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Management of patients with diabetes and CKD: conclusions from a “Kidney Disease: Improving Global Outcomes” (KDIGO) Controversies Conference

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The prevalence of diabetes around the world has reached epidemic proportions and is projected to increase to 642 million people by 2040. Diabetes is already the leading cause of end-stage kidney disease (ESKD) in most developed countries, and the growth in the number of people with ESKD around the world parallels the increase in diabetes. The presence of kidney disease is associated with a markedly elevated risk of cardiovascular disease and death in people with diabetes. Several new therapies and novel investigational agents targeting chronic kidney disease patients with diabetes are now under development. This conference was convened to assess our current state of knowledge regarding optimal glycemic control, current antidiabetic agents and their safety, and new therapies being developed to improve kidney function and cardiovascular outcomes for this vulnerable population.

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The prevalence of diabetes around the world is expected to reach 642 million people by 2040.¹ About 40% of people with diabetes will develop chronic kidney disease (CKD),² including a significant number who will develop end-stage kidney disease (ESKD).

Diabetes is the leading cause of ESKD in most developed countries, and has driven growth in ESKD globally over recent decades.^{3–5} There is a strong economic and health imperative to improve outcomes for people with diabetes and kidney disease.

The identification of renin-angiotensin system (RAS) blockade as an effective strategy for the prevention of ESKD in diabetes was a major step forward,^{6–8} but subsequent research has had limited success in building upon these gains. A number of promising treatments have been found to be ineffective or harmful, many of which have now been abandoned in this population.^{9–14} One common feature of these failures has been the emergence of unexpected adverse effects, highlighting the importance of safety monitoring in future trials and review of what is known about the safety of existing treatments in this patient population.

With a number of new agents under development targeting newly identified mechanistic pathways underlying

diabetic kidney disease (DKD), it is timely to reflect on what has been learned in order to better optimize both the care of affected patients as well as provide a road map for future research. Kidney Disease: Improving Global Outcomes (KDIGO) convened a Controversies Conference in Vancouver in February 2015 to bring together a multidisciplinary group of key experts from around the world to explore these issues. This report summarizes the key outcomes of this conference.

Lifestyle measures, including diet and exercise in DKD

Salt intake, obesity, and sedentary living have been linked to morbidity and mortality in multiple epidemiological studies.¹⁵ Dietary sodium restriction has been demonstrated to reduce blood pressure (BP) and albuminuria^{16–19} and enhances the effects of RAS inhibition. However, optimal dietary sodium intake in DKD remains controversial.

Other lifestyle interventions such as weight loss, and physical exercise, as well as supplementation with mono- and poly-unsaturated fats, have been shown to improve glycemic control, lower BP, reduce albuminuria, and alter high-risk biomarker profiles in the general population and are of interest in individuals with diabetes and CKD.^{20–23} In the recently completed Look AHEAD study, patients randomized to a multifactorial lifestyle approach, including dietary advice and increased exercise, demonstrated slower progression of CKD than patients in the comparator group who received support and education²⁴ but the effects on cardiovascular (CV) events and mortality were disappointing. It is hoped that there will be further follow-up of these patients to determine if the renal benefits based on lifestyle interventions are sustained.

Glycemic control

The fundamental abnormality in diabetes is abnormal glucose metabolism, and the degree of abnormality predicts development of nephropathy,²⁵ but the role of intensive glycemic control on kidney outcomes remains controversial. Trials of intensive glucose control, such as the DCCT/EDIC trial in type 1 diabetes mellitus (T1DM), were inadequately powered to address this question. However, surrogate endpoints including albuminuria, and new-onset CKD or hypertension were attenuated by intensified glycemic control and sustained for more than 20 years after the end of the randomized phase of the study.²⁶

In type 2 diabetes mellitus (T2DM), analyses from the ADVANCE trial found a >50% reduction in ESKD in the group randomized to intensive glycemic control that persisted out to 10 years.^{27–29} Event numbers were modest, and no reduction in ESKD has been reported in other trials,^{30,31} but benefits on endpoints such as albuminuria were shown. Together, these findings build on epidemiological data supporting the relationship between glycemic control and nephropathy in diabetes.^{32,33}

Additional opportunities to further define the link between glycemic control and kidney disease may be provided by ongoing studies including the follow-up of the TODAY trial, which focused on youth and adolescents with early onset T2DM who have a higher incidence of kidney disease.³⁴ Furthermore, ongoing follow-up of participants in several diabetes intervention and prevention studies of more than 10 years duration should provide additional data on the impact of glycemic control on various complications of diabetes, including kidney disease.^{35,36}

Glucose-lowering agents. The availability of a growing range of medications to manage T2DM has highlighted knowledge gaps that still have not been resolved. Metformin is an important therapy that is underutilized in patients with CKD largely because of the risk of lactic acidosis in this setting.³⁷ It may be possible to use reduced doses of metformin (≤ 1 g per day) in patients with stable impaired renal function, with a plan to discontinue therapy and seek review in the event of significant intercurrent illness.³⁷ Although the safety of this strategy has been questioned, many guidelines now suggest the use of metformin down to a glomerular filtration rate (GFR) of 30 ml/min/1.73 m².^{2, 38–41}

Preclinical and *post hoc* clinical analyses from early trials suggest that glucagon-like peptide 1 (GLP-1) receptor agonists, dipeptidyl peptidase-4 (DPP-4) inhibitors, and sodium-glucose cotransporter 2 (SGLT2) inhibitors may afford renal protection, partly independent of their glycemic effects.^{42,43} Although most trials are designed to address CV safety in order to meet the requirements of regulatory agencies, there are likely to be sufficient renal endpoints in some to determine whether these new approaches to lower glucose will confer renal benefits.

SGLT2 inhibitors are of great interest, particularly due to the marked reduction in CV mortality and renal risk as reported from the EMPA-REG OUTCOME trial, and suggested renoprotection from the CANTATA-SU trial.^{44–46} Of note, the balance of risks and benefits in people with CKD will be important to define separately, particularly as the glucose-lowering effects decline as estimated glomerular filtration rate (eGFR) falls although similar weight loss and BP reductions are observed, at least in CKD stage 3 patients. The CREDENCE trial will assess whether the SGLT2 inhibitor canagliflozin prevents ESKD in patients with T2DM and nephropathy (clinicaltrials.gov: NCT02065791).

Glucose lowering has generally been disappointing in terms of CV protection in the context of diabetes mellitus. Because kidney function is closely linked to CV events and mortality, it is hoped that analysis of data from future trials will allow assessment of whether CKD stage modifies CV protection associated with use of glucose-lowering agents. There are a number of large ongoing studies being conducted in the CKD population that will help to address this issue (clinicaltrials.gov: NCT01897532, NCT01989754).

Monitoring glycemic control in CKD. HbA1c is problematic in CKD due to reduced red cell survival time, use of erythropoietin, modifications of hemoglobin (e.g., carbamylation)⁴⁷ and mechanical destruction of red blood cells on dialysis. Thus, clinicians may often need to rely more on random or continuous home blood glucose monitoring. This is a tedious, inconvenient approach in people with CKD, who are often sick and frail.

Thus, alternatives to HbA1c have been sought. These include fructosamine, glycated albumin, and 1,5-anhydroglucitol. The results of ongoing studies are required to ascertain whether any of these alternative approaches are useful and whether they may be particularly relevant in certain stages of CKD.

Hypoglycemia. A major challenge in the management of DKD is the increased risk of hypoglycemia. In the ACCORD study, hypoglycemia in the intensively treated group was associated with an increase in mortality.⁴⁸ The authors could not demonstrate whether hypoglycemia *per se* was causative, but this issue remains a concern particularly in the CKD population, which has a higher risk of hypoglycemia and CV events and mortality. The increased risk of severe hypoglycemia in CKD⁴⁹ reflects altered insulin and drug pharmacology including metabolite accumulation, inadequate compensatory gluconeogenesis, and flattening of the relationship between mean glucose control and HbA1c. Therefore, careful individualized glycemic control targeting, medication prescription, patient education, therapeutic planning, and vigilance for hypoglycemia are all important components in the management of patients with DKD.

Data from both trials⁴⁹ and epidemiological studies⁵⁰ have demonstrated the adverse impact of the combination of hypoglycemia and CKD on mortality in T2DM. There are a limited number of glucose-lowering agents that are not associated with hypoglycemia that can be used in CKD. New trials of these agents will help to define clinical benefits in the context of a lower risk of hypoglycemia. The recently published LEADER study demonstrates the potential of these drugs to reduce CV risk in patients with T2DM, but whether such benefits extend to patients with CKD needs to be explored.⁵¹ Similarly, the EMPA-REG OUTCOME trial has demonstrated that empagliflozin, a SGLT2 inhibitor, was associated with slower progression of kidney disease and a reduction of clinically relevant renal events in patients with eGFR of at least 30 ml/min/1.73 m².⁴⁵

Other renoprotective therapies: dual RAS blockade and beyond. The benefits of RAS blockade for slowing kidney disease progression with or without diabetes is well established. Trials attempting dual RAS blockade (ONTARGET, ALTITUDE) found increased rates of adverse events (i.e., hyperkalemia, acute kidney injury [AKI]).^{12,13,52} More recently, the VA-NEPHRON-D trial¹⁰ evaluated losartan alone versus losartan and lisinopril in stage 2 to 3 DKD with

albuminuria, and was also terminated early due to hyperkalemia and AKI. Despite accumulating only 37% of the projected 739 endpoints, the hazards ratio for ESKD was 0.66 ($P = 0.07$), suggesting a potential emerging signal for renal protection. A network meta-analysis has also identified dual RAS blockade as the most promising potential therapy if it can be offered safely.⁵³ Novel therapies in sequestering potassium in the gut may mitigate the risk for hyperkalemia and permit further important clinical trials to proceed.⁵⁴ The risk for AKI may also be reduced by withholding RAS blockade during high-risk periods.

Aldosterone/mineralocorticoid inhibition may be a promising approach to test in this regard. Aldosterone blockade reduces CV mortality in patients with heart failure⁵⁵ and reduces albuminuria.^{56,57} The effectiveness of aldosterone antagonism in reducing CV and renal events in DKD is being tested with finerenone (clinicaltrials.gov: NCT02540993).⁵⁶ Potential mechanisms of action include promotion of salt and water loss, potentially improving volume and BP management, with anti-fibrotic effects demonstrated in animal studies.⁵⁸

Other potential mechanisms by which intraglomerular pressure could be reduced, independent of the RAS system, are also being assessed. For example, atrasentan has been shown to reduce albuminuria in DKD⁵⁹ and is now being tested in SONAR, a large outcome trial that will examine the effects on kidney failure using an enrichment design. This study will also help define whether a reduction in albuminuria can be used to predict clinical benefits such as slowing of progression of CKD (clinicaltrials.gov: NCT01858532). SGLT2 inhibitors may also reduce intraglomerular pressure by enhancing glomerular afferent arteriolar constriction⁶⁰ and may prevent ESKD.⁴⁵

Strategies targeting fibrosis, inflammation, and other processes in the kidney may also have clinical benefits, but are at an early stage of development.

Cardiovascular and other outcomes

Patients with diabetes and kidney disease are at high risk for cardiovascular disease (CVD)^{61–64} through both atherosclerotic and nonatherosclerotic mechanisms;⁶⁵ thus, multi-pronged strategies are required to reduce such risk. The relative contribution of traditional and nontraditional risk factors, as well as CKD complications such as mineral bone disorder, anemia, and fluid retention, to the excess CV burden in DKD at different stages of CKD requires further study.

Traditional risk factors including BP and dyslipidemia are important, and there has been progress in assessing interventions addressing these on CV outcomes in CKD. Recent KDIGO guidelines on BP⁶⁶ and lipid management⁶⁷ have recommended evidence-based treatment strategies that warrant uptake into clinical practice. These include single-agent RAS blockade and BP targets below 130/80 mm Hg in patients with diabetes and albuminuria (urinary albumin:creatinine ratio >3 mg/mmol or >30 mg/g), along with

routine treatment with fixed-dose, moderate-intensity statin with or without ezetimibe in DKD. However, the high residual CV risk in DKD highlights the unmet need for new strategies.

Volume control. The prevalence of volume overload in patients with CKD is well described.⁶⁸ There are several reasons why patients with T2DM retain salt and water, including insulin therapies, aldosterone escape on RAS blockers, potential increased activity of SGLT2 cotransporters,⁶⁹ and reduced GFR itself. However, the extent to which volume overload contributes to CVD morbidity and mortality is not well described. There are no studies that have examined intensified diuretic therapy targeted at objectively assessed volume overload, assessing harms and benefits of this strategy. The reductions in CV mortality and heart failure reported with SGLT2 inhibitors support the importance of volume control.^{46,70} Further trials of targeted interventions would be of value.

Lipid lowering. Pharmaceutically based lipid lowering has been shown to safely reduce CV events in CKD,⁷¹ and guidelines now recommend moderate-intensity therapy, with fixed dose and no additional measurements.⁶⁷ Recommended treatments incompletely mitigate excess CV risk in DKD, in which diverse lipid profiles are observed.⁷²

The role of intensified therapies aimed at abnormalities of lipoprotein(a), low high-density lipoprotein cholesterol, and high triglyceride concentrations requires further study. Novel agents such as proprotein convertase subtilisin/kexin type 9 inhibitors and perhaps cholesteryl ester transfer protein inhibitors are of interest in this regard. New studies could explore whether the risk conferred by dyslipidemias in DKD is similar to dyslipidemias in those without CKD, and characterize the response to therapy and whether that response confers the same benefit.

Antiplatelet/antithrombotic therapy. The use of antiplatelet and antithrombotic agents in patients with DKD or CKD for prevention of CVD has not been robustly studied. A *post hoc* analysis of the HOT trial indicated net benefit for prevention of CV events for aspirin in patients with CKD and high BP, but predominantly included patients with relatively mild CKD.⁷³ *Post hoc* analyses of trials of other antiplatelet agents have raised questions of whether the balance of benefit and harm is the same in patients with diabetes and/or CKD⁷⁴ and whether some agents may be more effective in CKD than others.⁷⁵ These results need to be interpreted with caution, as most participants with CKD had mild GFR reductions.

There are potential harms associated with antiplatelet/antithrombotic agents, so an improved understanding of when to use these agents, in whom, and for what duration, is critical. Given the very high rates of thrombotic and embolic events (venous and arterial), particularly in advanced CKD, use of these therapies and novel oral anticoagulants requires further evidence.

Atrial fibrillation is highly prevalent in CKD and dialysis,⁷⁶ but treatment with warfarin is likely to increase

risks of bleeding, vascular calcification, and calciphylaxis.⁷⁷ The role of both warfarin and novel oral anticoagulants (which do not need regular monitoring and may have lower complication rates) is a key research question. As the risk of bleeding in peritoneal dialysis and predialysis CKD may be less than hemodialysis, testing different anticoagulant strategies in advanced CKD, peritoneal dialysis, and hemodialysis populations should be a research priority.

An updated development path for new treatments?

The regulatory requirement for demonstrating clinical efficacy using hard endpoints, such as doubling of creatinine, ESKD, or death, in DKD has encouraged the design of large, operationally challenging clinical trials that selectively recruit patients with established DKD. Alternative strategies should be considered to complement this approach and grow the evidence base for the management of DKD.

Better identification of potentially useful treatments. The failure of many recent trials suggests that there may also be substantial variation between individuals in the molecular pathways driving disease progression and safety. Accordingly, the development of new medicines may require investigators to focus more on mechanisms operative within susceptible individuals rather than across populations.⁷⁸ This will necessitate advances in our understanding of these mechanisms and require access to kidney tissue.⁷⁹

Albuminuria and eGFR are the best currently available risk markers for DKD but have less value in early stages. GFR in early DKD is typically normal or elevated, and albuminuria frequently regresses spontaneously.^{80,81} Moreover, significant structural lesions often exist before the appearance of elevated albuminuria, so its absence does not preclude the presence of DKD.^{82–84} Alternative markers are needed to more accurately identify early disease. The development of biomarkers for later-stage DKD is equally important, but few markers have emerged as independent predictors after accounting for albuminuria and GFR.⁸⁵ Furthermore, the association may vary across different outcomes assessed (e.g., ESKD vs. death).⁸⁵

Combining morphometric evaluations of serial kidney biopsies with “-omic” studies (i.e., genomic, transcriptomic, epigenomic, proteomic, and metabolomic) in well-characterized cohorts of high-risk persons with diabetes may allow definition of mechanisms of progression and simultaneously identify markers of early structural lesions, which can be used to stratify risk of progression, and as endpoints for clinical trials. This approach may be particularly useful in T2DM, which increasingly affects young people⁸⁶ in whom it has a more aggressive course than does T1DM^{87,88} and may also be more treatment-resistant.^{34,89–91}

It should be noted that this approach also has challenges. In T1DM, histological changes are well described, typically homogenous, and predict adverse outcomes,^{92–94} but the

lesions are more heterogeneous in T2DM.^{82,95} Whether natural history varies by histologic lesion remains unknown, although longitudinal studies suggest a relationship with GFR decline.^{83,96} Nevertheless, the failure to date to provide better diagnostic and therapeutic tools for DKD suggests that bold action is needed.⁹⁷ While some may have concerns about the use of research biopsies to define DKD natural history and mechanisms, they are safe in experienced hands,^{98,99} and have been used successfully in previous studies.^{100,101}

Combining serial kidney biopsies with collection of blood and urine specimens, and perhaps other tissue specimens such as skin fibroblasts, is important. In addition, novel imaging techniques (e.g., quantifying fibrosis in the kidney)¹⁰² could be utilized and correlated with biopsy findings. By identifying important molecular pathways to disease and noninvasive markers to differentiate susceptible from nonsusceptible high-risk individuals, we may be able to target drugs more effectively and achieve the therapeutic breakthroughs that have proven so challenging.

Better trials of promising therapies. There is an urgent need to develop therapies that benefit patients earlier. An approach used successfully by regulators in the United States in the search for efficacious medicines for other major illnesses is to grant “subpart H” marketing approval for medicines with potential benefits based on assessment of surrogate endpoints. As part of this initial conditional approval, large safety and efficacy trials are mandated and must demonstrate a reduction in hard clinical endpoints to achieve final approval.

This approach may encourage adoption of therapies at an earlier stage of disease, with potential population-wide benefits. In the future, new biomarkers that reflect early hard endpoints may be identified, permitting final regulatory approval of new medicines for early DKD without the need for subpart H-type approvals.

Novel approaches to trial conduct. A common theme that needs to be addressed for CKD patients with diabetes is whether targeting levels of specific risk factors (vs. processes) through the use of intensified specific therapies (vs. multi-pronged strategies) is more effective.

To maximize efficiency, the conference attendees felt strongly that people with DKD should be randomized in multiple concurrent studies addressing important questions about the harm and benefit of several interventions. Cluster randomized approaches, rather than individual participant randomization, and other pragmatic trial designs may be more appropriate for strategy and lifestyle-type interventions (e.g., weight loss and exercise) and also to trials of new uses for existing medicines.¹⁰³

In addition, novel designs for randomized control trials widely used in other fields are starting to be applied to DKD. These include enrichment approaches or randomized trials conducted within a registry context. The latter may be particularly suitable for dialysis trials.

Safety as a key priority

Adverse drug reactions are common in CKD, reflecting pill burden, altered pharmacokinetics and pharmacodynamics, interactions with abnormal physiology, and frequently inadequate dose adjustments.

Safety is particularly important during intensification of glucose control in patients with DKD, as each glucose-lowering agent has limitations (Table 1). Other treatments also carry important risks (e.g., hypotension, dizziness, and falls when lowering BP, bleeding when using anticoagulants, and excessive sedation with sedative use in CKD). These factors not only have a direct effect on patient health and quality of life but may also impact medication adherence. Therefore, appropriate targeting, cautious prescribing, judicious dosing, and close monitoring are necessary for all therapies in patients with DKD. Given the sheer complexity of multifactorial management, optimal care is best delivered by comprehensive multidisciplinary teams targeted to individual patient needs.

There is a need for more pragmatic studies in real-world clinical practice to refine indications and identify potential modifiers of both treatment effects and safety that had been missed in clinical trials. These studies may include clinical trials performed in more relevant heterogeneous populations and/or formally evaluating safety in specific at-risk populations (e.g., studies specifically in patients with CKD). Many of the interventions in pragmatic trials could be considered complex in that there may be a number of interacting components within the experimental and control interventions, targeting a number of groups, and with a number of outcomes. The Medical Research Council has developed a framework to help researchers recognize and

Table 1 | Potential limitations of glucose-lowering agents in patients with diabetic kidney disease

Drug	Limitations
Metformin	<ul style="list-style-type: none"> Dose modification required at reduced eGFR, discontinuation at low eGFR Increased gastrointestinal side effects, hyperlactatemia, lactic acidosis
Sulphonylureas	<ul style="list-style-type: none"> Increased risk of hypoglycemia, accumulation of parent or active metabolites (with glibenclamide, glyburide, glimepiride), each require discontinuation at low eGFR
Thiazolidinediones	<ul style="list-style-type: none"> Fluid retention, increased risk of congestive heart failure
Dipeptidyl Peptidase (DPP-4) inhibitors	<ul style="list-style-type: none"> Dose modification (except linagliptin), possible heart failure
Glucagon-Like Peptide (GLP) 1 agonists	<ul style="list-style-type: none"> Discontinuation at low eGFR (exenatide), increased gastrointestinal side effects (nausea, vomiting, etc.)
Sodium Glucose coTransporter (SGLT) 2 inhibitors	<ul style="list-style-type: none"> Reduced efficacy at low eGFR, hypovolemia, interaction with loop diuretics
Insulin	<ul style="list-style-type: none"> Increased risk of hypoglycemia, prolonged insulin half-life

eGFR, estimated glomerular filtration rate.

Table 2 | Research recommendations

- Studies should examine optimal strategies for maintaining adherence to lifestyle or therapeutic interventions; a large, simple trial of reduced salt intake assessing patient-level outcomes in patients with diabetes and CKD (by degrees of CKD severity) is one such example.
- Studies should ascertain the safety of metformin in patients with CKD stage 3b and the utility of “sick day rules” for discontinuing the drug when patients become unwell.
- Studies should explore alternative approaches to the use of HbA1c as a measure for long-term glycemic control in patients with CKD and diabetes.
- With the advent of new hyperkalemia therapeutics, further studies should be conducted to ascertain safety and benefits of dual RAS blockade in patients with CKD and diabetes.
- Trials should examine the utility of increased diuretic therapy or targeted dialytic volume removal for reductions in CVD (atrial fibrillation in particular).
- Future research should elucidate the clinical benefits and mechanisms of action of SGLT2 inhibitors (glycosuric vs. natriuretic effects) in individuals with CKD and diabetes specifically with respect to cardiovascular and renoprotection.
- Studies should ascertain the extent of CVD benefits associated with use of new lipid modifying agents (e.g., PCSK9 inhibitors, CETP inhibitors) in patients with diabetes with various degrees of CKD severity; studies should also compare effects on the profile of lipid abnormalities observed in CKD or dialysis populations.
- The role and utility of antiplatelet and antithrombotic therapies should be further clarified; specifically, are benefit-risk ratios significantly different between patients with CKD and diabetes (or CKD) versus general population?; studies on NOACs in advanced CKD, HD, or PD should be undertaken to inform use.
- Multilevel “-omic” studies should be undertaken in patients with advanced CKD and diabetes to identify potential biomarkers for identifying high-risk individuals.
- Safety of antidiabetic combination therapies should be examined; ongoing large clinical trials and databases should be used to monitor for effect of severe hypoglycemia (and mild hypoglycemia) on outcomes in individuals with CKD.

CETP, cholesterylester transfer protein; CKD, chronic kidney disease; CVD, cardiovascular disease; HD, hemodialysis; NOAC, novel oral anticoagulants; PCSK9, proprotein convertase subtilisin/kexin type 9; PD, peritoneal dialysis; RAS, renin-angiotensin system; SGLT2, sodium-glucose cotransporter 2.

adopt appropriate methods for trials with complex interventions.¹⁰⁴

Another useful tool is post-marketing surveillance using electronic health records, administrative health data, or patient registries.^{105,106} Through distributed network audit and database access, large numbers and a broader range of patients could be enrolled inexpensively and rapidly in nonexperimental studies, providing a statistically powerful method to identify drug safety signals in specific at-risk populations. When conducted appropriately, observational studies with high external validity have the potential to provide useful information about real-world consequences of interventions that should augment—rather than compete—with considerations of net effects or internal validity.

Other important areas of research to reduce the risk of adverse drug reactions include point-of-care strategies that enable the use of risk stratification/prognostic tools, dedicated risk assessment and safety education programs, and the implementation of self-management

tools, such as self-monitoring and “sick day” protocols for drug discontinuation. There is also a need for more research in vulnerable populations such as young adolescents with type 2 diabetes and ethnic minorities who present many unique management issues and in whom CKD is over-represented.

Conclusion

The large and growing global burden of DKD needs urgent attention to identify novel treatment strategies to prevent progressive kidney failure and its complications. Several existing strategies are supported by evidence, and studies to ensure their appropriate implementation are urgently required. In addition, the efficacy of a number of newer therapies are currently being evaluated, while other treatments shown to be effective in the general population will also need to be studied in DKD in order to understand the balance of risks and benefits in this group. Novel approaches are required to identify potentially valuable treatments and to test the effects of these interventions. Careful consideration of the safety of these interventions is also crucial. To this end, a listing of research recommendations has been proposed to address the knowledge gaps enumerated in this report (Table 2) and help pave the way for future studies and further advance the evidence base in this area.

DISCLOSURE

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APPENDIX

Other Conference Participants

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