

Prevalence and direct medical costs of end-stage renal disease in patients with type 2 diabetes mellitus in Switzerland for 2001

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Summary

Background: The prevalence of end-stage renal disease (ESRD) in patients with type 2 diabetes mellitus (type 2 DM) has increased in recent decades throughout the world. In most industrialised countries, diabetic nephropathy in type 2 diabetics is the most frequent cause of ESRD.

Aims: The prevalence and direct medical costs for the insurance funds in Switzerland were determined for ESRD in patients with type 2 DM.

Methods: Prevalence was determined on the basis of a written retrospective cross-sectional analysis covering all centres for dialysis and transplantation in Switzerland. Costs were calculated separately for the three different therapeutic options for ESRD – haemodialysis, peritoneal dialysis and renal transplantation. Costs were calculated on the basis of the percentage of the patients in this cross-sectional study who received each of these treatments. Cost data from the Swiss Union for the Social Duties of the Insurance Funds (SVK) were used for all three treatments. SVK data were not available for some phases of transplantation, and

for these phases the consumption of health resources was determined by interviewing experts on the telephone, using a questionnaire.

Results: The cross-sectional study in the dialysis and transplantation centres was based on full collection of data. In Switzerland in the year 2001, the prevalence of ESRD in patients with type 2 DM came to 73.0 per million inhabitants. The direct medical costs of this complication came to a total of CHF 46,065,788 (0.1% of the total health expenditure). This corresponds to CHF 1570 per 100,000 inhabitants per day. 81.6% of these costs are for haemodialysis, 7.1% for peritoneal dialysis and 11.4% for renal transplantation. ESRD costs are CHF 215 per patient per day.

Conclusions: The prevalence of ESRD in patients with type 2 DM in Switzerland was 73.0 per million inhabitants in 2001. The costs of this avoidable late complication are considerable.

Key words: diabetes; nephropathy; Switzerland; end-stage renal disease

Introduction

Diabetic nephropathy in type 2 diabetes mellitus (DM) is a frequent and serious late complication which can in principle be avoided. Diabetic nephropathy is the most frequent cause of end-stage renal disease (ESRD) today in the USA, Japan and in most industrialised countries in Europe [1]. The significance of diabetic nephropathy in type 2 DM was neglected for a long time as it used to be thought that the risk of renal complications was much lower in type 2 than in type 1 diabetes [2]. However, there is now an abundance of evidence that the risk of nephropathy with progression to ESRD is similar in the two groups [3]. About 30 to 40% of all diabetics develop diabetic nephropathy [4].

The incidence and prevalence of patients with type 2 DM as underlying disease has increased in recent decades. For example, the incidence of ESRD in diabetics in the USA increased from 29.2 cases per million inhabitants in 1984 to 107.0 cases per million in 1994. The corresponding figures for Japan were 23.4 and 66.0 respectively, and 52.0 for Southwest Germany for 1994. The proportion of patients suffering from newly diagnosed ESRD for whom the cause was thought to be diabetes was 27.0% for the USA and 11.0% for Europe in 1982. The corresponding figures for 1992 had risen to 36.3% for the USA and 17.0% for Europe [5]. The proportion of patients with ESRD thought to be due to diabetes in the USA is now as high as about

40%. The reasons for this enormous increase are the increased prevalence of type 2 DM from hyperalimentation, a low physical activity, the increase in the age of the population, neglect of preventive health care, and, especially, the increase in the life expectancy of type 2 diabetics, which is largely due to progress in cardiovascular medicine.

Diabetic nephropathy is also important because of its economic consequences [6, 7]. Caro et al. have estimated that the costs of the complications of type 2 DM are US \$ 47,240 per patient over a period of 30 years. The management of the macrovascular complications make up 52% of these costs. This is the most important cost component. Nephropathy accounts for 21% of the costs, neuropathy for 17% and retinopathy for 10% [7].

There have been only a few studies and data on the epidemiology and costs of DM and its complications in Switzerland [8–11]. These studies determined the prevalence, the consumption of health resources and the direct medical costs of DM and its complications.

Our research group has analysed the medical records of patients with type 2 DM taken by 3100 suppliers of basic medical health care in Switzerland for the years 1998 and 1999. According to this

study, 27.8% of type 2 diabetics suffered from diabetic nephropathy, including microalbuminuria and proteinuria. We determined that the direct medical costs for type 2 DM and its complications in 1998 were CHF 750 million, which corresponds to 1.9% of the overall health expenditure [12]. We also found in a population-based study that there was a strong and significant association between the costs and the presence of diabetic complications. Thus, the annual treatment costs for type 2 diabetics with diabetic nephropathy were on average CHF 2237 higher than for type 2 diabetics without diabetic nephropathy. Information from other countries about the costs of diabetic nephropathy in ESRD in type 2 DM is rare and cannot be transferred *a priori* to Switzerland, because of profound differences in the health systems [13, 14].

Formulation of the questions

1. How high is the prevalence of ESRD in patients with type 2 DM in Switzerland?
2. What are the direct medical costs of ESRD in patients with type 2 DM in Switzerland from the third party payer perspective or health insurance funds?

Methods

We performed a cross-sectional study in all dialysis and transplantation centres in Switzerland for the year 2001, with the help of a questionnaire. The study population was formed by all patients with ESRD. In the dialysis centres, the study covered all patients enrolled in the “chronic dialysis programme” on the fixed date of 31 December 2001 (point prevalence). In the transplantation centres, the study covered all patients in the centre with renal transplantation as a consequence of ESRD during the period between 1 January 2001 and 31 December 2001 (period prevalence). The periods for data collection were fixed in such a way that multiple recording of data from a single patient was avoided if at all possible.

Recruitment of dialysis centres

Structure of questionnaire for dialysis centres (including pre-test)

To achieve a high participation rate, the questionnaire was restricted to a single A4 sheet, with versions in German and French. It was then tested in one dialysis centre each in German-speaking and French-speaking Switzerland. The variables in the questionnaire were the different types of dialysis. Classification of the diabetes as type 2 was left to the director of the centre.

Structure of questionnaire for transplantation centres (including pre-test)

The variables in the questionnaire were the various types of kidney transplantation, including renal transplantation from deceased donor, renal transplantation from living donor, combined transplantation of kidney and pancreas, or of kidney and islets of Langerhans. The questions covered the number of patients for each type of transplantation and the number among these with type 2 DM.

Determination of the direct medical costs for the health insurance funds of ESRD in patients with type 2 DM

Only the ESRD-specific costs were determined. The perspective was that of the statutory health insurance funds. The calculations covered three types of therapy in the year 2001:

1. costs of haemodialysis (centre for haemodialysis – full care and self-care);
2. costs of peritoneal dialysis (continuous out-patient peritoneal dialysis = CAPD and cyclical continuous peritoneal dialysis = CCPD);
3. costs of renal transplantation (deceased donor and living donor).

Calculations of the costs of haemodialysis for type 2 diabetics

For this purpose the number of patients with type 2 DM with haemodialysis in the centre was multiplied by the costs of centre haemodialysis per person and year, which were obtained from the SVK. This is composed of an average annual sum for haemodialysis in the centre plus the average annual sum for erythropoietin therapy. The average annual sum for haemodialysis in the centre was calculated as follows: The average number of dialyses per year (13 dialyses per month × 12 months) was multiplied by the SVK flat rate for haemodialysis in the centre (full care) [15]. The SVK flat rate contains the costs for personnel, laboratory and material and is CHF 497 [15, 16]. The average annual sum for erythropoietin was calculated based on the SVK indications concerning the consumption of erythropoietin (units Recormon® and Eporex®), the tariff of erythropoietin and the number of patients with dialysis for the year 2001 [17].

Calculations of the costs of peritoneal dialysis for type 2 diabetics

The calculation was analogous to that for haemodialysis. The average annual contribution for peritoneal dialysis was composed of three components – an average sum for the control of peritoneal dialysis in the centre, a flat rate for the six monthly follow-up visit of the peritoneal dialysis patients (which is somewhat more extensive) and an average sum for the material provided by the suppliers to the patients. The sum for the follow-up visit of peritoneal dialysis in the centre was calculated by multiplying the average number of visits per year (12 follow-up visits of peritoneal dialysis in the centre) by the SVK flat rate for the peritoneal dialysis in the centre [18]. The SVK flat rate contains the costs for personnel, laboratory and material and is CHF 364 [18].

Calculations of the costs of renal transplantation for type 2 diabetics

Only the following two types of renal transplantations are relevant for type 2 diabetic patients: 1. Renal transplantation from a deceased donor, 2. Renal transplantation from a living donor. For the calculation of the costs, a distinction must be made between: 2a. Renal transplantation with living donor and out-patient investigation; 2b. Renal transplantation with living donor and in-patient investigation. In the year 2001, the recipients of the transplants were almost exclusively investigated as out-patients.

Calculation of the costs for the actual transplantation (insertion of organ)

For the two types of renal transplantations relevant to type 2 diabetics, there is a current SVK flat rate for transplantation (organ insertion) which applies to the insurance funds. This is CHF 29,250 from a living donor and CHF 33,700 from a deceased donor [19]. There is no current flat rate for investigations or for follow-up treatment or controls of the recipient or living donor, so that the expenditure of health resources for these purposes had to be ascertained by interviewing experts. As experts we consulted the senior physicians in five of the six transplantation centres in Switzerland (the university hospitals of Geneva, Lausanne, Zurich, Basle and St. Gallen). The answers were then used as a basis for calculating the costs of these phases.

Determination of the consumption of resources

The following components were analysed for all phases of the renal transplantation (recipient: investigation and follow-up treatment; living donor; investigation, removal of organ, follow-up) and were used to determine the consumption of health resources:

- Out-patient consultations and procedures
- Number of days in hospital for in-patients
- Follow-up treatment of recipients: The consumption of health resources is expected to be very different in the first year after the operation than in later years, so that the consumption of health resources was investigated separately for these two different periods. Complications were only recorded for the first post-operative year [20].
- Laboratory: the laboratory studies which were most clearly listed (service spectrum, type and number of analyses, percentage of patients with these analyses).
- Immunosuppressive therapy
- Complications: Medical and surgical complications relevant to the costs and which occur at least 7 days after discharge from hospital after the transplantation. The questionnaire did not cover complications that occurred within 7 days of discharge from hospital and complications which developed immediately

after the period in hospital (which is usual for transplantation) and complications which increased the period in hospital. The reason for this is that these complications are already covered by the SVK flat rate for renal transplantation and are therefore no longer relevant to the expenditure of the health insurance funds [19, 21].

- Investigation of living donors: A distinction was made between pre-screening and investigation in the centre.
- Follow-up of the living donor. The expenditure of health resources was only determined for the first year after the transplantation.

Calculation of the costs for the different phases of the two types of renal transplantations relevant to type 2 DM patients (deceased donor and living donor)

The overall calculation of the costs assumes that both the recipient and the living donor were covered by general insurance. The specific direct medical costs for the different phases of renal transplantation with either deceased or living donor were calculated for each centre separately.

Out-patient services

The costs of each service were calculated by multiplying the quantity or number of this service by its price per unit and the percentage of patients who received the service. The price per unit was based on TARMED, Version 1.1. [22]. The calculations were based on the tax point value of CHF 1 [23]. The legally deductible costs for the recipient were CHF 830 for all out-patient services per calendar year. This deduction assumes that the recipient has minimum legal deductible costs of CHF 230 and a patient's contribution of 10%, which can rise to a maximum of CHF 600 per calendar year, and that these have been fully exhausted [24]. These deductions have been made for the recipient and not for the donor, as the recipient or his insurance covers the costs for the donor.

In-patient services

The costs for hospitalisation were calculated by multiplying the number of days in hospital by the daily flat rate of the hospital department in question (if the department has an additional case flat rate, this is added) and by the percentage of patients who were hospitalised. The calculations are based on the tariff (daily flat rate or process-service-tariff [PST]) for a cantonal patient with general insurance (Canton of Zurich) [25]. The tariff of the university hospital of Zurich was chosen because Zurich is a large transplantation centre, and it would have been too complicated to consider all the different tariff-systems in Switzerland. The PST consists of a daily flat rate with an additional case flat rate depending on the hospital department. The flat rates used are as follows: daily hospital flat rate for internal medicine: CHF 790; process-service-tariff: daily hospital flat rate for internal surgery: CHF 184 and hospital case flat rate for internal surgery: CHF 2740.

Drug costs (out-patients)

The public price in the speciality list for 2001 is authorized by the health insurance funds and was used as the basis for calculating the tariffs [26]. The pharmacist has granted a cost stabilisation contribution of 3.2% on the speciality list price to the health insurance funds and this is deducted. It was assumed that the drugs were sold from a conventional pharmacy and that the service-orientated compensation (LOA) was paid to the pharmacist [27]. In accordance with the LOA, the charges for 2001 are:

- Pharmacist charge of CHF 4.20 per prescribed drug per purchase

- Patient charge of CHF 7.35 per patient per pharmacist per doctor per 3 months (maximally 4 per year)

Laboratory (out-patients)

The cost of this service was calculated by multiplying the price per unit by the percentage of the patients who received the service. The price per unit was based on the tariff in the 2001 analysis list [28].

Calculation of the costs of renal transplantation in type 2 diabetics

The costs were calculated separately for the two types of transplantations, which are relevant to renal transplantation – from live, and from deceased donors. The costs for ESRD in type 2 diabetics in 2001 included not only the costs from patients receiving transplantations in 2001, but also the costs from the patients who had received transplantations in previous years.

Costs in 2001 from patients receiving transplantations in 2001

The number of patients receiving transplants was multiplied by the cost per transplantation. The costs for deceased donor are already included in the SVK flat rate. The costs for follow-up treatment during the recipient's first post-operative year and for the follow-up of the first postoperative year for the donor were calculated in full, based on the assumption that all transplantations were performed on 1 January 2001.

Costs in 2001 from patients receiving transplantations before 2001

The costs per renal transplantation were again calculated separately for living and deceased donors. For both types of renal transplantation, the number of transplant recipients before 2001 who were still living in 2001 was multiplied by the costs of a further year of postoperative treatment. For the recipients from living donors, the number of recipients of transplants from living donors before 2001 was additionally multiplied by the costs for a further postoperative follow-up year for the life donor and the result added to the previous sum. This then also covered the costs connected with the living donor.

The number of patients who received transplants before 2001 and who were still living in 2001 must be determined not by using the survival time of the transplant, but the survival time of a type 2 diabetic after renal transplantation. The median survival time of a transplanted type 2 diabetic is 17.5 years for a living donor and 11.9 years for a deceased donor [29]. The number of patients who had received a transplant before 2001 and were still alive in 2001 was calculated separately for the two types of donors in the following manner: The 10-year survival curve of the OPELZ Register (Europe 1990–2000) for type 2 diabetics after renal transplantation was extrapolated for the years 1980 to 2000 in order to determine the percentage of transplant recipients who were still alive in 2001. This percentage was then multiplied by the total number of type 2 diabetic patients who had received renal transplants in the years in question (1980–2000). The calculation of the number of living donors who donated a kidney before 2001 and were still alive in 2001 was performed

in the same way as for the recipients. This calculation started with the year 1980, as no figures for earlier years were available from SWISSTRANSPLANT [30]. As the average life expectancy of living donors is 25 years, it was assumed that all living donors from 1980 onwards were still alive.

The average life expectancy of living donors was calculated as follows: average age of a living donor at the time of the transplantation: 50 years [31]; life expectancy of a man at the age of 50, which corresponds to the age-class 1951: 23.2 years and life expectancy of a woman at the age of 50, which corresponds to the age-class 1951: 26 years [32]; living donors: 66% women, 34% men [31]. Average life expectancy of a living donor at the time of transplantation: $0.34 \times 23.2 + 0.66 \times 26 = 25$ years.

Calculation of the daily costs of ESRD per type 2 diabetic patient

For this purpose, the percentages of type 2 diabetics receiving the three types of treatments (haemodialysis, peritoneal dialysis and transplantation) were multiplied by the daily costs of these treatments and then added (weighted mean). The daily costs for renal transplantation were calculated as follows: The daily costs for the two relevant types of renal transplantations (living donor and deceased donor) were calculated separately for each centre. The percentage of these two types of transplantations was then used to calculate the overall daily rate for the treatment of renal transplantation (weighted mean). The costs of renal transplantation included investigation, transplantation, one year follow-up in the first postoperative year and several further years of follow-up, for both donor and recipient. The factor (number of years) for calculating follow-up treatment for a further post-operative year was calculated on the basis of the median survival time of type 2 diabetic who had received a renal transplant, not with the survival time of the transplant, as type 2 diabetics usually die with functioning transplants. This means that after transplantation from a deceased donor 10.9 years of follow-up treatment must be added and that after transplantation from a living donor 16.5 years must be added [29]. The same number of postoperative years of follow-up controls was calculated for the living donor as for the recipient, as the health insurance normally only pays for the costs of the living donor during the lifetime of the recipient. After this, the costs are covered by the living donor register. The costs for the two types of transplantations were then calculated for each centre, using the phases listed above. Finally, an average value (main value) was calculated from the daily costs for all six centres and upper and lower limits (daily costs of the most expensive and cheapest centres). The daily costs for renal transplantation (deceased donor) and renal transplantation (living donor) were then weighted in accordance with the percentages determined in the cross-sectional study, thus allowing the calculation of the overall daily costs of renal transplantation. To allow international comparison, the daily costs of ESRD are given not only in CHF, but also in € and US \$. The following rates of exchange were used for this purpose (29 June 2001): 1 Dollar = 1.7910 CHF and 1 Euro = 1.5197 CHF.

Results

Prevalence of ESRD and prevalence of ESRD in patients with type 2 DM in Switzerland in 2001

Full data collection was achieved in both the dialysis centres and in the transplantation centres. Sixty-five out of the 68 dialysis centres were included in the evaluation. All of the 6 transplantation centres were included in the analysis.

Results of the dialysis centres

Table 1 gives a summary for 2001 for all patients with ESRD in dialysis centres in Switzerland, their type of treatment and their classification to type 2 DM. The cross-sectional study gave a total of 2382 patients with ESRD in 2001 and 504 of these were classified as suffering from type 2 DM. Twelve patients with ESRD were in the De-

partments of Paediatrics; 4 of these were treated with haemodialysis in the centre and 8 with cyclical continuous peritoneal dialysis. None of the ESRD patients in the Departments of Paediatrics were suffering from type 2 DM, as this condition almost only occurs in adults.

Transplantation centres

Table 2 shows the total of patients with ESRD of all 6 transplantation centres in Switzerland for the year 2001, the percentage of patients with ESRD and type 2 DM and the mode of treatment. In patients with type 2 DM only renal transplantation with deceased donor or living donor are relevant. The combined renal pancreas transplantation and the transplantation of kidney plus islets of Langerhans are not carried through in type 2 diabetics.

Dialysis and transplantation centres

The cross-sectional study in the dialysis and transplantation centres in Switzerland recorded a total of 2628 patients with ESRD in Switzerland in 2001. This corresponds to a total prevalence of ESRD in Switzerland of 364.8 per million inhabitants in 2001; 2382 (90.6%) of these patients were dialysed and 246 (9.4%) underwent transplantation. (Numbers include Departments of Paediatrics) (Table 3) [33]. Eighty percent of the patients were treated by haemodialysis, which is therefore quite clearly the most important mode of treatment.

For the year 2001, we found a total of 526 patients with ESRD and type 2 DM; 504 (95.8%) of these patients were dialysed and 22 (4.2%) were transplanted. Table 4 shows the total of patients with ESRD and type 2 DM, their classification into the three modes of treatments – haemodialysis, peritoneal dialysis and transplantation – and their prevalence per million inhabitants in the year 2001. Eighty-five percent of the patients were treated by haemodialysis, which is therefore quite clearly the most important of the three modes of treatments.

Table 1

Dialysis centres in Switzerland: total ESRD, percentage of ESRD with type 2 DM and mode of therapy (assessed on 31 December 2001).

Total ESRD dialysis centres in Switzerland:	2,382	21.2%
percentage with type 2 DM	504	
Total ESRD with dialysis in the centre:	2,063 ¹	21.8%
percentage with type 2 DM	449	
Total ESRD with home haemodialysis:	29	0.0%
percentage with type 2 DM	0	
Total ESRD with CAPD ² :	189	22.2%
percentage with type 2 DM	42	
Total ESRD with CCPD ³ :	101 ⁴	12.9%
percentage with type 2 DM	13	

¹ Excluding Departments of Paediatrics: 2059

² Continuous out-patient peritoneal dialysis

³ Cyclical continuous peritoneal dialysis

⁴ Excluding Departments of Paediatrics: 93

Table 2

Transplantation centres in Switzerland: total ESRD, percentage of ESRD with type 2 DM and mode of treatment (assessed between 1 January 2001 and 31 December 2001).

Total ESRD transplantation centres in Switzerland:	246	8.9%
proportion with type 2 DM	22	
Total ESRD with renal transplantation (deceased donor):	153	11.1%
proportion with type 2 DM	17	
Total ESRD with renal transplantation (living donor):	77	6.5%
proportion with type 2 DM	5	
Total ESRD with combined renal pancreas transplantation:	12	0.0%
proportion with type 2 DM	0	
Total ESRD with transplantation of kidney plus islets of Langerhans (without retransplantation):	4	0.0%
proportion with type 2 DM	0	

Table 3

Total ESRD (dialysis and transplantation centres); classification into the three modes of therapies (absolute and in %) and prevalence.

	including Departments of Paediatrics	excluding Departments of Paediatrics	prevalence ¹
Total ESRD in dialysis centres (total dialysed)	2382 (90.6%)	2370 (90.6%)	330.7
Haemodialysis (centre and home dialysis)	2092 (79.6%)	2088 (79.8%)	290.4
Peritoneal dialysis (CAPD ² and CCPD ³)	290 (11.0%)	282 (10.8%)	40.3
Total ESRD in transplantation centres (total renal transplantations)	246 (9.4%)	246 (9.4%)	34.2
Total ESRD in dialysis and transplantation centres	2628	2616	364.8

¹ Per million inhabitants in 2001 (numbers include Departments of Paediatrics)

² Continuous out-patient peritoneal dialysis

³ Cyclical continuous peritoneal dialysis

Table 4

Total ESRD in type 2 DM (dialysis and transplantation centres); classification into the three modes of therapies (absolute and in %) and prevalence.

	ESRD-DM type 2 (absolute and in %)	prevalence ¹
Total ESRD-DM type 2 in dialysis centres (total dialysed)	504 (95.8%)	70.0
Haemodialysis ² (centre Haemodialysis, full care und limited care)	449 (85.4%)	62.3
Peritoneal dialysis (CAPD ³ and CCPD ⁴)	55 (10.5%)	7.6
Total ESRD-DM type 2 in transplantation centres (total transplantations)	22 (4.2%)	3.1
Total ESRD-DM type 2 in dialysis and transplantation centres	526	73.0

¹ Per million inhabitants in 2001 (numbers include Departments of Paediatrics)

² The cross-sectional study found no case of ESRD in type 2 DM with home dialysis, so that haemodialysis only includes centre dialysis (full care und limited care).

³ Continuous out-patient peritoneal dialysis

⁴ Cyclical continuous peritoneal dialysis

Table 5

Percentage of ESRD in type 2 DM in ESRD patients.

	including Departments of Paediatrics	excluding Departments of Paediatrics
Total ESRD	2.628	2.616
Total ESRD-DM type 2	526	526
Percentage of ESRD in type 2 DM in total ESRD in %	20.0	20.1

Table 6

Costs resulting in 2001 from transplantations performed in 2001.

Centres	number of transplantations	costs per transplantation (CHF)	costs per centre (CHF)
Basle	6	56,578	339,468
Berne	4	77,096	308,384
Geneva	2	77,097	154,194
Lausanne	3	84,709	254,127
St. Gall	0	83,863	0
Zurich	2	83,232	166,464
Total costs for all centres		1,222,637	

The prevalence of ESRD in patients with type 2 DM in Switzerland in 2001 was 73.0 per million inhabitants, assuming a resident population of 7,204,100 at the end of 2000. If the prevalence calculations include the 223 recipients who were given transplants before 2001 and were still living in 2001 (195 with deceased donor and 28 with living donor), this gives an alternative value for the prevalence of ESRD in patients with type 2 DM of 104.0 per million, for the inhabitants of Switzerland in 2001. Table 5 gives the percentage of type 2 diabetics with ESRD in the overall figures for ESRD.

Direct medical costs of ESRD in patients with type 2 DM in Switzerland from the perspective of the health insurance funds

Costs of therapy with haemodialysis (centre haemodialysis) of type 2 DM in 2001

The calculated costs per patient are as follows:

- For the average annual sum of the SVK for centre dialysis (full care + self care): CHF 77,532. Whereby 497 CHF: SVK flat rate for haemodialysis, full care, per service.
- For the average annual sum for erythropoietin therapy: CHF 6151. This gives a total of CHF

83,683 per haemodialysis patient per year. As mentioned above, all haemodialysed type 2 diabetics were dialysed in the centre. The total costs of treatment of the 449 type 2 diabetics with haemodialysis in 2001 came to CHF 40 million.

Costs of therapy with peritoneal dialysis of type 2 diabetics in 2001

The calculated costs per patient are as follows:

- For the average annual sum of the SVK for peritoneal dialysis (CAPD and APD = CCPD): CHF 56,220
- Including 12 × CHF 364: SVK flat rate for the control of peritoneal dialysis in the centre, per control
- Including 2 × CHF 926: SVK flat rate for 6 monthly control of peritoneal dialysis in the centre, per control
- Including CHF 50,000: average annual costs for material and equipment [34].
- Including the average annual sum for erythropoietin treatment: CHF 2829.

The total costs of treatment of type 2 diabetics with peritoneal dialysis in 2001 came to at least CHF 3.24 million. This makes CHF 59,049 per person and year (n = 55).

Table 7

Costs resulting in 2001 (recipient and donor) from transplantations in 2001.

Centres	numbers of transplantations	costs per transplantation (CHF)	costs per centre (CHF)
Basle	2	60,097	120,194
Berne	1	76,439	76,439
Geneva	1	80,718	80,718
Lausanne	0	90,389	0
St. Gallen	0	88,503	0
Zurich	1	88,387	88,387
Total costs for all centres		365,738	

Table 8

Total direct medical costs of ESRD in patients with type 2 DM in Switzerland in 2001 (total and subdivided according to type of therapy).

Costs of haemodialysis (CHF)	37,573,667
Costs of peritoneal dialysis (CHF)	3,247,695
Costs of transplantation (CHF)	5,244,426 (3,024,423 – 6,199,878)
Total (CHF)	46,065,788 (43,845,785 – 47,021,240)

Table 9

Daily costs of ESRD in type 2 DM per patient.

	costs per patient per day (CHF)	percentage of modes of therapy (%)*
(Centre) haemodialysis	229	85.4
Peritoneal dialysis	162	10.5
Transplantation	58 (32–67)	4.2
Daily costs for ESRD in type 2 DM (CHF)	215	

* Because of rounding the sum may not add to 100%

Costs of therapy with renal transplantation of type 2 diabetics

Renal transplantation (deceased Donor): The costs for renal transplantation (deceased donor) of type 2 diabetics in 2001 were composed of the costs resulting in 2001 from transplantations performed in 2001 [see a)] and the costs resulting in 2001 from transplantations performed before 2001 [see b)]. This comes to a total of CHF 4,418,102.

a) Costs resulting in 2001 from transplantations performed in 2001: These costs came in all to CHF 1,222,637 (see Table 6).

b) Costs resulting in 2001 from transplantations performed before 2001: 195 patients underwent renal transplantation from a deceased donor. A cost of CHF 16,387 was calculated for one year of “follow-up in further postoperative years”, giving a total of CHF 3,195,465. Final total of [a) and b)] for renal transplantation from deceased donor: CHF 4,418,102.

Renal transplantation (living donor): The costs for renal transplantation (living donor) of type 2 diabetics in 2001 was composed of the costs resulting in 2001 from transplantations performed in 2001 [see a) below] and the costs resulting in 2001 from transplantations performed before 2001 [see b) below]. This comes to a total of CHF 826,324.

a) Renal transplantation (living donors): costs resulting in 2001 (recipient and donor) from transplantations performed in 2001: These costs came to CHF 365,738 (Table 7).

b) Renal transplantation (living donors): costs resulting in 2001 (recipient and donor) from transplantations performed before 2001.

28 patients received a renal transplantation from a living donor. The costs of CHF 16,387 were calculated for one year “follow-up treatment in further years”, giving a total of CHF 458,836. CHF 50 was calculated as the cost for one year of “follow-up treatment of a further post-operative year” for each of the 35 living donors, giving a total of CHF 1750. Final total [a) and b)] renal transplantation from living donor: CHF 826,324.

Total medical costs of ESRD in patients with type 2 DM in Switzerland in 2001 from the perspective of the health insurance funds

The direct medical costs of ESRD in the 526 patients with type 2 DM in 2001 came to CHF 46,065,788 or CHF 87,578 per patient. The therapy of centre dialysis was the cause of 81.6% of the costs. Peritoneal dialysis caused 7.1% of the costs and renal transplantation 11.4% of the costs (Table 8).

Differences between the limiting values and the weighted mean (main value)

The lower limit differed from the weighted mean by 4.8%; the upper limit differed from the weighted mean by 2.1%.

Share in total health expenditure

The proportion of the direct medical costs of ESRD in patients with type 2 DM in Switzerland in 2001 to the total health expenditure for 2001 (CHF 46,065,788) gives a value of 0.1% [35].

Daily costs of ESRD in type 2 DM per patient

The erythropoietin costs were included in the calculations for haemodialysis and peritoneal dialysis. The daily costs for renal transplantation

(deceased donor) came to CHF 59 (CHF 33–68) and the percentage of the transplantations to type 2 diabetics was 77.3% (17 of 22). The daily costs of renal transplantation (living donor) were CHF 54 (CHF 30–64) and the percentage of the transplantations to type 2 diabetics was 22.7% (5 of 22). The daily costs for renal transplantation (both types) were then on average CHF 58 (CHF 32–67). The treatment of ESRD in type 2 DM costs CHF 215 or € 142 or US \$ 120, per day per patient (Table 9).

Discussion

We identified a total of 2628 patients with ESRD in Switzerland in 2001, corresponding to a prevalence of 364.8 per million inhabitants. We identified a total of 526 patients with ESRD and type 2 DM, corresponding to a prevalence of ESRD in patients with type 2 DM of 73.0 per million inhabitants. 20.0% of patients with ESRD were therefore type 2 diabetics. 449 (85.4%) of the 526 patients were treated by haemodialysis, 55 (10.5%) by peritoneal dialysis and 22 (4.2%) by transplantation. The direct medical costs of ESRD in the 526 patients with type 2 DM in 2001 came to CHF 46,065,788. The haemodialysis in a dialysis centre was the cause of 81.6% of the costs. Peritoneal dialysis caused 7.1% of the costs and renal transplantation 11.4% of the costs.

Comments on the epidemiology methods

Aggregated data

If individual data rather than aggregated data had been determined it would have prevented duplicate registration of individuals with ESRD and also made it possible to check the diagnosis of type 2 DM. On the other hand, it would have necessitated considerably more effort and made the study less practicable.

Prevalence

The prevalence of ESRD in patients with type 2 DM is given as a period prevalence for 2001, which was determined from the point prevalence in the dialysis centres and the period prevalence in the transplantation centres. This is defensible, as it can be assumed that the point prevalence and the period prevalence are not very different for a chronic disease such as ESRD. In addition, the questions in the dialysis centres were deliberately not directed towards the dialyses being performed on this given day, but the number of patients in the "chronic dialysis programme" on this given day. This procedure was designed to prevent almost all multiple registrations of ESRD patients.

The cross-sectional study was based on the assumption that all persons with ESRD were in treatment at the time of data collection, i.e. either as a registered patient in a dialysis centre or as a transplant recipient in a transplantation centre. It

was therefore assumed that all patients were covered by the total data collection. This may lead to a small underestimation of ESRD in patients with type 2 DM. In summary, a slight underestimation of the prevalence of ESRD by selection bias may be expected.

In addition to the above assumption, the prevalence of ESRD in patients with type 2 DM is influenced by two other circumstances. One is that this prevalence was calculated by determining the prevalence of ESRD in type 2 diabetics. This procedure is based on the assumption that ESRD in type 2 diabetics is always caused by diabetic nephropathy. However, depending on the literature source, between 20 and 30% of ESRD in diabetics is not due to diabetic nephropathy, but due to another non-diabetic renal disease [4, 36–39]. It follows that this assumption leads to an overestimation of the prevalence of ESRD due to type 2 DM. The second circumstance which could influence the determination of the prevalence of ESRD in patients with type 2 DM in the present study is that no definition of the diagnosis of type 2 DM was laid down. This was left to the discretion of the study physician. It is unclear whether this would lead to an over- or underestimation of ESRD in patients with type 2 DM. In summary, it should be stated that distortion of the results by these sources of bias can not be excluded.

Comments on the methods for calculating costs and interviewing the experts

Costs. The calculation of the costs of haemodialysis and peritoneal dialysis is based on the calculation of aggregated data rather than on individual data, which would have been more informative. However, the SVK statistics have been validated, so that the use of SVK flat rates for costing dialysis services, and of the average values in the SVK statistics for the number of these services and for the average requirement for erythropoietin may be regarded as giving a good approximation of reality [15, 18]. On the other hand, the costs for the complications suffered by patients on dialysis were excluded from the calculation, as the inclusion of this factor was regarded as being impracticable, and this certainly leads to relevant underes-

timisation of the costs of the two types of dialyses. What makes this underestimation particularly relevant is that 95.8% of the patients in the cross-sectional study with ESRD and type 2 DM were treated by dialysis.

The complications from renal transplantation were only included for the first postoperative year, and this may have led to relevant underestimation of the costs of renal transplantation. The complications in the first postoperative year are then included – particularly rejection and infections – but not the late complications. The late complications include cardiovascular complications and tumours – particularly squamous cell carcinoma, but also basal cell carcinoma of the skin and, rarely, melanomas. The justification for this procedure is that the study might otherwise have been impracticable. Moreover, when the recipient has type 2 DM diabetes it is almost impossible to distinguish between cardiovascular complications from the underlying diabetes and cardiovascular complications from the immunosuppressive therapy accompanying the renal transplant. However the aim of the present study was to estimate the costs of ESRD in patients with type 2 DM and not the costs of the underlying disease diabetes. The exclusion of the late complication of tumours, particularly skin tumours, probably leads to relevant underestimation of the costs. In a study with more than 1000 patients, Bouwes et al. found that the cumulative incidence for the development of skin cancers after renal transplantation was 7% after 1 year, 45% after 11 years and 70% after 20 years of immunosuppression [40]. The complications suffered by the recipient occurring during the first postoperative year and which did not require admission to hospital included additional consultations, additional physical investigations and additional diagnostic procedures (laboratory and imaging techniques). These were neglected from the calculation of the costs. The resulting underestimation of the costs seems to be defensible, as extensive routine consultations, routine physical investigations and routine diagnostic procedures (laboratory and imaging techniques) were included in the follow-up in the first post-operative year, so that it may be assumed that a large proportion of the costs have already been included in the calculations.

The costs of the immunosuppressive therapy in 2001 were used for the calculation of the costs of both the patients who received transplants in 2001 and of the patients who received transplants between 1980 and 2000. Using the costs of modern immunotherapy for the patients in the earlier period certainly leads to an overestimation of the costs. Immunosuppressive therapy has recently become much more expensive, particularly since the introduction to the market in 1996 of CellCept® (partially replacing Imurek®) and at least some of the patients who had received earlier transplants were still being treated in 2001 with older and cheaper immunosuppressive protocols. There was

however no available data on this, so that the costs for modern immunosuppressive therapy were used for the calculation. It can be assumed that this leads to a relevant overestimation of the costs of renal transplantation. A further reason to examine the costs of immunosuppressive therapy critically is that, according to the results of this study, they make up almost 50% of the follow-up costs for the recipient in the first postoperative year and almost 90% of the costs in subsequent years.

The cost component for 2001 for patients transplanted before 2001 is more than twice as great as the component for patients transplanted in 2001. The method used to determine the number of recipients who were given transplants before 2001 and were still alive in 2001 should therefore also be critically discussed. Recipients of renal transplants before 1980 were not included; this probably had little effect on the results, as long term survival was practically impossible before the introduction of cyclosporine in the early 1980s. The number of recipients was calculated by extrapolation of the recent 10 year survival curve in the OPELZ register (Europe 1990–2000) and by using the percentage of type 2 diabetics in all transplant recipients, as determined in the 2001 cross-sectional study from our group, so that overestimation of the number of recipients can be expected. This is because the survival curves (Europe 1990–2000) already reflect the effects of more modern immunosuppressive therapy and this has the prognosis of better survival than the therapies that were available in the early 1980s. It should also be expected that the percentage of type 2 diabetics in the transplant recipients will be lower in the earlier years [41]. The recent 10-year survival data had to be taken for the extrapolation, as no older data were available.

Comparison of the Swiss prevalence and cost data with the data of other countries

Prevalence. The Swiss prevalence of ESRD of 364.8 per million inhabitants is much lower than the prevalences in other European countries, especially in Germany (870) and Austria (722.4) and is only a fourth of the prevalence of the USA (1486.5) [14, 42, 43, data directly age-adjusted]. If however the prevalences of ESRD in patients with type 2 DM are compared, the Swiss prevalence of 73.0 ESRD per million inhabitants is an intermediate prevalence, clearly behind the one of Germany (141) and slightly behind the one of Austria (83.6) [42, 43]. Compared to the USA the Swiss prevalence of ESRD in patients with type 2 DM is only less than a sixth of the American one (459) ([14, prevalence of type 1 and type 2). Possible explanations for the different prevalences of ESRD in patients with type 2 DM are different prevalences and incidences of DM type 2 and different prevalences of the factors influencing the progression of diabetic nephropathy towards end-stage renal disease in these countries as for example genetic factors, hyperglycaemia, hypertension, smoking,

advanced age, microangiopathy (retinopathy) and macroangiopathy (coronary heart disease, occlusive arterial disease). Other reasons might be differences in the quality of medical treatment of type 2 diabetics, the survival rate of these patients and in the definition of ESRD in patients with type 2 DM [44]. A different distribution of the above mentioned factors in the compared country could explain the different prevalence of ESRD in patients with type 2 DM, but the data being available is mostly insufficient to show a causal relationship.

Costs. The comparison of the Swiss costs of ESRD in patients with DM type 2 is only possible in a limited way: Due to the health insurance perspective only the costs of dialysis are real costs, but not the costs of transplantation. In addition, the inclusion of erythropoietin, costs of complications and transportation are different from one country to another. The daily Swiss costs of ESRD per type 2 diabetic patient came to CHF 215 (Euro 142; US \$120) that is 20% more than the German costs (Euro 111) [13, 45] and only 85% of the US-American costs (US \$149) [14]. Possible explanations might be the different price levels in these coun-

tries, and in the case of Germany the different distribution of the modes of therapies and in the case of the USA a much larger spectrum in the prices for services.

Conclusion. This is the first determination of the prevalence and costs of ESRD in patients with type 2 DM in Switzerland. The selected study design made it possible to cover the whole of Switzerland. The Swiss prevalence in 2001 was 73.0 per million inhabitants, which means that it is in the intermediate range for a European country. This late complication is in principle avoidable, but the costs for Switzerland for 2001 came to CHF 46 million. There has been an increase in ESRD in type 2 DM throughout the world and this probably applies to Switzerland too, so that costs can be expected to rise in the future.

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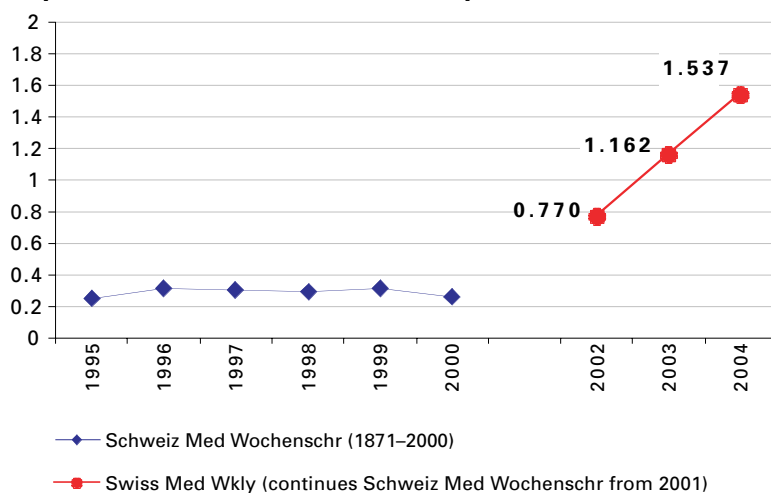
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