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Original Article

Prescribing Patterns of Antidiabetics and Neuropathic Pain Medications in Type 2 Diabetes Mellitus with Diabetic Peripheral Neuropathy and Diabetic Nephropathy: A Cross-Sectional Study In Tertiary Care Hospital, Lahore

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ABSTRACT

Background: Diabetic nephropathy and diabetic peripheral neuropathy are common complications of type 2 diabetes mellitus and can substantially influence medication selection, dosing, and safety. Objective: This study aimed to evaluate prescribing patterns of antidiabetic and neuropathic pain medications and identify factors associated with potentially unsafe prescribing among patients with type 2 diabetes mellitus, diabetic nephropathy, and diabetic peripheral neuropathy. Methods: A descriptive cross-sectional study was conducted among 306 patients attending Tertiary Care Hospital, Lahore. Data were extracted from prescriptions, clinical records, and laboratory reports. Demographic, clinical, laboratory, and medication-related variables were summarized using descriptive statistics, and multivariable logistic regression was used to identify predictors of potentially unsafe prescribing. Results: The mean age was 55.28 ± 9.56 years, and 184 patients (60.1%) were female. Metformin was prescribed to all patients, while SGLT2 inhibitors were prescribed in 123 patients (40.2%). Pregabalin was prescribed in 285 patients (93.1%), and vitamin B12 supplementation in 197 patients (64.4%). Renal-function-related prescribing concerns included metformin use despite low eGFR in 121 patients (39.5%), inappropriate sitagliptin dosing in 35 (11.4%), and SGLT2 inhibitor use below the recommended renal range in 15 (4.9%). Older age, retinopathy, and higher HbA1c were associated with increased odds of potentially unsafe prescribing. Conclusion: Renal-function-related prescribing concerns were frequent, supporting the need for structured medication review, renal-dose adjustment protocols, and multidisciplinary pharmacotherapy monitoring. Keywords: Type 2 diabetes mellitus; diabetic nephropathy; diabetic peripheral neuropathy; prescribing patterns; renal impairment; medication safety; inappropriate prescribing.

INTRODUCTION

Type 2 diabetes mellitus is a major chronic metabolic disorder associated with progressive microvascular complications, including diabetic nephropathy and diabetic peripheral neuropathy, both of which substantially influence long-term morbidity, quality of life, and therapeutic decision-making. Diabetic nephropathy is characterized by progressive renal impairment, commonly reflected by declining estimated glomerular filtration rate and rising serum creatinine, which can alter the pharmacokinetics, dosing requirements, and safety profile of several antidiabetic and neuropathic pain medications. In

patients who simultaneously develop diabetic peripheral neuropathy, prescribing becomes more complex because symptom control often requires medications such as pregabalin, gabapentin, or duloxetine, many of which require caution or dose modification in renal impairment (1).

Pharmacological management of type 2 diabetes mellitus has evolved beyond glycemic control toward organ protection, particularly kidney and cardiovascular risk reduction. Sodium-glucose cotransporter-2 inhibitors have demonstrated clinically important renal and cardiovascular benefits in patients with type 2 diabetes mellitus and chronic kidney disease, while glucagon-like peptide-1 receptor agonists have also shown favorable effects on albuminuria progression and cardiometabolic outcomes (2–4). These advances have shifted contemporary diabetes care toward early identification of renal risk and appropriate selection of kidney-protective therapies. However, real-world prescribing may not consistently reflect updated evidence, especially in settings where access, cost, clinical inertia, limited guideline implementation, and fragmented monitoring systems can influence therapeutic decisions (5).

Medication safety is particularly important in patients with diabetic nephropathy because renal dysfunction can increase the risk of drug accumulation, adverse drug reactions, and inappropriate dosing. Metformin, although widely used as a first-line antidiabetic agent, requires careful assessment in patients with reduced renal function because continued use in advanced renal impairment may increase the risk of serious adverse effects. Similarly, dipeptidyl peptidase-4 inhibitors such as sitagliptin require renal dose adjustment, while the clinical appropriateness of sodium-glucose cotransporter-2 inhibitor use depends on renal function, indication, and current prescribing recommendations. Neuropathic pain medications also require careful review, as pregabalin and gabapentin are predominantly renally eliminated and inappropriate dosing may increase the risk of dizziness, sedation, falls, and other dose-related adverse events (6–10).

Despite the clinical importance of renal-adjusted prescribing, potentially inappropriate medication use remains common among patients with diabetes and renal impairment. Prescribing errors may include continuation of metformin despite low renal function, inadequate renal dose adjustment of sitagliptin or other renally cleared agents, inappropriate use of medications outside recommended renal thresholds, and insufficient review of neuropathic pain therapy in patients with impaired kidney function. These problems are especially relevant in tertiary care hospitals, where patients often present with multiple comorbidities, longer disease duration, poor glycemic control, and advanced microvascular complications.

Local evidence on prescribing patterns among patients with type 2 diabetes mellitus complicated by both diabetic nephropathy and diabetic peripheral neuropathy remains limited. Understanding which antidiabetic and neuropathic pain medications are commonly prescribed, how frequently potentially unsafe prescribing occurs, and which clinical factors are associated with unsafe prescribing can help identify gaps in medication safety and guide targeted interventions such as renal-function monitoring, pharmacist-led medication review, and clinician education. Therefore, this study aimed to evaluate prescribing patterns of antidiabetic and neuropathic pain medications and to identify factors associated with potentially unsafe prescribing among patients with type 2 diabetes mellitus, diabetic peripheral neuropathy, and diabetic nephropathy attending two tertiary care hospitals in Lahore.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted to evaluate prescribing patterns of antidiabetic medications and neuropathic pain medications among patients diagnosed with type 2 diabetes mellitus complicated by diabetic peripheral neuropathy and diabetic nephropathy. The study was carried out in the outpatient departments and medical wards of Tertiary Care Hospital, Lahore, Pakistan. These tertiary care hospitals receive a large number of patients with diabetes and related complications and therefore provided an appropriate clinical setting for assessing real-world prescribing practices in patients with renal impairment and neuropathic symptoms.

The study population comprised adult patients aged 18 years or older with a confirmed diagnosis of type 2 diabetes mellitus, diabetic peripheral neuropathy, and diabetic nephropathy who were receiving pharmacological treatment at the time of data collection. Eligible patients were required to have available clinical records, active prescriptions, and relevant laboratory reports for assessment of prescribed medications and renal function. Patients were excluded if they had pregnancy or lactation, neuropathy unrelated to diabetes, severe liver disease, malignancy, or incomplete clinical records that prevented evaluation of prescribing patterns or renal-function-related medication safety.

A total of 306 patients were included using a non-probability convenience sampling technique. Participants were selected according to their availability during the data collection process and their fulfillment of the predefined eligibility criteria. This sampling approach was used because the study was observational and based on routinely available hospital records and prescriptions. Data were collected through a structured data collection form developed specifically for this study. Information was extracted from patient prescriptions, clinical records, and laboratory investigation reports. The collected data included demographic characteristics, hospital site, age, gender, duration of diabetes, duration of diabetic nephropathy, duration of diabetic peripheral neuropathy, family history of diabetes, retinopathy, hypertension, dyslipidemia, serum creatinine, estimated glomerular filtration rate where available, glycated hemoglobin, prescribed antidiabetic medications, prescribed neuropathic pain medications, dose frequency, and medication use in relation to renal impairment.

The main prescribing variables included use of metformin, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, regular insulin, long-acting insulin, pregabalin, and vitamin B12 supplementation. Prescribing patterns were assessed by documenting the medication name, dose frequency, and whether the drug was prescribed or not prescribed. Particular attention was given to medications requiring renal-function-based prescribing decisions, including metformin, sitagliptin, sodium-glucose cotransporter-2 inhibitors, and neuropathic pain medications. Potentially unsafe prescribing was evaluated by comparing active prescriptions with the patient's renal impairment status as documented in laboratory records and clinical files. Unsafe prescribing was considered when medication selection or dosing appeared inconsistent with renal-function-related prescribing precautions, including metformin use in patients with low renal function, inappropriate sitagliptin dosing in renal impairment, and sodium-glucose cotransporter-2 inhibitor use in patients whose renal function was below the recommended range for safe or appropriate prescribing.

The primary outcome was the presence of potentially unsafe prescribing in patients with renal impairment. Secondary outcomes included the frequency of commonly prescribed antidiabetic medications, the frequency of neuropathic pain medication use, the distribution of prescribing patterns by drug class, and the association of demographic, clinical, and laboratory factors with unsafe prescribing. Independent variables considered for association with unsafe prescribing included age, hospital site, duration of nephropathy, duration of neuropathy, dyslipidemia, retinopathy, serum creatinine, and glycated hemoglobin.

Data were entered into Microsoft Excel, checked for completeness and consistency, and analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize demographic, clinical, laboratory, and prescribing variables. Categorical variables were reported as frequencies and percentages, while continuous variables were reported as mean and standard deviation with observed ranges. Multivariable logistic regression analysis was performed to identify factors independently associated with potentially unsafe prescribing. Adjusted odds ratios with 95% confidence intervals were calculated to estimate the strength and direction of associations between independent variables and unsafe prescribing. A p-value of less than 0.05 was considered statistically significant. Variables included in the regression model were selected on the basis of clinical relevance and their potential association with prescribing safety in patients with diabetic nephropathy and diabetic peripheral neuropathy.

To support data integrity, all extracted information was checked against the available prescriptions, clinical records, and laboratory reports before analysis. Patient privacy and confidentiality were maintained throughout the study, and no personal identifiers were included in the final dataset. Ethical approval and permission were obtained from the relevant institutional review committees, and consent to participate was obtained from the patients.

RESULTS

A total of 306 patients with type 2 diabetes mellitus, diabetic peripheral neuropathy, and diabetic nephropathy were included in the analysis. Females represented 184 (60.1%) participants, while males accounted for 122 (39.9%). 306 patients were recruited from Two tertiary care hospitals. A family history of diabetes was present in 260 (85.0%) participants. Retinopathy was documented in 153 (50.0%) patients, hypertension in 163 (53.3%), and dyslipidemia in 30 (9.8%).

Table 1. Demographic and Clinical Characteristics of Participants

Variable	Category	n (%)
Gender	Male	122 (39.9)
	Female	184 (60.1)
Hospital	Tertiary Care Hospital	248 (81.0)
	Tertiary Care Hospital	58 (19.0)
Family history of diabetes	Yes	260 (85.0)
	No	46 (15.0)
Retinopathy	Yes	153 (50.0)
	No	153 (50.0)
Hypertension	Yes	163 (53.3)
	No	143 (46.7)
Dyslipidemia	Yes	30 (9.8)
	No	276 (90.2)

Table 2. Clinical and Laboratory Characteristics of Participants

Variable	Mean ± SD	Range
Age (years)	55.28 ± 9.56	34–69
Duration of diabetes (years)	5.32 ± 2.70	1–10
Duration of nephropathy (years)	1.98 ± 1.49	1–7
Duration of neuropathy (years)	3.41 ± 2.24	1–8
Serum creatinine (mg/dL)	2.49 ± 1.09	1.0–4.6
HbA1c (%)	8.68 ± 1.15	7.0–12.9

The mean age of participants was 55.28 ± 9.56 years, with an observed range of 34–69 years. The mean duration of diabetes was 5.32 ± 2.70 years. The mean duration of diabetic nephropathy was 1.98 ± 1.49 years, while the mean duration of diabetic peripheral neuropathy was 3.41 ± 2.24 years. Laboratory findings showed a mean serum creatinine level of 2.49 ± 1.09 mg/dL and a mean HbA1c level of 8.68 ± 1.15%, indicating that the study population included patients with impaired renal function and suboptimal glycemic control.

Table 3. Prescribing Pattern of Antidiabetic and Neuropathic Pain Medications

Drug/Class	Category	n (%)
Metformin	OD	173 (56.5)
	BD	133 (43.5)
DPP-4 inhibitor	Not prescribed	229 (74.8)
	OD	47 (15.4)
	BD	30 (9.8)
Regular insulin	Not prescribed	173 (56.5)
	BD	133 (43.5)
Long-acting insulin	Not prescribed	277 (90.5)
	BD	29 (9.5)
Pregabalin	Not prescribed	21 (6.9)
	OD	285 (93.1)

Drug/Class	Category	n (%)
Vitamin B12 supplementation	Not prescribed	109 (35.6)
	OD	197 (64.4)
SGLT2 inhibitor	Not prescribed	183 (59.8)
	OD	123 (40.2)

DPP-4, dipeptidyl peptidase-4; SGLT2, sodium-glucose cotransporter-2; OD, once daily; BD, twice daily.

Metformin was prescribed to all included patients, with 173 (56.5%) receiving once-daily therapy and 133 (43.5%) receiving twice-daily therapy. DPP-4 inhibitors were not prescribed in 229 (74.8%) patients, while 47 (15.4%) received once-daily therapy and 30 (9.8%) received twice-daily therapy. Regular insulin was prescribed twice daily in 133 (43.5%) patients, whereas long-acting insulin was prescribed twice daily in 29 (9.5%). Pregabalin was prescribed once daily in 285 (93.1%) participants, and vitamin B12 supplementation was prescribed once daily in 197 (64.4%). SGLT2 inhibitors were prescribed once daily in 123 (40.2%) patients and were not prescribed in 183 (59.8%).

Table 4. Renal-Function-Related Prescribing Concerns

Prescribing Criterion	n (%)
Metformin prescribed despite low eGFR	121 (39.5)
appropriate sitagliptin dosing in renal impairment	35 (11.4)
SGLT2 inhibitor use below recommended renal range	15 (4.9)

eGFR, estimated glomerular filtration rate; SGLT2, sodium-glucose cotransporter-2.

Renal-function-related prescribing concerns were observed across multiple medication classes. Metformin was prescribed despite low eGFR in 121 (39.5%) patients. appropriate sitagliptin dosingry in renal impairment was identified in 35 (11.4%) patients. SGLT2 inhibitor use below the recommended renal range was documented in 15 (4.9%) patients. These findings indicate that a clinically important proportion of patients with renal impairment were exposed to medication regimens requiring closer renal-function-based review.

Table 5. Multivariable Logistic Regression Analysis for Predictors of Potentially Unsafe Prescribing

Predictor	Adjusted OR	95% CI	p-value
Age	1.08	1.02–1.15	0.007
Hospital	0.08	0.02–0.28	<0.001
Duration of nephropathy	0.25	0.14–0.45	<0.001
Duration of neuropathy	0.71	0.53–0.95	0.021
Dyslipidemia	5.53	0.99–30.83	0.051
Retinopathy	18.33	5.23–64.27	<0.001
Serum creatinine	0.59	0.37–0.93	0.023
HbA1c	3.81	2.14–6.78	<0.001

OR, odds ratio; CI, confidence interval; HbA1c, glycated hemoglobin.

Multivariable logistic regression identified several factors associated with potentially unsafe prescribing. Increasing age was associated with higher odds of unsafe prescribing, with an adjusted OR of 1.08 and a 95% CI of 1.02–1.15. Retinopathy showed the strongest positive association, with an adjusted OR of 18.33 and a 95% CI of 5.23–64.27. Higher HbA1c was also associated with increased odds of unsafe prescribing, with an adjusted OR of 3.81 and a 95% CI of 2.14–6.78. Hospital site, duration of nephropathy, duration of neuropathy, and serum creatinine showed inverse associations with unsafe prescribing. Dyslipidemia showed an adjusted OR of 5.53 with a 95% CI of 0.99–30.83 and a p-value of 0.051.

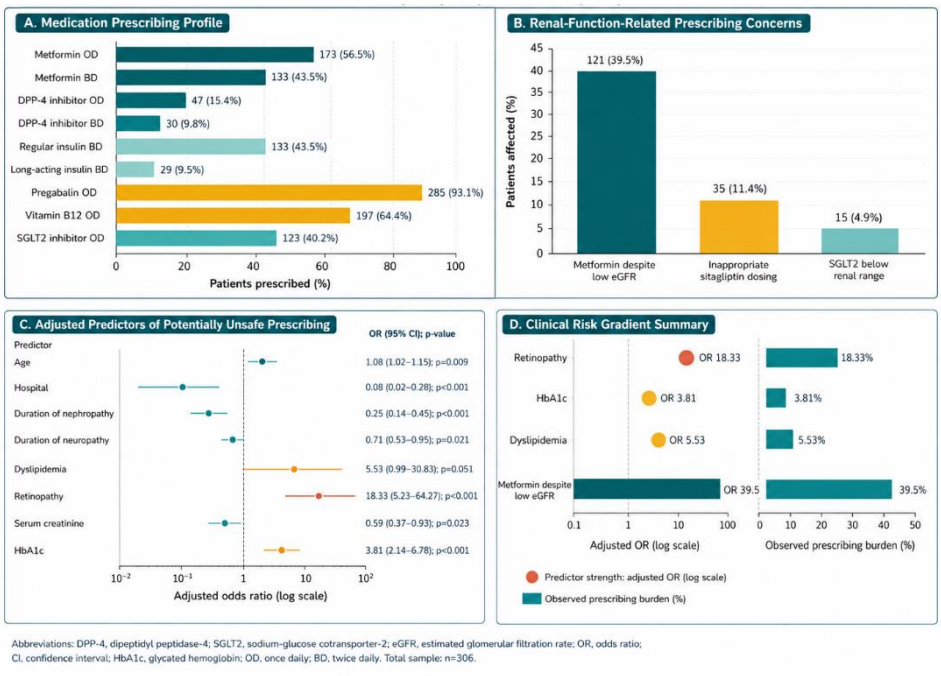

Figure 1 Integrates medication-use patterns, renal-function-related prescribing concerns, and adjusted predictors of potentially unsafe prescribing among 306 patients with type 2 diabetes mellitus complicated by diabetic nephropathy and diabetic peripheral neuropathy. Pregabalin was the most frequently prescribed neuropathic pain medication, used in 285 patients (93.1%), followed by vitamin B12 supplementation in 197 patients (64.4%) and SGLT2 inhibitors in 123 patients (40.2%). Renal-function-related prescribing concerns were most prominent for metformin, which was prescribed despite low eGFR in 121 patients (39.5%), while inappropriate sitagliptin dosing and SGLT2 inhibitor use below the recommended renal range were observed in 35 (11.4%) and 15 (4.9%) patients, respectively. In the adjusted regression model, retinopathy showed the strongest association with potentially unsafe prescribing (OR 18.33, 95% CI 5.23–64.27), followed by HbA1c (OR 3.81, 95% CI 2.14–6.78), indicating that patients with advanced microvascular complications and poor glycemic control represented a clinically important high-risk subgroup for medication-safety review.

DISCUSSION

The present study evaluated prescribing patterns of antidiabetic and neuropathic pain medications among patients with type 2 diabetes mellitus complicated by diabetic peripheral neuropathy and diabetic nephropathy in two yry care hospitals in Lahore. The findings show that metformin remained universally prescribed in this cohort, pregabalin was the dominant medication used for neuropathic symptoms, and SGLT2 inhibitors were prescribed in 40.2% of patients. A clinically important proportion of patients also had renal-function-related prescribing concerns, particularly metformin use despite low eGFR, which was observed in 39.5% of the study population. These findings indicate that although several prescribing practices were aligned with conventional diabetes and neuropathic pain management, renal-function-based medication safety was not consistently optimized.

The observed prescribing profile reflects the continued central role of metformin in type 2 diabetes management, but it also highlights an important safety concern in patients with diabetic nephropathy. Metformin is widely used because of its glycemic efficacy, affordability, and long-standing position as a first-line antidiabetic agent. However, its continued use in patients with reduced renal function requires careful clinical judgment and regular assessment of kidney function. The finding that 121 patients were prescribed metformin despite low eGFR suggests a gap between renal-risk assessment and prescribing practice. Similar concerns have been reported in patients with chronic kidney disease, where dose adjustment or discontinuation of renally sensitive drugs is often inconsistent despite available prescribing guidance and medication-safety recommendations (11).

SGLT2 inhibitors were prescribed in 40.2% of patients, indicating partial adoption of newer kidney-protective diabetes therapies. This finding is clinically relevant because SGLT2 inhibitors have increasingly been recommended for patients with type 2 diabetes and chronic kidney disease due to their

renal and cardiovascular benefits. However, the rate of use observed in this study also suggests that a substantial proportion of eligible or potentially eligible patients may not have received this therapeutic class. Underutilization of SGLT2 inhibitors has been reported in real-world settings and may be related to cost, limited familiarity with updated guidance, uncertainty about renal thresholds, concerns about reduced glucose-lowering efficacy at lower eGFR, and clinical inertia (12). More recent evidence has emphasized that the kidney-protective benefits of SGLT2 inhibitors may persist across a range of reduced eGFR categories, supporting the need for updated local prescribing practices and clinician education (13).

The study also identified renal-function-related concerns involving DPP-4 inhibitor dosing and SGLT2 inhibitor use below the recommended renal range. Inappropriate sitagliptin dosing was observed in 11.4% of patients, while SGLT2 inhibitor use below the recommended renal range was observed in 4.9%. Although these proportions were lower than the proportion observed for metformin, they remain clinically meaningful because both medication selection and dosing require renal-function-based interpretation. These findings emphasize the need for routine medication review in patients with diabetic nephropathy, particularly when multiple antidiabetic agents are being used. Clinical decision support systems, pharmacist involvement, and renal-dose adjustment protocols may reduce potentially unsafe prescribing and improve therapeutic safety in patients with chronic kidney disease (14).

Pregabalin was prescribed to 93.1% of participants, making it the most frequently used neuropathic pain medication in this study. This high frequency is expected in a cohort defined by diabetic peripheral neuropathy, as pregabalin is commonly used for painful diabetic neuropathy. However, the high rate of pregabalin use also raises an important prescribing-safety issue because pregabalin is primarily renally eliminated and requires dose consideration in patients with renal impairment. The current dataset documented pregabalin frequency but did not provide sufficient information to evaluate whether pregabalin dosing was adjusted according to renal function. Future studies should specifically assess renal dose adjustment of neuropathic pain medications, because inappropriate dosing may increase the risk of dizziness, sedation, falls, and other adverse drug effects in patients with diabetic nephropathy (15,16).

The multivariable regression model showed that older age, retinopathy, and higher HbA1c were associated with increased odds of potentially unsafe prescribing. Retinopathy had the strongest association, suggesting that patients with advanced microvascular disease may represent a higher-risk subgroup for prescribing concerns. Higher HbA1c was also associated with unsafe prescribing, which may reflect greater therapeutic complexity, more aggressive attempts to control hyperglycemia, or clinical difficulty in balancing glycemic targets against renal safety. Older age may further increase prescribing vulnerability because older patients commonly have more comorbidities, altered renal function, polypharmacy, and greater susceptibility to adverse drug events. These findings support the need for structured medication review among patients with advanced diabetic complications and poor glycemic control.

Inverse associations were observed for hospital site, duration of nephropathy, duration of neuropathy, and serum creatinine. These findings should be interpreted cautiously because the study design was cross-sectional and the regression model depends on how the unsafe prescribing outcome was operationalized. One plausible explanation is that patients with longer documented nephropathy duration or higher serum creatinine may have been more visibly recognized as renal-risk patients, prompting greater caution in prescribing. Similarly, hospital-level differences may reflect variation in prescribing protocols, specialist involvement, availability of renal monitoring, or institutional practice patterns. These interpretations remain exploratory and should not be considered causal without longitudinal data and clearer assessment of prescriber decision-making.

The study has several clinical implications. First, renal-function monitoring should be integrated into routine prescribing decisions for all patients with diabetic nephropathy. Second, medication review

should focus not only on antidiabetic agents but also on neuropathic pain medications, particularly renally cleared drugs such as pregabalin and gabapentin. Third, local implementation of renal-dose adjustment protocols could improve safety, especially for metformin, sitagliptin, and other renally sensitive therapies. Fourth, multidisciplinary involvement of physicians, pharmacists, nurses, and diabetes educators may improve guideline adherence, patient education, and pharmacovigilance. Such interventions are especially relevant in tertiary care settings where patients frequently present with multiple diabetic complications and complex medication regimens (17–19).

This study has limitations that should be considered when interpreting the findings. Its cross-sectional design does not allow causal inference between clinical predictors and potentially unsafe prescribing. The use of non-probability convenience sampling may limit generalizability beyond the included tertiary care hospitals. The study relied on available prescriptions, clinical records, and laboratory reports, and therefore prescribing appropriateness could have been affected by incomplete documentation or variable monitoring frequency. The exact clinical rationale behind individual prescribing decisions was not assessed. In addition, the available data did not permit detailed assessment of renal dose adjustment for pregabalin or other neuropathic pain medications. Future multicenter longitudinal studies should use explicit eGFR-based prescribing criteria, evaluate dose appropriateness for both antidiabetic and neuropathic pain medications, and assess patient outcomes such as adverse drug reactions, hospitalization, glycemic control, and renal disease progression (20).

CONCLUSION

This study found that patients with type 2 diabetes mellitus complicated by diabetic nephropathy and diabetic peripheral neuropathy were commonly prescribed metformin, pregabalin, vitamin B12 supplementation, insulin, and SGLT2 inhibitors, but renal-function-related prescribing concerns were also frequent. Metformin use despite low eGFR was the most common concern, affecting 121 patients (39.5%), followed by inappropriate sitagliptin dosing in renal impairment in 35 patients (11.4%) and SGLT2 inhibitor use below the recommended renal range in 15 patients (4.9%). Older age, retinopathy, and higher HbA1c were associated with increased odds of potentially unsafe prescribing, indicating that patients with advanced diabetic complications and poor glycemic control require more careful medication review. These findings support the need for routine renal-function monitoring, explicit renal-dose adjustment protocols, and greater multidisciplinary involvement to improve prescribing safety in patients with diabetes-related renal impairment.

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