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Abstract:

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Global Perspectives in Acute Kidney Injury: Canada

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**Introduction**

Canada is the second largest country in the world by total area (3.85 million square miles), but it is only the 39th most populated country (38 million inhabitants). Universal access to publicly funded health services is considered by many Canadians to be a fundamental value that ensures national healthcare insurance for everyone wherever they live in the country. However, since the Canada Health Act deals only with how the system is financed and not how health care is delivered, there is variation in the organization of health services between and within the 10 provinces and 3 territories. Furthermore, 30% of Canadians' healthcare is paid for through the private sector for services not covered or partially covered by the government, including prescription medications. This article describes the epidemiology of acute kidney injury (AKI) in Canada and how the healthcare system cares for patients with or at risk of AKI.

**What are some Healthcare Challenges in Canada?**

More than 8 in 10 Canadians live in cities, and more than 90% within 150 miles of the United States border. Patients who reside in rural and remote locations are often separated by large distances from dialysis centres and nephrologists. The Truth and Reconciliation Commission has highlighted Canada’s history of colonialism and policies of cultural genocide, which have contributed to striking health disparities between Indigenous and non-Indigenous populations. The greater prevalence of diabetes is one example that may increase the risks and consequences of AKI (1).

In 2017, healthcare spending in Canada reached 11.5% of Canada's gross domestic product. Canada's per-capita spending ranks seventh out of 38 countries by total health expenditure per
capita in the Organisation for Economic Co-operation and Development (OECD) (2). Canada has performed close to or above average on the majority of OECD health indicators, including indicators for wait-times and access to care. Yet, among the top 11 countries, Canada's healthcare system ranked third-to-last. Identified weaknesses included the high prevalence of chronic conditions, poor availability of after-hours care, and lack of prescription drug coverage.

What is the Epidemiology and Cost of AKI?

In a study of over 1 million adults who had serum creatinine testing in Alberta in 2008, 1.8% (0.8% of all adults) tested over one year met Kidney Disease Improving Global Outcomes (KDIGO) criteria for AKI based on a >0.3mg/dl increase in serum creatinine over two days or 50% increase over seven days (3). An additional 4.4% (1.8% of all adults) tested satisfied KDIGO criteria for acute kidney disease (AKD) based on serum creatinine changes between 7 and 90 days. One in four patients with AKI were identified during a hospitalization, while 95% of patients with AKD were identified in the outpatient or emergency department setting.

The direct healthcare costs of hospitalized patients with AKI in Alberta in 2015 in Canadian dollars (CAD; $1.00 CAD = $0.78 USD in 2015) increased with greater severity of AKI, ranging from a mean $3,779 increase for patients with stage 1 AKI to a $18,291 increase for patients with stage 3 AKI, after adjustment for patient demographics, comorbidities, hospitalization primary diagnosis, baseline estimated glomerular filtration rate and albuminuria (4). The estimated incremental cost of AKI in Canada was estimated to be over $200 million CAD.

How is AKI Prevented in High-risk Patients?
Patients at high risk of AKI are not identified in a standardized or systematic way in most of Canada. One exception is in cardiac catheterization units in Alberta, where an AKI risk model has been integrated within care for all patients receiving coronary angiography (5). In this setting, computerized clinical decision support provides point-of-care recommendations on safe contrast limits and intravenous fluid administration for AKI prevention in patients identified with a >5% risk of AKI. Invasive cardiologists then receive a quarterly report detailing their performance on contrast volume, intravenous fluid, and AKI incidence. The effectiveness of this approach is being evaluated in a cluster randomized stepped-wedge trial (ClinicalTrials.gov number NCT03453996).

**How is AKI Diagnosed?**

AKI is identified by serum creatinine testing or urine output measurement in hospitalized patients in Canada. Electronic alerts have not been systematically implemented across Canada to the extent they have been through the National Health Service in the United Kingdom. Some provincial and regional health systems have developed their own hospital e-alert systems (6), which largely remain the subject of research due to the lack of evidence that they improve clinical outcomes.

Urinalysis is used inconsistently in the diagnosis of AKI in Canada. Novel biomarkers of AKI are not broadly available in clinical settings in Canada and are not used to identify or guide interventions/care bundles in patients at high risk of AKI outside of research settings.

**What Happens Once Patients are Diagnosed with AKI?**
Some patients will initially be admitted to medical or surgical services related to the etiology of AKI (e.g., urology for obstruction), with a minority of hospitals admitting patients with primary kidney disorders (e.g., vasculitis) directly to nephrology. However, the most common model for medical or undifferentiated causes of AKI is admission to a hospitalist-run inpatient service. If nephrology consultation is required, this is usually provided in-person or via telephone if the hospital is not staffed with nephrologists. This system resembles a “hub and spoke” model, whereby patients from peripheral hospitals may require interhospital transfers to access nephrology services.

In a recent population-based study from Ontario (7), patients who received acute dialysis within 14 of admission and required hospital transfer (n=2113) for acute dialysis were compared to patients who did not require transfer (n=25,157). Transferred patients were more likely to reside in rural areas (24% versus 12%) and come from non-teaching hospitals (99% versus 59%). Reassuringly, interhospital transfer was not associated with increased mortality (HR=0.90, 95% CI 0.84-0.97) or chronic dialysis (HR=0.98, 95% CI 0.91-1.06).

**What Happens Once Patients Receive KRT?**

Patients with AKI in the ICU may be cared for under either “open” or “closed” models of care. In most major urban centres, patients with AKI in an ICU are primarily cared for by critical care physicians in a “closed” ICU, while in peripheral centres it is more common for general internists to care for patients in an “open” ICU.
The predominant model of care is for nephrologists to supervise all KRT modalities. In some hospitals, intensivists manage continuous renal replacement therapy (CRRT) or sustained low efficiency dialysis (SLED) independently without the involvement of nephrology. The Canadian-led Standard versus Accelerated Initiation of Renal-Replacement Therapy in Acute Kidney Injury (STARRT-AKI) trial required the attending intensivist and/or nephrologist to be in clinical equipoise as to whether participants should have KRT started immediately or deferred (8). Of 11,852 provisionally eligible participants, clinicians excluded 2196 (19%) participants because KRT was mandated and 5690 (48%) participants because deferral was mandated. This finding underscores the variability in opinions on when KRT initiation is indicated and suggests that collaboration and communication between specialties is essential to provide high quality care.

When the decision is made to initiate KRT in critically ill patients with AKI, CRRT is the predominant modality. Acute peritoneal dialysis (PD) is rarely performed, and some centers are also able to provide SLED in step-down units. A small number of centers only utilize SLED and do not perform CRRT for critically ill patients, including Toronto General Hospital (one of the largest transplant and cardiovascular centers worldwide). Here, a single dialysis nurse cares for two patients on SLED simultaneously, with estimated cost-savings of $200 per day relative to CRRT with citrate anticoagulation (9). Given that Canada is a single-payer and publicly funded healthcare system, the reliance on CRRT over SLED means many provinces and providers are not necessarily “choosing wisely.”

What Happens to Survivors of AKI?
Despite follow-up care with specialists being fully reimbursed, most patients do not see a nephrologist for post-AKI care. In patients with KDIGO stage 3 AKI who did not receive KRT, only 26% saw a nephrologist within 1-year of hospital discharge in Alberta, even though 87% of Canadian nephrologists surveyed indicated that they would follow-up such patients when provided with similar clinical scenarios (10). This gap is particularly concerning given that patients with more severe AKI are at increased risk of adverse events, including death, rehospitalization, CKD and cardiovascular disease (11).

These low rates of follow-up after AKI in a publicly funded healthcare system highlight the system-level barriers, including low patient/provider awareness of the consequences of AKI and competing health demands. For example, a recent Canadian trial that randomized survivors of AKI to early nephrologist follow-up or usual care did not reach its enrollment target because the in-person model of follow-up care was not acceptable to many patients, mainly due to hospitalization-related fatigue and reluctance to adding more physicians to their healthcare team (12).

**How does Canada Measure the Quality of its AKI Care?**

The provincial responsibility for healthcare in Canada means the choice of data and performance measures is made provincially rather than nationally, except for national databases managed by the Canadian Institute for Health Information. These sources include the Discharge Abstract Database, which contains information on hospital diagnoses and procedures, and the Canadian Organ Replacement Register, which records chronic dialysis modalities and transplantation activity.
Ontario (ICES Kidney, Dialysis, and Transplantation Program; ICES KDT) and Alberta (Alberta Kidney Disease Network; AKDN) have taken steps to link these healthcare data to additional provincial databases, which allows for determination of other healthcare services, including physician claims, outpatient prescription drug dispensing, and laboratory data (e.g., serum creatinine for ascertainment of AKI and CKD) (13). These data sources have been used primarily for research purposes, but ICES KDT and the AKDN are starting to work more closely with government and policy makers on structured measuring and reporting on the quality of AKI care.

**What Opportunities Exist to Improve AKI Care in Canada?**

Table 1 summarizes and contrasts several aspects of AKI care from the perspectives of Ontario and Alberta, which may not be generalizable to other provinces and territories in Canada. These differences and ongoing challenges reinforce that single-payer universal healthcare is not a solution to all problems. In particular, AKI care and outcomes are suboptimal in Indigenous people and remote areas, there have been minimal coordinated efforts to prevent AKI, and patients with AKI still experience several transitions in care (Figure 1).

Going forward, Canada needs to take advantage of its public health system, administrative data, and collaborative AKI research community. These strengths, which have identified several gaps in AKI care, now need to be translated into actionable and testable solutions that can help provide equitable care and improve outcomes for patients with AKI.
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AUTHOR CONTRIBUTIONS:

Samuel Silver: Conceptualization; Writing - original draft; Writing - review and editing.

Matthew James: Conceptualization; Writing - original draft; Writing - review and editing.

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Kidney Injury During Cardiac Catheterization: Design of a Randomized Stepped-Wedge Trial. *Can J Cardiol*, 35: 1124-1133, 2019


Table 1: Key considerations and approaches to AKI in Canada from the perspectives of Ontario and Alberta

<table>
<thead>
<tr>
<th>Domain of AKI</th>
<th>Ontario</th>
<th>Alberta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epidemiology</strong></td>
<td>--largest Indigenous population in Canada (~380,000); ~3% of provincial population  --rural population is ~14%</td>
<td>--258,640 Indigenous people; 6.5% of provincial population  --rural population is ~16%</td>
</tr>
<tr>
<td><strong>Prevention</strong></td>
<td>--no coordinated programs or electronic medical record triggers for high-risk patients</td>
<td>--AKI risk prediction and computerized decision support for prevention that is implemented at point of care in cardiac catheterization units</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>--serum creatinine and/or urine output  --biomarkers not available</td>
<td>--serum creatinine and/or urine output  --biomarkers not available</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>--hospitalists or general internists  --nephrologists available at academic centers and some large community hospitals  --single provincial health care provider (Ontario Health) and kidney care program (Ontario Renal Network)</td>
<td>--hospitalists or general internists  --nephrologists available at academic centers and some large community hospitals  --single provincial health care provider (Alberta Health Services) and kidney care program (Alberta Kidney Care – North and South)</td>
</tr>
<tr>
<td><strong>Kidney replacement therapy</strong></td>
<td>--CRRT, with a few SLED-only centers; usually managed by nephrologists, with some intensivist-led centers  --most centers that offer CRRT/SLED have chronic dialysis programs  --acute PD is very rare in adults</td>
<td>--CRRT in ICUs managed solely by intensivists  --IHD provided by nephrology programs  --no formal SLED programs  --acute PD very rare in adults</td>
</tr>
<tr>
<td><strong>Survivorship</strong></td>
<td>--no coordinated nephrology program outside of some academic settings  --most follow-up care is provided by primary care unless a patient is already under care of a nephrologist or referred</td>
<td>--no coordinated nephrology program outside of an ongoing clinical trial  --most follow-up care is provided by primary care unless a patient is already under care of a nephrologist or referred</td>
</tr>
<tr>
<td><strong>Quality assurance</strong></td>
<td>--ICES Kidney, Dialysis, Transplantation does research with administrative data  --no regular/formal reporting of AKI care/outcomes to decision-makers  --starting to work closer with Ontario Renal Network as AKI knowledge user, since they fund and coordinate kidney care in Ontario</td>
<td>--Alberta Kidney Disease Network maintains provincial laboratory and administrative health data for research  --Kidney Health Subsection of the Medicine Strategic Clinical Network, Alberta Health Services, developing formal provincial AKI reporting.  -- Kidney Health Strategic Clinical Network priority to reduce the risk of AKI through prevention, early identification, and appropriate management</td>
</tr>
</tbody>
</table>

Abbreviations: AKI=acute kidney injury; CRRT=continuous renal replacement therapy; ICU=intensive care unit; PD=peritoneal dialysis; SLED=sustained low efficient dialysis

Figure 1: Potential journeys through the Canadian healthcare system for a patient with AKI, highlighting the numerous transitions in care.
Figure 1

**Diagnosis of AKI with serum creatinine and admitted to hospital**
- MD = hospitalist/internist
- All medical services covered for hospitalized patients

**Urban Patient's Experience**
- In-person nephrology consult
  - Co-management with admission service

**Rural Patient's Experience**
- Telephone advice
  - Management by hospitalist/internist

**In-person nephrology consult**
- Co-management with admission service

**Closed ICU or hospital ward**
- KRT within hours
- Internist +/- nephrologist

**Does the patient still need KRT after hospital discharge?**
- Yes
  - Outpatient dialysis
    - Hospital close to home
- No

**Is there an indication for KRT?**
- Yes
  - Transfer to a KRT hospital
    - KRT within days
- No
  - Does the patient still need KRT after hospital discharge?
    - Yes
      - Outpatient dialysis
        - May require patient to stay in hotel to stay close to hospital
    - No

**Post-AKI care**
- 30-40% of AKI stage 3 or KRT patients have follow-up with a nephrologist
- Outpatient medications may require private insurance

**Primary care**
- Easy local access to nephrology

**Yes**