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MINIREVIEW

BCPT Basic & Clinical Pharmacology & Toxicology

A review of the Ghana National Health Insurance Scheme claims database: possibilities and limits for drug utilization research

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Abstract

Background: There are inadequate data on prescribed drug utilization in Sub-Saharan Africa (SSA). Drug utilization research (DUR) in this region is hampered by lack of access to databases that capture prescribed drug utilization such as health insurance claims, electronic medical records and disease registries. The primary objective of this MiniReview was to describe the content of the NHIS claims database in the context of the health care system in Ghana. We will also review the possibilities and limitations of analysing this novel database for drug utilization research (DUR) in Ghana.

Methods: We reviewed the history, composition of the database, coverage and health systems in Ghana. To demonstrate the application of the NHIS claims database for DUR, we reviewed the NHIS' drug formulary (NHIS medicines' list), assessed and quantified the utilization of the top 25 most commonly prescribed medicines and their distributions by age, sex, region of residence and by MDCs.

Results: As of December 2014, about 40% (~10.5 million) of the Ghanaian population were active beneficiaries of NHIS. There were 1.43 million unique patients in the NHIS claims database who received services from about 81 providers located in 9 out of the 10 regions in Ghana. The mean age of this sample of beneficiaries was 31 (standard deviation, 22) years, a third of whom were aged <18 years old. Nearly, 2 out of every 3 beneficiaries were females. On average, there were approximately 3 outpatient visits per beneficiary in 2015. There were about 522 unique drugs on the NHIS medicine list. Overall, analgesic was the most prescribed class of medicine (mostly paracetamol and diclofenac). Antimalarials, artemether-lumefantrine, were observed as the second most prescribed medicines followed by anti-infectives (metronidazole) and antihypertensives (amlodipine).

Conclusion: The Ghana NHIS claims database is a great resource for DUR. This database could also be extended to facilitate pharmacoepidemiological and other health services' research especially if transformed into one of the existing standardized common data models.

KEYWORDS

claims database, defined daily dose, drug utilization research, Ghana, national health insurance scheme

1 | INTRODUCTION

The Ghana National Health Insurance Scheme (NHIS) is operated and managed by the Ghana National Health Insurance Authority (NHIA).[1] The NHIA began processing submitted claims for reimbursement electronically in 2013; claims were previously processed manually since the inception of the NHIS in 2004. The electronic processing system facilitates a quicker workflow in the submission and reimbursement of claims and reduces human errors. The result of this system is an electronic administrative database, the NHIS claims database, that captures all final submitted claims that have been adjudicated and reimbursed by the NHIA. Currently, the most commonly reimbursed health care services and products include medical diagnosis, prescription drugs, medical investigations and procedures. Nearly, 40% of the approximately 27 million Ghanaians are currently enrolled in the NHIS; the goal of NHIA is to provide health coverage to all Ghanaians.[2] As a first of its kind in West Africa, the NHIS claims database is a novelty for facilitating research in multiple fields including drug utilization research (DUR), pharmacoepidemiology and pharmacovigilance and health services' research.

The primary objective of this MiniReview was to describe the content of the NHIS claims database in the context of the health care system in Ghana. We will also review the possibilities and limitations of analysing this novel database for drug utilization research (DUR) in Ghana. A DUR framework was selected for this review because reimbursement for drug dispensing constitutes about 50% of the total amount of money spent on reimbursement.[3] Drug utilization research could therefore be of benefit to NHIA through a better understanding of the factors influencing drug prescribing, dispensing and consumption by patients. Also, while the NHIS claims database has been reviewed for health services' research,[2,4] there are currently no published reviews to guide the application of this database for DUR. Therefore, this MiniReview will serve as a helpful guide to understanding the possibilities and limitations for the use of the NHIS claims database for DUR.

2 | THE HISTORY AND OPERATION OF NHIS IN GHANA

Universal health coverage in Ghana began with the establishment of the National Health Insurance Authority (NHIA) under the National Health Insurance Act 2003, (Act 650), and it became operational in 2004.[5] It replaced the cash-and-carry drug policy and fees for health services which was in existence since the 1980s that resulted in total out-of-pocket payment for health care services among Ghanaians. At inception, the NHIS was intended to cater for over 95% of the disease burden in Ghana, the only exceptions were cancer treatment (apart from breast and cervical cancer), organ transplants, cosmetic surgery, and a few others described on the exclusion list.[6]

As of December 2014, the active subscriber base was 10.5 million (equivalent to 39% of the total population), and in that same year, about 29 million outpatient visits were recorded,[2] or about three outpatient visits per enrolee per year. There was wide geographical variation in proportion of active membership; Upper West region with smallest population had the lowest active membership (4%) compared to Ashanti region (17%), the most densely populated region in Ghana (Figure 1). Dixon et al[7] reported that socioeconomic (SES) status was a major determinant of subscription to the NHIS; Ghanaians of higher SES are more likely to subscribe compared with their lower SES counterparts ($P < 0.01$). Other determinants include urban dwelling and higher educational status.[7] To remove these barriers and expand coverage to Ghanaians of lower SES, lower educational status and those living in rural areas, Social Security and National Insurance Trust (SSNIT) contributors and pensioners, persons under 18 years old, persons 70 years old and above, pregnant women, indigents (the core poor), persons with mental health conditions, categories of disabled persons designated by the Minister responsible for Social Welfare, as well as beneficiaries of the Livelihood Empowerment Against Poverty Programme (LEAP), are exempted from paying premiums.[8] Currently, these groups account for about 69% of the NHIS subscriber base.[8]

The revenue for operating the NHIS comes from different sources. These include 74% from a 2.5 percentage point national health insurance levy on goods and services, 20% from a 2.5 percentage point SSNIT contributions of workers, 3% from non-actuarially determined premium payments by scheme registrants from the informal sector, 2% from interest on investments and 1% from other sources.[9]

3 | THE HEALTH SYSTEM IN GHANA

Health in Ghana is under the political administration of the Ministry of Health. Several players are involved in service delivery in the health sector. They include the public sector which comprise of the Teaching Hospitals and the Ghana Health Service (GHS), the quasi-government hospitals (like the Trust Hospital of the Social Security and National Insurance Trust), private not-for-profit institutions which are mostly religiously based, and private for-profit health institutions including traditional health institutions. The GHS is responsible for the heaviest chunk of service delivery in the public sector and operates from community-based health planning and services (CHPS) mainly located

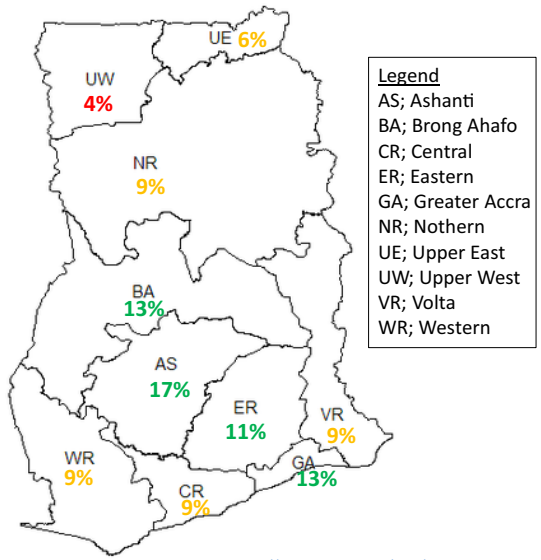

FIGURE 1 Regional distribution of active membership in the Ghana National Health Insurance Scheme
Source of data: 2013 Annual report (http://www.nhis.gov.gh/files/2013%20Annual%20Report-Final%20ver%2029.09.14.pdf)

in the rural areas to regional hospitals mainly found in urban areas. Service delivery is structured in three health care tiers, namely, primary, secondary and tertiary. The first port of call for client/patients is supposed to be the primary health facility. The average doctor-to-population ratio according to GHS 2014 annual reports was 1:9043,[10] but this ratio is even worse in the rural areas.

4 | COMPOSITION OF THE NHIS CLAIMS DATABASE

Figure 2 is an illustration of the workflow of claims processing at the NHIA previously described in-depth by Nsiah-Boateng et al.[2] Briefly, submitted claims go through five essential processes as quality control and fraud detection mechanisms before they are reimbursed.[9] These five steps are as follows: fulfilment, vetting/review, adjustment, review of results and payment. A bulk of the claims processing occurs during the vetting stage where a thorough investigation for accuracy is performed on all submitted claims is organized into six main categories of client information, services provided, diagnoses, investigations, medicines and client summary. These categories of information are further described in the next sections. Table 1 is a summary description of the major data elements captured in the NHIS claims database. We checked for the presence of corresponding data elements specified in the US Food and Drugs Association's (FDA) Sentinel Common Data Model (SCDM). All the SCDM data elements but vital signs are captured in the NHIS claims database. This demonstrates that the NHIS data compositions are very similar to other internal claims databases and that it can be easily transformed into a standardized database like the SCDM to facilitate DUR. The ensuing section further describes the content of each data element.

4.1 | Provider information

The provider is the health facility. The provider information is represented by a unique health facility code assigned by the NHIA after accreditation. The provider must also capture the scheme code which is another unique identity indicating where the visiting client's identity card was issued, and a date representing the month and year in which claim was submitted.

4.2 | Client profile

The client here is the NHIS-registered person accessing service from a provider. The client profile includes a unique identity number of the insured individual and a serial number. This is the lifelong ID for the cardholder. Every service provider has a unique identifier per patient. This is also captured in the claims database. This number is especially important when clinical auditors visit the provider to ascertain services provided. Other client attributes are the name, date of birth and gender.

4.3 | Services provided

The type of service provided (inpatient or outpatient or diagnostic or pharmacy) and corresponding dates are recorded in the claims database. An all-inclusive service, where a hospital provides all the services for a client, is differentiated from an unbundled service, where diagnostics are done from a separate facility. In the event where a client is admitted, the length of stay is captured. The presenting condition for attendance, whether it is emergency, acute or chronic, is captured for every visit. The discharge status of an episode (client treated and sent home, admitted, transferred to another facility, absconded or died) is also captured. The name of the physician/clinician in addition to the identity number is captured. For lower health facilities where there are no physicians/clinicians, the names of consulting medical assistants and/or nurses are captured.

4.4 | Procedure

All procedures have a Ghana-Diagnosis-Related Group (G-DRG) code. A G-DRG is a code signifying hospital cases that are quite similar with regard to their impact on hospital

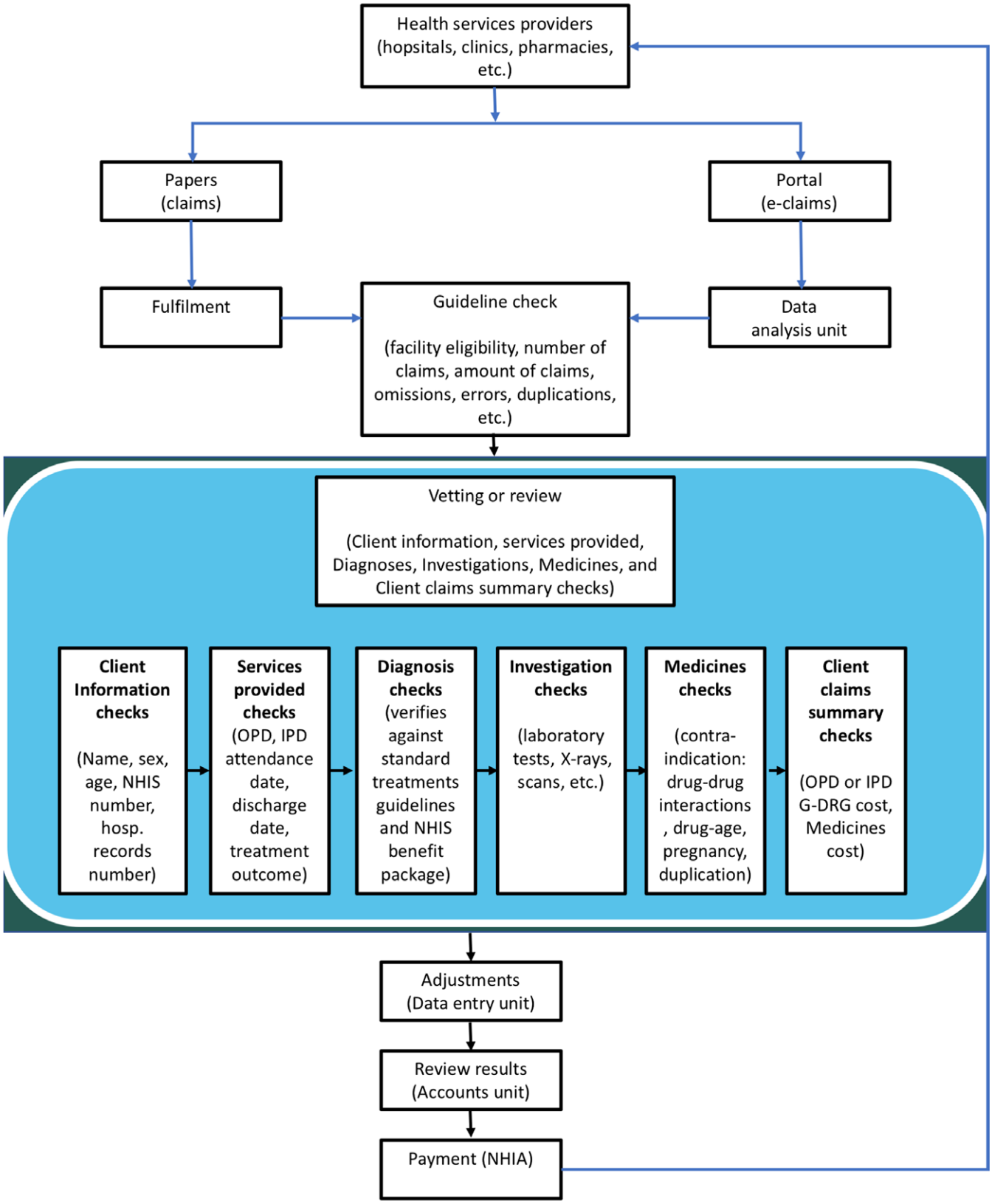

FIGURE 2 Workflow of NHIS claims processing system

Source: Nsiah-Boateng E, Asenso-Boadi F, Dsane-Selby L, Andoh-Adjei F-X, Otoo N, Akweongo P, Aikins M. Reducing medical claims cost to Ghana's National Health Insurance Scheme: a cross-sectional comparative assessment of the paper- and electronic-based claims reviews. MBC Health Services Research. 2017;17:115. https://doi.org/10.1186/s12913-017-2054-1

TABLE 1 Type of domains present in the NHIA's reimbursement database

NHIS data element	Description	Comparable data element in Sentinel Common Data Model
Provider information		Enrolment
Health facility code	Unique code for facilities registered with NHIA	
Scheme code	Code of scheme where client was registered. It is the responsibility of providers to capture this.	
Month of claim	Month and year when claims were submitted	
Client information		**Enrolment**
Surname, other names	Patient's name	
Date of birth	Recorded as Day/Month/Year of birth	
Client gender	Male/Female	
Client age	As at last birthday	
Client number	Unique ID provided by NHIS for each client	
Card serial number	A number provided by NHIS for each client	
Hospital record number	Unique ID of patient's clinical records	
Services provided		**Medical utilization**
Type of service	a Outpatient, inpatient, diagnostic, pharmacy. b All inclusive, bundled	
Service outcome	Captured as discharged, died, transferred out, absconded.	
Date of service provision	Day of service provision. For inpatients, more than one form may be filled.	
Type of attendance	Follow-up, emergency, acute episode	
Details of physician	Name and ID of consulting physician (physician assistant/nurse who prescribed medicine)	
Procedure	Type of procedure, date, code for diagnosis-related group (G-DRG)	
Diagnosis		**Diagnoses**
Date	The date diagnosis was performed	
Provider	Name of provider who performed diagnosis, in or outpatient setting	
Diagnosis code	The ICD-10 and G-DRG codes associated with diagnosis	
Description	Free text description of diagnosis	
Investigation		**Laboratory test**
Date	Date of medical investigation	
Provider	Name of provider	
Investigation code	The G-DRG associated with the investigation performed	
Unit price	The unit price of each investigation	
Description	Free text description of the investigation performed	
Medicines		**Pharmacy prescriptions**
Date	Date medicine was dispensed	
Quantity dispensed	Quantity dispensed per medicine	
Unit price	Unit price of each quantity dispensed	
Total cost	Total cost of all dispensed medicines	
Code	The Anatomical Therapeutic Chemical (ATC) of the dispensed medicine	
Summary report		**Not in SCDM**
Summary of services provided	Total cost of services provided per visit	

resources.[11] Each code is associated with a weight that is applied during vetting and reimbursement by health insurance schemes.[12,13] In Ghana, the G-DRG system of operation replaced the existing fees-for-service in 2008.[5,8] Subsequently, there have been two revisions in 2012 and 2015[5] to address prevailing challenges. For example, the 2015 edition merged G-DRGs for spontaneous delivery with episiotomy G-DRG (OBGY34) and spontaneous delivery without episiotomy G-DRG (OBGY33) into one code called spontaneous delivery with or without episiotomy OBGY34.[5] New G-DRGs are created while old existing ones may be expanded or replaced depending on provider feedback.[5] In other words, revisions are made not to increase or decrease the size of the list but to address provider needs and improve service delivery. The description and date of the procedure must accompany the G-DRG.

4.5 | Diagnosis

A description of the diagnosis, for example, malaria, or hypertension, or diabetes in addition to its International

Classification of Disease version 10 (ICD-10) code and Ghana-Diagnosis-Related Groups (G-DRG) are recorded in the database. The diagnosis must always agree with the procedure that was carried out and the investigation that was done, if any. It must also have some relationship with the prescribed medicine. The claim may be rejected if these are not adhered to.

The NHIS classifies diseases using 12 major diagnostic categories (MDC). These are as follows: adult surgery cases (ASUR); dental cases (DENT); ear, nose and throat cases (ENT); medical cases (MEDI); obstetrics and gynaecology cases (OBGY); outpatient cases (OPDC); ophthalmology cases (OPTH); orthopaedic cases (ORTH); paediatric cases (PAED); paediatric surgery cases (PSUR); reconstructive plastic surgery cases (RSUR) and ZOOM.

4.6 | Investigation

A description of the type of investigation, for example, "fasting blood sugar" (FBS) or "urine routine examination" (urine R/E) in addition to date of examination, cost and G-DRG is captured. The investigation must have a relationship with the final diagnosis. For example, the NHIS insists that every first prescription of a statin must be accompanied by a supporting investigation for cholesterol.

4.7 | Costs information

This, captured in the form of claims summary, is among the mandatory requirements. It is made up of the type of service(s) provided (inpatient/outpatient, investigation and pharmacy) and their corresponding tariffs as well as the total tariff, the G-DRG code, and the name and signature of the health insurance facility officer.

4.8 | ZOOM codes

These are codes developed for interventions that do not fall under any specific speciality and as such could be used across specialities.[5] ZOOM codes are used for detention and observation for periods not exceeding 24 hours. ZOOM codes are also used in the process of transfer or referral of a client, or for example, for a catheter change.

4.9 | Medicines

All prescribed medicines (using generic names) and their unique NHIS codes are captured in addition to their unit prices, quantities and costs. Reimbursement of dispensed medications is strictly limited to only medicines on the National Essential Medicine List of Ghana. The NHIS medicines' list conforms to the National Essential Medicine List of Ghana.[7] Nomenclature for the medicine code is generally based on three stages with limited exceptions. These are the first 6 upper case (capital) letters of the generic name of the medicine, followed by the first 2 upper case letters of the formulation and a number representing the different number of strengths available. For example, for amlodipine 5-mg and 10-mg tablets, the code is AMLODITA1 and AMLODITA2, respectively. To avoid confusion between suppositories and suspensions, RE (representing rectal) is used for the former and SU for the latter.

After reviewing the health care system in Ghana, the history and operation of the NHIS and a description of content of processed claims, we will now focus on features of the NHIS claims database relevant for DUR. Specifically, we will review the NHIS' drug formulary (NHIS medicines list), assess and quantify the utilization of the top 25 most commonly prescribed medicines and their distributions by age, sex, region of residence and by major diagnostic codes (MDCs).

5 | THE NHIS CLAIMS MEDICINES' LIST

The 2015 NHIS medicines' list has 522 formulations arranged alphabetically by their generic names. Every different formulation is considered separately. For example, paracetamol syrup, paracetamol tablet and paracetamol suppository constitute three medicines. Each of the medicines has a unique NHIS code. Different strengths of the same medicine, for example, ibuprofen 200 mg and ibuprofen 400 mg are considered as two medicines because again, each has a unique code. Different volumes of the same medicine are considered differently. For example, a 30-mL bottle of 25% benzyl benzoate and a 100-mL bottle of 25% benzyl benzoate are considered as two medicines. This brings the different types of active substances on the medicines' list to just under 250 different types. One important component of the NHIS medicine list is the addition of medicine unit prices. This is updated periodically to align with prevailing economic trends in the country. This is normally done through stakeholder meetings.

6 | MOST FREQUENTLY USED MEDICINES

We assessed medicines from 81 NHIS accredited health providers who submitted electronic claims to the NHIS in 2015 for reimbursement. The 25 most prescribed medicines were selected and arranged by their anatomical therapeutic chemical (ATC) classification. Their defined daily doses

(DDD) were then calculated using information from the website of the WHO Collaborating Centre for Drug Statistics Methodology in Norway.[14]

Usage was quantified by the use of the defined daily dose (DDD) [17] technique. The DDD is the assumed average maintenance dose per day of a drug used in an adult for its main indication [18]. For example, the DDD of paracetamol is 3 g. The dose of each adult paracetamol tablet on the NHIS list is 0.5 g bringing the DDD of paracetamol equivalent to 6 (6 times 0.5 g = 3 g) adult tablets.

Table 2 shows that overall, paracetamol was the most prescribed medicine in the e-claims database for 2015, followed closely by diclofenac, artemether-lumefantrine and then multivitamin in that order. Apart from diclofenac, the other three medicines are indicated in the management of malaria, the leading case reported at outpatient clinics in Ghana. The most prescribed anti-infective medicine was metronidazole, and amlodipine was the most prescribed medicine for non-communicable diseases.

Distribution of utilization of top 12 most frequently prescribed medications by demographic and disease states.

The data for assessing drug utilization were based largely on outpatient services as shown in Figure 3. Services, such as dispensing of medicines, delivered in outpatient settings constituted nearly 80% of the care delivered in over 11 different care settings.

In the Table S1, we present the 12 most prescribed medicines and their utilization patterns by age (categorized into six groups), sex, region of provider/patient and MDC. The 12 most prescribed medicines comprised of three analgesics (paracetamol, diclofenac and ibuprofen), four anti-infective agents (amoxicillin, co-amoxiclav, ciprofloxacin and metronidazole), three vitamin and iron preparations (iron III, folic acid and multivitamin), one anti-protozoal (artemether + lumefantrine) and one antihypertensive agent (amlodipine). The table shows that the outpatient units (OPDC) were responsible for most of the prescriptions. Of the 12 most prescribed medicines, only 3 (metronidazole, co-amoxiclav and ciprofloxacin) recorded less than 75% of prescriptions at the OPDC. About 25% of all paracetamol prescriptions were written for children <5 years old.

7 | STRENGTHS AND LIMITATIONS OF THE NHIS CLAIMS DATABASE

There are numerous research possibilities that can be pursued through the analysis of the Ghana NHIS claims database. We discuss a few of these possibilities within the framework of DUR, but we do recognize that the research possibilities of this database are unlimited. Firstly, the NHIS claims data are currently the largest single database that captures the health records and drug utilization data of Ghanaians. In resource-low settings, the lack of large and nationally representative databases has been the bane of DUR and its related fields such as pharmacoepidemiology and health services' research; inadvertently, the NHIS claims database is a solution to this problem in Ghana. Secondly, through a rigorous vetting of claims for accuracy and fraud detection by the NHIA, the first step of data quality assurance has already been built into the final claims records. This inherent data quality assurance step ensures that the data are a reflection of the real-world use of drugs and medical practice; this is critical for the generation of accurate and valid data through research. Thirdly, NHIS claims database contains all the minimum data elements required for DUR: enrolment, diagnosis, services, prescription fills and laboratory investigations. Therefore, the NHIS claims can easily be transformed into one of the existing common data models (CDM) such as the US Food and Drugs Association's (FDA) Sentinel CDM (SCDM) to facilitate cross-country comparison of data. Fourthly, the NHIA's medicine list includes majority of the WHO's essential medicine's list which lends itself to novel analysis to evaluate the health and economic impact of the utilization of these medicines in developing countries like Ghana.

The research possibilities of the NHIS claims database discussed in this MiniReview could be limited. Firstly, while the NHIA is gradually transitioning from manual claims processing to the electronic processing system, not all providers have the resources to electronically transmit their claims electronically. Therefore, although the data are generated on a national scale, there might be under-representation of data from patients who receive services from providers who are unable to participate in the electronic claims processing system. Secondly, although the claims records have undergone administrative quality checks, individual researchers may still need to conduct additional data validation processes using existing claims data validation techniques. By transforming the NHIS claims database into one of the existing CDMs such as the FDA's Sentinel CDM would be the first step in this research-specific data validation step. Others would be to ascertain the validity of codes (ICD, ATC, zoom, etc.) through expert adjudication of these codes prior to use for research analysis. Thirdly, while there are currently about 522 medicines on the NHIA's medicine list, this list does not include commonly used over-the-counter drugs and HIV and tuberculosis drugs which are provided through a separate health programme, the National Drugs Program. With about 11 registered private health insurance providers in Ghana, the future looks promising for linkage databases. Unfortunately, there is not yet a common identifier, which renders it difficult to track an individual who changes from one plan to another. In future, if both public and private

TABLE 2 Top 25 medicines prescribed according to 2015 NHIS e-claims database

Medicine	Number of prescriptions	DDDs	Anatomical and therapeutic classification code(s)
Anti-infective agents			
Metronidazole	340 707	984 781	JO1XD01
Co-Amoxiclav	275 626	2 119 321	J01CR02
Ciprofloxacin	248 841	1 186 353	J01MA02
Amoxycillin	221 711	1 704 082	J01CA04
Cefuroxime	169 274	1 206 985	J01DC02
Anti-protozoals			
Artemether + lumefantrine (Art+Lum)	420 000	319 245	P01BF01
Artesunate + Amodiaquine	148 006	—[a]	P01BF03
Dihydroartemisinin + piperaquine	109 266	—[a]	P01BF05
For NCDs[b] only			
Amlodipine	198 597	15 572 391	C08CA01
Nifedipine	188 986	10 797 097	C08CA05
Bendroflumethiazide	155 672	7 558 109	C03AA01
Metformin	114 763	3 755 476	A10BA02
Omeprazole	108 638	2 111 492	A02BC01
Analgesics			
Paracetamol	1 340 291	4 378 028	N02BE01
Diclofenac	651 043	3 226 310	MO1AB05, SO1BC03
Ibuprofen	208 811	998 829	M01AE01
Vitamin and iron preparations			
Multivitamin	418 926	—[a]	A11BA
Folic acid	333 481	96 738 363	B03BB01
Iron (III) preparations	297 285		B03AB02, B03AB05
Iron (II) preparations	152 193	2 694 070	B03AA01, B03AA02, B03AA03
Others			
Cetirizin	191 737	1 337 282	R06AE07
Sodium chloride infusion	185 515	—[a]	B05XA03
Simple linctus	179 976	—[a]	—
Dextrose saline infusion	137 194	—[a]	B05BB02
Oral rehydration salt	119 860	—[a]	A07CA

[a]Equivalent DDD not present at www.whocc.no website.
[b]Non-communicable diseases.

insurers will agree to register enrolees using national identification numbers, this could serve as the turning point. Since clients who engage with private insurers may differ from their public sector-insured counterparts, bringing the two together is likely to reduce selection bias in research outcomes. As with any database of this nature, the NHIS claims database was missing some data for the variables explored in this MiniReview. However, it is important to note that the level of missing data observed was minimal, <8%, for all the explored variables.

8 | THE FUTURE OF DUR

The creation of the NHIS claims database has ushered in a new era of DUR, pharmacoepidemiology and health

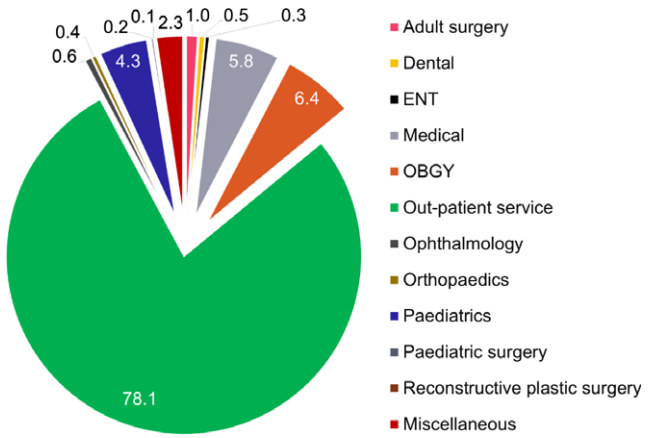

FIGURE 3 Distribution of health care settings where services were offered to patients

services research that were otherwise not possible in these parts of the world. The NHIA is strongly committed to the expansion and making significant improvement in the electronic claims processing system; this will further enhance the research potentials of the NHIS claims database. As a nationally representative database of patients in Ghana, the NHIS population is a novel framework to facilitate not only observational research but also primary research such as clinical trials and patient surveys since it is possible to contact and enrol the NHIA beneficiaries; the implementation of such primary research studies would require some legal clearances and institutional support. One of the promising strengths of the NHIS claims database beyond DUR is in the application of pharmacovigilance. For a resource-constrained setting, regulators such as the Ghana Foods and Drugs Board (FDB) can track and measure adverse drug events from this database. The implementation of pharmacovigilance studies would require a strong intercollaboration between the FDB and NHIA as well as capacity development in pharmacovigilance research.

9 | CONCLUSION

In conclusion, the Ghana NHIS claims database has numerous possibilities to drive DUR and its affiliated research fields. Several features and strengths of the NHIS claims database have been highlighted in this MiniReview to guide the use of this resource for research. Further, we identified inherent limitations that users should be cautious about when using this database, the suggestions provided in this MiniReview are some of the potential solutions to minimize the impact of these limitations on the quality of research output. The potential to leverage this claims database for large-scale and rapid pharmacovigilance is an exciting opportunity to protecting the Ghanaian public from adverse drug events.

ACKNOWLEDGEMENTS

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ETHICAL STATEMENT

No patient was contacted as part of this research. Ethical approval to carry out the research was obtained from The Ohio State University Institutional Review Board.

CONFLICT OF INTEREST

On my personal behalf as the corresponding author and on behalf of all the co-authors, I would like to say that there are no relevant conflict of interests with regard to the submission. None of us have any patents whether planned, pending or issued, broadly relevant to this work. Lastly, there are no other relationships or conditions or circumstances that present a potential conflict of interest in this submitted work.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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