Catalan Renal Patients Registry

Statistics Report 2002

Acknowledgements

We express our gratitude to all those who have made this report possible: the personnel of the centers and departments providing care to patients with treated end-stage renal disease in Catalonia, the Histocompatibility Laboratory of Catalonia, and the inspectors dedicated to issues related with treated end-stage renal disease in the health regions of the Catalan Health Service.

Introduction

The Registre de Malalts Renals de Catalunya (RMRC, Catalan Renal Patients Registry) is an obligatory population registry that records and collates information on all patients receiving renal replacement therapy (RRT) in Catalonia.

The RMRC, which is now assigned to the Health Care Section of the Catalan Health Service, was created in 1984 as a support tool within the Health and Social Security Department program dedicated to renal failure patients. At the same time, the Commission for Control and Monitoring the Registry was founded to assure the confidentiality and quality of the data and to optimize the Registry for the new information requirements related to health management in nephrology.

In 1988 the Registry underwent an external validation process, which showed exhaustive recording of relevant variables and excellent concordance. These results evidenced the validity of the data for use in clinical and epidemiological studies. These results can also be considered an indicator of the Registry's proper functioning.

In 1990, the RMRC became a local registry of the European Dialysis and Transplant Association (EDTA) to avoid duplication of data collection by the medical personnel. Since 1999 the Registry has cooperated with the Collaborative Transplant Study (CTS) by providing information on renal transplants performed in Catalonia.

Since the creation of the RMRC, a **Statistics Report** has been written annually to present and disseminate the results obtained after processing the data. In keeping with the aims of the Registry, this document contains information on the scope of the problems related to treated end-stage renal disease (ESRD) in Catalonia and on the sociodemographic characteristics, morbidity and mortality of patients receiving RRT. Additionally, a part of the report is devoted to presenting the results from non-systematic sources, and information from specific studies and databases outside the Registry that contribute to increasing the knowledge about treated ESRD in Catalonia, from both the clinical and epidemiological standpoints.

This document is largely dedicated to presenting the data from 2002 and the trends observed since 1984. No additional specific study has been done this year, but the chapter on dialysis has been expanded. For the first time, dialysis adequacy has been studied by analyzing the Kt/V value; these findings as well as the results from the most recent hemoglobin determinations are presented in this chapter. The section on mortality has also been extended, with a description of the trends in mortality over the various periods—1990-1994, 1995-1999 and 2000-2002—and analyses of mortality according to sex, age group and primary renal disease. An analysis of specific causes of death, such as cardiac and neoplastic disease, is also provided.

Material and methods

Incidence and prevalence

The reference populations for the calculations of incidence and prevalence proceed from the 1991 Catalan census for the period 1992-1995 and the 1996 census for the period 1996-2000. The 2000 census was used for the year 2001. Incidence in this report is defined as the number of patients residing in Catalonia who initiated RRT during the year as referred to the total population of Catalonia. Incidence rates are expressed per million person-years. Prevalence is defined as the total number of RRT patients residing in Catalonia and alive on 31 December, also as referred to the overall Catalan population. Prevalence rates are expressed per million population (pmp).

The information in some of the tables refers to the total of patients treated in Catalonia, both residents as well as non-residents. This is specified in each case.

Rates corresponding to each health region have been age- and sex-adjusted to render them comparable and to avoid a potential effect due to differences in the composition of the population. Incidence rates were adjusted according to the indirect method of standardization to allow comparison between the rates in each health region (HR) and the overall rate in Catalonia. Prevalence rates were adjusted by the direct method of standardization to the Catalan adult population (over 14 years old). Since ESRD is less frequent in children, the standardized incidence and prevalence values are higher than the crude values used to compare the data from Catalonia with other communities or countries. The confidence interval (at a 95% confidence level) of the rates adjusted by the indirect method was calculated according to the following formula (LONG, 1977):

$$\text{Specific rate} \pm 1{,}96 * \frac{\text{Overall rate}}{\text{Theoretical cases}} * \sqrt{\text{Observed cases}}$$

The confidence interval (at a 95% confidence level) of the rates adjusted by the direct method was calculated according to the following formula (RUE, 1993):

$$\text{Specific rate} \pm 1{,}96 * \sqrt{\frac{\text{HR stratum-specific rate}}{\text{Catalan stratum population}} * \left(\frac{\text{HR stratum population}}{\text{Population of Catalonia}}\right)^2}$$

Statistical analyses were performed with the SPSSx program. The chi square (c^2) test was used to determine the independence of the qualitative variables, the Student's *t* test for comparison between means of two groups, and analysis of variance (ANOVA) for comparisons among means of more than two groups.

Survival

Overall survival and survival analyses by primary renal diagnosis group, by age group, by number of concomitant diseases at the start of RRT, and by functional autonomy grade were performed with all new patients included in the Registry from 1 January

1984 to 31 December 2002. These cases were recorded prospectively; thus the information on them is complete and detailed follow up data are available.

To avoid potential bias, patients who initiated treatment before creation of the Registry have been excluded from these analyses. The data for these patients were collected retrospectively and information is incomplete in some cases. Additionally, due to the difficulty in retrieving information on patients who had already died at the time that data were collected, the number of survivors in this group of patients may be over-represented, particularly those who never received a transplant.

Survival according to treatment has been calculated using each sequence of treatment as the unit of analysis, rather than by patient. All treatment periods falling within 1 January 1984 and 31 December 2002 have been included. For the purpose of statistical calculation, changes in treatment were considered lost to follow-up.

Survival in transplant recipients has been calculated for patients receiving transplants between 1 January 1984 and 31 December 2002. Patients receiving multiple transplants (kidney plus pancreas, kidney plus liver, and double kidney) have been excluded from the analysis, since their characteristics are different from those of the other recipients. Survival for patients and for grafts have been calculated by type of transplant (from a living donor or cadaver) and by immunocompatibility characteristics (according to HLA-DR, A or B matches, and according to recipient reactivity).

Survival tables for the univariate analyses were elaborated by actuarial methods and the level of statistical significance was evaluated among the different curves of a single analysis. Overall comparison and paired comparisons of the subgroups were done with the Gehan test (SPSS, 1983), using the SPSSx program.

A proportional risks model was applied in the multivariate analyses using the SPSS program (version 10.06) and incorporating Breslow's proposed modification for the Cox regression, in which coefficients are estimated by means of the Newton-Raphson iterative algorithm. Statistical significance of the estimated relative risks was determined with the maximum likelihood method and the chi-square test.

Treated end-stage renal disease in Catalonia

Overall incidence and prevalence data for treated ESRD in Catalonia and number of transplants in 2002 are presented in Table 1 in absolute numbers and rates per million population (pmp), together with the number of deaths and mortality expressed per 100 patients.

Table 1. Overall results of end-stage renal disease in Catalonia, 2002.

The prevalence rate has continued to grow in the last years (Table 2). Despite slight fluctuations, the incidence rate is still one of the highest in Europe. This year the transplant rate fell slightly as compared to 2001 and is situated at 62.7 transplants pmp. This figure is a measure of the activity calculated from the total number of transplants performed (regardless of the origin of the donor or recipient) with respect to the general population of Catalonia. The mortality rate this year is nearly the same as that of recent years.

Table 2. Treated end-stage renal disease in Catalonia, 1996-2002

Description of the population receiving renal replacement therapy

Sociodemographic data

Figure 1 provides a summary of the changes in the mean age of patients starting RRT and in patient survival at the end of the year, over the period encompassing 1986-2002. The figure also shows the changes in the mean age of patients who died over this time. The age of the prevalent population has continued to increase at the same rhythm as in previous years, so that a relatively stable trend is being maintained. The annual mean age of the incident population shows greater variation, since there are fewer new cases than prevalent cases.

Figure 1. Mean age of patients receiving RRT, 1984-2002

As compared to the previous year, there is a slight decrease in the mean age of new cases, both overall and in the group of men. An increase of approximately half a year in the age of the prevalent population is observed both in men and in women.

With regard to the evolution in mean age of patients who died during the period of 1986-2001, the situation is similar to that seen for the incident population: there are slight fluctuations due to the limited number of cases, but the overall trend shows that RRT patients are surviving to an increasingly more advanced age. During this past year the overall mean has increased slightly.

There is a predominance of men among patients on RRT (61.5%), and the 60-80 year-old age groups in both sexes have the most cases (43.7%).

Figure 2 shows the distribution of new cases by age groups for the period of 1984 to 2002. In the groups of patients under 60 years old there is a gradual decrease in the percentage of incident patients over the yearly total, despite the fact that the number of patients in these groups starting RRT per year remains more or less stable. In contrast, in the groups over 60 years old there is a gradual increase both in absolute numbers and percentages that is much more significant in the groups over 70. According to these data, the high RRT incidence rates observed are maintained because increasingly older patients are being included. The distribution of patients by age group in 2002 is virtually the same as in previous years.

Figure 2. Age distribution of patients when starting RRT, expressed in number of cases and percent terms, 1984-2002

Figure 3. Treated ESRD incidence rates by age groups and sex, 2002

Figure 4. Treated ESRD prevalence rates by age groups and sex, 2002

Figures 3 and 4 depict the incidence and prevalence rates of treated ESRD by age and sex. The rates increase with age, particularly after the age of 40 and up to the age of 80. Thereafter they begin to fall, and the decrease becomes more marked in the group over 84 years old. The rates for men have always been higher than for women, although the distribution is similar.

Figure 5 shows the differences that exist in the family structure or living situation of patients initiating RRT in 2002, according to sex. Although most RRT patients live with their spouse, the percentage of men in this situation is higher. The family structure also shows some relation with the age of the patients. Most patients (80.7%) living in a residence or center for the elderly are over 64 years old. The percentage of patients living with their spouse is 54.1% in the group 15 to 44 years old, 65.3% in the group 45 to 64 years old, 63.5% in the group 65 to 74 years old and 44.7% in patients over 74 years old.

Distribution by educational level is described in Figure 6. Patients 15 to 44 years old have the highest level of education, with 14.8% having finished secondary school and 12.0% having higher education degrees. These percentages decline as patient age increases. There are also differences with respect to sex, since among the 5.8% of patients with higher education degrees among all the age groups, 74.1% are men. The same is true in the case of secondary school education (7.8% of patients), in which 79.5% are men.

Figure 5. Family structure or living situation according to sex. New cases, 2002

Figure 6. Educational level according to age group. New cases, 2002

Presentation of irreversible renal failure

Since 1993 the Registry has gathered information on patients starting RRT to determine whether initiation of this treatment was required because of acute presentation of the disease, because of aggravation of known disease or because of normal evolution of the disease process.

Since some diseases have a rapid evolution and always present in an acute form, the following diseases have been excluded from the analysis of this variable: type I membranoproliferative glomerulonephritis, diffuse extracapillary proliferative glomerulonephritis or rapidly progressive glomerulonephritis, tubulointerstitial nephritis, vascular renal disease caused by malignant hypertension, and ischemic renal disease due to embolism or atheromatous plaque.

Figure 7 presents the distribution of this variable for the period encompassing 1993 to 2002. Some small fluctuations are seen, although conclusions cannot be drawn from them. One factor that has shown a considerable decrease is the percentage of unreported cases, which reached 12.6% in 1993 and has decreased to 1.0% in 2002.

In the analysis of presentation by age group, the percentage of patients with normal evolution to ESRD is seen to decrease with advancing age (Figure 8).

There are also substantial differences in the presentation of ESRD ($p<0.00001$) with regard to the type of primary renal disease. In patients with polycystic kidney disease, ESRD is a consequence of the natural evolution of the disease in 82.9% of cases, whereas in patients with vascular kidney disease and in the group *other diseases,* this proportion is 57.6% and 45.3%, respectively (Figure 9).

Figure 7. Type of presentation of end-stage renal disease. New cases, 1993-2002

Figure 8. Type of presentation of end-stage renal disease according to age group. New cases, 1997-2002

Figure 9. Type of presentation of end-stage renal disease according to primary renal disease. New cases, 1997-2002

Primary renal disease

As compared to 2001, there has been a slight increase in new cases of diabetic renal disease and cases of unknown etiology. These two categories are the most common causes of ESRD (21.6% and 21.2%, respectively), followed by vascular renal disease (16.7%). The remaining pathologies have remained stable (Table 3 and Figure 10). Prevalence, in contrast, has shown little change in recent years, with a predominance of patients with glomerular disease.

Table 3. Incidence and prevalence according to primary renal disease, 2002

The distribution of primary renal disease shows significant differences ($p<0.0001$) between the age groups. Diseases of unknown origin are more frequent in the older groups (29.0% in those over 74 years old), mainly because it is difficult to precisely determine the etiology of renal failure in patients with deteriorated health status due to age, and because biopsy may mean an added risk or low therapeutic yield in some patients. Glomerular disease predominates in the 15 to 44 year-old group (27.1%) and polycystic kidney disease increases after 44 years. In nearly 50% of children, the primary renal disease (PRD) is included in the category of *other diseases*, which encompasses medullary cystic disease, cystinosis, “prune belly” syndrome and, particularly, renal hypoplasia.

Figure 10. Incidence and prevalence according to primary renal disease, 2002

Figure 11. Diagnostic tests according to primary renal disease. New cases, 2002

Since the year 2000 the Registry has recorded data on the criteria used for establishing the diagnosis of PRD: biopsy, pathognomonic diagnostic tests or clinical suspicion. In 2002, 69.8% of glomerular disease, 51.7% of nephropathy in the group *other diseases* and 10.8% of renal vascular disease were diagnosed by biopsy. In the remaining categories, diagnostic biopsy is less than 10%. Pathognomonic tests were the basis for diagnosis in 88.2% of polycystic kidney disease, 43.7% of those of interstitial etiology and nearly 25% of diabetic and vascular kidney disease and the *other diseases* group (Figure 11).

Type of treatment

Figure 12 depicts the distribution of patients by type of treatment on 31 December 2002. There is a percent decrease in patients treated with assisted hemodialysis and an increase in patients with a functioning cadaveric renal transplant (CRT) (0.6%), whereas the percentages of other therapeutic techniques remain very low. Additionally, the percentage of patients with a functioning living renal transplant (LRT) has remained stable (1.6%) and the number of patients on continuous cycling peritoneal dialysis (CCPD) is now higher than the number on continuous ambulatory peritoneal dialysis (CAPD)

Among the younger patients (less than 45 years old), 66.2% have a functioning transplant. This proportion decreases to 35.8% in patients 65 to 74 years old. The use of peritoneal dialysis (PD) decreases with advancing age of the patient and the technique also varies; whereas PD use is more frequent in the younger age groups, CAPD is used more often in older patients.

Figure 12. Prevalence by type of treatment, 2002

Figure 13. Prevalence by type of treatment, 1986-2002

Analysis of distribution by type of treatment and age in the period 1986-2002 shows that in the **0 to 44 year-old group,** 38.1% of patients had a functioning transplant and 61.9% were in dialysis (D) in 1986. These proportions inverted after 1987 and more patients had functioning transplants than were in dialysis. In 2002, 66.3% of patients had a functioning transplant and 33.7% were in dialysis. Among the **45 to 64 year-old group**, the percentage of patients with functioning transplants in 1986 was 17.4%. In 1995 the proportion of patients with functioning transplants was similar to that of patients in dialysis and in 2002 patients with functioning transplants increased to 58.1%. Regarding the **group of patients over 64 years old**, the percentage with a functioning transplant in 1986 was practically null, whereas in 2002, 23.5% of patients in this age group had functioning kidney grafts (Figure 13).

Table 4 shows the distribution of the type of treatment by health region. Prevalence data are expressed in absolute numbers and percentages, whereas incidence and mortality data are presented only in absolute numbers.

Figure 16 shows the movement of patients among the various treatment modalities during 2002 and the situation on 31 December.

Table 4. Type of treatment by health region of residence, 2002

Figure 14. Patients residing in Catalonia and receiving renal replacement therapy, 2002

Dialysis

The percentage of patients receiving dialysis treatment in their health region of residence (88.9%) is virtually the same this year as in previous years. The remaining 11.1%, consisting of patients who have to travel from another health region to undergo dialysis, include mainly those from *Barcelonès Nord i Maresme, Costa de Ponent* and *Centre*, who, because of geographical proximity, use the nephrological heath resources from the city of Barcelona. The largest number of patients residing outside of Catalonia and receiving dialysis treatment are attended in the Lleida health region. These cases mainly come from Aragonese towns in the *Franja de Ponent* (Table 5).

Table 5. Dialysis patients by health region of residence and health region of treatment, 2002

Hemodialysis

As in former years, an analysis has been performed of all patients initiating HD by year, including those who initiate HD as the first technique for RRT, those who have been treated previously with other techniques (transplant or peritoneal dialysis) and those from other autonomous communities who are dialyzed in Catalonia. Figure 15 shows the channels by which patients initiate hemodialysis (left columns) and discontinue hemodialysis (right columns).

The total number of patients initiating HD (1091 cases) represents a slight increase as compared to the previous year. There are 983 discontinuations for various reasons, resulting in a net increase of 108 persons. Given this rise in new cases, there has been an increase in patients initiating HD and using it as the first RRT method. The number of patients initiating HD because of graft failure or after having undergone peritoneal dialysis seems to have stabilized this year. Regarding discontinuations of HD, the number of deaths in this technique has increased substantially, (500 deaths in 1996, 600 in 2000 and 627 in 2002). This fact, together with the persistently high transplant rate, is the reason why the number of patients leaving this technique has also continued to grow in the last years.

Figure 15. Patients starting and discontinuing hemodialysis, 1991-2002

Table 6 lists the number of patients initiating assisted HD in each of the health regions of residence for the period of 2000-2002.

Table 6. Patients initiating hemodialysis by health region of residence, 2000-2002

Figure 16. Reasons for changing from hemodialysis to peritoneal dialysis, 1993-2002

Figure 17. Hours per week on hemodialysis, 1990-2002

Information on the causes prompting a change from hemodialysis to peritoneal dialysis has been recorded since 1993 (Figure 16). Lack of a vascular access is the main reason why patients discontinue HD and pass to PD (34.3%), followed by the patient's own decision in this respect (27.9%). Because of the small number of cases involved (204) and the high percentage of cases lacking data (26.5%), more detailed analyses cannot be performed to investigate the influence of other factors on this change of dialysis modality, such as primary renal disease, age, and time that the patient has been on dialysis.

This year has witnessed a new decrease in the percentage of patients who undergo dialysis for less than 10 hours weekly. Figure 17 illustrates this trend. Although the large majority of patients are dialyzed for 10 to 12 hours per week, the percentage was seen to fall in favor of those treated for 9 hours per week, with proportions of 16% in 1990, 31% in 1996 and 28.0% in 1997. This year the rate is 9.0%. Moreover, the percentage of patients dialyzed for 9 hours per week varies according to sex (5.9% of men and 13.7% of women), age (5.6% of patients 15 to 44 years old, 5.0% of those 45 to 64, 8.2% of those 65 to 74 and 14.7% of those over 74 years old) and the care level of the center where dialysis is provided (5.2% of patients dialyzed in nephrology services, 16.3% of those in nephrological care units and 6.9% of those in dialysis centers). The percentage of patients dialyzed less than 9 hours per week has decreased (0.1%), whereas the percentage of those dialyzed for more than 12 hours has increased (7.4%). Approximately 98% of patients attend three hemodialysis sessions per week.

Figure 18 shows the distribution of patients according to the number of hours of dialysis per week and body surface area. Among patients with a body surface area less than 1.7 m^2, 79.0% were dialyzed for 9 hours weekly or less and 4.4% were dialyzed for 12 hours weekly or more. None of the patients with a body surface area over 1.7 m^2 were dialyzed less than 9 hours weekly. As can be seen in the figure, mean body surface area increases significantly as the number of hours under dialysis increases ($p<0.00001$). Mean body surface area is 1.53 m^2 in patients dialyzed for less than 9 hours, 1.56 m^2 in those dialyzed for 9 hours, 1.61 m^2 in patients dialyzed for 10 to 12 hours and 1.81 m^2 in those dialyzed for more than 12 hours.

Figure 18. Percent distribution of patients on hemodialysis, by number of hours of dialysis weekly and body surface area, 2002

Vascular access

Vascular access was treated more in detail in the 1996 Report, which contained a specific chapter devoted to this subject. In the 1997 Report there is a general description of the distribution of the various types of vascular accesses used, and a study characterizing patients in whom four or more accesses have been performed. Additionally, in 1997 a study was initiated to investigate the morbidity and mortality associated with the type of vascular access used in the first dialysis. The 1998 Report contains a study of the risk factors for starting HD with a catheter and in 1999 a study was conducted to determine the mortality associated with HD initiation using a catheter.

Among the 3435 patients on hemodialysis alive and residing in Catalonia on 31 December 2002, information on dialysis access was recorded for 3407 patients (99.2%). Among this total, 2739 (80.4%) were dialyzed with an internal arteriovenous fistula (IAVF), 262 (7.7%) were dialyzed with various types of grafts and 406 (11.9%) were dialyzed with temporary or permanent catheters.

The IAVF is the preferred type of vascular access (80.4%), although its use has decreased once again by 2% as compared to last year. IAVFs are predominantly located at the wrist (59.3%) and secondarily at the elbow (40.7%); the left arm is preferentially used for both these sites.

With regard to grafts, heterologous grafts are the type most often used, with the saphenous vein being implanted in only 5.7% of these patients. Around half the grafts are placed in the lower extremities.

Figure 19. Type of vascular access at initiation of RRT, 1997-2002

Catheters are used in 11.9% of patients. Most are placed in the scapular region (96.3%) rather than the pelvic region (3.7%). The majority of temporary catheters are placed in the right side. Distribution of catheter location is as follows: 9.6% in the subclavian vein, 35.0% in the jugular vein, and 3.4% in the femoral vein. Finally, 51.9% of patients are dialyzed by means of a tunneled catheter (permcath), which has gained in use over the last years.

Figure 20. Type of vascular access by primary renal disease, 2002

Figure 21. Type of vascular access by age group, 2002

Figure 20 shows that patients with diabetic or interstitial renal diseases as well as those with *unknown* and *other* etiologies have the highest percentages of catheters (15.3%, 11.4%, 14.4% and 11.7%, respectively), whereas those with glomerular disease or polycystic kidney disease have the lowest (7.2% and 7.8%, respectively).

There are also differences in the distribution of vascular accesses according to patient age. The older the age group, the higher the percentage of patients with catheters and grafts (Figure 21).

Figure 22 Number of hospitalizations due to vascular access complications by type of vascular access, 2002

The study investigating hospital admissions due to complications associated with the vascular access was performed in patients alive on 31 December 2002. Among patients with catheters, 66.8% did not require hospitalization during this year, 18.2% had to be hospitalized once, 10.3% twice, and 4.7% more than twice. In the case of patients with IAVFs the proportions were 91.3%, 6.9%, 1.6% and 0.2%, respectively (Figure 22).

Hemodialysis adequacy

For the first time this year, the Registry includes data on the adequacy of the dialysis provided. For this purpose, the most recent Kt/V values have been recorded for both hemodialysis and peritoneal dialysis patients.

Several methods are used to calculate Kt/V (first and second-generation Daugirdas, Lowrie, Gotch-Diascan, etc.) and some of them are equilibrated, whereas others are not. The analyses presented show Kt/V data both as they were notified to the Registry and, for purposes of comparison, in equilibrated term. The criteria used to calculate the equilibrated Kt/V (when this was not provided) were taken from the European clinical practice guidelines for hemodialysis (NDT, 2000) as follows, for patients dialyzed with:

· IAVF: $eKt/V = spKt/V - (0.6 \times spKt/V /T) + 0.03$, or

. Catheter: $eKt/V = spKt/V - (0.47 \times spKt/V /T) + 0.02$,

in which spKt/V is the administered Kt/V and T is the number of hours in the dialysis session.

Figure 23. Notified Kt/V and equilibrated Kt/V, 2002

Figure 24. Equilibrated Kt/V by type of vascular access, 2002

Figure 23 shows the distribution of notified Kt/V and equilibrated Kt/V (eKt/V). As mentioned above, the eKt/V data are more homogeneous. According to the European clinical practice guidelines, dialysis adequacy is considered to be good when the patient's Kt/V value is greater than or equal to 1; thus the cut-off point has been placed at 1 in our study. Among the total, 16.8% of patients have eKt/V values less than 1.

Figure 24 shows that a higher percentage of patients dialyzed with a catheter have eKt/V values less than 1 as compared to those dialyzed with an IAVF or graft. Mean eKt/V is 1.16 for the group of patients with a catheter, 1.19 for those with a functioning IAVF and 1.23 for those with a graft.

Figure 25. Equilibrated Kt/V by age group and sex, 2002

Figure 26. Equilibrated Kt/V by primary renal disease, 2002

Mean eKt/V was found to be different according to sex, with values of 1.26 for women and 1.15 for men ($p<0.0001$). Analysis by age and sex (Figure 25) disclosed that in men eKt/V values are practically constant in all age groups, whereas in women they decrease with age, from 1.31 in the 14 to 44 year-old group to 1.25 in the group over 74 years of age.

There are also differences in eKt/V according to primary renal disease ($p<0.0001$). Patients with diabetes and vascular disease have lower mean eKt/V values than the overall value, whereas those with *unknown* etiology and the *other renal disease* group have higher values (Figure 26)

Significant differences were also found in relation to body mass index ($p<0.0001$): as the body mass index (BMI) increased, eKt/V decreased from 1.25 in the group with BMI <20 to 1.15 in the group with BMI >29 (Figure 27).

Figure 27. Equilibrated Kt/V according to body mass index, 2002

Hemoglobin

This year for the first time, most recent hemoglobin determinations were recorded.

Figure 28 shows the distribution of hemoglobin levels by sex. Among the total, 26.7% of patients have hemoglobin levels below 11 g/dL. As expected, distribution is more left-sided in women than in men, with a mean of 11.67 g/dL in women and 11.99 g/dL in men ($p<0.0001$).

The analysis of hemoglobin levels by age and sex shows that the levels in men are higher than in women for all the age groups. Both men and women under the age of 45 have lower levels (Figure 29).

Figure 28. Hemoglobin levels according to sex, 2002

Figure 29. Hemoglobin levels according to age group and sex, 2002

Patients with polycystic kidney disease have a significantly higher mean hemoglobin value (12.28 g/dL) than patients with other primary renal diseases, whereas patients in the group *other etiologies* have a significantly lower mean hemoglobin value (11.61 g/dL) (Figure 30).

Figure 30. Hemoglobin levels according to primary renal disease, 2002

In general, patients who are dialyzed for fewer hours weekly have a lower mean hemoglobin value (11.6 g/dL) than those dialyzed for more than 10 hours (12 g/dL).

Erythropoietin treatment

Figure 31. Percentage of patients treated with erythropoietin (EPO) according to primary renal disease, 2002

Among all the patients treated with hemodialysis, 95% receive EPO. The majority of these patients (85%) take recombinant human erythropoietin (r-HuEPO) and the remaining (15%) take novel erythropoiesis stimulating protein (NESP). In 2001, only 3.4% of patients were treated with NESP. Figure 31 shows the distribution of EPO-treated patients according to primary renal disease.

Peritoneal dialysis

Figure 32 summarizes the data on patients starting and discontinuing peritoneal dialysis. Since 1992 a gradual increase has been observed in patients initiating PD. This trend was interrupted in 1995, and subsequently there was a transient increase in 1998 and another increase in 2001, thanks to those initiating PD as the first technique. This year the rate fell once again, mainly due to the patients initiating PD after HD. Sixty-three patients initiated PD as the first technique this year. The number and distribution of patients starting and discontinuing the technique are similar to previous years. This year five fewer patients have initiated the technique than have discontinued it.

Figure 32. Patients starting and discontinuing peritoneal dialysis, 1991-2002

Figure 33 shows the distribution of the causes prompting a change from peritoneal dialysis to hemodialysis during the period of 1993-2002. Peritoneal infection, together with associated diseases or severe complications are the main reasons for changing the technique in 29.4% and 28.7% of patients, respectively. These rates increase to more than 40% if only the cases for which this information has been recorded are taken into account.

An analysis was performed among the patients starting PD during 2000-2002 to determine the probability of developing peritonitis according to the technique used (CCPD or CAPD). As can be seen in Figure 34, the cumulative one-year probability of developing peritonitis is 28% in a person receiving CCPD and 40% in a person receiving CAPD. The cumulative two-year probability is, however, 51% for both techniques.

Figure 33. Cause of the change from peritoneal dialysis to hemodialysis, 1993-2002

Figure 34. Cumulative probability of developing the first peritonitis according to the peritoneal dialysis technique. New peritoneal dialysis cases, 2000-2002

Figure 35 shows peritonitis episodes per person/year according to the PD technique used. There is a higher percentage of episodes per person/year among patients receiving CAPD than among those receiving CCPD.

The volume of dialysis fluid used in PD varies according to the technique. In CCPD a mean of 1.8 liters are used during the day, 11.6 liters at night and 0.6 liters as extra volume, whereas CAPD uses 5.8 liters during the day and 2.3 liters at night (Figure 36).

Figure 35. Number of peritonitis episodes per person/year according to peritoneal dialysis technique, 2000-2002

Figure 36. Dialysis fluids used according to the peritoneal dialysis technique, 2002

In the 1996 report there is a more detailed analysis of peritoneal dialysis in our setting, including information on the different types of peritoneal dialysis, the types of connections and catheters used, a study of peritonitis episodes, etc.

Peritoneal dialysis adequacy

As mentioned above, this year the Kt/V values (total, peritoneal and renal) have been recorded for patients on peritoneal dialysis. Figure 37 shows the Kt/V means according to the PD technique. Peritoneal Kt/V is higher than renal Kt/V in both techniques; but in CCPD patients, peritoneal Kt/V is higher than in CAPD patients, whereas the inverse occurs for renal Kt/V.

There are no differences between the mean total weekly Kt/V in men (2.49) and in women (2.50), but there is a relation with age group. The younger patients (under 45 years of age) have the highest mean total weekly Kt/V (2.8). This value gradually decreases up to the 64 to 74 year-old group (2.2) (Figure 38).

Figure 37. Mean Kt/V of peritoneal dialysis patients according to the technique, 2002

Figure 38. Mean total weekly Kt/V values in peritoneal dialysis patients according to age group and sex, 2002

Analysis by primary renal disease or by body mass index showed no statistically significant differences in overall weekly Kt/V. Nevertheless, there was a slight mean decrease from 2.66 in patients with a BMI less than 20 to 2.32 in those with a BMI over 29.

Figure 39. Mean Kt/V (renal, peritoneal and total) of peritoneal dialysis patients according to time on the most recent technique, 2002

Figure 39 shows the evolution of weekly peritoneal Kt/V values according to time under treatment in the most recent technique. Renal Kt/V shows a spectacular decrease from 1.0 at six months to 0.3 at two years. This is due to the loss of residual renal function. Peritoneal Kt/V shows a slight increase from 1.8 at six months to 2.0 at 2 years, resulting from adjustments in the technique to achieve stable total KT/V levels.

Hemoglobin

The mean hemoglobin value is 12.30 g/dL for patients receiving CCPD and 12.12 g/dL for those receiving CAPD. Mean hemoglobin level in men (12.36 g/dL) is slightly higher than that in women (12.00 g/dL), as is seen in Figure 40. Decreases in mean hemoglobin values are observed with increasing age.

There were no statistically significant differences in mean hemoglobin values according to primary renal disease. Patients with glomerular renal disease had the highest level (12.81 g/dL) and patients with polycystic kidney disease the lowest level (11.80 g/dL).

Mean hemoglobin values decreased with increases in the body mass index. Patients with a BMI below 20 had a mean of 12.46 g/dL, whereas those with a BMI over 29 had a mean of 11.72 g/dL. The differences were not statistically significant.

Figure 40. Most recent mean hemoglobin values in peritoneal dialysis patients according to age group and sex, 2002

Erythropoietin treatment
Among the total, 91.1% of patients in peritoneal dialysis receive EPO. In this group, 54.4% take r-HuEPO and the remaining 45.6% take NESP. NESP treatment in PD patients has increased considerably in the last year as compared to a rate of only 0.6% in 2001. Figure 41 shows the distribution of patients treated with EPO according to primary renal disease.

Figure 41. Most recent mean hemoglobin values in peritoneal dialysis patients according to primary renal disease, 2002

Transplants

In 2002, 372 renal transplants were performed in Catalonia, a slight decrease in number as compared to last year. This figure expressed per million population gives a transplant rate of 57.2 pmp, which is higher than the majority of European countries with considerable transplant activity.

Figure 42 shows overall transplant activity since 1984 according to the type of transplant. The number of transplants from living donors has continued to increase this year, with 18 such procedures being performed, five more than last year. The number of combined kidney-pancreas transplants has remained quite stable. The first combined kidney-liver transplant was carried out in 1988 and since then there have been 54 such procedures. In 1997 the first double kidney transplant (dual RT) was performed. This new modality attempts to take better advantage of the resources, considering as valid certain kidneys that would not have been accepted as single transplants. Sixteen dual RT were performed this year, double the number of last year. The third heart-kidney transplantation was also carried out this year; the first was done in 1999.

Figure 42. Number of transplantations, 1984-2002

Recipient data

As was seen in the graphs showing RRT distribution by age and sex, the population receiving this treatment is aging. The same is true for the patients receiving transplants, as seen by their continuous increase in mean age over the years. These trends are depicted in Figure 43, together with the percent distribution by age group of patients over 55 years old transplanted during the period of 1990 to 2002. The mean age of patients at the time of transplantation ranges from 34.1 years in 1985 to 49.0 years in 2000; mean age in 2002 was 48.3 years.

Since 1990 the percentage of transplantations performed in the 55 to 59 year-old group has remained stable. Nevertheless, the percentage of transplantations has increased in the over 60 year-old patients since 1988 and in the over 64 year-old patients since 1990, although these groups show more irregular trends.

The increase in the number of transplantations in diabetic patients also stands out, being 3.8% of the total in the period of 1984-1989 and 9.8% in the period of 2000-2002. It should be mentioned that this increase also implies a qualitative change, since presently the majority of these are simultaneous kidney-pancreas transplants. In 2002 17 transplants of this type were performed.

Figure 43. Percentage of kidney transplants in patients over 55 years old and mean age of patients receiving a transplant, 1990-2002

Table 7. Comparative data for renal transplantation in Catalonia within the period 1984-1989, 1990-1994,1995-2002

Table 7 summarizes the transplant data for the various factors studied according to a division into four time periods: the first covers transplants performed from 1984 to 1989, the second from 1990 to 1994, the third from 1995 to 1999 and the fourth from 2000 to 2002. The differences between these periods are significant in all cases, except for the data on retransplantation. To summarize the present situation in Catalonia, transplantations are now being performed in older patients, in a higher percentage of patients with diabetic renal disease (mainly kidney-pancreas transplants) and there is a slight tendency toward an increase in retransplantations. The trend regarding mean HLA-DR matches is not clear, although in recent years the mean number of HLA-DR matches has shown a decrease.

Table 8 depicts the distribution of patients with a functioning transplant by health region of residence and health region of treatment, both for transplants performed this year and for the total of patients with a functioning transplant monitored in Catalonia.

Table 8. Patients receiving a transplant by health region of residence and health region of treatment, 2002.

The percentage de patients from outside of Catalonia who received a renal transplant this year was 10.9% (43 patients). In the first years this proportion ranged from 20% to 25%; in 1995 it was 17.1%. This tendency can be explained by the increase in transplants carried out in other autonomous communities during the last years. This year most of the patients from outside of Catalonia receiving transplants in Catalan renal transplant units were from the Balearic Islands (15 patients), the Autonomic Community of Valencia (10 patients) and from Castilla-La Mancha (4 patients).

Despite the continuous increase in patients on RRT, the number on transplant waiting lists has not increased proportionately. The number of patients on waiting lists is quite stable, though the percentage over the total shows a decrease. There has also been an increase in the number of patients pending study (Figure 44). One noteworthy fact is the spectacular increase in the number of patients excluded from the waiting list for clinical reasons, starting in 1990: in 1989, 222 patients (6.3% of the total) were excluded from the waiting list for this reason and in 2002, 1038 (15.7%) were excluded. This may be a consequence of changes in the criteria used to report this information, since the age limit for transplantation was extended after that time.

The percentage of patients on the waiting list (or pending clinical or histocompatibility studies) and without a functioning transplant decreases with age from 88% of patients 15 to 44 years old to 3.2% of patients over 74. Among patients 45 to 64 years old, 20% are excluded from transplantation for clinical reasons. There are considerable differences in the situation of the waiting list according to the primary renal disease: 63.0% of glomerular disease patients on dialysis are on the waiting list (or pending study) to receive a transplant, whereas only 30.2% of diabetic patients and 29.7% of vascular patients are in this situation. Moreover the diabetic patient group has the highest percentage of cases excluded due to clinical reasons (44.6%).

Figure 44. Situation of RRT patients residing in Catalonia with regard to transplantation, 1990-2002

Figure 45 shows the situation of the transplant waiting list for patients initiating RRT during the period 1990-2002, and who were not initially excluded from the list for any reason (age, clinical reasons, or voluntary exclusion). At the end of the first year, 3.6% of patients had received a transplant, 18.4% had undergone all the studies and were on the list, and the 62.5% remaining were pending study. At 5 years, 39.9% had functioning transplants, 14.3% were on the waiting list, 4.9% were pending study, 15.5% were excluded and 25.3% had died. At 10 years, 40.6% continued with a functioning transplant, 4.6% were on the waiting list, 3.2% were pending study, 8.2% were excluded and the remaining 43.4% had died.

Figure 45. Situation of the waiting list and mortality. New cases from 1990 to 2002 who were not excluded from the list at initiation of RRT

Figure 46. Previous time interval on dialysis of patients receiving a first cadaveric kidney transplant. Transplants 1986-2002

Figure 46 shows the previous time on dialysis of patients residing in Catalonia who received a first cadaveric renal transplant during the period 1986-2002, expressed in annual means with the respective 95% confidence intervals. The overall mean for the period is 38.0 months, very similar to that of the previous year, which was 38.6 months. Although there are fluctuations, a clear tendency to decreases in the time on dialysis while waiting for a transplant is observed.

Figure 47 depicts the mean months on dialysis of patients alive on 31 December 2002 and on the waiting list for a first transplant (including patients with clinical or histocompatibility studies pending), analyzed by health region of residence. The overall mean for Catalonia is 43.2 months. Although differences are not statistically significant, the *Tortosa* and *Barcelonès Nord i Maresme* health regions present the shortest mean time on dialysis (37.2 and 37.8 months respectively), whereas the *Lleida* and *Girona* health regions present the longest waiting periods (50.9 and 49.7 months, respectively).

Figure 47. Time on dialysis of patients on the waiting list (31 December 2002) to receive a first cadaveric kidney transplant, by health region of residence

Figures 48, 49 and 50 summarize the probability of receiving a transplant as related to time on RRT and to other factors. The first figure shows that for the total of patients, cumulative probability in the second year is 31.4%, in the fourth year 49.4%, and in the sixth year 55.6%. In the next figure the same study is related to age; the probability of receiving a transplant is lower in the older patient groups. For patients under 15 years of age the cumulative probability of receiving a transplant is 51.2% in the first year, 75.2% in the second year, 88.7% in the third year and 94.8% in the sixth; For the group 15 to 44 years of age, cumulative probability is 48.6% in the second year, 71.2% in the fourth year and 80.1% in the sixth year. In the 45 to 64 year-old group cumulative probability is 28.3% in the second year, 47.7% in the fourth year and 54.1% in the sixth year. Finally, for the 64 to 74 year-old group cumulative probability is 13.6% in the second year, 26.0% in the fourth year and 20.8% in the sixth year (Figure 49).

Figure 48. Cumulative probability of receiving a first transplant. Patients on the waiting list at start of RRT, 1990-2002

Figure 49. Cumulative probability of receiving a first transplant by age group. Patients on the waiting list at start of RRT, 1990-2002

Figure 50. Cumulative probability of receiving a first transplant by primary renal disease. Patients on the waiting list at start of RRT, 1990-2002

Figure 51. Previous time on dialysis of patients who received a renal retransplant from a cadaveric donor. Transplants 1986-2002

Figure 50 shows the same study according to primary renal disease. Diabetic patients have the lowest probability of receiving a transplant, followed by those with vascular disease, those with an unknown etiology and the group of other causes.

In contrast to the decreases seen over the years in the time on dialysis before the first transplant, there are no clear tendencies in the time on dialysis before retransplantation. Patients who received a cadaveric retransplant during 1986 to 2002 were on dialysis a mean of 43.2 months after the first graft failed. Those who received a retransplant in 2002 were on dialysis a mean of 47.3 months after graft failure (Figure 51).

The study of annual transplant data (Figure 52) shows the treatment techniques received before transplantation and the number of transplant patients that start or return to other techniques over time. The characteristics of transplant recipients are described above, but it is worthy of mention that a small number of patients (17 this year) receive a transplant without having undergone any other renal replacement therapy. In 1996 and 1997 the number of patients who received a renal transplant outside Catalonia decreased, and thereafter the rate has remained stable at between 8% and 10% of transplants per year. This year it was 8.3%.

Figure 52. Annual patient flow: transplantations, 1991-2002

The study on immunosuppressive treatments has been carried out with data collected since 1990. The last three years have seen an increase in the use of new immunosuppressive drugs, such as mycophenolate and tacrolimus, and a significant decrease in the use of cyclosporine A and azathioprine. The distribution of immunosuppressive drugs used in the first six weeks after transplantation is shown in Figure 53, which compares drugs used in 1995 and those used in 2002. Because of the changes that have come about in protocols for immunosuppressive therapy, in 2000 a new category was included: anti-CD25 (humanized and chimerized). In keeping with the situation seen last year, the decrease in cyclosporine A, azathioprine, GAL and OKT3 use, and the increase in mycophenolate, tacrolimus and anti-CD25, has been maintained.

Figure 54 indicates the types of drugs used for maintenance immunosuppressive therapy in patients with functioning transplants on 31 December 2002. A considerable difference in immunosuppressor drug use between 1995 and 2002 is observed. Even though there has been a decrease, corticoids and cyclosporine A are presently the most commonly used immunosuppressors. Mycophenolate and tacrolimus are gaining ground, but are still not on a par with these agents.

Figure 53. Immunosuppressor drugs used during the first six weeks after transplantation. Transplants 1995 and 2002

Figure 54. Maintenance immunosuppressor therapy for functioning transplants on 31 December 2002

As was done in the last years, the Cockroft-Gault formula, which uses serum creatinine, age, weight and sex of the recipient was applied to estimate creatinine clearance. This useful test is recognized as an indirect measure of glomerular filtration.

Cockroft-Gault formula:

$$\text{Estimated creatinine clearance rate in men} = \frac{(140 - \text{age}) \times \text{kg body weight}}{\text{Serum creatinine mg/dL} \times 72}$$

$$\text{Estimated creatinine clearance rate in women} = \frac{(140 - \text{age}) \times \text{kg body weight}}{\text{Serum creatinine mg/dL} \times 85}$$

Figure 55 shows estimated creatinine clearance in patients with a functioning transplant on 31 December 2002 according to sex, as calculated with this formula. Men generally have better glomerular filtration rates than women do. As can be seen, only 8.7% of men have deficient filtration levels (below 30mL/min) as compared to 16.1% of women.

Figure 55. Estimated creatinine clearance by sex. Patients with a functioning graft on 31 December 2002

Glomerular filtration was also studied in relation to recipient and donor age, as is shown in Figures 56 and 57. The data presented correspond to the third-year update on 31 December. As can be seen in both figures, the greater the age of both recipients and donors, the poorer are the glomerular filtration rates and the higher are the percentages of deaths. The two figures also show that the percentage of patients who go back to dialysis is not very high.

Figure 56. Estimated creatinine clearance by recipient age. Update in the third year after transplantation. Transplants 1990-1999

Figure 57. Estimated creatinine clearance by donor age. Update in the third year after transplantation. Transplants 1990-1999

Figure 58. Percentage of graft failures and patient deaths in the first year after transplantation. Transplants 1984-2001

The causes of renal graft loss in the first year after transplantation can be divided into two groups: loss due to graft failure and loss due to the death of the patient (whether or not the kidney was functioning). Figure 58 shows that graft loss due to both these causes has decreased in recent years. In 1984 there were more than 17% of graft failures and more than 7% of deaths in the first year. Since 1998 there has been a considerable decrease in graft losses in the first year after transplantation, which can be attributed to the use of new drugs. In 1999 these percentages were the lowest, at 4.2% and 3.4%, respectively. In 2001 there was an increase to 6.4% and 4.6%.

The main causes of graft loss were analyzed in relation to the time interval between transplantation and graft loss, and to the date of transplantation. For this purpose, patients with graft failure were divided into two groups: graft failure in the first year after transplantation and graft failure in later years. Additionally, two periods were established according to whether transplantation was performed from 1990 to 1997 or later. Overall incidence of graft loss during the first year after transplantation was 16.5% persons/year in the period 1990-1997 and 10.1% persons/year in the period 1998-2000. The incidence of graft loss after the first year post-transplantation was 5.7% persons/year during the first period and 3.3% persons/year during the second period.

The main causes of graft loss during the first year after transplantation in both time periods are death of the patient, complications and acute rejection. Percentages in the second period are smaller than those in the first period (Figure 59). After the first year post-transplantation, the most frequent causes of graft loss are chronic rejection and death of the patient (Figure 60). Transplant recipients from the first period show a higher incidence of graft loss in all the causal categories.

Figure 59. Causes of graft loss during the first year post-transplantation by period, 1990-1997 and 1998-2002

Figure 60. Causes of graft loss after the first year post-transplantation by period, 1990-1997 and 1998-2001

Donor data

During 1995 certain relevant data on the donors, such as age, sex and cause of death were retrospectively collected up to 1990. This new information has improved the analyses presented regarding cadaveric transplants.

Figure 61. Cadaveric kidney transplants from donors over 50 years old and mean donor age, 1990-2002

Figure 62. Cadaveric kidney transplants according to cause of donor death. Transplants 1990-2002

Figure 61 shows that donor age is clearly increasing. In 1990, 20% of all kidneys came from donors over 50 years old, whereas in 2002 this figure had increased to 46.6%. Moreover, this last year 8.9% of kidneys came from donors 70 years of age or older, whereas in 1990-1994 these accounted for 1% to 2% of the total. With these changes, mean donor age has increased from 31.4 years in 1990 to 46.5 in 2002. As compared to the year 2000, this has implied an increase in donor age of almost two years,

In the last years there have been some changes in donor characteristics. As has been mentioned, donors are increasingly older. Analysis of the causes of death shows that fewer donor deaths are due to head injury and more are caused by cerebrovascular accidents (Figure 62).

In order to match donor and recipient age, the age groups have been recalculated. **Young recipients** are now considered to be those under 60 years old and **older recipients** are those 60 or over. Likewise, **young donors** are considered to be those under 60 years old and **older donors** are those 60 or over.

The next figure presents an analysis of estimated creatinine clearance calculated with the Cockroft-Gault formula in patients receiving a cadaveric renal transplant, according to donor and recipient age. Serum creatinine values used in the analysis correspond to results from determinations carried out on 31 December, the third year after transplantation. Included within the estimated clearance levels is the category non-functioning kidney (dialysis) and death of the patient.

In the third-year follow up, young recipients with renal transplants from young donors had better glomerular filtration, with normal rates in 36.7% of cases.

Figure 63. Estimated creatinine clearance in recipients of a cadaveric kidney according to donor and recipient age, in the third-year follow-up, 1990-1999

In contrast, young patients who received a kidney from an older donor had poorer estimated creatinine clearance (59 mL/min; 13.3%) and higher mortality than young patients receiving kidneys from young donors (7.6% as compared to 3.4%). Although 14.8% of older recipients receiving a transplant from a young donor have good glomerular filtration rates, mortality in this group is higher (13.8%) than the rate in older recipients receiving transplants from older donors (13.1%) (Figure 63).

Figure 64. Cold ischemia time of kidney grafts. Transplants 1990-2002

Figure 65. Days on hemodialysis after transplantation in patients with acute tubular necrosis. Transplants 1990-2002

For proper analysis of these data, they should be studied together with the patient and graft survival curves according to the donor characteristics.

The following figures analyze several aspects of kidney transplantation. Figure 64 shows the evolution of the time the organs remained in cold ischemia in the period 1990-2002. There is a trend toward decreases in this time interval. In 1991 the mean number of hours in ischemia was 23.2, whereas this year it was 17.2. The number of days on hemodialysis post-transplantation in patients presenting with acute tubular necrosis has also decreased: 14.8 days in 1990, 4.9 days in 2001 and an increase to 7.9 days this year (Figure 65). Figure 66 shows the percentage of cases of acute tubular necrosis. As can be seen, a decrease in these episodes is not so clear. It should be remembered that the number of cases with incomplete information on this factor is very high (21.7%).

Figure 66. Percentage of patients with episodes of acute tubular necrosis. Transplants 1990-2002

Morbidity

Concomitant disease

Morbidity in patients surviving at the end of the year was analyzed according to several parameters, such as primary renal disease, age, and the most recent type of treatment. For primary renal disease, a classification system often used in the EDTA was applied: **standard disease** (codes 00 to 66), **diabetes** (codes 80 and 81) and **others** (codes 82 to 99). Now, sixteen concomitant diseases have been studied instead of the thirteen analyzed in the year 2000. These additional diseases include hypertension (HTA), irreversible visual deficit and psychiatric disorders, which was added this year. Figure 67 shows that diabetic patients have the highest number of cardiovascular diseases (ischemic heart disease, cardiomyopathy, conduction disorders, and cerebrovascular and vascular diseases), whereas the remaining concomitant diseases studied follow a more homogeneous distribution. The mean number of diseases is similar to the year before in all the groups, despite the incorporation of this new disease.

Figure 67. Concomitant diseases according to primary renal disease. Cases on 31 December 2002

The highest percentage of concomitant diseases is found in the groups of older patients. Concomitant cardiovascular or chronic respiratory disease is present in 23% to 38% of patients 64 to 74 years old and 30% to 47% of patients over 74 years old. Joint disease is present in 44% of patients 64 to 74 years old and 65% of those over 74 years old. The percentage of concomitant diseases in the 45 to 64 year-old group ranges from 11% to 23%. Finally, in patients 15 to 44 years old, the proportion with concomitant diseases is around 5%, except in the case of myocardial disease, vascular disease, esophageal disease, diseases of the stomach and duodenum and joint disease, which are situated at 10% to 15%. The percentage of tuberculosis cases is less than 3% in the three age groups. Chronic liver disease affects 10% to 20% of patients in the various age groups. Moreover, 67% to 78% of patients, depending on age group, have hypertension (Figure 68).

Figure 68. Concomitant diseases by age group. Cases on 31 December 2002

Figure 69. Concomitant diseases by most recent treatment. Patients 45 to 64 years old with standard primary renal disease and either on the waiting list or with a functioning transplant. Cases on 31 December 2002

Since the populations in each of the treatment groups are different in parameters such as age and primary renal disease, which, as has been seen, are variables that affect morbidity, the study was repeated after adjusting the populations for these factors to make them more homogeneous. Thus, for each of the three treatment groups, we selected patients over 44 and under 65 years of age with standard PRD and, in the case of dialysis patients, those who were on the renal transplant waiting list. Results are presented in Figure 69. The mean ages of these new groups is 54.81 years for the dialysis patients (364 cases) and 55.16 for the patients with a functioning transplant (1177 cases). The mean values for concomitant diseases are similar in general terms, although dialysis patients still have a somewhat higher mean and higher percentages of most pathologies than patients with a functioning transplant. Apart from hypertension, the most frequent diseases presented by dialysis patients are joint disease (30.5%); cardiomyopathy (23.6%); esophageal, gastric or duodenal disease (21.4%); and chronic liver disease (15.9%). In patients with a functioning transplant, the most frequent diseases are vascular disease (15.1%), cardiomyopathy (12.3%) and chronic liver disease (15.4%).

Table 9. Main concomitant diseases, 2002

Summarizing this section, Table 9 depicts the main concomitant diseases at the start of RRT in new cases from 2002 and concomitant diseases in all patients alive at the end of the year. Comparison of these results with those from last year shows that patients starting RRT this year have a similar number of concomitant diseases. A slight increase in some pathologies and a decrease in others is also seen for the total of patients on 31 December.

Among the patients alive on 31 December, 477 had concomitant diabetes mellitus (DM). In this group, 313 patients (65.6%) had DM Type 2, 68 patients (14.3%) had DM secondary to other diseases, 33 patients (6.9%) had DM Type 1 and the remaining 63 patients (13.2%) had non-specific DM.

Malignant processes

Figure 70 show the distribution of malignant processes by sex. The most frequent in men are urinary tract (3.5%), skin (2.8%) and genital tract (1.9%) neoplasms. In women the most frequent neoplasms include breast (2.6%), skin (1.6%), urinary tract (1.5%) and genital tract (1.4%) processes. The groups of older patients have a larger number of concomitant malignant processes (urinary, genital and gastrointestinal tract), except for skin cancers, which affect patients 45 to 64 years old more frequently.

The 1995 Statistics Report can be consulted for more information on this subject. In that report the appearance of malignant diseases along the entire period of RRT was studied by actuarial methods according to several factors, such as type of treatment, site of origin of the neoplasm, sex, and age group.

This year the study on the probability of developing a malignant process used data from new cases in the period 1990 to 2002. The overall probability of developing a malignant process after the start of RRT was found to be 10.0% at 5 years and 16.9% at 10 years, and was higher for men than women ($p<0.00001$). By sex, the probability was 11.3% for men and 7.9% for women at 5 years after the start of RRT and 19.3% and 13.0%, respectively, at 10 years. These probabilities increase slightly from one year to the next.

Figure 70. Distribution of malignant processes according to sex. Cases on 31 December 2002

Another factor demonstrating statistically significant differences was age. The probability of developing a malignant process increases considerably in the groups of older patients. At 10 years after the start of RRT the proportion is 17.5% in the 45 to 64 year-old group, 24.7% in the 64 to 74 year-old group and 29.3% in patients over 74 years of age ($p<0.0001$).

Table 10 depicts the probability of developing several types of neoplastic processes at 5 years and 10 years after the start of treatment (dialysis or transplantation). The most frequent are those of urogenital and gastrointestinal origin and skin processes.

Table 10. Probability of developing malignant processes in RRT patients, 1990-2002

Hepatitis C virus

For a number of years, the Registry has been gathering information on hepatitis C virus (HCV) infection, taking advantage of the annual update and paying special attention to the follow up of patients who initiated renal replacement therapy from 1995 on. For this reason, calculation of the probability of testing positive for HCV in serum has been performed only in the patients starting RRT from that date on.

The percentage of cases for which this information is missing has continued to decrease, with figures of 8.9% (504 patients) in 1998, 7.8% (462 patients) in 1999 and 3.1% (205 patients) this year. Many of the cases for which this data is missing are transplant patients in whom HCV status is not known or has not been recorded.

Figure 71. Percentage of patients with antibodies against HCV according to most recent treatment. Cases on 31 December 2002

Figure 72. Probability of developing HCV seroconversion. New cases, 1995-2002

The percentage of patients with antibodies against HCV according to the most recent treatment are shown in Figure 71. Excluding patients in which this information was not recorded, the percentage of patients with HCV antibodies on 31 December 2001 was 16.2% in those receiving HD, a proportion lower than the previous year, and 25.8% in those with a functioning transplant, slightly higher than the year before (21.3%). The percentage of HCV-infected patients among those receiving peritoneal dialysis (9.9%) continues to be lower than that of the other treatment groups.

The overall rate of seroconversion in patients starting treatment from 1995 to 2002 (n=6212) was 1.76 seroconversions per 100 persons/year of follow up. The probability of HCV seroconversion was also calculated according to time on RRT. It is an approximate analysis since the exact date of seroconversion was not available, only the year was known. The cumulative probability was calculated with this information and considering that conversion was produced at the end of the year in which it was reported (Figure 72).

Degree of functional autonomy

This variable is measured with a scale based on the Karnofsky activity scale adapted by Gutman for patients on dialysis treatment (GUTMAN, 1981). The scale is used to assess the level of functional capacity according to five categories:

1. Able to carry on virtually normal physical activity (**Normal**)
2. Able to carry on nearly normal physical activity most of the time (**Nearly normal**)
3. Unable to carry on normal activity. Cares for self (**Limited**)
4. Requires assistance or special care most of the time. Dependent (**Special attention**)
5. Requires hospitalization or continuous care (**Continuous attention**)

The distribution of patients starting renal replacement therapy this year according to the level of functional capacity was quite similar to previous years. Figure 73 shows that the percentage of patients starting RRT this year with a good level of functional capacity is comparable to that of last year. Among the total, 60.6% carry on normal or nearly normal physical activity most of the time, whereas very few patients (1.6%) require hospitalization or continuous care. The distribution over time is very stable and there is a notable decrease in the percentage of cases for which this information is not reported.

Figure 74 depicts the distribution of patients by level of functional capacity on 31 December 2002 according to age groups. The percentage of patients able to carry on normal physical activity decreases with age: 87.9% of the group 15 to 45 years of age perform normal physical activity, whereas 18.0% of the over 74 year-old group have this capacity. The variations in the group of patients under 15 are due to the small number of cases and therefore, are not amenable to analysis.

Functional capacity is also affected by certain diseases such as diabetes and vascular disease. Only 54.6% and 69.3%, respectively, of these patients have normal or nearly normal functional autonomy, whereas more than 80% of patients with glomerulonephritis or polycystic disease have this capacity. In addition, more than 90% of transplant recipients have normal or nearly normal functional autonomy.

Figure 73. Grade of functional capacity in new cases according to year of RRT initiation, 1993-2002

Figure 74. Grade of functional capacity by age group. Cases on 31 December 2002

Cardiovascular risk factors

The study that follows has been conducted using the 2001 revised criteria of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP-III). It includes the 31 December data collected on dyslipidemia and other variables recorded in the Registry (presence of cardiovascular disease, obesity, diabetes, etc.). Following this classification, the only information that is not included is data on first degree family history of coronary disease.

Patients on RRT have an elevated risk of developing cardiovascular disease. In the following analyses the specific criteria used are an adaptation of the NCEP ATP-III. Patients with dyslipidemia are considered to be those having cholesterol levels higher than 199 mg/dL and obese patients are those having a body mass index higher than 30. High cardiovascular risk is defined by the presence of diabetes, ischemic heart disease, cerebrovascular disease or peripheral vascular disease. Moderate cardiac risk is defined by the presence of one or more of the following factors: age greater than 45 years in men and 55 years in women, hypertension (HTA) and dyslipidemia. Low risk is defined by the presence of only one of the aforementioned factors.

Although this data was requested from all patients alive on 31 December, notification was better among dialysis patients than among patients with functioning transplants. The analyses are presented according to the most recent type of treatment received.

Results

Among the 6622 patients on RRT alive on 31 December 2002, information regarding cholesterol was obtained in 87.3% of cases. The remaining variables (age, hypertension, cardiovascular disease, diabetes and obesity) required to perform the study on cardiovascular risk factors have been taken from the Registry.

Figure 75. Cardiovascular risk factors according to most recent treatment received, 2002

Figure 75 shows the most important risk factors. Age is a factor in 83.7% of HD patients and HTA affects 86.6% of patients on PD. Cardiovascular disease was present in 55% of HD patients and 27% of patients with a functioning transplant. Cardiovascular disease is defined as one or more of the following conditions: ischemic heart disease, cerebrovascular disease or peripheral vascular disease. Dyslipidemia, considered to be present when cholesterol levels are higher than 199 mg/dL, was found in 56% of patients with a functioning transplant. Diabetes and obesity affect a smaller percentage of patients.

The evaluation of dyslipidemia and cardiovascular risk factors is carried out in greater depth in the 17th Statistics Report, corresponding to data from the year 2000.

Survival

Survival of patients receiving renal replacement therapy

Overall survival of residents in Catalonia who started renal replacement therapy during the period of 1984 to 2002 is shown in Figure 76. First-year survival is 86.4%, 5-year survival is 55.2% and 10-year survival is 35.1%. Median survival is nearly 6 years.

Figure 76. Survival of patients receiving renal replacement therapy. New cases, 1984-2002

Figure 77. Survival of patients receiving renal replacement therapy according to age at the start of treatment. New cases, 1990-2002

Table 11. Univariate and multivariate survival analyses in patients over 14 years old receiving RRT (Cox regression). New cases, 1990-2002

Analysis of survival by age groups (Figure 77 and Table 11) shows poorer rates at 5 years. Five-year survival is only 22% in patients over 74 years old. The survival rate in children is similar to that in young adults (96% in the first year and 89% in the fifth year). In Figure 77 the differences in survival probability of patients between 20 and 50 years of age are relatively small in the first years, but they increase with increasing age and follow up time. Table 11 presents the univariate analysis (at one and five years) and multivariate analysis survival results in new cases over 14 years old (1990-2002), performed with the Cox regression method (COX, 1972). The weight of each of the following factors is studied: sex, age, PRD, functional capacity grade, situation on transplant waiting list, and morbidity at the start of treatment. Only statistically significant conditions appear in the table.

The first column contains the factor studied, the second, the number of patients included in each of the categories for each variable, the third, the univariate probability of 1-year survival, the fourth, the univariate probability of 5-year survival, and the fifth, the multivariate risk, i.e. the risk adjusted according to other factors. For example, when the other factors under study (PRD, functional capacity, waiting list status and concomitant disease) are equal, patients belonging to the 45 to 64 year-old age group at the beginning of treatment have a 2.76-times higher risk of death than those belonging to the 15 to 44 year-old group. For the qualitative variables, the first category of each of these is taken as the reference and is assigned a risk value of one. Thus, patients with diabetic nephropathy have a 1.69-times higher risk of death than patients with glomerular disease do after adjusting for the remaining variables studied. These results are very similar to those found in previous years (VIDAL, 1991). The last column contains the 95% confidence interval for multivariate risk.

These analyses disclosed considerable differences in survival according to primary renal disease. Patients with glomerular or polycystic diseases show similar results in the first three years, and have the highest survival rates (around 91% in the first year). Nevertheless, the differences increase over time; 5-year survival is 67% in patients with glomerular disease and 79% in patients with polycystic disease.

In patients with interstitial pathology, one-year and five-year survival rates are 88% and 63%, respectively. Survival values are similar in patients with vascular disease, other pathologies, and pathologies of unknown origin, with one-year rates of 81%, 80% and 86%, respectively, and 5-year rates of 44%, 46% and 52%. Patients with diabetes have the poorest survival rates (80% at the first year and 32% at the fifth). After adjusting for other factors influencing survival, it can be seen that patients with polycystic disease have the lowest risk of death, whereas patients with other primary renal diseases and diabetic patients have the highest risk (Table 11, multivariate risk).

Survival was also analyzed according to several factors related to morbidity at the time of initiating renal replacement therapy, such as grade of functional capacity, situation on the waiting list and certain concomitant diseases. The poorer the patient's level of functional independence is at the time of starting treatment, the poorer are the 1-year and 5-year survival rates. After adjusting for the remaining factors, the risk of death is 2.47 times higher in patients that need special attention than in those with normal functional capacity.

Survival of the dialysis patient

Hemodialysis

Table 12. Univariate and multivariate survival analyses in hemodialysis patients over 14 years old (Cox regression). Treatment sequences, 1990-2002

In this section survival is studied in patients receiving hemodialysis treatment. The unit of analysis is the sequence of treatment. Table 12 shows the results obtained in the univariate and multivariate survival analyses of patients on hemodialysis. Variables attaining statistical significance were included in the model. The results are very similar to those found in the overall analysis of RRT patients; the only differences are in some of the concomitant pathologies that significantly affect patient survival. The remaining variables show similar trends.

Peritoneal dialysis

Survival in patients receiving peritoneal dialysis was also analyzed separately. There were no differences with regard to sex or primary renal disease, but the age at the initiation of treatment did have an affect on survival, as is seen in Table 13. After adjusting for the other factors, patients over 74 years old had a 4.44-times higher risk of death than patients 15 to 44 years of age. Furthermore, patients requiring special attention had an approximately four-fold higher risk of death than those with normal functional capacity. Statistically significant concomitant diseases at the start of the sequence included cardiomyopathy, diabetes, chronic liver disease and intestinal disease.

Table 13. Univariate and multivariate survival analyses in peritoneal dialysis patients over 14 years old (Cox regression). Treatment sequences, 1990-2002

Survival of the transplant recipient and graft survival

To provide a more up to date view of the results, most of the data presented in this section belong to the period comprising 1990 to 2002. Figure 78 shows survival data for 5351 grafts from cadaveric donors transplanted in Catalonia during the period 1984 to 2002: 5-year survival is 69% and 10-year survival is 49%. After the first year post-transplantation, the possibility of losing the graft is less than 5% annually. Recipient survival is 90% at 5 years and 81% at 10 years. Death occurs mainly during the first year and annual rates are less than 2%. These results are quite satisfactory, particularly taking into account that the Registry includes information on all patients, a considerable number received transplants more than 10 years ago, and more than 20% of recipients are over 54 years old. It is important to remember these factors when comparing data from the Registry with those from other similar studies. The results for patients receiving grafts from living donors are even better. Survival in patients receiving living-donor grafts is 96% at 5 years and 92% at 10 years, and graft survival is 78% and 59%, respectively.

Figure 78. Patient and graft survival in cadaveric organ transplantation. Transplants 1984-2001

Table 14 summarizes patient and graft survival at one, three, and five years for different types of transplants and various periods. The results obtained are very similar to those presented in previous years.

This year the study of kidney transplantation by periods has also been divided into four intervals: 1984-1989, 1990-1994, 1995-1999 and 2000-2002. Some differences in patient survival are apparent between the last two periods and the first two periods, and graft survival shows a progressive improvement with each period. When viewing these analyses it should be kept in mind that there has been an increase in the mean age of recipients and in the number of risk factors they have, as was described in the section on recipient characteristics. This also applies to graft survival, since the characteristics of donors have also changed in recent years (e.g., older, and fewer deaths due to head injury); nevertheless, despite these factors, graft survival has also improved. The study for the period 1998 to 2002 has also been maintained, since a considerable change in graft survival is observed as compared to previous years.

Table 14. Survival of the patient and graft according to type of transplant and period (actuarial analysis)

Figure 79. Graft survival in cadaveric organ transplantation according to periods, 1990-1997 and 1998-2002

Table 15. Survival of patients with renal transplants from cadaveric donors according to recipient age and primary renal disease (actuarial analysis). Transplants 1990-2002

Figure 80. Graft survival in cadaveric organ transplantation, according to donor age. Transplants 1990-2002

Figure 81. Graft survival in cadaveric organ transplantation, according to donor and recipient age. Transplants 1990-2002

Because of the increasingly higher number of patients who receive more than one transplant (514 in the period of 1990 to 2002), retransplantation is now analyzed separately. Differences in recipient survival between the first and second transplant are not significant. With regard to graft survival, the results are higher in first transplantations. Five-year survival for the second graft is 65%, around 8% lower than for the first graft ($p<0.0001$). Nevertheless, these values indicate a very acceptable probability of survival for patients facing a second opportunity.

Figure 82. Graft survival in cadaveric organ transplantation, according to donor and recipient sex. Transplants 1990-2002

Analysis of survival according to the age at which patients received a transplant (Table 15) reveals a 5-year survival rate of 94% in patients under 55 years old. This value gradually decreases with increasing recipient age: 87% for patients 55 to 59 years old, 80% for patients 60 to 64 years old and 72% for patients over 64. Survival analysis by primary renal disease (Table 15) shows values that are very similar to those from other years: 5-year survival probability is 91% for patients with a standard PRD, 83% for those with diabetes and 86% for patients with other PRDs ($p=0.001$).

In Figure 80, graft survival is progressively lower as donor age increases. This trend is especially marked when donor age is over 60 and, above all, when it is over 70.

Figure 81 summarizes graft survival as related to age of the **recipient** (**young**: under 60 years old and **older**: more than or equal to 60 years old) and to the age of the **cadaveric donor** (**young**: under 60 years old and **older**: more than or equal to 60 years old). These age groups are the same as those used in the section presenting the donor data.

Graft survival varies considerably according to the age of the donor, both in young and older recipients. Five-year survival is 77% in young recipients of a graft from a young cadaveric donor, 60% in young recipients of a graft from an older cadaveric donor ($p<0.00001$), 68% in older recipients of a graft from a younger donor and 52% in older recipients of a graft from an older donor ($p<0.0001$).

Table 16. Univariate and multivariate analyses of graft survival (Cox regression). Cadaveric transplants 1990-2002

Figure 82 shows that there are no statistically significant differences in overall graft survival according to donor and recipient sex. Better graft survival is seen in the cases in which donor and recipient sex coincide, but statistically significant results are only found in male recipients, in whom graft survival results are better when the donors are also male.

Table 16 presents the results obtained in the univariate and multivariate analyses of graft survival using an actuarial method and Cox regression, respectively. As mentioned previously, the multivariate analysis takes into account all the factors studied that can influence survival (introduced in the regression) and calculates the risk for each of them, adjusting for all the others. In this case the factors studied are donor and recipient age at the time of transplantation, maximum and final percentage of antibodies, HLA-DR and HLA-AB matching, and whether or not the patient has cardiac conduction abnormalities or chronic obstructive pulmonary disease.

In summary, graft survival as related to HLA-DR matches between donors and recipients of cadaveric grafts transplanted in Catalonia during the 1990-2002 period is better in the group of patients with transplants having two HLA-DR matches. Five-year survival is 74%, a value 7% higher than that of patients receiving a transplant with no matches (p=0.002). These data confirm the trend observed in prior transplant series, as published in reports from other years. No statistically significant differences in graft survival were found in relation to locus A and locus B matches.

Recipients having antibodies against HLA antigens before transplantation require grafts from donors presenting antigens against which the recipient's antibodies will not react. This is one of the most important obstacles to finding suitable donors. Analysis of graft survival according to the recipient's anti-HLA reactivity, as determined by the panel reactive antibodies (PRA) test, is performed by separate study of the presence of antibodies immediately prior to transplantation (final-PRA) and the maximum level of antibodies presented by the patient at any time during treatment (maximum-PRA). For patients with no anti-HLA reactivity (maximum-PRA 0% to 10%), 5-year graft survival is 74%, for those with low reactivity (maximum-PRA 11% to 50%) graft survival is 69% and for those with high reactivity (hypersensitive, maximum PRA >50%) graft survival is 63%. This difference is also observed when studying only the percentage of antibodies at the time of transplantation: 5-year graft survival is 73% for recipients with no anti-HLA reactivity (final-PRA 0% to 10%), 64% for those with low reactivity (final-PRA 11% to 50%) and 57% for those with high reactivity (final PRA >50%). These data indicate that the presence of antibodies against HLA antigens in the recipient is one of the most important factors affecting renal graft survival. Thus, recipient reactivity at the time of transplantation, even though it may be low, is an essential factor to take into account when deciding long-term immunosuppressor dosage.

Some years ago retrospective data collection was initiated for the following variables: presence of acute tubular necrosis, cold ischemia time and days on dialysis post-transplantation. Although we still have a high percentage of patients in whom this information was not recorded, Figure 83 shows graft survival in patients alive after the first year with a functioning transplant, as related to the presence or not of acute tubular necrosis. Three- and five-year survival was 91% and 77%, respectively, in patients presenting tubular necrosis and 93% and 85%, respectively, in patients without tubular necrosis (p<0.00001).

Figure 83. Graft survival in patients alive the first year with a functioning cadaveric kidney, according to presence of acute tubular necrosis. Transplants 1990-2002

Mortality

Mortality in patients receiving renal replacement therapy during 2002 was 9.8% (718 patients): **15.4%** in the group of patients on **hemodialysis**, **12.6%** in those undergoing **peritoneal dialysis,** and **2.1%** in patients with a **functioning transplant**. The number of patients on RRT who died during 2002 is higher than the previous year, but the percentage among the total of treated patients has remained stable at 9.8%. The distribution of the causes of death is practically identical. The most common cause is heart disease, accounting for nearly 30.0% of all the deaths this year (Table 17). The group of deaths due to unknown causes has increased slightly as compared to the previous year and the group of miscellaneous causes has decreased.

Table 17. Causes of death, 2002

Mortality has been analyzed in percent term (per 100 persons/year) and in relation to sex and treatment period. Among the three periods studied, mortality in 1990-1994 was the lowest, with 9.4% for men and 8.6% for women. In the 1995-1999 period there was an increase to 11.3% for men and 10.9% for women and in the last period, mortality was similar between sexes at 11.2%. Table 18 shows the distribution of the causes of death according to the period. Despite the increases in the percentages, the distribution is quite similar. It should be remembered that the age of treated patients has increased over the years and this fact could justify the increase in mortality.

Table 18. Causes of death according to the treatment period in percentages (per 100 persons/year), 1990-2002

Figure 84 shows the distribution of causes of death according to sex and period of treatment. As was mentioned in reference to Table 18, despite the slight increase in mortality, the distribution of the causes of death has remained stable. The most frequent causes of death are cardiac and vascular disease and infection.

Figure 84. Causes of death according to sex and treatment period. RRT patients, 1990-2002

Figure 85. Mortality according to age group and period. RRT patients, 1990-2002

The concept that in recent periods overall mortality has increased because of aging of the population is confirmed in Figure 85. Despite the fact that overall mortality is higher in the third period, specific analysis according to age group shows that the rate has actually decreased over the different periods, particularly in the older groups of patients. Mortality in children is difficult to assess because of the small number of cases. As can be seen, overall mortality has increased because the populations in the different periods are not comparable. Patients are increasingly older and that is why mortality is higher.

Mortality according to PRD has increased more in patients with vascular disease, diabetic patients and in those with other pathologies. This trend in also related to the inclusion of older patients in this PRD group (Figure 86).

Figure 86. Mortality according to primary renal disease and treatment period. RRT patients, 1990-2002

Figure 87. Mortality due to cardiac causes, by age group and treatment period. RRT patients, 1990-2002

Figure 88. Mortality due to neoplasm, according to age group and treatment period. RRT patients, 1990-2002

Figures 87 and 88 show specific mortality due to cardiac and neoplastic diseases, analyzed by age group and period. In both cases there is a decrease in mortality over time, with the largest reduction in the older age groups, particularly with regard to mortality due to cardiac causes.

Table 19 summarizes mortality rates for specific causes in patients treated in the last three years (2000-2002). In adults, cardiac disease is the main cause of death, with an incidence of 0.9 deaths per 100 persons/year in the 15 to 44 year-old group and 9.1 deaths per 100 persons/year in patients over the age of 74. Mortality in the groups under 15 years old is difficult to assess because of the small number of cases.

Table 19. Causes of death according to age groups, expressed in percent term (per 100 persons/year). New cases, 2000-2002

Figure 89. Mortality according to cause of death and period. Hemodialysis patients, 1990-2002

Figure 90. Mortality according to age group and treatment period. Hemodialysis patients, 1990-2002

Mortality has also been analyzed according to each of the treatments. Figures 89 and 90 show the data for HD patients. An increase in mortality from 12.1 per 100 persons/year in 1990-1994 to 18.4 per 100 persons/year in 2000-2002 is evident in the first graph. Increases are seen in all the causes of death, but the highest occurred in cardiac and vascular disease and infection. In Figure 90 it can be seen that specific mortality per age group decreases over time, particularly in the final period and in the higher age groups.

With respect to peritoneal dialysis, Figure 91 shows a considerable decrease in overall mortality from 22.7 per 100 persons/year in 1990-1994 to 15.6 per 100 persons/year in 2000-2002. There is a substantial decrease in deaths due to cardiac causes and a smaller decrease in the remaining causes. This fact is related to the recent inclusion of young patients in cycling peritoneal dialysis, a group with fewer deaths due to these causes. The decrease in specific mortality by age group is less pronounced than that of patients on hemodialysis (Figure 92).

Figure 91. Mortality by cause of death and period. Peritoneal dialysis patients, 1990-2002

Figure 92. Mortality by age group and treatment period. Peritoneal dialysis patients, 1990-2002

Figure 93. Mortality by cause of death and period. Patients with a functioning renal transplant, 1990-2002

Figure 94. Mortality by age group and treatment period. Patients with a functioning renal transplant, 1990-2002

Overall mortality in patients with a functioning transplant has remained quite stable over the three periods, despite the aging of the population. Nevertheless, the increasing age of the patients has surely had an influence on the changing distribution of the causes of death. Deaths due to cardiac and neoplastic diseases have increased, whereas deaths due to the remaining causes have decreased (Figure 93). Specific mortality by age group (Figure 94) has improved considerably in recent years, particularly in the older age groups.

Figure 95. Causes of death over time on RRT, 1990-2002

Figure 96. Number of patients that died during the first year on RRT. New cases, 1984-2002

Figure 95 shows the distribution of causes of death over the first five years of RRT. The analysis was performed with the new cases during the 1990 to 2002 period. No time pattern was observed in the distribution of causes of death; percentages remain similar regardless of the time on RRT. Mortality due to cardiac disease is most frequent, near 35% at all the intervals studied. Miscellaneous causes show a trend to increases, from 8.3% in the first year to 12.6% in the fourth year of treatment, whereas the deaths due to unknown causes have remained between 8.5% and 10.4%. The other causes do not show specific patterns over time.

Figure 96 depicts the evolution of mortality during the first year of treatment, both in absolute numbers (the value represented by the columns is found in the left axis: number of patient deaths) and in the percentage over the annual incidence (the value represented by each of the points on the line is found in the right axis: percentage). The number of patients who die before completing one year of RRT is growing. In contrast, the percentage that this number of patients implies in the annual incidence is seen to fluctuate over the years, with a strong increase in the last four. Among the new patients in 1986, 9.4% died during the first year of treatment. In 1992 the proportion increased to 14.6%; subsequently there was a decrease to 9.6% in 1993 and again an increase to 13.1% in 1994 and 18.2% in 1995. In 1997 it decreased once again and later there was a new increase. The rate in 2001 was 13.8%. Mortality in patients initiating treatment in 2002 cannot be analyzed as yet because some patients have still not completed the first year of therapy.

Figure 97. Mortality rates during the first year of RRT by age groups. New cases, 1990-2002

Figure 98. Standardized mortality ratios (SMRs) during the first year of RRT (95% confidence interval). New cases, 1990-2002

First-year mortality was also analyzed according to age groups and compared with the overall mortality in the Catalan population. Figure 97 shows mortality rates in Catalonia by age groups for 1996 and mortality rates for RRT patients by age group during the first year of treatment. Specific rates for the renal patients have been calculated starting from mortality in the first year of treatment in the group of patients initiating RRT between 1990 and 2002. The figure shows that mortality rates in the Catalan population and in the Registry population increase with increasing age. Mortality rates in the RRT population are much higher for all the age groups. Figure 98 depicts the ratio between these two rates. Even though the group of patients over 84 years old presents the highest mortality (more than 378.4 per 1000 patients), this rate is only 2.3 times higher than that of the Catalan population, whereas mortality for the 45-54 year-old group (47.0 per 1000 patients) is 14.9 times higher than the Catalan population in the same age group. Overall, the RRT population has a mortality rate 6.9 times higher than that of the Catalan population.

Geographic distribution

Geographic distribution of resources

As decided in the Order of 16 June 1987 for the implementation of the Program for the care of renal failure patients, the functional structure of nephrological services is established as follows (Figure 99):

Nephrology Departments (ND). Nephrology departments comprise the functional framework for attending renal failure patients in Catalonia and guarantee the options for end-stage renal disease replacement therapy. Their sphere of activity covers a specific geographic area. Among their functions, the nephrology departments perform the following:

- Collaborate in the planning of coverage for health care needs
- Perform prevention and diagnosis of renal failure and prescribe renal replacement therapy
- Carry out quality control tasks in all nephrological care units and dialysis centers, for which the NDs are referral centers
- Participate in the Registry of renal disease patients
- In the case of departments with renal transplantation units (RTUs), take charge of managing the transplant waiting lists
- Participate in training programs
- Conduct research tasks

Nephrological care units (NCU). Nephrological care units function within accredited general hospitals. They provide less complex nephrological care and also work as dialysis centers. They are functionally dependent on a nephrology department and also promote active programs of home dialysis.

Figure 99. Functional levels of nephrology care in Catalonia

Dialysis centers (DC). Under the supervision of a nephrology department, dialysis centers provide dialytic replacement therapy to patients with end-stage renal disease and guarantee their clinical monitoring.

The geographic distribution of the resources for renal failure in Catalonia according to the various levels of care is shown in Figure 100.

Figure 100. Nephrological resources for the care of patients with chronic renal failure in Catalonia, 2002

Geographic distribution of the patients

Table 20 shows the evolution of incidence rates for RRT patients from 2000 to 2002, adjusted with the indirect method by age and sex and calculated for the population over 14 years of age. Table 21 shows the prevalence rates for RRT patients, also for the period of 2000 to 2002. The rates have been age- and sex-adjusted by the direct method for the population over 14 years old. In these tables the first column represents the number of cases, the second the standard deviation and the third the standardized rate. With regard to incidence, it must be kept in mind that because of the small number of cases, small fluctuations can produces significant changes in the rates, an effect that does not occur with prevalence.

Table 20. Incidence of RRT patients over 14 years old by health region. Rates expressed per million population, 2000-2002

Table 21. Prevalence of RRT patients over 14 years old by health region. Rates expressed per million population, 2000-2002

Figure 101. Incidence of treated end-stage renal disease in patients over 14 years old by health region. Rates expressed per million population, 2002.

Figure 102. Prevalence of treated end-stage renal disease in patients over 14 years old by health region. Rates expressed per million population, 2002

This effect is also seen in Figures 101 and 102, which only show the incidence and prevalence rates of treated end-stage renal disease corresponding to 2002, with 95% confidence intervals. These rates were calculated using the 1996 Catalan census as the reference population and adjusting for age and sex.

Figure 103. Prevalence of treated end-stage renal disease in rural and urban areas, 1984-2002

Figure 104. Age- and sex-adjusted prevalence of treated end-stage renal disease in rural and urban areas, 1996-2002

Figure 103 shows the prevalence rates for RRT patients in rural areas (less than 10,000 inhabitants) and urban areas (more than 10,000 inhabitants). The changing rates observed in this graph indicate that RRT became more accessible to the rural population during the earlier period, making the distribution of nephrological resources for the care of chronic renal failure patients in Catalonia more equitable. The trend in recent years is not so clear, in part because the rates for 1996 to 2002 were calculated with a more recent background population, the Catalan census for 1996. For this reason, the second period was analyzed for the population over 14 years old, after adjusting for age and sex. As can be seen, the prevalence rate for the urban population shows a clearer tendency to growth than that of the rural areas. In the year 2000 the rural prevalence rate did not grow at the same speed as in previous years. It appeared to recover in 2001, but once again this year the increase was lower.