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Data Resource Profile: The Enhanced Prescribing Database (EPD) in Northern Ireland

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Abstract

Introduction

The Enhanced Prescribing Database (EPD) is a comprehensive electronic database capturing detailed information on all Health and Social Care Northern Ireland (HSCNI) prescriptions dispensed in community pharmacies across Northern Ireland (the publicly funded healthcare system in Northern Ireland, equivalent to the NHS elsewhere in the United Kingdom). Established in 2010 by the Health and Social Care Business Services Organisation (HSC BSO), the EPD provides a valuable resource for monitoring prescribing practices and supporting population-based research.

Methods

When pharmacies in Northern Ireland submit dispensed prescriptions to the HSC BSO for reimbursement, these forms are scanned, and information is extracted from 2D barcodes. This data is initially stored in the Electronic Prescription and Eligibility System (EPES) for payment processing. The EPD is then created as a separate research database, derived from the EPES but tailored for research purposes. The inclusion of the unique Health and Care Number (HCN) facilitates linkage to other health and social care datasets within approved projects. Direct identifiers (including the HCN) are retained only within the secure environment for linkage, and are replaced with project-specific anonymous identifiers prior to researcher access.

Results

The EPD is held within the Health and Social Care Honest Broker Service (HSC HBS), the Secure Data Environment for Health and Social Care research in Northern Ireland. The database captures prescribing data from January 2010 onwards and is updated monthly, with data available up to December 2025 at the time of manuscript preparation. The EPD contains information on over 44 million prescribed items annually, with detailed information on dispensed items, prescriber information, patient demographics and classification data. Data quality is high, with product codes populated for over 99% of records, HCNs populated for approximately 70-90% of records, and scan rates (the proportion of prescriptions for which patient identifiers are successfully captured) improving from 74.9% in 2018/19 to 91.1% in 2024/25.

Conclusion

Researchers can access de-identified data via the HSC HBS following approval from the Health and Social Care Data Access Committee (HSCDAC). The EPD supports a wide range of research, including drug utilisation studies, prescribing practice evaluations, and analyses that use prescribing data as proxy indicators of treated disease. Ongoing system enhancements, including Optical Character Recognition, support incremental improvements in patient information capture and linkage completeness.

Keywords

Enhanced Prescribing Database, Prescribing data, Administrative data, Data linkage, Pharmacoepidemiology

Key Features

- **Unique dataset:** The Enhanced Prescribing Database (EPD) is a comprehensive electronic database capturing detailed information on all Health and Social Care Northern Ireland (HSCNI) prescriptions dispensed through community pharmacies across Northern Ireland (equivalent to NHS prescribing in other jurisdictions of the United Kingdom).
- **Purpose:** Established in 2010 by the Health and Social Care Business Services Organisation (HSC BSO) to support surveillance of prescribing patterns and to facilitate population-based research relevant to health service delivery and public health.
- **Dataset details:** Covers prescriptions dispensed from January 2010 onwards and is updated on a monthly basis, capturing over 44 million prescribed items annually for a population of approximately 1.9 million people, across around 508 community pharmacies.
- **Data linkage:** The inclusion of the Health and Care Number (HCN) allows linkage to other health and social care datasets, enabling the construction of comprehensive longitudinal patient profiles spanning multiple aspects of care.
- **Main data categories:** Includes detailed information on dispensed items (including product name, formulation, strength, and quantity), prescriber information, patient demographics, and classification data (e.g., British National Formulary (BNF) chapters, Anatomical Therapeutic Chemical (ATC) codes).
- **Access:** Access to de-identified EPD data is available to accredited researchers via the Health and Social Care Honest Broker Service (HSC HBS), subject to review and approval by the Health and Social Care Data Access Committee (HSCDAC).

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Background

Introduction

The widespread adoption of electronic health records and the digital transformation of healthcare systems have created new opportunities to capitalise on routinely collected data for research purposes. Datasets generated through the routine delivery of healthcare services, such as prescribing records, hospital admissions, and disease registries, offer a rich and comprehensive source of real-world evidence. These expansive data repositories enable researchers to gain vital insights into patterns of healthcare utilisation, treatment outcomes, and the dynamics of population health [1–3]. Furthermore, the ability to link distinct data sources through robust data linkage techniques has enabled researchers to construct comprehensive patient profiles, facilitating longitudinal analyses and enhancing the depth and breadth of investigations [4, 5]. This data-driven approach has paved the way for a growing number of data linkage studies that can inform evidence-based policymaking, optimise resource allocation in healthcare systems, and drive innovations in clinical practice [6–8]. Against this backdrop, this data resource profile examines the Enhanced Prescribing Database (EPD), an initiative that utilises the power of routinely collected prescribing data in Northern Ireland to facilitate a wide range of research projects, including drug utilisation studies [9, 10], evaluations of prescribing practices across the region [1, 11, 12], and analyses that use prescribing data as proxy indicators of disease, both to characterise prevalence (for example, psychotropic prescribing as a proxy indicator of mental illness) and to examine health outcomes [3, 5, 6, 13–15].

Healthcare in Northern Ireland

The healthcare system in Northern Ireland operates as Health and Social Care Northern Ireland (HSCNI), the publicly funded health and social care system in Northern Ireland and part of the UK's National Health Service (NHS), which provides publicly funded health and social care services to residents, free at the point of use [16]. The primary source of funding is a block grant allocated by the central UK government in Westminster according to the Barnett formula, which calculates Northern Ireland's share of public expenditure relative to its population size and other factors [17]. A smaller portion of funding is derived from regional taxes collected within Northern Ireland, such as income tax, national insurance contributions, and patient charges for certain services (e.g., dental treatment, optical services). The total health budget for Northern Ireland is determined annually by the Northern Ireland Executive, taking into account factors such as population health needs, service demand, and available resources, and is allocated by the Department of Health. For the 2023/24 financial year, the health budget amounted to approximately £7.3 billion [18]. This budget is distributed across various areas, with the largest portion allocated to the six regional Health and Social Care Trusts, which are responsible for the delivery of frontline healthcare services, including hospital care, ambulance services, and community care, as well as the Public Health Agency (PHA) which focuses

on public health initiatives and disease prevention. Funding is also allocated to cover the costs of primary care services, such as general medical practitioners (GPs), dentists, opticians, and pharmaceutical services, as well as administrative expenses for the Department of Health and related bodies.

The healthcare system in Northern Ireland is committed to providing universal access to health and social care services. In contrast to England, where a prescription cost applies, HSCNI-funded prescription items in Northern Ireland are provided free of charge regardless of the patient's age or income level [19]. This policy, which was fully implemented in 2010, ensures that all residents of Northern Ireland can obtain prescribed items from pharmacies without incurring any direct costs. This initiative aims to reduce financial barriers to accessing essential medical treatments and promotes equitable access to healthcare services across all socioeconomic groups. This also means that all prescriptions are sent to a central repository, the Health and Social Care Business Services Organisation (HSC BSO), for community pharmacy remuneration, resulting in a centralised collation of information on all dispensed medications in the Northern Irish population.

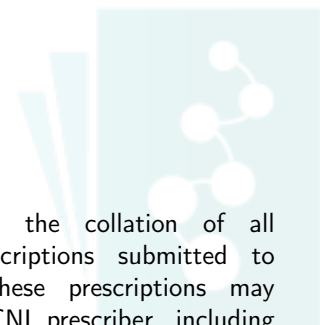
Overview of the Enhanced Prescribing Database (EPD)

The EPD is a comprehensive electronic database capturing detailed information on all HSCNI prescriptions dispensed in community pharmacies in Northern Ireland and submitted to the HSC BSO for reimbursement. The database excludes private prescriptions, medications dispensed directly within hospitals (secondary care), and handwritten prescriptions that cannot be electronically scanned. In 2024/25, there were 508 community pharmacies in Northern Ireland for a population of around 1.9 million people [20, 21]. On average, each community pharmacy in Northern Ireland dispensed over 89,000 items in 2024/25 [22]. The EPD was established in 2008 by the HSC BSO, a regional body within the structure of Health and Social Care in Northern Ireland responsible for providing a wide range of support services within the health and social care system, including financial services, human resources, legal services, technology services, and data management. By centralising dispensed prescriptions, the HSC BSO aimed to provide healthcare authorities, policymakers, and researchers with a valuable tool to monitor prescribing and conduct high-quality research studies ultimately aimed at improving public health outcomes across the region. After some pilot studies, by January 2010 the HSC BSO was able to provide researchers with access to bespoke data requests of EPD data.

Methods

Data Sources

The EPD is generated through the collation of all community-dispensed HSCNI prescriptions submitted to the HSC BSO for payment. These prescriptions may originate from any authorised HSCNI prescriber, including general practitioners, practice nurses, dentists, community nurses, supplementary prescribers (such as pharmacists and



physiotherapists with additional prescribing qualifications), and other HSCNI healthcare professionals with prescribing authority. Additionally, the dataset includes hospice invoices and prescriptions written in other parts of the UK but dispensed in Northern Ireland, covering both prescribed medicines and prescribed medical appliances (e.g. stoma products) submitted through community pharmacy reimbursement arrangements. However, the EPD excludes prescriptions dispensed directly within hospitals (secondary care settings), private prescriptions, and over-the-counter (OTC) medicines, as these are not submitted through the HSCNI reimbursement system. Data collected by the HSC BSO includes computer-generated prescriptions issued as paper forms and submitted for reimbursement by community pharmacists, dispensing doctors and appliance suppliers. Handwritten prescriptions account for a small minority of prescriptions overall (estimated by data providers to be around 6% of prescription forms in recent years) but do not contain the required scannable barcodes to allow patient HCN to be captured within the EPD.

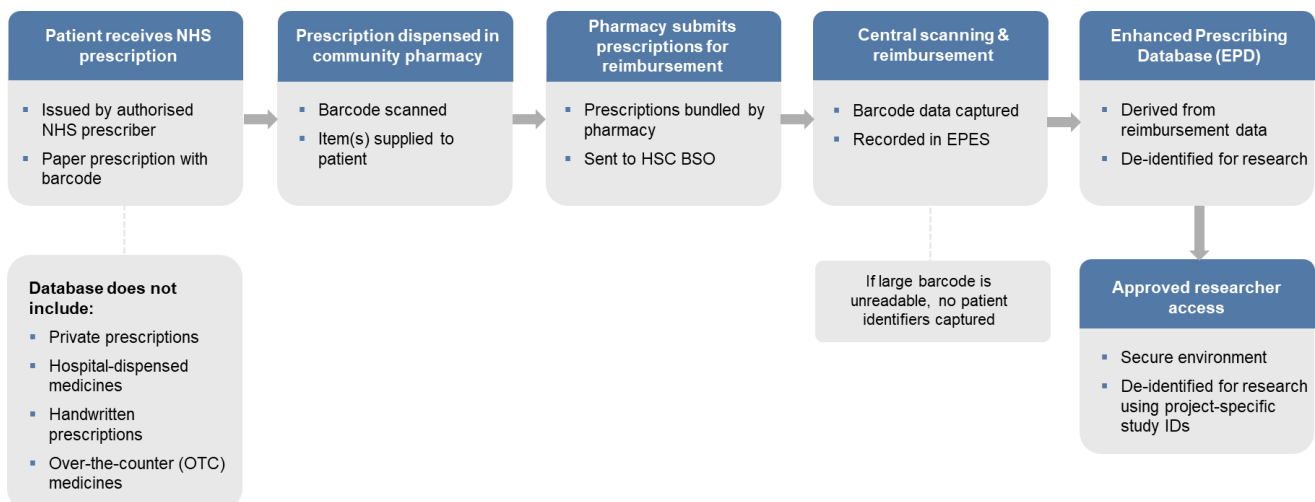
The process of incorporating prescription data into the EPD involves several key steps (see Figure 1):

1. **Prescription Generation and Dispensing:** When a patient visits a healthcare provider (typically a GP), they receive a prescription. This prescription contains two barcodes: a large 2D barcode containing comprehensive information including patient details, the unique NHS Health and Care Number (HCN), prescriber information, patient's registered GP practice, and prescribed item details; and a small barcode containing prescriber information, prescription form type, and an 11-digit reference number unique to each prescription form. Prescribed items are identified using a 15-digit Dictionary of Medicines and Devices (DM+D) code embedded within the large 2D barcode, which, when cross-referenced with the national DM+D system, enables derivation of the item name, formulation, strength, pack size, reimbursement cost, and British National Formulary

(BNF) classification. While both barcodes include prescriber-related information, only the large 2D barcode contains patient identifiers and the full prescription detail required for patient-level linkage.

2. **Community Pharmacy Processing:** The patient takes the prescription to a community pharmacy where the pharmacist scans the 2D barcode on the prescription, dispenses the prescribed item, and manually endorses the drug code and quantity of the dispensed items onto the prescription. Items on the prescription are dispensed to the patient.
3. **Pharmacy Retention and Submission:** After dispensing the prescribed item(s) to the patient, the prescription is retained by the pharmacy. Subsequently, stored prescriptions are bundled and sent to the Family Practitioner Service of the HSC BSO twice a month for reimbursement. Repeat prescriptions are submitted and processed in the same manner as acute prescriptions, with each dispensed item generating a separate record within the EPD.
4. **HSC BSO Processing and Data Extraction:** Upon receiving the bundles of prescriptions from pharmacies, the HSC BSO prepares and scans the prescriptions. This process captures an image of each form and reads the barcodes. Prescriptions that are successfully scanned have their drug information autocoded and imported into the system, unless the data breaks autocoding rules [23]. If a prescription is not successfully scanned or the associated information breaks the autocoding rules, the drug information is manually entered by BSO staff. Autocoding was introduced in April 2012 and accounts for around 68-70% of prescriptions. Prior to April 2012, all drug information was manually keyed by BSO staff. If only the small barcode is read or the prescription is not scanned, the HCN is not captured, which prevents linkage to other datasets. This typically occurs when the large 2D barcode is damaged or obstructed (for example

Figure 1: Processing of Community-Dispensed HSCNI Prescriptions and Creation of the Enhanced Prescribing Database (EPD)



Abbreviations: HSC BSO, Health and Social Care Business Services Organisation; EPES, Electronic Prescription and Eligibility System.

by pen markings, prescriber signatures, folding, creasing, or general wear of the prescription form), preventing successful scanning. Based on routine quality assurance monitoring by the HSC BSO, this affects approximately 10% of prescriptions [24]. Information required for processing financial reimbursements is recorded on the Electronic Prescription and Eligibility System (EPES), which is the primary system used to process payments to pharmacies. The implications of unsuccessful scanning for patient-level data capture and linkage are described in the Data Quality section.

5. **Data Storage and Quality Assurance:** The EPD is derived from the EPES for use in approved research projects. The EPD contains extracted and curated information from the EPES, forming the foundation for various research and analysis initiatives. Throughout the process of creating and maintaining both the EPES and EPD, numerous quality checks are performed, including validation of prescriber information, checking against authorised prescriber and contractor lists, and post-payment verification by contractors. While the EPES is used for operational purposes such as processing payments, the EPD serves as a dedicated resource for research and statistics, providing a comprehensive dataset for approved studies. Beyond linkage, de-identification and routine quality assurance associated with reimbursement processing, no additional processing is applied to the data prior to release for approved research projects.

The generation and use of the EPD operates within established HSCNI governance arrangements in Northern Ireland under the UK General Data Protection Regulation and the Data Protection Act 2018 [25]. Oversight of data handling and access is provided by the HSC BSO and HSC HBS, ensuring that prescription information is used lawfully, securely and for approved research purposes only.

Results

Data Content

Researchers can access data on prescriptions submitted to, and processed by the HSC BSO from January 2010 onwards (with data updates having a lag time of approximately 4–6 weeks, e.g. if requesting data early March you could access data up to the end of January and by the end of March data up to the end of February may be available – depending on processing). The EPD includes only dispensed prescriptions that have been submitted for reimbursement; prescriptions that are issued but not dispensed are not captured. Similar to other national medicines datasets, the EPD compiles information on the dispensed item, for example, name, formulation, strength, quantity, dose, date prescription was issued, and month and year that the prescription was scanned and processed at the HSC BSO for reimbursement (see Table 1). Additionally, by capturing the HCN, a unique identifier recorded across all health and social care contact in Northern Ireland, approved researchers can link prescribing data to other relevant health and social care datasets such as

hospital admissions, disease registries, and other longitudinal datasets available in Northern Ireland, such as the Northern Ireland Longitudinal Study (NILS) [26]. For items prescribed by a GP, information on the GP practice is captured during the prescription scanning process and stored within the prescriber fields of the EPD metadata, rather than being provided as a standalone variable. Together, these data allow patient-level information to be followed longitudinally across health and social care services. Projects requesting access to anonymised GP practice information require additional approval from the GP Editorial Board.

Data Quality

The EPD metadata is publicly available via the HSC HBS website (<https://bsc.hscni.net/directorates/digital/honest-broker-service/honest-broker-service-researcher-access/meta-data/>) [27]. This provides a summary of the available variables, including the number of records, percentage of populated records (defined as the proportion of records in which a given variable contains valid, non-missing information), and number of invalid records from 2017–2021. These years reflect the only period for which formal data quality summaries have been made available by the HSC HBS to date; comparable standardised metadata for earlier years are not available, and updated summaries for more recent years are expected to be released in future. With more than 44,000,000 prescribed items captured within the EPD each year, the database exhibits good data quality across most variables, with high percentages of populated records and low or no invalid records. A crucial indicator of data quality within the EPD is the 'scan rate' which represents the proportion of prescription items that have attributed patient information, including the patient HCN. The scan rate therefore has implications for how much demographic data can be linked to the prescription information, enabling more comprehensive analysis of prescribing patterns in relation to patient characteristics.

As shown in Figure 2, the scan rate has shown significant fluctuations and overall improvement since 2013 [24]. In 2013/14, the scan rate was 88.5%. A decline occurred from 2015/16 to 2018/19, with the rate dropping to its lowest point of 74.9% in 2018/19. This decline was attributed to technical issues with the scanning equipment, which resulted in around 25% of prescription items not having attributed patient information in 2017/18 and 2018/19 [24]. However, the purchase of new scanners by the HSC BSO resolved these technical problems [24]. Since 2019, there has been a marked recovery and consistent improvement. The rate rose to 87.6% in 2019/20 and has remained above 90% in recent years. In 2024/25 the scan rate was 91.1%. This improvement in scan rates over recent years indicates enhanced data quality and completeness, particularly in linking prescription data to patient information.

Where prescription barcodes cannot be successfully scanned, prescriptions undergo a manual data entry process for reimbursement purposes, during which medication details are recorded but patient identifiers, including the HCN, are not entered. Historically, prescriptions processed via manual data entry that were not successfully scanned were not included in research datasets, as they could not be reliably linked to individual patients. To mitigate this limitation, the

Table 1: Overview of the Variables Available in the Enhanced Prescribing Database (EPD)

Variable Name	Description
PATIENT_HCN	Health and care number of patient the script was prescribed to
ISSUE_DATE	Date the script was issued by the prescriber
PRESCRIBER_ID	HSC BSO specific ID enabling linkage to add prescriber details
SCAN_MONTH	Month prescription was scanned at HSC BSO and processed for payment
SCAN_YEAR	Year prescription was scanned at HSC BSO and processed for payment
VPID (Virtual Medicinal Product identifier)	Generic DM+D code
APID* (Active Pharmaceutical Ingredient)	Branded / Generic DM+D code
VTM_NM (Virtual Therapeutic Moiety Name)	Substance/Product name
VTM_ID (Virtual Therapeutic Moiety ID)	Substance/Product ID
AMP_NM* (Actual Medicinal Product Name)	Branded/generic name, form and strength of the Actual Medicinal Product.
VMP_NM (Virtual Medicinal Product Name)	Generic name, form and strength of the Virtual Medicinal Product.
Presentation	Product form / presentation e.g. tablet, liquid etc.
Strength	Product strength. The amount of the active ingredient that is present in each dosage.
ATC (Anatomical Therapeutic Chemical Classification)	Anatomical Therapeutic Chemical Classification System code.
BNF_CHAPTER	British National Formulary (BNF) chapter
BNF_SECTION	British National Formulary (BNF) section
BNF_PARAGRAPH	British National Formulary (BNF) paragraph
BNF_SUB_PARAGRAPH	British National Formulary (BNF) sub-paragraph
DDD (Defined Daily Dose)	The DDD is the assumed average maintenance dose per day for a drug used for its main indication in adults. Not all medications will have a DDD value.
DDDUnitType	DDD unit type, to interpret DDD value
PRESCRIBED_DRUG_DMAD_CODE	Dictionary of medicines and devices (DM+D) code
DISPENSED_QUANTITY_VALUE	The quantity of tablets, capsules, liquid etc. dispensed

*As of February 2024, these variables will no longer be provided for research use, except in exceptional circumstances.

Abbreviations: HCN, Health and Care Number; HSC BSO, Health and Social Care Business Services Organisation; DM+D, Dictionary of Medicines and Devices; ATC, Anatomical Therapeutic Chemical Classification; BNF, British National Formulary; DDD, Defined Daily Dose; VPID, Virtual Medicinal Product Identifier; APID, Active Pharmaceutical Ingredient; VTM, Virtual Therapeutic Moiety; VMP, Virtual Medicinal Product; AMP, Actual Medicinal Product.

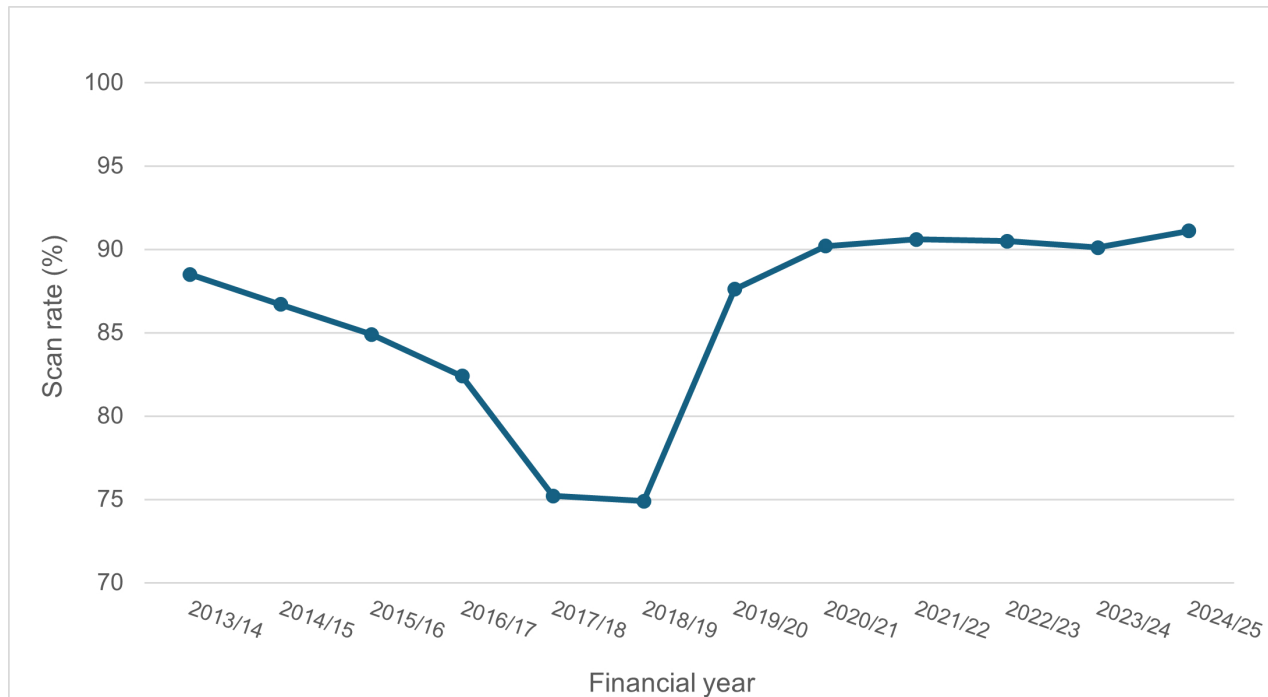
HSC BSO has implemented an Optical Character Recognition (OCR) process to extract HCNs from retained unsuccessfully scanned prescription images and link these back into the EPD. This process has been applied retrospectively to prescriptions dating back to 2017 and is now aligned with the current reimbursement workflow. Successfully matched prescriptions are appended to the EPD, improving linkage completeness for a subset of records, rather than representing a step-change in overall scan rates [24].

Future research applicants will be offered the option of including OCR-derived patient identifiers within EPD extracts, with appropriate caveats regarding the increased risk of error associated with prescriptions processed via manual data entry. These risks apply to all prescriptions that have been manually coded, including those that have successfully scanned and broken autocoding rules resulting in an HCN for linkage but manually keyed drug information. Researchers are therefore encouraged to consider linkage completeness and undertake sensitivity analyses where incomplete or uncertain linkage may plausibly influence study findings. Researchers are strongly

encouraged to consider prescribing patterns for specific drugs of interest. For example, in chronic conditions such as diabetes, patients would be expected to receive repeated prescriptions over time; therefore, a single prescription should not be used as a proxy for diagnosis. In contrast, other medications, such as antibiotics, are typically prescribed as a one-off course.

Key identifiers like the HCN (70%–90% populated), prescription issue date (99.8% populated), and product codes (VPID over 99% populated) have favourably complete information. Product details such as name, form, and strength are well-populated, ranging from 82.7%–100% across years. Prescription-level data such as quantity dispensed (over 99.99% populated), BNF classification (chapter and section 100% populated), ATC codes (87.5%–92.3% populated), and defined daily doses (80%–80.8% populated) also demonstrate excellent quality. Certain product identifiers (APID/AMP_NM) show lower population rates at around 22%; however, these are specific to branded products, and their completeness is not indicative of overall data quality. Rather than being unsuitable for use, the availability of these

Figure 2: Scan Rate of HSCNI Community Prescriptions in Northern Ireland, 2013/14–2024/25



Scan rate defined as the proportion of prescription items with attributed patient information, based on Quality Assurance of Administrative Data (QAAD) reporting.

variables depends on the type of product prescribed and should be considered in the context of specific research questions. While BNF chapter and section information is 100% complete for all items, more detailed levels such as paragraph and sub-paragraph are not applicable to all medications. As a result, BNF paragraph information is populated for 79.7% to 80.2% of records, and sub-paragraph information for 15.7% to 15.9%. These lower percentages reflect the inherent structure of the BNF system rather than indicating any data quality issues. Researchers should be aware that the absence of paragraph or sub-paragraph information for certain medications is expected and does not detract from the overall quality or usefulness of the data.

While the overall quality of the EPD is robust, researchers should consult the metadata for a comprehensive understanding of data completeness and its implications for specific research questions and are encouraged to discuss use of the data with the Honest Broker Service before submitting an application.

Discussion

Strengths

The EPD has several strengths for population-level prescribing research. Data collated by the HSC BSO undergoes regular validation, monitoring checks and auditing ensuring completeness and accuracy of information [28]. A key strength of the EPD is that the underlying data are derived from the EPES, which is used for pharmacy reimbursement. Given that prescription data are required for payment, there is a strong operational incentive for accurate submission and processing, contributing to the robustness of the information

captured in the EPD. Prescriptions are generally received and reimbursed monthly, generating a source of continuous data collection, and allowing timeliness of information provided [28]. Improvements in scanning processes over time are reflected in increasing scan rates, indicating enhanced data quality and completeness, particularly for patient-level linkage [24]. Dispensed prescriptions provided to the HSC BSO are processed and if successfully read at the scanning stage, the information from the prescription will be captured [28]. The inclusion of the HCN enables linkage to other health and social care datasets in Northern Ireland within the secure research environment, allowing longitudinal analyses across multiple aspects of care. In addition, geographical information derived from scan rates suggests that prescribing data captured within the EPD are broadly representative of the Northern Ireland population, based on GP practice location [28].

Limitations

As with all routinely collected administrative datasets, the EPD has limitations that should be considered when designing and interpreting research studies. Not all prescriptions have an associated HCN captured at the point of scanning, which can result in incomplete patient-level linkage and partial prescribing histories for some individuals. Missingness is not random and may vary by prescriber type, prescription format and time period. Researchers undertaking linkage-based analyses should assess linkage completeness for their study population and consider sensitivity analyses where incomplete linkage may plausibly introduce bias. While prescriptions dispensed through community pharmacies are comprehensively captured, prescriptions dispensed in secondary care settings and private prescriptions are not included. OTC medicines are also not captured, meaning that the EPD does not

reflect all medication use. Studies using the EPD should therefore be framed around NHS community prescribing, for which population coverage is near complete. While the EPD captures prescriptions from various prescriber types, linkage studies primarily reflect GP prescribing patterns, as non-GP prescriptions - most commonly dental prescriptions, but also pharmacy vouchers and prescriptions issued by community nurses - are more likely to be handwritten and therefore cannot be scanned for patient demographic information. However, according to data providers, handwritten prescriptions account for a small minority of prescription forms (estimated at around 6%), and analyses focusing on GP-issued prescriptions or item-level prescribing trends are therefore less affected by this limitation. The EPD does not contain clinical information and as such the use of prescription-based data requires certain assumptions which are understood limitations, for example, the use of prescription data as a proxy for diagnosis without information on the indication(s) for use. Although the EPD provides information on items dispensed by pharmacies, there is still a possibility that a patient will be non-adherent (e.g. to the medications). This is a recognised limitation of dispensing data and should be considered when interpreting treatment exposure. Ongoing system enhancements, including the application of OCR, have improved linkage completeness within the EPD and are expected to continue to enhance data utility. However, these enhancements do not remove the need for careful study design, sensitivity analyses, and cautious interpretation where incomplete or uncertain linkage may plausibly influence findings.

Exemplar Studies

The following examples illustrate current work programmes being undertaken by the Administrative Data Research Centre in Northern Ireland (ADRC NI). The examples describe projects linking data from the EPD to other datasets in the HSC HBS and Northern Ireland Statistics & Research Agency (NISRA) settings.

Example 1: The Health, Mental Health and Post-Release Mortality Risk of People in Prison in Northern Ireland (HSC HBS Project 072)

Generally, the health of people living in prison is poorer than the general population, with individuals in prison having higher rates of mental and physical conditions [29]. Furthermore, there are concerns about an increased mortality risk after release from prison [30]. There is a paucity of research about the health (and other long-term outcomes) of people who have been in contact with the criminal justice system in Northern Ireland. Using administrative data, a research team in the ADRC NI is undertaking a programme of work to improve understanding about the health, mental health, health service use and mortality risk of people in prison [6]. The South-Eastern Health and Social Care Trust (SEHSCT), (NHS), is responsible for the provision and delivery of a Healthcare in Prison Service (HIPS). Data from prisons in Northern Ireland (including sociodemographic variables, entry/release dates, substance addiction and mental health service use)

were extracted from the Electronic Patient Recording system (EMIS) by Trust staff who then transferred the data to the HSC HBS to undertake linkage to anonymised data. A Steering Group including senior members of the HIPS oversaw the transfer procedure. In addition, the Clinical Director and the Data Manager of HIPS serve as 'ambassadors' with respect to the data and facilitating liaison between HIPS and ADRC NI. The prison healthcare dataset has been linked to datasets held within the HSC BSO to create a population-based cohort. Pharmaceutical items dispensed in prison were not extracted from prison health records and are not available within the EPD. However, linkage to the EPD will enable researchers to examine prescription items dispensed to individuals before entry to, and after release from, prison.

Example 2: Childhood Interactions with Social Services and Risk of Poor Health and Social Outcomes in Adulthood (HSC HBS Project 030)

A recent scoping review has shown a higher risk of adult mental health conditions, suicide attempt and completed suicide, among individuals who were in receipt of child welfare services [31]. A current work programme in the ADRC NI will investigate the long-term outcomes associated with adverse childhood experiences in Northern Ireland. The Social Services Client Administration and Retrieval Environment (SOSCAR) dataset contains de-identified social care data for all children born between 1970 and 2015 in Northern Ireland. As Northern Ireland has an integrated health and social care system, the SOSCAR dataset includes data for all Health and Social Care Trusts (HSCTs) in Northern Ireland for any child in need, on child protection registrations, and/or children in care. Data on physical disability, mental impairment and intellectual disability are also included. The HSC BSO are the data custodians for SOSCAR, and data is held within in the Regional Data Warehouse for data linkage in approved projects. Population-wide SOSCAR data have been linked to other datasets in the HSC BSO including the EPD to examine prescription medication as a proxy indicator of mental ill-health of children known to social services [32].

Example 3: Impact of Mental Illness on Attendance at Breast Screening in the United Kingdom (Two-stage approach)

Estimates for global cancer statistics suggest that approximately one in four cancer cases and one in six cancer deaths in women worldwide are attributable to breast cancer [33]. A systematic review showed that women with mental illness were less likely to receive mammography screening [34]. Researchers in the Centre for Public Health, Queen's University Belfast, examined the relationship between breast cancer screening uptake and mental illness (measured by psychotropic medications) [5]. Using encrypted Health and Care Numbers, information from the National Breast Screening System (NBSS) (i.e. invitation/screening date) was linked to the EPD to assess psychotropic medication uptake as an indicator of mental illness, and the Northern Ireland Longitudinal Study (NILS) database to investigate demographic variables obtained from

the Northern Ireland 2011 Census returns. This involved a two-stage approach, with linkage of NBSS and EPD within the HSC HBS and subsequent linkage to the NILS database undertaken within NISRA. This study demonstrated the possibilities for data linkage and potential to undertake research via the collaboration between research organisations within Northern Ireland.

Example 4: The Effect of Air Pollution on Health and Mortality (HSC HBS and NILS Project)

The World Health Organisation states that air pollution is a risk factor for all-cause mortality and an increased risk for specific diseases [35]. Research on health outcomes related to polluted air in Northern Ireland is limited, however, researchers in the ADRC NI developed a work programme to examine the yearly pollution exposure in Northern Ireland since 2001 using data in the HSC HBS and NILS Research Support Unit [14, 36]. Researchers recently published findings relating to poorer general health and several long-term health conditions in Northern Ireland following increased long-term exposure to ambient PM_{2.5} (fine particulate matter pollution) [14]. In another project within this wider programme of work, data on annual air pollution concentrations in Northern Ireland (1km grid square level) from the Department for Environment Food and Rural Affairs (DEFRA) was linked with NILS data and the EPD using prescription data as a proxy indicator of health and multimorbidity. This project examines the relationship between air pollution exposure and prescription dispensed for drugs used in the treatment of various conditions, including diabetes, dementia, Parkinson's disease, and respiratory and cardiovascular conditions [3].

Data Access

Researcher access to anonymised data in the EPD is facilitated via the HSC HBS, the Secure Data Environment for the HSCs in Northern Ireland. This service has been established by the HSC BSO and enables the provision of de-identified health and social care data to accredited researchers within a secure setting. Individuals wishing to utilise the EPD for research purposes must submit an application to the Health and Social Care Data Access Committee (HSCDAC) for formal assessment to ensure the project's feasibility, health and social care relevance, and its implications for the delivery or improvement of public services. Further details can be found at <https://hscbusiness.hscni.net/services/2454.htm> [37].

Applications are considered and provided in line with the Five Safes' framework, a set of principles established to ensure the safe and responsible use of data:

Safe Data

The HSC HBS implements various data protection measures, including data minimisation, de-identification, pseudonymisation, aggregation, and suppression techniques. These measures remove or obfuscate direct identifiers, limit personal or identifiable information, reducing the risk of disclosure or re-identification of individuals. Direct identifiers, including the

HCN, are retained only within the secure environment for linkage purposes and are removed by HSC HBS staff prior to researcher access; project-specific anonymous identifiers are assigned to records to enable linkage within approved research projects. The specific techniques employed are tailored to the sensitivity of the data and the requirements of the approved research project, while maintaining the statistical utility of the data for analysis. The HSC HBS also ensure secure data handling and disposal protocols, in accordance with relevant data protection regulations.

Safe Projects

The HSC HBS implement a rigorous application and review process for research proposals seeking access to the EPD data. Proposed projects undergo comprehensive evaluations to assess their viability, ethical considerations, methodology, only granting access to well-designed projects that demonstrate a clear public benefit. Projects that involve the use of the EPD alone, or linkage with other datasets held internally within the HSC BSO's Regional Data Warehouse, are covered under existing governance arrangements for research use. However, any project proposing linkage to datasets held outside the HSC BSO requires separate independent ethical approval, typically from an NHS or HSC Research Ethics Committee, in addition to any required data-controller permissions. The applicants must also provide evidence that an independent review of the research project has been conducted, for example, by providing confirmation that external funding has been secured. Alternatively, applicants are required to produce evidence that an independent review of the study proposal has been conducted by an expert in the field of interest

Safe People

Data are only made accessible to the named research team. To ensure that researchers are committed to the secure handling, confidentiality, and appropriate use of the data, applicants must hold Accredited Researcher Status under the Digital Economy Act 2017 (DEA). Individuals within the approved research team are also required to sign a Data Access Agreement which ensures that researchers understand and agree to comply with the HSC HBS security policy, disclosure control policy, and licence agreement.

Safe Setting

Secure access to data is provided within the safe haven in the HSC BSO's headquarters in Franklin Street, Belfast. The safe haven provides a strictly controlled environment in which researchers can access approved project datasets under the supervision of HSC HBS staff members. Secure access to data is facilitated via dedicated computers which have no access to the internet and are modified to prevent the unauthorised use of external storage devices. Approved researchers can also access data remotely via the Health Data Research Northern Ireland tenancy of the UK Secure e-Research Platform (UK SeRP). Where a research project involves linkages of datasets held externally to the HSC BSO's data warehouse, remote access via UK SeRP is conditional upon the provision of

written agreement from data controllers indicating approval for anonymised data to be uploaded to the UK SeRP.

Safe Outputs

To protect the confidentiality of individual service users, the HSC HBS apply Statistical Disclosure Control measures to ensure that research outputs leaving the secure environment either via the physical safe setting or UK SeRP are non-disclosive, ensuring the continued safeguarding of the data. This process involves statistical disclosure control checks, output suppression, and redaction of any potentially identifiable information to protect individual privacy and confidentiality.

Conclusions

The EPD represents a valuable and comprehensive data resource for researchers, policymakers, and healthcare professionals in Northern Ireland and beyond. As a centralised repository of population-wide community-dispensed HSCNI prescriptions, the EPD offers ample opportunities for in-depth analysis of prescribing patterns, drug utilisation, and health outcomes. With over 44 million prescribed items captured annually since 2010, the EPD's strengths lie in its population-wide coverage, high data quality, and linkage capabilities through its inclusion of the HCN. The improving scan rate, exceeding 90% in recent years, enhances data linkage potential, while system enhancements such as OCR improve linkage completeness for a subset of prescriptions that previously lacked patient identifier. The EPD has already demonstrated its versatility through diverse research applications, from prison population health to the effects of air pollution. However, researchers should be mindful of inherent limitations, such as the lack of clinical indications and potential non-adherence to prescribed medications. Despite these constraints, the EPD remains invaluable for epidemiological research, health services planning, and policy development. Its insights into prescribing practices and population health trends can inform evidence-based decision-making and improve healthcare delivery, underlining its importance as a public health resource in Northern Ireland. As the availability of other health and administrative datasets continues to grow, the potential for linking the EPD with these resources expands. This increasing use of administrative data for research purposes will only enhance the value and utility of the EPD, offering even richer opportunities for comprehensive health research and policy development in Northern Ireland.

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Ethics Statement

This paper describes the Enhanced Prescribing Database (EPD), a research dataset, and does not present any results from specific studies. As such, it does not require ethical approval. The information presented is based on publicly available metadata and descriptions of the database structure and content.

Conflict of Interests Statement

The authors have no conflicts of interest to declare.

Publication Consent

The information presented is based on publicly available metadata and descriptions of the database. Permission to publish this information about the EPD has been obtained from the data custodians at the BSO. No individual patient data is presented in this paper, and therefore, individual consent for publication is not applicable.

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Data Availability Statement

The EPD is available through the HSC HBS within the BSO, Northern Ireland, but as restrictions apply, they are not publicly available. All proposals to use data are subject to review by the HSCDAC. Before any data can be accessed, approval must be given by the HSCDAC. When access has been granted, it is gained through a privacy protecting safe haven and remote access system. HBS has established an application process to be followed by anyone who would like to access data, which can be found at <https://hscbusiness.hscni.net/services/2454.htm>.

AI Disclosure Statement

The authors declare that no generative AI tools were used in the preparation of this manuscript.

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Abbreviations

ADRC NI: Administrative Data Research Centre Northern Ireland
 AMP_NM: Actual Medicinal Product Name
 APID: Active Pharmaceutical Ingredient
 ATC: Anatomical Therapeutic Chemical Classification
 BNF: British National Formulary
 BSO: Business Services Organisation
 CPM: Common Practitioner Model
 DDD: Defined Daily Dose
 DEFRA: Department for Environment Food and Rural Affairs
 DM+D: Dictionary of Medicines and Devices
 EPD: Enhanced Prescribing Database

EPES: Electronic Prescription and Eligibility System
 FPS: Family Practitioner Services
 GP: General Practitioner
 HBS: Honest Broker Service
 HCN: Health and Care Number
 HSC: Health and Social Care
 HSCNI: Health and Social Care Northern Ireland
 HSCB: Health and Social Care Board
 HSCDAC: Health and Social Care Data Access Committee
 ITS: Information Technology Services
 MDE: Manual Data Entry
 NHAIS: National Health Application and Infrastructure Services
 NHS: National Health Service
 NIHE: Northern Ireland Housing Executive
 NILS: Northern Ireland Longitudinal Study
 NIPS: Northern Ireland Prison Service
 NISRA: Northern Ireland Statistics and Research Agency
 OCR: Optical Character Recognition
 OTC: Over-the-counter
 PHA: Public Health Agency
 PFPPS: Pharmaceutical Family Practitioners Payment System
 SEHSCT: South Eastern Health and Social Care Trust
 SOSCAR: Social Services Client Administration and Retrieval Environment
 UK SeRP: UK Secure e-Research Platform
 VPID: Virtual Medicinal Product Identifier
 VMP_NM: Virtual Medicinal Product Name
 VTM_ID: Virtual Therapeutic Moiety ID
 VTM_NM: Virtual Therapeutic Moiety Name
 WHO: World Health Organization

