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A retrospective analysis of e-prescriptions for non-communicable diseases on a telehealth platform in Malaysia

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Abstract

Background The management of non-communicable diseases (NCDs) has benefited from telehealth services. As these services which include teleconsultation services and e-prescriptions are relatively new in Malaysia, the data generated provide an unprecedented opportunity to study medication use patterns for the management of NCDs in the country. We analyze e-prescriptions from a local telehealth service to identify medication use patterns and potential areas to optimize medication use in relation to clinical practice guidelines.

Methods A cross sectional observational study was conducted by retrieving e-prescription records retrospectively from a telehealth service. 739,482 records from January 2019 to December 2021 were extracted using a designated data collection form. Data cleaning, standardization and data analysis were performed using Python version 3.11. The diagnoses were classified according to the International Classification of Disease 10 (ICD-10), while medications were classified using the Anatomical Therapeutic Chemical (ATC) system. Diagnoses, frequency of use for medication classes and individual medications were analyzed and compared to clinical practice guidelines.

Results The top five NCD diagnoses utilized by the service were hypertension (37.7%), diabetes mellitus (25.1%), ischemic heart disease (24.3%), asthma (14.4%), and dyslipidemia (11.7%). Medications were prescribed mostly in accordance with guideline recommendations. However, angiotensin receptor blockers (ARBs) were significantly more frequently prescribed compared to angiotensin converting enzyme inhibitors (ACEIs). Several medication classes appeared underutilized, including ACEIs in hypertensive patients with diabetes or ischemic heart disease, sodium glucose cotransporter 2 inhibitors in diabetic patients with ischemic heart disease, and metformin in patients with diabetes.

Conclusions Telehealth services are currently being utilized for the management of NCDs. Medication use for the management of NCDs through these services are mostly in accordance with guideline recommendations, but there exist areas that would warrant further investigation to ensure optimal clinical and economic outcomes are achieved.

Keywords Telehealth, E-prescriptions, Non-communicable diseases, Community pharmacy

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Introduction

Non-communicable diseases (NCDs), also known as chronic diseases, result from a combination of genetic, environmental and behavioural factors and typically require lifelong management [1]. The most common NCDs include cardiovascular diseases, chronic respiratory diseases, and metabolic diseases such as diabetes, which are prevalent worldwide [2]. Taken together, these NCDs persist as an escalating clinical and economic burden on healthcare systems around the world due to their increased prevalence in ageing societies and their propensity, culminating in more serious and acute conditions that result in greater morbidity and mortality [3, 4]. Malaysia has been no exception to this phenomenon, as NCDs continue to see relatively high prevalence according to recent surveillance studies, and therefore continue to receive commensurate attention from healthcare workers and policymakers [5]. The chronic nature of NCDs necessitates that their medical management is approached holistically, including proper prescribing, routine follow up, good patient adherence, and corresponding lifestyle changes [6–8]. Proper evidence-based prescribing helps optimize both clinical outcomes and cost-effectiveness, thereby increasing the efficiency of the healthcare system as a whole, while routine follow-up ensures that prescribers can monitor and respond accordingly to the dynamic clinical status of the patient [9, 10]. However, consistent follow-up by patients suffering from NCDs remains a major challenge in many countries, with accessibility and cost being primary barriers. Patients might have difficulty accessing healthcare facilities due to long waiting times and transportation issues [11], while the healthcare costs such as consultation fees and medications might discourage some patients from seeking their regular medical care [12, 13].

In this regard, telehealth services provide an emerging avenue to improve accessibility to chronic medications of patients with NCDs. Telehealth services are defined as communication technologies that utilize data, audio, and video to connect healthcare professionals and patients over a distance, allowing the exchange of medical information [14]. Telehealth typically encompasses a wide range of services including real-time teleconsultations, remote patient monitoring, storage and forwarding of medical records, and electronic prescribing [14]. There are numerous potential benefits to improving adoption of telehealth services, including improving connectivity between healthcare professionals and patients [15], reducing overall healthcare costs [16], providing better assessments of patient's disease management at home [17], and preventing unnecessary exposure to infectious pathogens [18]. The use of telehealth services has seen increased growth over the past two decades, in tandem with improved technologies, increased internet

accessibility, and increased smartphone access [19]. In Malaysia, while adoption of telehealth services by all stakeholders had previously been slow, it has been accelerated by the Covid-19 pandemic which necessitated a transition towards telehealth to reduce transmission risk [20], as well as national-level initiatives such as the recently launched National Digital Economy Blueprint [21]. In particular, the equally robust private healthcare sector (where healthcare is funded out-of-pocket or by insurance) has seen numerous local health technology startups which have sought to fill a gap in the provision of healthcare services by leveraging digital infrastructure, offering services ranging from teleconsultations to e-prescriptions, the latter of which has been bolstered by new regulations defining the standards for e-prescription issuance [22].

The use of telehealth services and the corresponding e-prescribing allow insight into prescription patterns for NCDs and upon review could potentially improve prescribing practices, due to the large amounts of prescribing data generated through these services. The study of e-prescribing data in other countries with established systems has been common, allowing for convenient monitoring of guideline recommendations and identifying areas for improving prescribing for NCDs such as hypertension, diabetes, and dyslipidemia [23–25]. In contrast, previous studies including an analysis of prescribing patterns in Malaysia, such as the National Medical Care Survey, were comprehensive in nature and covered both the public and private sector but was extremely labour-intensive due to the use of manual prescriptions and records in most sampled healthcare institutions [26]. More recently, the use of electronic health insurance claims from primary care have also served as a proxy for prescribing data, but primarily involved the treatment of acute minor ailments rather than NCDs [27]. As such, the recent availability of electronic prescribing data from local telehealth services represents a unique opportunity to investigate recent prescribing patterns for NCDs in the country. Therefore, in this study, a retrospective analysis of e-prescriptions extracted from a telehealth services database was conducted. We analyzed the common NCDs managed through these services, identified prescribing trends for these NCDs, and compared these trends to recommendations from established clinical practice guidelines.

Materials and methods

Study design and setting

This study was a cross sectional study using data extracted retrospectively from a local health technology company that provided various telehealth services in community pharmacies, serving the private healthcare sector. Among the services offered include consultations

between patients and physicians, which are typically assisted by community pharmacists. These assisted consultations involve the pharmacists aiding users to consult qualified physicians through the telehealth platform by submitting relevant clinical information such as medical histories and updated clinical data including blood pressure and blood glucose readings measured at the pharmacy. Upon review, the physician may then choose to issue a corresponding e-prescription through the platform (i.e. approval) or reject the request and request for additional information, or require the patient to attend a physical consultation, following guidelines provided by the service provider which defines conditions that may be managed and medicines that may be prescribed (i.e. rejection). Any issued e-prescription may then be filled by the corresponding pharmacist assisting in the consultation. Due to the nature of this service, it is typically utilized for users (i.e. patients) with NCDs requiring continued supply of their chronic medications, where the patient's condition is stable and well-managed.

Data extraction and analysis

The prescribing data which is exclusively owned by the telehealth service provider was extracted and provided by the telehealth service provider in an anonymized format. To ensure confidentiality, the data provided was kept secure in a password-protected file and on approved devices that was only accessible to researchers directly involved in the data analysis. The data included assisted consultations for a period of 3 years between 1st January 2019 and 31st December 2021, which was analyzed from August 2023 to December 2023 at Taylor's University, Malaysia. The raw data extracted consisted of a unique ID for the assisted consultation (with no personal identifiable information), community pharmacy name, location, patient details such as gender, age, medical history, medication history, and current clinical data including blood pressure, random blood sugar, heart rate, diagnoses, and any associated e-prescription details, for example medications prescribed, dosage, route, frequency, duration and the supplied amount. A record represented a single request by the user for the service.

Data cleaning and analysis was performed using Python 3.11 with the Pandas, NumPy, and Matplotlib libraries [28, 29]. Both diagnoses, medical history, and medications included free text (i.e., prescribers were not restricted from using non-standard terminologies, abbreviations, or adding remarks), and therefore diagnoses were classified using the International Classification of Diseases (ICD-10) [30], while drugs were classified according to the Anatomical Therapeutic Chemical (ATC) classification system [31], where appropriate. The data were then analyzed and descriptive statistics were used to identify the five most common NCDs

diagnosed within the dataset. For these NCDs, both the most common medication classes and individual medications prescribed were then analyzed to identify prescribing trends, which were then also compared to current local clinical practice guidelines to identify potential areas where improvements in prescribing practices could be made.

Results

A total of 739,482 records involving 148,238 patients were extracted from the database. Each record consisted of a single assisted teleconsultation session, along with the relevant clinical data and associated e-prescription (if available), which itself could include multiple medications. After excluding records with a "Rejected" status, 542,668 e-prescriptions with an "Approved" status remained. In terms of demographics of the patients included in the records, the mean age of the telehealth users was 51 ± 21 years, which consisted primarily of adults aged between 18 and 59 years (66.5%), with a smaller proportion of older adults aged 60 years and above (29.3%) and adolescents aged between 13 and 17 years (4.2%). In terms of gender, the majority of patients were females (61.0%).

The top five most common diagnoses represented in the dataset and their prevalence are shown in Fig. 1, where hypertension, diabetes mellitus and ischemic heart disease were most prevalent. The remaining diagnoses comprised of 174 other conditions, which included both NCDs (such as gastro-esophageal reflux disease, cardiac arrhythmia, benign prostatic hyperplasia and dermatitis) and other minor ailments, with the vast majority of these diagnoses occurring at a frequency of below 3% (S1 Table).

The most common medication classes and individual medications prescribed for the top five diagnoses are shown in Figs. 2, 3, 4, 5 and 6, whereas the most common combination medications prescribed are shown in Table 1. For hypertension, the most common antihypertensives prescribed on an individual basis, in order of decreasing frequency, were calcium channel blockers (CCBs) ($n=26,036$, 35.3%), beta blockers ($n=11,521$, 15.6%), angiotensin II receptor blockers (ARBs) ($n=9240$, 12.5%), angiotensin converting enzyme inhibitors (ACEIs) ($n=6865$, 9.3%), and diuretics ($n=3357$, 4.5%) (Fig. 2). However, when also considering the components of single-pill combination medications which made up a significant proportion of prescriptions, CCBs were still the most frequently prescribed (48.8%), followed by ARBs (29.9%), beta blockers (15.5%), ACEIs (12.8%), and diuretics (11.7%).

In a similar manner, for diabetes mellitus, the most common oral glucose-lowering drugs (GLDs) prescribed on an individual basis were sodium-glucose

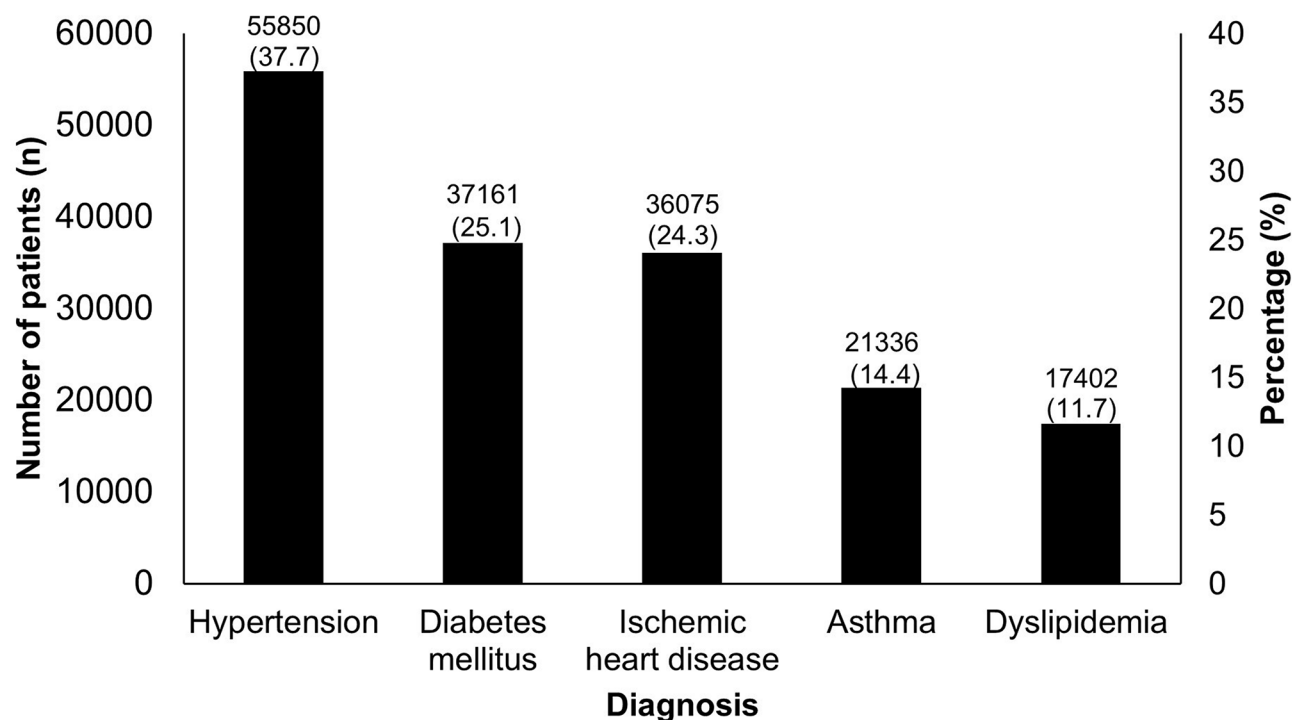


Fig. 1 Prevalence of top five non-communicable diseases for which e-prescriptions were issued through the telehealth service ($n = 148,238$). Multiple diagnoses were possible for a particular patient

co-transporter 2 (SGLT-2) inhibitors, metformin, sulfonylureas and dipeptidyl-peptidase 4 (DPP-4) inhibitors (Fig. 3). Only approximately 2% of prescriptions associated with a diagnosis of diabetes mellitus included insulins. Single-pill combinations were more frequently prescribed compared to antihypertensives, making up close to half of all GLD prescriptions. As almost all combinations prescribed included metformin, and when considering these combinations metformin became the most frequently prescribed GLD (56.4%), followed by DPP-4 inhibitors (47.1%), SGLT-2 inhibitors (28.9%), and sulfonylureas (13.9%). Injectable GLDs such as glucagon-like peptide 1 (GLP-1) receptor agonists were not significantly represented in the dataset.

Medications for ischemic heart disease overlapped significantly with those for hypertension, and therefore the remaining non-antihypertensives primarily consisted of antiplatelets (Fig. 4). For dyslipidemia, HMG-CoA reductase inhibitors (i.e., statins) were by far the most frequently prescribed medications both individually and in combination with other agents, making up 91.4% of all prescriptions, with the remaining consisting of individual prescriptions of fibrates and ezetimibe (Fig. 5). Lastly, for asthma, combination inhalers consisting of an inhaled corticosteroid (ICS) and a long-acting beta agonist (LABA) were much more frequently prescribed compared to other individual therapies, making up 72.9% of all prescriptions. Of these, combinations including

formoterol made up 58.9% of inhalers prescribed, while a combination of fluticasone and salmeterol accounted for the remainder. Of the individual therapies prescribed for asthma, ICS monotherapy and relievers such as salbutamol accounted for the majority of the prescriptions (Fig. 6).

We further analyzed the prescription trends for several diseases when patients had relevant co-morbidities that were factored into guideline recommendations (S2 Table). 12,503 prescriptions associated with patients with a diagnosis of hypertension also had a concurrent diagnosis or past medical history of diabetes mellitus. For these prescriptions, when considering combination therapies, most were prescribed CCBs ($n = 9001$, 45.0%), followed by ARBs ($n = 7394$, 37.0%), beta blockers ($n = 3690$, 18.4%), ACEIs ($n = 2524$, 13.6%), and diuretics ($n = 2240$, 11.2%). This is in accordance with the recommendations by current clinical practice guideline on hypertension [32]. A similar pattern was seen in the 19,004 prescriptions for patients with a diagnosis of hypertension and a concurrent diagnosis or past medical history of ischemic heart disease, with CCBs ($n = 14,231$, 52.2%), ARBs ($n = 7969$, 29.2%), beta blockers ($n = 5232$, 19.2%), and ACEIs ($n = 3547$, 13.0%) being the most prescribed medications. Lastly, there were 10,001 prescriptions associated with patients with a diagnosis of diabetes mellitus and a concurrent diagnosis or past medical history of ischemic heart disease. The GLDs primarily prescribed

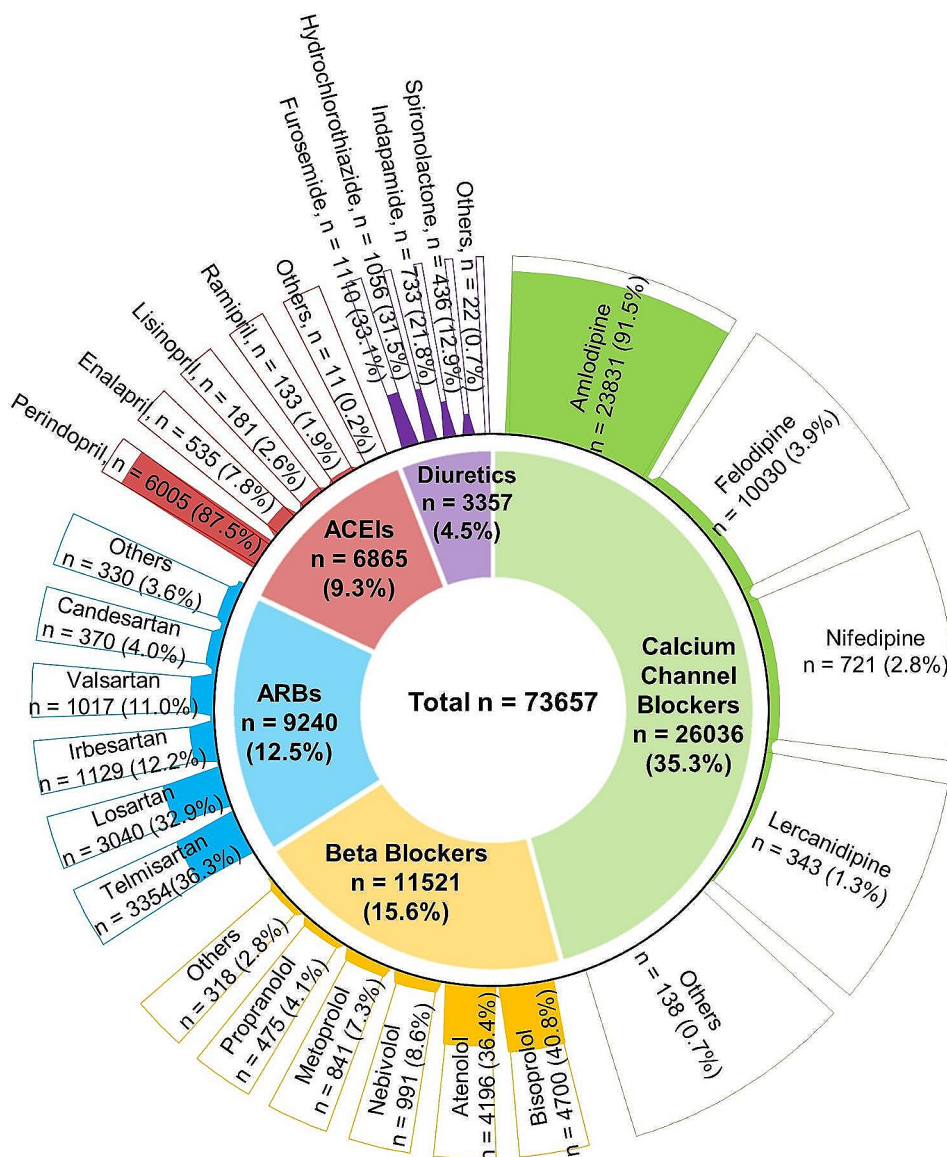


Fig. 2 The most common medication classes and individual medications prescribed for hypertension. ACEIs: Angiotensin-converting enzyme inhibitors; ARBs: Angiotensin receptor blockers

for these patients included metformin ($n=4191$, 54.9%), DPP-4 inhibitors ($n=3343$, 43.8%), SGLT-2 inhibitors ($n=2230$, 29.2%) and sulfonylureas ($n=1182$, 15.5%). Table 2 depicts the summary of the prescription patterns compared to recommendations from clinical practice guidelines.

Discussion

In this study, we have analyzed the most common diagnoses and corresponding medications prescribed from the utilization of an assisted teleconsultation service. While our results indicated that these services were used for a range of conditions including minor ailments, the vast majority of cases still involved common NCDs such as hypertension, diabetes mellitus, ischemic heart

disease, dyslipidemia, and asthma. Their relative frequencies were also consistent with the prevalence of NCDs reported in national surveillance studies [34]. These findings support the notion that in practice, teleconsultations services are suitable for the management of NCDs where patients’ conditions are stable and only require routine follow up with minor adjustments or continuation of their medications [35, 36].

Analysis of the e-prescriptions issued through the service provided some insights into the prescription patterns for these NCDs along with areas which may warrant deeper study due to differences from clinical practice guideline recommendations. These findings are summarized in Table 2. We observed that there was a significantly larger proportion of patients who were prescribed

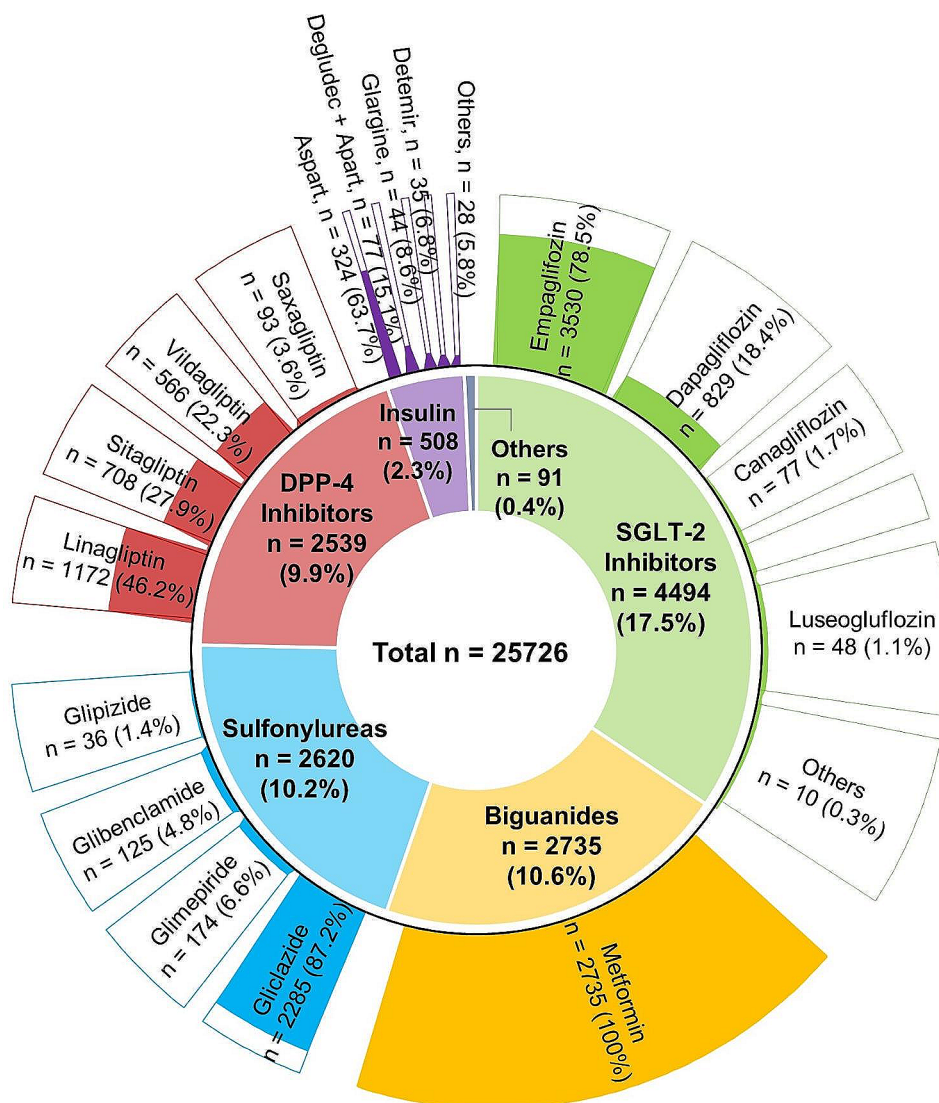


Fig. 3 The most common medication classes and individual medications prescribed for diabetes mellitus. DPP-4: Dipeptidyl-peptidase 4; SGLT-2: Sodium-glucose transport protein 2

ARBs compared to ACEIs, despite ARBs being recommended primarily if ACEIs are not tolerated (primarily due to adverse drug reactions such as dry cough) [32]. Studies have shown that the clinical outcomes of both classes of drugs are similar due to their similar action of inhibition on the renin-angiotensin system, and therefore the more cost-effective option of ACEIs are recommended to be used [37]. In addition, most clinical trials involved patients initiating treatment with ACEIs rather than ARBs based on a multinational cohort study [38]. There are several factors which could explain the increased propensity of ARB prescribing. Preference in prescribing ARBs over ACEIs could be due to its better safety profile [38]. Furthermore, in view of the nature of the dataset which comprised of private healthcare patients that pay out-of-pocket or through insurance

claims, cost to this segment of the health system overall was not considered [39], especially when there is an added element of perceived safety and the availability of more popular combination pills which include ARBs.

Related to these findings were the relative lower number of ACEIs and ARBs in hypertensive patients with diabetes, with 49.4% of patients in this population not being prescribed either medication class, with other classes such as CCBs, particularly amlodipine, being significantly more popular. Due to extensive data confirming their benefits in reducing cardiovascular risk and reno-protective effects [32, 40], both ACEIs and ARBs are recommended in this patient population. While there are numerous reasons a patient may be on an alternative medication, for example if their hypertension was currently well-controlled on a CCB prior to the diagnosis

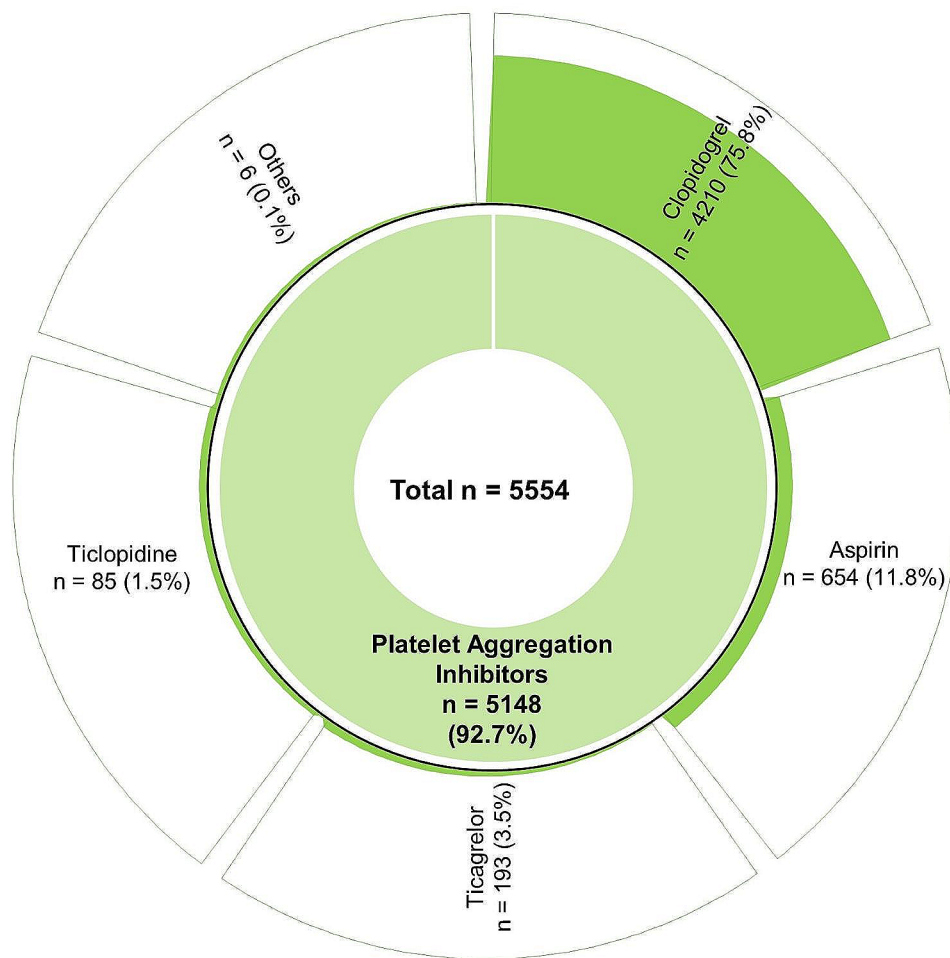


Fig. 4 The most common medication classes and individual medications prescribed for ischemic heart disease

of diabetes mellitus, this observation could warrant a more thorough study. In a similar manner, hypertensive patients with ischemic heart disease are also recommended to be initiated on beta blockers, ACEIs, or ARBs to further reduce cardiovascular risk [32, 41], but our findings showed a consistent pattern of CCBs being more prevalent compared to these recommended medication classes. It should however be noted that CCBs do confer clinical benefit in this patient population, although the level of evidence for this is slightly lower [32]. Overall, the prescribing patterns involving antihypertensive agents seem to suggest that certain medication classes may be under-prescribed in specific patient populations that may benefit from their use, although the caveat that the data does not provide sufficient clinical context for individual cases should be considered in this interpretation.

For patients with a diagnosis of diabetes mellitus, we observed that while a majority of patients were prescribed metformin either individually or as part of a combination pill, there was still a significantly proportion of patients (45.1%) who were not on metformin. Although

metformin is recommended as part of the oral GLD regimen for all Type 2 diabetes patients due extensive clinical evidence to its benefit, weight loss effect, lack of hypoglycemia, and relatively low cost [33, 42], there may be two reasons for this observation. Firstly, in Malaysia metformin does not require a prescription (Pharmacy Medicine). Secondly, metformin may not have been prescribed for that particular prescription or refill, since a prescription does not necessarily constitute a full medication history. Of the other oral GLDs, DPP-4 inhibitors and SGLT-2 inhibitors were more frequently prescribed compared to older classes such as sulfonylureas, likely due to their favorable side effect profiles [43]. SGLT-2 inhibitors in particular have seen increasing popularity in recent years due to clinical trials demonstrating significant benefits in reducing cardiovascular risk and are even indicated for reduction of cardiovascular risk in patients without diabetes [44–46]. However, here we observed that of diabetic patients with a concurrent diagnosis or past medical history of ischemic heart disease, who would benefit most from being prescribed SGLT-2

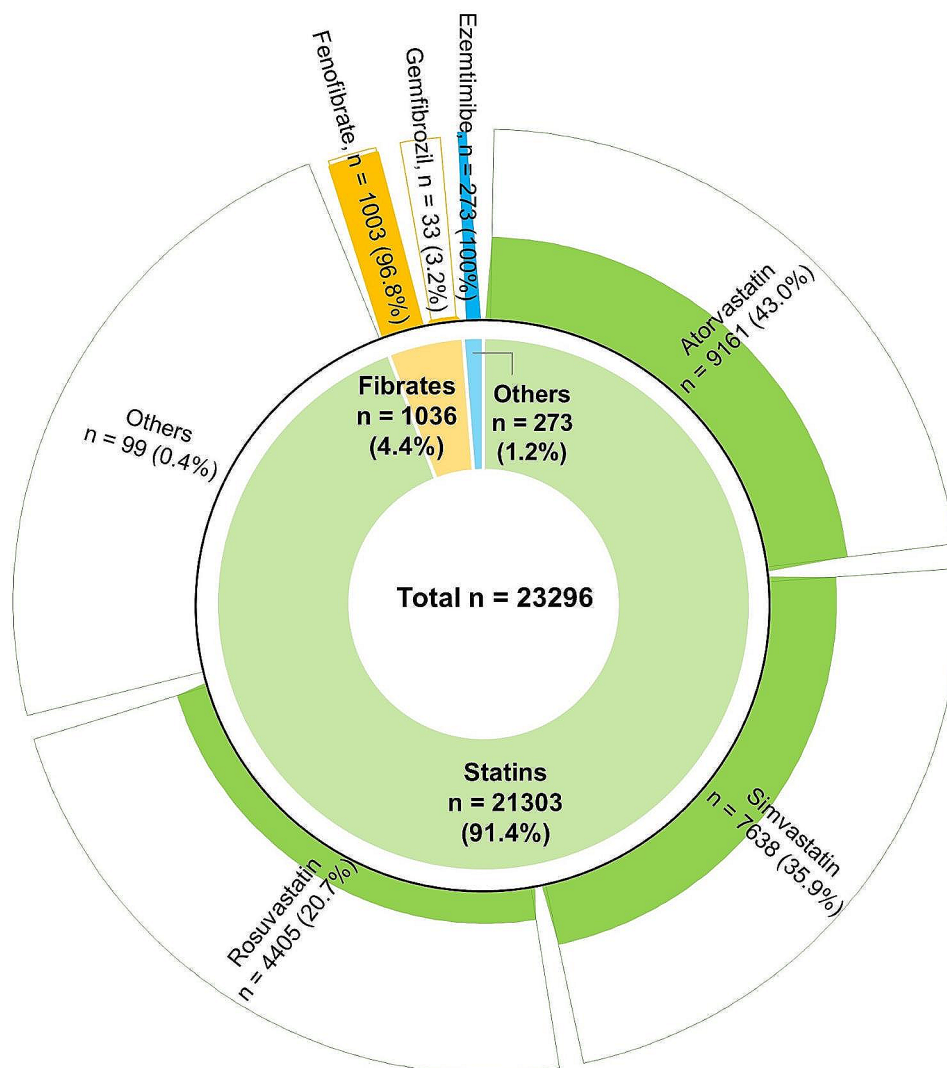


Fig. 5 The most common medication classes and individual medications prescribed for dyslipidemia

inhibitors, only 29.2% had prescriptions including this class of drugs, suggesting that there exists a population of patients who may potentially benefit from a review or switch of GLDs. Nevertheless, the switch of GLDs to SGLTs inhibitors have been low in Asia-Pacific countries due to several barriers, including unfamiliarity with its organ protective role and clinical indications, its potential adverse effects and safety profile in elderly patients [47].

Prescriptions for patients with a diagnosis of dyslipidemia mostly consisted of the various statins, ezetimibe, and a small proportion of fibrates for hypertriglyceridemia. Interestingly, a small number of patients were still being prescribed the combination of statins and gemfibrozil, which has since been contraindicated by the US FDA due to increased risk of myositis [48], but overall prescribing patterns for dyslipidemia were largely as expected. Similarly, prescriptions for medications

specific for ischemic heart disease consisted primarily of antiplatelets and reflected current practice, although it was notable that clopidogrel was found to be more frequently prescribed compared to aspirin, the latter of which has a large body of evidence for secondary prevention of cardiovascular events [49]. This differed from previous observations [50] and could be due to recent evidence favoring clopidogrel over aspirin monotherapy [51], or perhaps due to aspirin being a non-prescription item. We also observed a small number of patients still prescribed ticlopidine, which has fallen out of favor due to less convenient dosing and risk of neutropenia and thrombocytopenic purpura [52]; this was likely due to legacy prescribing or patient intolerance of conventional antiplatelets.

Prescriptions for asthma showed that combination inhalers were highly prescribed, with the majority consisting of ICS-LABA combinations. Of the combination

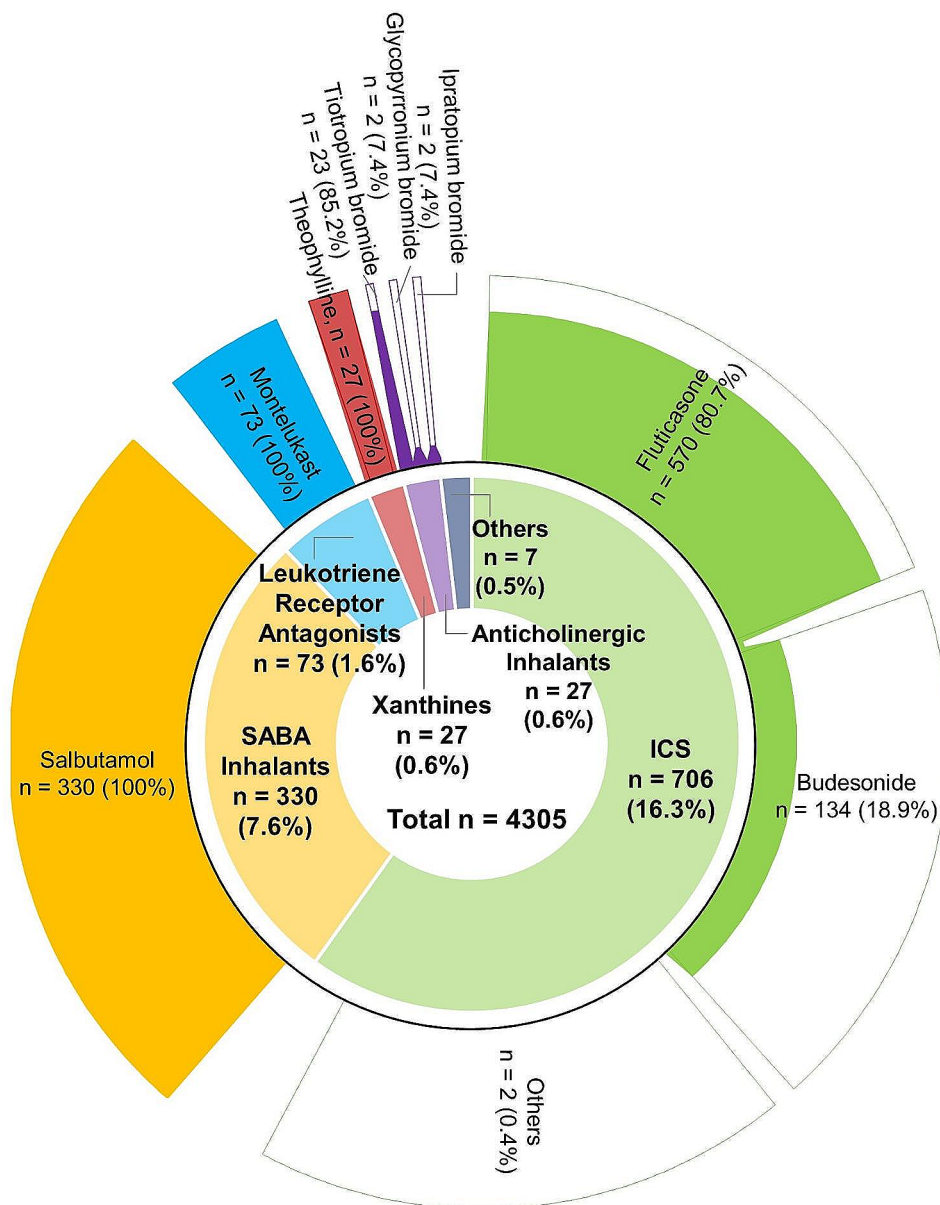


Fig. 6 The most common medication classes and individual medications prescribed for asthma. ICS: Inhaled corticosteroid; SABA; Selective beta-2 adrenoceptor agonists

inhalers, 58.8% consisted of ICS-formoterol combinations, which when coupled with relatively lower rates of individual salbutamol prescriptions. This may indicate that new guideline recommendations recommending ICS-formoterol combinations as both maintenance and reliever therapy (MART) have increased prescribing of these combinations due to the favorable clinical and cost implications [53, 54]. However, it was worth noting that 41.0% of combination inhalers still included salmeterol-fluticasone, which is currently not indicated for MART [53, 54]. Lastly, we still observed a small number of theophylline prescriptions, which is no longer recommended

due to poor benefit-risk ratio [55]. These may be due to legacy prescribing and may warrant closer review.

The findings of this study should be interpreted in the context of several inherent limitations. Firstly, the demographics represented in this study may not be generalizable to the entire primary care population as urban and remote areas in Malaysia have different accessibility of services and users with different insurance coverage schemes. Furthermore, the distinction between diagnosis and past medical history was unclear in the context of follow up of NCDs. The use of individual prescription data may also not represent full medication histories, as patients may be obtaining medicines from outside

Table 1 Combination medications prescribed for the top diagnoses

Diagnosis	Medication classes	Most common medications prescribed	
Hypertension	<i>n</i> = 16,638, 22.6%		
	ARB and CCB (<i>n</i> = 8319, 50.0%)	Telmisartan and Amlodipine (<i>n</i> = 3482, 41.9%) Valsartan and Amlodipine (<i>n</i> = 3458, 41.6%) Losartan and Amlodipine (<i>n</i> = 714, 8.6%) Olmesartan Medoxomil and Amlodipine (<i>n</i> = 653, 7.8%) Others (<i>n</i> = 12, < 0.5%)	
	ARB and Diuretic (<i>n</i> = 4692, 28.2%)	Losartan and diuretic (<i>n</i> = 1444, 30.8%) Telmisartan and diuretic (<i>n</i> = 1168, 24.9%) Irbesartan and diuretic (<i>n</i> = 897, 19.1%) Valsartan and diuretic (<i>n</i> = 876, 18.7%) Candesartan and diuretic (<i>n</i> = 260, 5.5%) Others (<i>n</i> = 47, 1%)	
	ACEI and CCB (<i>n</i> = 1999, 12.0%)	Perindopril and Amlodipine (<i>n</i> = 1999, 100%)	
	ACEI and Diuretic (<i>n</i> = 699, 4.2%)	Perindopril and diuretic (<i>n</i> = 699, 100%)	
	Others (<i>n</i> = 929, 5.6%)		
	Diabetes Mellitus	<i>n</i> = 12,648, 49.2%	
		Biguanide and DPP-4 inhibitor (<i>n</i> = 8702, 68.8%)	Metformin and Sitagliptin (<i>n</i> = 4280, 49.2%) Metformin and Vildagliptin (<i>n</i> = 2257, 25.9%) Metformin and Linagliptin (<i>n</i> = 1721, 19.7%) Metformin and Saxagliptin (<i>n</i> = 444, 5.1%)
		Biguanide and SGLT-2 inhibitor (<i>n</i> = 2084, 16.5%)	Metformin and Dapagliflozin (<i>n</i> = 1397, 67.0%) Metformin and Empagliflozin (<i>n</i> = 687, 33.0%)
		Biguanide and sulfonyleurea (<i>n</i> = 936, 7.4%)	Metformin and Sulfonyleurea (<i>n</i> = 936, 100%)
DPP-4 inhibitor and SGLT-2 inhibitor (<i>n</i> = 830, 6.7%)		Linagliptin and Empagliflozin (<i>n</i> = 830, 100%)	
Others (<i>n</i> = 96, 0.8%)			
Ischemic Heart Disease		<i>n</i> = 406, 7.3%	
	Platelet aggregation inhibitors	Aspirin and Clopidogrel (<i>n</i> = 406, 100%)	
Dyslipidemia	<i>n</i> = 684, 3.0%		
	Statin and Ezetimibe (<i>n</i> = 564, 82.4%)	Simvastatin and Ezetimibe (<i>n</i> = 284, 50.4%) Atorvastatin and Ezetimibe (<i>n</i> = 280, 49.6%)	
	Statin and Fibrate (<i>n</i> = 6, 0.9%) Others (<i>n</i> = 114, 16.7%)	Simvastatin and Fenofibrate (<i>n</i> = 6, 100%) Atorvastatin and Amlodipine (<i>n</i> = 114, 100%)	
Asthma	<i>n</i> = 3135, 72.8%		
	LABA and ICS (<i>n</i> = 3135, 100%)	Formoterol and Budesonide (<i>n</i> = 1676, 53.4%) Salmeterol and Fluticasone (<i>n</i> = 1288, 41.0%) Formoterol and Beclometasone (<i>n</i> = 120, 3.8%) Formoterol and Fluticasone (<i>n</i> = 51, 1.6%)	

ACEI: Angiotensin-converting enzyme inhibitor; ARB: Angiotensin receptor blocker; CCB: Calcium channel blocker; DPP-4: Dipeptidyl-peptidase 4; ICS: Inhaled corticosteroid; LABA: Long-acting beta agonist; SGLT-2: sodium-glucose co-transporter 2

the service. Similarly, prescriptions were not linked to individual diagnoses, and therefore it was possible for patients to receive prescriptions for limited indications only. The telehealth service only requires sufficient clinical information for the prescriber to confidently issue a repeat prescription. Comprehensive clinical information is often obtained during their regular physical follow up with their main doctor. In Malaysia, there is a lack of a centralized electronic medical records for an individual. Manual medical records are still common and may be fragmented, as patients may have medical records scattered across various healthcare providers, both in the public and private sector. Therefore, the nature of these

services and the healthcare system may result in some data incompleteness. Lastly, without detailed clinical profiles it was not possible to determine the true appropriateness of individual prescriptions. Thus, while several interesting prescribing patterns were observed in this study, they warrant more detailed investigations before definitive conclusions on prescribing can be made.

Conclusion

In this study, we have analyzed e-prescriptions from an assisted teleconsultation service to identify prescription patterns for NCDs in Malaysia. Our results indicate that common NCDs such as hypertension, diabetes mellitus,

Table 2 Summary of relevant findings compared to clinical practice guideline recommendations

Non-communicable disease	Clinical practice guideline recommendations*	Findings from e-prescriptions
Hypertension	ARBs should be considered when ACE inhibitors are not tolerated [32].	ARBs are significantly more commonly prescribed compared to ACE inhibitors.
Hypertension and diabetes	ACE inhibitors or ARBs should be initiated in hypertensive patients with diabetes with or without proteinuria [32].	A significant proportion of hypertensive patients with diabetes were prescribed other medication classes instead, which were CCBs.
Hypertension and ischemic heart disease	Beta blockers, ACE inhibitors or ARBs should be initiated in hypertensive patients with ischemic heart disease [32].	A significant proportion of hypertensive patients with ischemic heart disease were prescribed other medication classes instead, which were CCBs.
Diabetes mellitus	Metformin is the first-line choice of oral GLD and is recommended as part of any combination therapy, if tolerated and if no contraindications [33].	A significant proportion of diabetic patients were prescribed medication classes other than metformin, which included DPP-4 inhibitors, SGLT-2 inhibitors, and sulfonylureas.
Diabetes mellitus and ischemic heart disease	SGLT-2 inhibitors have shown to reduce cardiovascular risk in patients with ischemic heart disease [33].	A significant proportion of diabetic patients with concurrent ischemic heart disease were not prescribed SGLT-2 inhibitors. The GLDs primarily prescribed were metformin and DPP-4 inhibitors.

*Malaysia's Clinical Practice Guidelines

ischemic heart disease, dyslipidemias, and asthma indeed form the majority of e-prescriptions associated with the service, supporting the suitability of such services for the management of chronic diseases. Prescribing for the aforementioned NCDs were mostly in accordance with best practices, and areas where prescribing may not be entirely appropriate were highlighted. These included prescribing that may not be cost-effective such as the preference for ARBs over ACEIs. Other findings were primarily in specific patient populations where a proportion of prescriptions did not include drugs that currently demonstrate the greatest clinical evidence of benefit, although these may be due to legacy prescribing, and clinical appropriateness at the individual prescription level could not be ascertained. Nevertheless, the findings of this study provide a broad overview of prescription patterns in private sector primary care. Further detailed studies investigating the individual areas identified may aid the causes of these observations, providing specific recommendations to improve prescribing for NCDs and their long-term management in primary care.

Abbreviations

ACEI	Angiotensin converting enzyme inhibitor
ARB	Angiotensin receptor blocker
ATC	Anatomical Therapeutic Chemical
CCB	Calcium channel blocker
DPP-4	Dipeptidyl-peptidase 4
GLD	Glucose-lowering drug
GLP-1	Glucagon-like peptide
HMG-CoA	3-hydroxy-3-methylglutaryl coenzyme A
ICD-10	International Classification of Disease 10
ICS	Inhaled corticosteroid
ID	Identity
LABA	Long-acting beta agonist
NCD	Non-communicable disease
SGLT-2	Sodium-glucose co-transporter 2

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12913-024-11341-0>.

Supplementary Material 1: S1 Table. The list of other diagnoses and their percentile in descending order

Supplementary Material 2: S2 Table. The most common medication classes and their medications prescribed based on the following diseases and respective concomitant condition

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Author contributions

HYY, JSEL, MHMMZ and NAR made substantial contributions to the conception of the work; JSEL and YHL performed the data curation and formal analysis; HYY, JSEL and NAR designed the methodology; JSEL supervised the project; HYY, JSEL, YHL and NAR drafted the work; HYY, JSEL, YHL, HCO, MHMMZ and NAR reviewed, edited and approved the submitted version. NAR acquired the funding.

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Data availability

All data generated or analysed during this study are included in this published article [and its supplementary information file].

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Universiti Malaya Research Ethics Committee (UM.TNC2/UMREC_2038, 28th July 2022). Consent was not required in this study given the retrospective nature of this study.

Consent for publication

This is not applicable as the data was provided in an anonymized format. The data were reported collectively without reference to an individual.

Competing interests

The authors declare no competing interests.

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