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Data Resource Profile: The Scottish Combined Medicines Dataset (SCoMeD)

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Abstract

Introduction

Prescribing data has been collected electronically in Scotland for many years; however, data are collated in individual, non-overlapping datasets based on the origin of the prescription (e.g., primary or secondary care). The vision was to create a unified view of all prescribing data to provide a longitudinal dataset of medicines use for patients treated by the National Health Services (NHS) Scotland, irrespective of where or how that care was provided.

Methods

The Scottish Combined Medicines Dataset (SCoMeD) is, in essence, a data virtualisation tool collating information from three previously available prescribing datasets: the Prescribing Information System (PIS); the Hospital Electronic Prescribing and Medicines Administration (HEPMA) national dataset; and the Homecare Medicines (HCM) dataset. This allows the creation of study cohorts (patient groups of interest) that meet specified criteria across all prescribing settings and facilitates the retrieval of the prescribing history for individuals pre-identified from other datasets. Records contain a unique patient identifier (Community Health Index number) which is used to identify patients for inclusion in the dataset and also enables linkage to other routinely collected data, including hospital admission episodes and death records.

Results

SCoMeD contains details on the patient (age, sex, geographical information) and on the medication prescribed. Medication-related information includes what was received and when; strength and dose information are also available. The earliest date of data availability depends on the source (PIS, 01/2010; HEPMA, 07/2022; HCM, 01/2019). Data is held by Public Health Scotland.

Conclusion

SCoMeD facilitates a range of different studies, including cross-sectional/point-prevalence studies and drug utilisation studies as well as longitudinal studies, e.g., cohort and case-control studies. With the possibility to link to other relevant datasets, additional areas of interest may include health policy evaluations and health economics studies. Access to data is subject to approval; researchers need to contact the electronic Data Research and Innovation Service in the first instance.

Keywords

Scotland; Prescribing

Key features

- The Scottish Combined Medicines Dataset (SCoMeD) is a collection of medicine-related data stemming from three electronic prescribing systems, covering community prescriptions; in-hospital medicine prescriptions and administrations; and medicines prescribed in secondary care and delivered directly to a patient's home, respectively.
- This resource has been created to provide a whole system, longitudinal view of medicines use of individuals treated by the National Health Services (NHS) Scotland who were identified through a unique patient identifier, irrespective of where or how that healthcare was provided.
- SCoMeD captures information on all medicines prescribed in primary care; this includes, e.g., medicine name, strength, quantities, and dates of prescribing. Similarly, SCoMeD captures information on medicines prescribed in secondary care, including name, strength, formulation, and administration or delivery details as appropriate. Patient demographics (age, sex) are also available.
- SCoMeD includes a unique NHS Scotland person identifier so can be readily linked to other health datasets such as hospital admission episodes or death records.
- SCoMeD will be available for approved research projects through a Trusted Research Environment.

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Background

Scotland has universal healthcare, provided by the National Health Services (NHS) Scotland; services are free at the point of care for all residents. Due to the single-payer system in place, administrative health records have nationwide coverage, and data completeness is high. Furthermore, as healthcare data are generated through direct clinical care and data is subject to validation and regular quality checks, data quality is high [1]. The Scottish Government digital strategy, published in 2021 in the wake of the COVID-19 pandemic, committed to advance the use of digital services to deliver personalised care [2]; this was complemented by a national digital health and social care strategy [3], which is accompanied by annual delivery plans [4].

Moving from paper-based to electronic prescribing has been promoted for various reasons, not least to improve patient safety [5–7]. As a by-product, this digitisation of processes has led to the establishment of electronic databases comprising details on prescriptions issued in routine care, which may be used for both quality improvement and research purposes. Nevertheless, as healthcare – and, by extension, the prescribing of medicines – takes place across different settings, data are collected into individual, non-overlapping datasets based on the origin of the prescription and the place and means of supplying these medicines.

In Scotland, implementation of electronic prescribing started in General Practices in the 1980s, and the central processing for reimbursement of NHS prescriptions dispensed in the community led to the creation of a large-scale, comprehensive, national prescription database. The addition of a unique patient identifier (the Community Health Index (CHI) number) to prescriptions in 2004 meant that prescriptions could be related to the individual patient for whom they were prescribed; since 2009, data from prescriptions electronically submitted to Community Pharmacies are being collected on a national level in the Prescribing Information System (PIS) [8]. In secondary care, electronic prescribing has also been supported for many years. However, due to a diversity of requirements and processes in place, the landscape of digital prescribing records within secondary care is more fractured than in primary care where data is processed through a single system for reimbursement; although the majority of hospital settings are using the same system, some specialist areas (such as Intensive Care Units (ICUs) or cancer care) have different software solutions in place tailored to their specific needs. Data stemming from the main implementation of the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system, covering mostly inpatient beds, have been collected on a national level since the COVID-19 pandemic [9]. Similarly, data capturing Homecare deliveries – medicines prescribed in secondary care and delivered directly to a patient's home – are now also collected on a national level through the Homecare Medicines (HCM) database. While PIS has been available for research purposes for over a decade [10], HEPMA data has been made available much more recently [9]. Thus far, HCM data has only been used for pilot projects within Public Health Scotland, initially focusing on anti-seizure medicines [11] and rheumatology [12].

PIS, HEPMA, and HCM have been built separately and can be interrogated individually; bringing information from these

datasets together to obtain a wider picture of medicines use is, however, complex – not least because the three datasets contain different variables, with varying levels of complexity. Therefore, at Public Health Scotland (PHS), the vision was to create a unified view of prescribing data to provide a longitudinal dataset of medicines use for patients treated by NHS Scotland, irrespective of where or how that care was provided. This “whole system prescribing” approach was aimed at supporting both internal (e.g., audits or quality improvement projects) as well as external (research) use.

Methods

The Scottish Combined Medicines Dataset (SCoMeD) is, in essence, a data virtualisation tool collating information from all three aforementioned source datasets, all of which are held by PHS: PIS; HEPMA; and HCM. This allows the creation of study cohorts/groups of patients that meet specified criteria based on time, medicines exposure, and/or patient characteristics across all prescribing settings, and also facilitates the retrieval of the prescribing history for individuals pre-identified from other datasets. Of note, records require a valid CHI number to be included in SCoMeD so as to reliably combine records relating to the same individual; nevertheless, the share of records without valid CHI is very small (approx. 2.5% in PIS).

PIS holds information on medicines supplied in a community setting, including those supplied through NHS Scotland services provided in community pharmacies. Community pharmacy services in Scotland include, e.g., Pharmacy First (treatment of minor conditions) [13], emergency hormonal contraception, and smoking cessation services. PIS data can include not dispensed/not collected prescriptions unless explicitly excluded when requesting data. Details on coverage, data collection, and data quality have been published previously [8]. HEPMA captures data on all medicines prescribed and administered within inpatient wards in hospitals covered by the electronic prescribing system, excluding systemic anti-cancer therapy and intensive care units (ICUs). This can include whole prescriptions that were written but never administered. Additional details with regards to coverage, data collection, and data quality have also been published previously [9]. HCM data relates to medicines for ambulatory care patients managed in secondary care where the medicine is delivered to the patient in their home by specialist providers; these are typically highly specialist medicines such as biologics. Data are extracted from the national homecare service providers and include patient-level information such as age and sex, as well as medicine-related information including product/generic name and formulation. HCM can include prescriptions that were dispensed but not delivered.

In addition to these three source datasets, SCoMeD also uses data from standard reference files held by PHS covering medicines nomenclature (NHS dictionary of medicines and devices, dm+d [14]) as well as information on geography and deprivation (Health Board, Local Authority, Scottish Index of Multiple Deprivation [15]). These are also listed for reference in the data dictionary which will be made available to users of SCoMeD.

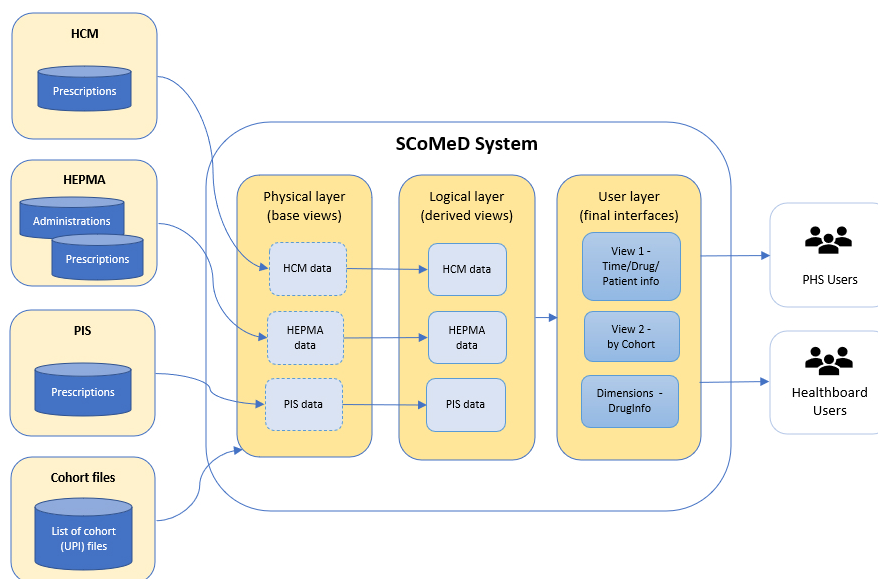
Figure 1 depicts a graphical overview of how the different datasets are combined to create the use view of the data. Prescription data from the existing datasets and cohort files are combined before logic is applied to the data in the derived views, which are used to create the final interface. Users will have direct access to this interface (the user layer), with appropriate security permissions applied. View 1 allows users to apply filters to the virtual dataset; due to the size of the source datasets, there will be an initial mandatory filter for time period of interest, while additional filters can be applied to the query results. View 2 can be used where a user wishes to search for a pre-defined list of unique patient identifiers. Additional reference information (geography, medicines) can be added to the two views by linking with the dimension interface.

Since SCoMeD is a virtual dataset, data are obtained from the three source systems to populate the interface according to parameters set by the user; there is no regular scheduled load of data into a separate database. This means that when a user queries the data, it will display the latest current data as available from the three source data sets. However, the earliest as well as the latest available dates vary for each of the source datasets (see also Table 1). Historic data may be added to HCM when a new homecare company agrees to provide data. Regardless of origin, the returned data is responsive to any changes or updates to variable values in the reference datasets – e.g., it will always show the current drug description across all the data returned. Supplied quantities in HCM may be corrected if a delivery is returned to the company; and the number of given administrations for a current HEPMA prescription will be updated on a daily basis as new data gets loaded. PIS records are, however, not subject to retrospective changes.

Each row returned by SCoMeD represents a unique prescribing event, from one of the three source datasets. For PIS and HCM, each row contains details of the prescription and supply relating to each prescribing event; i.e., each row in PIS represents one prescription, and each row in HCM relates to one supply of medicine to the patient. In contrast, the source HEPMA data also includes separate records relating to each individual administration of the medicine, in addition to information on a prescription; therefore, each prescription is split across multiple rows of data. To maintain the same level of granularity across SCoMeD, for HEPMA prescriptions, administrations have been aggregated for each prescription.

Relevant variables to include in SCoMeD were identified and agreed upon based on potential analytical needs and taking into consideration the range of previous uses of the data. Appropriate fields from PIS, HEPMA and HCM were identified to populate these. Some of these were straightforward (e.g., patient age, medication name), whereas some required data derivations (e.g., prescribed or supplied quantities) due to differences in the underlying datasets with regards to variable names, coding, and/or meaning. Not all data fields are the same across the underlying datasets, or definitions of the fields may differ. For instance, while both PIS and HEPMA contain separate variables related to the date of prescribing and the date of supply (either dispensing or administration), respectively, HCM only contains a single date field (indicating the date of delivery); hence, in order to standardise variables across the datasets, date of delivery is used as a proxy for both date of prescribing and date of supply in HCM, resulting in these dates being identical. As a more complex example: while prescribed/supplied quantities

Figure 1: Creation of the Scottish Combined Medicines Dataset (SCoMeD)



PIS and HCM contain prescription records as dispensed through community pharmacies or delivered through specialist companies to the patient's home, respectively; in contrast, HEPMA also comprises separate records detailing each individual administration of the prescribed medicines within a hospital setting.

Cohort file refers to information pertaining to the patients of interest, such as geography and deprivation.

HCM, Homecare Medicines; HEPMA, Hospital Electronic Prescribing and Medicines Administration; PHS, Public Health Scotland; PIS, Prescribing Information System; UPI, unique patient identifier.

Table 1: Data availability in the Scottish Combined Medicines Dataset (SCoMeD) as of April 2025

Data source	Earliest date of data availability	Update frequency	Timeliness	Coverage (at time of writing)
PIS	01/2010	Monthly	Two-month lag (e.g., an update in 02/2025 will show data to 12/2024)	100%, national
HEPMA	07/2022	Daily or weekly ¹	Data available for activity up to the date of submission to Public Health Scotland	91%, 12 out of 14 territorial NHS Health Boards ²
HCM	01/2019	Monthly	Up to a one-month lag (data uploaded on 1 st of each month) ³	98% of Home Care Medicines market in Scotland

HCM, Home Care Medicines; HEPMA, Hospital Electronic Prescribing and Medicines Administration; PIS, Prescribing Information system.

¹Update frequency depends on the Health Board.

²Health Boards in Scotland differ considerably in area size and population coverage.

³New data may only be available up to a week later due to various data curation tasks.

are variables directly available in both PIS and HCM, values for these are derived from the number of administrations in HEPMA – each scheduled administration is counted as 1 towards the prescribed quantity and each given administration is counted as 1 towards the supplied quantity. In addition, administrations that are recorded as “not given” but where the “not given reason” indicates that the patient did receive the medicine (e.g., “patient self-administered”) are also counted towards the supply amount. Because an administered dose might require multiple dose units (e.g., paracetamol 1g requires two 500mg tablets) quantity from HEPMA records may not be equivalent to the other data sources.

All fields, including details of how they were derived from the source datasets, are recorded in a data dictionary which will be made available to SCoMeD users as a reference.

Results

SCoMeD contains details related to two aspects: first, details on the patient (age, sex, geographical information); and second, details of the medication prescribed. Medication-related information includes what was received and when; strength and dose information are also available. The data includes, where possible, the ability to identify where the patient received the medicine (both with regards to the setting, i.e., primary and secondary care; and the geographical region, i.e., the Health Board where treatment was received). For a selection of the most relevant data items available in SCoMeD, see Table 2.

The SCoMeD data quality is high due to the high data quality of all three underlying source datasets. PIS is sourced from a national payment system and holds information on 100% of NHS Scotland prescriptions dispensed within the community and claimed for payment by a dispensing contractor, including community pharmacies, dispensing doctors, and appliance suppliers (e.g., stoma services). As the primary source of data used to monitor the national community medication bill within Scotland and the pharmacy contract agreed with dispensing contractors, this is of high quality, with coverage and completeness consistent since 2010 [8]. HEPMA has been rolled out across Health Boards in Scotland

incrementally, therefore coverage has increased over time to its current level; it is expected that coverage will further increase while implementation is ongoing in some Health Boards. The data quality within the national HEPMA data resource is high since data are extracted from a live clinical system aimed at supporting the prescribing and administration of medicines; i.e., all data are directly generated in clinical practice [9]. HCM data extracts are submitted by private homecare providers; as homecare provider data systems are used to submit claims for medicine supply, data are also considered of high quality. HCM coverage has increased to its current level over time due to additional companies agreeing to provide data. Duplicate records that may exist in the underlying datasets due to data entry errors are investigated at the source and removed if identified as true duplicates. In addition, data quality including data consistency and completeness is monitored continuously for all datasets by the data controller (Public Health Scotland).

Discussion

The SCoMeD data resource is a valuable addition to the expanding array of datasets providing patient-level information from Scotland on a national scale. First and foremost, SCoMeD provides a longitudinal view of medicines use from three datasets capturing medicines use across healthcare settings. This includes data stemming from secondary care, which is still relatively scarce, particularly for research purposes. As such, SCoMeD represents a unique attempt to consolidate prescribing from both primary and secondary care in a single dataset, providing data in a consistent, pre-cured format – thereby considerably simplifying the use of prescribing data. While currently primarily being used for NHS Scotland internal purposes, the data resource will benefit research in a wide range of areas. For example, SCoMeD supports cross-sectional/point prevalence studies including drug utilisation studies aimed at evaluating medicines uptake and their usage over time; data on medicines prescribed, whether received by the patient or not, allow the mapping of treatment pathways and monitoring of adherence to clinical guidelines/monitoring of clinical practice. Details on where/when medicines were dispensed, administered, or

Table 2: Selection of main variables included in the Scottish Combined Medicines Dataset (SCoMeD)

Category	Main variables	Comments
Patient details	Unique Patient Identifier	Pseudonymised
	Age at prescribed date	
	Age at supplied date	
	Sex	
	Postcode	Available at both time of event and current.
	Health Board of Residence	Health board of residence of the patient, not necessarily the same as the health board of treatment.
		Available at both time of event and current.
	Health Board of Treatment	Health board responsible for prescribing of the medicine.
Medication details	Prescribed date	For community prescribing records (PIS) this is the date of prescribing. For records from HEPMA this is the date the prescription started. For HCM records this is the date that the medication was supplied.
	Supplied date	For community prescribing records (PIS) this is the date that the medication was dispensed. For records from HEPMA this is the first date of administration. For HCM records this is the date that the medication was supplied.
	Drug code	These are available as dm+d codes, BNF codes, and ATC codes.
	Medication Name	These are available at VTM or VMP level. ¹
	Medication Strength	
	Dose instructions	Free text field(restricted to internal users with access to confidential data). ²
	Prescribed Quantity	For records from PIS/HCM this is based on the number of units of the VMP (e.g. doses, ml, tablets); in data from HEPMA this is the count of scheduled administrations.
	Supplied quantity	For records from PIS this is based on the units dispensed. For HCM this is the units supplied. For HEPMA this is a count of administrations excluding those treated as not given.

ATC, Anatomic Therapeutical Classification; BNF, British National Formulary, dm+d, NHS dictionary of medicines and devices; HCM, Home Care Medicines; HEPMA, Hospital Electronic Prescribing and Medicines Administration; PIS, Prescribing Information system; VMP, Virtual Medicinal Product; VTM, Virtual Therapeutic Moiety.

¹VTM is the drug substance (e.g., adalimumab); VMP is the generic description of the medicine (e.g., adalimumab 40mg/0.8ml prefilled injection).

²Data would need to be processed to ensure confidentiality and prevent de-identification prior to release to researchers within the Trusted Research Environment.

delivered, also facilitate the analysis of medication exposure. Nevertheless, although SCoMeD provides information suitable to answer a large variety of research questions, there might be studies where the use of the underlying individual data sources would be more appropriate. This may include, for instance, studies on missed doses in hospitals linked to critical scheduling (such as Parkinson's disease control) which would require more granular data on medicines administrations as provided by HEPMA; or studies on indication for prescribing of certain medications (e.g., biologics) which is available in HCM.

Since SCoMeD includes a unique patient identifier, it is possible to link the data to a range of additional datasets capturing other relevant information (such as patient characteristics, hospital episodes, or causes of death). For instance, hospital in-patient admissions and outpatient attendances (Scottish Morbidity Records), the Scottish Cancer

Registry, or death records covering the entire population of Scotland are routinely collected electronically [1] and are, as far as possible, standardised using agreed formats and coding systems, such as the International Classification of Diseases 10th edition (ICD-10) [16]. Thus, SCoMeD also offers scope to conduct studies aimed at assessing treatment outcomes, such as cohort and case-control studies. Potential areas of interest to be supported by the use of SCoMeD may also include, e.g., health policy evaluations and health economics studies.

Initial projects conducted using SCoMeD thus far have centred on the use of anti-seizure medicines (ASMs) in pregnancy. ASMs have been the focus of increased scrutiny for several years due to their potential to cause harm to unborn babies [17, 18]; the Medicines and Healthcare products Regulatory Agency (MHRA) in the UK has encouraged NHS Scotland to develop information and intelligence to

provide a better understanding of the use, risks, and benefits of medicines taken in pregnancy, which has facilitated the development of SCoMeD – with ASMs as a starting point.

The first use of SCoMeD data was to obtain an overall picture of the prescribing of ASMs in Scotland, with a main focus on valproate and topiramate. The aim was to provide up-to-date information on how these two medicines are used in female patients, and to describe exposure to ASMs during pregnancy; this was subsequently extended to also include prescribing in male patients due to reproductive risks associated with the use of valproate in men. Findings have been made publicly available via a dashboard on the PHS website, with regular updates scheduled twice a year [19]. Alongside this, an extended version of the dashboard data has been developed for internal NHS Scotland use; the more granular data providing additional detail available to NHS Health Boards may be used for further auditing or planning purposes.

A research project aimed at assessing the safety of ASMs in pregnancy, linking SCoMeD to other national datasets (on pregnancies, pregnancy outcomes, congenital conditions, and child health) and using rigorous analytical methods, has recently been completed. The objectives of this study were to estimate the risk of adverse pregnancy, baby, and child outcomes among those prescribed ASMs, using matched cohorts of ASM exposed and unexposed pregnancies [20]. An additional project focusing on aspects of switching between ASMs, polytherapy, and dosing shortly before, during, and after pregnancy is currently in progress.

Strengths and weaknesses

Routinely collected data from across NHS Scotland is a valuable resource in supporting research, primarily due to nation-wide coverage, the granularity of included information, and the quality of data. The added main strength of SCoMeD is the comprehensiveness of the data, comprising patient-level data from both primary and secondary care. By combining three existing datasets – all of which have been used previously for internal NHS Scotland purposes and/or research studies – this new dataset facilitates the analyses of medicines use and treatment outcomes longitudinally, regardless of where a patient was treated, thus streamlining access to a range of relevant data as well as simplifying the use of data combined across different settings. Nevertheless, some limitations of SCoMeD need to be kept in mind. First, the data stems from routine clinical care and has not been collected primarily for research purposes. As such, the dataset may not include all desired information; for instance, indication for prescribing is not available, and the date of prescribing in HCM is a proxy date (using the date of delivery to the patient's home), with potential implications on data accuracy when specifically investigating aspects of prescribing intention. In addition, data is not entirely standardised due to differences in structure, formatting, and content of the three underlying source datasets. Furthermore, there are still some data gaps, with certain areas of prescribing not captured within SCoMeD at present. For instance, chemotherapy prescribing, although available electronically in Scotland [21], has not been added

to SCoMeD for various reasons – not least because systemic anti-cancer therapy is prescribed in a very different format (regimens rather than medicines names) making the addition of this data infeasible for the time being. Similarly, certain specialist areas such as ICUs are currently not included due to different prescribing software being used in these departments. Privately purchased prescription medicines are also not covered.

Data access

SCoMeD is controlled by PHS, and access to data is subject to approval. Applications for research purposes will need to be submitted to the electronic Data Research and Innovation Service [22] at Public Health Scotland and require approval by the NHS Scotland Public Benefit and Privacy Panel for Health and Social Care [23]. Work is ongoing to make data available to researchers through the National Safe Haven, a Trusted Research Environment. The National Safe Haven is designed to safeguard data [24, 25]; available analytical software includes, for example, R/R Studio (Posit) as well as standard MS Office applications. Although the National Safe Haven can be accessed remotely (certain restrictions apply), it is only available from within the UK. Researchers from other countries aiming to analyse Scottish healthcare data would need to collaborate with a researcher/institution situated in the UK.

Metadata files and other supporting documents are currently under development and will be available in due course.

Conclusion

Informed by clinical needs and guided by the Scottish Government's digital care strategy, healthcare services are increasingly provided electronically; this includes the prescribing of medicines across all healthcare settings in both primary and secondary care. By providing detailed, longitudinal data on the prescribing and supply of medicines in Scotland – linkable to a range of other data sources including hospital episodes and death records – this data resource offers an unprecedented opportunity to conduct studies on medicines use.

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We thank Andrew Merrick (Public Health Scotland) for his valuable insights.

Ethics statement

The project was approved following the Data Protection Impact Assessment process at Public Health Scotland to ensure alignment with Information Governance standards. Formal ethical approval was not required since this study did not involve human participants, nor animals. No data was collected or generated specifically for this project.

Conflict of interest statement

All authors were employed at/affiliated with the data provider at the time of writing. The data provider had the right to comment on the manuscript and had to approve the manuscript before submission.

Publication consent

Consent has been gained from the data provider to publish and openly share the data included in this study.

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Author contributions

All authors substantially contributed to the conception and design of the work. TM drafted the initial manuscript, with input from all authors. All authors critically reviewed and revised the draft; and approved the final manuscript.

Data availability statement

SCoMeD data are available from Public Health Scotland (phs.prescribing@phs.scot) to NHS users upon request; and will be made available to researchers pending approval of application. Data are not publicly available due to ethical reasons.

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Abbreviations

ATC:	Anatomical Therapeutic Chemical
BNF:	British National Formulary
CHI:	Community Health Index
dm+d:	Dictionary of Medicines and Devices
HCM:	Homecare Medicines
HEPMA:	Hospital Electronic Prescribing and Administration System
ICU:	Intensive Care Unit
NHS:	National Health Services
PHS:	Public Health Scotland
PIS:	Prescribing Information System
SCoMeD:	Scottish Combined Medicines Dataset
UPI:	Unique Patient Identifier
VMP:	Virtual Medicinal Product
VTM:	Virtual Therapeutic Moiety

