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Associations between comorbidities, treatment choice and outcome in the elderly with end-stage renal disease

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Abstract

Background. New patients treated for end-stage renal disease are increasingly elderly: in France, 38% are 75 years or older. The best treatment choices for the elderly are still debated.

Methods. We studied case-mix factors associated with choice of initial dialysis modality and 2-year survival in the 3512 patients aged 75 years or older who started dialysis between 2002 and 2005 and were included in the French REIN registry.

Results. Overall, 18% began with peritoneal dialysis (PD), 50% with planned haemodialysis (planned HD) and 32% with unplanned HD, that is, HD that started on an emergency basis. At least one comorbid condition was reported for 85%, and three or more for 36%, but case-mix varied with age. PD was chosen significantly more often than planned HD for the oldest (≥85) compared with the youngest (75–79) patients: odds ratio 2.1 (95% confidence interval, 1.5–2.8), in those with congestive heart failure: 1.8 (1.5–2.3) and severe behavioural disorder: 2.2 (1.3–3.5), but less often for obese patients: 0.5 (0.3–0.8) and smokers: 0.4 (0.2–0.9). Two-year survival rates were 58, 52 and 39% in patients aged 75–79, 80–84 and ≥85, respectively. Compared with planned HD, unplanned HD was associated with a risk of mortality 50% higher, and PD with a risk 30% higher, independent of patient case-mix.

Conclusion. PD is a common treatment option in French elderly patients, but our study suggests the need for caution in the long-term use. The high frequency of unplanned HD would require further attention.

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Introduction

In the past 15 years, while age *per se* was no more considered as a selection criterion for dialysis, the number of elderly persons treated for end-stage renal disease (ESRD) has increased dramatically [1,2] to the point that nearly four of every 10 patients who began dialysis in France in 2005 were >75 years [3]. ESRD incidence that year was 590 pmp, one of the highest rates in Europe [4]. Nevertheless, the best treatment choices and their long-term benefits for the specific needs of these elderly patients who have multiple comorbidities and frequently lack mobility and the ability to live alone are still under debate. Previous studies of elderly patients on dialysis were small and often limited to a single-treatment modality [5–7]. Few large population-based studies investigate the determinants of either the selection of dialysis modalities or long-term outcome in incident patients, and they rarely include a broad case-mix [1,2,8,9].

In France, unlike many other countries [10–12], old age is not a contraindication for peritoneal dialysis (PD), which can be performed by trained home-care nurses without reliance on family members [13]. PD was widely thought to be preferable to haemodialysis (HD) for patients with congestive heart failure until Stack *et al*. [14] showed that these patients may appear to have better survival rates when treated with HD. Malnutrition, obesity and chronic respiratory diseases are common relative contraindications for PD, but there is no consensus about other comorbidities [11]. The role of comorbidities on the choice of first treatment in the elderly has not been studied sufficiently [9]. Several studies have investigated their impact on general survival [15,16] and others, the relative

long-term outcome of PD *vs* HD [14,17,18–20] but few have examined these issues among the elderly [2,8,9].

Accordingly, we used data from the French Renal Epidemiology and Information Network (REIN) registry [21] to study the clinical conditions and laboratory indicators associated with choice of first treatment and with 2-year survival (measured from the first day of treatment) in patients older than 75 years of age who began dialysis between 2002 and 2005.

Subjects and methods

Population

The French REIN registry is intended to include all ESRD patients on renal replacement therapy (RRT)—either dialysis or transplantation—living in metropolitan France or in overseas districts. Patients with a diagnosis of acute renal failure are excluded, i.e. those who recover all or some renal function within 45 days or are considered as such by experts when they die before 45 days. The registry began in 2002 and is growing progressively to include the entire country. The details of its organizational principles and quality control are described elsewhere [21]. In this analysis, we included 3512 patients aged 75 years and over who began dialysis between 2002 and 2005 in one of the following 12 regions, which together cover 48% of the French population: Auvergne, Basse-Normandie, Bourgogne, Bretagne, Centre, Champagne-Ardenne, Languedoc-Roussillon, Limousin, Lorraine, Midi-Pyrénées, Provence-Alpes-Côte d'Azur and Rhône-Alpes.

Information

Baseline information at dialysis initiation included age, gender, primary renal disease, comorbidities, severe disabilities and mobility, glomerular filtration rate (GFR) estimated with both the simplified MDRD equation and the Cockroft–Gault (CG) formula, haemoglobin, albuminaemia, body mass index (BMI) and initial treatment modalities. Information on race is not available, but most patients can be considered white. Patients were classified according to their first treatment modality (intent-to-treat analysis): PD, planned HD and unplanned HD. Unplanned HD was defined as any first HD begun on an emergency basis, that is, in life-threatening circumstances requiring dialysis within 24 h. This information was missing for 2% of patients and was not recorded for patients starting with PD. Primary renal diseases were grouped into four categories: glomerulonephritis, vascular nephropathy (hypertension or renal vascular disease), diabetic nephropathy and others including unknown ESRD causes. For the purpose of this study, nine comorbidities were analysed: diabetes (type 1 or 2), congestive heart failure (New York Heart Association stages I to IV), ischaemic heart disease (including history of coronary vascular disease, myocardial infarction, coronary artery bypass surgery, angioplasty or abnormal angiography), peripheral vascular disease (Leriche classification stages I–IV), cerebrovascular disease, dysrythmia, chronic respiratory disease, malignancy, liver disease (cirrhosis or viral hepatitis) and severe behavioural disorders. Only severe disabilities that may affect patient mobility and independence are recorded in the registry; these include severely impaired vision, amputation, haemiplegia and paraplegia.

Outcome

Five types of events are collected on occurrence from the first day of any treatment: renal transplantation, changes in place of dialysis, switch of dialysis modality, transient recovery of renal function and death. They were registered up to 31 December 2005 (median follow-up 8.6 months). Vital status as well as treatment modality are checked annually for all patients on 31 December, so that event records can be considered exhaustive.

Statistical analysis

Patient characteristics were first compared by age groups (75–79 years, 80–84 years, >85 years) with the chi-square test.

Factors associated with choice of PD as first treatment modality were also analysed with chi-square tests. Those with a *P*-value of 0.20 in the bivariate analysis were considered for multivariate logistic regression as well as well-established determinants of mortality, independent of their crude *P*-value, such as mobility. Patient survival from the first day of treatment was then estimated with the Kaplan–Meier method. Patients were censored on 31 December 2005 or after withdrawal from dialysis for recovery of renal function. They were not censored for transplantation, but this was a rare event.

Risk factors for death during the first 24 months were studied with Cox proportional hazard models. For items with >5% of the missing data (haemoglobin, albuminaemia, BMI, GFR and mobility), a missing category was created. All the factors with a *P*-value of 0.2 in the crude analysis were candidates for the multivariate analysis. After testing the hypothesis of linearity, age was analysed as a continuous variable. We used the option strata in the PROC PHREG for the Cox analysis to take into account that observations within a region could be not truly independent and that confounding by region of treatment is possible ('region effect'). With this kind of stratification, risk is assessed separately in each stratum and pooled across all strata, a method that corresponds to a conditional, fixed-effects model.

Sensitivity analyses

The Cox proportional hazard model compared all PD patients with planned HD patients, but also with all HD patients, overall and separately according to the presence of diabetes and congestive heart failure at initiation. SAS software, version 8 (SAS Institute, Cary, NC, USA) was used to perform analyses.

Results

Baseline patient characteristics

Between 2002 and 2005, 3512 patients older than 75 began dialysis in the 12 regions participating in the REIN registry. The median age of this group was

Table 1. Patient characteristics at dialysis initiation, by age group

	Total ($n=3512$) %	75–79 years ($n=1596$) %	80–84 years ($n=1353$) %	≥85 years ($n=563$) %	*P*
Men	59.3	60.3	58.0	59.3	NS
Primary renal disease					<0.001
Glomerulonephritis	6.1	7.2	5.6	4.1	
Vascular nephropathy	36.4	32.4	38.1	43.6	
Diabetic nephropathy	21.1	25.6	19.2	12.8	
Other or unknown	36.4	34.8	37.1	39.5	
Renal biopsy	8.3	11.2	6.7	3.8	<0.001
Comorbidity					
Diabetes	36.0	41.2	34.5	23.3	<0.001
Ischaemic heart disease	34.4	34.5	34.9	32.6	NS
Peripheral vascular disease	29.3	30.5	29.5	25.4	NS
Cerebrovascular disease	12.8	13.5	12.8	10.6	NS
Congestive heart failure	37.7	34.9	38.9	43.0	0.002
Dysrhythmia	29.0	25.9	31.4	31.9	0.002
Chronic respiratory disease	12.8	13.6	12.6	10.8	NS
Malignancy	8.6	8.4	9.4	7.3	NS
Liver disease	2.2	2.5	2.1	1.4	NS
Severe behavioural disorder	4.5	4.5	5.4	5.7	NS
Any of the above	84.6	83.9	85.7	83.9	NS
Severe disability					
Severe vision impairment	1.9	2.2	2.3	0.6	0.04
Paraplegia or haemiplegia	1.9	2.5	1.6	1.3	NS
Amputation	1.6	2.4	0.9	1.1	0.005
Any of the above	5.3	6.8	4.7	2.9	0.001
Mobility					<0.001
Walk without help	64.3	68.4	63.3	55.2	
Need assistance with mobility	27.3	23.9	28.1	35.1	
Totally dependent for transfers	8.4	7.7	8.6	9.8	
Smoking					
Former smoker	22.6	24.5	22.0	18.6	<0.001
Current smoker	3.5	4.8	2.6	2.4	
Pre-dialysis anaemia care					
Haemoglobin<11 g/dl	60.8	61.8	59.1	62.3	NS
Pre-dialysis ESA treatment	44.0	44.5	43.8	43.5	NS
Nutritional status					
Albuminaemia <35 g/l	57.9	58.0	56.9	59.6	NS
Body mass index <18.5 kg/m^2	6.5	4.9	7.5	8.5	<0.001
Body mass index 25–30 kg/m^2	30.2	33.5	28.8	24.3	
Body mass index ≥30 kg/m^2	11.4	14.8	9.9	5.6	
Baseline eGFR <10 ml/min/1.73 m^2	59.4	62.4	60.0	49.3	<0.001
First treatment modality					<0.001
Planned haemodialysis	49.7	52.2	48.8	44.9	
Unplanned haemodialysis	32.3	33.4	32.9	27.9	
Peritoneal dialysis	18.0	14.4	18.3	27.2	

ESA: erythropoietin stimulating agent; eGFR: glomerular filtration rate estimated with the simplified MDRD equation; NS: Not significant.

80 years (range 75–100 years); 46% of the patients were aged 75–79 years, 38% 80–84 years and 16% older than 85 years; two were centenarians. More than one-third had diabetes, and it was nearly always (96%) type 2 (Table 1). At initiation of treatment, 85% had at least one comorbidity, and 36% had three or more. Primary renal disease differed significantly across age groups. Vascular nephropathy was more frequent among those older than 85 years, while diabetes-related nephropathy was more frequent in those aged 75–79 years. As age at initiation increased, patients were less likely to have diabetes, severe disabilities, elevated BMI or have ever smoked; but they were more likely to have congestive heart failure, dysrythmia, reduced mobility and low BMI. Starting dialysis with an MDRD eGFR value <10 ml/min/1.73 m^2 was less frequent in patients over 85. Using the CG formula, the distribution of the eGFR<10 ml/min/1.73 m^2, by age group, was different: 57% for patients aged 75–79 years, 68% for patients aged 80–84 years and 72% for patients older than 85 years. Most patients were first treated with HD (82%)—77% by in-centre HD, 5% in self-care units, and 18% with home PD—6% with continuous ambulatory and 2% with automated PD. One-third of patients started HD on an emergency basis, which we defined as unplanned HD.

Determinants of the choice of treatment modality

Starting dialysis with PD rather than planned HD was significantly associated with older age, congestive heart failure and severe behavioural disorders (Table 2).

Table 2. Factors associated with choice of PD *vs* planned HD

	Peritoneal dialysis %	Adjusted OR[a]	95% CI
Age at initiation (year)			
75–79	21.7	1	
80–84	27.3	1.3	1.0–1.6
≥ 85	37.7	2.1	1.5–2.8
Gender			
Men	25.5	1	
Women	28.0	1.1	0.9–1.4
Primary renal disease			
Glomerulonephritis	21.1	1	
Vascular nephropathy	29.3	1.5	0.9–2.4
Diabetic nephropathy	24.2	1.5	0.8–2.6
Other or unknown	26.0	1.4	0.8–2.2
Diabetes			
No	29.5	1	
Yes	25.9	0.8	0.6–1.1
Congestive heart failure			
No	23.8	1	
Yes	36.4	1.8	1.5–2.3
Malignancy			
No	28.9	1	
Yes	19.6	0.7	0.5–1.1
Severe behavioural disorder			
No	25.5	1	
Yes	39.4	2.2	1.3–3.5
Any severe disability			
No	26.5	1.0	
Yes	21.0	0.9	0.6–1.5
Mobility			
Walk without help	27.5	1	
Need assistance with mobility	26.3	0.8	0.6–1.1
Totally dependent for transfers	23.4	0.7	0.4–1.2
NA	26.0	0.9	0.7–1.3
Smoking			
Never smoker	30.0	1	
Former smoker	24.9	0.7	0.5–0.9
Current smoker	16.4	0.4	0.2–0.9
Haemoglobin (g/dl)			
≥11	34.4	1	
<11	27.2	0.8	0.6–1.0
NA	19.5	0.7	0.5–1.1
Albuminaemia (g/l)			
≥35	31.8	1	
<35	28.3	0.8	0.6–1.0
NA	23.6	0.9	0.6–1.2
Body mass index (kg/m^2)			
<18.5	30.4	1.0	0.6–1.6
18.5–25	29.8	1	
25–30	30.0	1.0	0.8–1.4
≥30	17.1	0.5	0.3–0.8
NA	21.7	1.0	0.6–1.3
Baseline eGFR (ml/min/1.73 m^2)			
<10	25.0	1	
≥10	32.3	1.4	1.1–1.7
NA	19.5	1.1	0.7–1.6

[a]OR adjusted for all variables as well as for region of residence.
NA: not available; eGFR: glomerular filtration rate estimated with the simplified MDRD equation.

Those starting PD also had an MDRD eGFR ≥10 ml/min/1.73 m^2 significantly more often than those starting HD (similar results were observed with the CG equation). In contrast, PD was chosen significantly less often for obese patients and smokers. It was also less frequent for patients with malignancies, anaemia, hypoalbuminaemia or diabetes, but the associations were of only borderline significance. The percentage of patients starting PD varied from 3% to 38% across regions, and the patients' characteristics did not explain this difference. These results were similar (data not shown) when we compared those starting PD with all patients starting HD (not simply planned cases), except that the associations with malignancy, anaemia and hypoalbuminaemia levels became statistically significant: 0.6 (0.4–0.9), 0.6 (0.5–0.8) and 0.7 (0.5–0.9), respectively. Treatment modality was not associated with chronic respiratory disease or with any type of vascular disease (of the heart, brain or peripheral vessels), regardless of the reference group.

Two-year outcome

During a 2-year follow-up, 66 patients recovered renal function, two had kidney transplantations, 57 switched from PD to HD and 51 from HD to PD and 1096 died (Table 3). Patient median survival was 26.8 months. Cardiovascular disease was the cause of death in 39% of the cases. Overall, survival was 68.5% (66.7–70.2) at 1 year, 52.7% (50.4–55.1) at 2 years and 39.3% (35.9–47.8) at 3 years, but, as expected, it decreased strongly with age, especially after 2 years (Figure 1). Death occurred after withdrawal of treatment in 17, 19 and 22% of the groups aged 75–79 years, 80–84 years and older than 85 years, respectively, in a median time of 5 months (range: 2 days–44 months) after the onset of dialysis. Treatment was withdrawn for medical reasons in 67% of the cases and at the patient's request in 25%.

Relations between comorbid conditions, treatment modality and 2-year mortality

Older age, congestive heart failure, peripheral vascular disease, malignancy, chronic respiratory disease, behavioural disorders, disability, reduced mobility, low BMI and albuminaemia were independently associated with a higher risk of death at 2 years (Table 4). Unplanned HD and PD were also significantly associated with a higher risk of death than planned HD, even after adjusting for all other risk factors. When those starting PD were compared with all those starting HD, the crude and adjusted risks at 2 years were similar for both treatment modalities (Table 5). There was no differential association between PD and either planned or all HD with diabetes or congestive heart failure.

Discussion

In this registry-based study, we found that despite a high comorbidity rate (85%), elderly patients who started dialysis between 2002 and 2005 appeared to

Table 3. Two-year outcome according to treatment modality at initiation

First treatment modality		Two-year outcome				
		Haemodialysis	Peritoneal dialysis	Renal function recovery	Transplantation	Death
Planned haemodialysis	*n*	1216	20	27	2	441
n = 1706	%	71	1	2	0	26
Unplanned haemodialysis	*n*	620	31	25	0	434
n = 1110	%	56	3	2	0	39
Peritoneal dialysis	*n*	57	325	14	0	221
n = 617	%	9	53	2	0	36

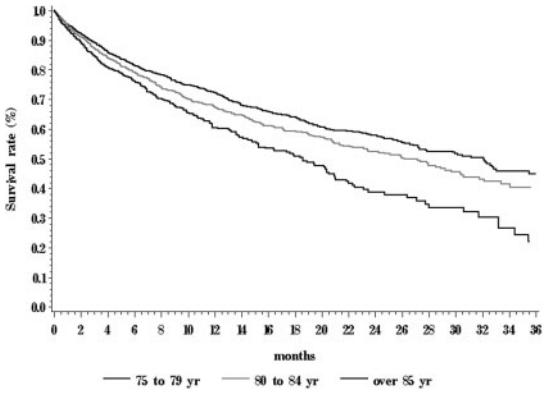

Fig. 1. Survival rate by age group.

benefit from dialysis: 50% of all those 75 years or older survived more than 2 years, as did 40% of those 85 or older. Comorbidity profiles tended to change with age. Nearly one in five started with PD, a frequent choice in France for the oldest patients, particularly those with congestive heart failure or severe behavioural disorders. Obesity, hypoalbuminaemia, anaemia, malignancy and smoking, on the other hand, reduced the preference for PD. After careful adjustment for initial conditions, patients who started HD on an emergency basis (unplanned HD) had a mortality risk 50% higher than their counterparts with planned HD, and those who started with PD had a 30% higher risk.

The frequency of diabetes and coronary heart disease in our cohort was in the upper range of incident European dialysis populations older than 60 years: 36 *vs* 18–46% for diabetes, and 34 *vs* 25–37% for coronary heart disease, whereas the frequency of peripheral vascular disease (29%) was around the median. The frequency of cerebrovascular disease (13%) was in the lower range (14–31%) as was that of malignancies (9 *vs* 10–20%) [15]. The 80% proportion of those with at least one comorbidity in the North Thames Dialysis Study including 125 incident patients aged 70 years or older was close to the 85% we observed, but the elderly patients in the UK were less likely to have diabetes and more likely to have cardiovascular diseases than their French counterparts [5]. In contrast, octogenarians and nonagenarians starting dialysis in the US [2] had hypoalbuminaemia more often (76 *vs* 58%), and those aged 65 years and over had diabetes, ischaemic heart disease, congestive heart failure, cerebrovascular disease and malignancies much more often [9]. Rates of severe behavioural disorders or dementia were low (<5%) and are similar across studies. Although international comparisons of comorbid conditions may be hampered by differences in definitions or data collection methods, we cannot rule out the possibility that elderly French patients may be 'healthier' at dialysis initiation than their US counterparts. In this respect, it is worth pointing out that as French patients grow older they tend to be thinner and have diabetes and severe disabilities less often, but congestive heart failure and dysrythmia more often. Although this may reflect survival bias from competing causes of death, it may also result from comorbidity selection during referral to RRT. This change in the case-mix profile with aging has implications for treatment choice.

To study the factors determining the choice of dialysis modality, we first compared patients who started with PD to those with planned HD and then to all those who started HD. By excluding patients who started with unplanned HD, we improved the comparability of the groups with respect to pre-dialysis care and conditions surrounding dialysis modality selection, because HD is much more likely to be chosen than PD in emergency situations. Until the study by Stack *et al.* [14], congestive heart failure was considered a good indication for PD because it provides the possibility of continuous ultrafiltration. As in the study by Winkelmayer *et al.* [9], but in contrast to the CHOICE study [11], elderly French patients with congestive heart failure were more likely to start with PD than their counterparts without it. Some clinicians favour PD for diabetic patients [11] while others do not; potential advantages include that neither vascular access nor systemic anticoagulation is needed and that fluid removal is more gradual. Both of these advantages are useful in patients with polyvascular disease. The main drawback is that patients may be more

Table 4. Risk factors associated with 2-year mortality

	No. of deaths	Adjusted HR[a]	95% CI
Age (per year)	1121	1.04	1.03–1.06
Primary renal disease			
Glomerulonephritis	52	1	
Vascular nephropathy	207	1.1	0.8–1.5
Diabetes nephropathy	434	1.2	0.9–1.8
Other and unknown	428	1.2	0.9–1.6
Comorbidity[b]			
Diabetes	410	1.1	1.0–1.3
Ischaemic heart disease	398	1.1	0.9–1.2
Peripheral vascular disease	380	1.4	1.2–1.6
Cerebrovascular disease	160	1.1	0.9–1.3
Congestive heart failure	492	1.4	1.2–1.6
Dysrhythmia	339	1.1	0.9–1.2
Chronic respiratory disease	169	1.3	1.1–1.6
Malignancy	134	2.1	1.7–2.5
Severe behavioural disorder	89	1.5	1.1–1.8
Any severe disability *vs* none	74	1.1	0.8–1.4
Mobility			
Walk without help	326	1	
Need assistance with mobility	251	1.6	1.3–1.9
Totally dependent for transfers	106	2.5	1.9–3.2
NA	438	1.2	1.0–1.5
Haemoglobin (g/dl)			
≥11	250	1	
<11	489	1.0	0.9–1.2
NA	382	0.9	0.6–1.1
Albuminaemia (g/l)			
≥35	191	1	
<35	365	1.2	1.0–1.5
NA	565	1.1	0.9–1.4
Body mass index (kg/m^2)			
<18.5	74	1.6	1.2–2.0
18.5–25	423	1	
25–30	202	0.8	0.6–0.9
≥30	68	0.6	0.5–0.8
NA	354	1.1	0.8–1.4
eGFR (ml/min/1.73 m^2)			
<10	387	1	
≥10	499	1.0	0.9–1.2
NA	235	1.2	0.9–1.6
First treatment modality			
Planned haemodialysis	441	1	
Unplanned haemodialysis	434	1.5	1.3–1.8
Peritoneal dialysis	221	1.3	1.1–1.6

[a]HR: hazard ratio, adjusted for all variables as well as for region of residence; [b]HR for the presence *vs* absence of each comorbidity. BMI: Body mass index; eGFR: glomerular filtration rate estimated using the MDRD equation.

susceptible to malnutrition and ultrafiltration failure. In the REIN registry, elderly patients with diabetes were less likely, although not significantly so, to start with PD. Our findings that obese patients and those with low albumin or haemoglobin concentrations were less likely to choose PD are consistent with others in younger populations [10,11]. Smoking was strongly associated with starting with HD, perhaps as a surrogate marker for chronic respiratory disease. Finally, we also found that PD starters tended to have a higher GFR level at initiation than HD starters, a result consistent with that of Xue *et al*. [10], who reported a lower baseline creatinine value in the former.

Table 5. Hazard ratio of 2-year mortality in patients starting with PD, compared with planned or all HD patients, according to the presence of diabetes and congestive heart failure at baseline

	PD compared with planned HD		PD compared with all HD	
	HR	95% CI	HR	95% CI
All patients				
Crude HR	1.3	1.1–1.5	1.1	0.9–1.2
Adjusted[a] HR	1.3	1.1–1.6	1.1	0.9–1.3
Patients with diabetes				
Crude HR	1.4	1.0–1.8	1.1	0.8–1.4
Adjusted[a] HR	1.3	0.9–1.7	1.0	0.8–1.3
Patients without diabetes				
Crude HR	1.4	1.1–1.7	1.1	0.9–1.4
Adjusted[a] HR	1.4	1.1–1.7	1.1	1.0–1.5
Patients with congestive heart failure				
Crude HR	1.3	1.0–1.7	1.1	0.9–1.4
Adjusted[a] HR	1.4	1.1–1.8	1.0	0.9–1.4
Patients without congestive heart failure				
Crude HR	1.2	1.0–1.6	1.0	0.8–1.2
Adjusted[a] HR	1.3	1.0–1.6	1.1	0.8–1.3

[a]Hazard ratios adjusted for age, primary renal disease, comorbidities, disabilities and mobility as listed in Table 4, albuminaemia, anaemia, body mass index, eGFR and region of residence.

After controlling for all other factors, older age remained a strong independent predictor for choosing PD. This is unusual since, except for such countries as Canada, the UK and Scandinavian countries [7], PD is more often prescribed for autonomous young patients [10,12]. In France, the availability of assistance of home-care nurses makes it possible to maintain very old people on PD [13]. There are, however, important disparities in the use of PD across regions; this use ranges from 3% to 38% of patients, independent of their conditions. This suggests that the management of old patients depends not only on their personal characteristics but also on the experience and strategies of each centre as well as on regional health policies. Reasons for these variations, which also concern young patients, are the object of in-depth investigation.

In Europe, the crude probability of 1-year and 2-year survival from Day 1 in incident patients over 75 years of age between 1998–2002 was 69.6 and 51.1%, respectively, close to our findings: 68.5 and 52.7%, respectively [4]. In contrast, the stable 1-year survival of 46% observed in the dialysis patients aged 80 years and older in the US from 1996–2003 [2], was well below the 67.3% and 60.5% we found in those aged 80–84 years and older than 85, respectively. These results, although crude, are consistent with previous international comparisons that show better survival of prevalent HD patients in Europe than in the US, even after adjusting for the case-mix [16]. It is worth

pointing out some other aspects of these patient outcomes, which are rarely reported. Switching from PD to HD was frequent; it occurred in one of 10 patients by 2 years, but the reverse was rare. Although two patients were transplanted, this remains a rare option for those older than 75 years of age in France as in the rest of Europe except Norway [1,4]. Renal function recovery in 2% of the cohort, in contrast, was not as exceptional.

It is well known that comorbidities have a major impact on patient survival. Many studies use a global index that shows that the higher the number or severity of comorbid conditions, the lower the survival rate [2]. However, it is also important to characterize the profile of patients at high risk of death. Because they need large sample sizes, such investigations in the elderly have often lacked the power to identify significant risk factors [5,6]. In our large registry-based sample, comorbidities most strongly associated [hazard ratio (HR) $\geq$1.5] with 2-year mortality among the elderly patients were malignancy, severe behavioural disorders, low BMI, reduced mobility and congestive heart failure. Diabetes, all types of cardiovascular diseases and chronic respiratory disease were also significantly related to a higher risk of death, but with lower HR, ranging from 1.1 to 1.4. These findings are consistent with those observed in younger patients from two large international studies, in prevalent HD patients [16] and in an incident European registry-based population [15]. They are also consistent with those observed in older hospitalized patients or community residents where factors related to frailty (reduced mobility, severe behavioural disorders) are strong predictors of mortality [22,23].

As expected, hypoalbuminaemia (<35 g/l), a marker of malnutrition, was independently related to mortality, but less strongly than was low BMI (<18.5 kg/m^2). The 'obesity paradox' previously described was also observed in the REIN elderly population, with a strong inverse dose–effect relation between BMI and 2-year mortality [24]. Finally, it is generally accepted that high-risk patients may benefit from starting dialysis earlier, but the timing of initiation remains controversial [25]. In our study, PD patients were more likely to start with a higher GFR, but its level at onset was not associated with mortality after adjustment for all other risk factors.

One-third of the ESRD elderly population started dialysis in life-threatening circumstances: this unplanned HD was unsurprisingly associated with the highest mortality risk. This finding is consistent with the worse patient outcome well known to be related to shorter pre-dialysis care [5], even though the REIN registry definition of unplanned HD cannot be compared with so-called 'late referral' in that some patients may start dialysis on an emergency basis despite timely referral to a nephrologist. Numerous publications, critically reviewed by Ross *et al*. [26] and Vonesh *et al*. [19], have compared the outcome of PD *vs* HD over the past decade. Only a few were devoted to incident elderly patients [8,9] or provided data by age group including at least one group >65 years [17,18,20]. Overall, despite differences in results due to the degree of case-mix adjustment and to the use of various comparison subgroups, the most recent large-scale studies suggest that the elderly population treated with PD has a higher long-term ($\geq$2 years) mortality risk than their HD counterparts [8,9,17,18,20]. In one study, the poorer outcome for PD was limited to elderly patients with diabetes [9]. In other studies [8,17,20], as in ours, the impact of diabetes on the HR of PD *vs* HD was less important or null. Contrary to our findings and despite the higher frequency of congestive heart failure in elderly PD *vs* HD starters, an analysis of US data reported that this comorbid condition modified the HRs of mortality for PD and HD [14]. Our finding that the 2-year mortality rate among those who started with PD did not significantly differ from that of all who started with HD (intent-to-treat analysis) may seem inconsistent with the above cited studies. Nevertheless, the 30% higher adjusted mortality risk in PD patients compared with their counterparts with planned HD at initiation is consistent with the more pronounced risk of PD *vs* HD observed by Winkelmayer *et al*. [9] among the group of patients with early nephrologist visits. In both cases, the analysis is limited to patients assumed to have had time to make an educated decision and be prepared for treatment. These results suggest that excluding unplanned HD may provide a fairer estimate of HRs for comparing mortality associated with PD and HD. The worse survival in elderly patients treated with PD, however, may be counterbalanced by overall greater satisfaction and better quality of life [27,28]. This technique also has the great advantage of allowing elderly patients to remain at home and avoid long journeys.

A major strength of this study is that it is based on a large non-selected population including all incident dialysis patients older than 75 years from 12 regions, covering half of the country, and it had a follow-up close to 100%. These data can therefore be generalized to the entire elderly population on dialysis in metropolitan France. Moreover, because so many comorbidities were recorded at baseline, and so few data were missing [21], we were able to conduct a broad case mix analysis of this population. Selection bias due to early death is also limited since all patients are registered and followed from the first day of treatment.

This study, however, has limitations. First, although the REIN registry collects and records many comorbidities and laboratory values, we cannot exclude the possibility that unmeasured factors unequally distributed between HD and PD patients affected our results. Second, the number of PD patients starting in an unplanned manner was unknown. Our definition of unplanned dialysis (life-threatening circumstances requiring dialysis within 24 h) was indeed not applicable to PD as temporary catheter is not used in France.

However, since it may happen that some patients with a peritoneal catheter may start dialysis in life threatening circumstances or that some others may be coded as starting with PD after a few sessions of unplanned HD, we have started to record this item in our new information system. Third, data were not available to adjust for social factors, dialysis adequacy and compliance with treatment. In particular, because there is no consensus nowadays about the best indicator for dialysis adequacy measurement, allowing comparison between HD and PD and easy to collect for registry purposes, we were unable to take into account the dose of dialysis in both groups and so, we could not exclude that some PD patients might be under-dialysed. Fourth, we also used an intent-to-treat analysis, in which the patient switches from one type of dialysis to another were not considered (crossover effect). Finally, it would be interesting to evaluate quality-of-life in these patients. This information is not available as part of registry core data. But in the framework of the national public health programme, quality-of-life is evaluated in a representative sample of dialysis and transplanted patients on a regular basis and the first results are under analysis.

In conclusion, results from the REIN registry show that many clinical factors and laboratory indicators influence the choice of dialysis modality, but that PD is not necessarily selected for the healthiest patients in France. In terms of survival, old patients with ESRD definitely benefit from dialysis treatment. Because registry data are observational in nature, we cannot conclude that being on PD carries a higher mortality. Nonetheless, this study and some earlier ones suggest the need for caution in the long-term use of PD in the elderly population. Further population-based studies are needed to evaluate a timely switch from PD to HD. Our finding that HD began in life-threatening circumstances in a third of the patients requires further investigation to identify potential modifiable determinants.

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