



Optimizing Collaborative Care of Patients with Chronic Kidney Disease Associated with Type 2 Diabetes: An Example Practice Model at a Health Care Practice in Kentucky, United States

Benjamin Gatlin · Jamie Miller · Sergio Chang

Received: September 15, 2023 / Accepted: October 17, 2023 / Published online: November 2, 2023
© The Author(s) 2023

ABSTRACT

Suboptimal multidisciplinary team collaboration is a barrier to effective health care provision for patients with chronic kidney disease (CKD) associated with type 2 diabetes mellitus (T2DM). We describe an example practice model of a clinical practice called Baptist Health Deaconess, based in Madisonville, Kentucky, USA, where a small multidisciplinary team consisting of an endocrinologist, nurse practitioner, and pharmacist (authors of this article) work collaboratively in an ambulatory care setting to provide health care to the patients they serve. Many of the patients who receive care at Baptist Health Deaconess are on a low income, have poor health literacy, and do not have a primary care physician. The presence of a pharmacist in the team allows for insurance/access investigations to assess drug choice and affordability; such aspects can be performed quickly with a pharmacist in the office.

PLAIN LANGUAGE SUMMARY

Health care professionals (HCPs) supporting people living with type 2 diabetes mellitus (T2DM) and chronic kidney disease (CKD) may work at one or more health care settings such as a health care practice, a hospital, a pharmacy, or they might support people in their own homes. When HCPs do not work well together this negatively affects the quality of care that people visiting them receive. This paper gives the point of view of three HCPs (a nurse practitioner, a pharmacist, and a diabetes specialist [an endocrinologist]) who work at a health care practice called Baptist Health Deaconess situated in Kentucky, USA. The three HCPs describe how many of the people who visit them at their practice do not have much money, they do not really understand what their conditions are about or how they can be best treated, and they do not have a primary care physician. The HCP team believe that having a pharmacist on their team (which is not common throughout the USA) means that they work better together because it saves money, people with T2DM and CKD visiting get the best treatment recommendations for them, and this is all done quicker compared to having no pharmacist on the team.

B. Gatlin (✉) · J. Miller · S. Chang
Baptist Health Deaconess Madisonville,
Madisonville, KY, USA
e-mail: benjamin.gatlin@baptistdeaconess.com

Keywords: Chronic kidney disease; Collaborative care; Pharmacist; Transition of care; Type 2 diabetes

Key Summary Points

Effective care of patients with type 2 diabetes mellitus (T2DM) and chronic kidney disease (CKD) requires coordinated efforts from a multidisciplinary team (MDT) of health care professionals (HCPs).

Suboptimal cross-team collaboration is a key barrier to effective health care provision for patients with T2DM and CKD; unfortunately, this often cumulates in patients receiving suboptimal care.

This best practice developed by three HCPs (a pharmacist, a nurse practitioner, and an endocrinologist) who work at Baptist Health Deaconess Madisonville, Kentucky, USA, demonstrates how an effective small MDT collaboration can help to overcome barriers to effective care of patients with CKD in the community they serve.

Including a pharmacist in the team, who can support HCPs with performing services such as drug checks (affordability, type, and adherence) and patient education, can help to ensure timely and appropriate care of patients with CKD and T2DM.

INTRODUCTION

Diabetes affects more than 37.3 million people worldwide and is the leading cause of chronic kidney disease (CKD) [1]. Many people with CKD associated with type 2 diabetes (T2DM) have multiple comorbidities such as hypertension [2], hyperlipidemia, and cardiovascular disease [3, 4], which impact their quality of life and health status [5, 6].

As a result of the complex and progressive nature of CKD associated with T2D and its management, patients meet with a range of health care professionals (HCPs). Each HCP involved in CKD care provides patients with specialist advice on the management and/or care of a specific aspect of their CKD and/or associated comorbidity [7]. These HCPs are found in primary and secondary (specialist) care settings and include primary care practitioners/physicians (PCPs), nephrologists (kidney function specialists for patients with advanced [stage 3+] CKD), endocrinologists (diabetes/hormone specialists), pharmacists, dieticians, social workers, and cardiologists [8, 9]. To coordinate these aspects of CKD management and support, HCPs often work as part of a multidisciplinary team (MDT) [7]. However, there are barriers to effective MDT collaboration in CKD, and the optimal structure and function of the “ideal” multidisciplinary CKD practice is still unknown [10]. Our article highlights the current barriers to successful MDT collaboration and effective care in CKD and then describes an example practice model involving a practice based in Kentucky, USA, where a small MDT team work successfully together to overcome many of these barriers.

BARRIERS TO EFFECTIVE MDT COLLABORATION IN CKD

Effective MDT collaboration is a key aspect of optimized care when working with patients with CKD associated with T2DM. MDTs are associated with better care processes such as pharmacist–clinician collaborations [11] and reduced prescription errors [12]. Moreover, a patient-centric approach encourages patients to be active participants in their own care and may lead to better outcomes [13].

Suboptimal team communication can happen when one or more members of the MDT are not included in all pertinent communications or are unclear of their role within the team, when there are limited resources, and/or when further training is needed (Fig. 1). Ineffective collaboration is a key barrier to effective co-management of patients with CKD [14, 15].

Barriers: Primary Care Services

PCPs play an important role in identifying and/or diagnosing CKD and in managing patients with early-stage CKD (stages 1–3). Moreover, PCPs are central to MDT collaboration as they play an important role in referring patients with advanced CKD (stage 3+) or rapidly declining kidney function to nephrologists [16] and other specialist services. However, it is important to also note that around 25% of adult Americans do not have an identified source of primary care [17], and although there are ongoing efforts to reduce this percentage, for those who do not have access to regular primary care services (particularly those who are older and with comorbidities), effective collaboration across specialists and supporting services is even more important.

Barriers: Pharmacy Services

Pharmacists have an important role within the CKD MDT, which includes monitoring for drug-related adverse effects and drug incompatibilities, providing patient education, and ensuring patients have access to medicines. A prospective

study involving 70 community pharmacists and 2055 older patients (aged ≥ 65 years) with renal impairment found that pharmacist access to and understanding of estimated glomerular filtration rate (eGFR) results led to a decrease in prescription problems [18]. However, only approximately 53% of the pharmacist interventions were accepted by PCPs, possibly as a result of lack of PCP availability. The authors concluded that more efforts are needed to improve communications between pharmacists and physicians, and, unless fixed, this is an obstacle to a potential reduction in drug-related problems. Moreover, effective collaboration between pharmacists and clinicians presents an opportunity to optimize care for patients with CKD [19].

Barriers: Other Specialist Services

As noted previously, the types of HCPs included in the MDT working with a patient vary according to the needs of the patient and by local clinical practice guidelines/protocols. Ineffective collaboration between specialist teams, including poor continuity of care across specialist visits, has been reported by patients as a barrier to effective care [20]. Indeed, effective

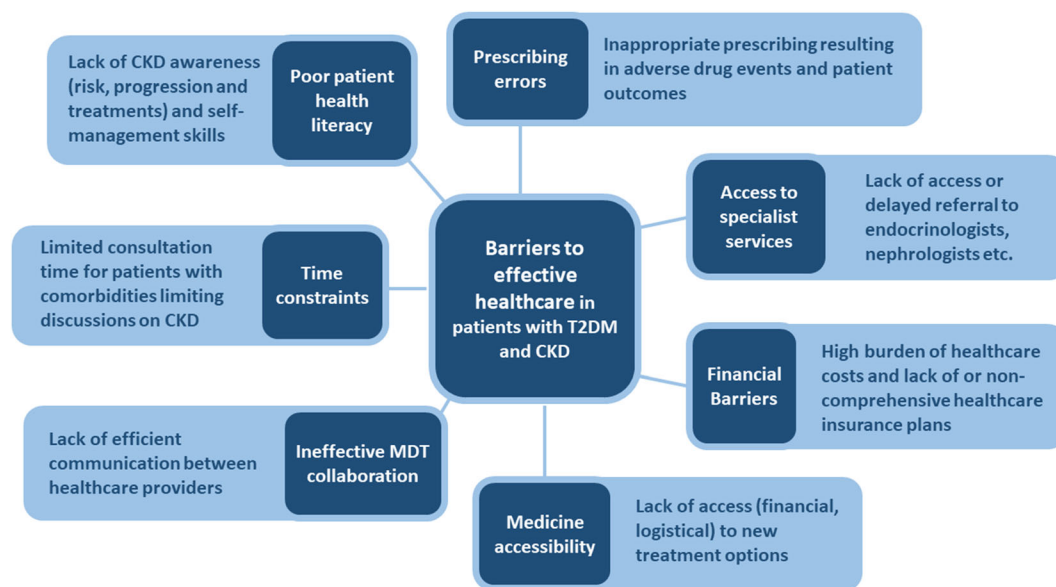


Fig. 1 Barriers to effective multidisciplinary team (MDT) collaboration and health care in patients with type 2 diabetes mellitus (T2DM) associated with chronic kidney disease (CKD). *BHDM* Baptist Health Deaconess Madisonville

cross-team MDT communication, which includes collaboration with the patient and their family, may facilitate successful care and management of patients with CKD [21] and improve outcomes [22]. In a study involving patients with T2DM and stage 3/4 CKD who regularly attended a secondary care diabetes center, those who were referred to a CKD clinic (and so were in the care of an MDT including endocrinologists and nephrologists) did better (lower risk of end-stage renal disease) than those who were not referred [22], suggesting that effective cross-specialist management in CKD may improve outcomes.

BARRIERS TO PROVIDING EFFECTIVE CARE AND SUPPORT TO PATIENTS WITH CKD

Effective MDT collaboration is always important, but good cross-team communication alone is not enough to ensure a patient with CKD receives the care and support they need (Fig. 1). Several barriers to optimal CKD care (detection and management) exist (Fig. 1) [14, 15, 21, 23].

Time Constraint Barriers

Limited available time during a consultation is an ongoing concern for both patients and HCPs. Using PCPs as an example, they feel that their allotted consultation time with their patients with CKD is not long enough, especially if their patients have multiple comorbidities [23]. Managing patients who have multiple comorbidities requires additional time to address all relevant medical and behavioral aspects, as well as to talk to the patient [23] about things such as treatment adherence and risks. Furthermore, time constraints on consultations limit the opportunity for open discussion between PCP and patient, thereby reducing the opportunity for conversations about CKD [15, 23]. Such time constraints between patient and physician are also likely to be present during consultations in a secondary care setting.

Poor Health Literacy

Low health literacy is associated with poor outcomes [24], but health literacy degree varies according to many factors. Around 25% of people with CKD have limited health literacy, and low health literacy disproportionately affects those of low socioeconomic status and those of non-White ethnicity [24]. Patients with limited health literacy may have reduced self-management skills [24] and be more susceptible to becoming overburdened by treatments, resulting in reduced treatment adherence [15] and, as a consequence, inferior clinical outcomes [25, 26]. PCPs believe that a lack of CKD awareness and a lack of self-management skills among patients with CKD are barriers to optimal CKD management [15]. To overcome these literacy barriers, educational interventions involving concerted efforts across the MDT are needed [13, 15, 23]. For example, interventions such as a medicines use review (MUR) conducted by pharmacists in collaboration with patients aim to identify issues with non-adherence and increase patient understanding of their medicines [27].

Prescribing Errors

Inappropriate prescribing is unfortunately common across all CKD stages [28], but a large proportion of prescribing errors, such as drug-dosing errors, are preventable [29]. Medication errors, such as prescribing drugs that have unfavorable pharmacodynamic/pharmacokinetic effects, pose clinical and cost problems for health care systems and contribute to adverse drug effects in patients with CKD, including hyperkalemic episodes or hemorrhagic events, which can result in recurrent medical treatment or rehospitalization [30]. Pharmacists contribute to significant health care cost savings across a variety of settings [31]. Furthermore, pharmacists play an active role in detecting, resolving, and preventing medication errors and medication-related problems [31] and are well positioned to perform interventions, including discontinuing unnecessary medicines, switching patients onto less expensive

agents (where appropriate), or altering the route of drug administration, which can significantly reduce health care costs [32].

Specialist Services and Medicine Access

PCPs have reported a lack of access to specialist services (such as nephrologists, dietitians, etc., who facilitate long-term care and patient education) as a key barrier to achieving optimal care of patients with CKD [23, 33]. For example, some physician PCPs find it difficult to secure nephrologist consultations for their patients as a result of limited access to nephrologists within their geographical area and/or health insurance restrictions [14]. In parts of Kentucky, there can be extended wait times for patients due to the limited number of available nephrologists.

The cost of medicine can be a barrier to patients accessing appropriate prescribed medications. In 2016, a Commonwealth Fund International Health Policy Survey found that one in four chronically ill adults in the USA were likely to skip medications because of cost, and that this was more likely in patients who have two or more chronic conditions [34]. Additionally, some patients may have inadequate health insurance, their health care plan may not include certain medicines, or they may not have a good understanding of what is included. Patients with CKD may also be at risk of missing out on treatment opportunities because of medical inertia [35], which may prevent/delay patients from accessing potentially beneficial medications.

AIMS AND OVERVIEW: BEST PRACTICE MODEL

This best practice developed by three HCPs (a pharmacist, a nurse practitioner, and an endocrinologist) who work at Baptist Health Deaconess Madisonville, Kentucky, USA, demonstrates how an effective small MDT collaboration can help to overcome barriers to effective care of patients with CKD in the community they serve.

Introducing Baptist Health Deaconess Madisonville

Baptist Health Deaconess Madisonville (hereafter referred to as BHDM) is a 410-bed acute and skilled care facility located in Madisonville, Kentucky. The facility places special emphasis on community outreach and training students to provide medical care in rural areas.

Patient Demographics

BHDM serves patients from a wide geographical area. Most patients who visit the practice come from low-income communities, have poor health literacy, and do not have a PCP. Each month the practice sees around 30–40 patients who have CKD (mostly stages 3a or 3b). Around 30–40% of patients who visit the practice have evidence of kidney damage (proteinuria) but have a normal eGFR. The practice includes an endocrinology department, so most of the patients who visit also have T2DM; on this basis, a frequent reason for repeat visits is glycemic control.

The MDT at BHDM

Figure 2 gives an overview of the small MDT team collaboration.

Cross-Team Collaboration: Ambulatory Care Pharmacist

Extends Consultation Time Physicians have limited time with their patient during a consultation, so to address this time constraint, the pharmacist also meets with the patient, which effectively extends the consultation time. This extra time helps to reduce the time from report to action (e.g., the response time from a patient reporting a concern to the physician taking action), thereby reducing delays in care for their patients (Fig. 3).

Medical Chart Review The pharmacist reviews the patient's medical chart with the patient. Two important aspects of this chart review are to check the patient's kidney function test

results/kidney function test needs and to review the patient's list of current drug treatments. The benefit of having a pharmacist in the MDT in this capacity was demonstrated in a study that found that serum creatinine and eGFR testing (methods that test kidney function) ordered or reviewed by pharmacists led to identification of 40% of patients who had previously unrecognized CKD [36]. The intention of the collaborative approach at BHDM is that patients are directed to an appropriate treatment plan sooner.

Patients with CKD will probably have comorbidities that require additional drug treatments. The pharmacist reviews the drug list to check for drug contraindications as well as to check for recent drug discontinuations. Early identification of missed contraindications may prevent significant health consequences for patients. Indeed, medical chart review by pharmacists can result in the identification of dosing errors and, as a result, lead to improved drug optimization for patients [37]. Furthermore, unchecked discontinuations may lead to

inappropriate withdrawal of treatment, e.g., discontinuation of potassium supplements in patients taking angiotensin-converting enzyme inhibitors (ACEis) or angiotensin receptor blockers (ARBs) or discontinuation of the newer CKD drug finerenone because of fear of the patient later developing hyperkalemia (manageable for most patients without needing to discontinue the drug). Drug dosage and frequency are also checked by the pharmacist for possible prescription errors. Indeed, one study found that appropriate drug dosing and activities in CKD overseen by pharmacists led to less drug use and lower costs associated with managing patients with end-stage renal disease undergoing hemodialysis [38]. Also, decisions made by pharmacists regarding drug–drug interactions are trusted; a recent prospective study found that a great proportion (92%) of pharmacist recommendations on how to manage detected negative drug–drug interactions were accepted and fully implemented by prescribers [39].

During the consultation, the pharmacist requests feedback from the patient on whether

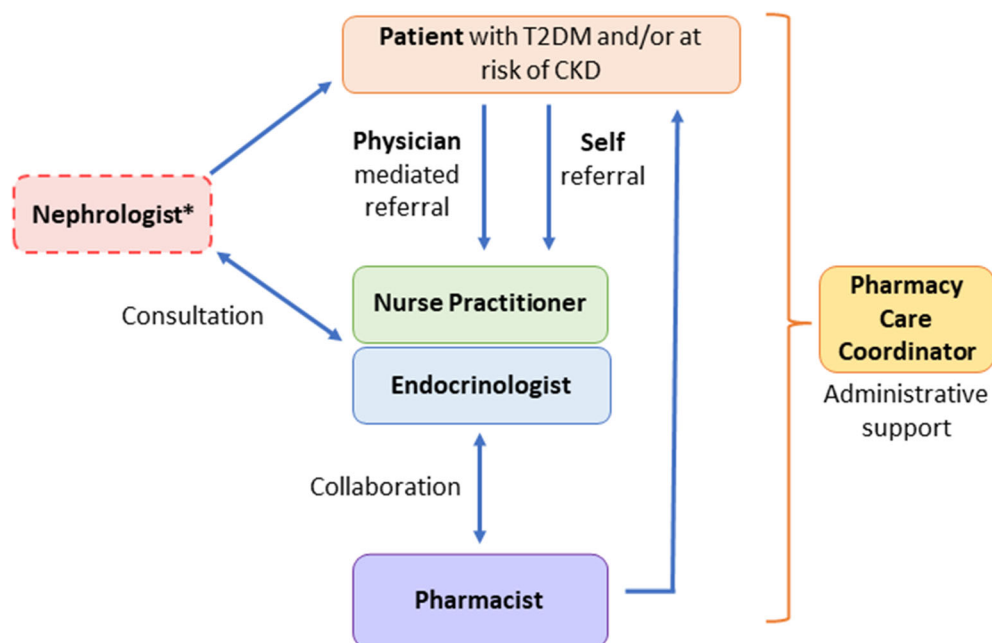


Fig. 2 Baptist Health Deaconess Madisonville multidisciplinary team (MDT) member role flow diagram. *Nephrologist services will only occasionally be used (not

active members of the MDT for each patient with advanced-stage chronic kidney disease [CKD]). *T2DM* type 2 diabetes mellitus

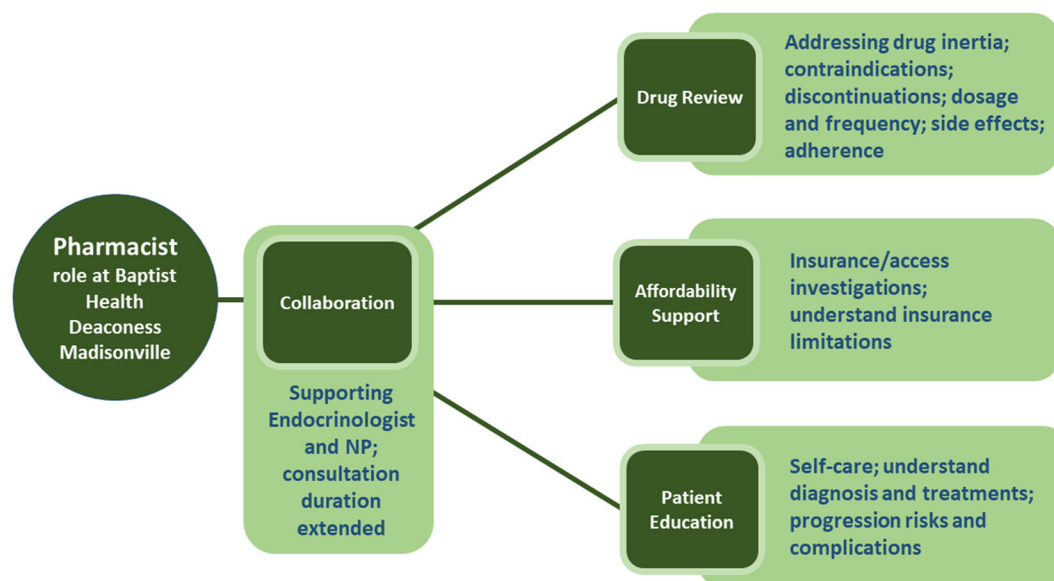


Fig. 3 Closer view of the pharmacist's role within the multidisciplinary team at Baptist Health Deaconess Madisonville. *NP* nurse practitioner

they are experiencing drug adverse effects, and if any adverse effects are reported, the pharmacist will suggest possible alternatives or consider reducing the dose of the drug but will also check the patient's level of treatment adherence. Drug adjustments/discontinuations may also be made for cost reasons if the patient's health insurance only covers a short period of treatment or certain treatments, or if the patient cannot afford to pay for certain drugs. Such an extensive review of a patient's current and recent drug treatments by the pharmacist may not occur during a physician-only visit/approach.

Patient Education Patients do better when they are empowered to be active participants in their own care, so effective patient education is an important aspect of patient care. The pharmacist's role in patient education is to support the efforts made by the endocrinologist and nurse practitioner; a patient should understand what their T2DM or CKD diagnosis means for them, the treatments available, their risks of T2DM/CKD worsening and what they can do to reduce that risk, and ongoing care. Although this is the desired outcome of patient education, it is important to remember that the cost of

treatment does limit the number of options available to some patients. The pharmacist has an important role in this regard in communicating clearly to the patient what their health insurance plan covers in relation to the practice's services and how much various treatments will cost, to avoid confusion and wasting time when an alternative could have been sought.

The pharmacist uses a holistic approach to patient education, and this means focusing on the whole patient and not just their CKD or their diabetes. It starts with checking the patient's current level of health literacy to identify areas where the patient's knowledge about their various conditions is limited; the pharmacist helps to fill those knowledge gaps (referring to a physician specialist as needed). Lifestyle changes can have a major beneficial impact on a patient's risk of developing associated comorbidities (e.g., T2DM and hypertension leading to CKD) or worsening of chronic conditions [40, 41]. The pharmacist encourages self-care, which includes questions about adherence, their diet, the amount of exercise they get, and the amount of alcohol consumed over a certain period of time; from this, the pharmacist provides recommendations on changes that can be made to improve the

patient's health status. Other potential patient education tools that could be used during a consultation include anticipating questions a patient may ask during a consultation and having answers ready and talking through easy-to-follow clinical pathway diagrams [13].

Cross-Team Collaboration: Endocrinologist and Nurse Practitioner

The endocrinologist and the nurse practitioner work closely with the pharmacist at BHD. Both have their own patients who they see regularly, and their other responsibilities include ordering and reviewing laboratory test results and making decisions on drug-dose changes as needed. The endocrinologist and the nurse practitioner will also seek support from the pharmacist regarding potential new drug treatment initiations for a patient or, if a patient is experiencing adverse effects, about alternative treatments. They will also refer a patient to the pharmacist if the patient would benefit from disease education support, adherence concerns (including refills), and/or filling of knowledge gaps. As noted, the main advantages of this MDT collaborative approach are fewer delays to action (drug treatment start or drug-dose reduction/discontinuation) and ensuring patients are onboard in terms of knowing what their T2DM associated with CKD means for them and the treatment options available in their circumstances.

Supporting Team Members

Nephrology services may occasionally be consulted to confirm a CKD diagnosis and, where appropriate, provide CKD treatment advice for patients who have T2DM and CKD. Nephrologists are thus consulted on an as-needed basis and are not active members of the MDT at BHD. Pharmacy care coordinators (PCCs) work closely with the endocrinologist, nurse practitioner, and pharmacist to offer administrative support to them and their patients. For example, PCCs will contact patients to remind them about prescription refills and serve as an additional point of contact for patients who want to let the care team know about adverse effects they are experiencing with a particular

drug and any associated risk of non-adherence. PCCs also coordinate with the outpatient pharmacy team to ensure that medication is mailed or picked up by patients as needed.

WIDER CONTEXT: THE SMALL-TEAM COLLABORATIVE APPROACH TO CARE OF PATIENTS WITH CKD

As noted previously in this article, effective MDT collaboration and reliable health care provision to patients who have CKD associated with T2DM require that each member understands their role within the team, that members are included in all pertinent communications, and that there are sufficient support and resources available to the team. Patients also have an important role to play in their own care and should be encouraged to learn and understand their conditions and the treatments available to them now and in the longer term.

The small team collaborative care approach at BHD in Kentucky, USA, has overcome many of these barriers and achieved reliable and sustainable health care provision for patients who are typically of a low socioeconomic status, have poor health literacy, and may not have a PCP. Thus, effective MDT collaboration is important for these patients. The presence of a pharmacist in the MDT means that drug treatments for conditions including T2DM and CKD are initiated/withdrawn appropriately (and considered in relation to affordability) and that patients receive all the support they need both when in the practice and when at home (Fig. 3).

This best practice model has some limitations. It is based on a single clinical practice in Madisonville, Kentucky, USA, with a patient population who are mostly of low socioeconomic/educational status, and this means that the opinions and feedback provided by the authors of this paper (and also the MDT team) cannot be generalized to other clinical practices in the USA. Additionally, it does not provide quantitative outcomes data to demonstrate effectiveness of the collaborative care model. Further research is needed to assess the impact of incorporating a pharmacist into the health care team on patient outcomes in this model.

This article is based on previously published studies and does not contain any new studies with human participants or animals performed by any of the authors.

CONCLUSION

Suboptimal cross-team collaboration is a barrier to effective health care provision for patients with T2DM and CKD. The small MDT at BHDM in Kentucky, USA, operate a successful clinical practice owing to their effective cross-team collaboration. The presence of a pharmacist on the team means that monitoring, drug checks (affordability, type, and adherence), and patient education are timely and appropriate.

Medical Writing and Editorial Assistance. Medical writing support was provided by Charlotte Maddocks, MSc, of Alligent, part of Envision Pharma Group, and this support was funded by Bayer Corporation. Envision Pharma Group's services complied with international guidelines for Good Publication Practice (GPP4).

Author Contributions. Benjamin Gatlin, Jamie Miller and Sergio Chang contributed to the writing and reviewing of each draft and reviewing and approving the final draft for submission.

Funding. Medical writing support and the journal's Rapid Service Fee was funded by Bayer Corporation. The authors did not receive any honoraria for this review.

Data availability. Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Declarations

Conflict of Interest. The authors, Benjamin Gatlin, Jamie Miller, and Sergio Chang, have nothing to disclose.

Ethical Approval. This article is based on previously published studies and does not

contain any new studies with human participants or animals performed by any of the authors.

Open Access. This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License, which permits any non-commercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc/4.0/>.

REFERENCES

1. Centers for Disease Control and Prevention. National diabetes statistics report. <https://www.cdc.gov/diabetes/data/statistics-report/index.html>. Accessed 8 Dec 2022.
2. Van Buren PN, Toto R. Hypertension in diabetic nephropathy: epidemiology, mechanisms, and management. *Adv Chronic Kidney Dis.* 2011;18: 28–41.
3. Jankowski J, Floege J, Fliser D, Bohm M, Marx N. Cardiovascular disease in chronic kidney disease: pathophysiological insights and therapeutic options. *Circulation.* 2021;143(11):1157–72.
4. Kanda T, Wakino S, Hayashi K, Plutzky J. Cardiovascular disease, chronic kidney disease, and type 2 diabetes mellitus: proceeding with caution at a dangerous intersection. *J Am Soc Nephrol.* 2008;19(1):4–7.
5. Centers for Disease Control and Prevention. Chronic kidney disease basics. <https://www.cdc.gov/kidneydisease/basics.html>. Accessed 8 Dec 2022.

6. Lee WC, Lee YT, Li LC, et al. The number of comorbidities predicts renal outcomes in patients with stage 3–5 chronic kidney disease. *J Clin Med*. 2018;7(12):493.
7. National Institute of Diabetes and Digestive and Kidney Diseases. Managing chronic kidney disease. <https://www.niddk.nih.gov/health-information/kidney-disease/chronic-kidney-disease-ckd/managing>. Accessed 12 Dec 2022.
8. Centers for Disease Control and Prevention. Your diabetes care team. https://www.cdc.gov/diabetes/library/features/diabetes_care_team.html. Accessed 12 Dec 2022.
9. Chen RA, Scott S, Mattern WD, Mohini R, Nissen AR. The case for disease management in chronic kidney disease. *Dis Manag*. 2006;9(2):86–92.
10. Collister D, Pyne L, Cunningham J, et al. Multidisciplinary chronic kidney disease clinic practices: a scoping review. *Can J Kidney Health Dis*. 2019;6:2054358119882667.
11. Cooney D, Moon H, Liu Y, et al. A pharmacist based intervention to improve the care of patients with CKD: a pragmatic, randomized, controlled trial. *BMC Nephrol*. 2015;16:56.
12. Song YK, Jeong S, Han N, et al. Effectiveness of clinical pharmacist service on drug-related problems and patient outcomes for hospitalized patients with chronic kidney disease: a randomized controlled trial. *J Clin Med*. 2021;10(8):1788.
13. Nicholas SB, Wright EE, Billings LK, Ambriz E, Gee P, Peeler T. Living with chronic kidney disease and type 2 diabetes mellitus: the patient and clinician perspective. *Adv Ther*. 2023;40:1–18.
14. Greer RC, Liu Y, Cavanaugh K, et al. Primary care physicians' perceived barriers to nephrology referral and co-management of patients with CKD: a qualitative study. *J Gen Intern Med*. 2019;34(7):1228–35.
15. Ramakrishnan C, Tan NC, Yoon S, et al. Healthcare professionals' perspectives on facilitators of and barriers to CKD management in primary care: a qualitative study in Singapore clinics. *BMC Health Serv Res*. 2022;22(1):560.
16. Martin KE, Thomas BS, Greenberg KI. The expanding role of primary care providers in care of individuals with kidney disease. *J Natl Med Assoc*. 2022;114(352):S10–9.
17. Levine DM, Linder JA, Landon BE. Characteristics of Americans with primary care and changes over time, 2002–2015. *JAMA Intern Med*. 2020;180(3):463–6.
18. Mongaret C, Aubert L, Lestrille A, et al. The role of community pharmacists in the detection of clinically relevant drug-related problems in chronic kidney disease patients. *Pharmacy (Basel)*. 2020;8(2):89.
19. Li H, Radhakrishnan J. A pharmacist-physician collaborative care model in chronic kidney disease. *J Clin Hypertens (Greenwich)*. 2021;23(11):2026–9.
20. Lo C, Teede H, Fulcher G, et al. Gaps and barriers in health-care provision for co-morbid diabetes and chronic kidney disease: a cross-sectional study. *BMC Nephrol*. 2017;18(1):80.
21. Neale EP, Middleton J, Lambert K. Barriers and enablers to detection and management of chronic kidney disease in primary healthcare: a systematic review. *BMC Nephrol*. 2020;21(1):83.
22. Low S, Lim SC, Wang J, et al. Long-term outcomes of patients with type 2 diabetes attending a multidisciplinary diabetes kidney disease clinic. *J Diabetes*. 2018;10(7):572–80.
23. Sperati CJ, Soman S, Agrawal V, et al. Primary care physicians' perceptions of barriers and facilitators to management of chronic kidney disease: a mixed methods study. *PLoS ONE*. 2019;14(8):e0221325.
24. Taylor DM, Fraser S, Dudley C, et al. Health literacy and patient outcomes in chronic kidney disease: a systematic review. *Nephrol Dial Transplant*. 2018;33(9):1545–58.
25. Cedillo-Couvert EA, Ricardo AC, Chen J, et al. Self-reported medication adherence and CKD progression. *Kidney Int Rep*. 2018;3(3):645–51.
26. Tesfaye WH, McKercher C, Peterson GM, et al. Medication adherence, burden and health-related quality of life in adults with predialysis chronic kidney disease: a prospective cohort study. *Int J Environ Res Public Health*. 2020;17(1):371.
27. National Pharmacy Association. Medicines use review. <https://www.npa.co.uk/services-and-support/nhs-services/medicines-use-review/>. Accessed 16 Dec 2022.
28. MacRae C, Mercer S, Guthrie B. Potentially inappropriate primary care prescribing in people with chronic kidney disease: a cross-sectional analysis of a large population cohort. *Br J Gen Pract*. 2021;71(708):e483–90.
29. Chahine B. Potentially inappropriate medications prescribing to elderly patients with advanced chronic kidney by using 2019 American Geriatrics

- Society Beers Criteria. *Health Sci Rep.* 2020;3(4):e214.
30. Sommer J, Seeling A, Rupprecht H. Adverse drug events in patients with chronic kidney disease associated with multiple drug interactions and polypharmacy. *Drugs Aging.* 2020;37(5):359–72.
 31. Dalton K, Byrne S. Role of the pharmacist in reducing healthcare costs: current insights. *Integr Pharm Res Pract.* 2017;6:37–46.
 32. McMullin ST, Hennenfent JA, Ritchie DJ, et al. A prospective, randomized trial to assess the cost impact of pharmacist-initiated interventions. *Arch Intern Med.* 1999;159(19):2306–9.
 33. Lo C, Teede H, Ilic D, et al. Identifying health service barriers in the management of co-morbid diabetes and chronic kidney disease in primary care: a mixed-methods exploration. *Fam Pract.* 2016;33(5):492–7.
 34. Sarnak DO, Squires D, Kuzmak G, Bishop S. Paying for prescription drugs around the world: why is the U.S. an outlier? *Issue Brief (Commonw Fund).* 2017;2017:1–14.
 35. Gembillo G, Ingrasciotta Y, Crisafulli S, et al. Kidney disease in diabetic patients: from pathophysiology to pharmacological aspects with a focus on therapeutic inertia. *Int J Mol Sci.* 2021;22(9):4824.
 36. Al Hamarneh YN, Hemmelgarn B, Curtis C, Balint C, Jones CA, Tsuyuki RT. Community pharmacist targeted screening for chronic kidney disease. *Can Pharm J (Ott).* 2016;149(1):13–7.
 37. Holm H, Bjerke K, Holst L, Mathiesen L. Use of renal risk drugs in patients with renal impairment. *Int J Clin Pharm.* 2015;37(6):1136–42.
 38. Pai AB, Boyd A, Depczynski J, Chavez IM, Khan N, Manley H. Reduced drug use and hospitalization rates in patients undergoing hemodialysis who received pharmaceutical care: a 2-year, randomized, controlled study. *Pharmacotherapy.* 2009;29(12):1433–40.
 39. Aghili M, Kasturirangan MN. Management of drug-drug interactions among critically ill patients with chronic kidney disease: impact of clinical pharmacist's interventions. *Indian J Crit Care Med.* 2021;25(11):1226–31.
 40. de Boer IH, Khunti K, Sadosky T, et al. Diabetes management in chronic kidney disease: a consensus report by the American Diabetes Association (ADA) and Kidney Disease: Improving Global Outcomes (KDIGO). *Diabetes Care.* 2022;45(12):3075–90.
 41. Kidney Disease: Improving Global Outcomes Diabetes Work Group. KDIGO 2022 clinical practice guideline for diabetes management in chronic kidney disease. *Kidney Int.* 2022;102(5S):S1–127.