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ORIGINAL PAPER

# Optimising antidiabetic medication management for type 2 diabetes and renal dysfunction in Can Tho City, Vietnam

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## Abstract

**Introduction:** The research aimed to delineate and investigate the utilisation of antidiabetic drugs in type 2 diabetes patients with kidney failure at a hospital in Can Tho City, Vietnam.

**Material and methods:** The research analysed the use of antidiabetic drugs at various time points, determined the drug interaction rate, and evaluated the appropriate use of drugs and the relationship with the achievement of target blood glucose and $HbA_{1c}$ levels. A two-tailed Student's t-test was employed to compare continuous variables, an ANOVA test was used to assess multiple values, and an $\chi 2$ test was utilised to evaluate categorical variables.

**Results:** Insulin monotherapy was the predominant regimen for treating type 2 diabetes in patients with impaired kidney function. Metformin was the most prescribed oral medication. Approximately 85.78% of patients received safe and appropriate diabetes treatment. Statistical analysis revealed a significant relationship between achieving target blood glucose and $HbA_{1c}$ after 3 months and factors such as safe drug use and minimal drug interactions ($p < 0.05$). Patients with chronic kidney disease demonstrated better blood glucose control compared to those with acute kidney disease.

**Conclusions:** The most common drug used for type 2 diabetes patients with impaired kidney function was insulin monotherapy, with usage increasing with the severity of chronic kidney disease. The chronic kidney disease group exhibited a higher rate of achieving target blood glucose and $HbA_{1c}$ compared to the acute kidney disease group. Rational, safe, and interaction-free drug use significantly contributed to better blood sugar control compared to less prudent medication choices.

**Key words:** diabetic kidney disease, insulin, oral hypoglycaemic medications, blood glucose, $HbA_{1c}$.

## Introduction

Diabetes is a global health concern, with a rising prevalence of type 2 diabetes worldwide. According to the World Health Organisation, approximately 422 mln people worldwide have diabetes, contributing to 1.6 mln annual deaths [1]. In the United Kingdom, it is projected that over 5 mln individuals will have diabetes by 2025, with 90% having type 2 diabetes [2]. Based on the STEPwise survey on risk factors for non-communicable diseases conducted by the Ministry of Health in 2015, in the age group of 18–69 years, the proportion of people with diabetes and prediabetes in Vietnam was 4.1% and 3.6%, respectively [3]. The rate of diabetes is increasing, especially in young people, accompanied by complications in many organs in the body (like blood vessels, retina, kidneys, and cardiovascular system) that lead to a substantial economic and social burden for a developing country like Vietnam.

One severe complication of type 2 diabetes is diabetic kidney disease. This complication occurs discreetly, and the initial symptoms may not be noticeable because the kidneys can compensate for lost function. When clinical signs become evident, kidney function failure has occurred sharply, leading to irreversible damage. Therefore, this complication has a high mortality rate, affecting 30–40% of diabetes patients [4]. Kidney failure induced by type 2 diabetes is a significant clinical complication, with studies in the United States revealing renal failure complications in 40% of type 2 diabetes patients [5]. The mortality rate for diabetic patients with proteinuria is reported to reach 50% seven years after its onset [6]. In a recent study at several haemodialysis centres in France, among 12,093 patients receiving haemodialysis, there were 884 diabetic patients, accounting for 6.8%. In Germany, the prevalence of chronic kidney disease (CKD) in patients with type 2 diabetes increased from 5.3% in 2006 to 7.3% in 2011 and

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11.2% in 2016 [7]. This ratio in southern and northern European countries was about 9–16%, respectively [8]. Meanwhile, a survey in a hospital in Hanoi, Vietnam, showed that the rate of kidney complications due to type 2 diabetes was 33.1% [9].

Effectively treating diabetes in patients with concurrent kidney failure is crucial for reducing complications, hospitalisation risks, and mortality among those dealing with this challenging condition. Despite various studies on this issue in Vietnam, there is a lack of comprehensive research on drug use in diabetic patients with kidney complications in Can Tho City, the fourth largest city in Vietnam. Additionally, monitoring drug use in diabetic patients has shown promise in slowing the progression of renal complications [10]. This study aims to assess the current drug usage in diabetic patients with kidney failure at a hospital in Can Tho City and propose strategies to enhance treatment efficacy in this population. Evaluation of the antidiabetic drug use strategy, the rational and safe use of drugs, the prevalence of drug interaction, the effectiveness of control of blood glucose and $HbA_{1c}$ levels, and their relationship in type 2 diabetes patients with kidney failure were determined.

## Material and methods

### Study subjects

An analytical cross-sectional descriptive study was conducted on inpatients with type 2 diabetes and impaired renal function at a Can Tho City hospital in Vietnam from June 2020 to June 2021.

Patients included in the study were 18 years of age or above, diagnosed with type 2 diabetes based on the Ministry of Health criteria [3], experiencing chronic or acute kidney failure, and requiring treatment with blood glucose-lowering medications. Patients received inpatient treatment at the hospital and outpatient treatment within 3 months of discharge. Chronic kidney disease was classified stage 1–5 according to the Ministry of Health's Vietnam classification. Acute kidney injury (AKI) diagnosis followed KDIGO 2012 criteria, requiring one of the following: a serum creatinine increase of ≥ 0.3 mg/dl (or ≥ 26.5 µmol/l) within 48 hours, a serum creatinine increase of ≥ 1.5 times the baseline value within 7 days, or urine volume < 0.5 ml/kg/hour for 6 hours.

Exclusion criteria involved medical records lacking sufficient information on medications, fasting blood glucose, and $HbA_{1c}$. Patients with cancer, HIV/AIDS, pregnancy, or breastfeeding, and those not undergoing follow-up examinations were also excluded. The complexity of drug use in HIV and cancer patients, involving multiple medications, warranted exclusion, as limited studies have compared and evaluated drug usage in these populations.

### Sampling and sample size

Applying the formula to estimate a proportion of the study population

$$n = \frac{Z^2 p\,(1-p)}{C^2}$$

where

n – sample size,

Z – confidence interval, with the reliability of 95% ($\alpha$ = 0.05), and Z = 1.96,

C – tolerance, C = 7% = 0.07.

Based on the research findings by Nguyen (2018) regarding drug use and the effectiveness of treating type 2 diabetes, it was observed that 45.5% of patients achieved the targeted blood glucose control goal [11]. The sample size, determined with a *p*-value of 45.5%, was initially set at 195. An additional thirty samples were included to account for potential sample loss at a rate of 15%, resulting in a final sample size of 225. The entire sampling method was employed to collect 225 medical records, encompassing all patients attending examinations during the study period until the predetermined sample size was reached.

### Data collection

The proportions of antidiabetic drugs used in eligible patients were categorised into 3 groups: oral monotherapy, insulin monotherapy, and oral drug combinations. The proportion of these regimens used for each type of kidney disease patient (chronic or acute) was assessed and described as frequencies and percentages.

To evaluate potential drug interactions, the interactions of blood glucose-lowering drugs with other medications were scrutinised using information from Drugs.com and Medscape. Clinically significant drug interactions (CSDI) were identified based on major and moderate interactions in Drugs.com or contraindicated, serious-use alternative, and closely monitored levels in Medscape. The relationship between kidney disease types (acute and chronic) and the number of drugs in the prescription with CSDI was examined by an $\chi^2$ test with a 95% confidence interval.

An evaluation of the reasonableness and safety of antidiabetic drug usage in patients with type 2 diabetes and impaired kidney function was conducted. Criteria for assessment included indications, dosage, route of administration, duration of use, and the absence of hypoglycaemia complications. A prescription was considered safe and reasonable when meeting all requirements without complications of hypoglycaemia. The results were presented as frequencies and percentages.

Effectiveness in blood sugar control was gauged by recording blood glucose and $HbA_{1c}$ levels at the study's initiation ($t_0$), hospital discharge ($t_1$), and 3-month post-follow-up examination ($t_2$, $t_3$, and $t_4$). Target blood glu-

cose values ranged 70–130 mg/dl, and target $HbA_{1c}$ values ranged 6.5–7%. The percentage of patients achieving target blood glucose and $HbA_{1c}$ levels at different time points was identified and analysed by Wilcoxon and $\chi^2$ tests. The relationship between kidney disease types and rational and safe drug use with the proportion of patients achieving target blood glucose and $HbA_{1c}$ levels after 3 months was analysed by a Student's *t*-test and an $\chi^2$ test, respectively.

### Data analysis

Data and questionnaires were entered into Microsoft Excel 2013 and analysed using Stata 16.0 MP software. Various statistical tests were employed for different types of data. A two-tailed Student's *t*-test was employed to compare continuous variables, an ANOVA test was used to assess multiple values, and an $\chi^2$ test was used to evaluate categorical variables. The Fisher test was utilised for adjustment if the number of observations was less than 5. The results were statistically significant when $p < 0.05$; the odds ratio was also calculated for categorical variables with a 95% confidence interval.

### Limitations

Our study offers a comprehensive overview of drug use in type 2 diabetes patients with impaired renal function, providing valuable insights into the challenges and successes in managing this patient population. However, certain limitations were encountered during the study. The relatively high average age of our study subjects led to an inherent presence of comorbidities beyond diabetes and impaired renal function. To address this, future studies should assess all potential drug interactions within prescriptions to ensure a more thorough examination.

Furthermore, the study's duration was limited to approximately 3 months. To obtain a more complete understanding of drug utilisation patterns in type 2 diabetes patients with renal complications, we recommend extending the research period to around one year. This prolonged timeframe would enable a more comprehensive exploration of the dynamics of drug use, treatment outcomes, and potential long-term effects on this specific patient population.

## Results

Our study analysed 225 medical records and identified a higher prevalence of CKD cases (145) than acute kidney injury. Notably, CKD stages 4 and 5 constituted the majority, accounting for 60.69%, stage 3 comprised 38.62%, and stage 2 had a minimal proportion of 0.69%. Females represented a larger portion, with 149 cases compared to males, and the prevalence of CKD was significantly higher in women (69% vs. 31%). Most patients were aged 60 years or older, with 156 cases exhibiting a higher rate of CKD compared to age groups under 60 years old.

Regarding the duration of diabetes, the study observed 126 cases with a disease duration of 5–10 years, which had a higher number of CKD patients (81 cases) compared to other groups. At the study's commencement, the average blood glucose and $HbA_{1c}$ levels in diabetic patients were 232.27 ±106.40 mg/dl and 8.18 ±1.68%, respectively.

In 1125 prescriptions derived from 225 medical records, insulin monotherapy emerged as the predominant treatment approach, accounting for 93.50% of AKI and 95.86% of chronic kidney disease. Metformin was administered across all stages of CKD and was extensively prescribed in acute kidney injury, constituting 76.92% of cases. The utilisation of insulin monotherapy exhibited an upward trajectory with the progression of CKD severity, ranging from 60.00% in stage 2 to 98.53% in stage 5. Conversely, monotherapy with oral antidiabetic drugs witnessed a decline in prevalence with the increasing severity of chronic kidney disease, plummeting from 40.00% in stage 2 to a mere 1.47% in stage 5.

Of the 3 types of insulin used, mixed insulin was the predominant choice, followed by rapid-acting insulin, while long-acting insulin saw limited usage. The concurrent use of mixed insulin was observed in patients across both acute and CKD (all stages). In contrast, slow-acting insulin was not recommended in AKI and stages 2 and 3 of CKD (Table 1).

Among the 1125 prescriptions, the proportion of prescriptions with CSDI was 72% on Drugs.com and 53.24% on Medscape. Specifically, on Drugs.com, moderate and major interactions accounted for 63.47% and 8.53%, respectively.

An interesting finding emerged when comparing CKD patients to those with acute kidney injury. Prescriptions for patients with CKD were less likely to have CSDI than those with acute kidney injury, and this difference was statistically significant ($p < 0.05$) as *per* the $\chi^2$ test. The rate of CSDI increased with the stage of chronic kidney disease. Stage 2 CKD had a lower rate of CSDI than stage 3 CKD (40.00% vs. 67.50%). However, the difference was insignificant when Fisher tested with $p > 0.100$. Chronic kidney disease stages 4 and 5 had a higher rate of CSDI than stage 3, but the difference was not statistically significant when testing $\chi^2$ ($p > 0.100$). Moreover, a relationship was observed between the number of drugs in prescriptions and the likelihood of CSDI occurrence. Prescriptions with 7–9 drugs and 10–12 drugs showed a statistically significant relationship with the possibility of CSDI appearance ($p < 0.001$) (Table 2).

**Table 1.** Diabetes treatment regimens and drugs (n = 1125)

| Regimens and drugs | Chronic renal disease | | | | | Acute renal disease |
|---|---|---|---|---|---|---|
| | Stage 2 *n* (%) | Stage 3 *n* (%) | Stage 4 *n* (%) | Stage 5 *n* (%) | Total *N* (%) | *n* (%) |
| Regimens | | | | | | |
| Oral antidiabetic drugs monotherapy | 2 (40.00) | 7 (2.50) | 3 (3.00) | 5 (1.47) | 17 (2.34) | 20 (5.00) |
| Insulin monotherapy | 3 (60.00) | 270 (96.43) | 87 (87.00) | 335 (98.53) | 695 (95.86) | 374 (93.50) |
| Oral antidiabetic drugs combination | 0 (0.00) | 3 (1.07) | 10 (10.00) | 0 (0.00) | 13 (1.79) | 6 (1.50) |
| Drugs | | | | | | |
| Metformin | 2 (100.0) | 7 (70.00) | 3 (23.08) | 5 (100.0) | 17 (56.67) | 20 (76.92) |
| Gliclazide + metformin | – | – | 10 (76.92) | – | 10 (33.33) | 6 (23.08) |
| Acarbose + metformin | – | 3 (30.00) | – | – | 3 (10.00) | – |
| Insulin types | | | | | | |
| Rapid-acting (fast-acting) | 0 (0.00) | 25 (9.26) | 17 (20.00) | 53 (15.82) | 95 (13.67) | 12 (3.21) |
| Long-acting (slow-acting) | 0 (0.00) | 0 (0.00) | 5 (5.58) | 10 (2.99) | 15 (2.16) | – |
| Mixed | 5 (100.0) | 245 (90.74) | 63 (74.12) | 272 (81.19) | 585 (84.17) | 362 (96.79) |

**Table 2.** Factors related to clinically significant drug interactions

| Factors | CSDI *n* (%) | Non-CSDI *n* (%) | OR (95% CI) | *p*-value |
|---|---|---|---|---|
| Types of kidney disease | | | | |
| Chronic | 507 (69.93) | 218 (30.07) | 1.34 (1.01–1.79) | 0.04 |
| Stage 2 | 2 (40.00) | 3 (60.00) | 0.32 (0.03–2.86) | 0.19 |
| Stage 3 | 189 (67.50) | 91 (32.50) | 1 | – |
| Stage 4 | 69 (69.00) | 31 (31.00) | 1.07 (0.64–1.82) | 0.78 |
| Stage 5 | 247 (72.65) | 93 (27.35) | 1.28 (0.89–1.83) | 0.16 |
| Acute | 303 (75.75) | 97 (24.25) | | |
| Number of drugs in a prescription | | | | |
| 2–3 | 44 (27.67) | 115 (72.33) | 1 | – |
| 4–6 | 124 (30.39) | 284 (69.61) | 1.14 (0.75–1.76) | 0.52 |
| 7–9 | 268 (82.97) | 55 (17.03) | 12.74 (7.90–20.56) | < 0.001 |
| 10–12 | 214 (91.06) | 21 (8.94) | 26.63 (14.62–49.17) | < 0.001 |

CI – confidence interval, CSDI – clinically significant drug interactions, OR – odds ratio

In the assessment of 225 medical records, the majority of diabetes treatment drugs were utilised following the indicated criteria, accounting for an impressive 98.67%. Additionally, all medical records demonstrated appropriate usage concerning dosage, route of administration, and duration of use, reaching a comprehensive 100%. Furthermore, 87.11% of patients experienced no hypoglycaemic complications, reflecting a significant aspect of drug safety and patient well-being. The overall rate of safe and reasonable drug use, considering all evaluated criteria, stood at a commendable 85.78% (Table 3).

Upon Wilcoxon testing, it was observed that the average fasting blood glucose values gradually decreased throughout treatment, reaching statistical significance with a *p*-value less than 0.001. Furthermore, at one month ($t_2$), 2 months ($t_3$), and 3 months ($t_4$) post-treatment, the rate of achieving the target blood glucose was significantly higher compared to the initial survey, as evidenced by a statistically significant $\chi^2$ test with *p*-values less than 0.05. Additionally, the rate of achieving the target $HbA_{1c}$ at the $t_4$ time-point was significantly higher than at the commencement of the survey, as indicated by a $\chi^2$ test with $p < 0.05$ (Table 4).

Following 3 months of treatment, the CKD group exhibited notable improvements, with a 32.41% increase in the rate of achieving target blood glucose (reaching 44.83%) and a 30.34% increase in reaching target $HbA_{1c}$ (59.31%), compared to the time-point $t_o$, (*t*-test with $p < 0.001$). A similar positive trend was observed in patients with acute kidney injury. When comparing the 2 kidney disease populations, the CKD group demonstrated superior outcomes, boasting a significantly higher rate of achieving target blood glucose (9.91% higher) and $HbA_{1c}$ (17.84% higher). This difference was found to be statistically significant through *t*-tests ($p < 0.001$) (Table 5).

The rate of achieving target blood glucose was highest in the group using drugs safely and appropriately without CSDI (61.54%) and lowest in the group using drugs that were not safe and reasonably associated with CSDI (15.79%); the difference was statistically significant. Similar results were obtained for target $HbA_{1c}$ achievement, in which the percentage of medical re-

**Table 3.** The proportion of rational and safe use of antidiabetic drugs based on guidelines and recommendations

| Criteria | Frequency (*N* = 225) | Percentage |
|---|---|---|
| Indications | 222 | 98.67 |
| Dosage | 225 | 100.0 |
| Route of administration | 225 | 100.0 |
| Duration of use | 225 | 100.0 |
| No complications of hypoglycaemia | 196 | 87.11 |
| Rational and safe use | 193 | 85.78 |

**Table 4.** The percentage of patients achieving target blood glucose and $HbA_{1c}$ levels at different time points (*n* = 225)

| Parameters | $t_0$ | $t_1$ | $t_2$ | $t_3$ | $t_4$ |
|---|---|---|---|---|---|
| Fasting blood glucose concentration | | | | | |
| Mean ±SD (mg/dl) | 232 ±106 | 185 ±75 | 177 ±73 | 171 ±52 | 156 ±41 |
| *p* (Wilcoxon test) | – | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Target blood glucose achieve | | | | | |
| Yes, *n* (%) | 26 (11.56) | 35 (15.56) | 44 (19.56) | 47 (20.89) | 91 (40.44) |
| No, *n* (%) | 199 (88.44) | 190 (84.44) | 181 (80.44) | 178 (79.11) | 134 (59.56) |
| OR (95% CI) | 1 | 1.4 (0.8–2.5) | 1.9 (1.1–3.3) | 2.0 (1.2–3.5) | 5.2 (3.1–8.8) |
| *p* ($\chi^2$ test) | – | 0.21 | 0.02 | < 0.01 | < 0.001 |
| $HbA_{1c}$ level | | | | | |
| Mean ±SD (%) | 8.18 ±1.68 | – | – | – | 7.23 ±1.31 |
| *p* (Wilcoxon test) | – | – | – | – | < 0.001 |
| Target $HbA_{1c}$ achieve | | | | | |
| Yes, *n* (%) | 63 (28.00) | – | – | – | 117 (52.00) |
| No, *n* (%) | 162 (72.00) | – | – | – | 108 (48.00) |
| OR (CI 95%) | 1 | – | – | – | 2.8 (1.8-4.2) |
| *p* ($\chi$2 test) | – | – | – | – | < 0.001 |

CI – confidence interval, OR – odds ratio

**Table 5.** Comparison of the proportion of patients achieving target blood glucose and $HbA_{1c}$ between chronic and acute kidney injury ($n$ = 225)

| Time-point | Chronic kidney disease | Acute kidney injury | Difference (chronic – acute) | $p$-value |
|---|---|---|---|---|
| Target blood glucose achievement (%) | | | | |
| $t_0$ | 12.41 | 10.00 | 2.41 | 0.14 |
| $t_4$ | 44.83 | 32.50 | 12.33 | < 0.001 |
| $t_4 – t_0$ | 32.41 | 22.50 | 9.91 | < 0.001 |
| Target $HbA_{1c}$ achieve (%) | | | | |
| $t_0$ | 28.97 | 26.25 | 2.72 | 0.24 |
| $t_4$ | 59.31 | 38.75 | 20.56 | < 0.001 |
| $t4 – t_0$ | 30.34 | 12.50 | 17.84 | < 0.001 |

**Table 6.** Relationship between achieving target blood glucose and $HbA_{1c}$ after three months with safe and reasonable drug use and drug interactions ($n$ = 225)

| Parameters | Achieved $n$ (%) | | Not achieved $n$ (%) | | OR (CI 95%) | | $p$-value | |
|---|---|---|---|---|---|---|---|---|
| | Blood glucose | $HbA_{1c}$ | Blood glucose | $HbA_{1c}$ | Blood glucose | $HbA_{1c}$ | Blood glucose | $HbA_{1c}$ |
| Use drugs safely and appropriately without CSDI | 24 (61.54) | 28 (71.79) | 15 (38.46) | 11 (28.21) | 1 | 1 | – | – |
| Use drugs safely and appropriately with CSDI | 61 (39.61) | 79 (51.30) | 93 (60.39) | 75 (48.70) | 0.41 (0.18–0.89) | 0.41 (0.17–0.93) | 0.013 | 0.021 |
| Use drugs unsafely and inappropriately without CSDI | 3 (23.08) | 5 (38.46) | 10 (76.92) | 8 (61.54) | 0.19 (0.03–0.91) | 0.24 (0.05–1.10) | 0.016 | 0.03 |
| Use drugs unsafely and inappropriately with CSDI | 3 (15.79) | 5 (26.32) | 16 (84.21) | 14 (73.68) | 0.12 (0.02–0.53) | 0.14 (0.03–0.55) | 0.001 | 0.001 |

CI – confidence interval, CSDI – clinically significant drug interactions, OR – odds ratio

cords with safe and appropriate drug use without CSDI and unsafe and inappropriate drug use with CSDI was 71.79% and 26.32%, respectively (Table 6).

## Discussion

In our investigation, CKD was observed at a higher rate than AKI. Within the CKD group, stages 5 and 3 constituted the majority. The number of female patients surpassed that of males, and the incidence of CKD in women was significantly higher than in men. This finding aligns with similar studies; for instance, Nguyen Thi Thanh Nga's research in 2014 reported that female patients accounted for 73.4%, and Rhee *et al*. in 2019 showed a female proportion of 50.9% [12, 13].

The average age of the patients was 63.73 ±12.73 years, with a substantial proportion being over 60 years old, consistent with studies by Majumder *et al*. (average age of 62.10 ±1.34 years) [14]. Another study by Alice reported an average age of 59.2 ±11.7 years, slightly lower than our findings [15]. Most patients in our study had a diabetes detection time of 5–10 years, compared to the average of 6.71 ±3.15 years. This variation might be explained by the geographical differences in the studies, with our research possibly capturing cases later due to factors like limited access to healthcare in certain regions.

Among 1125 prescriptions from 225 medical records, 98.21% of CKD patients and 98.50% of AKI patients utilised monotherapy regimens, while only a small percentage (1.79% for CKD, 1.50% for AKI) used combination regimens. This aligns with Rhee's study, where monotherapy accounted for 94.10% of the population [13], but it differs from Nguyen's recent study, which reported a lower monotherapy rate of 72.80% [16].

The research employed 4 drugs – metformin, gliclazide, acarbose, and insulin – comprising a smaller selection compared to studies in other countries, such as Xu *et al*., who used 8 active ingredients [17]. This limitation arises from the study's focus on severe kidney disease, where metformin is contraindicated. Insulin monotherapy usage was high in both CKD (95.86%) and AKI (93.50%), with an increasing trend in CKD severity from stage 2–5. Despite the potent hypoglycaemic effects of insulin, caution is warranted when combining it with metformin, gliclazide, or acarbose in patients with severely impaired renal function due to the heightened risk of hypoglycaemia.

The investigation primarily focused on drug interactions between diabetes treatment drugs and accompanying medications, excluding interactions involving antibiotics, hypertension drugs, and hyperlipidaemia medications. Given the relatively high average age and

numerous comorbidities in the subject population, combined medications may contribute to an increased incidence of drug interactions.

Results indicated a higher likelihood of CSDI in patients with complications of AKI compared to those with chronic kidney diseases (69.93% vs. 75.75%), with a statistically significant difference. Furthermore, the number of drugs in a prescription was positively correlated with the likelihood of CSDI appearance, emphasising the importance of monitoring drug interactions, particularly in prescriptions with 7–9 or 10–12 drugs. It was consistent with the study of Bajracharya *et al*., showing the positive relationship between drug interactions with the number of medicines prescribed and comorbidities [18]. These findings emphasise the importance of vigilant monitoring for drug interactions, especially in the context of kidney disease. The variations observed in drug interactions based on kidney disease type and the number of drugs prescribed underscore the need for personalised and careful medication management in diabetic patients with impaired kidney function.

The study revealed that 85.78% of patients received medications for diabetes management that adhered to all specified criteria, encompassing indication, dosage, route of administration, duration of use, and the absence of hypoglycaemic complications. However, 3 cases were identified in which drug indications deviated from recommendations, indicating contraindications. Specifically, 2 patients in CKD stage 4 were prescribed metformin combined with gliclazide, and one patient in CKD stage 5 was prescribed metformin monotherapy. These findings highlight a high level of adherence to treatment guidelines and safety measures in the prescription and administration of diabetes treatment drugs in patients with impaired kidney function. The focus on indications, dosage, administration, and duration of use contributes to the overall effectiveness and safety of the treatment approach in this specific patient population.

The primary driver behind unsafe and inappropriate drug use in this study was the occurrence of hypoglycaemia in patients using insulin. Notably, in patients with type 2 diabetes and kidney failure, particularly when the epidermal growth factor receptor is less than 30.0 ml/min/1.73 $m^2$, β-cell dysfunction is diminished. Despite the insulin dose not being excessively high, the prolonged half-life of insulin (increased 2–5 times) in such patients leads to hypoglycaemia. The objective of diabetes treatment in individuals with impaired kidney function is to regulate blood glucose and $HbA_{1c}$ levels without inducing severe clinical hypoglycaemia.

Hyperglycaemia stands out as a prominent risk factor contributing to the onset and progression of renal complications in patients with diabetes. The direct relationship between $HbA_{1c}$ levels and the likelihood of kidney complications emphasises the pivotal role of $HbA_{1c}$ control in mitigating kidney disease progression. In our study, we adopted a target blood glucose level of 70–130 mg/dl and a target $HbA_{1c}$ level of 6.5–7.0%, aligning with the recommendations of KDIGO [19]. The rationale behind choosing these specific targets was grounded in the fact that our patients had a prolonged duration of diabetes detection and presented with multiple underlying diseases, yet the incidence of hypoglycaemia complications remained relatively low (12.89%).

Throughout the course of treatment, we observed a consistent decrease in fasting blood glucose levels, starting at 232 ±106 mg/dl at the study's initiation and declining to 156 ±41 mg/dl after three months ($p < 0.001$). Furthermore, the target blood glucose rate exhibited a gradual increase over the months, reaching its zenith at three months, with 40.44% of patients attaining the target. Over the treatment period, the $HbA_{1c}$ value experienced a significant reduction from 8.18 ±1.68% at the initial time-point to 7.23 ±1.31% at the $t_4$ time-point ($p < 0.001$). It is noteworthy that our findings differ from those of Nguyen's study, in which a statistically significant difference was not observed [11].

In the comparison between the CKD and AKI groups after 3 months of treatment, the CKD group demonstrated a higher rate of achieving target blood glucose (9.91%) and a higher rate of achieving $HbA_{1c}$ (17.84%), with statistical significance ($p < 0.001$). This outcome aligns with the study's characteristics, where patients with CKD were mainly under 60 years old, while patients with AKI were mostly over 60 years old. It suggests that patients with AKI in the study exhibited poorer characteristics, including weak physical condition due to old age, comorbidities, progression of CKD, and encountering more CSDI. These factors may contribute to a reduction in the effectiveness of anti-diabetes drugs.

## Conclusions

Insulin monotherapy emerged as the predominant treatment for type 2 diabetes in patients with impaired kidney function, showcasing an increased utilisation trend corresponding to the severity of chronic kidney disease. Notably, CKD patients exhibited a higher success rate in attaining target fasting blood glucose and $HbA_{1c}$ levels compared to their AKI counterparts. The judicious use of drugs, characterised by reasonableness, safety, and the absence of clinically significant drug interactions, proved more effective in controlling blood sugar than the utilisation of less optimal medications.

This underscores the importance of regular and continuous monitoring for type 2 diabetes patients with impaired kidney function to ensure adequate blood sugar control and mitigate the risk of kidney disease complications. To bolster the reliability of findings, future research should explore the effectiveness of blood sugar control in this patient population over an extended

study period and across multiple centres. Such an approach would provide a more comprehensive understanding of the dynamics involved and contribute to the refinement of treatment strategies.

## Disclosure

1. Ethical approval for the study was obtained from the Medical Ethics Council of Can Tho University of Medicine and Pharmacy and Can Tho General Hospital (No. 43/HĐĐĐ-PCT dated May 2020).
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