Screening for chronic kidney disease in Canadian indigenous peoples is cost-effective

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Canadian indigenous (First Nations) have rates of kidney failure that are 2- to 4-fold higher than the non-indigenous general Canadian population. As such, a strategy of targeted screening and treatment for CKD may be cost-effective in this population. Our objective was to assess the cost utility of screening and subsequent treatment for CKD in rural Canadian indigenous adults by both estimated glomerular filtration rate and the urine albumin-to-creatinine ratio. A decision analytic Markov model was constructed comparing the screening and treatment strategy to usual care. Primary outcomes were presented as incremental cost-effectiveness ratios (ICERs) presented as a cost per quality-adjusted life-year (QALY). Screening for CKD was associated with an ICER of $23,700/QALY in comparison to usual care. Restricting the model to screening in communities accessed only by air travel (CKD prevalence 34.4%), this ratio fell to $7,790/QALY. In road accessible communities (CKD prevalence 17.6%) the ICER was $52,480/QALY. The model was robust to changes in influential variables when tested in univariate sensitivity analyses. Probabilistic sensitivity analysis found 72% of simulations to be cost-effective at a $50,000/QALY threshold and 93% of simulations to be cost-effective at a $100,000/QALY threshold. Thus, targeted screening and treatment for CKD using point-of-care testing equipment in rural Canadian indigenous populations is cost-effective, particularly in remote air access–only communities with the highest risk of CKD and kidney failure. Evaluation of targeted screening initiatives with cluster randomized controlled trials and integration of screening into routine clinical visits in communities with the highest risk is recommended.

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Chronic kidney disease (CKD) is a worldwide public health problem with an increasing prevalence.[1] CKD is a potent, independent risk factor for several adverse health outcomes, including kidney failure, hospitalization, cardiovascular events, and early death.[2,3] Early detection, appropriate risk stratification, and subsequent treatment of CKD may delay or prevent many of its associated complications, but at increased up-front cost.[4] With the availability of reliable point-of-care quantitative blood and urine tests, it is possible to screen for CKD and to present results quickly and accurately.[5]

Mass screening for CKD in the general population is not advised,[6,7] and it offers poor value for money in low-risk populations. In contrast, targeted screening in high-risk groups, such as those with diabetes and/or hypertension, has been shown to be cost-effective.[8] Furthermore, screening is also a cost-effective strategy in certain high-risk ethnic groups, such as African Americans, where there is an elevated risk of kidney failure and its associated complications.[9]

Canadian indigenous peoples (First Nations) have rates of kidney failure that are 2- to 4-fold higher than the nonindigenous general Canadian population.[10] These rates are largely attributable to elevated rates of diabetes,[11] with over 60% of kidney failure cases attributed to diabetic nephropathy in indigenous peoples compared with 35% in the general population.[12,13] Indigenous communities in rural locations often have reduced access to primary and specialist care and therefore have reduced access to opportunistic screening and treatment for chronic conditions. As a result, patients in these communities often travel long distances or else relocate entirely to receive complex care such as dialysis, adversely impacting their quality of life.[14–17]

To date, the cost-effectiveness of mass screening for CKD in Canadian First Nations or other high-risk indigenous populations has not been assessed. Therefore, the objective of this study was to assess the cost utility of one-off, point-of-care screening and treatment for CKD using both estimated glomerular filtration rate (eGFR) and urine

albumin-to-creatinine ratio (ACR), in a rural adult Canadian indigenous population. We hypothesized that, due to a higher prevalence of albuminuria, increased rates of progression to kidney failure,[18,19] and increased costs of providing renal replacement therapy in remote communities,[20] screening- and risk-based treatment for CKD in Canadian indigenous peoples would be cost-effective.

RESULTS

Model validity

The life expectancy remaining at age 45 years was 28.96 years in the usual care arm and 29.04 years in the screening arm; at age 65 years, life expectancy was 13.43 years in the screening arm and 13.42 years in the usual care arm (Supplementary Tables S1 and S2). This latter metric represents an approximately 8-year lower life expectancy in this indigenous population than in the general Manitoba population,[21] a finding consistent with the life expectancy gap previously described in Manitoba's indigenous population.[22]

Baseline findings

Screening for CKD in rural and remote Canadian indigenous peoples was associated with an incremental cost-effectiveness ratio (ICER) of $23,700 per quality-adjusted life-year (QALY). In the usual care scenario, total costs were $12,790 and effectiveness was 12.9869 QALYs, whereas screening was associated with a cost of $13,400 and effectiveness of 13.0124 QALYs (Table 1).

Sensitivity and scenario analyses

The results of our one-way sensitivity analyses are illustrated in Figure 1 and Table 2. Primary model drivers were the baseline prevalence of any kidney damage, treatment effectiveness with respect to reduction of disease progression, the incremental costs of CKD management, treatment adherence, and the cost of dialysis. However, the model was found to be robust to univariate changes across plausible ranges of these variables. Probabilistic sensitivity analysis demonstrated that at a threshold of $50,000/QALY, approximately 72% of simulations found screening to be cost-effective (12% were dominant and <0.1% of simulations were inferior), and that at a threshold of $100,000/QALY, 93% of simulations found screening to be cost-effective (Figure 2).

In scenario analyses, extension of the benefits of treatment to those with moderately increased albuminuria (urine ACR ≥ 30 mg/g or 3 mg/mmol from baseline ≥ 300 mg/g or 30 mg/mmol) found screening to be the dominant treatment strategy when considering all communities together and those accessible only by air. When considering road access communities, screening was associated with an ICER of $9,800/QALY. Increase of home modality uptake by 25% produced an ICER of $4,240/QALY across all communities. Increasing uptake by 50% or 100% resulted in screening being the dominant treatment strategy. Results of scenario analyses are presented in Table 1.

Table 1 | Results of cost-effectiveness simulation and scenario analyses

Population	Incremental cost ($C)	Incremental QALYs	Cost/QALY (ICER)
Baseline model			
All FINISHED communities	605	0.0255	23,700
Air access communities	292	0.0375	7790
Road access communities	806	0.0154	52,480
Threshold for relative risk reduction afforded by treatment extended to patients with moderately increased albuminuria (urine ACR ≥ 3 mg/mmol)			
All FINISHED communities	−26	0.0643	Screening dominant
Air access	−620	0.0873	Screening dominant
Road access	430	0.0435	9800
Scenario analysis of increased home modality uptake			
Increase by 25%	108	0.0255	4240
Increase by 50%	−389	0.0255	Screening dominant
Increase by 100%	−1385	0.0255	Screening dominant

ACR, albumin-to-creatinine ratio; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life-year.

Comparison of road and air access communities

Due to higher assumed costs of satellite dialysis and treatment-related transportation, increased prevalence of progressive CKD, and higher levels of severely increased albuminuria, the incremental cost of screening in air access–only communities totaled $292 with an incremental effectiveness of 0.0375 QALYs (ICER $7790/QALY). Conversely, road accessible communities had lower assumed satellite dialysis costs, a lower prevalence of high-risk CKD, and lower levels of severely increased albuminuria, with a resulting incremental cost of $806 and incremental effectiveness of 0.0154 QALYs from the screening strategy (ICER $52,480/QALY) (Table 1).

DISCUSSION

In this study, we found that screening and treatment for CKD in comparison to usual care in Canadian rural indigenous is highly cost-effective (ICER $23,700/QALY). Moreover, in the most remote communities accessible only by air travel, screening was found to be even more cost-efficient (ICER $7,790/QALY). The primary model drivers of cost-effectiveness included treatment effectiveness, baseline CKD prevalence, adherence to prescribed treatment, and the incremental cost of managing CKD on case finding. Nonetheless, these drivers, when varied over a plausible range, consistently produced an ICER below or near $50,000/QALY. Together, these findings suggest that large-scale CKD screening initiatives in this high-risk population are economically justifiable.

To our knowledge, this is the first formal cost-effectiveness analysis examining the economic and health impact of a mass screening strategy for CKD in indigenous peoples. Several other studies have explored the question of mass versus opportunistic screening for CKD in a variety of different