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The role of pharmacists in the management of AKI patients: What recent studies added to our knowledge?

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ABSTRACT

Introduction: Acute kidney injury (AKI) is a complex syndrome requiring special management. It also complicates the prognosis of many hospitalized patients. Some essential yet nephrotoxic medications and the use of certain procedures that may alter renal hemodynamics further complicate the management of AKI patients. Fortunately, as part of the renal care team, pharmacists can have a significant role in the multidisciplinary approach used to optimize renal patients' health-related quality of life by delivering safe and effective pharmaceutical care.

Objective: The present review aims to explore pharmacists' contributions to the management of patients with AKI as well as their influence on improving renal patients' care.

Methods: An online search was performed in the databases PubMed, Scopus, and ScienceDirect for relevant articles published in English between 1 January 2015 and 31 December 2021. Review articles, books, guidelines, websites, and conference proceedings were excluded.

Results: Only 12 articles out of 51 initially gathered met the eligibility criteria for this review. The three main roles that pharmacists play in the management of AKI patients are patients' education, collaborating with other renal care practitioners, and identifying and solving drug-related problems (DRPs). The latter task span includes medication reconciliation, dosage adjustments, and identifying adverse drug reactions.

Conclusion: In view of the complexity of the AKI course, trained pharmacists, as members of the renal care team, can play a pivotal role in managing AKI patients and minimizing their medications burden. This can positively impact the overall renal care process as well as the patient's outcome. Further studies can provide more support to the importance of pharmacists' role in managing AKI.

Implication for health policy/practice/research/medical education:
Being complex in terms of its course and treatments, acute kidney injury (AKI) necessitates careful inter-professional management among renal care providers, and pharmacists are no exception. The role of pharmacists can be of great importance when introduced properly. They can communicate with patients and educate them, collaborate with renal care professionals, as well as aid in formulating individualized care plans that optimize patients' outcomes and minimize treatment side effects and safe AKI recovery. More studies are required to explore the role of pharmacists' interventions during AKI.

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Review

Introduction

Acute kidney injury (AKI) is a disease that affects the course and worsens the outcomes of many hospitalized patients. It is described as a sudden decline in kidney function that can occur over a period of hours. It includes both kidney injury and impairment, which involve structural damage and loss of renal function, respectively. Many individuals with AKI rarely have a simple but complex etiology of the disease. The coexistence of sepsis, ischemia, and nephrotoxicity complicates AKI diagnosis as well as its therapy. Pre-renal, post-renal, and intrinsic AKI are the three types of AKI. Different from pre- and post-renal AKI that are caused by extra-renal diseases that eventually lead to a decline in estimated glomerular filtration rate (eGFR), intrinsic AKI is caused by an actual kidney illness. Although pre- or post-renal conditions do not originate from a real kidney disease, they may persist and eventually evolve into renal cellular damage, inducing intrinsic renal disease (1).

The prevalence and causes of AKI are highly variable

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depending on the geographical area. In developed countries, hospital acquired factors such as sepsis, ischemic and nephrotoxic drugs are more common, whereas developing countries are more prone to community acquired disease-induced AKI such as infectious diseases, diarrhea, animal venoms and dehydration, among others. Moreover, AKI is shown to be age-dependent as it is found to be more common among the elderly who are older than 65 years old. This has been attributed to changes in the anatomy and physiology of the ageing kidney, as well as certain procedures and medications that are nephrotoxic or alter renal hemodynamics, but are required for certain underlying comorbidities in elderly patients (2).

As part of the renal care team, pharmacists have a significant role in the multidisciplinary approach practiced to optimize renal patients' health-related quality of life by providing safe and effective pharmaceutical care. There are several primary goals that pharmacists should accomplish in giving the best pharmaceutical care, including identifying actual and potential drug-related problems (DRPs), resolving the actual ones, and preventing any potential ones from turning into actual problems. Specifically, pharmacists intervene in DRPs by modifying drug doses, monitoring laboratory parameters, improving patients' adherence, assessing their compliance, and discussing recommendations with other renal care professionals. Therefore, it is of great importance that pharmacists are equipped with adequate training and experience, which are vital to ensure proper pharmaceutical care plans are provided to the patients (3).

In the process of AKI care, evaluating kidney functions as well as laboratory results is essential to assess and monitor the disease progression. The etiology of kidney injury shall be determined if drug therapy is suspected to be a contributing factor. In addition to assessing the patient's lifestyle, both underlying diseases and medications taken should be evaluated. For instance, drugs such as non-steroidal anti-inflammatory drugs (NSAIDs) may directly cause the injury, but others can predispose patients to nephrotoxicity such as diuretics. These drugs should be withdrawn from the therapy and substituted with alternative ones. Drugs that are significantly eliminated by the kidneys should have stringent monitoring to assess any signs of adverse effects. In addition, pharmacists' intervention in drug dosage adjustments must be based on the estimated kidney function. Preventive strategies to decrease the risk of AKI should always be implemented as well. In sum, effective collaboration amongst all healthcare professionals is essential to exert a significant influence on the success of the management of AKI (4).

Objectives

The aim of this review is to discuss the importance of pharmacists' role in optimizing therapeutic outcomes in patients with AKI, including the development of appropriate pharmaceutical care plans and their collaboration with other renal care team members.

Materials and Methods

Literature search

A comprehensive literature search on the role of pharmacists in AKI patients was performed with assistance from undergraduate pharmacy students using online search engines, i.e., PubMed, Scopus, and ScienceDirect. The keywords used when searching the selected databases are shown in Table 1.

Eligibility criteria

To guide the search process, eligibility criteria for the selected articles were defined prior to the database search. The inclusion and exclusion criteria for the literature search are shown in Table 2.

Selection of studies

Found articles were compiled into Google Drive, and duplicates were deleted. A full-text screening was then performed to examine whether the remaining articles were eligible for inclusion in this review. In addition, references cited in the included articles were reviewed to ensure the citations in the articles were credible.

Data extraction and analysis

Articles that passed the process of eligibility were included in this review. The data of the authors, study year, objectives, population, and key findings were then extracted and tabulated. Due to the variety of articles

Table 1. Keywords identification for search using database

Database	Keywords
PubMed	(role) AND (pharmacist) AND (acute kidney injury)
Scopus	TITLE-ABS-KEY (the AND role AND of AND pharmacists AND in AND acute AND kidney AND injury AND patients) AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017)
Science Direct	"role" and "pharmacist" and "acute kidney injury"

Table 2. Inclusion and exclusion criteria for literature search

Criteria	Inclusion	Exclusion
Year	From 2015 to 2021.	Literature published before 2015.
Type of article/ study	Clinical trial, random controlled trial, retrospective study, case study, research article, commentaries. Articles that have been published and are available online.	Review articles, books, guidelines, websites, conferences, proceeding.
Language	English	Non-English

included in this review, the results are provided as a narrative synthesis.

Results

Of the 51 articles identified during the literature search, 12 articles satisfied the eligibility criteria. Selected articles covered three main pharmacists' roles in AKI (Figure 1).

Based on the findings from these articles, the roles of pharmacists in AKI management were identified and categorized into three main roles: educational-based interventions, collaboration with other healthcare practitioners, as well as identifying and solving DRPs. Important data extracted from the 12 articles are listed in Table 3.

Discussion

Educational-based intervention

Patient education is a well-established component of chronic kidney disease (CKD) self-management, and it is regarded as critical in reducing AKI harm (5). Vicary and associates conducted a study in New Zealand, in which they assessed the current practices of general practitioners (n = 37) and community pharmacists (n = 25) in educating their patients on when to withhold their medications during acute dehydrating illnesses (6). The assessment was followed by a second study (7), in which the researchers evaluated an intervention that aimed to provide information to patients regarding key medications that could worsen AKI. These key medications were also known as "Double Whammy" (NSAIDs with angiotensin-converting enzyme inhibitors [ACEIs]/angiotensin receptor blockers [ARBs]/diuretics) and "Triple Whammy" (NSAIDs with ACEIs/ARBs and diuretics), which were associated with an increased risk of AKI during dehydrating illness. It is well established that drugs affecting the renin-angiotensin-aldosterone system, such as ACEIs or ARBs, increase the risk of prerenal injury as a result of their actions on the efferent arterioles (8,9).

Figure 1. Flowchart of searching strategy and key roles of pharmacists in AKI patients.

Table 3. Findings from the collected articles

Author	Type	Population	Objectives	Key Findings
Vicary et al (6)	Original research	32 pharmacists and 37 GPs in Hawke's Bay, New Zealand.	To explore practices in patients' education for withholding medicines that can contribute to community-acquired AKI during acute dehydration.	• GPs were sure that pharmacists were able to educate the patients, and they supported the pharmacists' role in advising them on when to withhold ARBs or ACEIs. • 50% of the GPs expected pharmacists to educate the patients or contact the prescribers before dispensing, and less than half of the pharmacists did so.
Vicary et al (7)	Original research	39 community pharmacists and 113 consenting patients who received intervention.	To evaluate an AKI educational intervention delivered by community pharmacists to patients for self-management during acute dehydration.	• The educational approach improved patients' awareness and confidence to temporarily withhold some key medicines during acute dehydrating illness.
McDaniel and Bentley (8)	Discussion	-	-	• Pharmacists' role is to identify DRPs and interventions to avoid unwanted complications. • Pharmacists were also trained to make rational drug dose adjustments in patients with AKI and CKD. Dose adjustment is critical during changes in renal function, and pharmacists can ensure optimal therapy is provided.
Yamamoto et al (9)	Original research	129 hospitalized patients with CKD.	To assess the effects of pharmacists' participation in patients' hospitalizations due to drug- related kidney injury.	• After pharmacist participation, patient hospitalizations due to RASIs–related eGFR and hyperkaliemia declined. NSAID and RASIs prescriptions decreased and acetaminophen prescriptions increased. • A significant number of citizens shifted from CKD stage G3 to CKD stage G1-2.
Hawley et al (10)	Original research	2 pharmacy residents were embedded in a Veterans Affairs nephrology clinic of Boston Healthcare Systems, USA.	To assess the impact of integrating pharmacists within an interprofessional nephrology clinic for conducting MR.	• Pharmacists were able to conduct 118 MR visits for 87 unique patients. • A total of 344 medication discrepancies and 301 DRPs were identified by the pharmacists. • The interprofessional team strongly agreed that pharmacists' involvement helped the team provide better care for patients.
Elvey et al (11)	Original research	18 healthcare staff in England.	To understand factors that influence the implementation of a primary care intervention to improve post-AKI after-discharge care.	• 3 main factors that influence implementation: 1- New intervention from other practice work. 2- Development of skill mix. 3- Inter-organizational communication.
Phipps et al (12)	Original research	36 healthcare practitioners (nephrology) in 3 regions of England.	To examine the role of individual and collective cognitive work in managing medicines for AKI.	• Pharmacists should be able to detect & manage AKI since it is very complex, especially in the presence of other comorbidities. • Pharmacists should be able to assess medications' efficacy, which has a good balance between safety and SEs.

Table 3. Continued

Author	Type	Population	Objectives	Key Findings
Stoops et al (13)	Original research	All infants admitted to Children's of Alabama's 48-bed level IV NICU that met the exposure criteria.	To test if AKI is preventable in NICU patients and if high-risk infants of drug-induced AKI could be identified with a program previously used in the pediatric NICU setting.	• When comparing the percentage of patients with highly nephrotoxic medication exposures with AKI in the pre-NINJA and initiation era, no significant changes were observed (25.2% versus 30.9%), but in the sustainability era, the percentage decreased very significantly to 11.0%.
Daifi et al (17)	Original research	ESRD patients (18 years old and older) who received in-center HD at 14 Greenfield Health Systems HD centers.	To evaluate the impact of a clinical pharmacist in a HD facility by assessing the efficacy of MR among HD patients.	• 1407 DRPs were identified. Adherence was the most common problem (31%), followed by drug without indication (21.6%), sub-therapeutic dose (13.1%), and cost/ accessibility/need for refills (11.9%). • In a follow-up patient survey, 94.7% of the patients were reported to understand their medications better and 77% of them reported adherence after MR.
Patricia and Foote (18)	Original research	93 unique HD patients in the UnitedStates.	To determine the types of DRPs in HD patients and the acceptance of pharmacists' recommendations.	• 376 DRPs were identified. The most common ones were drug omissions and untreated indications. Pharmacists had conducted 440 interventions and 77% of them were accepted. • MR should be conducted more often in HD patients.
Sukkha et al (19)	Original research	158 patients admitted to the medical wards presented with AKI on admission.	To assess the quality of dosage adjustments suggested by clinical pharmacists in comparison to standard dosing guidelines, and to examine physicians' approval of pharmacists' interventions and economic benefits.	• 172 out of 190 interventions (90.5%) were consistent with the standard references. • 170 interventions (89.5%) were accepted and complied with, 10 (5.3%) were partially accepted and 10 were rejected. • Interventions resulted in a total cost savings of US $5560 in total (US $45/ intervention).
Coulter (20)	Discussion	-	-	• Pharmacists must be alert to detect ADRs, which rely on having a high level of suspicion. • Pharmacists have to continuously share with their peers their practices in identifying uncommon ADRs.

ACEIs; Angiotensin converting enzyme inhibitors, ADRs; Adverse drug reactions, AKI; Acute kidney injury, ARBs; Angiotensin receptor blockers, CKD; Chronic kidney disease, DRPs; Drug-related problems, eGFR; Estimated glomerular filtration rate, ESRD; End-stage renal failure, GPs; General practitioner, HD; Hemodialysis, MR; Medication reconciliation, NICU; Neonatal intensive care unit, NINJA; Nephrotoxic injury negated by just-in-time action, RASIs; Renin-angiotensin system inhibitors, SEs; Side effects

Additionally, NSAIDs have been implicated in several forms of kidney injury, fortunately, NSAID-induced AKI is usually reversible once the offending agent is discontinued (8).

Most of the general practitioners in the study by Vicary et al.'s first study were confident that the pharmacists were able to educate their patients on withholding ACEIs or ARBs during acute illnesses (6). However, they still had the perception that not all community pharmacists have ample knowledge to provide such education, along with business model limitations and insufficient time. The community pharmacists, on the other hand, were convinced that their intervention was not well accepted as they were unsure if the prescribers wanted to be contacted and they did not know if the prescribers already had a discussion regarding the medications with their patients. In fact, general practitioners expected community pharmacists to educate patients about withholding "at-risk" medications during acute illnesses and to contact them when the patients were receiving the combination therapy while dispensing the prescription (6). Based on their findings, Vicary et al proposed that patients' education on withholding their medications is not something that is done on a regular basis. Instead, education on NSAIDs prescribing with concurrent risky medications differs depending on who is providing it. However, it is important for both general practitioners and community pharmacists to communicate with each other to provide the best and safest treatment for the patients while still including the patients' agreements, in addition to secondary care providers such as nurses.

The previous findings led Vicary and colleagues to conduct a second study to evaluate an educational-based intervention, which was provided by community pharmacists (n = 39), to discontinue the key medications whenever their patients feel unwell, therefore the risk of AKI is reduced (7). The intervention consisted of verbal education by community pharmacists, along with a sick-day guidance sheet, which provides graphic and direct information regarding the list of medications that cause AKI, instructions on withholding the medication for 24 to 48 hours, instructions on contacting a general practitioner if the symptoms of AKI worsen, as well as actions to be taken to self-manage when taking medications that would cause AKI.

It was found that 58% of the participating patients managed to recall the information provided by the community pharmacist, and 27% highlighted the importance of their pharmacist's advice as well as having the guidance sheet. However, only 55% of the patients retained the sick-day guidance sheet.

In terms of actions that would be taken by the patients if they were severely ill, 62% agreed to withhold their key medicines, and 4% stated that they would not be encouraged to stop their anti-hypertensive drugs. Additionally, 49% of the patients were willing to contact their physicians upon stopping their medication due to severe nausea and vomiting, while only 35% would contact them after one day. The educational intervention provided by the community pharmacists in New Zealand was found to be practical as it would help patients temporarily withhold certain medications when having an acute illness to reduce the risk of AKI, as concluded by the researchers (7).

Collaboration with other renal care practitioners

Other contributions by pharmacists in the renal care process include aiding consultations or referrals and communicating with the primary care team. In a post-intervention survey by Hawley et al, the inter-professional nephrology team strongly agreed that pharmacists' involvement helped the patients and the team in providing better care (10). Collaborative planning is also advantageous in providing consistent education for the patients (6).

Recently, Elvey et al conducted a qualitative study to comprehend the factors that would affect implementing interventions in primary care to improve post-AKI after-discharge care (11). The researchers interviewed 18 healthcare staff, five of whom were pharmacists. The interview focused on the implementation of the intervention from the participants' personal perspective, such as their clinical role, experience in delivery of the intervention, comments on excellent output, and suggestions with reasons for improving the intervention. The study concluded that pharmacists played a crucial role in the post-AKI after-discharge care; a role that complemented the work of the other renal care team members. However, one should not ignore the fact that building understanding and trust across different professionals takes time (11).

When AKI cases are encountered, healthcare practitioners face several challenges. In their qualitative study, Phipps and colleagues identified three main areas of these challenges, i.e., challenges in terms of clinical context, challenges within organizational context, and challenges related to the resolution of problems that arose or would arise. These difficulties would indeed result in disrupted information flow, miscommunication, or communication barriers between inter- and intraorganizational parties, complicating information gathering and patient coordination (12).

What is important to note is that proper communication with pharmacists should be maintained, as well as good information flow should be provided to them, and thus better management of AKI could ensue. In fact, pharmacists can play a pivotal role in the information

gathering process by sourcing important information from patients themselves, especially when these patients understand their condition appropriately. Other crucial roles of pharmacists that can also be acknowledged are their partaking with other renal care team members in decision making, communication, and team coordination (12), which can be achieved if they have adequate understanding, training, and organized design work (11,12).

An example of pharmacists' role in ensuring a great team coordination while handling AKI patients was shown in a study conducted by Stoops et al (13), which examined the ability of a systematic surveillance programme to identify infants at high-risk for nephrotoxic medication-induced AKI. Infants admitted to the neonatal intensive care unit (NICU) between March 2015 and September 2017, were screened for exposure to high-risk nephrotoxic medications, which were defined as at least three nephrotoxic medications within one day or at least four calendar days of IV aminoglycosides administration. It was found that the pharmacists' daily serum creatinine monitoring and medications stewardship had significantly decreased the rates of nephrotoxic exposure as well as AKI. Approximately, 100 AKI episodes and 157 days of AKI in the NICU were prevented throughout the study duration (13). Kidney function monitoring is most important following the initiation of therapy, especially for patients who are at risk. For instance, McDaniel and Bentley highlighted that close monitoring of renal function and drug levels during the early period of therapy (days to weeks) can assist in preemptively managing deterioration of renal perfusion (8).

Identifying and solving drug-related problems

Medication reconciliation

"Medication reconciliation is the process of comparing a patient's medication orders to all of the medications that the patient has been taking." As defined by the Joint Commission on Accreditation of Healthcare Organizations (14). During transitions of care, medication reconciliation should be performed to come up with a detailed and complete list of the patient's medications. This list should include all prescription and non-prescription medications, vaccines, parenteral nutrition, diagnostic agents, blood derivatives, intravenous solutions, as well as vitamins, nutritional and herbal products (15). Indeed, medication reconciliation serves as an effective method of identifying and resolving DRPs, polypharmacy, and non-adherence in patients with renal diseases (16).

Hawley et al conducted a study to assess the impact of integrating pharmacy residents within an inter-professional nephrology clinic for conducting medication reconciliation (10). Similarly, a retrospective study was conducted by Daifi et al regarding the implementation of clinical pharmacists in a hemodialysis facility of Greenfield Health System (17). The main objective of both studies was to evaluate the impact of clinical pharmacists' interventions on improving renal care via assessing the efficacy of medication reconciliation and the identification of DRPs.

During their visit, renal patients were asked to present their home medications to the pharmacist for medication reconciliation. The pharmacist would inquire about their mode of administration and identify any signs of problems such as side effects, tolerability, and cost. Subsequently, medication review was conducted to assess any medication related issues. After that, each patient or caregiver was provided with an individualized medication reconciliation form and a calendar according to their specific regimen. Surveys were conducted on either patients (17), or team members in the nephrology clinic (10) to measure self-reported adherence or to assess the value of pharmacists' inclusion in the management of renal patients, respectively.

Over the 9-month study period, Hawley and colleagues revealed that the pharmacists were able to conduct 118 medication reconciliation visits for 87 unique patients, of which less than 10% had AKI. From the visits, a total of 344 medication discrepancies and 301 drug therapy problems were identified by the pharmacists. A high number of DRPs were also found in a prospective study conducted by Patricia and Foote (18), in which 376 discrepancies were identified amongst 93 hemodialysis patients in the United States. In both of the studies (10,18), the common medication discrepancies included active drugs being omitted from the medication list, continuation of a drug that had been discontinued previously, and taking a drug in a different way than instructed. For DRPs, the common ones that had been recorded by them were untreated indications and potentially inappropriate medication, which led to the potential for actual adverse drug reaction. Hawley et al highlighted that the pharmacists contributed to 398 changes in the renal care process as a result of their direct intervention, of which 228 recommendations for medication optimization were given. Fortunately, 79% of these recommendations were implemented by renal care providers (10).

Similarly, according to Daifi and colleagues, a total of 157 patients were included, and it is reported that 1407 medication related problems were identified. Adherence was found to be the most common problem (31%) followed by drug without indication (21.6%), sub-therapeutic dose (13.1%) and cost/accessibility/need for refills (11.9%). The study also reported a 12% increase in the number of patients with normal blood pressure following pharmacists' interventions, a positive response

that has been imputed to identifying and solving patients' adherence issues (17).

Hawley et al, as well as Patricia and Foote concluded in their studies that the incorporation of pharmacists into nephrology is beneficial and resulted in the identification and resolution of many DRPs. This is mainly because the integration of pharmacists into the inter-professional team potentially improves patients' outcomes (10,18). In similar studies, McDaniel and Bentley as well as Daifi et al concluded that pharmacists' contributions in hemodialysis facilities fostered renal care via medication reconciliation and DRPs identification, which subsequently led to cost savings (8,17).

In terms of cost savings achieved, Daifi et al estimated that a total of US $447 355 was saved after implementing clinical pharmacists due to the identification of DRPs (17). The cost-saving effect of pharmacists' interventions in renal dosing was also reported by Sukkha et al, in which almost US $5600 was saved following 190 interventions in 158 patients who were admitted to the medical wards and presented with AKI on admission (19). Sukkha and colleagues also found that there were six incidents where patients encountered adverse drug reactions (ADRs) from antimicrobial agents, four of which were cases of AKI. The total cost avoidance was estimated to hinder the possibility of ADRs occurrences and was estimated at US $938.

What was interesting in these studies discussed in this section, is that patients as well as renal care providers acknowledged their pharmacists' interventions, in addition to finding them helpful and beneficial (10). For instance, 94.7% of the patients in the Daifi et al study were reported to understand their medications better, and 77% of them reported adherence after medication reconciliation. In summary, pharmacists can efficiently play a crucial role in medication reconciliation for the better management of AKI patients (17).

Dosage adjustment

Pharmacists play an important role in identifying possible causes of drug-induced AKI, in addition to assessing drug dosing and recommending any necessary adjustment (8). In a retrospective study, the researchers assessed physician acceptance of pharmacist suggestions and estimated the economic benefits in terms of direct cost savings and cost avoidance as a result of ADRs prevention among AKI or CKD patients who were hospitalized in Siriraj hospital, Thailand. Pharmacists' participation in renal dosage adjustment improved the appropriateness of the dosage for the 158 recruited patients, as 79.5% of the dosages of the prescribed medications were discovered to be too high before pharmacists' intervention. In addition, 190 (90.5%) of the interventions were in accordance with the standard references, and the majority were accepted and complied with by the physicians, indicating that pharmacist assistance in renal dosage modifications was positively effectual, and actually resulted in a cost savings of U$45 per intervention (19).

In a recent study that was conducted in Fujieda, Japan, renin-angiotensin system inhibitors (RASIs)-induced AKI was identified in 129 hospitalized CKD patients out of 14150 hospitalized patients. The researchers reported that prior to their interventions, pharmacists would inspect and identify any dose and combination of nephrotoxic drugs based on the pocketbook and patient's prescription. They would then cross-check the prescription against the patient's kidney function and intervene as necessary. The study observed that pharmacists' interventions resulted in a decline in the rate of hospitalization due to RASIs-induced AKI. The study also revealed that after implementing pharmacists' interventions, acetaminophen prescriptions increased and NSAIDs prescriptions decreased, and RASIs prescriptions decreased among 6930 hospitalized patients with eGFR less than 60 mL/min/1.73 m^2. Surprisingly, a large number of Fujieda residents progressed from CKD stage 3 (eGFR 30-59 mL/min/1.73 m^2) to CKD stage 1-2 (eGFR greater than or equals to 60 mL/min/1.73 m^2) (9).

In fact, strategies that enable introducing trained clinical pharmacists into the renal care process and linking them with nephrologists and patients would most likely promote safe prescribing and provide necessary management (6).

Adverse drug reactions

Coulter (20) discussed the role of renal pharmacists in identifying ADRs in renal patients. The author suggested that having a high index of suspicion is crucial in detecting these ADRs. In renal patients, the complex pharmacokinetics and pharmacodynamics alterations usually result in a high prevalence of ADRs, and the presentation of these ADRs could be misinterpreted as symptoms of other diseases.

For instance, patients on warfarin might present with two rare ADRs, i.e., calciphylaxis, which is characterized by ischemic tissue with black eschar; or purple toe syndrome that is characterized by bilateral purple discoloration of the feet, which might be misdiagnosed as normal cholesterol emboli.

To precisely identify the causative agent and decide whether to continue, de-prescribe, or re-prescribe a drug, the pharmacist might need a high level of suspicion, which can be gained and improved over years of experience, which the author claimed to be the best teacher for the pharmacist to discover ADRs. Coulter also underscored that renal pharmacist will encounter a variety of situations throughout the course of their careers, and they will eventually learn about ADRs and become attentive as a result of their dealings with them. In addition to

merely reporting ADRs, pharmacists should inform their colleagues about their experiences in recognizing less prevalent ADRs, which would enhance other pharmacists' awareness regarding uncommon or rare ADRs (20). In fact, as a part of the renal care team, pharmacists should be able to detect and manage AKI despite its complexity, and assess medications' safety and efficacy prior to supplying them to an AKI patient, especially in the presence of other comorbidities (12).

Conclusion

This review is an attempt to provide credence to the importance of the role of pharmacists in the management of AKI. Once introduced, pharmacists' interventions can have an impactful role in the management of AKI patients. From participating in educating patients while collaborating with other renal care professionals to managing and preventing DRPs. The latter is of great importance and can be achieved with the help of skilled pharmacists who conduct medication reconciliation, adjust medication doses, and monitor for ADRs. All these interventions could ensure personalized pharmaceutical care plans for better quality and more effective treatment of this group of patients. It is hoped that this review will engross the attention on more research exploring the important role of pharmacists in managing patients with AKI.

Limitations of the study

It is possible that some studies with interesting findings were missed. This is because electronic searches were limited to studies in the English language, and non-English language studies were excluded. Also, some studies were possibly missed because they were published in institutions or scientific societies' websites, or because they were not indexed in the databases searched.

Authors' contribution

ARFN is the single author in the manuscript.

Conflicts of interest

The author declares no conflict of interest. The funder had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the author.

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