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Arna R. Emilsdottir and Ragnar Palsson

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Global Dialysis Perspective: Iceland

Arna R. Emilsdottir and Ragnar Palsson

Division of Nephrology, Landspitali–The National University Hospital of Iceland,
Faculty of Medicine, School of Health Sciences, University of Iceland, Reykjavik, Iceland.

Corresponding author:

Ragnar Palsson, MD
Division of Nephrology, Department of Medicine
Landspitali–The National University Hospital of Iceland
Hringbraut
101 Reykjavik, Iceland
Phone: (+354)-620-1528
Email: ragnarp@landspitali.is
Introduction

Iceland is an island nation located in the North Atlantic with a population of approximately 364,000 people and a total area of 103,000 km$^2$.\textsuperscript{1} It is one of the most sparsely populated countries in Europe, which can pose challenges in health care provision. Two thirds of the population live within the capital area of Reykjavik, while the remainder is dispersed widely along the coastline, as central areas of the country are largely uninhabitable.

Life expectancy in Iceland is high, 81.0 years for men and 84.2 for women.\textsuperscript{2} Iceland has a universal healthcare system which covers anyone who has been a legal resident for more than six months. Over 80% of healthcare costs are covered by the state and funded through taxes.\textsuperscript{3} In 2019, per capita gross domestic product (GDP) was 66,945 US dollars (USD) and in that year, government spending on healthcare amounted to 7.4% of Iceland’s GDP.\textsuperscript{4,5} Co-pays for primary care clinic visits, dental services, and medications account for the majority of out-of-pocket costs. Annual out-of-pocket expenses per individual are currently capped at 613 USD for medical care and at 488 USD for prescription medications, with lower thresholds set for senior citizens.

The number of practicing physicians per 1000 inhabitants in Iceland is 3.9, slightly above the mean in European Union countries of 3.6 per 1000 inhabitants.\textsuperscript{3,6} The number of adult nephrologists per 100,000 inhabitants is 2.75. To stay up to date, avoid isolation of small groups of Icelandic physicians, and ensure an adequately broad case-mix and sufficient patient volume during training, postgraduate education must be obtained abroad in most medical specialties. Icelandic nephrologists currently in practice have received their training in the Netherlands, Sweden, and the United States.

All hospitals in Iceland are run by a non-profit model within the public system. The only tertiary care hospital is Landspitali–The National University Hospital of Iceland (LUH) in Reykjavik. LUH serves as the primary teaching hospital of the University of Iceland, including its medical school, which is the only school of its kind in the country. The first hemodialysis (HD) treatment in Iceland was
performed at LUH in 1968 and to this day, all kidney replacement therapy (KRT) in Iceland has been
directed by the hospital’s nephrologists.7

KRT in Iceland

Due to the small size of the Icelandic population, the number of incident KRT patients varies
substantially from year to year. During the period from 2014-2018 the mean ± standard deviation
(SD) incidence rate was 88.4 ± 32.5 per million population (pmp).8 The mean age of incident patients
was 60.8 years during this period. Approximately a third (32%) were women. HD was the most
common initial treatment modality (68%).

The number of prevalent patients on KRT in Iceland has increased in recent years as shown in Figure
1, primarily due to the growing number of kidney transplant recipients.8 The number of prevalent
patients at the end of 2018 was 266, or 754 pmp. Glomerulonephritis was reported as the primary
cause of kidney disease in 24.4% of cases, followed by hypertension (16.2%), diabetes mellitus
(11.3%) and polycystic kidney disease (10.9%). Among prevalent patients on KRT at that time, 59
(22%) were receiving HD, 19 (7%) were on peritoneal dialysis (PD), 118 (44%) had received a kidney
transplant from a living donor and 70 (26%) had received a kidney transplant from a deceased
donor.8

Dialysis management, organization, and cost

Dialysis in Iceland is directed by nephrologists at LUH, where the vast majority of HD treatments are
also provided. At the time of writing 95 patients (261 pmp) were receiving dialysis in Iceland, of
which 79 (83%) were undergoing HD and 16 (17%) were receiving PD. Home HD treatment is not
currently offered in Iceland but to improve service to patients who live outside the capital area, four
additional small hospital-based dialysis units are currently run, one in each quarter of the country,
serving a total of only 13 individuals at this time (Figure 2). HD treatments in Iceland at all centers are administered by trained dialysis nurses rather than technicians. A multidisciplinary team at LUH which also includes a clinical pharmacologist, social worker and dietician contributes to other aspects of patients’ care. Besides nephrologists, other team members, including dialysis nurses, can complete their training in Iceland. HD patients in Reykjavík are seen at minimum twice monthly by nephrologists in the dialysis unit but frequently far more often, as a nephrologist is always present at the hospital while dialysis is ongoing to address issues that may arise. Telemedicine is utilized for virtual dialysis rounds on patients in the rural hemodialysis units who are managed in close collaboration with local nurses and physicians. In the setting of critical illness, continuous venovenous hemodiafiltration is provided in intensive care units, where temporary dialysis catheters are placed by anesthesiologists.

Among current HD patients, 56% receive their treatment through an arteriovenous fistula (AVF), 6% have an arteriovenous graft (AVG) and the remaining 38% use tunneled dialysis catheters, placed by interventional radiologists (Table 1). Despite efforts to lower the proportion of patients using catheters, only 37% of patients with end-stage kidney disease had an AVF or AVG at the time of dialysis initiation from 2016-2020. All patients undergo conventional intermittent HD rather than hemodiafiltration, generally thrice weekly. The mean (SD) HD treatment time is 233 ± 23 minutes. From January, 2014, to June, 2021, patients on HD, surviving beyond 3 months and censored in the setting of kidney transplantation, had 1- and 2-year unadjusted survival rates of 88% (95% confidence interval (CI): 80-92%) and 75% (95% CI: 65-82%), respectively.

Patients on PD are typically seen every 4-6 weeks at the PD clinic at LUH. Most receive continuous ambulatory PD, although during the period from 2012-2018 43% of patients also at least briefly tried automated PD. The peritonitis rate during this period was 0.84 episodes per person-year, which represents an area for improvement, but the most common causes for PD discontinuation were either kidney transplantation or death.
The cost of each HD treatment at LUH is currently estimated 536 USD, inclusive of dialysis medications such as erythropoiesis-stimulating agents, intravenous iron supplements and anticoagulants. Patients themselves, however, receive dialysis free of charge. Despite national coverage of dialysis costs thereby resulting in considerable government expense, there are no formal restrictions on dialysis care in Iceland based for instance on age or life-expectancy criteria. Management decisions are left entirely to nephrologists to personalize in discussion with individual patients and their families. When a decision is made not to initiate KRT or to discontinue dialysis, both inpatient and home palliative care services are available.

**Kidney transplantation**

The first kidney transplant of an Icelandic patient was performed in London in 1970. Iceland is now a member of Scandiatransplant, a multinational organ exchange organization which also includes Denmark, Finland, Sweden, Norway, and Estonia. Deceased donor transplants of Icelandic patients are still predominantly performed overseas through contracts with foreign hospitals within this collaboration, although since 2019, a portion of deceased donor kidney transplants have been performed in Iceland by local surgeons. Living donor transplants have, on the other hand, been carried out in Iceland since 2003. In effort to make decisions on organ harvesting less difficult for families and increase the donor organ pool, the legislation on organ donation in Iceland was changed in 2019 so that consent is now presumed, unless potential donors had opted out prior to their death or their families object to donation.

From 2011-2020, the mean ± SD rate of kidney transplantation was 40.1 ± 9.4 pmp per year. Approximately half (22.8 ± 5.3 pmp per year) of kidney transplant recipients during this time had living donors. The ratio of living to deceased donor kidney transplants was previously even higher and at the end of 2018, 334.5 pmp in Iceland had a functioning kidney allograft from a living donor and 198.5 pmp from a deceased donor. During the years of 2000-2014, 5- and 10-year death-
censored graft survival was 95.5% (95% CI: 92.0-99.1%) and 88.1% (95% CI: 80.4-96.5%), respectively.\textsuperscript{10}

**Future challenges**

Patients in Iceland with kidney disease have easy access to care, including KRT. Universal coverage of healthcare costs and other social support systems minimize the financial hardship of those who fall ill. While utilization of telemedicine and provision of hemodialysis in small regional dialysis units has improved care of patients with kidney failure in rural areas, many continue to have to travel long distances or move closer to these units to receive treatment. Opportunities lie in increasing use of PD and home HD, which are currently underutilized.

As a small island nation with very few practicing specialists in each field, including nephrology, which is, moreover, reliant on other countries for postgraduate training, our healthcare system is unusually fragile. For years, as an example, our ability to perform living donor kidney transplants in Iceland was dependent on the availability of a single transplant surgeon. Therefore, the maintenance of our capability to offer competitive modern medical care as its spectrum expands and complexity increases represents a continuous challenge for our healthcare system.
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Arna R Emilsdottir: Data curation; Formal analysis; Writing - original draft; Writing - review and editing
Ragnar Palsson: Conceptualization; Data curation; Formal analysis; Project administration; Supervision; Writing - original draft; Writing - review and editing
References:


### Table 1. Current Dialysis Population and Service in Iceland

<table>
<thead>
<tr>
<th>Measures/characteristic</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalent dialysis patients (N/pmp)</td>
<td>95/261</td>
</tr>
<tr>
<td>Mean age ± SD (years)</td>
<td>67.4 ± 15.9</td>
</tr>
<tr>
<td>Sex (%)</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>30.5</td>
</tr>
<tr>
<td>Men</td>
<td>69.5</td>
</tr>
<tr>
<td>Type of dialysis treatment (%)</td>
<td></td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>83</td>
</tr>
<tr>
<td>Peritoneal dialysis</td>
<td>17</td>
</tr>
<tr>
<td>Home hemodialysis</td>
<td>0</td>
</tr>
<tr>
<td>Vascular access in patients on HD (%)</td>
<td></td>
</tr>
<tr>
<td>Arteriovenous fistula</td>
<td>56</td>
</tr>
<tr>
<td>Arteriovenous graft</td>
<td>6</td>
</tr>
<tr>
<td>Central venous catheter</td>
<td>38</td>
</tr>
<tr>
<td>Primary kidney disease (%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension and vascular disease</td>
<td>31.6</td>
</tr>
<tr>
<td>Glomerular disease</td>
<td>17.9</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>14.7</td>
</tr>
<tr>
<td>Cystic kidney diseases</td>
<td>8.4</td>
</tr>
<tr>
<td>Obstructive uropathy and vesicoureteral reflux</td>
<td>5.4</td>
</tr>
<tr>
<td>Paraprotein-related kidney disease and amyloidosis</td>
<td>2.1</td>
</tr>
<tr>
<td>Other or unspecified kidney disease</td>
<td>20.0</td>
</tr>
<tr>
<td>Number of hemodialysis units</td>
<td>1 main unit with 4 remotely managed sites</td>
</tr>
<tr>
<td>Number of peritoneal dialysis clinics</td>
<td>1</td>
</tr>
<tr>
<td>Structure of dialysis units</td>
<td>All hospital-based</td>
</tr>
<tr>
<td>Staffing in dialysis units</td>
<td>Hemodialysis treatment delivered by nurses only</td>
</tr>
<tr>
<td>Minimum number of times HD patients are seen by a nephrologist</td>
<td>Twice monthly</td>
</tr>
<tr>
<td>Nurse : patient ratio</td>
<td>Usually 1:3, rarely 1:2</td>
</tr>
<tr>
<td>Mean (± SD) duration of HD sessions (minutes)</td>
<td>223 ± 23</td>
</tr>
<tr>
<td>Capacity of primary dialysis unit</td>
<td>Up to 18 patients per shift, with 2</td>
</tr>
<tr>
<td>Type of HD provided</td>
<td>Conventional intermittent HD, CVVHDF when required in the setting of critical illness</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cost of one intermittent HD session (USD)</td>
<td>536 USD</td>
</tr>
<tr>
<td>Funding</td>
<td>Public, universal healthcare system</td>
</tr>
<tr>
<td>Out-of-pocket cost</td>
<td>Dialysis is free of charge to patients. See text for annual caps on cost for other medical care and prescription medications</td>
</tr>
<tr>
<td>Economic model of HD units</td>
<td>Nonprofit</td>
</tr>
</tbody>
</table>

*HD, hemodialysis; PD peritoneal dialysis; CVVHDF, continuous veno-venous hemodiafiltration; pmp, per million population; SD, standard deviation; USD, United States dollar.*
**Figure Legends**

**Figure 1.** Prevalent kidney replacement therapy patients per million population (pmp) in Iceland from 2001-2018. The median (interquartile range) proportion of dialysis patients treated with PD during this time was 25% (20-32%). *HD, hemodialysis; PD, peritoneal dialysis.*

**Figure 2.** A map of Iceland showing the location of hemodialysis units. All kidney replacement therapy is directed by nephrologists at Landspitali–The National University Hospital of Iceland, which is located in the capital of Reykjavik (blue star). 4 rural dialysis units currently offer service to small numbers of local patients in different quarters of the country (red triangles). *Km, kilometers.*
Figure 1

![Graph showing prevalent patients, pmp across different years. The bars represent different categories: HD, PD, and Transplant.](image-url)