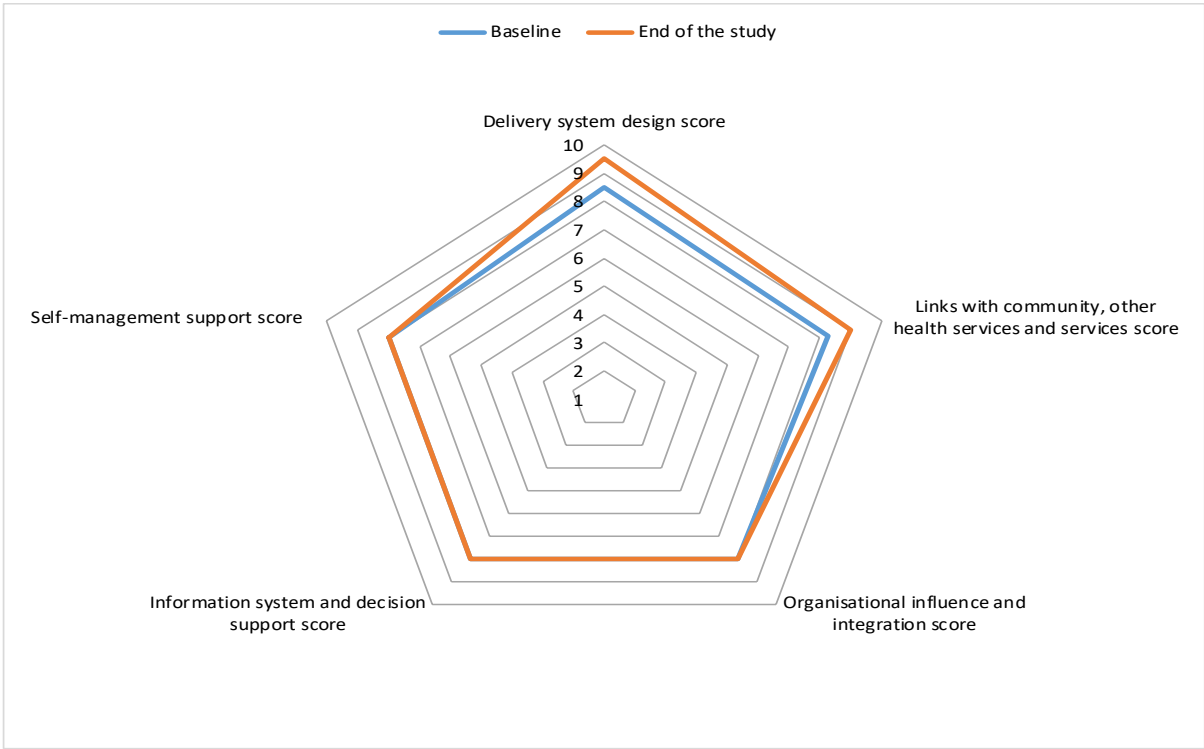
ACCHS= Aboriginal Community Controlled Health Service

Table 4. Participant characteristics at baseline (n=357), stratified by Medication Appropriateness Index (MAI) assessment.

Patient characteristics	MAI participants (n=357)	Non-MAI participants (n=1099)	P-value
Location classification by ASGS-RA (2016)			
Major city (RA1)	17 /357 (4.8%)	21 /1099 (1.9%)	
Inner regional (RA2)	93 /357 (26.1%)	338 /1099 (30.8%)	
Outer regional (RA3)	133 /357 (37.3%)	467 /1099 (42.5%)	0.52
Remote (RA4)	53 /357 (14.9%)	127 /1099 (11.6%)	
Very remote (RA5)	61 /357 (17.1%)	146 /1099 (13.3%)	
Mean age at baseline (SD) [years]	*n=356*	*n=1092*	
	57.2 (16.4)	57.2 (36.7)	0.98
Sex (n,%)			
Male	153 /356 (43.0%)	409 /1092 (37.5%)	0.17
Female	203 /356 (57.0%)	683 /1092 (62.6%)	
Ethnicity (n,%)			
Aboriginal and/or Torres Strait Islander	331 /356 (93.0%)	996 /1089 (91.5%)	0.40
Non-Indigenous	25 /356 (7.0%)	93 /1089 (8.5%)	
Mean body mass index (BMI; kg/m2) (SD)	*n=312* 31.8 (11.8)	*n=951* 32.4 (24.4)	0.43
BMI<25 kg/m2 (n,%)	61 /312 (19.5%)	180 /951 (18.9%)	0.83
Pensioner/concessional (n,%)	294 /356 (82.6%)	908 /1092 (83.2%)	0.90
CTG scripts eligible (n,%)	267 /356 (75.0%)	792 /1092 (72.5%)	0.65
Engaged in Health Care Home (HCH) program (n,%)	38 /357 (10.6%)	106 /1099 (9.7%)	0.68
Number of medications per participant# a	*n=283*	*n=820*	
Mean (SD)	7.2 (8.2)	7.3 (10.6)	0.88
Median (IQR)	7.0 (5-9)	7.0 (5-9)	
Prior medication review (MBS item 900) b	41 /357 (11.5%)	108 /1099 (9.8%)	0.61
Doctors' encounters prior to enrolment (per 12 months) c	*n=335*	*n=1001*	
Mean (SD)	8.6 (8.2)	7.1 (19.6)	**<0.01**
Median (IQR)	7 (1-11)	5 (3-9)	
Mean number of medication 'adherent days' (SD)d	*n=283*	*n=820*	
	6.0 (3.9)	6.2 (4.9)	0.33
Self-assessed health status (SF1) (n,%) # e			
Excellent	11 /247 (4.5%)	31 /728 (4.3%)	
Very good	34 /247 (13.8%)	99 /728 (13.6%)	
Good	105 /247 (42.5%)	309 /728 (42.5%)	0.96
Fair	64 /247 (25.9%)	212 /728 (29.1%)	
Poor	30 /247 (12.2%)	59 /728 (8.1%)	
Very poor	3 /247 (1.2%)	18 /728 (2.5%)	
Recorded clinical diagnoses (n,%): #			
Diabetes mellitus			
Type 1	1 /357 (0.3%)	10 /1099 (0.9%)	0.23

Type 2	221 /357 (61.9%)	665 /1099 (60.5%)	0.64
Hypertension	219 /357 (61.3%)	712 /1099 (64.8%)	0.24
Dyslipidaemia	191 /357 (53.5%)	539 /1099 (49.0%)	0.14
Patients with established or existing CVD^	117 /357 (32.8%)	343 /1099 (31.2%)	0.67
Coronary heart disease	100 /357 (28.0%)	292 /1099 (26.6%)	0.68
Peripheral vascular disease	11 /357 (3.1%)	32 /1099 (2.9%)	0.85
Cerebrovascular disease (stroke)	13 /357 (3.6%)	54 /1099 (4.9%)	0.44
Chronic kidney disease	127 /357 (35.6%)	437 /1099 (39.8%)	0.40
Patients with a clinically high risk of CVD [f]	73 /203 (36.0%)	229 /650 (35.2%)	0.86
Patients with a diagnosis of rheumatic heart disease (RHD) or acute rheumatic fever (ARF)	8 /357 (2.2%)	34 /1099 (3.1%)	0.24
Chronic obstructive pulmonary disease (COPD)	33 /357 (9.2%)	82 /1099 (7.5%)	0.34
Depressive disorder	21 /357 (5.9%)	56 /1099 (5.1%)	0.53
Mean BP >= 140/90* [mmHg] (n,%)	21 /267 (7.9%)	79 /744 (10.6%)	0.39
Dyslipidaemia[g] (n,%)*	231 /261 (88.5%)	721 /769 (93.8%)	0.16
Patients with comorbidity (1 or more chronic diseases) [#]	312 /357 (87.4%)	966 /1099 (87.9%)	0.79
Patients with multi-morbidity (2 or more chronic diseases) [#]	271 /357 (75.9%)	858 /1099 (78.1%)	0.31
Number of chronic diseases:	*n=357*	*n=1099*	
Mean (SD)	2.2 (0.1)	2.3 (0.1)	0.11
Median (IQR)	2.0 (2-3)	2.0 (2-3)	
Biomedical parameters (n,%): [##]			
Type 2 with HbA1c >8% or >65mmol/mol	77 /166 (46.4%)	208 /489 (42.5%)	0.27
Type 2 with HbA1c >7% or >54 mmol/mol	107 /166 (64.5%)	313 /489 (64.0%)	0.84
Patients with albuminuria [h]	102 /168 (60.7%)	358 /617 (58.0%)	0.52
Participants with eGFR recorded [i] (n,%)			
eGFR ≥90 (Stage 1)	43 /278 (15.5%)	130 /877 (14.8%)	
eGFR ≥60<90 (Stage 2)	94 /278 (33.8%)	339 /877 (38.7%)	
eGFR ≥45<60 (Stage 3a)	30 /278 (10.8%)	79 /877 (9.0%)	0.50
eGFR ≥30<45 (Stage 3b)	15 /278 (5.4%)	50 /877 (5.7%)	
eGFR ≥15<30 (Stage 4)	15 /278 (5.4%)	27 /877 (3.1%)	
eGFR <15 (Stage 5)	81 /278 (29.1%)	252 /877 (28.7%)	

Bold p-value implies statistically significant change at the 0.05 level. Cluster adjusted p-value for ACCHS and patients. P-values were determined using the . svy linearized : logit Stata command (proportions) and using the cluster-adjusted SD from the . svy linearized : mean Stata command (means).

Note: The study was not powered to detect differences between MAI assessed and non-MAI assessed participants. Comparisons between these groups have only been made for participant characteristics at baseline.

BMI= body mass index; BP= blood pressure; CTG= Close the Gap prescriptions (for Aboriginal peoples and Torres Strait Islanders) to waive or reduce the Pharmaceutical Benefits Scheme (PBS) patient contribution (co-payment). CVD= cardiovascular disease. MBS= Medicare Benefits Schedule.

SD = standard deviation (cluster adjusted).

IQR = inter-quartile range

*Refers to the mean of variables measured in the 12 months prior to patient enrolment into the study.

[#] Sourced from the pharmacist's logbook.

[##] Biomedical results were sourced from GRHANITE

^ CVD= cardiovascular disease: It refers to any of the following: coronary heart disease, cerebrovascular disease, and peripheral vascular disease.

[a] Denominator sourced from logbook data entered by pharmacists when reporting medication adherence, to source comparative data on non-MAI participants.

[b] Prior MBS claim was measured for the 12-month period prior to participant enrolment.

[c] Medicare GP consultation claim items: vocational registration: 3, 23, 36, 44. Non-vocational registration: 52, 53, 54, 57.

[d] A self-reported single-item question ('How many days in the last week have you taken this medication?') exploring the extent of non-adherence, assessed as a mean score for all medications. An 'adherent day' was defined as not missing any doses of prescribed medicines on that day. Pharmacists recorded the number of adherent days for each medication the patient was taking.

[e] Derived from the first question of the Short Form (SF)-36 health related quality of life instrument that asks: '*In general, would you say your health is excellent, very good, good, fair, poor, or very poor?*'

[f] Patients with any of the following: diabetes mellitus and age >60 years, diabetes mellitus and microalbuminuria (urinary ACR >2.5 mg/mmol for males and >3.5 mg/mmol for females), estimated glomerular filtration rate <45 mL/min per 1.73 m2, systolic blood pressure (BP) ≥180 mm Hg, diastolic BP ≥110 mm Hg, and total cholesterol >7.5 mmol/L.

[g] Dyslipidaemia = Dyslipidaemia is defined by one or more of the following: Low Density Lipoprotein (LDL) >=3.5mmol/L; Total cholesterol (TC) >= 5.5mmol/L; Triglycerides (TG) > =2.0mmol/L; High density lipoprotein (HDL) < 1.0 mmol/L for men and <1.3 mmol/L for women. Data was sourced from GRHANITE information.

[h] Albumin:creatinine ratio >2.5 mg/mmol for males and >3.5mg/mmol for females. Data was sourced from GRHANITE information.

[i] Estimated glomerular filtration rate (eGFR). eGFR reference range: Normal or Stage 1: CKD >89, Stage 2: 60-89 Stage 3A: 45-59, Stage 3B: 30-44, Stage 4: 15-29, Stage 5:<15. (Units in ml/min/1.73m2). Data was sourced from GRHANITE information.

Table 5: Medication Appropriateness Index (MAI) results for IPAC participants who were assessed at both baseline (first assessment after enrolment) and final (end of the study) assessments (n=357).

MAI based outcome measures	MAI assessed patients (n=357)		P-value
	At baseline	At end of study	
Time from patient enrolment to baseline MAI			
Mean time (days), (SD)	21.9 (95.8)		
Range (days)	0-189		
Median time (days), (IQR)	0 (0-29.3		
Number of participants with MAI assessed >100 days since enrolment, N (%)	23 (6.4%)		
Time from baseline MAI to end of study MAI			
Mean time (days), (SD)		268.2 (298.5)	
Range (days)		61-446	
Median time (days), (IQR)		270 (218-316)	
Number of participants with MAI assessed >100 days since baseline assessment, N (%)		356 (99.7%)	
Time taken to complete:			
Mean time (mins) to complete MAI (SD)	67.2 (63.9)	77.2 (127)	0.101
Median time (mins) to complete MAI (IQR)	60 (45-75)	60 (45-90)	
Number of medications:			
Total number of medications	2804	2963	
Mean number of medications/participant (SD)	7.8 (18.5)	8.3 (29.4)	0.147
Appropriate prescribing:			
Mean number of medications/participant rated appropriate (MAI score =0), (SEM)	6.04 (7.4)	7.30 (9.4)	**<0.001**
Number of medications rated appropriate (MAI score =0) (n,%)	2157/2804 (76.9%)	2606/2963 (88.0%)	**0.001[#]**
Number of participants with medications rated appropriate (MAI score =0 for all prescribed medications, %)	115/357 (32.2%)	198/357 (55.5%)	**<0.001~**
Inappropriate prescribing:			
Mean 'MAI score/participant' (SD)[a]	6.02 (23.6)	3.20 (11.7)	**0.003**
Mean 'MAI score/medication' (SD)[b]	0.76 (8.5)	0.39 (4.4)	**0.004**
Mean number of medications/participant with ≥ 1 inappropriate rating (any C-rating for any medication), (SD)	1.8 (5.3)	1.0 (3.6)	**0.001**
Number of medications with ≥ 1 inappropriate rating (at least one C-rating in any MAI question) (n,%)	647/2804 (23.1%)	357/2963 (12.1%)	**0.008[#]**

Number of participants with at least one inappropriate medication rating (C-rating for any prescribed medication, %)	242/357 (67.8%)	159/357 (44.5%)	**<0.001~**
Overuse of medicines*:			
Number of *participants* with any medication that met:			
≥ 1 overuse criteria	132/357 (37.0%)	87/357 (24.4%)	**<0.001~**
≥ 2 overuse criteria	30/357 (8.4%)	10/357 (2.8%)	**0.001~**
all 3 overuse criteria	3/357 (0.8%)	0/357 (0.0%)	-
Number of *medications* that met:			
≥ 1 overuse criteria	249/2804 (8.9%)	147/2963 (5.0%)	**0.017#**
all 3 overuse criteria	8/2804 (0.3%)	3/2963 (0.1%)	**0.005#**
Mean number of *medications/participant* with ≥ 1 overuse criteria (SD)	0.70 (2.3)	0.41 (2.1)	**0.016**

C-rating refers any MAI criterion that pharmacists rated as 'inappropriate'. Bold p-value implies statistically significant change at the 0.05 level.

P-values (paired data) were derived from the cluster-adjusted confidence interval (ACCHS cluster) as this is equivalent to a paired t-test.

[#] P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired).

[~] P-value, cluster adjusted p-value (ACCHS cluster) that were determined using the . svy linearized : clogit Stata command (paired data).

SD = SD, cluster adjusted standard deviation (ACCHS cluster)

IQR = inter-quartile range.

^Denominator is the number of all medications.

[a] The MAI is scored per drug (across the 10 Q's) for each patient and then summed for that patient. The summated MAI score was then divided by the number of participants for the *mean MAI score per participant*. Only a C-rating gives a weighted score.

[b] The 'summated MAI score' was divided by the total number of medications that were MAI assessed. Only a C-rating gives a weighted score.

*Overuse means 'unnecessary' medications: a 'C-rating' to at least one medication the patient was taking for ANY of the 3 overuse MAI questions (Q1, 2, 8).

Table 6: Clinical examples of medication inappropriateness given by IPAC pharmacists, according to the ten individual Medication Appropriateness Index (MAI) criteria.

Medication appropriateness index (MAI) indicators	Medication	Example of inappropriate rating
Q1: Drug not indicated	*Aspirin*	No clinical history or evidence of cardiovascular disease
	Omeprazole	No clinical history of gastro-oesophageal reflux disease or dyspepsia
	Salbutamol	No clinical history of asthma or chronic obstructive pulmonary disease nor dyspnoea
	Exenatide	No clinical history of diabetes. Using medication for weight-loss in polycystic ovarian syndrome.
Q2: Medication is ineffective for the condition	*Methenamine hippurate*	Limited evidence for use in recurrent urinary tract infections
	Tramadol	Opioids are not recommended for osteoarthritis and neither paracetamol nor non-steroidal anti-inflammatory drugs were in use despite ongoing pain
Q3: Dosage incorrect	*Metformin*	Dose too high given current estimated glomerular filtration rate
	Atorvastatin	Dose too low and not meeting targets for optimal serum lipid levels
	Pregabalin	The planned down-titration has not occurred
Q4: Directions incorrect	*Tiotropium*	Directions from respiratory physician was to use 'as required'. Tiotropium requires once-daily inhalations and is not to be used as a rescue medication.
	Diclofenac	Directions were for one tablet twice daily plus 'as required'. Patient may use as often as needed which may exceed the maximal daily dose.
	Combined oxycodone and naloxone hydrochloride in a controlled -release formulation	Directions were for 'as required' use for pain control. Controlled-release opioid medication is unsuitable for use 'as required' because the time to onset of action is too slow.
Q5: Directions Impractical	*Atorvastatin*	Prescribed for night-time dose but the patient's preference is for all medications to be taken in the morning.
	Metformin	Dosage specified as twice-daily for a patient with memory loss from an accidental brain injury. Can be simplified to once-daily to aid patient adherence.
Q6: Significant drug-drug interactions	*Allopurinol*	Interaction present with perindopril which increases the risk of blood dyscrasias.
	Celecoxib	A 'triple whammy' effect may occur with the combination of frusemide, celecoxib and perindopril (concurrent use of a diuretic, angiotensin converting-enzyme inhibitor and an anti-inflammatory agent) to precipitate acute kidney injury.
	Tramadol	Tramadol being used with dothiepin and amitriptyline which increases the risk of serotonin syndrome
Q7: Significant drug-disease interactions	*Omeprazole*	Patient has osteoporosis. Omeprazole may reduce bone density and increase bone fracture risk.
	Diclofenac	Patient is at high risk of a cardiovascular event with a history of angina and hypertension and this medication may further increase risk.

Q8: Unnecessary duplication of drugs	*Paracetamol*	Prescription duplicates paracetamol 665mg tablets that were already prescribed at maximal daily dose.
	Prazosin	Patient is also taking tamsulosin in a combination product used for benign prostatic hypertrophy, hence the use of prazosin is unnecessary. Concurrent use of two different alpha-receptor blockers increases the risk of postural hypotension and falls.
	Amitriptyline	Prescription is unnecessary as the patient was already prescribed nitrazepam, desvenlafaxine and pregabalin.
Q9: Unacceptable therapy duration	*Rabeprazole*	Medication for gastroprotection should have been stopped when ibuprofen ceased.
	Clopidogrel	Clopidogrel was inadvertently continued beyond the planned cessation date.
Q10: Most expensive drug	*Macrogol laxative*	Not listed on the PBS, could change to a listed laxative
	Mirabegron	Not listed on the PBS, but other alternatives are listed for urge incontinence.

PBS= Pharmaceutical Benefits Scheme

Table 7: Medication Appropriateness Index (MAI) results for participants in this assessment (n=357) at baseline (first assessment after enrolment) compared with final assessment. Presented are the ten individual MAI criteria and the proportion of medications with ≥ 1 inappropriateness rating (C-rating).

Medication appropriateness index (MAI) questions	Number of medications with a C-rating (inappropriate)*		Difference (%)	P-value
	N(%)	N(%)		
	At baseline	At end of study		
Q1: Drug not indicated	156/2804 (5.6%)	97/2963 (3.3%)	-2.29%	**0.033**
Q2: Medication is ineffective for the condition	103/2804 (3.7%)	51/2963 (1.7%)	-1.95%	**0.010**
Q3: Dosage incorrect	194/2804 (7.0%)	92/2963 (3.1%)	-3.81%	**< 0.001**
Q4: Directions incorrect	88/2804 (3.1%)	65/2963 (2.2%)	-0.94%	0.107
Q5: Directions Impractical	89/2804 (3.2%)	16/2963 (0.5%)	-2.63%	**0.001**
Q6: Significant drug-drug interactions	144/2804 (5.1%)	58/2963 (2.0%)	-3.18%	0.059
Q7: Significant drug-disease interactions	72/2804 (2.6%)	38/2963 (1.3%)	-1.29%	**0.008**
Q8: Unnecessary duplication of drugs	83/2804 (3.0%)	46/2963 (1.6%)	-1.41%	0.066
Q9: Unacceptable therapy duration	164/2804 (5.9%)	98/2963 (3.3%)	-2.54%	**0.029**
Q10: Most expensive drug	41/2804 (1.5%)	33/2963 (1.1%)	-0.35%	0.447

Bold p-value implies statistically significant change at the 0.05 level.

P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired).

C-rating refers any MAI criterion that pharmacists rated as 'inappropriate'.

*Column cannot be summated. Each medicine may have an inappropriate rating in several MAI criteria. The total number of medicines with a C-rating are given for each MAI-criterion. The denominator is all medicines.

P-value was determined using Fisher's exact test. Results are cluster adjusted.

Table 8: Medication Appropriateness Index (MAI) results for participants in this assessment (n=357) at baseline (first assessment after enrolment) compared with final assessment. Presented are the ten individual MAI criteria and the proportion of medications with a Z-rating.

Medication appropriateness index (MAI) questions	Number of medications with a Z-rating*		Change (%)	P-value
	N (%)	**N (%)**		
	At baseline	**At end of study**		
Q1: Drug not indicated	18/2804 (0.6%)	10/2963 (0.3%)	-0.30	0.253
Q2: Medication is ineffective for the condition	58/2804 (2.1%)	30/2963 (1.0%)	-1.06	0.142
Q3: Dosage incorrect	63/2804 (2.3%)	46/2963 (1.6%)	-0.69	0.579
Q4: Directions incorrect	13/2804 (0.5%)	10/2963 (0.3%)	-0.13	0.611
Q5: Directions Impractical	6/2804 (0.2%)	4/2963 (0.1%)	-0.08	0.511
Q6: Significant drug-drug interactions	19/2804 (0.7%)	10/2963 (0.3%)	-0.34	0.610
Q7: Significant drug-disease interactions	36/2804 (1.3%)	20/2963 (0.7%)	-0.61	0.543
Q8: Unnecessary duplication of drugs	446/2804 (15.9%)	294/2963 (9.9%)	-5.98	0.600
Q9: Unacceptable therapy duration	40/2804 (1.4%)	37/2963 (1.3%)	-0.18	0.832
Q10: Most expensive drug	53/2804 (1.9%)	11/2963 (0.4%)	-1.52	**< 0.001**

Bold p-value implies statistically significant change at the 0.05 level.

P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired).

Z-rating refers to any MAI criterion that pharmacists rated as 'unknown'.

*Column cannot be summated. Each medicine may have a Z-rating in several MAI criteria. The total number of medicines with a Z-rating are given for each MAI-criterion. The denominator is all medicines. P-value was determined using Fisher's exact test.

Table 9: Type of medications prescribed for participants assessed with the Medication Appropriateness Index (MAI) at both baseline and final assessments (n=357).

Medication type	Number of medications at baseline (%) (n=2804)	Number of medications at final assessment (%) (n=2963)	Difference (%)	p-value
Cardiovascular [a]	1014/2804 (36.2 %)	1056/2963 (35.6%)	-0.52	0.487
Hypertension [b]	430/2804 (15.3 %)	483/2963 (16.3%)	0.97	0.058
Dyslipidaemia	294/2804 (10.5 %)	302/2963 (10.2%)	-0.29	0.395
Blood and electrolytes [c]	342/2804 (12.2 %)	379/2963 (12.8%)	0.59	0.333
Endocrine [d]	593/2804 (21.2 %)	615/2963 (20.8%)	-0.39	0.475
Diabetes	482/2804 (17.2 %)	506/2963 (17.1%)	-0.11	0.775
Gastrointestinal [e]	152/2804 (5.4 %)	147/2963 (5.0%)	-0.46	0.085
Dyspepsia	125/2804 (4.5 %)	114/2963 (3.9%)	-0.61	**0.011**
Genitourinary [f]	35/2804 (1.3 %)	36/2963 (1.2%)	-0.03	0.911
Musculoskeletal [g]	62/2804 (2.2 %)	80/2963 (2.7%)	0.49	0.255
Neurological [h]	36/2804 (1.3 %)	36/2963 (1.2%)	-0.07	0.786
Respiratory [i]	235/2804 (8.4 %)	277/2963 (9.4%)	0.97	0.111
Asthma and COPD	225/2804 (8.0 %)	269/2963 (9.1%)	1.05	0.069
Psychotropic [j]	127/2804 (4.5 %)	133/2963 (4.5%)	-0.04	0.891
Anti-infectives [k]	27/2804 (1.0 %)	22/2963 (0.7%)	-0.22	0.134
Analgesics [l]	128/2804 (4.6 %)	123/2963 (4.2%)	-0.41	0.372

Bold p-value implies statistically significant change at the 0.05 level.

P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired).

COPD=chronic obstructive pulmonary disease

Medications include those used for the following conditions:

[a] heart failure, angina, hypertension, arrhythmia, dyslipidaemia, pulmonary hypertension, other.

[b] angiotensin converting enzyme inhibitors (ACEI), sartans, calcium-channel blockers, beta blockers, thiazide diuretics, other.

[c] anaemia, anticoagulants, antiplatelets, electrolyte imbalance, thrombolytics, other.

[d] adrenal insufficiency, bone, diabetes, thyroid disorders, other.

[e] antiemetics, diarrhoea, dyspepsia, motility disorders, laxatives, inflammatory bowel disease, other.

[f] benign prostatic hyperplasia and prostatitis; kidney stones; urinary tract disorders, other.

[g] gout, osteoarthritis, rheumatoid arthritis, other.

[h] Alzheimer's, epilepsy, migraine, multiple sclerosis, myasthenia gravis, parkinsonism, other.

[i] asthma and chronic obstructive pulmonary disease, cough, other.

[j] antidepressants, antipsychotics, anxiety and sleep disorders; alcohol dependence; bipolar disorder, nicotine dependence, opioid dependence, other)

[k] antibacterial, antifungal, antiviral, antiretroviral, antiprotozoal, antihelmintic, other.

[l] non-opioid, opioid, other.

The table excludes medications for the following conditions as few participants were prescribed these medications: dermatological; ear, nose and throat; eye; immunomodulators and neoplastics, allergy and anaphylaxis; vaccines.

Table 10: Medications with ≥ 1 inappropriate rating* prescribed for participants as a proportion of all medications rated as such, assessed with the medication appropriateness index (MAI) at both baseline and final assessments (n=357).

Medication type	Number of medications with an inappropriateness rating at baseline (%) (n=647)	Number of medications with an inappropriateness rating at final assessment (%) (n=357)	Difference (%)	p-value
Cardiovascular [a]	164/647 (25.4 %)	77/357 (21.6 %)	-3.78	0.378
Hypertension [b]	52/647 (8.0 %)	31/357 (8.7 %)	0.65	0.828
Dyslipidaemia	57/647 (8.8 %)	22/357 (6.2 %)	-2.65	0.206
Blood and electrolytes [c]	92/647 (14.2 %)	56/357 (15.7 %)	1.47	0.433
Endocrine [d]	136/647 (21.0 %)	64/357 (17.9 %)	-3.09	0.341
Diabetes	104/647 (16.1 %)	44/357 (12.3 %)	-3.75	0.184
Gastrointestinal [e]	54/647 (8.4 %)	39/357 (10.9 %)	2.58	0.271
Dyspepsia	49/647 (7.6 %)	31/357 (8.7 %)	1.11	0.553
Genitourinary [f]	12/647 (1.9 %)	5/357 (1.4 %)	-0.45	0.468
Musculoskeletal [g]	28/647 (4.3 %)	19/357 (5.3 %)	0.99	0.497
Neurological [h]	13/647 (2.0 %)	7/357 (2.0 %)	-0.05	0.971
Respiratory [i]	49/647 (7.6 %)	31/357 (8.7 %)	1.11	0.667
Asthma and COPD	45/647 (7.0 %)	29/357 (8.1 %)	1.17	0.644
Psychotropic [j]	41/647 (6.3 %)	30/357 (8.4 %)	2.07	0.259
Anti-infectives [k]	4/647 (0.6 %)	3/357 (0.8 %)	0.22	0.731
Analgesics [l]	38/647 (5.9 %)	22/357 (6.2 %)	0.29	0.856

P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired). COPD=chronic obstructive pulmonary disease. *A medication with an inappropriateness rating is a medication with at least one 'C-rating' using the Medication Appropriateness Index (MAI).
Medications include those used for the following conditions:
[a] heart failure, angina, hypertension, arrhythmia, dyslipidaemia, pulmonary hypertension, other.
[b] angiotensin converting enzyme inhibitors (ACEI), sartans, calcium-channel blockers, beta blockers, thiazide diuretics, other.
[c] anaemia, anticoagulants, antiplatelets, electrolyte imbalance, thrombolytics, other.
[d] adrenal insufficiency, bone, diabetes, thyroid disorders, other.
[e] antiemetics, diarrhoea, dyspepsia, motility disorders, laxatives, inflammatory bowel disease, other.
[f] benign prostatic hyperplasia and prostatitis; kidney stones; urinary tract disorders, other.
[g] gout, osteoarthritis, rheumatoid arthritis, other.
[h] Alzheimer's, epilepsy, migraine, multiple sclerosis, myasthenia gravis, parkinsonism, other.
[i] asthma and chronic obstructive pulmonary disease, cough, other.
[j] antidepressants, antipsychotics, anxiety and sleep disorders; alcohol dependence; bipolar disorder, nicotine dependence, opioid dependence, other)
[k] antibacterial, antifungal, antiviral, antiretroviral, antiprotozoal, antihelmintic, other.
[l] non-opioid, opioid, other.
The table excludes medications for the following conditions as few participants were prescribed these medications:
dermatological; ear, nose and throat; eye; immunomodulators and neoplastics, allergy and anaphylaxis; vaccines.

Table 11. Medication type that was rated as inappropriate* as a proportion of medication type prescribed for participants ('per category') assessed with the Medication Appropriateness Index (MAI) at both baseline and final assessments (n=357).

Medication type	Number of medications with an inappropriateness rating per category at baseline (%)	Number of medications with an inappropriate rating per category at final assessment (%)	Difference (%)	p-value
Cardiovascular [a]	164/1014 (16.2 %)	77/1056 (7.3 %)	-8.88	**0.013**
Hypertension [b]	52/430 (12.1 %)	31/483 (6.4 %)	-5.67	0.175
Dyslipidaemia	57/294 (19.4 %)	22/302 (7.3 %)	-12.10	**0.008**
Blood and electrolytes [c]	92/342 (26.9 %)	56/379 (14.8 %)	-12.12	**0.012**
Endocrine [d]	136/593 (22.9 %)	64/615 (10.4 %)	-12.53	**0.002**
Diabetes	104/482 (21.6 %)	44/506 (8.7 %)	-12.88	**<0.001**
Gastrointestinal [e]	54/152 (35.5 %)	39/147 (26.5 %)	-9.00	0.152
Dyspepsia	49/125 (39.2 %)	31/114 (27.2 %)	-12.01	0.063
Genitourinary [f]	12/35 (34.3 %)	5/36 (13.9 %)	-20.40	**0.035**
Musculoskeletal [g]	28/62 (45.2 %)	19/80 (23.8 %)	-21.41	**0.005**
Neurological [h]	13/36 (36.1 %)	7/36 (19.4 %)	-16.67	0.226
Respiratory [i]	49/235 (20.9 %)	31/277 (11.2 %)	-9.66	0.102
Asthma and COPD	45/225 (20.0 %)	29/269 (10.8 %)	-9.22	0.130
Psychotropic [j]	41/127 (32.3 %)	30/133 (22.6 %)	-9.73	0.079
Anti-infectives [k]	4/27 (14.8 %)	3/22 (13.6 %)	-1.18	0.911
Analgesics [l]	38/128 (29.7 %)	22/123 (17. 9 %)	-11.80	0.051

Bold p-value implies statistically significant change at the 0.05 level. P-value, cluster adjusted p-value (ACCHS and patients cluster) that were determined using the . svy linearized : logit Stata command (data not paired).

COPD=chronic obstructive pulmonary disease

*A medication with an inappropriateness rating is a medication with at least one 'C-rating' using the Medication Appropriateness Index (MAI).

Medications include those used for the following conditions:

[a] heart failure, angina, hypertension, arrhythmia, dyslipidaemia, pulmonary hypertension, other.

[b] angiotensin converting enzyme inhibitors (ACEI), sartans, calcium-channel blockers, beta blockers, thiazide diuretics, other.

[c] anaemia, anticoagulants, antiplatelets, electrolyte imbalance, thrombolytics, other.

[d] adrenal insufficiency, bone, diabetes, thyroid disorders, other.

[e] antiemetics, diarrhoea, dyspepsia, motility disorders, laxatives, inflammatory bowel disease, other.

[f] benign prostatic hyperplasia and prostatitis; kidney stones; urinary tract disorders, other.

[g] gout, osteoarthritis, rheumatoid arthritis, other.

[h] Alzheimer's, epilepsy, migraine, multiple sclerosis, myasthenia gravis, parkinsonism, other.

[i] asthma and chronic obstructive pulmonary disease, cough, other.

[j] antidepressants, antipsychotics, anxiety and sleep disorders; alcohol dependence; bipolar disorder, nicotine dependence, opioid dependence, other)

[k] antibacterial, antifungal, antiviral, antiretroviral, antiprotozoal, antihelmintic, other.

[l] non-opioid, opioid, other.

The table excludes medications for the following conditions as few participants were prescribed these medications:

dermatological; ear, nose and throat; eye; immunomodulators and neoplastics, allergy and anaphylaxis; vaccines.

Table 12: Participants and the type of medications prescribed for them, as assessed using the Medication Appropriateness Index (MAI) at both baseline and final assessments (n=357).

Medication type	Number of participants at baseline (%) (n=357)	Number of participants at final assessment (%) (n=357)	Difference (%)	p-value
Cardiovascular [a]	324/357 (90.8 %)	325/357 (91.0 %)	0.28	0.794
Heart failure	41/357 (11.5 %)	47/357 (13.2 %)	1.68	0.186
Angina	58/357 (16.3 %)	65/357 (18.2 %)	1.96	0.209
Hypertension	262/357 (73.4 %)	275/357 (77.0 %)	3.64	**0.048**
ACE Inhibitors	180/357 (50.4 %)	188/357 (52.7 %)	2.24	0.312
Sartans	45/357 (12.6 %)	58/357 (16.3 %)	3.64	**0.014**
Calcium channel blockers	99/357 (27.7 %)	103/357 (28.9 %)	1.12	0.478
Beta blockers	51/357 (14.3 %)	69/357 (19.3 %)	5.04	**0.012**
Thiazide diuretics	28/357 (7.8 %)	34/357 (9.5 %)	1.68	0.190
Other antihypertensives	23/357 (6.4 %)	26/357 (7.3 %)	0.84	0.579
Arrhythmia	32/357 (9.0 %)	23/357 (6.4 %)	-2.52	0.068
Dyslipidaemia	257/357 (72.0 %)	266/357 (74.5 %)	2.52	0.143
Other (unspecified)	61/357 (17.1 %)	37/357 (10.4 %)	-6.72	**0.005**
Blood and electrolytes [b]	212/357 (59.4 %)	233/357 (65.3 %)	5.88	**0.006**
Anaemia	36/357 (10.1 %)	36/357 (10.1 %)	0.00	>0.999
Anticoagulants	34/357 (9.5 %)	36/357 (10.1 %)	0.56	0.650
Antiplatelets	149/357 (41.7 %)	163/357 (45.7 %)	3.92	0.060
Endocrine [c]	258/357 (72.3 %)	258/357 (72.3 %)	0.00	>0.999
Bones	48/357 (13.5 %)	51/357 (14.3 %)	0.84	0.589
Diabetes	218/357 (61.1 %)	219/357 (61.3 %)	0.28	0.789
Thyroid disorders	22/357 (6.2 %)	23/357 (6.4 %)	0.28	0.572
Other endocrine disorders	21/357 (5.9 %)	18/357 (5.0 %)	-0.84	0.510
Gastrointestinal [d]	134/357 (37.5 %)	116/357 (32.5 %)	-5.04	**0.009**
Dyspepsia	120/357 (33.6 %)	109/357 (30.5 %)	-3.08	0.082
Genitorurinary [e]	24/357 (6.7 %)	31/357 (8.7 %)	1.96	0.197
Musculoskeletal [f]	47/357 (13.2 %)	65/357 (18.2 %)	5.04	**0.009**
Gout	23/357 (6.4 %)	24/357 (6.7 %)	0.28	0.664
Neurological [g]	34/357 (9.5 %)	33/357 (9.2 %)	-0.28	0.856
Respiratory [h]	110/357 (30.8 %)	115/357 (32.2 %)	1.40	0.380
Asthma and COPD	104/357 (29.1 %)	110/357 (30.8 %)	1.68	0.265
Psychotropic [i]	88/357 (24.7 %)	93/357 (26.1 %)	1.40	0.366
Antidepressants	58/357 (16.3 %)	71/357 (19.9 %)	3.64	**0.014**
Nicotine dependence	8/357 (2.2 %)	5/357 (1.4 %)	-0.84	0.280
Anti-infectives [j]	21/357 (5.9 %)	18/357 (5.0 %)	-0.84	0.447
Analgesics [k]	95/357 (26.6 %)	94/357 (26.3 %)	-0.28	0.892
Non-opioid	85/357 (23.8 %)	83/357 (23.3 %)	-0.56	0.792
Opioid	22/357 (6.2 %)	23/357 (6.4 %)	0.28	0.810

Bold p-value implies statistically significant change at the 0.05 level. P-value was cluster adjusted (ACCHS cluster) and determined using the . svy linearized : clogit Stata command (paired data).

Participants were on multiple types of medications, so the number of participants receiving medication in subcategories does not total 100%.

COPD=chronic obstructive pulmonary disease

Medications include those used for the following conditions (not shown, all p>0.05 unless otherwise indicated):

[a] pulmonary hypertension.

[b] electrolyte imbalance, thrombolytics, other.

[c] adrenal insufficiency.

[d] antiemetics, diarrhoea, motility disorders, laxatives, inflammatory bowel disease, other gastrointestinal medications *(-1.40%, p<0.05*).

[e] benign prostatic hyperplasia and prostatitis; kidney stones; urinary tract disorders, other.

[f] osteoarthritis, rheumatoid arthritis, other.

[g] Alzheimer's, epilepsy, migraine, multiple sclerosis, myasthenia gravis, parkinsonism, other.

[h] cough, other.

[i] antipsychotics, anxiety and sleep disorders; alcohol dependence; bipolar disorder, opioid dependence, other.

[j] antibacterial, antifungal, antiviral, antiretroviral, antiprotozoal, antihelmintic, other.

[k] other.

The table excludes medications for the following conditions as few patients were prescribed these medications: dermatological; ear, nose and throat; eye; immunomodulators and neoplastics, allergy and anaphylaxis; vaccines.

Table 13: Participants prescribed medications with an inappropriateness rating,* according to the Medication Appropriateness Index (MAI) by medication type, at both baseline and final assessments (n=357).

Medication type	Number of participants at baseline (%) (n=357)	Number of participants at final assessment (%) (n=357)	Difference (%)	p-value
Cardiovascular [a]	117/357 (32.8 %)	46/357 (12.9 %)	-19.89	**<0.001**
Heart failure	12/357 (3.4 %)	4/357 (1.1 %)	-2.24	**0.047**
Angina	9/357 (2.5 %)	5/357 (1.4 %)	-1.12	0.288
Hypertension	43/357 (12.0 %)	24/357 (6.7 %)	-5.32	**0.010**
ACE Inhibitors	15/357 (4.2 %)	10/357 (2.8 %)	-1.40	0.314
Sartans	6/357 (1.7 %)	2/357 (0.6 %)	-1.12	0.142
Calcium channel blockers	9/357 (2.5 %)	3/357 (0.8 %)	-1.68	0.072
Beta blockers	9/357 (2.5 %)	10/357 (2.8 %)	0.28	0.796
Thiazide diuretics	5/357 (1.4 %)	2/357 (0.6 %)	-0.84	0.274
Other antihypertensives	7/357 (2.0 %)	3/357 (0.8 %)	-1.12	0.220
Arrhythmia	7/357 (2.0 %)	1/357 (0.3 %)	-1.68	0.073
Dyslipidaemia	54/357 (15.1 %)	19/357 (5.3 %)	-9.80	**<0.001**
Other (unspecified)	20/357 (5.6 %)	7/357 (2.0 %)	-3.64	**0.016**
Blood and electrolytes [b]	71/357 (19.9 %)	46/357 (12.9 %)	-7.00	**0.004**
Anaemia	10/357 (2.8 %)	3/357 (0.8 %)	-1.96	0.054
Anticoagulants	11/357 (3.1 %)	5/357 (1.4 %)	-1.68	0.083
Antiplatelets	35/357 (9.8 %)	26/357 (7.3 %)	-2.52	0.168
Endocrine [c]	91/357 (25.5 %)	51/357 (14.3 %)	-11.20	**<0.001**
Bones	14/357 (3.9 %)	11/357 (3.1 %)	-0.84	0.504
Diabetes	70/357 (19.6 %)	36/357 (10.1 %)	-9.52	**<0.001**
Thyroid disorders	3/357 (0.8 %)	4/357 (1.1 %)	0.28	0.654
Other endocrine disorders	10/357 (2.8 %)	3/357 (0.8 %)	-1.96	0.057
Gastrointestinal [d]	51/357 (14.3 %)	37/357 (10.4 %)	-3.92	0.051
Dyspepsia	46/357 (12.9 %)	30/357 (8.4 %)	-4.48	**0.020**
Genitorurinary [e]	9/357 (2.5 %)	4/357 (1.1 %)	-1.40	0.102
Musculoskeletal [f]	19/357 (5.3 %)	17/357 (4.8 %)	-0.56	0.666
Gout	9/357 (2.5 %)	3/357 (0.8 %)	-1.68	0.069
Neurological [g]	13/357 (3.6 %)	7/357 (2.0 %)	-1.68	0.133
Respiratory [h]	35/357 (9.8 %)	19/357 (5.3 %)	-4.48	**0.019**
Asthma and COPD	32/357 (9.0 %)	17/357 (4.8 %)	-4.20	**0.020**
Psychotropic [i]	33/357 (9.2 %)	21/357 (5.9 %)	-3.36	**0.031**
Antidepressants	16/357 (4.5 %)	12/357 (3.4 %)	-1.12	0.366
Nicotine dependence	2/357 (0.6 %)	1/357 (0.3 %)	-0.28	0.572
Anti-infectives [j]	4/357 (1.1 %)	3/357 (0.8 %)	-0.28	0.655
Analgesics [k]	26/357 (7.3 %)	17/357 (4.8 %)	-2.52	0.086
Non-opioid	19/357 (5.3 %)	9/357 (2.5 %)	-2.80	**0.035**
Opioid	10/357 (2.8 %)	10/357 (2.8 %)	0.00	>0.999

Bold p-value implies statistically significant change at the 0.05 level. P-value was cluster adjusted (ACCHS cluster) and determined using the . svy linearized : clogit Stata command (paired data).

Participants were on multiple types of medications, so the number of participants receiving medication in subcategories does not total 100%.

*A medication with an inappropriateness rating is a medication with at least one 'C-rating' from the Medication Appropriateness Index (MAI).

COPD=chronic obstructive pulmonary disease

Medications include those used for the following conditions (not shown, all p>0.05):

[a] pulmonary hypertension.

[b] electrolyte imbalance, thrombolytics, other.

[c] adrenal insufficiency.

[d] antiemetics, diarrhoea, motility disorders, laxatives, inflammatory bowel disease, other.

[e] benign prostatic hyperplasia and prostatitis; kidney stones; urinary tract disorders, other.

[f] osteoarthritis, rheumatoid arthritis, other.

[g] Alzheimer's, epilepsy, migraine, multiple sclerosis, myasthenia gravis, parkinsonism, other.

[h] cough, other.

[i] antipsychotics, anxiety and sleep disorders; alcohol dependence; bipolar disorder, opioid dependence, other.

[j] antibacterial, antifungal, antiviral, antiretroviral, antiprotozoal, antihelmintic, other.

[k] other.

The table excludes medications for the following conditions as few patients were prescribed these medications: dermatological; ear, nose and throat; eye; immunomodulators and neoplastics, allergy and anaphylaxis; vaccines.

Table 14: Inter-rater reliability of the Medication Appropriateness Index (MAI) as applied by two raters (pharmacists) to 6 patients with 31 medications (310 MAI questions).

MAI criterion	A	B	C	D
Drug not indicated	31	0	0	0
Drug ineffective	31	0	0	0
Incorrect dose	31	0	0	0
Incorrect directions	31	0	0	0
Impractical directions	31	0	0	0
Drug-drug interactions	27	0	4	0
Drug-disease interactions	31	0	0	0
Unnecessary duplication	31	0	0	0
Unacceptable duration	31	0	0	0
Cost most expensive	31	0	0	0
	31	0	0	0

'Criterion' refers to the MAI criterion. 'Fulfilled' refers to a C-rating for the criterion.

A = both raters agreed criterion not fulfilled; B = rater 1 scored criterion not fulfilled, rater 2 scored criterion as being fulfilled;

C = rater 1 scored criterion as fulfilled, rater 2 scored criterion as not fulfilled; D = both raters scored criterion as being fulfilled.

For example: If a drug was not indicated, this would generate a C-rating and would indicate that this criterion was fulfilled.

APPENDIX A: Medication Appropriateness Index: Examples for Pharmacist Training for the IPAC Project.
Source: Ms Megan Tremlett: Pharmaceutical Society of Australia

Medication Appropriateness Index (MAI) – Examples

Question	Example
1. **Is there an indication for the drug?** A= indicated B= marginally indicated C= not indicated Z= do not know	• Amlodipine is prescribed and hypertension is recorded in patient history =A • KCl prescribed to patient taking a diuretic without history of hypokalaemia =B • Olanzapine prescribed but schizophrenia and related psychoses or bipolar disorder not documented=C
2. **Is the medication effective for the condition?** A= effective B= marginally effective C= ineffective Z= do not know	• Pantoprazole prescribed for peptic ulcer disease =A • Amitriptyline for neuropathic pain =B (not indicated but accepted as effective) • Quinine sulfate prescribed for leg cramps =C
3. **Is the dosage correct?** A= correct B= marginally correct C= incorrect Z= do not know	• Warfarin 3mg daily for patient with AF and stable INR of 2.2 =A • Atorvastatin at highest end of usual dose range but cholesterol level remains elevated =B (dose is necessary but additional therapy is needed) • Digoxin 250mcg daily for elderly patient with CrCl 25ml/min =C+ (dose too high)
4. **Are the directions correct?** A= correct B= marginally correct C= incorrect Z= do not know	• Prednisolone 5mg m with food =A • Latanoprost eyedrops instil 1 drop into the eye at night =B (should specify which eye or both eyes) • KCl without directions regarding food =C
5. **Are the directions practical?** A= practical B= marginally practical C= impractical Z= do not know	• Amitriptyline 25mg tab 1 n =A • Directions given as 'mdu' =B • Ipratropium MDI 2 puffs q6h =C (qds more appropriate to fit waking hours rather than directing every 6 hours)
6. **Are there clinically significant drug-drug interactions?** A= insignificant B= marginally significant C= significant Z= do not know	• Metoprolol and rabeprazole =A • Metformin and esomeprazole =B (interaction documented but clinical significance not established) • Diltiazem and atorvastatin =C (diltiazem inhibits CYP3A4 metabolism of atorvastatin)

7. **Are there clinically significant drug-disease/condition interactions?** A= insignificant B= marginally significant C= significant Z= do not know	• Rivaroxaban in a patient with asthma =A (no interaction or precaution documented) • Atenolol in a patient with diabetes and no worsening of glycaemic control =B • Doxepin in an elderly patient with glaucoma =C (contraindicated)
8. **Is there unnecessary duplication with other drugs?** A= necessary B= marginally necessary C= unnecessary Z= do not know	• Regular indacaterol inhaler plus prn use of salbutamol MDI in patient with COPD =A (necessary duplication of beta agonists for therapeutic effect) • Combination of paracetamol 500mg & 665mg SR tabs not exceeding max total recommended daily dose =B • citalopram m plus fluvoxamine n =C (2 drugs from same SSRI class with resulting risk of serotonin overload)
9. **Is the duration of therapy acceptable?** A= acceptable B= marginally acceptable C= unacceptable Z= do not know	• Dual antiplatelet therapy with aspirin & clopidogrel for 6-12 months after insertion of drug-eluting stent =A • Long-term PPI use with occasional intermittent symptoms =B • Long term monotherapy with oral corticosteroid in patient with COPD =C (unfavorable risk:benefit ratio) *note that if the drug is not indicated, rating =C
10. **Is this drug the least expensive alternative compared to others of equal utility?** A= less expensive B= equally expensive C= more expensive Z= do not know	• Magmin tab =A (PBS-subsidised for Aboriginal and Torres Strait Islander patients, cheaper to patient than OTC magnesium supplement) • Ramipril 5mg tab =B (same cost to patient as perindopril 5mg tab, listed in CARPA as alternative option for heart failure) • FerroGrad C tab =C (non-PBS, >10% more expensive than Ferro-tab which is PBS-subsidised for Aboriginal and Torres Strait Islander patients) *note that if the drug is not indicated, rating =C

APPENDIX B. The IPAC Health Systems Assessment (HSA) form used with participating IPAC health services (n=18).

The IPAC140 Health System Assessment Form

Role	Name	Position within health service	Date	Section/s answered
Interviewer				
Interviewed Service representative				

Question	Section A: General and demographic characteristics of the IPAC participating service								
1	Service name:								
2	Street: Suburb/Town:		State:			Postcode:			
3	IPAC Project 'Go-to' contact person: *(name/phone/email)*								
4	Estimated total service population (not ABS)				%age Indigenous:				
5	Estimated total number of regular (active) clients				%age Indigenous:				
6	Total number of episodes of care (EOC) (Report if data is available from OSR- Online Services Reporting. *All contacts with the same client on the same day are counted as one episode of care.* Reported for the 12 month period in the most recent OSR)	Year (EOC data):		**Total**			**Indigenous**		

7	Service opening hours (indicate time in total hours. *E.g. 8 hours*)	Mon	Tue	Wed	Thu	Fri	Sat	Sun

8	Service on public holidays	Opened ☐ Closed ☐	
9	Does this service operate an appointment system?	Yes ☐ No ☐	
10	Does this service have the flexibility to accommodate any of the following?	☐ Drop-ins? ☐ Long/family consults? ☐ Seeing multiple providers in single visit?	
11	Average booking time to see preferred GP.	☐ Same day / ☐ 1-7 days / ☐ >7 days but <14 days / ☐ >14 days	
12	Average waiting time to see a GP in an emergency.	☐ ≤1 hour or ☐ >1 hour	
13	Does this health service provide transport support to clients?	Yes ☐ No ☐	
14	If question 13 is **Yes**, outline the reasons for transport support:	To collect medicines — ☐ To attend the clinic — ☐ To go to hospital or other health services — ☐ Other reasons — ☐ *Please specify:*	
15	Does this service use translators as required? *(either on the phone or on-site)*	☐ Yes (Telephone ☐ On-site ☐) No ☐	
16	Does this service offer separate men's and/or women's areas if needed?	Yes ☐ No ☐	
17	Does this service provide cultural orientation and training to new and existing staff?	To all staff ☐ To some staff ☐ (Please specify)	
18	Does this service also operate other clinics?	Yes ☐ No ☐	
19	Will/does the practice pharmacist provide services in separate IPAC site?	Yes ☐ *(If yes, please complete The IPAC Health System Assessment Form for each of the other sites)* No ☐	
20	Clinical Information System used in the service *(please specify version)*	Best Practice ☐ Version................. Communicare ☐ Version.................	

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Please return completed form to: erik.biros@jcu.edu.au

The IPAC140 Health System Assessment Form

Question	Section B: Staff characteristics of this service		
	Total Staff	**Head count #**	**Total Full time equivalent (FTE)***
21	All staff (clinical and non-clinical)		
22	All staff who are *Aboriginal and/or Torres Strait Islander*		
23	All administrative staff		
24	All administrative staff who are *Aboriginal and/or Torres Strait Islander*		
25	All doctors		
26	All doctors who are *Aboriginal and/or Torres Strait Islander*		
27	All registered nurse practitioners, remote area nurses, and/or Practice Nurses		
28	All registered nurse practitioners, remote area nurses, and/or Practice Nurses who are *Aboriginal and/or Torres Strait Islander.*		
29	All AHWs/practitioners–male		
30	All AHWs/practitioners- female		
31	Aboriginal/Torres Strait Islander hospital liaison officer		

*For example: If there are 8 doctors at the clinic and 4 of them work 1.0FTE each, and 4 work 0.5 FTE each, the total FTE is 4+ 2= 6 FTE

Question	Section C: Allied health staff employed by this service		
	Staff	**Head count #**	**Full time equivalent (FTE)**
32	Physiotherapist		
33	Dietitian		
34	Diabetes educator		
35	Respiratory educator		
36	Tobacco control officer / smoking cessation officer		
37	Exercise Physiologist		
38	Psychologist		
39	Social Worker		
40	Audiologist		
41	Optometrist		
42	Pharmacist		
43	Dentist		
44	Podiatrist		
45	Other –specify:		

Question	Allied health staff	Accessible at the clinic (onsite)	How often are clinic (onsite) sessions available?						If not accessible at the clinic- what is the average travel drive time for a patient to access the allied health staff?		
			daily	weekly	fortnightly	monthly	quarterly	irregularly	0-30 mins	31-60 mins	>61 mins
46	Physiotherapist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
47	Dietitian	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
48	Diabetes educator	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
49	Respiratory educator	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
50	Tobacco control officer,	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Section D: Rate the access to the listed allied health services within your local community

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	or smoking cessation officer										
51	Exercise Physiologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
52	Psychologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
53	Social Worker	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
54	Audiologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
55	Optometrist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
56	Pharmacist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
57	Dentist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
58	Podiatrist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
59	Other -specify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
60	Other -specify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Question	Specialist	Accessible at the clinic (onsite)	Section E: Rate the access to the listed specialist medical practitioner services within your local community						If not accessible at the clinic- what is the average travel drive time for a patient to access the specialist?		
			How often are clinic (onsite) sessions available?								
			daily	weekly	fortnightly	monthly	quarterly	irregularly	0-30 mins	31-60 mins	>61 mins
61	General Physician	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
62	Surgeon	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
63	Cardiologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
64	Nephrologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
65	Ophthalmologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
66	Rheumatologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
67	Paediatrician	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
68	Endocrinologist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
69	Psychiatrist	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
70	ENT surgeon	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
71	Other- specify:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Question	Section F: Community engagement by this service	
		Number
72	How many community pharmacies does this health service engage with?	
73	In the last 30 days, how many times has community pharmacy:	

a. telephoned this service?
☐ <1 time
☐ 1-2 times
☐ 3-5 times
☐ >5 times
☐ On-site pharmacy

b. emailed this service?
☐ <1 time
☐ 1-2 times
☐ 3-5 times
☐ >5 times
☐ On-site pharmacy

c. personally visited this service?
☐ <1 time
☐ 1-2 times
☐ 3-5 times
☐ >5 times
☐ On-site pharmacy

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74	How many hospitals does this health service regularly engage with?		
75	Does this health service have a partnership (or engagement) with community groups? *(Any of: schools, child care centres, sports centres, Councils, community organizations like Red Cross, etc.)*	Yes ☐	No ☐
76	If question 75 is **Yes**: are there clear mechanisms for healthcare providers to use these services to support patients? *(Choose a response from 1-10, <u>where 10 is 'routine or established mechanism' and 1 is 'minimal or absent'</u>).*		

Question	Section G: Other program engagement by this service		
77	Is this health service involved in any other research programs? **If yes**, please provide the name of the research project below:	Yes ☐	No ☐
78	If question 77 is **Yes**: What is the period of involvement in the research project? (MM/YY-MM/YY)		
79	Is this service engaged in any program supporting improvements in quality care indicators like nKPIs? (For example: Healthcare Homes). **If yes**, name the program/s below:	Yes ☐	No ☐

Please use the following scale to answer Section H and Section I:

1-2	3-4	5-6	7-8	9-10
Communication is rare (or has substantial difficulties) or never occurs	Communication is poor with significant difficulties	Communication is average and there are still several difficulties	Communication is generally good, but occasional difficulties exist	Communication is excellent and occurs through well-developed systems and/or relationships.

Question	Section H: How adequate is the quality of communication with the hospital system (*transitional care*) specialists and Primary Health Networks?	
	Communication	**Scale from 1 to 10**
80	Communication that a patient has been admitted	
81	Communication that a patient has attended outpatient services.	
82	Communication that a patient has been seen by a specialist.	
83	Communication that a patient has been discharged.	
84	Communication of the patient's discharge medication.	
85	Communication with specialists (as indicated in section E).	
86	Does this health service have a formal agreement with any Primary Health Networks? (*E.g. Memorandum of understanding, and/or other partnership agreement and/or financial contract, etc.*)	Yes ☐ No ☐
87	If question 86 is **Yes**, please rate the quality of communication:	

Question	Section I: How adequate is the quality of communication with community pharmacy?		
	Communication	**Scale from 1 to 10**	**Yes or No**
88	Communication with community pharmacy/s		
89	Communication with community pharmacists		
90	Is support provided to this clinic by community pharmacy?		☐ or ☐
91	If question 90 is **Yes**, what type of support is provided by community pharmacy to patients/staff of this health service? (*Please tick all appropriate.*)	Dose administration aids	☐
		Dispensing of medicines	☐
		Home medicines reviews	☐
		Response to queries about medications	☐

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		Educational sessions to staff within the clinic	☐
		Educational sessions to community groups/your patients	☐
		Home delivery of medicines to patients	☐
		Delivery of medicines to the clinic	☐
		Quality control of medicines stock onsite	☐
		Assistance with script collection	☐
		Other. *Please specify:*	☐

Question	Section J: Care Planning	
92	Is chronic disease 'care planning' a part of routine practice or ad hoc?	Routine ☐ Ad hoc ☐
93	Is 'care planning' done jointly with patients/families and healthcare providers?	Yes ☐ No ☐
94	Does 'care planning' incorporate self-management goals/strategies?	Yes ☐ No ☐

Question	Section K: *What systems does this health service have to support the clinical management of chronic disease?* For the following, choose a response from 1-10, <u>where 10 is 'routine or established' and 1 is 'minimal or absent'</u>.	Ranking 1-10
95	A chronic disease coordinator?	
96	Continuing quality improvement activities?	
97	An identified position to support quality improvement activities (ie a CQI lead)?	
98	External support for CQI (i.e. from State/Terr and/or national CQI support services)?	
99	A commitment to support CQI, from management?	
100	A commitment to support CQI, from staff?	
101	Professional development support for clinical management of chronic diseases?	
102	Training for staff in the prevention and clinical management of chronic diseases?	
103	Clients are identified for preventive and early detection activity (according to risk categories)?	
104	Specific educational support for the patient to be able to self-manage their chronic disease? (i.e. risk reduction, peer support, educational strategies and resources)	
105	Involvement of families in the provision of support to patients as part of routine practice (where appropriate)?	
106	Provision of brief interventions by staff? (smoking, alcohol, nutrition, physical activity)	
107	Chronic disease register? (i.e. to generate and use electronic lists of patients with chronic diseases from any source)	
108	Annual review of the chronic disease register? (I.e. to assess its currency).	
109	Use of chronic disease registers (from any source) for patient recall and reminders?	
110	Follow-up of patients as a routine, and in accordance with best practice?	
111	Follow-up of patients using community knowledge (staff and community) where appropriate?	
112	Routine use of 'patient feedback' surveys (to gauge patient satisfaction/experience with the service) so as to support quality improvement activities?	
113	Routine and systematic use of other methods to seek 'community feedback' on the quality of care? *(i.e. community review of 'performance information')*	
114	Registration of eligible patients to the PBS Co-payment scheme (i.e. CTG scripts)?	Yes ☐ No ☐ Not Applicable ☐
115	Onsite storage of medications?	Yes ☐ No ☐
116	Onsite quality control of medication stock?	Yes ☐ No ☐
117	Online patient request for repeat prescriptions?	Yes ☐ No ☐
118	Access to Section 100 for medicines? (i.e. dispensing of medicines onsite)	Yes ☐ No ☐

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		Not Applicable ☐		
119	If question 118 is **Yes** (to S100), in the last 6 months, how many times has community pharmacy made any contact with this service?	☐ 1-2 times	☐ 3-5 times	☐ >5 times
120	Home medicines review?	Yes ☐	No ☐	
121	If question 120 is **Yes**, how many referrals are made <u>per week</u> by this service?	☐ <2	☐ 2-5	☐ >5
122	Any Healthcare provider in the service who makes home visits?	Yes ☐	No ☐	
123	Medication adherence monitoring? *If yes, please explain:*	Yes ☐	No ☐	
124	Medication audits? *If yes, please explain:*	Yes ☐	No ☐	
125	Onsite pathology testing (such as 'point of care' testing)? (excludes co-located pathology services)	Yes ☐	No ☐	
126	If question 125 is **Yes**: Is participation part of QAAMS? *(Quality Assurance for Aboriginal and Torres Strait Islander Medical Services)*	Yes ☐	No ☐	
126a	**What is the name of the pathology service/s that your health service uses (for patient blood tests such as Hb A1c, lipids, ACR, or eGFR)? (If this is a hospital, please name the hospital).**			

Question	Section L: Which of the following resources are used by the service routinely?	
	Choose a response from 1-10, where 10 is 'routine or established use' and 1 is 'minimal or absent'	Ranking 1-10
127	Health Pathways (Qld and Vic)	
128	Map of Medicine (Vic)	
129	CARPA Standard Treatment Manual	
130	National Guide to a preventive health assessment for Aboriginal and Torres Strait Islander people (3rd ed.)	
131	CRANAplus Clinical Governance Guide, or other clinical governance protocols	
132	Medication related resources (e.g. Australian Medicines Handbook, Therapeutic guidelines, MIMs, etc.)	
133	Chronic Conditions Manual (Qld).	
134	Other system/guide. *Please indicate:*	

Question	Section M: Economic characteristics of the service	
135	Total budget of the health service (excluding capital works) (AUD).	
136	Estimated budget allocated for chronic diseases (AUD).	
137	Of the patients attending the service – what % are patients with chronic diseases? (from CIS or best estimate)	%
138	Of the patients with chronic disease, what % are HCC holders? (from CIS or best estimate)	%
139	Bulk-billing provided for HCC holders with chronic diseases.	Yes ☐ No ☐
140	Bulk-billing provided for non-HCC clients with chronic diseases.	Yes ☐ No ☐

Code for domains:
Domain 1: brown: **Delivery system design**
Domain 2: green: **Information systems and decision support**
Domain 3: blue: **Self-management support**
Domain 4: grey: **Links with community, other health services**
Domain 5: yellow: **Organisational influences and integration**

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