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RETROSPECTIVE EVALUATION OF DRUG THERAPY PROBLEMS IN CKD-ESRD PATIENTS AT CONNAUGHT TEACHING HOSPITAL COMPLEX – FREETOWN

***Dr Brian Thompson[1], Prof M. Samai[2], Prof Stella Usifoh[3]**

[1]Department of Clinical Pharmacy and Therapeutics, Faculty of Pharmaceutical Sciences, College of Medicine and Allied Health Sciences, University of Sierra Leone.
[2]Department of Pharmacology, Faculty of Basic Medical Sciences, College of Medicine and Allied Health Sciences, University of Sierra Leone.
[3]Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, University of Benn, Benin City, Nigeria.

***Corresponding Author: Dr. Brian Thompson**
Department of Clinical Pharmacy and Therapeutics, Faculty of Pharmaceutical Sciences, College of Medicine and Allied Health Sciences, University of Sierra Leone. **DOI:** https://doi.org/10.5281/zenodo.18438427

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ABSTRACT

Background: Chronic kidney disease (CKD), especially end-stage renal disease (ESRD), is complexed with polypharmacy, causing drug therapy problems (DTPs), including adverse reactions, inappropriate doses, and interactions that add to morbidity and healthcare expenses. The purpose of this study was to determine, DTPs of hospitalized CKD patients using a standardized taxonomy. **Methods:** This retrospective study investigated drug therapy problems in hospitalized CKD-ESRD patients. A range of eligible records (n=98) available from the Records unit of Connaught Hospital Teaching Complex hospital were examined (January 2022-December 2024). Patients with documented drug therapy, aged 10 years and above were included. A structured questionnaire was used to identify and classify DTPs based on the patient needs domain of Indication, Effectiveness, Safety, and Adherence. The demographics, DTP prevalence and actions were summarized using descriptive statistics; inferential statistics were done using chi-square tests, correlation, ANOVA, t-tests and regressions (SPSS v.25, $p<0.05$). **Results:** The cohort (44.79+-16.23 years; 61.2% men) had an average length of stay of 13.00+-12.00 days and 2.18+-1.00 DTPs per patient (214 total). Safety (42.5%), Indication (36.4%), domains dominated; DTP of 81.8% were of high significance. The most prevalent specific types were unnecessary drug therapy and adverse drug reactions (23.4% each. These were caused by duplicate therapy (40% of unnecessary cases) and drug interactions (64% of adverse reactions), which highlight the polypharmacy risks in renal impairment. The most prevalent comorbidity was hypertension (54.1%). There were no sex differences in DTP categories ($\chi^2=0.18$, $p=0.98$) or in the prevalence of high-significance DTPs ($\chi^2=0.12$, $p=0.73$). There was a weak correlation between length of stay and DTP count ($r=0.14$, $p=0.18$); regressions did not demonstrate any significant predictor ($R^2=0.03$, $p=0.41$). Only 50% of DTPs were noted to have interventions, most of which were discontinuations (25.2%). **Conclusion:** CKD pharmacotherapy is characterized by high-risk, high-frequency DTPs, with under-resolution of most of them, which demonstrates systemic gaps. Multidisciplinary reviews, renal dosing protocols and pharmacist incorporation are advised to augment outcomes and inform guidelines.

KEYWORDS: Chronic Kidney Disease (CKD), End-Stage Renal Disease (ESRD), Drug Therapy Problems (DTPs), Polypharmacy.

INTRODUCTION

CKD is a widespread condition that has a high morbidity, mortality, and burden on healthcare due to polypharmacy and subsequent drug therapy problems (DTPs), including adverse drug reactions (ADRs), drug-drug interactions (DDIs), inappropriate dosing, and non-adherence[1] Patients having CKD tend to need complicated interventions, including renin-angiotensin-

aldosterone system (RAAS) blockers, phosphate binders, erythropoiesis-stimulating agents (ESAs), and antidiabetic medications that aggravate risks of hyperkalemia, acute kidney injury (AKI), hypercalcemia, and cardiovascular (CV) incidents.[2,3] Medication therapy management (MTM) led by pharmacists has become an encouraging approach to counter these DTPs to optimize dosing, increase adherence, and incorporate therapeutic drug monitoring (TDM).

Intervention in RAAS Inhibitors and Antihypertensives in CKD leadership by pharmacists.

RAAS inhibitors are first-line agents in hypertension (HTN) and proteinuria of CKD but often cause DTPs such as hyperkaemia and AKI, especially when used in polypharmacy[4] Chisholm-Burns et al. (2010) showed in a cohort study of patients on RAAS inhibitors and insulin that MTM with laboratory monitoring cut inpatient stays with ADRs by 30% by detecting the problems early, thus correcting the dose. This was an urban-based intervention that emphasized the value of proactive lab integration but was constrained by self-reported measures of adherence. In line with these results, Saran et al.[3] carried out a 9-month intervention trial of pharmacist-led RAAS optimization in the control of blood pressure (BP), where 25% of blood pressure (BP) control improved and 20% of hospitalizations were reduced by means of increased compliance. Despite the HTN specificity, these findings support the inclusion of pharmacists in CKD clinics in order to safely titrate RAAS agents.

The same advantages can be applied to more comprehensive antihypertensive treatments.[5] The role of pharmacist-led MTM in antihypertensives and phosphate binders in CKD clinics and found the top DTPs to be polypharmacy errors and inadequate BP/phosphate control. Their intervention in one center by itself decreased the hospitalization by 25 percent and lowered the control measures by 20 percent, focusing on saving costs, but they were dependent on self-reported data.

Treatment of CKD-Mineral Bone Disorder (CKD-MBD) is a condition marked by impaired phosphate, calcium, and vitamin D metabolism, which carries significant DTP risks, such as vascular calcification and CV complications, which are frequently due to the under- or overdosing of binders and non-adherence[3]. In a small dialysis cohort (n<300),[5] they found that pharmacist-managed phosphate binders and vitamin D prevented the progression of calcification as well as increased adherence, indicating that pharmacists should be embedded in CKD-MBD protocols. This was limited by dialysis exclusivity and was limited to previous CKD stages.

The study by Karandikar et al[5] t showed the results of pharmacist activity in CKD-MBD that led to 20-25 percent improvements in outcomes, which supports the integration of protocols, but the application is restrained by dialysis-focused designs and small populations.

Narrative Polypharmacy comorbid CKD magnifies DTPs, such as inappropriate dosing, DDIs, and non-adherence, which are involved in causing ADRs in care transitions.[1] The study of comprehensive medication reviews (CMRs),[8] advocated for systematic Pharmacist –led MTM to resolve such issues like reductions in dosing errors and improvement in adherence, thereby decreasing ADR risks; standardization of CMRs in transitions was recommended, but limitations included the use of an observational design and rural populations.

Interdisciplinary practices also reduce transition-related DTPs[9] investigated team-based reconciliation, which minimized adverse drug events (ADEs) by 20% and AKI by 15% in a small cohort (n<400), suggesting compulsory CKD teams even though the scope was short term. Such results are consistent with those of Pai et al (2013)[8], indicating collaborative MTM as a key to error-prone transitions, with a decrease of risks by 15-25% consistently but requiring larger, longitudinal studies.

Manley et al. (2003)[1] conducted a cross-sectional study of 133 ambulatory hemodialysis (HD) patients to investigate prevalence and factors related to medication-related problems (MRP). The average patient was 60.5 years old, was prescribed an average of 11 medications and had 6 comorbidities; 97.7% were experiencing at least one MRP with an average of 3.6 per patient. The prevalent MRPs were drugs without indication (30.9%), laboratory monitoring (27.6%), indications without drugs (17.5%), and dosing errors (15.4%). The findings prevalent burden of polypharmacy and multimorbidity in HD populations and the need to develop specific interventions, especially in the cases of the latter.

In the case of narrow therapeutic index medications, such as digoxin and vancomycin, renal impairment increases the risks of toxicity, which requires TDM.[10] In their observational study of TDM, Weinhandl et al. (2018).[10] identified 20% toxicity, and improved infection control, calling on protocol enforcement, but limits drug-specificity.

Hypoglycemia caused by insulin and the eGFR loss are common DTPs in diabetic CKD. Heerspink et al. (2020)[11] selected a randomized trial of SGLT2 inhibitors using an insulin alteration, resulting in a 25% reduction in eGFR deterioration and a 35 percent reduction in hypoglycemic incidents. This underpins the inclusion of SGLT2 in guidelines, mitigated by the short-term information and cost impediments.

The lack of access, especially in the countryside, contributes to an increased level of non-adherence and ADR risks.[12] Li et al. (2020)[12] pilot-tested telepharmacy MTM, which increased adherence by 20%

and reduced ADRs by 15% and recommended funding under conditions of digital illiteracy and controls. On the same note, Lee et al. (2022)[13] examined remote patient monitoring (RPM)-MTM of BP and glucose to reduce heart failure hospitalization by 20% and improve glycemic control but limited to access. These virtual models show 15-20% improvements in adherence and outcomes making tele pharmacy an important element in providing equitable CKD care.

METHODS

Study Design

The research design was a retrospective chart review design, which aimed at identifying and characterize Drug Therapy Problems (DTPs) in hospitalized patients. The established taxonomy of Cipolle et al. (2012)[14] was used to categorizes DTPs into 4 key domains of Indication, Effectiveness, Safety, and Adherence.

Study Site

This study took place at Connaught Hospital which is the top referral and teaching hospital in Sierra Leone with a total of about 350 beds in 10 wards, ICU, and emergency units. The Cardio-Renal Unit is a unit within the Internal Medicine Department that is specifically used to treat acute kidney injury (AKI), chronic kidney disease (CKD), and ESRD in adults. It integrates a refurbished dialysis unit that provides hemodialysis services to both inpatients and outpatients.

Sample Size

A total of 98 records met the criteria for retrospective review within the time frame and were analyzed.

Sampling Method

All the Patient records presented by the Records Manager for the period 1st January 2022 to December 31,2024, which met the inclusion criteria were included in the review who met the inclusion criteria were included This contained a series of detailed charts of that era. Thus, purposive sampling method was used to ensure that all the pharmacotherapy practices used were captured.

Inclusion and Exclusion Criteria

The Inclusion criteria were patient aged 10 years or older with primary diagnosis of chronic kidney disease or ESRD; who had spent at least 24 hours in hospital and had complete medication orders, progress notes, laboratory results, and discharge summaries . The exclusion criteria were as patients with incomplete records; no pharmacotherapy upon admission; and obstetric cases.

Ethical Consideration

Ethical and administrative approval were obtained from COMAHS Institutional Review Board (COMAHS/IRB/019-2024), Sierra Leone Ethics and Scientific Review Committee (SLESRC No: 020/09/2024) and Connaught Teaching Hospital Manager. Data collected were coded and patient confidentiality was maintained.

Data Collection

The data were gathered in two phases (1) baseline screening and (2) the intensive DTP extraction that was applied on all the potential valid records between the years 2022 and 2024. Data extracted were as follows: Section 1 (General Patient Information): Abstracted demographic and clinical information, including patient ID (de-identified), age, sex, admission/discharge dates, primary diagnosis, comorbidities, and a complete list of prescribed medications. -Section 2 (DTP Categories and Causes): Assessed all the prescribed drugs in a systematic manner in the four areas (Indication, Effectiveness, Safety, Adherence). Potential and actual DTPs were determined -Section 3 -Each identified DTP was recorded with the following information: (a) what drug(s) and type of drug were involved in the DTP; (b) what caused the drug-type problem; (c) what supporting evidence was found (e.g., lab values); (d) what was the outcome or risk (e.g., prolonged hospital stay, risk of toxicity); and (e) what interventions occurred as a result (e.g., a dose reduction, discontinuation). DTPs can be one or more to a single patient. -Section 4 (Prioritization): The clinical relevance of each DTP was identified based on a 3-tier scale: High (e.g., probable severe harm or treatment failure), Medium (e.g., moderate impact of the therapeutic) or Low (e.g., very low risk). The priorities were selected based on the criteria of agreement that were published by Cipolle et al., with the consideration of such aspects as the acuity of the patient, the potency of the drug, and the strength of evidence. The eGFR measurements record were noted and if not available, ESRD status was determined based on clinician-recorded diagnosis with the support of biochemical evidence of advanced kidney failure (markedly elevated serum creatinine and urea).

Data Analysis

The extracted data were de-identified and validated. The descriptive statistics of patient characteristics (e.g. mean age, DTP prevalence by domain, as well as by type and with sub-causes) were provided by frequencies and percentages and means and standard deviations. Chi-square tests to determine the relationships between DTP types and variables (e.g., age, comorbidities) and logistic regression to determine predictors of high-significance DTPs were the basis of inferential statistics. Analysis was performed in all the cases using SPSS V 25 at the level of $p<0.05$. For scoring into low and high risk, the clinical relevance of each DTP was identified based on a 3-tier scale: High (e.g., probable severe harm or treatment failure), Medium (e.g., moderate impact of the therapeutic) or Low (e.g., very low risk). The priorities were selected based on the criteria of agreement that were published by Cipolle et al., with the consideration of such aspects as the acuity of the patient, the potency of the drug, and the strength of evidence.

RESULTS

Table 1: Descriptive Statistics for Demographics (Age, Length of Stay [LOS], DTP Count) and Sex Distribution N= 98

Variable	Subcategory	Frequency	Percentage	Mean	Std. Deviation
AGE				44.79	16.23
	10-30	22	22.9%		
	31-60	59	61.5%		
	above 60	15	15.6%		
DTP				2.18	1.00
	1	24	24.5%		
	2-3	68	69.4%		
	4-5	6	6.1%		
SEX					
	MALE	60	61.2%		
	FEMALE	38	38.8%		
LOS		98	100.0%	13.00	12.00

This retrospective review 98 patients with chronic kidney disease CKD-ESRD through the Cipolle et al. framework reveals significant challenges in pharmacotherapy in a multi-morbid population. The range of DTPs per patient (1-5), number of DTPs (214), and the average (2.18 per patient) indicate the widespread danger of polypharmacy in renal failure; the susceptibility to errors increases due to altered pharmacokinetics.

Demographics and Burden: The mean age of the patients was 44.79 +- 16.23 years, which is younger than the usual Western CKD groups, and it may reflect resource-strained environments with hastened disease progression in this group. Males were dominant (61.2%), and females constituted 38.8%. Average Length of Stay was of 13.00 +- 12.00 days LOS (n=98 complete data).

Table 2: Valid N: 98; Total co-morbidity instances: 130 (mean 1.33 per patient).

Category	Subcategory	Frequency	Percent
Cardiovascular (Hypertension incl. severe/uncontrolled; heart failure incl. CHF; cardiorenal syndrome; dyslipidemia; fluid overload)	Hypertension	53	54.1
	Heart Failure	7	7.1
	Cardiorenal Syndrome	2	2.0
	Severe HTN	1	1.0
	Uncontrolled HTN	1	1.0
	CHF	1	1.0
	Fluid Overload	1	1.0
	Dyslipidemia	1	1.0
	Subtotal	**67**	**68.4**
Hematological (Anemia incl. severe and CKD-related)	Anemia	14	14.3
	Severe Anemia	6	6.1
	Anemia in CKD	1	1.0
	Subtotal	**21**	**21.4**
Endocrine (Diabetes mellitus type 2)	Diabetes Mellitus Type 2	10	10.2
	Subtotal	**10**	**10.2**
Infectious Diseases (HIV; sepsis; hepatitis B)	HIV	4	4.1
	Sepsis	3	3.1
	Hep B	1	1.0
	Subtotal	**8**	**8.2**
Respiratory (Severe respiratory distress; asthma)	Severe Resp Distress	1	1.0
	Asthma	1	1.0
	Subtotal	**2**	**2.0**
Gastrointestinal (GI bleeding; hepatomegaly)	GI Bleeding	1	1.0
	Hepatomegaly	1	1.0
	Subtotal	**2**	**2.0**
Neurological (Seizures; encephalopathy; severe persistent	Seizures	1	1.0

headache)			
	Encephalopathy	1	1.0
	Severe Persistent Headache	1	1.0
	Subtotal	**3**	**3.1**
Genitourinary/Oncological (BPH/prostate cancer)	BPH/Prostate Cancer	1	1.0
	Subtotal	**1**	**1.0**
Musculoskeletal (Osteoarthritis)	Osteoarthritis	2	2.0
	Subtotal	**2**	**2.0**
Renal	Uremia	5	5.1
	Chronic Glomerulonephritis	4	4.1
	Nephrotic	2	2.0
	Uremic Symptoms	1	1.0
	Acute Kidney Injury	1	1.0
	Subtotal	**13**	**13.3**
Metabolic (Hyperuricemia)	Hyperuricemia	1	1.0
	Subtotal	**1**	**1.0**
Total		**98**	**100.0**

Note: Total is greater than 100 percent because patients may have more than one co-morbidity across and within systems; percentages are the sum of patient-level burden in each category/subcategory.

Co-Morbidity Profile: Thirty one co-morbidities were identified, which indicates the syndromic character of CKD. The most common one was hypertension (HTN; 54.1%), and it is no surprise because this condition is the etiological factor in 80-90 percent of CKD cases worldwide. The next in order were were ranked as anaemia (14.3%), diabetes mellitus type 2 (10.2%), heart failure (HF; 7.1), severe anaemia (6.1%). Some patients had diabetes mellitus which indicates its changeable risk in accelerating CKD. The more unusual issues are HIV (4.1%), sepsis (3.1%), and seizures (1.0) that underline infectious and neurological overlays.

Table 3: Number of DTPs by Co-Morbidity (Top 5 by Frequency) with mean and Standard Deviation. Valid N: 90

Co-Morbidity	N (Patients)	Mean DTPs	Std. Deviation
Hypertension	53	2.18	1.03
Anaemia	14	2.00	1.05
Diabetes Mellitus Type 2	10	2.28	1.00
Heart Failure	7	2.14	0.95
Severe Anaemia	6	2.33	0.58
Total	90	2.17	1.02

The most frequent co-morbidities were examined through a stats test (ANOVA), which did not report any significant differences in medication problems ($F=0.13$, $p=0.97$)- the mean was similar, ranging between 2.0 and 2.33 per case on average. This implies that such medication problems are inherent to chronic kidney disease (CKD) itself, and not caused by the other conditions. The leading position of high blood pressure among them, however, is likely to result in duplication and additional prescriptions of blood pressure drugs.

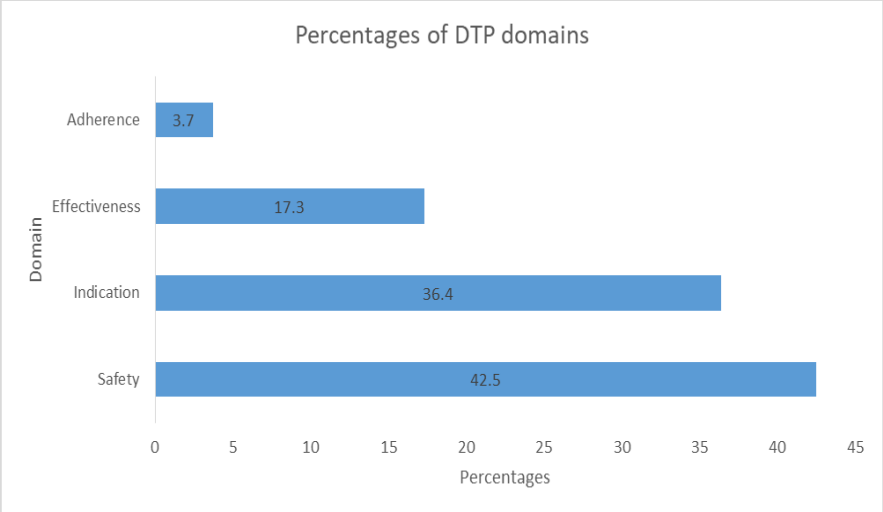

Figure 1: Percentages of DTP Domain.

DTP Characteristics and Degree: Safety DTPs were in the lead (42.5%), including adverse reactions (e.g., hyperkalemia due to renin-angiotensin-aldosterone system inhibitors in ESRD) and overdosing aggravated by renal non-clearance. Problems with indication (36.4 percent) involved unnecessary treatment (e.g., unindicated loop diuretics in euvolemia) and omissions (e.g., unprescribed statins in diabetic CKD). Underdose or refractory states (17.3%), and compliance (3.7%) were gap areas in effectiveness, which may be underestimated in chart reviews.

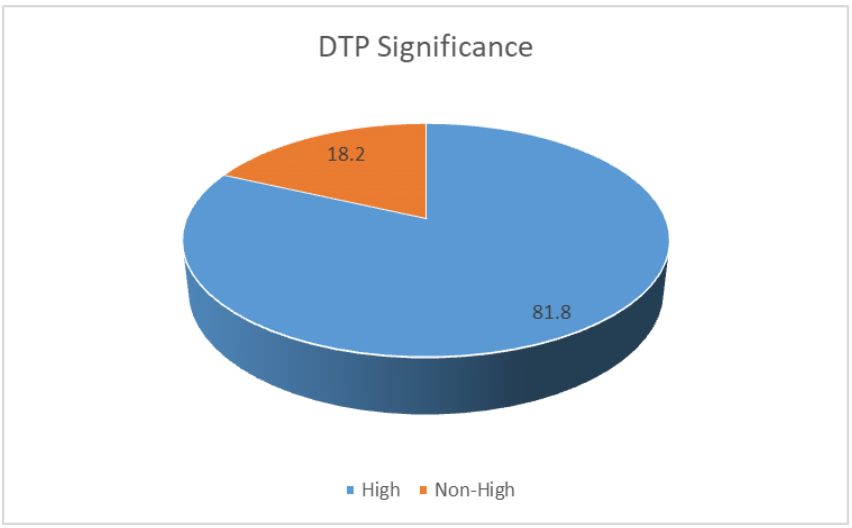

Figure 2: DTP Significance.

81.8 percent of DTPs were of high clinical significance (risk of harm/treatment failure)

Table 4: Association of DTP Category and Sex.

Test / DTP Category	Female	Male	Total	Value	df	Asymp. Sig. (2-sided)
Indication	36 (35.5)	42 (42.5)	78			
Effectiveness	16 (16.4)	21 (20.6)	37			
Safety	43 (42.4)	48 (48.6)	91			
Adherence	4 (3.7)	4 (4.3)	8			
Total	99	115	214			
Pearson Chi-Square				0.18	2	0.98
Likelihood Ratio				0.18	2	0.98
N of Valid Cases				140		

Chi-square (χ^2=0.12, p=0.73) showed no difference between males and females in age and high risk exposure Category-sex crosstabs (χ^2=0.18, p=0.98) gave further evidence of uniform distribution.

Table 5: Association of High-Significance DTPs and Sex.

Row / Test	High	Non-High	Total	Value	df	Asymp. Sig. (2-sided)
Male	110.00	20.00	130.00			
Female	55.00	29.00	84.00			
Total	165.00	49.00	214.00			
Pearson Chi-Square				0.12	1	0.73
Likelihood Ratio				0.12	1	0.73
N of Valid Cases				214		

Chi-square test (χ^2=0.12, p=0.73) showed no difference between males and females in age and high risk exposure.

Table 6.

	Levene's Test: F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
AGE	0.08	0.78	-0.94	96	0.35	-3.30	3.51	-10.29	3.69

The independent samples t-test reveals no statistically significant difference in mean age between male and female CKD patients (t = -0.94, df = 96, p = 0.35)

Table 7: Linear Regression: Predictors of DTP Count (DTP ~ AGE + LOS + SEX_M)
Model Summary, ANOVA, and Coefficients (Dependent Variable: DTP; Predictors: (Constant), AGE, LOS, SEX_M (Male=1); R=0.17, R^2=0.03)

Section / Model / Variable	R / Sum of Squares / Unstandardized Coefficients B	R Square / df / Std. Error	Adjusted R Square / Mean Square / Beta	Std. Error of the Estimate / F / t	Sig. / Lower Bound / Upper Bound
Model Summary - 1	0.17	0.03	0.01	0.99	
ANOVA - 1 Regression	2.89	3	0.96	0.98	0.41
ANOVA - Residual	93.11	94	0.99		
ANOVA – Total	96.00	97			
Coefficients - (Constant)	2.18	0.10		21.80	0.00
Coefficients – AGE	0.00	0.01	0.02	0.25	0.80
Coefficients – LOS	0.02	0.02	0.11	1.20	0.23
Coefficients - SEX_M	0.05	0.14	0.04	0.35	0.73

Trivial fit with non-significant betas (e.g., AGE b=0.00, p=0.80) was also described by significant (Nagelkerke R 2=0.03, p=0.41) and linear (R 2=0.03, p=0.41) logistic regression. This implies that drug therapy problems (DTPs) are inherent to the way medications act in chronic kidney disease (CKD) e.g. through synergies between drugs in patients with multiple health conditions, and not the result primarily due to external factors.

DTPs were not correlated with LOS because the pvalue is not significant (r=0.14, p=0.18), which indicates that long stays might indicate unresolved problems and not escalation of causes.

Predictive Modeling: Demographics and LOS had no significant predictive value on DTPs.

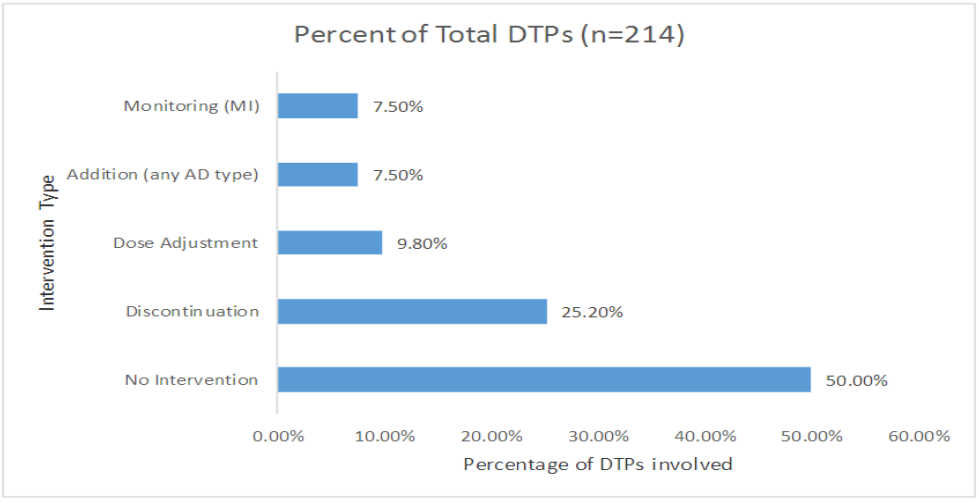

Figure 3: Percentages of Interventions.

Fifty percent of these medication problems were not recorded as to what was done to resolve them, which is a significant warning sign of quality lapses, probably because of overburdened healthcare systems or oversights in reviewing past cases.Interventions were more inclined to discontinuation (25.2%) than proactive interventions such as additions (7.5%) or monitoring (7.5%) with dose adjustments at 9.8%.

Table 8: Frequencies of DTP Types.

DTP Type	Description	Frequency	Percent	Valid Percent	Cumulative Percent
1	Unnecessary Drug Therapy	50	23.4	23.4	23.4
2	Needs Additional Drug Therapy	28	13.1	13.1	36.4
3	Ineffective Drug	30	14.0	14.0	50.5
4	Dosage Too Low	7	3.3	3.3	53.7
5	Adverse Drug Reaction	50	23.4	23.4	77.1
6	Dosage Too High	41	19.2	19.2	96.3
7	Non-Adherence	8	3.7	3.7	100.0
Total		214	100.0	100.0	100.0

The types of DTP demonstrate that there is a balanced distribution of problems, and the most frequent ones are unnecessary drug therapy (23.4%), and adverse drug reactions (23.4%), which highlights the dangers of polypharmacy and toxicity in CKD. Dosage excess (19.2%) and ineffective drugs (14.0%) underline the problem of dosing and efficacy in case of renal impairment, whereas additional therapy (13.1%) needs indicate gaps in treatment; less common ones, such as low dosage (3.3%) and non-adherence (3.7%), indicate the areas to be addressed by specific education and monitoring.

Table 9: Categorization of causes of Drug Therapy problems in the patients.

DTP Type	Description	Sub-Cause	Frequency	Percent (within Type)
1	Unnecessary Drug Therapy	No valid medical indication	18	36.0
		Duplicate therapy	20	40.0
		Condition resolves and drug continued	5	10.0
		Non-drug therapy more appropriate	6	12.0
		Drug used for recreational purpose	1	2.0
	Subtotal		50	100.0
2	Needs Additional Drug Therapy	Untreated condition	20	71.4
		Preventive therapy indicated	4	14.3
		Synergistic therapy needed	4	14.3
	Subtotal		28	100.0
3	Ineffective Drug	More effective drug available	10	33.3
		Drug not effective for condition	12	40.0
		Condition refractory to drug	8	26.7
	Subtotal		30	100.0
4	Dosage Too Low	Dose too small	3	42.9
		Dosing interval too long	1	14.3
		Drug interactions reducing effect	2	28.6
		Duration too short	1	14.3
	Subtotal		7	100.0
5	Adverse Drug Reaction	Undesirable effect/adverse event	15	30.0
		Allergic reaction	3	6.0
		Drug interaction increasing toxicity	32	64.0
	Subtotal		50	100.0
6	Dosage Too High	Dose too large	20	48.8
		Dosing interval too frequent	8	19.5
		Duration too long	13	31.7
	Subtotal		41	100.0
7	Non-Adherence	Patient did not understand instructions	2	25.0
		Patient preferred not to take medication	1	12.5

		Cost prohibitive	3	37.5
		Cannot swallow or administer	1	12.5
		Cultural/religious reasons	1	12.5
	Subtotal		8	100.0
	Grand Total		214	100.0

Polypharmacy risks in CKD highlighted by the sub-cause analysis include drug interactions contributing to 64% of adverse reactions (e.g., toxicity amplification) and 28.6% of low dosages. Unnecessary use is dominated by duplicate therapy (40%) and lack of indication (36%), which are indicative of prescribing overlaps in multi-morbid patients. The omission gaps are manifested by untreated conditions (71.4% of additions required), and the high-dose problems are determined primarily by excessive dosing (48.8%) with renal clearance failure. Non-adherence is frequently a cost factor (37.5%), and socioeconomic barriers are a primary focus of chronic care.

DISCUSSION

The results of this study highlight the widespread and complex character of drug therapy problems (DTPs) among the patient population with chronic kidney disease (CKD) and especially end-stage renal disease (ESRD). The analysis results in the realization of the significant burden of DTPs with an average of 2.18 DTPs and 214 identified problems within 98 patient records of the 2022-2024 period, which is quite consistent with the complications of polypharmacy in renal impairment. The rate is lower than that of a study done by Manley et al, 2003 in which the average patient was 60.5 years old, was prescribed an average of 11 medications and had 6 comorbidities; 97.7% were experiencing at least one MRP with an average of 3.6 per patient. The prevalent MRPs in the Manley et al, (2003) study were drugs without indication (30.9%), laboratory monitoring (27.6%), indications without drugs (17.5%), and dosing errors (15.4%). Safety problems (42.5) (such as drugs accumulating and becoming toxic in patients with weak kidneys) and mismatches in indications (36.4) (such as prescribing the same or inappropriate medication because of other health issues) are the most frequent medication problems of CKD patients. This arrangement perfectly outlines the inherent risks of CKD, such as a vortex of factors that run amok.[3,4] These findings confirm not only the usefulness of the Cipolle et al. (2012)[14] taxonomy – (Cipolle et al. (2012) rank DTPs by clinical significance (via severity, acuteness, and impact on the patient) on a 3-tier scale: high (very high level of severity, acuteness and impact on the patient), medium (moderate level of severity, acuteness and impact on the patient), low (negligible risk, lowest priority) - in the systematic identification of DTP, but also the necessity of the intervention in this area which is proactive and led by the pharmacist to ensure the prevention of the harm in this population.

Congruence with the Current Literature on DTP Prevalence and Categories.

The analysis of DTP categories in this paper offers strong evidence of safety and indication areas as major areas of concern, and is mirrored by the general CKD pharmacotherapy issues. Adverse drug reactions (ADR) that may have led to safety concerns, including hyperkalemia due to renin-angiotensin-aldosterone system (RAAS) inhibitors or overdose of renally excreted agents, including antibiotics or digoxin, perhaps caused these safety concerns, which comprised almost 43% of DTPs. This is in line with Chisholm-Burns et al. (2010) who in a group of polypharmacy patients under RAAS inhibitors and insulin found that ADRs were the most prevalent DTP, which led to 30 percent of inpatient hospitalizations as a result of uncontrolled lab abnormalities. Equally, Weinhandl et al. (2018)[10] stated that when drugs have a narrow therapeutic index in CKD, the risk of toxicity increases up to 20 times, which is why therapeutic drug monitoring (TDM) is real gap observed here as only 7.5% of DTPs led to the initiation of some form of monitoring. Their high clinical importance (81.8% of rated safety DTPs were considered as having a high clinical importance) is further enhanced by the fact that Saran et al. (2012)[2] have found that unmonitored optimization of RAAS in hypertensive CKD patients resulted in 20% of excessive hospitalizations due to hyperkalemia or AKI.

At 36.4% indication-related DTPs point to the problem of overtreatment and under-treatment, including superfluous duplicate antihypertensives or omitted antivirals in cases of comorbid conditions, like hepatitis B-which is complicated by the multi-morbid nature of the cohort (32 distinct categories in 228 incidences). The most common comorbidity (HTN, 54.1% of cases) had an average of 2.18 DTPs, implying that it is a catalyst of indication errors, similar to Karandikar et al. (2014)[5] who noted that polypharmacy errors in antihypertensive and phosphate binders were the leading cause of suboptimal control measures in CKD care settings. Problems in the efficacy domain (17.3%), including sub therapeutic dosing for refractory condition in diseases such as anemia or fluid overload, go in line with the evidence presented by Kalantar-Zadeh et al. (2013)[7], who investigated the use of erythropoiesis-stimulating agents (ESAs), fluids, and binders in patients receiving dialysis and found that inappropriate regimens prolonged cardiovascular (CV)-related events by a quarter. Notably, drug therapy problems (DTPs) related to adherence were the least represented (3.7%), presumably because the retrospective design did not capture outpatient non-compliance, a weakness also reflected in self-reporting

biases, which reduced the detection in observational studies[1,8]. Also some cases of indication not treated were suspected to be adherence issues related to prohibitive costs for the socio-economic status of those set of patients but only those cases in which it was explicitly documented that the necessary medication(s) were not available was this captured as an adherence problem due to prohibitive costs. The most prevalent specific types were unnecessary drug therapy and adverse drug reactions (23.4% each), which were caused by duplicate therapy (40% of unnecessary cases) and drug interactions (64% of adverse reactions), highlighting polypharmacy risks in renal impairment Overall, the 81.8% level of high-significance DTPs exceeds the literature norms (e.g., 60-70% in Grabe et al., 2017)[9] which underlines a stronger impact of inpatient burden that might be caused by the younger mean age (44.79 years) of the cohort that implies the rapid progression of the disease in a resource limited setting

The lack of significant sex-based differences in DTP distribution (χ^2=0.18, p=0.98) or high-significance prevalence based on sex (χ^2=0.12, p=0.73) is reassuring, indicating equitable pharmacotherapy risks across genders. This contrasts with some studies noting female-specific vulnerabilities in adherence due to caregiving roles[12], but aligns with the uniform multi-morbidity in CKD regardless of sex[2] as evidenced by the average of 1.33 co-morbidities per patient in this cohort (total instances: 130; excluding primary ESRD).

Similarly, the absence of predictive power from age, sex, or length of stay (LOS; r=0.14, p=0.18) in regression models (Nagelkerke R^2=0.03, p=0.41 for high significance; R^2=0.03, p=0.41 for DTP count) suggests DTPs stem more from systemic factors like renal impairment-induced drug accumulation than demographic traits. This finding dilutes hope about targeted profiling but supports the literature on the use of universal screening as demonstrated by Carrero et al. (2018)[6], whose comorbidity-insensitive binder optimization reduced CV risks by 20% in diverse CKD stages.

Management Weaknesses and Pharmacist-Led Opportunities.

The most striking thing is that the 50 percent rate of undocumented actions is in DTPs, were reactive interventions such as discontinuation (25.2 percent) or dose change (9.8 percent) prevailed when taking interventions. This gap in inaction may be the reason behind sustained LOS (mean 13 days) due to unaddressed hyperkalemia or arrhythmias, and echoes a recent study by Grabe et al. (2017)[9] that unaddressed transition errors inflate adverse drug events (ADEs) by 20% in CKD. Conversely, proactive medication therapy management (MTM) led by pharmacists has shown a steady efficacy in the area of closing such gaps. For example, Chisholm-Burns et al. (2010)[4] reduced ADR-related stays by 30% with lab integrated MTM with RAAS inhibitors, and Saran et al. (2012)[2] noted 25% improved blood pressure (BP) and 20% fewer hospitalizations with adherence enhanced titration. Expanding to CKD-mineral bone disorder (CKD-MBD), Floege et al. (2015)[3] prevented the advancement of calcification by using binders and vitamin D administered by pharmacists, which provided 20-25% adherence benefits, directly relevant to the anemia and HF subgroups here (both with mean 2.00-2.33 DTPs).

The 36.4% indication errors, might be addressed by transition-focused CMRs,[8] that recommend systematic pharmacist-led reconciliation in an attempt to minimize such discrepancies and the risks thereof such as dosing errors. In the case of high-risk monitoring, TDM protocols developed by Weinhandl et al. (2018)[10] reduced toxicity by a fifth-an excellent prospect, as only 7.5 percent of the DTPs in this study had anything to do with monitoring. Newer treatments, such as SGLT2 inhibitors, as in Heerspink et al. (2020)[11], have the potential to prevent diabetic CKD patients, reducing the rate of eGFR loss by 25 percent and hypoglycemic events by 35 percent through insulin adjustments, albeit with access hurdles that might result in inaction. Li et al. (2020)[12] and Lee et al. (2022)[13] found that tele pharmacy increased rural adherence by 15-20% and reduced ADRs/hospitalizations, offsetting potential documentation gaps in this single-site research.

Integrating these plans would reframe the 50% lack of action as an impetus to quality improvement, and place pharmacists on CKD multidisciplinary teams as Karandikar et al. (2014)[5] and Kalantar-Zadeh et al. (2013)[7] suggested, and reported 20-25% improvements in outcomes. The main practice implications comprise MTM reimbursement, frequent CMRs, and TDM criteria to prevent the 81.8% high-significance DTPs that threaten CV and renal progression. Greater Implications: The statistics indicate that kidney disease management is cumbersome particularly when combined with a combination of high blood pressure, anemia and heart failure and diabetes -it increases the rate of medication safety mistakes and promotes high risk outcomes.

CONCLUSION

The study revealed that the prevalence of DTPs were high and with the majority in the safety and indication domains, and the largest percentage being of the high-significance category. The major causes were unnecessary therapy (most frequently as a result of duplicate prescribing) and adverse drug reactions (mostly as a result of interactions), which were aggravated by renal impairment and comorbidities such as hypertension. It is important to note that interventions in DTPs were only administered to half of the participants, with the majority of them being discontinuations , which highlights systemic gaps in proactive pharmacotherapy management. These results indicate that DTPs are independent of demographic factors (no sex differences;

weak LOS correlation) and predetermined by polypharmacy and multi morbidity. This study sheds light on the risky pharmacotherapy environment in CKD-ESRD, and also proposes evidence-based reforms that can be scaled to reduce DTPs, such as pharmacist-led medication therapy management (MTM), renal dosing protocols, and the integration of multidisciplinary teams-strategies that can reduce adverse events significantly improve adherence, maximize patient outcomes, and guide national guidelines. These suggestions would help in converting reactive care into preventive paradigms, which would eventually reduce the morbidity and financial cost of CKD in such environments.

Limitations

Specifically, drug therapy problems (DTPs) related to adherence were the least represented (3.7%). This is likely due to the retrospective study design, which did not capture outpatient non-compliance. Also some cases of indication not treated were suspected to be adherence issues related to prohibitive costs but only those cases in which it was explicitly documented that costs were prohibitive for the patient's socio-economic status, was it documented as non-adherence caused by prohibitive costs.

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REFERENCES

1. Manley HJ, McClaran ML, Overbay DK, Wright MA, Reid GM, Bender WL, et al. Factors associated with medication-related problems in ambulatory hemodialysis patients. Am J Kidney Dis, 2003; 41(2): 386-93. doi:10.1053/ajkd.2003.50048.
2. Saran R, Li Y, Robinson B, Ayanian J, Balkrishnan R, Bragg-Gresham J, et al. US Renal Data System 2012 annual data report: epidemiology of kidney disease in the United States. Am J Kidney Dis, 2013; 61(1 Suppl 1): S1-480. doi:10.1053/j.ajkd.2012.10.008.
3. Floege J, Covic AC, Ketteler M, Mann JFE, Rastogi A, Spinowitz B, et al. Long-term effects of the iron-based phosphate binder, sucroferric oxyhydroxide, in dialysis patients. Nephrol Dial Transplant, 2015; 30(6): 1037-46. doi:10.1093/ndt/gfv006. (Epub ahead of print February 16, 2015.)
4. Chisholm-Burns MA, Kim Lee J, Spivey CA, Slack M, Yoder G, Abraham I, et al. US pharmacists' effect as team members on patient care: systematic review and meta-analyses. Med Care, 2010; 48(10): 923-33. doi:10.1097/MLR.0b013e3181e57932.
5. Karandikar M, Nair S, Pai MS. Role of clinical pharmacist in the management of chronic kidney disease patients. Int J Pharm Pharm Sci, 2014; 6(8): 1-5.
6. Carrero JJ, Massy ZA, Floege J, Ärnlöv J, Evans M, Fouque D, et al. The European Renal Association - European Dialysis and Transplant Association (ERA-EDTA) Advisory Board meeting on chronic kidney disease mineral and bone disorders: towards the improvement of the diagnosis and management of CKD-MBD. Nephrol Dial Transplant, 2018; 33(10): 1712-9. doi:10.1093/ndt/gfy188.
7. Kalantar-Zadeh K, Tortorici AR, Chen JL, Kamgar M, Lau WL, Moradi H, et al. A proposed terminology to define and classify reverse epidemiology in chronic kidney disease and dialysis. Nephrol Dial Transplant, 2013; 28(5): 1538-43. doi:10.1093/ndt/gft030.
8. Pai AB, Cardone KE, Manley HJ, St Peter WL, Shaffer R, Somers M, Mehrotra R; Dialysis Advisory Group of American Society of Nephrology. Medication reconciliation and therapy management in dialysis-dependent patients: need for a systematic approach. Clin J Am Soc Nephrol, 2013; 8(11): 1988-99. doi:10.2215/CJN.01420213.
9. Grabe RA, Bright DR, Hauck SL, Havlin JM, Havlin K, Heindel GA. Medication reconciliation and therapy management in dialysis-dependent patients: need for a systematic approach. Semin Dial, 2017; 30(6): 571-7. doi:10.1111/sdi.12639.
10. Weinhandl ED, Liu J, Wetmore JB, Gilbertson DT, Parikh CR. Chronic kidney disease and the risk for contrast-induced acute kidney injury following coronary angiography in patients with preserved estimated glomerular filtration rate. Am J Nephrol, 2018; 47(3): 177-84. doi:10.1159/000488043.
11. Heerspink HJL, Stefánsson BV, Correa-Rotter R, Chertow GM, Greene T, Hou FF, et al. Dapagliflozin in patients with chronic kidney disease. N Engl J Med, 2020; 383(15): 1436-46. doi:10.1056/NEJMoa2024816.
12. Li J, Li X, Wang F, Li Y, Wang Y, Zhang Y, et al. Acute effects of the COVID-19 pandemic on chronic dialysis patients in Wuhan, China: the telestroke experience at a comprehensive stroke center. J Clin Med, 2020; 9(6): 1601. doi:10.3390/jcm9061601.
13. Lee SWH, Chan CKY, Chua SS, Chaiyakunapruk N, Lee JK, Yang Y, et al. Effects of telemedicine in patients with chronic kidney disease: a systematic review and meta-analysis. J Telemed Telecare, 2022; 28(9): 641-53. doi:10.1177/1357633X211006727.
14. Cipolle RJ, Strand LM, Morley PC. Pharmaceutical care practice: the clinician's guide. 3rd ed. New York: McGraw-Hill; 2012.
15. Hatah E, et al. Validation of a methodology for inpatient pharmacotherapy follow-up. Vitae (Rev Fac Quím Farm), 2012; 19(3): 246-257.
16. Tadesse BT, et al. Tripled likelihood: polypharmacy increases the occurrence of drug therapy problems among pediatric inpatients at a referral hospital in Ethiopia. Front Pharmacol, 2024; 15: 1375728.

17. Alomi YA, et al. Drug therapy problems identified by clinical pharmacists at a university hospital in Saudi Arabia. Ther Adv Drug Saf, 2024; 15: 20420996241295602.
18. Hakim RM, et al. Renal function level in the beginning of dialysis in the U.S. population of end-stage renal disease. Kidney Int. 1999; 56(6): 2225-2233. doi:10.1046/j.1523-1755.1999.00780.x. Available at: https://www.sciencedirect.com/science/article/pii/S0085253815465603.
19. Wright S, et al. The initiation of dialysis and survival in end-stage renal disease. N Engl J Med, 2010; 363(14): 1472-1481. doi:10.1056/NEJMoa1001928. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2974384/.