# CREATING AND EVALUATING AN OPPORTUNITY FOR MEDICATION RECONCILIATION IN THE ADULT POPULATION OF SOUTH AFRICA TO IMPROVE PATIENT CARE

Pranusha Naicker[1*], Natalie Schellack[1], Brian Godman[2,3], Elmien Bronkhorst[1]

[1]School of Pharmacy, Faculty of Health Sciences, Sefako Makgatho Health Sciences University, South Africa. Emails: pranusha0106@gmail.com; natalie.schellack@smu.ac.za; elmien.bronkhorst@smu.ac.za
[3]Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, UK. Email: Brian.godman@strath.ac.uk
[4]Department of Laboratory Medicine, Division of Clinical Pharmacology, Karolinska Institute, Karolinska University Hospital Huddinge, Stockholm, Sweden. Email: Brian.Godman@ki.se

*Corresponding author
Pranusha Naicker, Department of Pharmacy, Sefako Makgatho Health Sciences University, BMS Building N302, Molotlegi Street, Ga-Rankuwa, 0208, South Africa; Telephone: 0622715219; Email: pranusha0106@gmail.com

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**Abstract:**

**Background and aims:** Adverse drug events (ADEs) are a major cause of morbidity and mortality, with more than 50% of ADEs being preventable. Adverse Drug Reactions (ADRs) are typically the result of an incomplete medication history, prescribing or dispensing error, as well as over- or under-use of prescribed pharmacotherapy. Medication reconciliation is the process of creating the most accurate list of medications a patient is taking and subsequently comparing the list against the different transitions of care. It is used to reduce medication discrepancies, and thereby ultimately decreasing ADEs. However, little is known about medicine reconciliation activities among public hospitals in South Africa. **Methods:** Prospective quantitative, descriptive design among Internal and Surgical wards in a leading public hospital in South Africa. **Results**: 145 study participants were enrolled. Over 1300 (1329) medicines were reviewed of which there was a significant difference ($p$=0.006) when comparing the medications that the patient was taking before or during hospitalisation. A total of 552 (41.53%) interventions were undertaken and the majority of patients had at least 3.96 medication discrepancies. The most common intervention upon admission was transcribing the home medication onto the hospital prescription (65.2%) followed by medication duplication (13.44%). During patient's hospital stay, interventions included patient counselling (32.5%) and stopping the previous treatment (37.5%). **Conclusion**: To ensure continuity of patient care, medication reconciliation should be implemented throughout patients' hospital stay. This involves all key professionals in hospitals.

**Keywords:**
MEDICATION RECONCILIATION, MEDICATION ERRORS, PHARMACEUTICAL CARE, SOUTH AFRICA.

## 1. Introduction

South Africa has a progressive constitution (1), which states that every citizen has the right to access quality healthcare. To ensure this realisation, the National Department of Health (NDoH) in 2011 developed national core standards (NCS) for patient safety, which describes what a hospital or clinic must do to make sure that patients are respected and their rights upheld, including getting access to needed care (2,3), serving as an exemplar to other African countries where there are concerns with initiatives in practice to enhance the rational use of medicines (4-7). Furthermore, patients' safety concerns prompted the World Health Organisation (WHO) to form a patient safety program in response to a World Health Assembly in 2002 with the vision that "*every patient receives safe healthcare, every time, everywhere*" (8). The NDOH in South Africa expects that implementation of such programmes will result in a reduction in the number and severity of patient safety incidents (9). This is needed as patient harm due to gaps in patient care is common across countries (10), causing many avoidable deaths each year as well as adding to costs (11-13). A large majority of these gaps are the unintended results of highly complex and imperfect healthcare delivery systems in which minor mishaps sometimes combine to cause harmful or disastrous results (9).

Medication discrepancies and errors are common when patient's cross-organisational boundaries (10), and the lack of necessary information to patients, caregivers and healthcare providers, have resulted in an increase in medication discrepancies (14-16). In order to improve patients' safety, the WHO introduced the High 5's initiative together with the Joint Commission, which introduced medication reconciliation as a National Patient Safety Goal in 2006 (17-19). This comprised a process of systematically identifying the most complete and accurate list of the medication a patient is taking at home and comparing them with newly ordered medication in the hospital during admission, transfer and discharge (20,21). According to the Joint Commission (2006), this reconciliation is undertaken to avoid medication errors such as omissions, duplications, dosing errors, or drug interactions (19). It is recommended that the process should be undertaken at every transition of care in which new medications are ordered or existing orders are rewritten. Medication reconciliation is the process of obtaining and maintaining accurate and complete medication information for a patient, and using this information within and across the continuum of care to ensure safe and effective medication use (22). Studies have shown that for instance pharmacists and other professionals can play a role with improving medication reconciliation (23-25). Studies have shown that the monitoring of medication orders by clinical pharmacists may prevent more than half (58%) of all errors (26), with Kuo *et al* indicating that 89% of clinical pharmacists' recommendations were accepted by the prescribers to improve patient care (27).

It is also recommended that to help improve the use of medicines, pharmacists should move onto the wards (28); however, this can be difficult especially in lower and middle income countries (LMICs) as this is time-consuming creating extra work for other staff when resources are limited. This must be balanced against published studies in public hospitals in South Africa finding 37 adverse events per 100 admissions, with 67.8% of these occurring during the patient's hospitalisation and 32.2% being present on admission (29). Furthermore, more adverse events to medicines occur within hospitals, including those in South Africa, than are currently being reported through voluntary reporting systems (3, 30-33). This has increased the role of pharmacy technicians to improve patient safety through performing medication reconciliation (24,34).

Standardised medication error databases to identify and quantify medication errors in hospitals are currently not available in South Africa. Voluntary reporting systems, as part of pharmacovigilance (PV) programmes, are though available (3). However, typically to date there has been under-reporting of ADRs in hospitals despite PV programmes being a National Standard (33,35-37). This is starting to be addressed through proactive educational initiatives (38).

To the best of our knowledge, there is currently limited literature regarding the effectiveness of a medication reconciliation tool among public hospitals in South Africa to address current concerns. Consequently, the purpose of this study is to determine the effect of a pharmacist-driven medication reconciliation service implemented in specific wards at a leading academic tertiary hospital in South Africa during admission, transfer, and discharge of the patient, where currently there is no tool or system to record patients' medication upon admission and discharge, or a system to perform medication reconciliation. Subsequently, use this information to define the responsibility of public healthcare providers in South Africa and wider to enhance the identification of patient safety incidents and improve their management to minimise future patient harm and suffering, and to ensure where possible that medication errors are routinely investigated and managed to prevent repetition and to learn from prior mistakes (39). This is particularly important at this time in South Africa as it improves its public health system, including enhancing access to medicines in the public system for patients with chronic diseases (3,40). We also hope that the findings will also be of interest to other public hospitals in South Africa as well as other LMICs as they seek to improve care in their public hospitals.

## 2. Methods

### *2.1 Study design setting and population*

The research study followed a quantitative, descriptive study design. It was conducted prospectively at DGMAH over a nine-month period between September 2015 and June 2016. DGMAH is a rural public sector academic hospital (teaching facility) located in Ga-Rankuwa in the Gauteng Province of South Africa. It has 28 clinical departments, rendering all three levels of service and is one of four academic institutions in the Province. It is representative of other academic hospitals in the Province as well as the healthcare system in South Africa.

The study was conducted in the Internal Medicine and Surgical wards with a total of ±154 admissions per ward per month. This study included all participants over the age of 18 years old who took chronic medication at the time and for whom medications were prescribed in hospital. The ward characteristics are defined in further detail in Table 1.

**Table 1: Ward characteristics**

| **Unit** | **Number of beds** | **Number of admissions per month** | **Occupancy Rate (%)** | **Number of medications per ward** | | **Number of interventions** | |
|---|---|---|---|---|---|---|---|
| | | | | Admission | In-hospital | Admission | In-hospital |
| **Medical** | 128 | 150 | 85.33 | 205 | 333 | 97 | 130 |
| **Surgical** | 180 | 100 | 180 | 263 | 459 | 161 | 164 |

### *2.2 Definitions and key aspects of the study*

- ***Medication reconciliation:*** This is a process of systematically identifying the medications a patient is currently taking in their home and comparing them with newly ordered medications in the hospital (20).
- ***Medication error:*** Any preventable event that occurs during any stage of the medication use process that may cause or lead to inappropriate medication use or patient harm *while the medication is in the control of the healthcare professional, patient or consumer* (41,42). Furthermore it can also be defined as "*Any preventable events that may cause or lead to inappropriate medication use or patient harm"*.
- ***Pharmaceutical care:*** The responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life (43). It is further stated that it is based on a relationship between the patient and the healthcare providers, who accept responsibility to provide care to the patients, and involves the active participation of both the patient and the healthcare provider in drug therapy decisions (44).

### *2.3 Study procedures*

Pharmaceutical care was rendered on a daily basis to all participants admitted to the Internal and Surgical wards of DGMAH. A data collection instrument (DCI) was adapted and developed from a number of studies in order to meet the objectives set out in this study (45,46). The form contained a patient database sheet to collect demographic data and a section to evaluate the patient's medication therapy, in order to identify potential and actual drug problems.

This DCI was divided into three sections, which included:

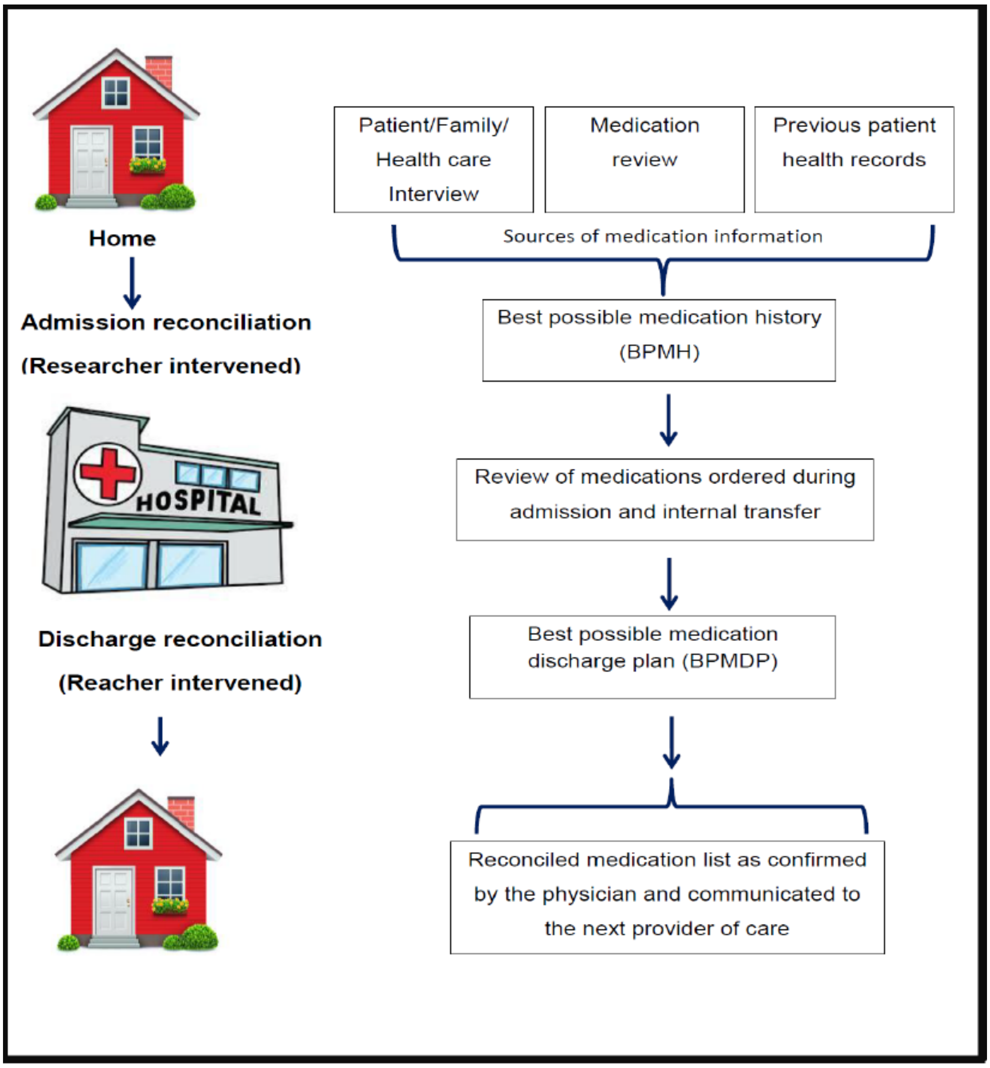
- Section 1: participant's demographics, information about home medication and all the medication that was prescribed during admission and transfer of the patient, and if the medication was continued or discontinued upon discharge.
- Section 2: participant's home medication which included if he/she was taking any medication at home, if and how the patient brought their home medication to hospital as well as which resource the information was obtained from, e.g. patient, patient file, next of kin, or a healthcare professional. This section also included all the home medication names and if the medication is continued or discontinued upon admission and discharge.
- Section 3: medication that was prescribed during admission and transfer of the patient, and if the medication was continued or discontinued upon discharge. The reason for discontinuation was recorded in this section.

The data collection tool was used to review participants who met the following inclusion criteria: participants who were taking chronic medication at the time and for whom medications have been prescribed in hospital, signed the consent form, and older than 18 years old. For the first four months, the participants were selected by including all bed numbers that were even and for the second four months uneven bed numbers were included. All records were available as hard copies.

Data (sources of medicines) included all prescription medication, herbal medication, nutritional supplements, over the counter (OTC) medication, vaccines, diagnostic and contrast agents, radioactive medications and parenteral nutrition. The recorded medication history was revised when the in-patient therapy was prescribed on the drug chart; and, upon the participants discharge, interventions were made with a new proposed drug therapy that was communicated verbally to the patient's physician, and the necessary changes were made in the form of a new reconciled medication list. Information had been recorded in the records according to usual practices of DGMAH.

All the information obtained was captured in a Microsoft Excel™ spreadsheet and later imported to the Statistical Analysis System (SAS) (SAS Institute Inc, Carey New York City, United States of America), Release 9.3 for analysis. Descriptive analyses such as mean, median, mode and interquartile range were used to summarise the data. Demographic results were descriptive for age, sex, education, occupation and medication use. Frequencies, cross-tabs and measures of central tendency were used to compare medical record information. Results are presented in tables and graphs. A summary of the study procedure is illustrated in Figure 1.

**Figure 1: Data collection Process**



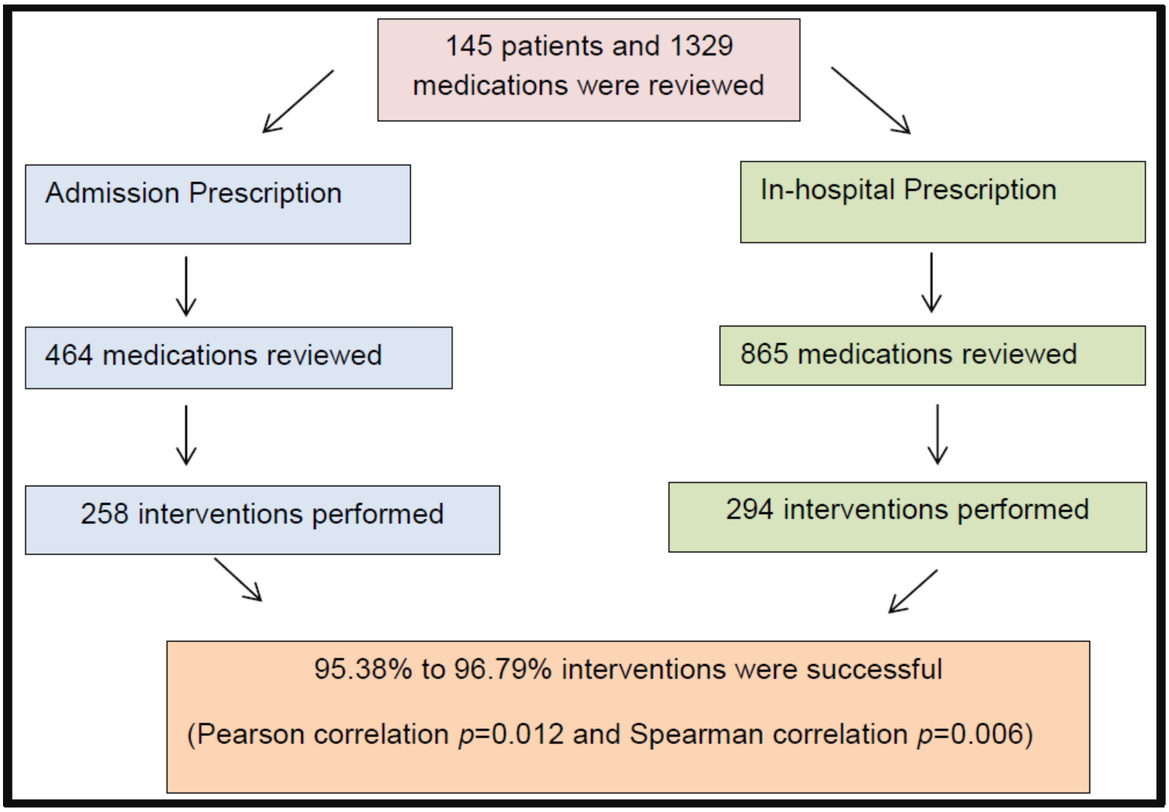
### *2.4 Ethical considerations*
Data collection commenced after obtaining approval from the Sefako Makgatho Health Sciences University Research Ethics Committee (SMUREC/H/169/2015:PG) and permission and consent from DGMAH management. Informed consent from the participants or a family member was obtained and each participant was given an information leaflet if they required any further information. All data were collected within the hospital environment and medical charts were not taken from the hospital premises. No patient or prescriber names or details were written on data collection forms or included in a Microsoft Excel™ spreadsheet. No participants were identified or contacted, thus ensuring that anonymity and confidentiality were maintained. Confidentiality was also maintained during record reviews with the use of numerical identification of files and through the presentation of aggregate data and not individual data.

## 3. Results

### *3.1 Patient enrolment*
During the nine-month study period, 145 study participants from the Surgical and Internal Medicine wards were selected and enrolled on the basis of the inclusion criteria. A combination of an interview and review of the medical chart were used to determine the chronic medication patients were taking prior to admission. The medication was reviewed to identify any discrepancies. In total 1329 medications were reviewed: 464 medications upon admission and 865 medications during the hospital stay.

A total of 552 (41.53%) interventions were performed, of which 258 (55.60%) interventions were performed upon admission and 294 (40%) of the interventions were performed during the patient's hospital stay, with a statistical significance of $p$=0.012 (Pearson correlation and $p$= 0.006 Spearman correlation) (Figure 2).

**Figure 2 - Medication reconciliation process in the surgical and internal wards**




### *3.2 Patient Characteristics*
The majority of the participants were female (110 [75.86%]), with an average age of 54.4 years (range: 18 to 86 years). The majority of the population (97.93%) was African. The population was divided

equally in terms of their occupational status: pensioners (37%), employed (32%) and unemployed (30%). The most common language spoken was Tswana (28.97%) followed by Sotho (17.93%) and Zulu (17.24%). Fewer than 2% (1.38%) of the study participants communicated in English. Less than half of the participants (42.66%) completed primary school and less than 12% (11.72%) continued to a college or training institute (Table 2).

**Table 2: Patient Characteristics**

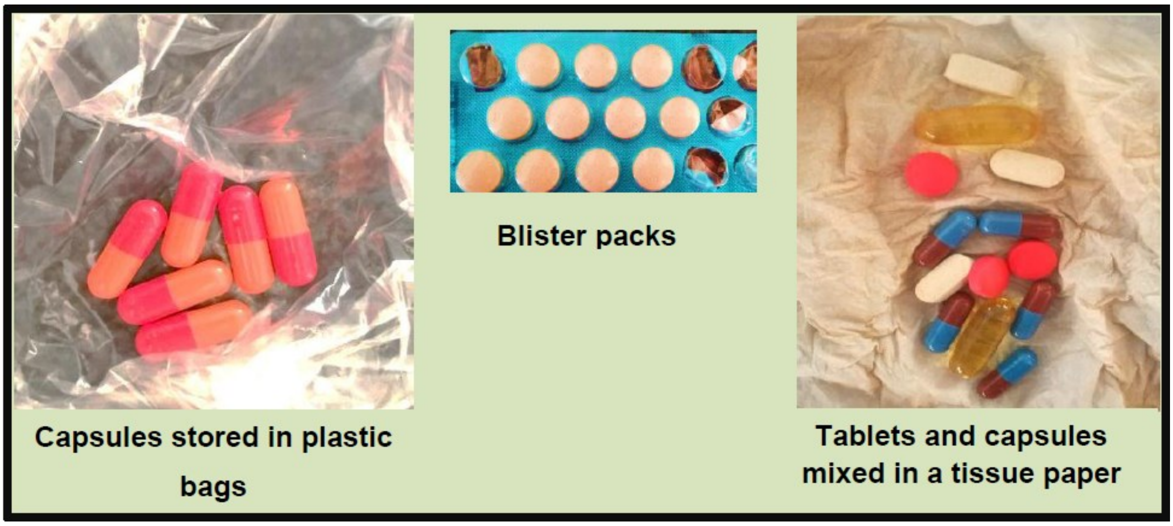
| | Number (n=145) | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 35 | 24.14 |
| Female | 110 | 75.86 |
| **Ethnic Group** | | |
| African | 142 | 97.93 |
| Caucasian | 3 | 2.07 |
| **Language** | | |
| Tswana | 42 | 28.97 |
| Sotho | 26 | 17.93 |
| Zulu | 25 | 17.24 |
| Tsonga | 24 | 16.55 |
| Other | 28 | 19.31 |
| **Level of education** | | |
| Primary School | 72 | 42.66 |
| High School | 56 | 38.62 |
| College/training institute | 17 | 11.72 |
| **Occupation** | | |
| Employed | 47 | 32.41 |
| Unemployed | 44 | 30.34 |
| Pensioner | 54 | 37.24 |

***3.3 Medication reconciliation on admission***

In total, 1329 medications were reviewed throughout the study with 464 (34.91%) upon admission. Over half (51.03%) of the study population did not bring their actual chronic medication to the hospital.

Figure 3 illustrates how the remaining 48.9% of the participants brought their medication: either in the original packaging (40%), as single unidentified tablets/capsules (4.83%), repackaged and unlabelled (3.45%) or repackaged and labelled (0.69%).

**Figure 3: Example of how patients brought their medication to the hospital**




Information obtained was not always conclusive upon interviewing the participants (due to sedation, poor understanding, or a language becoming a barrier for correct reconciliation to be undertaken). More than half (55.86 %) of the total participants required further investigation into the type of medicine taken by reviewing their medical charts (Table 3).

**Table 3: Sources of medication reconciliation**

| Parameter | Number (n=145) | Percentage |
|---|---|---|
| **Source of medication reconciliation information** | | |
| Patient file | 62 | 42.75 |
| Patient | 81 | 55.86 |
| Next of kin | 1 | 0.69 |
| Healthcare professional | 1 | 0.69 |
| **Medicines brought in from home** | | |
| Original Packaging | 58 | 40 |
| Tablets/capsule as is | 7 | 4.83 |
| Repackaged and labelled | 1 | 0.69 |
| Repackaged and unlabelled | 5 | 3.45 |
| None | 74 | 51.03 |

### *3.4 Review time*

The mean time to interview a participant/caregiver, as well as review a medical chart, was 16.4 (± 4.75) minutes (median (IQR): 15 (14-19)). The time taken to review a patient's medicine increased with the length of hospital stay to (13.6 (± 7.80)) days. Participants who were pensioners required more time (17.9 (± 5.24)) with the pharmacist. There is a significant difference in the time spent with employed participants compared to pensioners (*p=0.001*), also the time spent with self-employed participants compared with employed participants (*p=0.005*). There was no statistical significance (*p=0.065*) between the time spent with study participants with primary school education and those who received high school education or education at colleges/training institutes.

The time taken to review a participant's medicine decreased as the study progressed as the reviewer had more experience by the end of the study (Table 4). There is no statistical difference in the time spent on medication reconciliation during the different transitions of care. (r = 0.125*, p=0.133*), as well as the number of medications at the different points of care (r = 0.012, *p*=0.885).

**Table 4: Time spent on medication reconciliation per occupation category**

| Occupation | n=145 | Mean (± SD) | *p* value | Test |
|---|---|---|---|---|
| Employed<br>Mean (± SD)<br>Median (IQR) | 31 | 14.4 (± 2.89)<br>15 (12 – 15) | *0.001** | ANOVA followed by pairwise *t*- *tests* |
| Self-employed<br>Mean (± SD)<br>Median (IQR) | 16 | 14.7 (± 4.06)<br>15 (12 – 17) | *0.0050** | |
| Unemployed<br>Mean (± SD)<br>Median (IQR) | 44 | 16.5 (± 4.82)<br>15 (14 – 20) | *0.0050** | |
| Pensioner<br>Mean (± SD)<br>Median (IQR) | 54 | 17.9 (± 5.24)<br>17 (15 – 22) | *0.001** | |
| **Education** | | | | |
| College/Training Institute<br>Mean (± SD)<br>Median (IQR) | 17 | 15.2 (± 4.72)<br>15 (13-16) | *0.065* | ANOVA |
| High school<br>Mean (± SD)<br>Median (IQR) | 56 | 15.6 (± 4.71)<br>15(12-18) | | |
| Primary school<br>Mean (± SD)<br>Median (IQR) | 72 | 17.3 (± 4.70)<br>15(15-20) | | |
| **Time spent on medication during the different transitions of care** | | | | |
| Number of medications on admission and time spent | | | | Pearson correlation, Spearman correlation |
| r | 0.125 | | *0.133* | |
| $r_s$ | 0.157 | | *0.058* | |
| Number of medications in hospital and time spent | | | | |
| r | 0.012 | | *0.885* | |
| $r_s$ | 0.013 | | *0.878* | |

*Significantly different

### ***3.5 Medication used during hospital stay***

The medication used was classified according to the Anatomical Therapeutic Chemical (ATC) classification system (47-49). A total of 1329 medicines were reviewed during the admission and discharge phase in hospital. More than half (50.8%) of the medication that patients brought with them from home was disclosed to the nursing staff. The total number of medicines brought into the hospital upon admission were 464, with an average of 3.2 medicines per patient on admission, and 865 medications were prescribed with an average of six medications per patient during their hospital stay.

Table 5 indicates the different types of medication most frequently used, including medicines for the cardiovascular system (485 items; 35%), alimentary tract system (275 items; 21%) and anti-infective medicines (236 items; 18.1%).

**Table 5: Most frequently prescribed medicines**

| **Drug name** | **Therapeutic class** | **ATC Code** | **Admission Frequency Number n= 464 (%)** | **In-hospital Frequency Number n= 865 (%)** |
|---|---|---|---|---|
| **Alimentary Tract and Metabolism** | | | | |
| **Metformin** | Biguanide | A10BA02 | 35 (7.33) | 26 (3.00) |
| **Insulin** | Insulin | A10AC01 | 10 (2.15) | 24 (2.77) |
| **Cardiovascular System** | | | | |
| **Amlodipine** | DHP-CCB | C08CA01 | 23 (4.96) | 39 (4.51) |
| **Enalapril** | ACE-inhibitor | C09AA02 | 45 (9.70) | 58 (6.71) |
| **Simvastatin** | HMG CoA Reductase Inhibitors | C10AA01 | 15 (3.23) | 25 (2.89) |
| **Furosemide** | High ceiling diuretic | C03CA01 | 12 (2.59) | 31 (3.58) |
| **HCTZ** | Low ceiling diuretic (thiazide) | C03AA03 | 54 (11.64) | 59 (6.82) |
| **Anti-invectives for systemic use** | | | | |
| **Fixed dose combination of Anti-retrovirals: Efavirenz Tenofovir Emtricitabine** | Anti- retroviral | J05AR06 | 34 (7.33) | 35(4.04) |
| **Isoniazid Rifampicin Ethambutol Pyrazinamide** | Anti-tuberculosis | J04AM06 | 23 (4.96) | 52 (6.01) |
| **Antithrombotic agents** | | | | |
| Acetylsalicylic acid (aspirin) | Platelet aggregation inhibitor | B01AC06 | 18 (3.88) | 27 (3.12) |
| **>Analgesic** | | | | |
| Enoxaparin | Low molecular weight heparin | B01AB05 | 0 (0) | 34 (3.93) |
| Tramadol | Opioid | N02AX02 | 6 (1.29) | 56 (6.47) |
| **Analgesics and Antipyretic** | | | | |
| Paracetamol (Acetaminophen) | Anilides | N02BE01 | 17 (3.66) | 44 (5.09) |
| Traditional Medicine | | | | |
| Traditional Medicine | Traditional Medicine | | 5 (1.07) | 0 |

***3.6 Interventions***
A significant difference between the admission and in-hospital prescription (r: r = 0.209, *p*: 0.0012) resulted in more interventions made during hospital stay (Table 6).

**Table 6: Intervention upon admission vs interventions during hospital stay**

| | R and $R_s$ | *p* value | Test |
|---|---|---|---|
| Intervention upon admission vs interventions during hospital stay | r = 0.209, $r_s$ = 0.228 | *p*=0.0012*, *p*=0.006* | Pearson correlation, Spearman correlation |

***Significant difference**

A total of 552 (41.53%) interventions were suggested for the 145 study participants during the different transitions of care (admission, in-hospital stay and discharge), with an average of 3.80 interventions per patient. More than 70% (79%) of all medicines were continued upon admission and nearly 40% (37.5%) of the medicines were discontinued during their hospital stay. The discontinuation of medicines upon admission was due to either the participant receiving the same or generic form of the medication in hospital, and the participant was unaware of this, or the healthcare staff were unware that the patient is continuing with their home medication even if it was prescribed in hospital. During the patient's hospital stay, the main reasons for discontinuation were either acute indications (24 %) or long-term use of a prophylactic medication, such as extended days of surgical antimicrobial prophylaxis (20%).

In addition, more than 60% (66.12%) of medication was not transcribed to the hospital prescription forms, which resulted in medication omissions; consequently, patients did not receive their medication. A total of 294 (40%) interventions were made in hospital whereby over 30% (32.5%) of the participants required counselling as many did not know about their new medication. Different types of interventions and examples of medication errors observed are shown in Table 7.

**Table 7: Types of interventions for patient's medication during hospital stay and examples of interventions performed**

| Intervention | Percentage | | Examples of interventions performed | *p* value | Test |
|---|---|---|---|---|---|
| | Upon admission | Upon hospital medication during hospital stay | | | Fishers Exact Test |
| Alternative medication | 1.65 | 0.36 | Patient was prescribed omeprazole for the treatment of peptic ulcers, however due to the lack of stock, ranitidine was issued for the time being | 0.103 | |
| Change dose | 0.83 | 2.85 | Cloxacillin given as 12 hourly instead of 6 hourly as prescribed | 0.233 | |
| Change frequency | 2.07 | 1.43 | Patient was taking levodopa-carbidopa three times a day before admission but was ordered as twice daily during hospitalisation | 0.740 | |
| Counselling | 13.22 | 32.5 | Patient was taking ibuprofen before | **‹0.001*** | |

| | | | | | |
|---|---|---|---|---|---|
| | | | admission, however patient continued to use own supply of ibuprofen while being treated for Upper Intestinal Gastric Bleed | | |
| Monitor patient | 1.65 | 8.21 | Patient is unaware of the new treatment, taking metformin without the knowledge of the healthcare staff while receiving insulin on a sliding scale resulting in low blood glucose levels | **‹0.001*** | |
| Stop the medication | 7.44 | 37.5 | Patient is receiving Amoxicillin/clavulanic acid for 27 days with no signs of an infection | **‹0.001*** | |
| Stop the medication and monitor the patient | 2.07 | 4.29 | Patient complains about being dizzy. Upon investigation: patient is taking enalapril 10mg daily while receiving 5mg enalapril in hospital resulting in medication duplication and low BP | 0.846 | |
| Transcribed to prescription | 66.12 | 11.07 | Patient admitted to the internal medicine ward on ARV treatment, but during the hospital stay no ARV treatment was transcribed onto the hospital Rx | **‹0.001*** | |
| Use when necessary | 2.07 | 1.79 | Patient was taking diclofenac, 50mg as needed before admission. While in hospital, patient continued to use own supply of diclofenac | 0.729 | |

*Significant difference

**4. Discussion**

The majority of the study population was African (97.93%) and more than half were female (75.86 %), which is in line with the general South African population (50). Just under half (42.66%) of the study participants completed primary school and approximately 10% completed further training at a Tertiary

Training Institute. More than 30% (32.41%) of the participants were employed, contrary to the majority of South Africans, whereby nearly 60% of the population is employed (50).

South Africa has eleven official languages. The study was conducted in Gauteng province and according to the 2011 census; the majority of the population in the province speak isiZulu, English and Afrikaans. Languages mostly spoken by the study participants included Tswana (28.97%), Sotho (17.93%) and Zulu (17.24%). This is important when interviewing patients on their medicine use in hospitals and other settings and countries where multiple languages are spoken. Otherwise, adherence can be compromised especially if patients do not understand the instructions (51-53).

On admission, more than half of the study participants (51.03%) did not bring their home medication to the hospital. For the remaining study participants (48.97%), the majority of the medicines brought in were labelled, and in the original packaging, and consequently could be identified. This is very similar to a study performed in Brazil (54), where half of the patients (50%) brought their medication to the hospital on admission and close to 30% brought a list of medicines they were currently taking. The importance of reviewing actual medicines brought in by patients on admission by healthcare workers have also been highlighted in other studies (55).

Medicines with the highest prevalence were those used for the cardiovascular system (35%), alimentary tract (21%) and anti-infectives (18.1%). One would have expected the use of anti-infectives to be higher in South Africa, due to the AIDS pandemic and a recent rise in antimicrobial resistance (AMR) (56,57), which resulted in the recent instigation of national strategies to fight AMR (3, 58-61). However, South Africa has recently experienced a rise in non-communicable diseases (NCD), which include cardiovascular diseases, diabetes, cancers, chronic respiratory diseases and mental illness, resulting in initiatives to improve the availability of medicines to treat patients with chronic diseases as well as initiatives to enhance adherence rates (3,62-64). In addition, in South Africa as in a number of other African countries, traditional healers play a role in healthcare. However, although there are more than 200,000 traditional healers across the country (65), encouragingly less than 1.5% (1.07) of all the medicines brought in by the study participants were identified as traditional medicines. This though might not be an accurate reflection of traditional medicines used by the study participants, as published studies have shown that patients may be reluctant to disclose the use of traditional medicine because they fear disapproval and doctors do not always ask their patients about any traditional medicine use (66).

In this study, sources of information about medicines being taken by patients included interviews with participants (55.86%) and medical chart reviews (42.75%). Medical chart reviews were not conducted in patients that were sedated, had either poor understanding of the study, or where language barriers (even with the help of an interpreter) could not be overcome. It has also been stated (67) that failure to communicate properly can have negative consequences such as patients may fail to comply with instructions or elect not to have potentially life-saving treatment. In addition, it is important to encourage the development of electronic recording systems to facilitate the tracking and easy retrieval of accurate information necessary for high-quality patient care (68,69). These are thoughts for the future as the uses of electronic recording systems grow across South Africa as well as other African countries.

The average time to interview a patient as well as review a medical chart was 16.4 minutes. There was a significant difference ($p$=0.001) in the time spent interviewing employed participants and pensioners as typically pensioners enquired more about their medicines and typically required extra counselling such as side-effects and potential interactions. This is similar to a study performed in the United Kingdom whereby patient counselling took approximately 30 minutes more in pensioners in comparison to other age groups (70). The results from these studies suggest that in-patient counselling of elderly patients is a positive step to achieving maximum benefit from their medication and minimise unnecessary problems caused by excessive, inappropriate or inadequate consumption of medicines (70). Interestingly, there was no significant difference ($p$=0.065) in the time spent interviewing participants with primary school education although it took nearly two minutes longer (17.3 minutes) compared to participants who completed secondary or tertiary education (15.4 minutes). According to the 2012 General Household Survey (GHS) conducted by Statistics South Africa (50), 7.1% of South Africans are illiterate and this could result in more time being spent with patients with primary school education, as further clarification may be needed. Pharmacists can play a role with support and counselling for patients regarding their medicine use (70).

In this study, 1329 medicines were reviewed upon admission and during hospital stay. Discrepancies in medication history may impair the effectiveness and safety of medicines (47). There was a significant difference ($p$=0.006) when comparing the medicines patients were taking before or during hospitalisation; subsequently a total of 552 (41.53%) interventions were performed. The majority of patients had at least 3.96 medication discrepancies on average, which is high compared to studies conducted in countries such as the UK, USA and Canada which saw 0.93 -1.32 discrepancies per patient (71). When evaluating the origin of medication discrepancies, the most prevalent were omissions (medications used before admission but not transcribed during hospitalisation) which accounted for more than 60% (66.12%) of the interventions (Table 7). The predominance of omissions may be related to the collection of incomplete and inaccurate medication histories (54). Other studies have shown similar results, particularly with respect to a higher incidence of omissions (71-74), which needs to be addressed.

A total of 40% of all interventions performed were during the patients' hospital stay, of which 32.5% required patient counselling as many participants did not know about the new treatment being prescribed. Over 35% (37.55%) of the interventions included discontinuing the previous treatment either due to an acute condition that had been resolved or the over-use of empiric therapy or extended antimicrobial prophylactic use. In addition, almost 14% (13.44%) of participants received duplicate therapy as they continued to take the same medicine prescribed in hospital (Table 7). Duplication of medication may be attributed to the miscommunication between staff and participants, with many patients in this study unaware of which medicines were being prescribed or given to them, or they were unaware when their medicines were temporarily stopped; similar to other studies (75-78).

This is a concern as the lack of patient education, communication, and transcribing home medication to prescription charts may result in treatment failure, poor prognosis and increased hospital stay (72). Furthermore, inadequate knowledge, insufficient training and increased workload of staff have also been listed as major causes of medicines discrepancies (76-78). Since physicians, nurses and pharmacists do play key roles in medication management, including ordering, monitoring and educating patients during hospitalisation, and at discharge, a multidisciplinary team approach is considered fundamental to enhance medication reconciliation, especially with errors often originating in medication histories (79). Applying medication reconciliation to the different stages of transitions can lead to better patient safety outcomes. The medication reconciliation tool used by pharmacists in this study was effective in identifying medication discrepancies and addressing these to improve patient safety. Consequently, multidisciplinary teams including pharmacists using such tools should become part of routine care in this and other public hospitals in South Africa. We will be following this in the future.

## 5. Limitations

We are aware that this study was conducted in only one leading academic public hospital. As a result, may not be fully representational of other teaching hospitals in South Africa. However, we intend to extend this study to other hospitals given the concerns identified, as well as use the findings to improve care within DGMAH. Performing medication reconciliation in a paper-based patient management system was also a challenge as not all patient files were neatly stored, which increased the time to review them. However, in view of our methodology, we believe our findings are robust providing direction to this and other public hospitals in South Africa. In addition, support the need for electronic systems within hospitals.

## 6. Conclusion

Medication reconciliation has the potential to bridge the communication gap between the healthcare team and the patient. Our study demonstrates that they are a number of issues with medication reconciliation throughout the hospitalization of patients that need to be addressed to improve patient care. This is because the lack of medication history and in-patient therapy led to a high number of necessary interventions in order to improve patient care and reduce errors. Based on our findings, medication reconciliation practices by multidisciplinary teams, including pharmacists, should become routine especially in resource-limited settings such as South Africa to improve patient safety. To ensure continuity of patient care, medication reconciliation should be implemented throughout the patient's hospital stay. Pharmacists are especially well suited to deal with these issues as they have in-depth knowledge on pharmacokinetics, pharmacodynamics, drug interactions and drug formulation. With this information, appropriate interventions will need to be studied to reduce errors in the process of medication reconciliation. These are considerations for the future and we will be following this up.

### Competing interest

The authors declare no competing interests with this study. The study was self-financed as part of ongoing studies to improve the quality of care within public hospitals in South Africa.

### Author contributions

PN, NS, and EM designed the study with PN principally involved in data collection and analysis. PN and BG produced the initial draft manuscript. All authors critiqued successive drafts of the manuscript before submission.

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