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Rethinking Models of Chronic Kidney Disease Care: A Narrative Review

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Chronic kidney disease · Models of care · Health systems · Implementation

Abstract
Background: Chronic kidney disease (CKD) affects over 850 million people worldwide and is associated with significant morbidity and mortality. There has been recent expansion in treatment options to reduce CKD progression and cardiovascular risk, and it is essential that this translates into clinical practice. ***Summary:*** The primary objectives of this review were to outline current CKD care models and associated care gaps and review the literature for alternative care models, with a focus on the early detection and management of CKD. Several care models have been proposed to improve CKD management including nurse-led, pharmacy-led, integrated care models and digital interventions, with mixed results. ***Key Messages:*** There is a need for ongoing health systems and implementation research to improve translation of evidence into practice in the management of CKD.

Introduction

Chronic kidney disease (CKD) is estimated to affect more than 10% of the world's population with an increasing prevalence over the past 3 decades [1–3]. There has been no improvement in the global age-standardised mortality rate from CKD from 1990 to 2017, despite significant improvements in other chronic conditions such as cardiovascular disease, cancer, and chronic obstructive pulmonary disease [3, 4]. Without fundamental change, CKD is estimated to be the 5th leading cause of years of life lost by 2040 [5]. As the burden of CKD rises, we have entered a new era of CKD management that has been shown to reduce the risk of progressive kidney disease and the associated cardiovascular complications [6–8].

Historically, the translation of evidence-based CKD guidelines into clinical practice has been suboptimal, and as such, there is an increasing international focus on improving implementation of CKD care. As outlined by Nee et al. [9], there are significant barriers to CKD care across all levels of the health system, including community and clinician awareness and education, fragmented care, socioeconomic disparities, and prescription prices [9]. In addition, the burden of CKD disproportionately affects low- and lower middle-income countries [3, 10] where access to care is further limited by resourcing, workforce shortage, and diagnostic testing and medication availability [11–13]. Addressing these barriers will require both a global and local response to improve care across the system, including education of health professionals, public awareness campaigns, health policy, funding, and envisaging new and improved models of care. We aimed to review current models of CKD care

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and review the literature for alternative care models to understand current knowledge gaps and guide future design and evaluation.

Established Models of Care

There is variation in both funding and care models for kidney disease internationally. The most common funding model is a mix of public and private funding, with kidney failure care most likely to be publicly funded [14]. The Global Kidney Health Atlas found testing in at-risk individuals and early management to reduce CKD progression were least likely to be publicly funded [14]. This is of significant concern as the greatest impact in reducing morbidity, mortality, and cost of CKD care is in earlier detection and management [15]. While CKD care is thought to be primarily the domain of the nephrologist [16], nephrology services are unable to manage the estimated 10% of the world's population with CKD [14, 17]. Primary care physicians have a key role in risk factor identification, testing, and early management of kidney disease. Concerningly, the Global Kidney Health Atlas survey found that most countries rated CKD awareness among primary care physicians as below average or extremely low [14].

The Kidney Disease Improving Global Outcomes (KDIGO) international guidelines recommend nephrology evaluation in those with high and very high risk of kidney failure (including ≥3–5% 5-year risk of requiring kidney replacement therapy), persistent severely increase albuminuria, persistent haematuria, rapid decline in kidney function, hereditary kidney disease, or unclear cause of kidney disease [18]. Thus, most of the early management in testing, diagnosis, and initiation of vital medications is the domain of the primary care practitioner.

Current Care Gaps

CKD is underdiagnosed within the general population. Despite over 10% of the world's population having CKD, it is estimated that 90% do not know they have it [19–21]. Epidemiological studies have found gaps in all stages of CKD testing, diagnosis, and management. Approximately only 1 in 5 patients at risk are appropriately tested with both kidney function and urine albumin creatinine ratio [22, 23]. Furthermore, once pathology is consistent with CKD, it is commonly not coded for in the medical record [22, 24]. While there is a paucity of data, screening of high-risk individuals is likely to be much lower in low- and lower middle-income countries due to limited availability of diagnostic tests and lack of data confirming cost-effectiveness of screening high-risk individuals in resource poor settings [25]. When CKD is identified, there are also gaps in monitoring, particularly in relation to testing and monitoring of albuminuria (less than one third of cases) [26–30]. Barriers to albuminuria testing (where available) include a perceived lack of benefit and unfamiliarity with guideline recommendations [31], despite albuminuria measurement being a guideline recommendation to guide risk stratification and medication management [18]. Similarly, use of well-established guideline medications such as angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARB) is suboptimal, ranging from less than one third [27, 30, 32] to two thirds [32–35]. Sodium glucose co-transporter 2 (SGLT2) inhibitor uptake has been poor, with only 5–7% of patients with diabetes and CKD being prescribed these medications [36–38]. SGLT2 inhibitors are on the World Health Organisation Medicines list for diabetes [39]; however, access and cost remain a significant issue in low- and low-middle-income countries [40]. In light of significant gaps in care, there is a need to review current care models, in order to improve the implementation of testing, diagnosis, and management in primary care.

Barriers to CKD Care in Primary Care

A systematic review of qualitative research into CKD care by Neale et al. [41] identified common barriers to detection and management in primary care including time constraints, lack of knowledge or anxiety in providing a CKD diagnosis, and difficulty interpreting CKD guidelines. They also concluded important enablers of improvement were technology and a collaborative approach [41].

Lo et al. [42] sought to understand challenges in caring for patients with comorbid diabetes and kidney disease across the primary and tertiary care sectors in Australia. Key findings were current challenges in care coordination including communication between service providers, access to timely specialist care, importance of patient empowerment in self-management, and the need to address upstream determinants of health rather than a reactive approach [42].

Importantly, while primary care physicians commonly cite that a barrier to delivering a CKD diagnosis is concern for patient fear of the diagnosis [41], patient-centred

Table 1. Alternative care models for CKD care with examples

Model of care	Key components of the care model	Study
Nurse-led	• Patient education • Intensification of medication/risk factor control • Provider education and facilitation	Major et al. [50] Scherpbier-de Haan et al. [51] van Zuilen et al. [52] Garcia-Garcia et al. [53]
Community health worker	• Education • Risk factor monitoring • Medication management	Jafar et al. [54] Jiamjariyapon et al. [55]
Pharmacist-led	• Chart review • Prescription recommendation	Cooney et al. [56]
Self-management		Chen et al. [57] Lightfoot et al. [58]
Digital technologies as an aid	• Clinical decision support and electronic audit • Commonly coupled with education and practice facilitation • May be part of a care bundle including nursing, pharmacy and physician reviews	Carroll et al. [59] Litvin et al. [60] Jhamb et al. [61] Jones et al. [22] Mosa et al. [62] Pefanis et al. [63] Samal et al. [64] Vazquez et al. [65]
	• Patient facing education, self-management, and/or lifestyle interventions	Lightfoot et al. [58] Greenwood et al. [66]
Integrated care models	• Multidisciplinary coordinated care	Valentijn et al. [67][a]

[a]Systematic review.

research has found that patients do want to know and would prefer earlier diagnosis [43, 44]. Additionally, a recent pilot of an educational decision aid in primary care found increased patient satisfaction with care when used [45]. Key to good healthcare is patient-centred care with a focus on patient education, shared decision-making, and patient empowerment [46, 47]. Furthermore, patient confidence in managing chronic disease has been associated with reduced healthcare utilisation [48], and interventions focussed on patient empowerment in chronic disease have been shown to improve self-care and efficacy and in some cases clinical outcomes [49].

Alternative Models of Care

Several models of CKD care have been trialled internationally (Table 1). A systematic review by Nicoll et al. [68] outlined seven randomised control trials of models of CKD care including nurse-led, pharmacist-led, self-management, and multidisciplinary care interventions. Broadly, they found some improvements in guideline-directed care, particularly in pharmacy- and nursing-led models, but minimal or no improvement in kidney outcomes, noting the important limitation that most studies were not adequately powered to assess this [68]. Digital technologies were not evaluated as part of this review.

Nurse-Led Models of Care

Nurse-led models of care are becoming increasingly common across jurisdictions and diseases. A Cochrane review examined the outcomes of randomised controlled trials of nurse-led care for any health condition in primary care excluding mental health [69]. They concluded with moderate evidence that nurse-led care was similar or in some areas better than doctor-led care; however, there was significant variation in nursing education and role, conditions, and outcomes assessed that limits generalisability of results [69].

Expanded nursing roles, including CKD nurse practitioners have been trialled to improve CKD care. MASTERPLAN, a key study from The Netherlands, trialled intensive nurse practitioner support in patients with CKD in addition to standard nephrology care [52]. There was improvement in blood pressure, cholesterol, and proteinuria; however, efficacy of the intervention was questioned as it failed to reach primary cardiovascular or secondary kidney end points over a median follow-up of 4.83 years [17, 52]. However, when median follow-up was extended to 5.7 years, the intervention demonstrated a 20% reduction in the composite kidney end point of death, kidney failure, and 50% increase in serum creatinine (HR: 0.80; 95% CI: 0.66–0.98) [70]. Subsequent studies within the primary care setting found the addition of nurse practitioner care either aimed at provider or patient education improved elements of care including appropriate diagnosis, blood pressure targets, and medication management [50, 51], but no improvement in kidney outcomes [50]. While studies on nurse-led models of CKD care in low- and middle-income countries are limited, a nurse-led multidisciplinary clinic servicing a disadvantaged community in Mexico found significant improvements in care processes, indicating the potential for implementing nurse-led models of care in low- and middle-income settings [53]. There has also been good patient satisfaction with nurse-led care models [71]. Further work is required to design and evaluate expanded nursing roles in CKD care, particularly in the intersection between primary and tertiary healthcare.

Community Healthcare Workers

Community healthcare workers are community members who have received training to provide a level of healthcare services to the community [72]. Most commonly, this model of care provides services to vulnerable groups, including those in remote areas and those with limited access to nursing and medical staff [72]. Community healthcare workers and the equipping of primary care physicians are two of the more common models of CKD care in low- and middle-income countries [73]. Two randomised control studies have demonstrated an improved rate of decline in eGFR when community health workers were utilised among other integrated care strategies for patients with CKD or at high risk of CKD [54, 55].

Digital Technologies as an Enhanced Model of Care

Digital technologies have a significant potential to provide appropriate resources and clinical decision support to the primary care practitioner and can be used to facilitate patient education and management. There has been mixed success with clinical decision support software (CDSS) more broadly with high heterogeneity between interventions [74, 75]. A qualitative systematic review identified key recommendations for CDSS implementation including enhancing the clinical process, providing relevant clinical information, appropriate education and training, integration into standard workflow, and need for further research and design in multimorbidity [76].

Implementation trials of CDSS for CKD have had mixed results with outcomes ranging from low uptake with no benefit [64], to improvement in monitoring and guideline-directed care [22, 60, 62, 63]. Potentially combining interventions incorporating CDSS and practice support has greater benefit, with one study finding improvement in both guideline-directed care and an associated reduction in the annualised loss of eGFR when combining CDSS with practice facilitation compared to CDSS alone [59]. The impact of a CKD electronic medical record intervention in primary care on hospitalisations has also been tested; however, it did not show efficacy of the primary end point in reducing all cause hospitalisations at 1 year, nor the secondary end points including cardiovascular events, dialysis, and death [65]. Again, it must be noted there was a short follow-up duration of 12 months. The investigators also reviewed change in care processes in a random 10% sample and found improved care processes within the intervention group (with more patients having a problem list updated, receiving education, and using ACE inhibitor or ARB) [65]. Similarly, a study trialing an electronic medical record intervention bundle including automated electronic nephrology consultation, pharmacy review, and patient education showed improvement in care processes including time on ACE inhibitor or ARB and SGLT2 inhibitors; however, there was no difference in the primary outcome of 40% decline in eGFR or kidney failure over a median follow-up of 17 months [61, 77].

There is also an increasing number of available patient facing digital technologies and trials, including general medication tracking, kidney education, and self-management [58], an on-demand CKD digital physical rehabilitation program [66], and in more advanced CKD remote patient monitoring [78, 79]. It is important that these interventions are designed with a patient-centred approach and cater for varied health and technology literacy [80].

Overall, there continues to be rapid improvement and growth of digital technology and artificial intelligence in healthcare, with interventions aimed at both the provider and patient. This is a key ongoing area for research and development.

Integrated Care

The chronic care model conceptualised late last century provides a framework for the management of chronic conditions across the health system with a focus on integrated care, self-management, and ongoing follow-up [81, 82]. The World Health Organisation further endorsed a framework for integrated people-centred care in 2016, where care is designed around the person, rather than the disease or institution [83].

Models of integrated care have been widely adopted across levels of health services and disease groups; however, the body of evidence is challenging to generalise due to the heterogeneity of conditions and interventions. Specifically, within kidney disease, there are examples of population health improvement with integrated care models particularly among disadvantaged groups [84, 85]; however, more broadly, it is difficult to draw conclusions based on high heterogeneity, relatively short duration of follow-up, and overall low quality of evidence [67]. Nonetheless, there is a consensus that a team based integrated patient centred approach is recommended [9, 18]. Tonelli et al. [11] have provided a framework for integrated kidney care programs in low- and middle-income countries; they highlight the need for a focus on primary and secondary care which may be more cost-effective than kidney replacement therapy, while noting a need to take into consideration disease burden, resourcing, and cultural factors.

Learning from Other Chronic Conditions

There have been significant successes in the management of other chronic conditions from broader health promotion to improvements in testing, diagnosis, and management. Most markedly, there has been significant decline in cardiovascular associated deaths locally and internationally [4, 86, 87]. This has been attributed to not only improvements in available treatment options but also the implementation of risk factor control, detection, and medications [88, 89]. Similarly in diabetes, while globally there is increased prevalence and morbidity (largely driven by diabetic kidney disease) [90], within the Australian context there has been a decline in the aged standardised diabetes incidence and a relative stabilisation of prevalence from 2011 to 2021 following a significant increase from 2000 to 2011 [87]. Quality of kidney care across the domains of monitoring and management is also higher in patients with diabetes [27, 28, 91]. This is likely reflective of significant public health awareness, clinician education, and incentivisation of the diabetes cycle of care, in addition to multidisciplinary care models that include primary care physicians, diabetes nurse educators, and specialist services.

Study Design

A key learning from the reviewed studies is that a greater follow-up period is likely required to see intervention benefit of renal outcomes, particularly in relation to traditional end points of progression to kidney failure, renal death, and 50% increase in serum creatinine. This is due to the slowly progressive nature of kidney disease in addition to the time taken to implement changes in the subacute context of secondary prevention in primary care. Future research should consider using previously validated surrogate renal end points including change in eGFR slope [92] and 30% decline in albuminuria (the latter in cohorts with severely increased albuminuria and high risk for CKD progression) [93, 94].

Additionally, researchers need to consider the most appropriate research question and whether a traditional randomised clinical trial is the most appropriate design, particularly when evaluating complex interventions. Implementation science aims to address and evaluate the translation of evidence-based research into clinical practice [95]. The field draws upon multiple theoretical frameworks and methodologies to understand not only if an implementation intervention works but also the processes, enablers and barriers, intended and unintended consequences, and ultimately the feasibility, integration, and adoption into routine care [96, 97].

Future Directions

Implementation of evidence-based treatment for CKD and associated cardiovascular risk has the potential to greatly alter the trajectory of disease and associated morbidity and mortality. Current kidney disease care models have been insufficient in delivering high-standard CKD care across the disease spectrum. A proactive approach of initiating care earlier in the disease spectrum is required, prior to patients developing high and very high-risk disease or cardiovascular complications. Care needs to be comprehensive and patient-centred, yet also scalable and cost-effective. Equity is essential, and it is acknowledged that dedicated resourcing and additional strategies will be required for disadvantaged groups. Furthermore, low- and middle-income countries face significant additional challenges in the development of models of CKD care, including development of health policy [11, 12, 25], resourcing and availability of workforce [12, 98], and medication access and costs [12, 40], highlighting the need for scalable and cost-effective care models.

Future approaches should focus on improving patient and provider education, communication, and collaboration between primary and secondary services, alongside population health measures. A focus for ongoing research is alternative care models including community CKD nursing and pharmacy roles, clinical decision support systems, and integrated care approaches. Researchers need to carefully consider the most appropriate trial design for the proposed intervention, particularly for complex implementation interventions. Trial design also needs to consider appropriate duration and outcomes, including potential use of surrogate renal end points, to avoid type 1 error due to insufficient duration.

Conclusion

Addressing the global burden of CKD care requires implementation of guideline-directed care. There is a need to ensure scalable and equitable care models that improve implementation in earlier disease stages. Further research is required to understand the optimal approach.

Conflict of Interest Statement

H.W. has no conflicts of interest to disclose. M.J. is responsible for research projects that have received research funding from Boehringer Ingelheim and Eli Lilly Alliance and the University of New South Wales (UNSW). C.N. and J.O.D. have no conflicts of interest to disclose.

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Author Contributions

H.W. and C.N. contributed to the concept of the review. H.W. drafted the initial review. H.W., C.N., M.J., and J.D. contributed to the design, critical revision of the manuscript, and approved the final manuscript for submission.

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