ORIGINAL ARTICLE

Functional Status of Elderly Adults before and after Initiation of Dialysis

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ABSTRACT

BACKGROUND

It is unclear whether functional status before dialysis is maintained after the initiation of this therapy in elderly patients with end-stage renal disease (ESRD).

METHODS

Using a national registry of patients undergoing dialysis, which was linked to a national registry of nursing home residents, we identified all 3702 nursing home residents in the United States who were starting treatment with dialysis between June 1998 and October 2000 and for whom at least one measurement of functional status was available before the initiation of dialysis. Functional status was measured by assessing the degree of dependence in seven activities of daily living (on the Minimum Data Set–Activities of Daily Living [MDS–ADL] scale of 0 to 28 points, with higher scores indicating greater functional difficulty).

RESULTS

The median MDS–ADL score increased from 12 during the 3 months before the initiation of dialysis to 16 during the 3 months after the initiation of dialysis. Three months after the initiation of dialysis, functional status had been maintained in 39% of nursing home residents, but by 12 months after the initiation of dialysis, 58% had died and predialysis functional status had been maintained in only 13%. In a random-effects model, the initiation of dialysis was associated with a sharp decline in functional status, indicated by an increase of 2.8 points in the MDS–ADL score (95% confidence interval [CI], 2.5 to 3.0); this decline was independent of age, sex, race, and functional-status trajectory before the initiation of dialysis. The decline in functional status associated with the initiation of dialysis remained substantial (1.7 points; 95% CI, 1.4 to 2.1), even after adjustment for the presence or absence of an accelerated functional decline during the 3-month period before the initiation of dialysis.

CONCLUSIONS

Among nursing home residents with ESRD, the initiation of dialysis is associated with a substantial and sustained decline in functional status.

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In the United States, increasing numbers of elderly patients with end-stage renal disease (ESRD) are starting dialysis.[1] In 1999, nursing home residents accounted for 4% of all new patients with ESRD and 11% of new patients with ESRD who were older than 70 years of age.[2] The benefits of dialysis in such patients are uncertain. Mortality in the first year after the initiation of dialysis exceeds 35% among patients older than 70 years of age and exceeds 50% among patients older than 80 years of age.[2] Moreover, the extent to which dialysis extends life and its effect on the quality of life in elderly patients who are frail or disabled remain unclear.[3-5]

Functional status — the ability to perform activities such as walking, bathing, dressing, getting out of bed, and using the toilet — is a key aspect of the quality of life, a strong predictor of survival, a determinant of caregiving needs and health care costs, and a factor in decisions about medical procedures such as the use of feeding tubes or cardiopulmonary resuscitation.[6-9] In patients with a limited life expectancy, dialysis may be started with the intention of alleviating symptoms and improving function. High rates of functional impairment have been reported among patients with ESRD.[10,11] However, the trajectory of functional status during the transitional period from chronic kidney disease to ESRD is unclear, and to our knowledge, the effects of the initiation of dialysis on functional status have not been investigated.

We studied the trajectory of functional status before and after the initiation of dialysis among elderly nursing home residents with ESRD. We aimed to evaluate the frequency of short-term and long-term maintenance of functional status after the initiation of dialysis and to estimate the effect of the initiation of dialysis on the trajectory of functional status.

Methods

Subjects

We used data from the U.S. Renal Data System (USRDS) linked with data from the Minimum Data Set to identify nursing home residents who started treatment with dialysis between June 1998 and October 2000. The USRDS includes data on more than 99% of persons starting dialysis in the United States. The Minimum Data Set is a registry of nursing home residents in the United States. The principal investigator had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

On the basis of these linked data, the study cohort consisted of persons who were residing in a nursing home or who were admitted to a nursing home before the first ESRD service date, with a length of stay of at least 90 consecutive days (not including departures of 15 days or less) or a length of stay of less than 90 consecutive days due to death, and persons who had resided in a nursing home for 90 consecutive days, were discharged no more than 15 days before the first ESRD service date, and then returned to a nursing home within 90 days.[2] Of the 3902 nursing home residents who met these criteria, we excluded 200 for whom no assessments of functional status before the start of dialysis were available, for a total of 3702 nursing home residents.

Outcome

Minimum Data Set assessments were completed by nursing staff at admission and quarterly thereafter, as well as at the time of acute changes in clinical status and readmission from a hospital. Functional status was evaluated according to the ability to perform each of seven activities of daily living (eating, dressing, toileting, maintaining personal hygiene, walking, transferring from a chair to a standing position, and changing positions in bed). Each activity was rated from 0 to 4 points, with 0 indicating independence, 1 the need for supervision, 2 the need for limited assistance, 3 the need for extensive assistance, and 4 dependence. The total Minimum Data Set–Activities of Daily Living (MDS–ADL) score, which has been validated previously, ranges from 0 to 28 points, with higher scores indicating more extensive functional impairment.[12-14]

Covariates

Data on demographic characteristics, coexisting conditions, and selected laboratory data at the time of the initiation of dialysis were obtained from the Medical Evidence Report (form 2728) of the Centers for Medicare and Medicaid Services; this form typically was completed by the attending nephrologist or other designated dialysis personnel. Coexisting conditions were considered to be present if they were documented on either the USRDS or the Minimum Data Set forms. Laboratory measurements were obtained at the time of the initiation

of dialysis. Hospitalization status at the time of the initiation of dialysis, discharge diagnoses, and procedures were determined by linking the medical evidence form with the USRDS hospitalization files. We used validated methods to classify the primary and secondary diagnosis codes into diagnostic categories.[15,16]

STATISTICAL ANALYSIS

The distribution of MDS–ADL scores and the frequency of missing data at quarterly intervals before and after the initiation of dialysis were first evaluated graphically. We determined the change in functional status at 3, 6, 9, and 12 months after the initiation of dialysis, using the last measurement of functional status before the initiation of dialysis as a baseline. We defined a decline in functional status as an increase of two or more points in the MDS–ADL score and maintenance of functional status as no increase or an increase of one point. Because there were missing follow-up data on 22% of residents for at least one time point after the initiation of dialysis, we repeated the analyses, reclassifying residents with missing follow-up data due to hospitalization as having a decrease in functional status and reclassifying residents with missing data due to discharge home as having a functional status that was maintained. We then used logistic regression to determine the odds of a maintained functional status versus death or functional decline 12 months after the start of dialysis.

As a complementary approach, we used a random-effects model to describe the change in functional status from 12 months before to 12 months after the initiation of dialysis. Our base model fit separate slopes before and after the initiation of dialysis, allowed a sharp change shortly after the initiation of dialysis, and adjusted for age at the initiation of dialysis, sex, and race. We also included two random effects — intercept and time relative to the initiation of dialysis; this allowed a unique trajectory for each resident, which varied randomly around the trajectory described by the model's fixed effects. From this base model, the estimate for the initiation-of-dialysis variable indicated the magnitude of change in functional status associated with the start of dialysis. We then conducted the analyses, modeling the trajectory as a cubic spline rather than as a linear function of time, to determine whether there was evidence of a decrease in functional status before dialysis as compared with after dialysis.

To evaluate the robustness of our results, we repeated the analyses, limiting the analytic cohort to subgroups with more data on activities of daily living (i.e., patients who survived for at least 3 months after the initiation of dialysis, and patients with assessments of activities of daily living within 1 month before the initiation of dialysis and one such assessment after the initiation of dialysis) in order to assess the influence of the timing of these assessments and of missing data on the study results. To determine whether demographic or selected clinical factors might have influenced the rate of change of functional status, we fit companion models that included interaction terms for age, sex, race, serum albumin concentration, presence or absence of dementia, and hospitalization status at the initiation of dialysis. Analyses were conducted with the use of SAS software, version 9.1.

RESULTS

CHARACTERISTICS OF THE COHORT

The mean (±SD) age of the residents was 73.4±10.9 years; 60% were women, and 64% were white (Table 1). As compared with residents who did not have assessments of functional status, residents included in the analytic cohort had a similar age and estimated glomerular filtration rate at the start of dialysis, but they were more likely to be women and to have a history of congestive heart failure, stroke, or dementia. Among the 69% of nursing home residents who were hospitalized at the start of dialysis, the most common diagnoses at discharge were chronic kidney disease in 62%, congestive heart failure in 30%, and acute kidney injury in 24%, whereas less than 10% of residents had a discharge diagnosis of atherosclerotic vascular disease or infection. Access procedures were also common; 62% of nursing home residents underwent catheter placement and 23% underwent placement or revision of an arteriovenous fistula or graft. Less than 5% of nursing home residents were hospitalized solely for chronic kidney disease, for a condition related to chronic kidney disease (e.g., acidosis or hyperkalemia), or for a dialysis-related procedure.

Figure 1A shows the proportions of nursing home residents with assessments of activities of daily living during quarterly intervals before and after the initiation of dialysis and the cumulative mortality rate after the initiation of dialysis. The median time from the start of dialysis to the first assessment of activities of daily living after dialysis was 17 days (interquartile range, 10 to 32).

Table 1. Characteristics of the Subjects at the Initiation of Dialysis.*

Characteristic	Subjects†
Age (yr)	73.4±10.9
Estimated glomerular filtration rate (ml/min/1.73 m² of body-surface area)	10.7±4.9
Albumin (g/dl)	2.9±0.6
Female sex (%)	60
Race (%)‡	
White	64
Black	32
Other	4
Coexisting condition (%)	
Diabetes	68
Congestive heart failure	66
Coronary artery disease	44
Peripheral vascular disease	37
Cerebrovascular disease	39
Chronic obstructive pulmonary disease	24
Cancer	12
Dementia	22
Depression	35
Hemodialysis (vs. peritoneal dialysis) (%)	95
Hospitalized at initiation of dialysis (%)	69

* Plus–minus values are means ±SD.
† Data shown are for 3702 subjects, except for the estimated glomerular filtration rate (3577 subjects) and albumin concentration (2654 subjects).
‡ Race was reported in the U.S. Renal Data System database.

LIKELIHOOD OF SURVIVAL AND MAINTENANCE OF FUNCTIONAL STATUS

The distribution of MDS–ADL scores was similar throughout the year preceding the initiation of dialysis, with a slight worsening during the last quarter before the initiation of dialysis; this worsening corresponded to an increase in the median score from 11 to 12 (Fig. 1B). After the initiation of dialysis, the cumulative mortality rates were 24% at 3 months, 41% at 6 months, 51% at 9 months, and 58% at 12 months. Among survivors, there was a substantial worsening in functional status, reflected by an increase in the median score from 12 to 16 during the 3 months after the initiation of dialysis (Fig. 1B). Significant functional decline was observed in each component of the MDS–ADL score after dialysis ($P<0.001$ for the comparison with the scores before dialysis), and half the cohort had functional decline in two or more activities of daily living (see Fig. S1 in the Supplementary Appendix, available with the full text of this article at NEJM.org).

Within 3 months after the start of dialysis, 61% of the nursing home residents had died or had a decrease in functional status as compared with their functional status before dialysis, and 39% had the same functional status that they had before dialysis (Fig. 2). By 12 months, 87% of residents had died or had a decrease in functional status; in other words, only one of eight residents had a functional status that was maintained after the initiation of dialysis. The results were similar when hospitalized nursing home residents for whom data were missing were reclassified as having decreased functional status and when discharged residents for whom data were missing were reclassified as having a functional status that was maintained.

After adjustment for demographic and clinical factors, older age, white race, cerebrovascular disease, dementia, hospitalization at the start of dialysis, and a serum albumin level below 3.5 g per deciliter were independently associated with a lower odds of a functional status before dialysis that was maintained 12 months after the start of dialysis (see Table S1 in the Supplementary Appendix).

TRAJECTORY OF FUNCTIONAL STATUS

With the use of a random-effects model, the initiation of dialysis was associated with a decline in functional status, indicated by an increase of 2.8 points (95% confidence interval [CI], 2.5 to 3.0) in the MDS–ADL score. This decline was independent of age, sex, race, and trajectory of functional status before the initiation of dialysis (Table 2). The annual change in function was indicated by an increase of 2.2 points during the 12 months before the initiation of dialysis and an increase of 1.4 points during the 12 months after the initiation of dialysis ($P=0.06$). Additional adjustment for the presence or absence of coexisting conditions, estimated glomerular filtration rate, serum albumin level, and hospitalization status did not appreciably change the results. The results were also similar for analyses that restricted the analytic cohort to nursing home residents for whom no data were missing during the period immediately before or after dialysis, or both, and those who survived for at least 3 months after starting dialysis. The decline in functional status associated with the initiation of dialysis was more pronounced among older nursing home residents and among residents

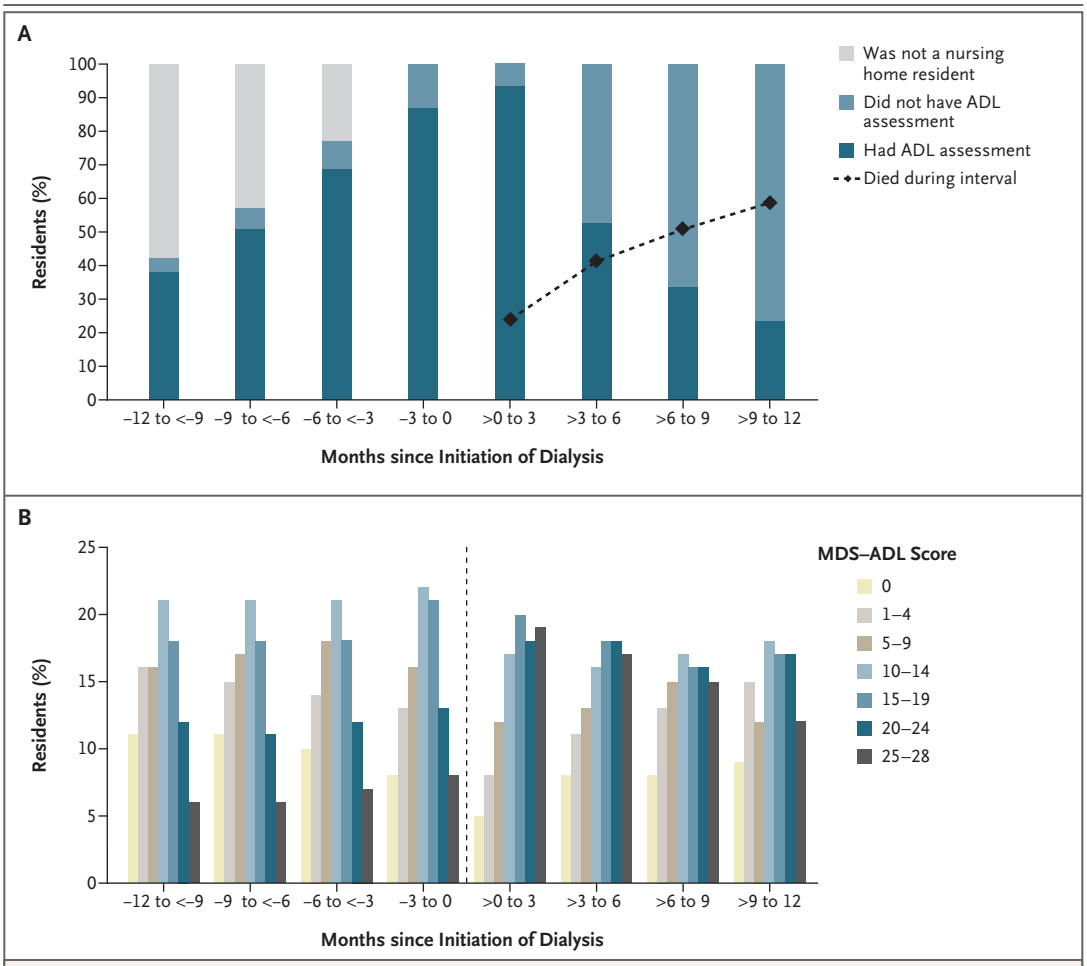

Figure 1. Decline in Functional Status and Cumulative Mortality among Nursing Home Residents before and after the Initiation of Dialysis.

Panel A shows the percentage of 3702 nursing home residents who underwent assessments of activities of daily living (ADL) during 3-month intervals before and after the initiation of dialysis. The cumulative mortality rates were 24% at 3 months, 41% at 6 months, 51% at 9 months, and 58% at 12 months after the initiation of dialysis. Panel B shows the distribution of Minimum Data Set–ADL (MDS–ADL) scores among nursing home residents before and after the initiation of dialysis. Higher MDS–ADL scores indicate poorer functional status. The dashed vertical line indicates the initiation of dialysis.

who were hospitalized ($P<0.001$ for both interaction terms). The magnitude of the decline associated with the initiation of dialysis did not differ significantly according to sex, race, the presence or absence of dementia, or the serum albumin concentration. The cubic spline model (Fig. 3) showed that the rate of functional decline accelerated (i.e., the MDS–ADL score increased) approximately 3 months before the initiation of dialysis, but even after accounting for this acceleration, the decline in functional status associated with the initiation of dialysis remained large and significant (1.7 points; 95% CI, 1.4 to 2.1). Functional status stabilized between 1 and 4 months after the initiation of dialysis and then continued on a downward trajectory.

DISCUSSION

Among U.S. nursing home residents with ESRD who were beginning to undergo dialysis, there was a marked decline in functional status during the period surrounding the initiation of dialysis, and by 1 year after the start of dialysis, only one of eight residents had functional capacity that was maintained at the predialysis level. These find-

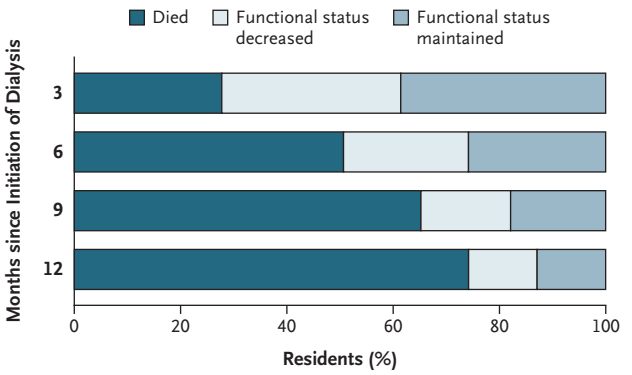

Figure 2. Change in Functional Status after Initiation of Dialysis.

Data were missing for 549 nursing home residents at 3 months, 696 residents at 6 months, 823 residents at 9 months, and 787 residents at 12 months from the full analytic cohort of 3702 residents.

ings suggest that in most nursing home residents with ESRD, functional decline continues despite the initiation of dialysis.

The strengths of our study include the use of linked national registries to identify nursing home residents who were beginning to undergo dialysis, serial validated measurements of functional status before and after dialysis, and information on multiple coexisting conditions, nutritional status, and hospitalization. Our findings with respect to the magnitude and temporal course of functional decline in relation to the start of dialysis extend the results of previous studies showing high rates of disability among ambulatory and nursing home populations with ESRD.[10,17,18] The MDS–ADL scale measures basic activities that are essential for independent functioning. The changes we observed will probably be meaningful to residents and families and are associated with a higher cost of care among residents with functional status that declines as compared with those in whom functional status is maintained.

Why does functional status decline in so many nursing home residents despite the treatment of uremia? First, there is a high prevalence of disability at baseline in this patient population, and a large number of patients have one or more coexisting conditions, such as stroke, peripheral vascular disease, or dementia; these conditions adversely affect functional status and are not corrected by dialysis. Second, functional decline may be a consequence of hospitalization occurring at the time of the initiation of dialysis or a consequence of clinical events leading to hospitalization, rather than a consequence of declining kidney function. Our data provide some support for this hypothesis, although nursing home residents who were not hospitalized around the time of the initiation of dialysis also had clinically significant deterioration. Third, the benefits of correcting uremia may be outweighed by physical risks associated with dialysis and the psychosocial burden of such therapy. For example, vascular access is required, and dialysis may be associated with a reduction in the time available for physical activity and meals, increased depressive symptoms, and adverse physical symptoms such as dizziness, fatigue, or cramping, which in turn might interfere with rehabilitation. Finally, kidney failure may be a reflection of terminal multiorgan dysfunction rather than a primary cause of functional decline, and thus the initiation of dialysis may not rescue patients from an inevitable decline.

These findings have important implications for the medical care of elderly patients with advanced chronic kidney disease. The period before and after the initiation of dialysis is a time of high risk — nearly all patients have worsening disability that is often permanent, and many die during the subsequent months. Efforts to address the goals of care, alleviate suffering, and maintain functional independence might be best targeted to this critical period rather than withheld until after patients have started to undergo dialysis. Previous studies have shown that rehabilitation services are underutilized among patients with ESRD,[19] despite evidence that rehabilitation is cost-effective.[20,21] Provision of dialysis care in inpatient rehabilitation facilities could reduce the burden on the patient and facilitate participation in rehabilitation programs,[21,22] although dialysis care is not available in most rehabilitation or nursing home facilities. In addition, interventions that promote self-care (e.g., the use of assistive devices) and the use of community services have been shown to prevent disability in community-dwelling geriatric populations, but they have not been tested in patients with ESRD.[23,24] A recent small, randomized trial suggested that there was no difference in short-term mortality rates among ambulatory, nondiabetic elderly patients with chronic kidney disease who received a low-protein diet and delayed initiation of dialysis, as compared with immediate dialysis[25]; whether such a strategy in conjunction with rehabilitation might preserve functional status is unknown.

Table 2. Adjusted Models of Change in Functional Status.*

Model and Timing of Assessment	Change in MDS–ADL Score	P Value
	points (95% CI)	
Model adjusted for age, sex, and race†		
At initiation of dialysis	2.8 (2.5–3.0)	
During 12 mo before start of dialysis	2.2 (1.8–2.6)	
During 12 mo after start of dialysis	1.4 (0.8–2.0)	
Before vs. after start of dialysis		0.06
Model adjusted for coexisting conditions‡		
At initiation of dialysis	2.8 (2.5–3.0)	
During 12 mo before start of dialysis	2.2 (1.8–2.6)	
During 12 mo after start of dialysis	1.4 (0.8–2.0)	
Before vs. after start of dialysis		0.04
Model adjusted for coexisting conditions and laboratory values, 2618 subjects§		
At initiation of dialysis	2.7 (2.4–3.0)	
During 12 mo before start of dialysis	1.9 (1.4–2.4)	
During 12 mo after start of dialysis	1.8 (1.1–2.5)	
Before vs. after start of dialysis		0.80
Among 2360 residents surviving for at least 3 mo after initiation of dialysis‡		
At initiation of dialysis	2.5 (2.2–2.8)	
During 12 mo before start of dialysis	2.1 (1.6–2.7)	
During 12 mo after start of dialysis	2.1 (1.4–2.8)	
Before vs. after start of dialysis		0.90
Among 1375 residents with at least one ADL assessment 1 mo before start of dialysis and one ADL assessment after start of dialysis‡		
At initiation of dialysis	2.2 (1.8–2.5)	
During 12 mo before start of dialysis	3.3 (2.6–4.0)	
During 12 mo after start of dialysis	1.1 (0.2–2.1)	
Before vs. after start of dialysis		<0.001

* Positive numbers for the change in the Minimum Data Set–Activities of Daily Living (MDS–ADL) score indicate a decline in functional status. Data shown are for 3702 subjects, except where indicated.
† Race was reported in the U.S. Renal Data System database.
‡ The model was adjusted for age, sex, race, hospitalization status, and presence or absence of diabetes, congestive heart failure, coronary artery disease, peripheral vascular disease, cerebrovascular disease, chronic obstructive pulmonary disease, cancer, dementia, and depression.
§ The model was adjusted for age, sex, race, hospitalization status, albumin concentration, estimated glomerular filtration rate, and presence or absence of diabetes, congestive heart failure, coronary artery disease, peripheral vascular disease, cerebrovascular disease, chronic obstructive pulmonary disease, cancer, dementia, and depression.

By providing information on anticipated changes in functional status as well as life expectancy, our study may help inform discussions about dialysis with elderly patients. Our finding that nursing home residents who begin to undergo dialysis have major declines in functional status around the time of the initiation of dialysis and over the course of the following year was consistent with the use of several different analytic approaches and assumptions. However, since we did not have a control group of nursing home residents with ESRD who did not start treatment with dialysis, we were unable to infer whether dialysis was the cause of functional decline and, if so, to what extent, or whether dialysis might improve life expectancy in this population. Because of the nature

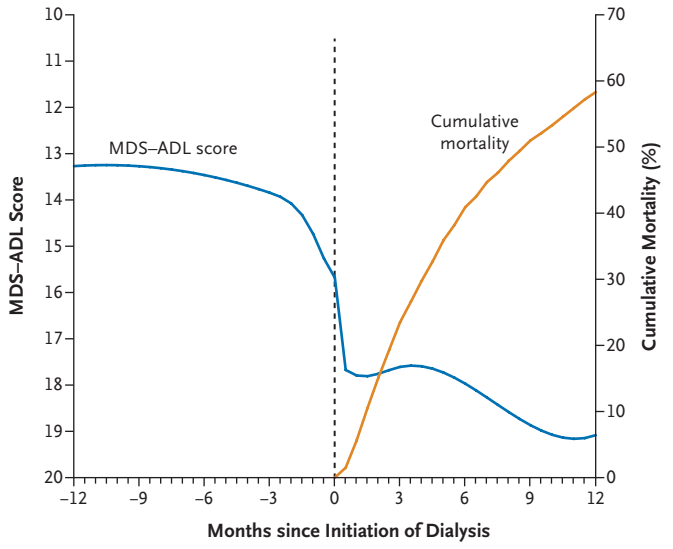

Figure 3. Smoothed Trajectory of Functional Status before and after the Initiation of Dialysis and Cumulative Mortality Rate.

The dashed vertical line indicates the initiation of dialysis in a hypothetical 75-year-old nursing home resident. MDS–ADL denotes Minimum Data Set–Activities of Daily Living. The numbers on the MDS–ADL axis run from highest to lowest.

and timing of the data collection and the limitation of the study cohort to persons who underwent dialysis, the decline in functional status that occurred just before the start of dialysis may have been underestimated. Clinical events occurring simultaneously with the initiation of dialysis and the reasons for the initiation of dialysis could not be determined from the current data. Finally, we did not have serial estimated glomerular filtration rates before the initiation of dialysis; these estimates might have provided useful information about the pace of functional decline relative to the decline in kidney function and might have addressed the question of whether conservative (i.e., nondialytic) approaches to the management of advanced chronic kidney disease are feasible. Nevertheless, even if dialysis can extend the lives of residents of nursing homes, it does not appear to restore health or functional status. Efforts to address the goals of care, control symptomatic distress, and provide supportive care for disability are critical in this population, regardless of whether dialysis is started.

In conclusion, nursing home residents who are starting to undergo dialysis have a substantial and sustained decline in functional status in addition to very high mortality.

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