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Review Article

Pharmacists' strategies to detect, resolve, and prevent DRPs in CKD patients

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Abstract

Pharmacists have undergone obstacles in the process of detecting, resolving, and preventing CKD patients' DRPs. Thus, optimal strategies were needed. A total of 19 articles were included based on the article searching process. Based on the articles, it can be concluded: The strategies of detecting DRPs in CKD patients were carried out through medication reconciliation and medication review. The outcomes of these strategies were the number of DRPs/patients and types of DRPs detected. Strategies to resolve and prevent DRPs in CKD patients were conducted through interprofessional collaboration, education, and counselling. The outcome of these strategies was a change in the patients' DRPs status. Optimization of detection, resolution, and prevention strategies were performed by improving pharmacists' professional hard and soft-skills as well as modifying the pharmaceutical care delivery model. A decrease in the number of DRPs/patients and a change in DRPs status were reported as the outcomes of optimizing this process.

Keywords

Chronic Kidney Disease, Drug-Related Problems, Pharmaceutical Care, Pharmacist

Introduction

Background

Chronic Kidney Disease (CKD) is one of the deadliest diseases globally, ranked 17th in 1990 and 12th in 2017. Its global prevalence has increased by 29.3% from 1990 to 2017 (Bikbov et al. 2020). CKD patients with various comorbid diseases can experience polypharmacy. This condition can trigger the emergence of Drug-Related Problems (DRPs) (Hassan et al. 2009). One study showed that patients with polypharmacy, patients with ≥ five comorbid types, and patients with CKD stage 5 had a risk of developing DRPs of 4.695; 3.616; 3.941 times than those without polypharmacy and those with < 5 comorbid types and CKD below stage 5 (Garedow et al. 2019). Several studies have reported that DRPs prevalence in CKD patients reached 93% (Belaiche et al. 2012; Holm et al. 2015; Garedow et al. 2019). The mean number of DRPs/patients ranged from 5.31 to 10 (AbuRuz et al. 2013; Ramadaniati et al. 2016). Drug interactions, indications without drugs, medication non-adherence, drug use without indications, and overdoses were reported to be the most DRPs in CKD patients (Chia et al. 2017; Njeri et al. 2018).

Based on these problems, DRPs management in CKD patients carried out by pharmacists is crucial. It has been proven to give some advantages, namely a better quality of life for patients, a shorter average Length of Stay (LOS), mortality prevention, and health cost reduction (Cardone et al. 2010). However, pharmacists have undergone obstacles in the process of detecting, resolving, and preventing DRPs in CKD patients (Mongaret et al. 2020). Therefore, this literature review aims to give insights to the pharmacists' optimal strategies for detecting, resolving, and preventing DRPs in CKD patients.

Method

The method used in this literature review article was through articles search on three databases with specific keywords for each database. It is shown as follows:

- Google Scholar: ("Pharmaceutical Care" OR "Pharmacist") AND ("Chronic Kidney Disease" OR "Kidney Failure" OR "End Stage Renal Disease") AND ("Drug-Related Problem" OR "Medication-Related Problem" OR "Drug-Therapy Problem").
- PubMed: (((pharmaceutical care [MeSH Terms]) OR (clinical pharmacist [MeSH Terms])) AND ((((chronic kidney failure [MeSH Terms]) OR (chronic renal insufficiency [MeSH Terms])) OR (disease, end stage renal [MeSH Terms])) OR (Chronic Kidney Disease))) AND ((((Drug-Related Problems) OR (Medication-Related Problems)) OR (Drug-Therapy Problems)) OR (Pharmaceutical Care Issues)).
- Science Direct: ("Pharmaceutical Care" OR "Pharmacist") AND ("Chronic Kidney Disease" OR "Kidney Failure" OR "End Stage Renal Disease") AND ("Drug-Related Problem" OR "Medication-Related Problem" OR "Drug-Therapy Problem" OR "Pharmaceutical Care Issues").

The article selection process used inclusion and exclusion criteria. The inclusion criteria included research articles that discussed about pharmaceutical care activities in CKD patients with DRPs as one of the study outcomes. The process of article selection is shown in Figure 1.

Results and discussion

The term pharmaceutical care according to the Pharmaceutical Care Network Europe (PCNE) in 2013, is "The pharmacist's contribution to the care of individuals in order to optimize medicines use and improve health outcomes" (Allemann et al. 2014). Based on the definition, the process of detecting, resolving, and preventing DRPs in CKD patients by pharmacist is a part of pharmaceutical care. Tables 1, 2 summarises 19 selected studies regarding the pharmaceutical care for CKD patients with DRPs as one of the study outcomes.

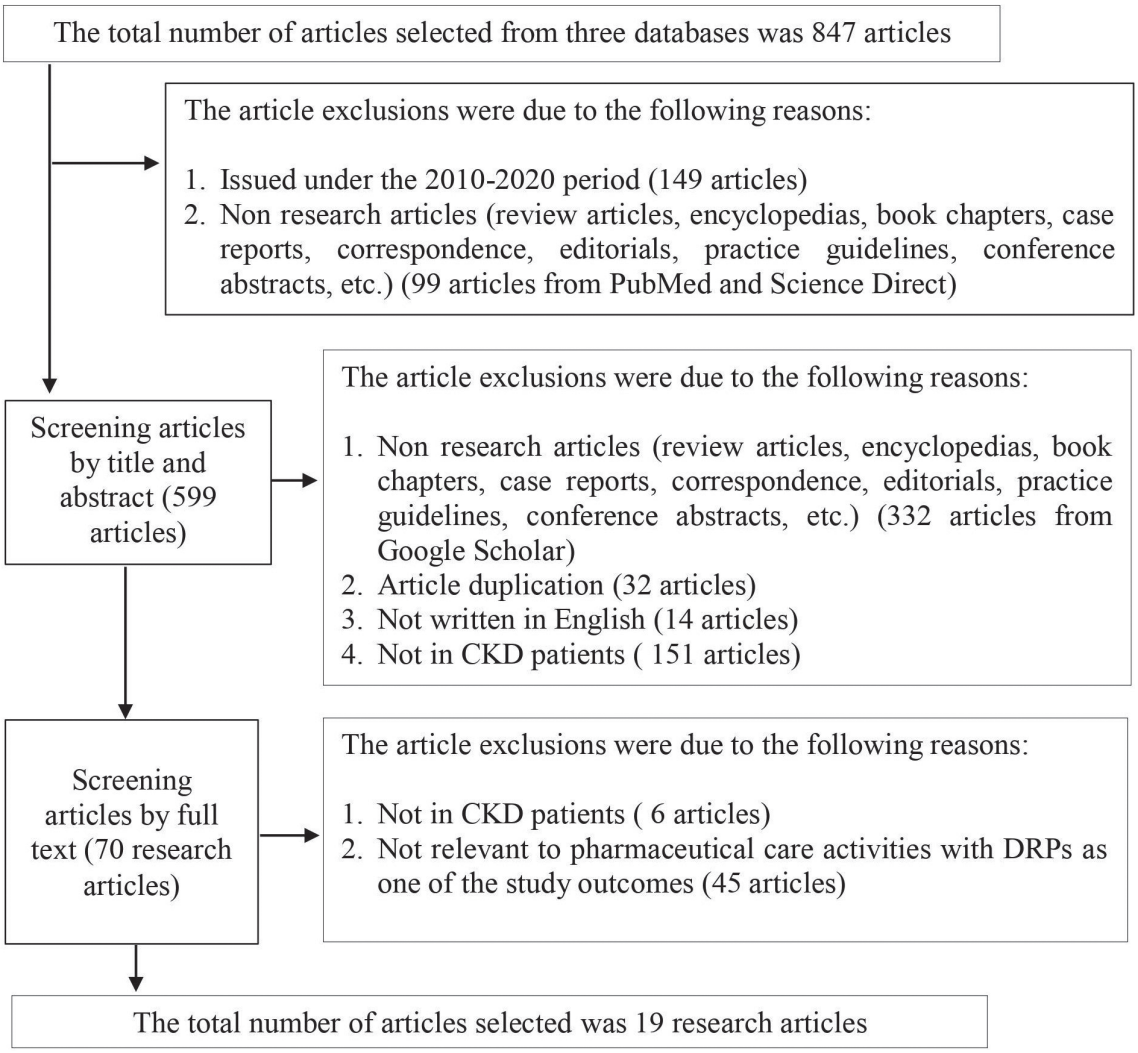

Figure 1. Article Selection Scheme.

Table 1. Summary of Four Studies on Pharmaceutical Care for CKD Patients (Experimental Study).

References	Participants (Mean Age (year))	Pharmaceutical care activities*					Study outcomes			
		1	2	3	4	5	Prevalence of DRPs	Mean of DRPs	Acceptance recommendation	DRPs status
(AbuRuz et al. 2013)	130 CKD patients (56.3±17.8)	√	√	√	√		(Not Reported)	5,31±2,61 DRPs/patient	A total of 690 recommendations were given, 86.6% were accepted, 69.2% were accepted and implemented, 2.3% were corrected by physicians	17% DRPs resolved and 37.4% DRPs prevented
(El Borolossy et al. 2014)	Haemodialysis patients CG: 25 patients (11.5±0.6) IG: 25 patients (10.8±0.64)	√	√	√	√		(Not Reported)	IG: 0,329 DRPs/ patient	Three types of interventions were accepted by patients 100%, 98%, and 96%, respectively. Physicians accepted three types of recommendations 100%, 95%, and 100%, respectively	(Not Reported)
(Lalonde et al. 2017)	CKD without dialysis patients. IG: 304 patients (71.9±12.0) CG: 138 patients (71.2±12.5)	√	√	√			(Not Reported)	(Not Reported)	(Not Reported)	The decreased DRPs/patient in both groups: 2.16±2.10 to 1.60±1.79 for IG and 1.70±2.02 to 1.62±1.79 for CG. The difference in the decline between the two groups was -0.32 (95% CI, -0.63 to -0.01).
(Monterroza and Bolivar 2017)	47 CKD patients (Not Reported)	√	√	√	√		(Not Reported)	(Not Reported)	There were 35 recommendation accepted from a total of 41 recommendation	(Not Reported)

Pharmaceutical care activities*: (1) Medication Reconciliation, (2) Medication Review, (3) Interprofessional Collaboration, (4) Education, (5) Counselling. CKD: Chronic Kidney Disease. DRPs: Drug-Related Problems. IG: Intervention Group. CG: Control Group.

Table 2. Summary of 15 Studies on Pharmaceutical Care for CKD Patients (Observational Study).

References	Participants (Mean Age (year))	Pharmaceutical care activities*					Study outcomes			
		1	2	3	4	5	Prevalence of DRPs	Mean of DRPs	Acceptance recommendation	DRPs status
(Belaiche et al. 2012)	67 CKD patients (70)	√	√	√		√	93%	2 DRPs/patient	Nephrologist accepted 82.6% of total 142 recommendations	(Not Reported)
(Joel et al. 2013)	37 Haemodialysis Patients (Not Reported)	√	√	√			51,35%	2,05 DRPs/patient	A total of 39 recommendations, 23.07% were accepted and the therapy was changed, 48.72% was accepted but the therapy was not changed, and 28.05%, neither the recommendation was accepted nor prescriber changed the therapy	(Not Reported)
(Holm et al. 2015)	79 CKD without dialysis patients (78.7±10.2)	√	√	√			62%	1,8 DRPs/patient	Recommendations accepted by physicians were 95.7% of 69 recommendations	(Not Reported)
(Pourrat et al. 2015)	177 CKD without dialysis patients (78.1)	√	√	√			(Not Reported)	(Not Reported)	Recommendations accepted by general practitioners were 33.3% of 18 recommendations	33,3% DRPs resolved
(Patricia and Foote 2016)	90 Haemodialysis Patients (Not Reported)	√	√	√			(Not Reported)	0,5±0,8 DRPs/patient	Recommendations accepted by the prescriber and nurse were 27% of 64 recommendations	(Not Reported)
(Ramadaniati et al. 2016)	105 CKD patients (Not Reported)	√	√	√			(Not Reported)	10 DRPs/patient	(Not Reported)	(Not Reported)
(Chia et al. 2017)	Haemodialysis Patients. UC: 190 patients (60.4±10.8) CC:134 patients (62.0±11.4)	√	√	√		√	(Not Reported)	CC: 3,8 DRPs/patient	Physicians accepted 67.6% of 343 recommendations	83,3% DRPs resolved
(Njeri et al. 2018)	60 CKD without dialysis patients (54.2±16.8)	√	√				(Not Reported)	4,5±1,4 DRPs/patient	(Not Reported)	(Not Reported)
(Dvořáčková et al. 2019)	1850 CKD patients (Not Reported)	√	√	√			(Not Reported)	0.65 DRPs/patient	Physicians accepted 92.79% of 1192 recommendations	(Not Reported)
(Garedow et al. 2019)	103 CKD patients (45.83±17.7)	√	√	√		√	78,6%	1,94±0,873 DRPs/ patient	A total of 218 recommendations, 81.6% were accepted	79,8% DRPs resolved
(Manley et al. 2020)	726 Dialysis patients (64±15)	√	√	√			(Not Reported)	(Not Reported)	(Not Reported)	(Not Reported)
(Mongaret et al. 2020)	442 CKD without dialysis patients (81.5±6.6)	√	√	√			22,4% (Community pharmacist) dan 41,6% (Expert pharmacist)	(Not Reported)	The physicians accepted the community pharmacist recommendations were 52.5% of 99 recommendations	(Not Reported)
(Roy et al. 2020)	200 CKD patients (57.95±20.33)		√				(Not Reported)	3,61 DRPs/patient	(Not Reported)	(Not Reported)
(Savitha et al. 2020)	833 CKD patients (53.73±12.76)	√	√	√		√	29,41%	1,02 DRPs/patient	Recommendations accepted and applied by nephrologist were 97.6% of 250 recommendations	(Not Reported)
(Sluiter et al. 2020)	125 CKD patients (72±12)	√	√	√		√	(Not Reported)	(Not Reported)	The nephrologist accepted 81% of 277 recommendations for medication discrepancies. The nephrologists accepted 25% of 422 recommendations on drug selection and dosage issues	(Not Reported)

Pharmaceutical care activities*: (1) Medication Reconciliation, (2) Medication Review, (3) Interprofessional Collaboration, (4) Education, (5) Counselling. CKD: Chronic Kidney Disease. DRPs: Drug-Related Problems. UC: Usual Care. CC: Collaborative Care.

Pharmacists' strategies in detecting DRPs in CKD patients

Medication reconciliation and medication review are strategies used by pharmacists to detect DRPs. The purpose of medication reconciliation is to detect medication discrepancies in order to get early prevention. In this way, the pharmacists will have a complete and accurate reconciled medication list (National Institute for Health and Care Excellence 2015). Later, the reconciled medication list can be used in a medication review to detect DRPs. Based on the medication review defined by PCNE, this activity's scope begins with DRPs evaluation based on the data to the intervention planning. Meanwhile, the follow-up activities of DRPs found both the actual and the potential ones are not the scope of this activity (Griese-Mammen et al. 2018). Therefore, medication reconciliation and medication review are pharmacists' strategies in detecting DRPs.

DRPs classification system used as an instrument for evaluating DRPs is essential in medication reviews (Da Costa et al. 2019). Ten of nineteen studies showed the DRPs classification types they used; the Hepler and Strand, Norwegian, Societe Francaise de Pharmacie Clinique (SPFC), and PCNE (Belaiche et al. 2012; Joel et al. 2013; Holm et al. 2015; Ramadaniati et al. 2016; Chia et al. 2017; Njeri et al. 2018; Dvořáčková et al. 2019; Mongaret et al. 2020; Roy et al. 2020; Savitha et al. 2020). However, the reasons for choosing the DRPs classifications were not explained in these studies. The other studies applied a modified DRPs classification according to the study needs, and the rest did not explain the type of DRPs classification used (AbuRuz et al. 2013; El Borolossy et al. 2014; Pourrat et al. 2015; Patricia and Foote 2016; Lalonde et al. 2017; Monterroza and Bolivar 2017; Garedow et al. 2019; Manley et al. 2020; Sluiter et al. 2020).

The results of DRPs evaluation are presented in Tables 1 to 2 for the number DRPs/patient, and Tables 3 to 6 present the types of DRPs. Studies presented in Table 1 dan 2 report DRPs prevalence up to 93% and the number of DRPs up to 10 DRPs/patients. The high prevalence and number of DRPs indicate that pharmacists need efforts to optimize strategies in detecting, resolving, and preventing DRP in CKD patients. Further, the discussion of the optimization strategies in detecting, resolving, and preventing DRP in CKD patients will discussed on other section of discussion in this review. In addition, based on Tables 3 to 6, the types of DRPs detected were problems of drug selection, dosage, and medication non-adherence. These problems are the highest types of DRPs among other DRPs classifications in Tables 3 to 6. The symptoms of CKD patients are often unrecognized until advanced stages. Thus, drug selection and dosage problems are the main challenges in CKD patients (Holm et al. 2015). The dosage selection in CKD patients is crucial because inappropriate dosage selection in CKD patients leads to ineffective treatment or toxicity (Hassan et al. 2009). Further, medication non-adherence problem is caused by several factors, including inadequate knowledge about CKD, health beliefs, expensive medical costs, the complexity of drugs received, adverse effects, and psychological factors such as stress and depression (Chironda and Bhengu 2016). In addition, several drug classes based on the Anatomical Classification System caused the most DRPs in CKD patients from the study of: Alimentary Tract and Metabolism (Antidiabetic drugs) (Holm et al. 2015; Pourrat et al. 2015; Mongaret et al. 2020), Cardiovascular System (Belaiche et al. 2012; AbuRuz et al. 2013; Garedow et al. 2019), and Antiinfectives for systemic use (Holm et al. 2015; Dvořáčková et al. 2019).

Table 3. Studies Results regarding Types of DRPs in CKD Patients based on Hepler and Strand.

No	DRPs Types	(Joel et al. 2013) (N)	(Chia et al. 2017) (N)	(Njeri et al. 2018) (N)	Total (N)
1	Non-adherence	7	219	42	268
2	Untreated indication	2	62	49	113
3	Drug use without indication	1	78	25	104
4	Over dosage	9	66	20	95
5	Adverse drug reaction	4	29	24	57
6	Drug interactions	10	6	59	75
7	Improper drug selection	3	19	33	55
8	Sub therapeutic dosage	3	30	19	52

Table 4. Study Results regarding Types of DRPs in CKD Patients based on Norwegian.

No	DRPs Types	(Holm et al. 2015) (N)
1	Incorrect dose	40
2	Inappropriate drug	36
3	Other	8
4	Interaction	4

Table 5. Studies Results regarding Types of DRPs in CKD Patients based on SPFC.

No	DRPs Types	(Belaiche et al. 2012) (N)	(Mongaret et al. 2020)		Total (N)
			CP* (N)	EP* (N)	
1	Over dosage	12	73	133	245
2	Subtherapeutic dosage	27			
3	Non conformity to guidelines/contraindication	17	26	26	69
4	Untreated indication	45			45
5	Drug monitoring	6		14	20
6	Improper administration	10		6	16
7	Drug use without indication	11		5	16
8	Adverse drug reaction	14			14

*CP: Community Pharmacists; *EP: Expert Pharmacists.

Based on this discussion, the outcomes of the pharmacists' strategies in detecting DRPs in CKD patients were the number of DRPs/patients and types of DRPs detected. After that, the pharmacists used the DRPs findings to make intervention plans as a form of the follow-up to the DRPs' findings (Da Costa et al. 2019). This process is the end of the pharmacists' strategies in detecting DRPs in CKD patients.

Pharmacists' strategies in resolving and preventing DRPs in CKD patients

Follow-up plans to resolve and prevent DRPs in CKD patients are aimed at three levels: prescribers, drugs, and

Table 6. Studies Results regarding Types of DRPs in CKD Patients based on PCNE.

PCNE V6.02					PCNE V.8.02	
Based on Problems					**Based on Problems**	
Problem	**(Ramadaniati et al. 2016) (N)**	**(Dvořáčková et al. 2019) (N)**	**(Savitha et al. 2020) (N)**	**Total (N)**	**Problem**	**(Roy et al. 2020) (N)**
Treatment effectiveness	483	1134	101	1718	Treatment safety	578
Adverse reactions	476	18	110	604	Treatment effectiveness	141
Treatment costs	68	5	39	112	Others	6
Others		35		35		
Based on Causes					**Based on Causes**	
Drug selection	628	677	77	1382	Drug selection	641
Dose selection	387	459	34	880	Other	58
Drug use process	214	6	8	228	Dose selection	12
Other	107		114	221	Patient related	7
Logistics	148	12		160	Dispensing	2
Treatment duration	47	21	5	73		
Drug form	2	16	7	25		
Patient	17	1	5	23		

patients (Pharmaceutical Care Network Europe Foundation 2017). The pharmacists' activity to resolve and prevent DRPs at the prescriptions and drug levels are an interprofessional collaboration. In this stage, the pharmacists could discuss with the prescribers about recommendations to the findings of both actual and potential DRPs. Based on this literature review, the most DRPs in CKD patients were drug selection problem, dose selection problem and medication non-adherence. An example of pharmacist' plan to the DRPs' findings is to provide a recommendation of the used antihypertensive Fixed Dosed Combination (FDC) for CKD patients with hypertension which could prevent patients from polypharmacy. In addition, antihypertensive FDC is more cost-effective compared to free combination therapy, thereby save medical costs. Polypharmacy and expensive medication cost were risk factors of CKD patients' non-adherence. Therefore, the use of antihypertensive FDC could resolve and prevent DRPs in CKD patients with hypertension (Akazawa and Fukuoka 2013; Chironda and Bhengu 2016; Kawalec et al. 2018; Wang et al. 2020). Later, the pharmacists' recommendations on the findings can be considered by the prescribers in determining the patient's treatment therapy. After that, the acceptance of the recommendations will be the basis of the pharmacists to intervene at the drug level during the dispensing process. The pharmacists may undertake drug-level interventions with the consent of the prescribers obtained through interprofessional collaborative activities (Belaiche et al. 2012; AbuRuz et al. 2013; Joel et al. 2013; El Borolossy et al. 2014; Holm et al. 2015; Pourrat et al. 2015; Patricia and Foote 2016; Chia et al. 2017; Monterroza and Bolivar 2017; Dvořáčková et al. 2019; Garedow et al. 2019; Mongaret et al. 2020; Savitha et al. 2020; Sluiter et al. 2020).

Tables 1, 2 shows that the percentage of pharmacists' recommendation acceptance for the DRPs findings in CKD patients is 25% to 100%. Several considerations by the nephrologists to decline the given recommendation have been reported in one study. Some reasons for this occasion are the drug was prescribed by another prescriber, there was no valid indication to discontinue or start taking the drug, the patient did not want to change his medication, the patient was not compliant, and the nephrologist wanted to see patients progress until the results of laboratory tests proved it (Sluiter et al. 2020).

Additionally, low awareness and inadequate medication adherence were the main obstacles for health professionals in providing CKD management services (Sperati et al. 2019). Several studies showed that medication non-adherence was the most type of DRPs in CKD patients (Joel et al. 2013; Chia et al. 2017; Njeri et al. 2018). Therefore, the strategies to prevent and resolve DRPs in patients level are by education and counselling (American Society of Health-System Pharmacists 1997). Through patients education and counselling, it is important for pharmacist to provide the common adverse effect and the severe adverse effect information of the drug used to the patients. Adverse effect is one of the risk factor of CKD patients' medication non-adherence. Therefore, CKD patients' adequate understanding about adverse effect could resolve and prevent patients from the medication non-adherence problem as one types of DRPs (American Society of Health-System Pharmacists 1997; Chironda and Bhengu 2016). Providing education and counselling significantly increased CKD patients' knowledge, medication adherence, attitude, and practice (Ghimirey et al. 2013; Aggarwal et al. 2018; Chandrasekhar et al. 2018). Increased knowledge through education and counselling leads patients to be more actively involved in the disease management process (American Society of Health-System Pharmacists 1997). Through this activity, medication reconciliation can also occur optimally because patients can provide complete medical history information.

The results of several studies revealed that a process of resolving and preventing of DRPs in CKD patients through interprofessional collaboration, education, and counselling successfully resolve and prevent DRPs in CKD patients. These findings were confirmed by the changed of patients DRPs' status in 4 studies at Tables 1, 2. The meaning of DRPs status change is a transformation of the status from DRPs' findings to the DRPs resolved and DRPs prevented after the process of resolving and preventing through interprofessional collaboration, education, and counselling (AbuRuz et al. 2013; Pourrat et al. 2015; Chia et al. 2017; Garedow et al. 2019). The changed of DRPs status in CKD patients was the outcome of pharmacists' strategies in re-

solving and preventing DRPs in CKD patients. Based on this discussion section, it is known that the interprofessional collaboration, education, and counselling are strategies to resolve and prevent the DRPs of CKD patients with the outcome is the patients' DRPs status change.

Optimizing the process of detecting, resolving, and preventing DRPs in CKD patients

Pharmacists have undergone in conducting a series of detecting, resolving, and preventing DRPs in CKD patients. A study reported that the number of DRPs assessed by expert pharmacists was 1,9 times higher than that of community pharmacists. The pharmacists' ability to detect the DRPs on CKD patients depends on their experiences and trainings. Besides, this study also reported that 48% of community pharmacists experienced interprofessional communication difficulties. These issues become obstacles in a the series of detecting, resolving, and preventing DRPs in CKD (Mongaret et al. 2020). Based on these problems, pharmacists need solutions to optimize the process of detecting, resolving, and preventing of DRPs in CKD patients.

Improving the hard and soft skills of pharmacists' professional is a the way to optimize the process of detection, resolution, and prevention of DRPs in CKD patients. Professional hard-skills cover the knowledge of the disease and management of CKD therapy as well as social knowledge such as culture and economics understanding. Meanwhile, professional soft-skills cover the ability to communicate well and effectively, personal barriers management skills, and the ability to be assertive and empathetic (American Society of Health-System Pharmacists 1997; Da Costa et al. 2019). Thus, pharmacists training can be one way of the ways to increase the pharmacists' professional hard-skills and soft-skills.

Lalonde et al. in 2017 conducted a study about pharmacists' training impact on DRPs in CKD patients using the ProFil program. The ProFil is a program designed to assist pharmacists in carrying out therapeutic management to CKD patients, consisting of training and communication components. The ProFiL program was given to pharmacists, who provided intervention to the intervention group patients, while the control group only received the usual care. The results showed that through the ProFil program application, the mean of DRPs/patients in the intervention group has decreased as presented in Table 1. Other results are the increased knowledge (difference of 4.5%; 95% CI, 1.6% -7.4%) and clinical competencies (difference of 7.4%; 95% CI, 3.5% -11.3%) occurred in pharmacists who attended this program (Lalonde et al. 2017). The decrease in the number of DRPs/patients was the outcome of the training intervention as form of optimization of the detection, resolution, and prevention process of DRPs in CKD patients.

Additionally, modification of the delivery model is an effort to optimize the detection, resolution, and prevention of DRPs in CKD patients. Consultation with a pharmacist before the patient consulted a nephrologist was discussed in two studies of CKD out-patient care. The counselling with pharmacist aims to explore patients' understanding of CKD, comorbid diseases they have experienced, and the treatment during the consultation session. After that, the pharmacist will perform comprehensive medication reviews. Before the patient attends a consultation session with the nephrologist, a reconciled medication list and recommendations on DRPs findings are given to the nephrologist as consideration for determining patient therapy (Belaiche et al. 2012; Chia et al. 2017). This model can improve pharmacist services' quality and efficiency because the patients' DRPs can be handled on the same day visit. Through a modified delivery model, 83.3% of the DRPs in CKD patients were resolved. This is the outcome of optimizing the detection, resolution, and prevention process of DRPs in CKD patients through a modified pharmaceutical care delivery model, as reported in this study (Chia et al. 2017). According to each healthcare facility's needs, using such modified delivery model is flexible.

The strategies of optimizing detection, resolution, and prevention of DRPs in CKD patients provide several benefits. It has positively impacted to patients and the health care system such as preventing CKD patients' unplanned admissions and making the average of LOS shorter (Chia et al. 2017). Further, it has an economic advantage of saving $ 4 in medical costs through $ 1 spending on DRPs management of CKD patients (Manley and Carroll 2002).

Conclusion

Pharmacists' roles in detecting, resolving, and preventing DRPs in CKD patients are part of pharmaceutical cares aiming to optimize patient therapy; therefore, the patients' effectiveness and safety can be guaranteed. The process of detecting DRPs in CKD patients was carried out through medication reconciliation and medication review. The outcomes of this process are the of number DRPs/patients and types of DRPs can be detected. Further, the processes of resolving and preventing DRPs be done through interprofessional collaboration, education, and counselling for CKD patients or their families. The outcome of this process is the change of patients' DRPs status. Pharmacists need to improve their professional hard and soft-skills; thus, the process can be optimized. Additionally, modification of the pharmaceutical care delivery model can also be applied as needed. The decrease in the number of DRPs/patient and the change of DRPs status were reported as the outcomes of this optimization process.

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References

AbuRuz SM, Alrashdan Y, Jarab A, Jaber D, Alawwa IA (2013) Evaluation of the impact of pharmaceutical care service on hospitalized patients with chronic kidney disease in Jordan. International Journal of Clinical Pharmacy 35(5): 780–789. https://doi.org/10.1007/s11096-013-9806-8

Aggarwal HK, Deepak J, Subhash M (2018) Impact of patient education and knowledge on medication adherence in chronic kidney disease patients. Journal, Indian Academy of Clinical Medicine 19(3): 166–174.

Akazawa M, Fukuoka K (2013) Economic impact of switching to fixed-dose combination therapy for Japanese hypertensive patients: A retrospective cost analysis. BMC Health Services Research 13(1): 1–1. https://doi.org/10.1186/1472-6963-13-124

Allemann SS, Van Mil JWF, Botermann L, Berger K, Griese N, Hersberger KE (2014) Pharmaceutical care: The PCNE definition 2013. International Journal of Clinical Pharmacy 36(3): 544–555. https://doi.org/10.1007/s11096-014-9933-x

American Society of Health-System Pharmacists (1997) ASHP guidelines on pharmacist-conducted patient education and counseling. American Journal of Health-System Pharmacy 54(4): 431–434. https://doi.org/10.1093/ajhp/54.4.431

Belaiche S, Romanet T, Allenet B, Calop J, Zaoui P (2012) Identification of drug-related problems in ambulatory chronic kidney disease patients: a 6-month prospective study. Journal of Nephrology 25(5): 782–788. https://doi.org/10.5301/jn.5000063

Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M, Adebayo OM, Afarideh M, Agarwal SK, Agudelo-Botero M, Ahmadian E, Al-Aly Z, Alipour V, Almasi-Hashiani A, Al-Raddadi RM, Alvis-Guzman N, Amini S, Andrei T, Andrei CL, Andualem Z, Anjomshoa M, Arabloo J, Ashagre AF, Asmelash D, Ataro Z, Atout MMW, Ayanore MA, Badawi A, Bakhtiari A, Ballew SH, Balouchi A, Banach M, Barquera S, Basu S, Bayih MT, Bedi N, Bello AK, Bensenor IM, Bijani A, Boloor A, Borzì AM, Cámera LA, Carrero JJ, Carvalho F, Castro F, Catalá-López F, Chang AR, Chin KL, Chung S-C, Cirillo M, Cousin E, Dandona L, Dandona R, Daryani A, Gupta RD, Demeke FM, Demoz GT, Desta DM, Do HP, Duncan BB, Eftekhari A, Esteghamati A, Fatima SS, Fernandes JC, Fernandes E, Fischer F, Freitas M, Gad MM, Gebremeskel GG, Gebresillassie BM, Geta B, Ghafourifard M, Ghajar A, Ghith N, Gill PS, Ginawi IA, Gupta R, Hafezi-Nejad N, Haj-Mirzaian A, Haj-Mirzaian A, Hariyani N, Hasan M, Hasankhani M, Hasanzadeh A, Hassen HY, Hay SI, Heidari B, Herteliu C, Hoang CL, Hosseini M, Hostiuc M, Irvani SSN, Islam SMS, Balalami NJ, James SL, Jassal SK, Jha V, Jonas JB, Joukar F, Jozwiak JJ, Kabir A, Kahsay A, Kasaeian A, Kassa TD, Kassaye HG, Khader YS, Khalilov R, Khan EA, Khan MS, Khang Y-H, Kisa A, Kovesdy CP, Defo BK, Kumar GA, Larsson AO, Lim L-L, Lopez AD, Lotufo PA, Majeed A, Malekzadeh R, März W, Masaka A, Meheretu HAA, Miazgowski T, Mirica A, Mirrakhimov EM, Mithra P, Moazen B, Mohammad DK, Mohammadpourhodki R, Mohammed S, Mokdad AH, Morales L, Velasquez IM, Mousavi SM, Mukhopadhyay S, Nachega JB, Nadkarni GN, Nansseu JR, Natarajan G, Nazari J, Neal B, Negoi RI, Nguyen CT, Nikbakhsh R, Noubiap JJ, Nowak C, Olagunju AT, Ortiz A, Owolabi MO, Palladino R, Pathak M, Poustchi H, Prakash S, Prasad N, Rafiei A, Raju SB, Ramezanzadeh K, Rawaf S, Rawaf DL, Rawal L, Reiner Jr RC, Rezapour A, Ribeiro DC, Roever L, Rothenbacher D, Rwegerera GM, Saadatagah S, Safari S, Sahle BW, Salem H, Sanabria J, Santos IS, Sarveazad A, Sawhney M, Schaeffner E, Schmidt MI, Schutte SE, Sepanlou SG, Shaikh MA, Sharafi Z, Sharif M, Sharifi A, Silva DAS, Singh JA, Singh NP, Sisay MMM, Soheili A, Sutradhar I, Teklehaimanot BF, Tesfay BE, Teshome GF, Thakur JS, Tonelli M, Tran KB, Tran BX, Ngoc CT, Ullah I, Valdez PR, Varughese S, Vos T, Vu LG, Waheed Y, Werdecker A, Wolde HF, Wondmieneh AB, Hanson SW, Yamada T, Yeshaw Y, Yonemoto N, Yusefzadeh H, Zaidi Z, Zaki L, Zaman SB, Zamora N, Zarghi A, Zewdie KA, Ärnlöv J, Coresh J, Perico N, Remuzzi G, Murray CJL, Vos T, GBD Chronic Kidney Disease Collaboration (2020) Global, regional, and national burden of chronic kidney disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet 395(10225): 709–733. https://doi.org/10.1016/S0140-6736(20)30045-3

Cardone KE, Bacchus S, Assimon MM, Pai AB, Manley HJ (2010) Medication-related problems in CKD. Advances in Chronic Kidney Disease 17(5): 404–412. https://doi.org/10.1053/j.ackd.2010.06.004

Chandrasekhar D, Ganesan VM, Sreekumar S, Pradeep A, Geoji AS, George AE (2018) Impact of intensified pharmaceutical interventions in medication adherence in chronic kidney disease patients. Journal of Young Pharmacists 10(2): e208. https://doi.org/10.5530/jyp.2018.10.46

Chia BY, Cheen MHH, Gwee XY, Chow MMY, Khee GY, Ong WC, Choong HL, Lim PS (2017) Outcomes of pharmacist-provided medication review in collaborative care for adult Singaporeans receiving hemodialysis. International Journal of Clinical Pharmacy 39(5): 1031–1038. https://doi.org/10.1007/s11096-017-0528-1

Chironda G, Bhengu B (2016) Contributing factors to non-adherence among chronic kidney disease (CKD) patients: a systematic review of literature. Medical & Clinical Reviews 2(4): e29. https://doi.org/10.21767/2471-299X.1000038

Da Costa FA, Van Mil JWF, Alvarez-Risco A (2019) The Pharmacist Guide to Implementing Pharmaceutical Care. Springer.

Dvořáčková E, Rychlíčková J, Pávek P, Hojný M, Vlček J (2019) Analysis and management of drug related problems on a nephrology ward from a pharmacist's point of view. Die Pharmazie-An International Journal of Pharmaceutical Sciences 74(10): 625–629. https://doi.org/10.1691/ph.2019.9568

El Borolossy R, El Wakeel L, El Hakim I, Badary O (2014) Implementation of clinical pharmacy services in a pediatric dialysis unit. Pediatric Nephrology 29(7): 1259–1264. https://doi.org/10.1007/s00467-014-2760-4

Garedow AW, Mulisa Bobasa E, Desalegn Wolide A, Kerga Dibaba F, Gashe Fufa F, Idilu Tufa B, Debalke S, Goro KK (2019) Drug-Related Problems and Associated Factors among Patients Admitted with Chronic Kidney Disease at Jimma University Medical Center, Jimma Zone, Jimma, Southwest Ethiopia: A Hospital-Based Prospective Observational Study. International Journal of Nephrology 2019: e1504371. https://doi.org/10.1155/2019/1504371

Ghimirey A, Sapkota B, Shrestha S, Basnet N, Shankar PR, Sapkota S (2013) Evaluation of pharmacist counseling in improving knowledge, attitude, and practice in chronic kidney disease patients. SAGE Open Medicine 1: e2050312113516111. https://doi.org/10.1177/2050312113516111

Griese-Mammen N, Hersberger KE, Messerli M, Leikola S, Horvat N, van Mil JWF, Kos M (2018) PCNE definition of medication review: reaching agreement. International Journal of Clinical Pharmacy 40(5): 1199–1208. https://doi.org/10.1007/s11096-018-0696-7

Hassan Y, Al-Ramahi R, Aziz NA, Ghazali R (2009) Drug use and dosing in chronic kidney disease. Annals Academy of Medicine Singapore 38(12): e1095.

Holm H, Bjerke K, Holst L, Mathiesen L (2015) Use of renal risk drugs in patients with renal impairment. International Journal of Clinical Pharmacy 37(6): 1136–1142. https://doi.org/10.1007/s11096-015-0175-3

Joel JJ, Muhammed Musthafa M, Shastry CS (2013) A Study on Drug Related Problems and Pharmacist Intervention in Patients Undergoing Haemodialysis in a Tertiary Care Hospital. International Research Journal of Pharmaceutical and Applied Sciences (IRJPAS) 3(5): 263–265.

Kawalec P, Holko P, Gawin M, Pilc A (2018) Effectiveness of fixed-dose combination therapy in hypertension: Systematic review and meta-analysis. Archives of Medical Science 14(5): 1125–1136. https://doi.org/10.5114/aoms.2018.77561

Lalonde L, Quintana-Barcena P, Lord A, Bell R, Clement V, Daigneault A-M, Legris M-È, Letendre S, Mouchbahani M, Jouini G, Azar J, Martin E, Berbiche D, Beaulieu S, Beaunoyer S, Bertin E, Bouvrette M, Charbonneau-Séguin N, Desrochers J-F, Desforges K, Dumoulin-Charette A, Dupuis S, El Bouchikhi M, Forget R, Guay M, Lemieux J-P, Morin-Bélanger C, Noël I, Ricard S, Sauvé P, Paradis FS-M (2017) Community pharmacist training-and-communication network and drug-related problems in patients with CKD: a multicenter, cluster-randomized, controlled trial. American Journal of Kidney Diseases 70(3): 386–396. https://doi.org/10.1053/j.ajkd.2017.05.008

Manley HJ, Aweh G, Weiner DE, Jiang H, Miskulin DC, Johnson D, Lacson EK (2020) Multidisciplinary Medication Therapy Management and Hospital Readmission in Patients Undergoing Maintenance Dialysis: A Retrospective Cohort Study. American Journal of Kidney Diseases: The Official Journal of the National Kidney Foundation 76(1): 13–21. https://doi.org/10.1053/j.ajkd.2019.12.002

Manley HJ, Carroll CA (2002) The clinical and economic impact of pharmaceutical care in end-stage renal disease patients. Seminars in Dialysis 15(1): 45–49. [Wiley Online Library] https://doi.org/10.1046/j.1525-139x.2002.00014.x

Mongaret C, Aubert L, Lestrille A, Albaut V, Kreit P, Herlem E, Noel N, Touré F, Lallier F, Slimano F, the MIRPhO Investigators Study (2020) The Role of Community Pharmacists in the Detection of Clinically Relevant Drug-Related Problems in Chronic Kidney Disease Patients. Pharmacy 8(2): e89. https://doi.org/10.3390/pharmacy8020089

Monterroza DAA, Bolivar JFC (2017) Pharmaceutical care practice in patients with chronic kidney disease. Farmacia Hospitalaria: Organo Oficial de Expresion Cientifica de La Sociedad Espanola de Farmacia Hospitalaria 41(2): 137–149. https://doi.org/10.7399/fh.2017.41.2.10508

National Institute for Health and Care Excellence (2015) Medicines optimisation: the safe and effective use of medicines to enable the best possible outcomes. https://www.nice.org.uk/guidance/ng5/chapter/1-Recommendations#medicines-reconciliation

Njeri LW, Ogallo WO, Nyamu DG, Opanga SA, Birichi AR (2018) Medication-related problems among adult chronic kidney disease patients in a sub-Saharan tertiary hospital. International Journal of Clinical Pharmacy 40(5): 1217–1224. https://doi.org/10.1007/s11096-018-0651-7

Patricia NJ, Foote EF (2016) A pharmacy-based medication reconciliation and review program in hemodialysis patients: a prospective study. Pharmacy Practice (Granada) 14(3): e785. https://doi.org/10.18549/PharmPract.2016.03.785

Pharmaceutical Care Network Europe Foundation (2017) Classification for Drug related problems V 8.01. PCNE Classification, 10 pp. https://www.pcne.org/upload/files/215_PCNE_classification_V8-01.pdf

Pourrat X, Sipert A-S, Gatault P, Sautenet B, Hay N, Guinard F, Guegan F, Halimi J-M (2015) Community pharmacist intervention in patients with renal impairment. International Journal of Clinical Pharmacy 37(6): 1172–1179. https://doi.org/10.1007/s11096-015-0182-4

Ramadaniati HU, Anggriani Y, Wowor VM, Rianti A (2016) Drug-related problems in chronic kidneys disease patients in an Indonesian hospital: Do the problems really matter. International Journal of Pharmacy and Pharmaceutical Sciences 8(12): 298–302. https://doi.org/10.22159/ijpps.2016v8i12.15193

Roy DA, Shanfar I, Shenoy P, Chand S, Up N, Kc BR (2020) Drug-related problems among chronic kidney disease patients: a clinical pharmacist led study. International Journal of Pharmaceutical Research 12(4). https://doi.org/10.31838/ijpr/2020.12.04.017

Savitha RS, Ramesh M, Shetty MS, Kiran KK (2020) Drug-Related Problems and Pharmacist Interventions in Inpatients with Chronic Kidney Disease. International Journal of Research in Pharmaceutical Sciences 11(1): 960–966. https://doi.org/10.26452/ijrps.v11i1.1921

Sluiter HE, van't Riet E, Taxis K, Jansman FGA (2020) Pharmacist-led medication reviews in pre-dialysis and dialysis patients. Research in Social and Administrative Pharmacy 16(12): 1718–1723. https://doi.org/10.1016/j.sapharm.2020.02.006

Sperati CJ, Soman S, Agrawal V, Liu Y, Abdel-Kader K, Diamantidis CJ, Estrella MM, Cavanaugh K, Plantinga L, Schell J, Simon J, Vassalotti JA, Choi MJ, Jaar BG, Greer RC (2019) Primary care physicians' perceptions of barriers and facilitators to management of chronic kidney disease: a mixed methods study. PLoS ONE 14(8): e0221325. https://doi.org/10.1371/journal.pone.0221325

Wang X, Chen H, Ej E, Wu J, Serna O, Paranjpe R, Abughosh S (2020) Cost-effectiveness analysis of antihypertensive triple combination therapy among patients enrolled in a Medicare advantage plan. Expert Review of Pharmacoeconomics and Outcomes Research 00(00): 1–8. https://doi.org/10.1080/14737167.2020.1800457