

Primary Care Provider Education and Computer-Based Tools for Improving Confidence in CKD Management: A Literature Review

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Abstract

Background: Chronic kidney disease (CKD) is a global health burden that affects upwards of 13.4% of the population and costs health systems billions annually. Guidelines to identify and manage CKD have been published for over twenty years. Thus finding effective interventions to stem this global health burden is an essential focus of current research.

Objective: This literature review attempts to answer the question: Do interventions directed to primary care providers such as education, awareness of clinical practice guidelines, and electronic clinical decision support tools improve the confidence that PCPs have in managing and caring for CKD patients?

Methods: A literature search of PubMed, CINAHL, and SCOPUS databases using the key terms 'CKD', 'chronic kidney disease', 'PCP', 'primary care provider', and 'education' was performed. Results were limited to articles within the past decade and included only randomized controlled trials to maintain the power of results.

Results: Five articles met the criteria for inclusion in this literature review, with a further two articles included after reviewing reference lists. The seven articles included in this review employed a variety of primary care provider educational interventions and several system-level computerized interventions using electronic patient record systems.

Conclusion: Despite various interventions to assist with adopting previously published guidelines in both educational and system-level spheres, minimal impact on the confidence level of primary care physicians and impact on those living with CKD was observed. Implementation of integrated and interdisciplinary interventions may be necessary for evaluation in future studies.

Introduction

Nationally, chronic kidney disease (CKD) is a significant health burden that exacts a high cost on patients and society alike.(1,2) Recent estimates of the global health burden of CKD report global prevalence at 13.4% of the population.(2) In Canada alone, the estimation of those living with CKD is more than 4 million people (3) and is expected to rise due to the growing elderly population and rising rates of diabetes mellitus and hypertension.(4) Chronic kidney diseases' global costs to the health care system are expected to exceed 40 billion dollars annually.(3) Similarly, the prevalence rate in Manitoba is approximately 14%, affecting over 134,000 Manitobans – more than any other province in Canada.(5) Of note, several earlier Canadian studies have shown a disparity between the prevalence of CKD in rural settings when compared to those in urban settings.(1) These studies reflect the challenges of accessibility and quality of care that rural populations in Canada face.

Guidelines for the evaluation, management, and treatment of CKD were developed and first published in 2002 by the Kidney Disease: Improving Global Outcomes (KDIGO) non-profit organization to aid in implementing evidence-based recommendations for kidney disease.(6) Further revisions and development were published in 2012 and are currently undergoing updates in 2022. In Canada, the adoption and adaptation of evidence-based clinical guidelines for CKD management were first published in 2008.(7)

Definition of CKD

KDIGO currently defines CKD as “abnormalities of kidney structure or function, present for >3 months, with implications for health”.(6) Abnormalities of kidney structure or function are marked by one or more of the following: decreased GFR, albuminuria, urine sediment

abnormalities, tubular disorders affecting electrolytes, histological abnormalities, structural abnormalities detected by imaging, or a history of kidney transplantation.(6) Further classification or grading of CKD is made based upon GFR and albuminuria values. This information is summarized in figure 1 below. Further information is provided within the figure as to CKD prognosis based on GFR by the colours represented. Secondly, the numbers provided within the heat map reference the frequency of monitoring recommended by KDIGO. Lastly, recommendations for monitoring or referral to a nephrology specialist are also outlined within the heat map figure below.

				Albuminuria categories Description and range		
				A1	A2	A3
				Normal to Mildly Increased	Moderately Increased	Severely Increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
GFR Categories (ml/min/1.73m ²) Description and Range	G1	Normal or High	≥ 90	Monitor 1	Monitor 1	Refer 2
	G2	Mildly Decreased	60-89	Monitor 1	Monitor 1	Refer 2
	G3a	Mildly to Moderately Decrease	45-59	Monitor 1	Monitor 2	Refer 3
	G3b	Moderately to Severely Decreased	30-44	Monitor 2	Monitor 3	Refer 3
	G4	Severely Decreased	15-29	Refer 3	Refer 3	Refer 4+
	G5	Kidney Failure	< 15	Refer 4+	Refer 4+	Refer 4+

**Prognosis of CKD by GFR and Albuminuria Categories & Referral Decision Making*

Numbers in Heat Map Representing Frequency of Monitoring (# / year)

Green - Low Risk (If no other markers of Kidney Disease, no CKD)

Yellow - Moderately increased risk

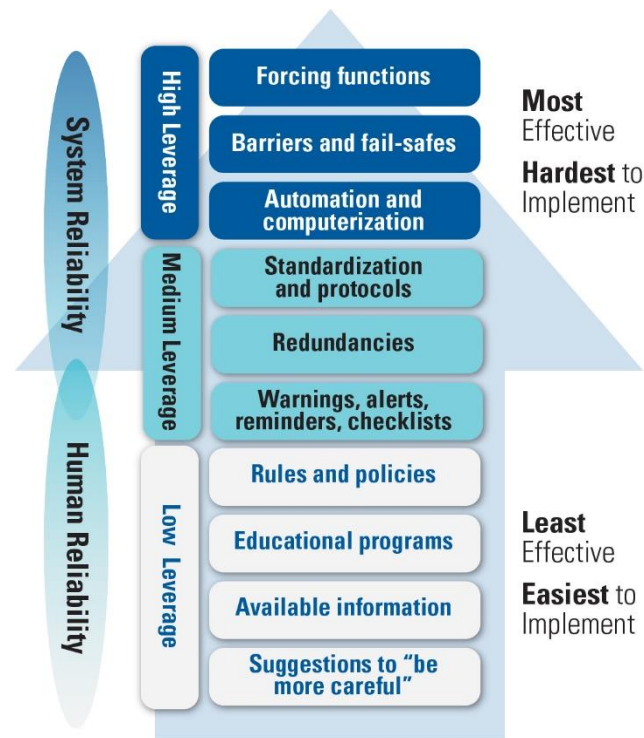
Orange - High Risk

Red - Very High Risk

Figure 1: Heat map adapted from KDIGO 2012 clinical practice guidelines for CKD evaluation and management.(6)

CKD Intervention

Given CKD's significant health burden and the need for timely detection and early intervention, primary care providers are particularly well-positioned to intervene and effectively manage most CKD cases, as several studies have pointed out.(1,4,8-10) Smekal (9) and Sperati (8) both identify PCPs' lack of knowledge or uncertainty about CKD, which often prompts the implementation of educational interventions to address awareness of CKD and guideline-concordant care. While educational interventions are the easiest interventions to implement, they are also the least effective according to the hierarchy of effectiveness which has been implemented by the Institutes of Safe Medication Practices, The Canadian Patient Safety Institute, and others.(11) Further commentary regarding this hierarchy and the consideration of intervention effectiveness indicates that education is a low-leverage improvement intervention; while still often necessary, it is rarely sufficient in isolation.(12) According to this same hierarchy, implementation of interventions which employ reminders, checklists and double-checks are more effective than education alone.(11) Even more effective are computerization and automation interventions which are some of the most effective measures to employ. While these interventions may be less feasible, these system-based approaches are less reliant on variable human factors.(11) Chronic kidney disease, in particular, with its stratification according to GFR and albuminuria laboratory values, lends itself to employing electronic medical record data within an automated or computerized intervention.



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Figure 2: Hierarchy of effectiveness.(13)

Study Question and Goals

Despite the desired benefits of care practices delivering improved care outcomes, reduced health costs and delayed progression of CKD, implementing clinical practice guidelines for CKD remains an ongoing challenge.(4,8-10) Regardless of desired outcomes, the publication and dissemination of clinical practice guidelines for CKD nearly 20 years ago have authors such as Sperati (8) continuing to outline several provider-level barriers to CKD management, including primary care providers' lack of knowledge of CKD, limited familiarity with CKD guidelines, and difficulty managing CKD in the context of comorbid patients amongst others. With these known evidence-practice gaps (9) present in CKD care, this literature review endeavours to answer the following clinical question: Do primary care provider interventions such as

education, awareness of clinical practice guidelines and electronic clinical decision support tools improve the confidence that PCPs have in appropriately managing CKD patients.

Methods

This literature review consists of an appraisal and critique of relevant clinical trials for interventions aimed at education and implementation of clinical guidelines in chronic kidney disease (CKD) targeted to primary care providers and those of the health care team that would most impact the care and outcomes of CKD patients.

To yield relevant papers, PubMed, CINAHL, and Scopus databases were searched. Keywords include Chronic Kidney Disease, CKD, Primary Care Provider, PCP, and Education. Searches were performed on February 12, 2022, and results were restricted to those of most relevance to the current clinical question. Construction of the searches performed was as follows: ((CKD OR Chronic Kidney Disease) AND (PCP OR Primary Care Provider) AND (Education)). Exclusion criteria were set to those articles published within the past ten years (2011-2021) and those articles published in academic journals in English. Unique to the PubMed search was the ability to include article filters based upon the study's methodology, including Clinical trials (Protocols, Phases I-IV, Controlled), reviews, systematic reviews, randomized controlled trials, meta-analysis, and multicenter studies. These searches generated 38, 122, and 69 individual results in CINAHL, PubMed, and SCOPUS, respectively, when the search was performed. Employing citation management software, duplicates were removed, reducing the total number of articles to 178. Further refinement of the search was performed by reviewing titles for relevance to yield 46 articles and finally reviewing abstracts to result in 13 remaining articles for full-text review. After a full-text review, six articles were selected for inclusion in this literature

review. A brief manual assessment of reference lists identified a further two articles for inclusion for this literature review.

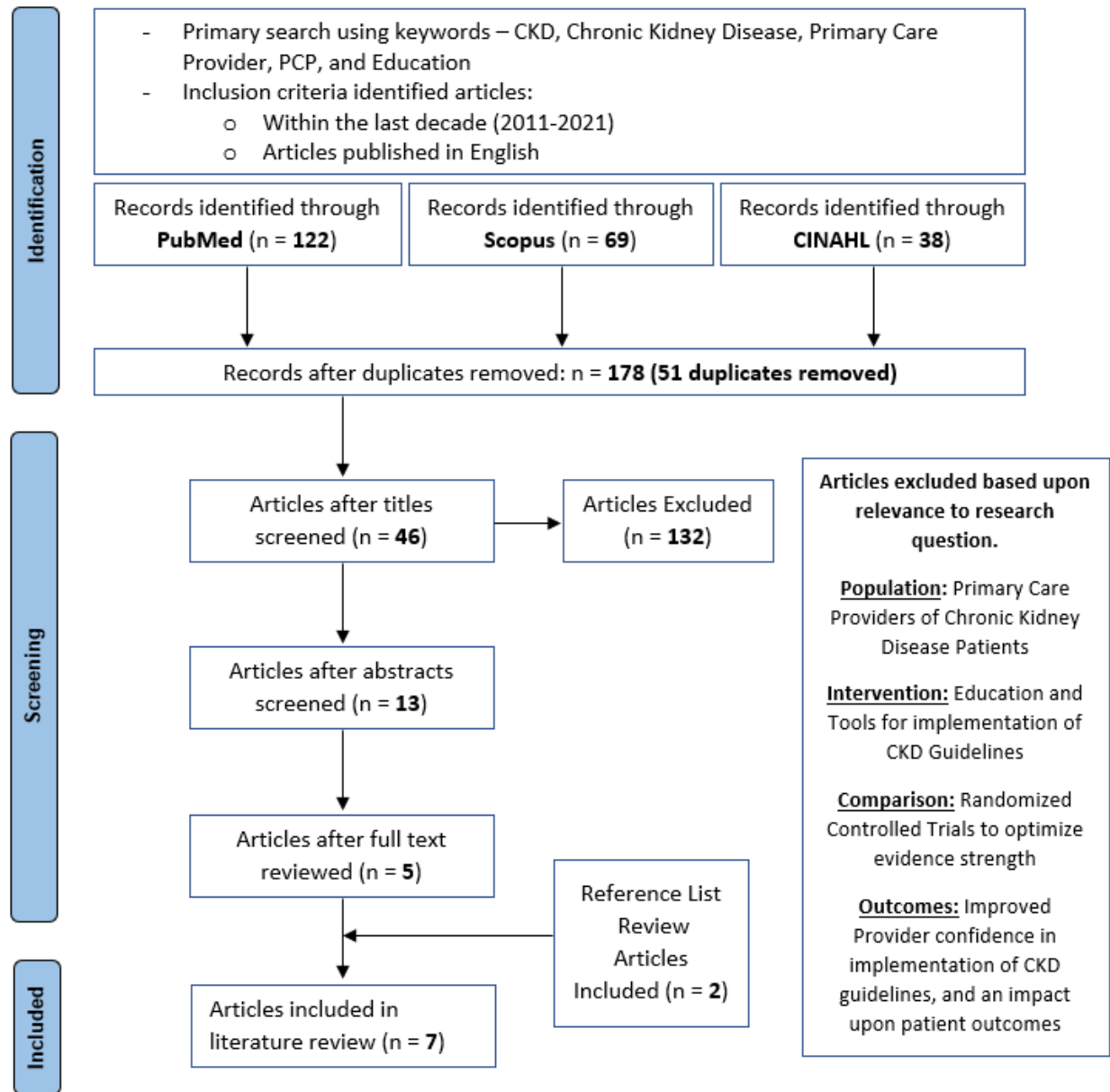


Figure 3: PRISMA diagram outlining protocol methodology identifying search criteria and results.

Results

The literature search resulted in 7 articles that presented insight into PCP responses to education and system-level interventions in practice settings and in the context of managing CKD. All included articles were randomized controlled trials (RCTs) that employed convenience clusters of primary care providers and patients within primary care practices. The sample sizes of the RCTs ranged from 137 to 6699 patients, and trial periods spanned from 10 months to 3 years in length. These seven studies also represent upwards of 438 primary care providers from academic hospital settings, veteran's medical centers and public primary care clinics.

Abdel-Kader (14) examined referrals of patients to nephrology in an RCT in 2011 as their primary outcome indicator. Both interventional and control groups received two CKD educational sessions, while the interventional arm also employed electronic medical record (EMR) alerts from the already in use EMR software for referral. Unfortunately, no improvement in the rate of referrals was found, and similarly, within secondary outcomes, no statistically significant changes were observed between control and interventional groups. The secondary outcomes observed no change in albuminuria or proteinuria testing, ACE/ARB use, improved BP control, NSAID use, CKD documentation, or documented annual bloodwork.

A second RCT by Drawz (15), two PCP clinics were provided education to use an electronic CKD registry and measured outcomes by documented measurement of PTH. While both groups received CKD guideline education, only the interventional group was provided access to use the registry throughout the trial. It was concluded that the education and access to the registry only "marginally improved adherence" to CKD guidelines over education alone.(15) Secondary outcomes of this study also failed to uncover any statistically significant outcomes. These included no change in the use of renin-angiotensin system (RAS) blockers, diuretic use,

completed bloodwork, or BP values at goal.

The conventional tool to monitor kidney function was measuring eGFR and the outcome modality used by Carroll (16) to assess the interventional effect on CKD management by PCPs. Clinical decision support (CDS) algorithms were added to practitioners' EMRs. Though both groups were provided with CDS to prompt screening, diagnosis and treatment of CKD, the control group was provided with additional practice considerations such as developing administration buy-in, audits and feedback, facilitating structured team approaches, and target setting. These multi-dimensional interventions based on the TRANSLATE approach used in other chronic disease management strategies were instrumental in demonstrating a reduced loss of eGFR over time within the intervention group. Disappointingly, despite having a sample size of nearly 7000 patients, no changes in BP, NSAID avoidance, new CKD diagnosis or increased use of ACEi/ARBs were observed.

The four remaining reviewed studies assessed changes in blood pressure as their primary study outcome. With 79 PCPs and 746 patients, Tout (17) employed a CKD registry to identify all patients with CKD at the point of care with embedded reminders for ACE/ARB prescriptions, elevated BPs and without recorded urine albumin results. Despite these alerts through an EMR registry for CKD, no changes in SBP over the 12-month interventional period were seen. Amongst Touts' secondary outcomes (BP control, urine albumin testing results, albuminuria severity, RAS inhibitor prescriptions and changes in eGFR), only a modest increase in prescriptions for ACEi/ARBs was seen in the interventional arm.

A smaller study in 2019 by Tuot (18) employed a 2x2 RCT with 79 PCPs and only 137 patients. A CKD registry with point-of-care notifications and quarterly feedback was implemented in conjunction with a CKD self-management support program for patients

compared to usual care. Tout did note more significant changes in SBP, decreases in SBP for those patients who had uncontrolled BP and decreases in albuminuria. However, these changes were statistically non-significant between interventional arms and as compared to usual care. No changes were noted regarding patient self-efficacy, quality of life, or CKD awareness with the interventions.

Peralta (19,20) also pursued measurement of change in BP as a primary study outcome to understand practitioner engagement with the care of CKD patients. A pragmatic randomized controlled trial and a cluster-randomized trial, published in 2020, demonstrated no statistically significant change in blood pressure. The smaller of these two studies (19), with 80 PCPs and 524 patients, implemented an electronic clinical decision support system (eCDSS) for one arm, an eCDSS with the addition of pharmacist reinforcement of CKD education in a second arm, with both groups being compared to usual care. Findings of note were those of greater PCP awareness of CKD guidelines. Peralta's larger RCT trial (20) with 70 PCPs and 1819 patients also used a three-arm study approach. One arm utilized a CKD registry and PCP education to screen for CKD. The second arm added pharmacist co-management along with education for screening, and both arms were again compared to usual care. It was concluded that the interventions did not increase the burden on the provider and cited the ability of the applications to be embeddable into existing health record software as an advantage to its implementation and use. Increased new use of RAS inhibitors and diuretics was also noted within the intervention groups. Peralta (20) also reports that difficulty in observing between study arm differences made it difficult to determine if CKD screening could further improve care for those with HTN.

Discussion

Implementing change in primary care for the acknowledged health burden of chronic kidney disease is not a straightforward endeavour. At its core, employing clinical practice guidelines such as those by KDIGO can be challenging for practitioners in complex and diverse clinical practices. Education and informational sessions are often thought of as a simple first step, and leveraging technology already present in many clinical settings is a logical and cost-effective next step. Within the context of our clinical question at the outset of this study, do these simple and logical steps affect the confidence of PCPs in implementing CKD guidelines and improve the management of CKD? Regrettably, in the studies examined, using brief educational seminars regarding CKD guidelines and interventions to improve CKD care did not elicit effective or significant change to study outcomes. Simultaneously, leveraging electronic disease registries and clinical decision support tools also appeared to have little impact on CKD patients' ongoing care in study outcomes. No statistically significant changes in primary outcomes as compared to controls were observed in any of the studies reviewed, except for a notable reduction in eGFR decline in the interventional group in the study by Carroll.(16)

Leveraging education as outlined by the hierarchy of effectiveness from the Institute for Safe Medication Practices (11) should make the ineffective interventions reviewed unsurprising. These findings are consistent with the hierarchy of effectiveness in that education is often the easiest to implement yet has the least effectiveness when used as an intervention in isolation or is unaccompanied by other complementary and effective interventions. According to the hierarchy of effectiveness, clinical decision support tools and automated clinical disease registries have the potential to provide a higher degree of effectiveness when implemented as an intervention. Thus, in concept, a combination of both education and computerization or automation should make for a more effective step towards greater PCP confidence in CKD care. Carroll (16) indicates this

potential effectiveness possibility as they demonstrate a reduction in eGFR decline by employing a multimodal intervention that not only includes education and electronic information systems but also engages a team-based approach, target setting, and local physician champions, amongst others in their “nine-point TRANSLATE action plan” interventions. In contrast, the remaining six studies provided little support for the integration or superiority of combining education and computerization to improve the implementation of CKD guidelines and PCP confidence in CKD care.

Practically, of the studies reviewed, more effective systems-level interventions must be leveraged to improve PCP confidence in CKD guidelines and CKD management. The authors noted several practical suggestions that could aid future studies in this pursuit. Firstly, several studies noted that the interventions employed were not burdensome to providers (20) and were integrated within the typical workflow of providers. Considering the complex environments that PCPs work within, customization and provider input have been mentioned as essential components to developing interventions that will have lasting and effective impacts (20). Customizing disease registries and clinical decision support systems within electronic patient records to unique clinic workflows and varying patient populations is imperative for smooth and effective workflow. As crucial as customization is, input from other healthcare team members and PCPs can aid in a more streamlined system that works within the daily workflow of PCPs, but they also provide a means of improved uptake and willingness to use the systems that are implemented. Secondly, as previously mentioned, other aspects of chronic care models may also be of utility when applied to CKD guideline implementation and care. As was reasonably applied in the study done by Carroll (16), multimodal or integrated interventions that include team-based or multidisciplinary team care; which has been successful in other chronic disease care such as

diabetes and hypertension, may also have the potential of improving results over those evidenced in the studies reviewed.(14,15,16) Direct patient education, self-management support, CKD care navigation specialists, administrative buy-in, and local physician champions are a few of numerous aspects of chronic care models that have the potential to be implemented for further uptake of CKD guidelines and CKD provider confidence.

In contrast, several limitations were identified by the studies evaluated in this review. Several studies employed passive clinical decision support systems and registries despite the ease of use or integration into the primary care providers' workflow. These passive systems afforded opportunities to navigate away or bypass order sets and alerts within electronic charts. In terms of the hierarchy of effectiveness, this passiveness reduces the overall leverage that these interventions have upon changing behaviour and outcomes. Most effective within the hierarchy of effectiveness are functions that cannot be bypassed or contain barriers and fail-safes such as ongoing reminders to complete required order sets and tests or forcing acknowledgement of required nephrology referrals at specified eGFR thresholds as examples. Considering these types of interventions are often understood as the most effective, they are often viewed as the most difficult to implement, with ongoing challenges of continued provider buy-in or support. These high-leverage interventions are often perceived as intrusive and disruptive to typical workflows. A second limitation mentioned by several studies was the lack of a standardized screening protocol within the CKD guidelines. This lack of screening protocol for CKD individuals was an important factor in the lack of confidence that PCPs have in CKD management. Timely identification of patients with CKD and earlier interventional care has the potential to mitigate complications and progression of the condition, as is seen in other chronic diseases. A robust screening protocol to identify at-risk patients may encourage and support PCPs in CKD care,

which can be effectively managed within the primary care setting before complications and further expertise are necessitated. Further noted limitations within the studies evaluated were the challenges of insufficient power to note statistically significant changes between interventional arms and an absence of more extended study periods or post-intervention follow-up, which may have evaluated ongoing and recurrent education. Again, notably, the exception is the study by Carroll (16), which incorporated a trial period of 3 years overall. Interestingly a longitudinal approach to the interventions studied may have provided further insight into the challenges faced by employing education and electronic clinical decision supports in CKD care and practice.

Limitations

Primarily the limitations of this literature review begin with the paucity of data and research specific to educational and electronic interventions directed at PCPs within the scope of chronic kidney disease. In isolation, educational or clinical decision support systems have been studied at length in other settings and environments, but to a much lesser degree within nephrology. Secondly, the main search criteria focused on randomized controlled trials to provide greater veracity to the results and outcomes reported using quantitative data. Yet, broadening search criteria to include qualitative studies may have yielded further reports with insight into the perceived lack of confidence change amongst PCPs when employing clinical systems and educational interventions and perhaps revealed more robust indicators of change and confidence.

Future directions

An integrated approach including not only education and clinical decision support systems into CKD guideline implementation is suggested for future studies and CKD care. A

multimodal approach that uses CKD guidelines as a foundation and builds upon it with ongoing and recurring education and seeks to educate the entire healthcare team may be a more effective way forward. Much in the same way as other chronic care models include an interdisciplinary team of health care service providers, so too must providers within the context of CKD care. With current KDIGO CKD guidelines undergoing revision and updating, a unique opportunity exists to move forward with CKD guideline implementation through an interprofessional-focused approach. Leveraging electronic patient record systems with more challenging to circumvent functionality directed at the entire healthcare team and pursuing standardized screening criteria for CKD may be a more effective method for improving confidence for providers. Figure 4 below provides a graphical view of this suggested perspective in improving provider guideline implementation confidence. With the support and awareness of the entire healthcare team, the latest evidence-based practice guidelines, and the use of reliable and effective electronic systems, PCPs can be confident that CKD patients are receiving care that will make a lasting difference.

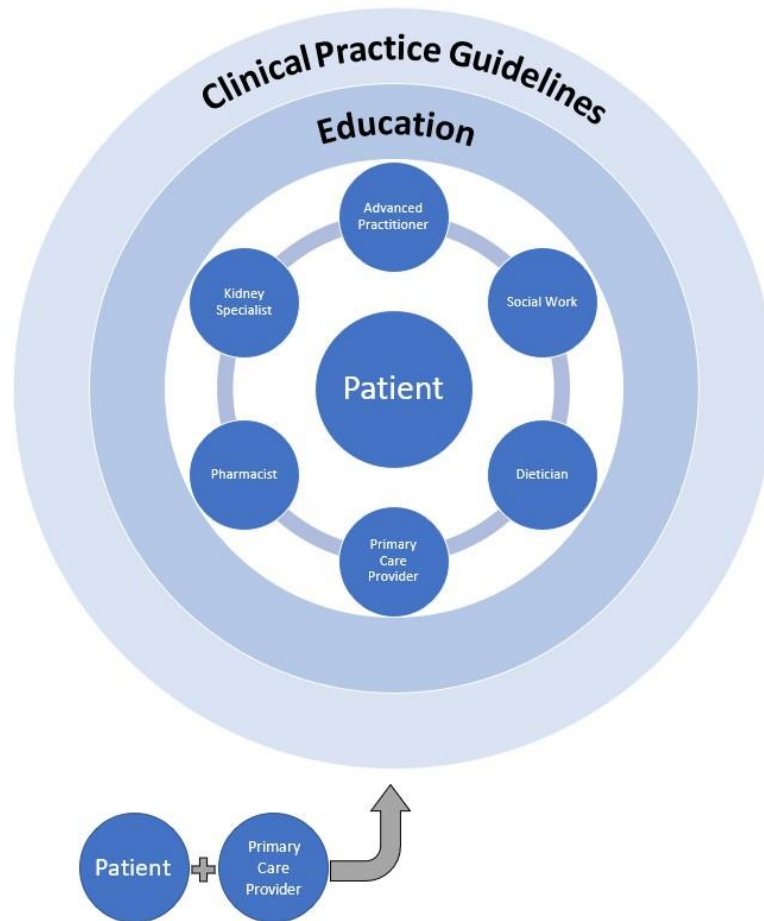


Figure 4: An adapted interdisciplinary care model in an environment of guideline implementation and ongoing education.(21)

Conclusion

Despite a variety of interventions to assist with the adoption of previously published guidelines in both educational and system-level spheres, such as clinical decision support tools embedded within electronic patient records, disease registries, and educational seminars, there has been minimal evidence to show increased confidence levels of primary care physicians in implementing CKD guidelines when caring for those living with CKD. Implementing an integrated interprofessional care approach and continuous education and leveraging chronic disease management strategies would be prudent for better care for those living with chronic kidney disease.

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Appendix

Table 1: Summary of articles examined in this literature review including study type & size, GFR calculation, trial period, intervention, outcomes, results, conclusions, and limitations.

Study	Abdel-Kader, K ¹⁴ 2011 US	Carroll, J ¹⁶ 2018 US	Drawz, P ¹⁵ 2012 US	Peralta, C ¹⁹ 2020 US	Peralta, C ²⁰ 2020 US	Tuot, D ¹⁷ 2018 US	Tuot, D ¹⁸ 2019 US
Study Type & Sample Size	Cluster - RCT • 30 PCPs • 248 patients	Cluster - RCT • 30 Primary Care Practices • 6699 Patients	Cluster - RCT • 2 PCP Clinics • 781 Patients	Cluster - RCT NCT02925962 • 80 PCPs • 524 Patients	CRT NCT02059408 • 1819 Patients (HTN & No Diabetes)	RCT NCT03473509 • 79 PCPs • 746 Patients	RCT NCT01530958 • 2 Primary Care Clinics (79 PCPs) • 137 patients
GFR Calculation	MDRD	?	?	CKD-EPI	CKD-EPI using Creatinine and Cystatin-C	MDRD	MDRD
Trial Period	10M (Initially 6m) Education occurred prior to consent	3 Year Period	12M Study period Pre-intervention period - 12M prior	12M Intervention period + 9M follow-up	14M Intervention period (after randomization)	12M Intervention period	18M study period within each clinic
Intervention	• Interventional arm receiving EMR alerts vs. no alerts • Both arms receiving 2 CKD Educational Sessions	• Clinical Decision Support (CDS) + Practice Facilitation (Based on TRANSLATE model) vs. CDS only • Both arms receiving CDS to prompt screening, diagnosis, and treatment of CKD	• Access and Education for use of an electronic CKD Registry vs. No registry access • Both arms receiving a lecture on CKD guidelines at study initiation	• 3 Study Arms: - eCDSS - eCDSS + Pharmacist reinforcement of CKD education - Usual Care • Both intervention arms were risk stratified using triple marker testing (serum Creatinine, serum Cystatin-C, Urine Albumin Creatinine Ratio)	• 3 Study Arms: - CKD Screening with Patient / Provider Education - CKD Screening with Patient / Provider Education and Pharmacist Co-management - Usual Care • Both intervention arms were risk stratified using triple marker testing (serum Creatinine, serum Cystatin-C, Urine Albumin Creatinine Ratio)	• Employing a CKD registry (embedded CKD guideline reminders) to identify all patients with CKD at point of care. (BP >140/90, those without ACE/ARB prescription, without albuminuria quantification) vs. usual care registries (cancer screens and immunization info)	• 2x2 factorial pilot trial • 1st arm: - CKD registry vs. usual care registry • 2nd arm: - CKD Self-Management Support for Patients vs. usual care 4 Groups: - CKD Registry + CKD-SMS - CKD Registry Only - CKD-SMS Only - Usual Care Only
Outcomes	• 1° Outcomes: - Referral to a Nephrologist (Order or Encounter) • 2° Outcomes: Measures of CKD Care: - Albuminuria and Proteinuria quantification - ACE/ARB use - BP control - NSAID use - CKD documentation - Annual bloodwork	• 1° Outcomes: - Annualized loss of eGFR • 2° Outcomes: - Changes in SBP - NSAID avoidance Use of ACEi/ARBs - CKD diagnosis	• 1° Outcomes: - PTH adherence • 2° Outcomes: - P, Hgb, Proteinuria, BP within goal, Tx with diuretic or RAS blocker	• 1° Outcomes: - Change in BP over 12 months • 2° Outcomes: - PCP awareness of CKD, BP control and use of ACEi/ARB/Statin therapies	• 1° Outcomes: - Change in BP over 12 months • 2° Outcomes: - BP control at study end, and proportion of RAS inhibitors, NSAIDs, and Diuretic Rx fills during study period	• 1° Outcomes: - Change in SBP at 12 months • 2° Outcomes: - BP control, albuminuria testing, albuminuria severity, proportion Rx RAS inhibitors, and change in eGFR	• 1° Outcomes: - Change in SBP at 12 months • 2° Outcomes: - BP control, albuminuria testing, albuminuria severity, Patient reported self-efficacy of chronic disease management

Study	Abdel-Kader, K ¹⁴ 2011 US	Carroll, J ¹⁶ 2018 US	Drawz, P ¹⁵ 2012 US	Peralta, C ¹⁹ 2020 US	Peralta, C ²⁰ 2020 US	Tuot, D ¹⁷ 2018 US	Tuot, D ¹⁸ 2019 US
Results	<ul style="list-style-type: none"> No observed difference in renal referrals No change in proteinuria assessments, but may have improved for those who lacked one at base-line 	<ul style="list-style-type: none"> Reduced decline in eGFR in intervention group No CKD stage progression in intervention group Improvement in HbA_{1c} in intervention group No changes in BP, NSAID avoidance, or increased use of ACEi/ARBs, new CKD diagnoses 	<ul style="list-style-type: none"> Measurement of PTH in both arms of the study increased No consistent improvement in secondary outcomes. 	<ul style="list-style-type: none"> No statistically significant change in SBP was noted between intervention and control groups PCP awareness was significantly greater in interventional arms in "as-treated" analysis 	<ul style="list-style-type: none"> No statistical difference in BP changes between study arms. (Both in intention-to-treat analysis or as-treated analysis) No significant differences in BP control at end of study Increased new use of RAS inhibitors and Diuretics in intervention groups 	<ul style="list-style-type: none"> No change in SBP between study arms was noted No significant change in BP control over intervention period No change in eGFR or albuminuria severity over study period between study arms Increased ACE/ARB Rx in intervention arm 	<ul style="list-style-type: none"> Larger, yet non-statistically significant (among interventional arms vs usual care) Change in SBP Decreases in SBP for patients with uncontrolled BP Lower albuminuria No associated changes in self-efficacy, QOL or CKD awareness with interventions
Conclusions	<p>Trends of improved BP control in those with uncontrolled BP</p> <p>Absence of other downstream effects</p>	<p>"Multimodal intervention in primary care slowed annualized loss of eGFR"</p>	<p>"CKD guideline education and access to a CKD registry only marginally improved guideline adherence over education alone."</p>	<p>more PCP awareness was noticed</p> <p>Higher use of ACE/ARB in intervention arms</p>	<p>Study protocol did not increase provider burden</p> <p>No between study arm differences - unable to determine if CKD screening can further improve care for those with HTN</p>	<p>"A Primary Care CKD registry directed at the entire healthcare team enhances delivery of guideline concordant care"</p>	<p>Demonstrated feasibility of implementing provider and patient level interventions simultaneously</p> <p>A larger trial will be required to provide power necessary to detect meaningful BP changes require a more robust patient intervention</p>
Limitations	<ul style="list-style-type: none"> Small Single-Center Practice Passive CDSS - Requiring PCPs to trigger order set 	<ul style="list-style-type: none"> Significantly more control practices withdrew from study than intervention practices (Ownership changes/EMR limitations) - Necessitated use of propensity scoring for final result analysis No "true" control group without any intervention 	<ul style="list-style-type: none"> Study limited to education and chronic disease registry. Other chronic care model interventions not included (delivery system redesign, direct patient education, self-management support) Many care providers did not employ the CKD registry (5 out of 37 in intervention arm) 	<ul style="list-style-type: none"> Smaller sample size limited power to detect differences between study arms Low completion rate of required testing in interventional arm (41%) Pharmacist follow-up limited by patient unreachability via phone Study employed in a single academic practice - limiting generalizability 	<ul style="list-style-type: none"> Potential crossover between study arms - Patient/Provider reassignment <50% of intervention patients had screening completed (due to appointment scheduling) 	<ul style="list-style-type: none"> The registry could not exclude those with AKI Unavailability of medication data / complications 	<ul style="list-style-type: none"> Pilot trial without sufficient power to detect significant changes in clinical or behavioural outcomes Primary Care Clinics with a significant proportion of low-income participants - may not be generalizable Could not assess provider adherence to registry or patient participation

