Cost analysis of establishing dialysis facilities for the treatment of chronic renal failure in Greenland

Christian Kronborg, Trine Kjær, Mickael Bech

University of Southern Denmark, Institute of Public Health, Health Economics Research Unit, Odense, Denmark

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ABSTRACT

Objectives. At present there are no facilities offering treatment for chronic renal failure with dialysis in Greenland. Patients in need of treatment must go to Denmark. It has been proposed that treatment facilities should be established at Dronning Ingrids Hospital in Nuuk, Greenland. The objective of this study is to explore the costs of such an alternative compared with the situation today.

Methods. The costs of establishing dialysis facilities in Nuuk, Greenland, and providing dialysis for Greenlandic patients were compared with the costs of the current way of managing dialysis for Greenlandic patients in need of treatment. Data for the study were collected from publicly available statistics, from Dronning Ingrids Hospital in Nuuk and from Rigshospitalet in Copenhagen.

Results. The actual number of patients in dialysis was found to be lower than expected. Based on Danish prevalence statistics, it was expected that about 27 persons in Greenland would be in dialysis each year. Over a time horizon of 10 years, the additional costs of establishing and offering dialysis treatment in Nuuk were expected to amount to an average of 1.4 million Danish kroner (€190,000) per year compared with the current treatment costs. Results were sensitive to the demand for dialysis treatment among people in need of treatment. If all patients in need of dialysis were treated, the additional costs of establishing dialysis facilities and providing treatment in Nuuk were estimated to about 7 million Danish Kroner (€930,000) per year compared with the status quo.

Conclusions. Changes in the demand for dialysis treatment may influence the cost of establishing treatment facilities in Nuuk.

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Keywords: cost-benefit analysis, cost analysis, haemodialysis, peritoneal dialysis, Greenland

ORIGINAL ARTICLE
INTRODUCTION

The geography of Greenland and its very small population (around 57,000 inhabitants) are a challenge to organizing a modern and efficient health care system. One of the many challenges is to organize the treatment of illnesses with low incidence and prevalence that nevertheless require substantial investments in medical equipment and the hiring of specialists. For a number of such illnesses, patients are treated at hospitals outside Greenland, requiring that patients travel to another country or sometimes even leave Greenland permanently for the treatment of certain chronic conditions. This paper reports on a study of the treatment of renal failure for which there is currently no treatment facilities in Greenland. Recently, members of the Greenlandic Parliament requested an assessment of the possibility of establishing nephrology facilities in Greenland, with the intention of treating most cases of renal failure in the country.

The objective of this study was to analyse the costs of establishing nephrology facilities for patients with chronic renal failure offering dialysis treatment in Greenland compared with the current situation where patients are treated and live permanently in Denmark. This study is based on the assumptions of a preliminary but unfinished analysis of whether nephrology facilities could be established in Nuuk, Greenland. This paper will not go into the clinical details involved in establishing such a facility.

Currently, patients that undergo haemodialysis must move permanently to Denmark for treatment. Patients in peritoneal dialysis can stay in Greenland, but have to travel to Denmark regularly for check-ups. In terms of survival rates, the 2 forms of dialysis can be regarded as equally good (1).

Establishing outpatient dialysis facilities in Greenland for patients with chronic renal failure might cause more patients in need of dialysis to demand and undergo treatment than is currently the case. First, access to examination and treatment might be easier if medical specialists were located in Greenland. Second, the personal costs incurred by patients might be reduced. The result of more patients demanding treatment would increase the costs incurred by the Greenlandic health care system. However, some of these additional costs would be offset by savings from offering treatment in Greenland so patients do not need to travel to Denmark.

In a cost-benefit framework, the additional costs should be compared to the social benefit that might come from offering treatment in Greenland. The social benefits of establishing nephrology facilities in Greenland would include improvements in the quality of life of patients in need of dialysis. Furthermore, patients in need of treatment who would demand dialysis if it were provided in Greenland but who do not demand treatment under the current circumstances would benefit from an increased life expectancy and improved quality of life. Additionally, the society as a whole would benefit from having the certainty of access to treatment in emergency situations. That is, individuals with altruistic preferences would find it valuable that treatment was available even though they did not expect to use it themselves either immediately or in the future.
MATERIAL AND METHODS

In this study we compared the overall costs to the Greenlandic health care system from 2 alternative ways of organizing dialysis treatment for patients suffering from chronic kidney failure: relying on the status quo that reflected the current organization and establishing new dialysis facilities in Greenland.

Information from Statistics Greenland on projections of the Greenlandic population together with information from the Danish Society of Nephrology on the incidence and prevalence of renal failure in Denmark was used to estimate the expected number of chronic renal failure patients in Greenland in need of dialysis treatment over a time period of 10 years, 2006–2015.

In order to estimate the costs of establishing dialysis facilities in Greenland, we assumed that such a unit would be established at Dronning Ingrids Hospital (DIH, Queen Ingrid’s Hospital) in Nuuk as an independent hospital ward. This was in line with suggestions from a group of experts appointed by the health authorities in Greenland to address the question of managing chronic renal failure in the population. Even though the unit would include the possibility for managing renal conditions in general, this study included only the costs of haemodialysis and peritoneal dialysis at the DIH facilities. Furthermore, it was assumed that the unit would need 350 square meters of floor space at the hospital for 12 dialysis stations, changing rooms, offices, and other appurtenant facilities. Furthermore, it was assumed that the unit would need to be staffed by 1 full-time specialist consultant in nephrology, 4 full-time equivalent nurses specializing in nephrology, one-fifth full-time equivalent nurse, 1 full-time equivalent interpreter, one half full-time equivalent medical secretary and one-quarter full-time equivalent dietician. Depending on the ability to recruit a consultant in nephrology, this function would be handled in cooperation with Rigshospitalet in Copenhagen.

In the status quo situation, it is assumed that patients would be treated as they are today. That is, surgical procedures, dialysis and check-up visits would take place at Rigshospitalet. In the alternative situation, with the establishment of a unit in Greenland, we assume that patients would undergo the initial surgical procedure at Rigshospitalet and that dialysis and check-up visits thereafter would take place at DIH.
Cost estimation

All costs were estimated from the perspective of the Greenlandic health care system (including direct costs of treatment as well as patient transport costs) and are reported in 2007 values in Danish kroner (DKK; €1=DKK 7.5). Productivity gains and changes in social benefits were not included.

The construction costs at the hospital were estimated as amounting to DKK 25,000 per square meter. Based on information from producers of dialysis machines, it was estimated that 1 unit would cost DKK 130,000. The lifetime of one dialysis unit was taken to be 10 years. Furthermore, it was assumed that the operating costs (i.e., electricity, heating and water) and maintenance of apparatus and buildings would amount to 3% of their initial costs. Salaries, including pension and other salary allowances, were used to estimate the staff costs.

The cost of surgery for implantation of the catheter in the patient’s abdomen was based on the relevant diagnosis related group (DRG) charges from the Danish National Board of Health (2). This charge was the same for haemodialysis and peritoneal dialysis patients. The charge included surgery and a hospital stay of up to 14 days (being hospitalized on average for 5 days). It was assumed that the training of patients in peritoneal dialysis would take place during this hospitalization.

The cost of haemodialysis at Rigshospitalet was based on the charges agreed upon between the Ministry of Health in Greenland and Rigshospitalet, which amount to DKK 2,243 per session and which was regarded as a full-cost estimate. In contrast, the costs of haemodialysis at the new unit at DIH were divided into the capital cost of the dialysis unit and the variable costs of dialysis fluids, utensils and disinfections. For the initial analyses, the latter were taken as DKK 500 per session. In sensitivity analyses, we examined the ways in which the variable costs affected the overall results.

The costs of peritoneal dialysis were estimated to amount to DKK 550 per day. It was assumed that patients in peritoneal dialysis would have 4 check-up visits annually. We

Table 1. Unit costs in Danish kroner (DKK). 1 DKK=0.13 EUR and 0.18 $ (November 25, 2010).

| Unit costs | Range used in sensitivity analyses | Source and comments |
|------------|-----------------------------------|---------------------|
| Construction costs at Dronning Ingrid Hospital in Nuuk | 8.75 million - 17.5 million | The National Board of Health, DkDRG 1122. |
| Price per dialysis machine | 130,000 | Wage administration |
| Specialist in nephrology | 711,540 per year | Annual salary for full-time employment |
| Nurse specializing in nephrology | 393,003 per year | |
| Nurse | 336,969 per year | |
| Medical secretary | 236,853 per year | |
| Interpreter | 202,614 per year | |
| Dietician | 292,041 per year | |
| Surgery, catheter | 29,950 per patient | |
| Hemodialysis at Rigshospitalet | 2,243 per session | Rigshospitalet |
| Check-up visit at Rigshospitalet | 1,315 per visit | Rigshospitalet |
| Greenlandic Patient Home in Copenhagen | 890 per day | Rigshospitalet |
| Patient Hotel, Nuuk | 890 per day | Assumption |
| Transport, Greenland-Denmark | 8,000-16,000 | Air Greenland |
| Transport, return ticket Greenland-Denmark | 15,000-30,000 | |
| Air transport in Greenland, return ticket | 6,000-12,000 | |
used the outpatient charges agreed on with the Ministry of Health in Greenland for visits to Rigshospitalet, whereas it was assumed that the cost of check-up visits at the new nephrology unit at DIH would be covered by the general costs of the personnel of the unit.

It was assumed that patients would live at the Greenlandic Patient Home in Copenhagen during short stays in Denmark for ambulatory treatment at Rigshospitalet. We used the charge of DKK 890 per day for staying there. We also assumed that patients in haemodialysis at Rigshospitalet staying permanently in Denmark would live at the Greenlandic Patient Home. For patients in peritoneal dialysis, we assumed that each stay would last 5 days.

If a nephrology unit was established at DIH, a patient from outside Nuuk would need a place to stay when going there for check-up visits. We assumed that patients would stay at the hospital’s patient hotel and that the cost would be DKK 890 per day. For patients in peritoneal dialysis, we made the same assumption as above that patients from outside Nuuk would stay at the patient hotel for 5 days. Furthermore, we assumed that one-third of the patients in both haemodialysis and peritoneal dialysis would be living outside Nuuk at the time of the incidence of the kidney failure.

In addition to the treatment costs above, we also included transportation costs between Greenland and Denmark as well as transportation within Greenland. Air transport was assumed to be by normal scheduled flights. We used information on fares from Air Greenland.

We estimated annual costs as well as total costs over the entire time horizon of 10 years. Total costs were estimated at current values using discount rates of both 3% and 6% per year (3).

Sensitivity analyses
To analyse the effects of changes in these assumptions, we performed a number of sensitivity analyses. Furthermore, we analysed consequences of changes in demand due to changes in access to treatment from having established dialysis facilities in Nuuk.

RESULTS

According to the Ministry of Health in Greenland, there were a total of 5 patients in peritoneal and 3 in haemodialysis dialysis in March 2007. These figures are rather low compared with equivalent figures from Denmark. In 2005, the Danish Society of Nephrology had 2,636 patients registered as being in dialysis in a population of 5.4 million in Denmark (4,5). As of 1 January 2006, the Greenlandic population was 56,901 (6). On the basis of the Danish prevalence statistics, it was to be expected that 27 persons in Greenland would have been in dialysis in that year.

Figure 1 shows the prognosis for the growth of the Greenlandic population until 2015, and the number of people expected to be in need of dialysis based on prevalence estimates from Denmark. However, the Danish and the Greenlandic populations differ. The proportion of persons older than 60 years of age in Denmark made up 22% of the entire population in 2007 (7). In Greenland, persons aged 60 years or older make up 10% of the population (6). In 2015, it is expected that one-quarter of the Danish population will consist of people aged 60 years or older, whereas in Greenland, 12% are expected to be 60 years or older (7,8).
The incidence of chronic kidney failure treated by dialysis in Denmark has increased from 69 persons per million per year in 1991 to 138 persons per million per year in 2001 (4). The average incidence rate in Denmark from 1991 to 2006 was 127 persons per million per year. Applying these estimates to Greenland, it was expected that between 4 and 8 people in Greenland would start dialysis treatment each year. In the cost analysis below, we use the average Danish incidence rate, which gives an estimate of 7 new patients in dialysis treatment each year.

Table II shows the costs of treating patients with chronic kidney failure by dialysis within the first year of establishing a nephrology unit at DIH. For comparison, Table II also shows the cost of treating the same group of patients under the status quo. The cost of the first year would be around DKK 17 million for treatment at DIH, whereas status quo treatment would cost DKK 5.4 million.

The figures for the status quo situation were estimated under the assumption that the prevalence of chronic kidney failure and the demand for treatment by dialysis remain at their present levels. Over this time horizon, the costs of establishing a nephrology unit at DIH would total DKK 82.8 million, whereas the costs would amount to DKK 68.9 million (undiscounted) if the status quo was retained. Thus, the costs of establishing dialysis in Nuuk would involve an additional cost of DKK 13.9 million compared with the status quo over a 10-year period. The present values of this extra cost are DKK 13.9 million and DKK 13.8 million calculated with discount rates of 3% and 6%, respectively. Thus, over a time horizon of 10 years, the additional costs of establishing and offering dialysis in Nuuk would be expected to amount to an average of DKK 1.4 million per year compared with the status quo.

![Figure 1. Prognosis of population size (right axis) and the expected prevalence of persons in need of dialysis (left axis) 2006–2015.](image-url)
As stated above, these figures were estimated based on keeping both the prevalence and demand fixed. In the following section, we present a number of sensitivity analyses where these restrictions were relaxed.

Figure 2 shows the average annual additional cost of dialysis treatment at DIH compared with the status quo. The current number of patients in treatment is lower than what we would expect and, in the base case, we assumed that 40% of the number of people currently in need of dialysis were actually treated. In this analysis, it was assumed that the demand under the status quo situation would also change. If demand among patients in need of dialysis increased, Figure 2 shows that dialysis at DIH would provide a cost saving compared with the status quo if more than 60% of the people in need of dialysis assumed to exist actually demanded the treatment.

Table II. Cost of dialysis in the first year of the establishment of a nephrology unit at Dronning Ingrid Hospital in Nuuk compared with the status quo. The values represent Danish kroner (DKK).

|                      | Dronning Ingrid Hospital | Status Quo |
|----------------------|--------------------------|------------|
| Construction of facilities at DIH | 8,750,000               | 0          |
| Purchase of dialysis machines | 1,803,500               | 0          |
| Maintenance of buildings   | 262,500                  | 0          |
| Maintenance of dialysis machines | 46,800                 | 0          |
| Staff                   | 3,082,000                | 0          |
| Surgery                 | 75,600                   | 75,600     |
| Dialysis – variable costs |                         |            |
| Hemodialysis            | 1,926,200                | 4,150,700  |
| Peritonealdialysis      | 930,100                  | 912,700    |
| Transport               | 98,900                   | 286,200    |
| Total                   | 16,975,600               | 5,425,200  |

Table III. Annual costs of treating patients with chronic kidney failure by dialysis in Greenland and in Denmark (undiscounted). The values represent Million Danish kroner (DKK).

| Year | Dronning Ingrid Hospital | Status Quo |
|------|--------------------------|------------|
| 1    | 17.0                     | 5.7        |
| 2    | 6.6                      | 6.0        |
| 3    | 6.7                      | 6.3        |
| 4    | 6.9                      | 6.7        |
| 5    | 7.1                      | 7.0        |
| 6    | 7.3                      | 7.4        |
| 7    | 7.5                      | 7.7        |
| 8    | 7.7                      | 8.1        |
| 9    | 7.9                      | 8.5        |
| 10   | 8.1                      | 8.5        |
| Total| 82.8                     | 68.9       |

Figure 2. Average additional annual cost of dialysis treatment at Dronning Ingrid Hospital compared with the status quo, with varying percentages of the estimated number of people in need of dialysis actually demanding treatment. Notes: Demand was assumed to be equal under the 2 alternatives that were studied. Costs are given in current values estimated with discount rates of 0%, 3% and 6% per year.
Figure 3. Average additional annual cost of dialysis treatment at Dronning Ingrid Hospital compared with the status quo, with varying percentages of the estimated number of people in need of dialysis actually demanding treatment.

Notes: Demand is assumed to be constant under the status quo situation, but to change with dialysis available at DIH. Costs are given in current values estimated with discount rates of 0%, 3% and 6% per year.

Table IV. Sensitivity analyses: total costs of the 2 alternatives, difference in costs, and average additional annual costs of dialysis treatment at Dronning Ingrid Hospital in Nuuk compared with the status quo. Danish kroner (discount rate 3% per year).

| Dronning Ingrid Hospital | Status quo | Difference | Average additional annual cost |
|--------------------------|------------|------------|-------------------------------|
| Base case                | 73,648,850 | 59,787,667 | 13,861,183                    | 1,386,118 |
| Construction costs doubled | 84,705,204 | 59,787,667 | 24,917,537                    | 2,491,754 |
| Cost of dialysis fluids for haemodialysis at DIH doubled | 78,322,084 | 59,787,667 | 18,534,417                    | 1,853,442 |
| Cost of dialysis fluids for peritoneal dialysis doubled | 83,100,842 | 68,380,387 | 14,720,455                    | 1,472,046 |
| Cost of dialysis fluids for haemodialysis and peritoneal dialysis doubled | 87,774,075 | 68,380,387 | 19,393,689                    | 1,939,369 |
| DIH Patient hotel costs, DKK 1500 per day | 85,625,957 | 59,787,667 | 25,838,290                    | 2,583,829 |
| Proportion of patients living in Nuuk, 50% | 69,301,339 | 59,787,667 | 9,513,672                     | 951,367  |
| Proportion of patients living in Nuuk, 1/3 | 64,953,828 | 59,787,667 | 5,166,161                     | 516,616  |
| Air transport cost doubled | 73,922,876 | 62,886,697 | 11,036,180                    | 1,103,618 |
| Staff costs increased by 50% | 87,188,093 | 59,787,667 | 27,400,426                    | 2,740,043 |
Figure 3 shows the average annual additional cost of dialysis treatment at DIH if demand under the present-day situation (the status quo) remained at its present level, whereas dialysis at DIH caused demand to increase. If demand increased so that everyone in need of dialysis actually demanded treatment if it was offered at DIH, whereas demand remained unchanged under the status quo provision, then the extra costs would be expected to reach close to DKK 7 million per year.

Table IV shows the results of a number of sensitivity analyses where we changed single parameters such as the construction costs at DIH, costs of dialysis fluids, transport costs and the proportion of patients assumed to be living in Nuuk. The average additional annual cost of establishing and offering dialysis treatment in Nuuk as compared with the status quo situation ranges between DKK 500,000 and DKK 2.5 million.

**DISCUSSION**

At present, it is estimated that about 40% of the actual number of people in need of dialysis treatment are in fact receiving such treatment. This factor creates the greatest challenge for the estimation of the additional costs of establishing dialysis facilities at DIH, since it is not known how prevalence and demand will change in the future. That is, demand may remain unchanged, or it may increase as a consequence of better access to treatment and increased awareness of illnesses that create a need for dialysis.

In a cost-benefit framework, the additional cost of an average DKK 1.4 million per year if dialysis facilities are established in Nuuk, Greenland, should be compared to the benefits created. In another study, the societal benefit of having the possibility to offer treatment in Nuuk has been estimated at DKK 6.4 million per year (9). That is, the societal benefits are expected to be higher than the costs to the Greenlandic health care system to establish and offer dialysis treatment in Nuuk.

A major limitation of this study is that we do not have exact figures for several parameters for the estimation of the costs of the 2 alternatives, for example, for the prevalence of chronic renal failure treated by dialysis in the Greenlandic population and for unit costs. Consequently, we have carried out several sensitivity analyses to analyse the effects of changes in the most significant parameters that indicated some uncertainty in the estimated costs. The most influential factor on the costs of establishing dialysis facilities is how the demand for dialysis would be affected if facilities become available in Nuuk. That is, while currently there may be individuals in Greenland who are in need of dialysis but do not demand such treatment, this could change if dialysis facilities were to become available.

In conclusion, the present study provides information that can inform a preliminary economic evaluation of the costs involved in establishing dialysis treatment facilities in Greenland. Although caution should be taken in the interpretation of our results, given the uncertainty surrounding the estimates, this study does provide valuable inputs into the decision-making process on the organization and delivery of public health care services in Greenland.
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Christian Kronborg
University of Southern Denmark, Institute of Public Health
Health Economics Research Unit
J.B. Winsløws Vej 9
5000 Odense C
DENMARK
E-mail: cka@sam.sdu.dk

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