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 km² (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, whereas 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 (2). Iceland has a universal health care system, which covers anyone who has been a legal resident for >6 months. Over 80% of health care costs are covered by the state and funded through taxes (3). In 2019, per capita gross domestic product was 66,945 United States dollars (USD), and in that year, government spending on health care amounted to 7.4% of Iceland’s gross domestic product (4,5). Copays 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 3.6/1000 inhabitants (3,6). The number of adult nephrologists per 1,000,000 inhabitants is 2.75. To stay up to date, avoid isolation (3,6). The number of adult nephrologists per 1,000,000 inhabitants is 2.75. To stay up to date, avoid isolation (3,6). The number of adult nephrologists per 1,000,000 inhabitants is 2.75. To stay up to date, avoid isolation (3,6). The number of adult nephrologists per 1,000,000 inhabitants is 2.75. To stay up to date, avoid isolation (3,6).

KRT in Iceland
Because of the small size of the Icelandic population, the number of incident KRT patients varies substantially from year to year. During the period from 2014 to 2018, the mean ± SD incidence rate was 88.4±32.5 per million population (pmp) per year (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% of patients, followed by hypertension (16%), diabetes mellitus (11%), and polycystic kidney disease (11%). 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, a social worker, and a dietician,
Figure 1. Prevalent patients on KRT per million population (pmp) in Iceland from 2001 to 2018 (8). The median (interquartile range) proportion of patients on dialysis treated with peritoneal dialysis (PD) during this time was 25% (20%–32%). HD, hemodialysis.

Figure 2. A map of Iceland showing the location of hemodialysis units. All KRT is directed by nephrologists at Landspítali—The National University Hospital of Iceland, which is located in the capital of Reykjavík (blue star). Four rural dialysis units currently offer service to small numbers of local patients in different quarters of the country (red triangles).
contributes to other aspects of patients’ care. Other than nephrologists, other team members, including dialysis nurses, can complete their training in Iceland. Patients on HD 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 HD units who are managed in close collaboration with local nurses and physicians. In the setting of critical illness, continuous venovenous hemofiltration is provided in intensive care units, where temporary dialysis catheters are placed by anesthesiologists.

Among current patients on HD, 56% receive their treatment through an arteriovenous fistula, 6% have an arteriovenous graft, 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 ESKD had an arteriovenous fistula or arteriovenous graft at the time of dialysis initiation from 2016 to 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% to 92%) and 75% (95% CI, 65% to 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 to 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.

### Table 1. Current dialysis population and service in Iceland

| Measures/Characteristic | Values |
|-------------------------|--------|
| Prevalent dialysis patients, N/pmp | 95/261 |
| Mean age ± SD, yr | 67.4±15.9 |
| Sex, % | | |
| Women | 30.5 |
| Men | 69.5 |
| Type of dialysis treatment, % | | |
| Hemodialysis | 83 |
| Peritoneal dialysis | 17 |
| Home hemodialysis | 0 |
| Vascular access in patients on hemodialysis, % | | |
| Arteriovenous fistula | 56 |
| Arteriovenous graft | 6 |
| Central venous catheter | 38 |
| Primary kidney disease, % | | |
| Hypertension and vascular disease | 31.6 |
| Glomerular disease | 17.9 |
| Diabetes mellitus | 14.7 |
| Cystic kidney diseases | 8.4 |
| Obstructive uropathy and vesicoureteral reflux | 5.4 |
| Paraprotein-related kidney disease and amyloidosis | 2.1 |
| Other or unspecified kidney disease | 20.0 |
| No. of hemodialysis units | 1 main unit with 4 remotely managed sites |
| No. of peritoneal dialysis clinics | 1 |
| Structure of dialysis units | All hospital based |
| Staffing in dialysis units | Hemodialysis treatment delivered by nurses only |
| Minimum no. of times patients on hemodialysis are seen by a nephrologist | Twice monthly |
| Nurse-patient ratio | Usually 1:3, rarely 1:2 |
| Mean ± SD duration of hemodialysis sessions, min | 223±23 |
| Capacity of primary dialysis unit | Up to 18 patients per shift, with 2 shifts per day on weekdays and 1 shift per day on weekends |
| Type of hemodialysis provided | Conventional intermittent hemodialysis, CVVHDF when required in the setting of critical illness |
| Cost of one intermittent hemodialysis session, USD | 536 |
| Funding | Public, universal health care system |
| Out-of-pocket cost | Dialysis is free of charge to patients; the text has annual caps on cost for other medical care and prescription medications |
| Economic model of hemodialysis units | Nonprofit |

pmp, per million population; yr, years; min, minutes; CVVHDF, continuous venovenous hemodiafiltration; USD, United States dollar.
The cost of each HD treatment at LUH is currently estimated at 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 on the basis of, for instance, 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 (7). Iceland is now a member of Scandiatransplant, a multinational organ exchange organization that 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 an 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 to 2020, the mean±SD rate of kidney transplantation was 40.1±9.4 pmp/yr (9). Approximately half (22.8±5.3 pmp/yr) of kidney transplant recipients during this time had living donors. The ratio of living to deceased donor kidney transplants was previously even higher; at the end of the 1990s, 544.5 pmp in Iceland had a functioning kidney allograft from a living donor, and 198.5 pmp had one from a deceased donor. During the years of 2000–2014, 5- and 10-year death-censored graft survival rates were 96% (95% CI, 92% to 99%) and 88% (95% CI, 80% to 97%), respectively (10).

Future Challenges

Patients in Iceland with kidney disease have easy access to care, including KRT. Universal coverage of health care costs and other social support systems minimize the financial hardship of those who fall ill. Although utilization of telemedicine and provision of HD in small regional dialysis units have 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, that is, moreover, reliant on other countries for postgraduate training, our health care 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 health care system.

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Author Contributions

R. Palsson conceptualized the study; A.R. Emilsdottir and R. Palsson were responsible for data curation; A.R. Emilsdottir and R. Palsson were responsible for formal analysis; R. Palsson was responsible for project administration; R. Palsson provided supervision; A.R. Emilsdottir and R. Palsson wrote the original draft; and A.R. Emilsdottir and R. Palsson reviewed and edited the manuscript.

References

1. Statistics Iceland: Population by urban nuclei, sex and age January 1, 2001-2021, 2021. Available at: https://px.hagstofa.is/pxin/pixel/web/en/luaur/luaur_mannfjoldi_2_bygdir/mayo/ Byggdakjarar/MANO30101.pxp. Accessed March 29, 2021
2. Statistics Iceland: Life expectancy and number of survivors 1971-2021, 2021. Available at: https://px.hagstofa.is/pxin/pixel/web/en/luaur/luaur_Faerdirandar_danir_danir/ MANO5401.pxp. Accessed March 29, 2021
3. OECD/European Observatory on Health Systems and Policies: Iceland: Country Health Profile 2019. State of Health in the EU, Brussels, Belgium, OECD Publishing, Paris/European Observatory on Health Systems and Policies, 2019
4. The World Bank Group: GDP by capita, 2019. Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD. Accessed March 29, 2021
5. Statistics Iceland: Health expenditure, 2021. Available at: https://www.statice.is/statistics/economy/public-finance/health-expenditure/. Accessed March 29, 2021
6. The Directorate of Health: Health officials and auxiliary personnel 1981–2020, 2020. Available at: https://www.landlaeknir.is/servlet/let/filestore/93/item4303/TB6.1_2012_ juni2013_HBS.xls. Accessed April 1, 2021
7. Asmundsson P, Palsson R: Treatment of end-stage renal disease in Iceland 1968–1997. Laeknabladid 85: 9–24, 1999
8. Annual Reports - ERA-EDTA Registry: ERA-EDTA Registry, 2020. Available at: https://www.era-edta.org/en/registry/publications/annual-reports. Accessed March 29, 2021
9. Ericzon B-G, Jorgensen KA, Weinreich ID: Scandiatransplant: Annual report 2020, 2020. Available at: http://www.scandiatransplant.org/resources/AnnualScandiatransplantdatareport2020.pdf. Accessed March 29, 2021
10. Palsson TP, Andresdottir MB, Jonsson E, Indridason OS, Palsson R, Jonsson J: Kidney Transplantation in Iceland: Patient and Allograft Survival. Poster presented at the University of Iceland’s 18th Annual Biomedical Research Conference, Reykjavik, Iceland, January 3, 2017. Available at: https://www.laeknabladid.is/media/2017-fylgirit-91/pdf—loka-utgafa.pdf. Accessed March 29, 2021

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