NEFROLOGÍA. Volumen 27. Número 4. 2007

DOPPS Study on the Estimation of Patient's Life Years Attributable to Modifiable Hemodialysis Practices in Spain

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SUMMARY

The increased mortality risk in hemodialysis (HD) patients unable to meet six targets in different areas of HD practice has been reported previously. Using a prevalent cross-sectional sample of Spanish HD patients (n = 613) from the second stage of the Dialysis Outcomes and Practice Patterns Study to determine the percentage with low dialysis dose, hyperphosphatemia, hypercalcemia, hypoalbuminemia, anemia, and catheter use and based on the mortality hazard ratios and the total HD population in Spain, according to the Spanish Society of Nephrology Report, we estimated the number of patient life years that could potentially be gained in our country. These characteristics of HD practice were selected because each is modifiable through changes in practice, each is associated with mortality, and each has a large number of patients outside the target guidelines. The targets that define «within guidelines» are as follows: dialysis dose (single pool Kt/V > 1.2), anemia (hemoglobin > 110 g/L), albumin after standardization (> 40 g/L), serum phosphorus (1.1-1.5 mmol/L), serum calcium (2.1-2.4 mmol/L), and facility catheter use (< 10%). Cox proportional hazards regression models were used to calculate the relative risk of mortality for all patients outside each guideline. In all models, calcium values were adjusted for low serum albumin. A separate Cox survival model adjusted for all six HD practices simultaneously to account for correlation that may exist between some facility practices. All models were adjusted for age, sex, race, time on ESRD, and 14 summary comorbid conditions. Patient years attributable to each of the six practice patterns were estimated and are reported here as the potential patient years gained. Comparison of the estimates by individual guideline shows that, in Spain, increasing patient albumin above 40 g/L in all patients would lead to an estimated gain of 9,269 patient years (a 7.9% increase). Additionally, if all facilities could decrease catheter use to less than 10%, 2,842 patient years could be gained (a 2.4% increase). Though it may be an unrealistic goal, if all Spanish patients currently outside the guidelines achieved all six target levels, an estimated 17,300 life years could be gained over the next five years (a 15% increase). A more achievable goal of bringing 50% of patients who are currently outside targets within targets would result

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in 9,266 life years gained. In conclusion, this analysis suggests large opportunities to improve HD patient care in Spain.

Key words: ***Mortality risk guidelines. Calcium values. Albumin. Anemia. DOPPS.***

ESTIMACIÓN, SEGÚN EL ESTUDIO DOPPS, DE LOS AÑOS DE VIDA DE PACIENTES ATRIBUIBLES A LAS PRÁCTICAS DE HEMODIÁLISIS MODIFICABLES EN ESPAÑA

RESUMEN

El creciente riesgo de mortalidad en los pacientes sometidos a hemodiálisis (HD) que son incapaces de alcanzar seis objetivos en diferentes áreas de práctica de HD ya se había constatado anteriormente. Mediante el uso de una muestra representativa actual de pacientes españoles sometidos a HD (n = 613) obtenida de la segunda fase del Estudio de Pautas de Práctica y Resultados de Diálisis para determinar el porcentaje de pacientes con dosis de diálisis bajas, hiperfosfatemia, hipercalcemia, hipoalbuminemia, anemia y uso de catéteres, y en función de los coeficientes de riesgo de mortalidad y de la población total sometida a HD en España, de acuerdo con el Informe de la Sociedad Española de Nefrología, hemos calculado el número de años de vida de paciente que podrían obtenerse en nuestro país. Estas características de la práctica de hemodiálisis se seleccionaron porque cada una es modificable mediante cambios en la práctica, cada una está asociada a la mortalidad, y cada una presenta un gran número de pacientes fuera de las directrices objetivo. Los objetivos que definen la expresión «dentro de las directrices» son los siguientes: dosis de diálisis (Kt/V de compartimiento único >1,2), anemia (hemoglobina > 110 g/l), albúmina después de la estandarización (> 40 g/l), fósforo en suero (1,1-1,5 mmol/l), calcio en suero (2,1-2,4 mmol/l) y uso de catéteres en los centros (< 10%). Se utilizaron modelos de regresión de riesgos proporcionales de Cox para calcular el riesgo de mortalidad relativo de todos los pacientes situados fuera de cada directriz. En todos los modelos, los valores de calcio se ajustaron para niveles bajos de albúmina en suero. Un modelo separado de supervivencia de Cox ajustó las seis prácticas de HD simultáneamente para tener en cuenta la correlación que podría existir entre algunas prácticas de los centros. Todos los modelos se ajustaron para tener en cuenta los factores de edad, sexo, raza, tiempo en ESRD y 14 condiciones de comorbilidad resumidas. Se calcularon los años-persona atribuibles a cada una de las seis pautas de práctica, que se presentan aquí como los años-persona que pueden obtenerse potencialmente. La comparación de las estimaciones por cada pauta individual pone de manifiesto que, en España, el aumento del nivel de albúmina por encima de 40 g/l en todos los pacientes daría lugar a un aumento aproximado de 9.269 años-persona (un incremento del 7,9%). Asimismo, si todos los centros redujesen el uso de catéteres a menos del 10%, podrían obtenerse 2.842 años-persona (un incremento del 2,4%). Aunque puede ser un objetivo poco realista, si todos los pacientes españoles que se encuentran actualmente fuera de las directrices alcanzasen los seis niveles objetivo, podrían obtenerse aproximadamente 17.300 años de vida durante los próximos cinco años (un incremento del 15%). Un objetivo más factible, a saber, conseguir que el 50% de los pacientes que actualmente no alcanzan los objetivos los alcancen, daría como resultado un aumento de 9.266 años de vida. Para concluir, este análisis parece indicar que existen grandes oportunidades de mejorar el cuidado prestado a los pacientes sometidos a HD en España.

Palabras clave: ***Guías de riesgo de mortalidad. Valores de calcio. Albúmina. Anemia. DOPPS.***

INTRODUCTION

During recent years international and national guidelines have been developed to improve health care quality and the results obtained for patients submitted to hemodialysis (HD).

Currently, two sets of guidelines are used in Spain, the European Better Practices Guidelines (EBPG) and the Kidney Diseases Outcomes Quality Initiative (KDOQI). Besides, the Spanish Society of Nephrology has elaborated a set of guidelines that are available on line at www.senefro.org for HD units (last version, June 28th of 2006), vascular access on HD (last version, November 22d of 2004), and dialysis fluid quality (last version, March of 2006).

There are no significant differences between the Spanish values and international ones. By showing significant differences between higher mortality risk and low dialysis doses,[1] hyperphosphatemia,[2] hypercalcemia,[2] hypoalbuminemia,[3,4] anemia,[5] and the use of catheters as compared with the use of fistulae,[6-8] the outcomes obtained from the Dialysis Outcomes and Practice Parameters Study (DOPPS) have shown the value of both EBPG and KDOQI guidelines.[9]

In 2003, the Spanish Society of Nephrology (SEN) started the ANSWER study; this is a multicenter, prospective, observational and cohort study on new patients submitted to HD. Although the study will not be concluded until December of 2007, some data regarding mortality factors were presented in Philadelphia, PA, at the 2005 Renal Week, which is the annual meeting of the American Society of Nephrology. The provisional results of the analysis were presented at the ERA-EDTA meeting that took place in Istanbul in 2005. The outcomes of the ANSWER study are very similar to those obtained with the DOPPS study, including higher mortality risk in patients with hypoalbuminemia, hyperphosphatemia and anemia.

Besides, a Spanish group has reported a study showing considerably higher mortality risk due to infection in patients carrying a catheter as compared with those having a fistula ($p < 0.01$).[10]

We used a representative sample of Spanish patients submitted to HD obtained from the DOPPS-II study (2002-2004) in order to determine the percentage of patients not reaching the target values in the six different areas of HD practice. For these analyses, Cox survival models were used with adjustments in order to take into account the patients characteristics for calculating the mortality risk coefficients (HR). According to the mortality RR, the proportion of patients not reaching each target and the total patient population submitted to HD in Spain, we calculated the number of patient's life years that could be obtained provided that each chronic patient submitted to therapy at a dialysis center in Spain and currently not reaching the specified target could reach that goal. Besides calculating the life years obtained by adhering to each particular guideline, the analysis was carried out for all the results obtained simultaneously in order to take into account the overlapping effects. In the present study, sis objective care areas were considered: dialysis dose, anemia, serum phosphate (PO_4), serum calcium (Ca), serum albumin, and the use of catheters for vascular access.

METHODS

Centers sample for DOPPS

This analysis shows the DOPPS data, an international cohort study investigating the relationships between the outcomes obtained by the patients and the HD practices. The DOPPS data were gathered from more than 300 dialysis units randomly selected in 12 countries, with a four-month follow-up period.[11,12] The first phase of the study (DOPPS I) gathered data from the United Stated (1996-2001), Japan (1999-2001), and Europe (France, Germany, Italy, Spain, and the United Kingdom, 1998-2000). The second phase (DOPPS II, 2002-2004) continued gathering data from the original seven countries plus Australia, Belgium, Canada, New Zeeland, and Sweden. In the present analysis, we used data from DOPPS II to evaluate adherence to guidelines in Spain; data from both study phases were used to calculate the relative mortality risk associated to patients having not reached the target values in all the countries.

The DOPPS sample was randomly selected so that it could be representative of all dialysis unit types and all geographical regions of the participating countries. Each participating unit had to assist at least 24 HD patients; this criterion only excludes approximately 5% of the patient population on HD therapy.

Patient's data used for the analysis

A random sample of patients was selected ($n > 20.000$) from the participating centers in the 12 countries included in the DOPPS study. Data from DOPPS I and II were included because it is not expected that relative mortality risks for the practices investigated will not change with time, and the com-

bination of the two datasets allows obtaining a more stable estimate based on a larger patients sample. Patients older than 18 years submitted to HD could participate in the study, and each center registered a random sample of 20-40 patients (according to the unit size). The patients selected for the study provided longitudinal data on their demographical profile, more than 65 indicators of initial comorbidity, measurements on their socio-economical status, use of vascular access, characteristics of the HD therapy, administered HD dose, and laboratory data including measurements on anemia and mineral metabolism management.

The percentage of not reaching each one of the targets was calculated based on the data obtained from a current representative sample of Spanish patients on HD (n = 613) at the beginning of their participation in the DOPPS II study; this percentage was weighed by number of patients per center in order to take into account a disproportionate sample in relation to the unit size.

To calculate the total population of Spanish patients submitted to HD in 2006, we have extrapolated the results from the foreign population of outpatients submitted to HD reported by the 2005 Spanish Society of Nephrology Report.[13] An average annual growth rate of 5.1% was applied to this population. This rate was observed in the population of patients submitted to HD in Spain between 1998 and 2002.[13] An extrapolation was used to calculate the population of Spanish patients submitted to HD in 2006. However, we have not taken into account the population growth in life years models since we think that it originates conservative estimations of the life years obtained.

Definition and selection of the target intervals

The selection of the six HD practice characteristics was based on three qualities: they may be modified by practice changes, they are associated to mortality, and for each one of them, a high proportion of patients present values out of the target range. The following targets were used to define the expression "within the guidelines": dialysis dose (single compartment Kt/V ≥ 1.2), anemia management (hemoglobin ≥ 110 g/L), albumin (≥ 40 g/L), serum phosphate (1.1-1.5 mmol/L), serum calcium (2.1-2.4 mmol/L), and use of catheters in the centers (≤ 10%). All values but phosphate level represented the KDOQI guidelines.[14] Spanish experts gave the objective phosphate value representing the usual goals of clinical practice.

Albumin standardization

Standardization was carried out in three steps. First, a mean (4.25) and a range (3.5-5.0) were obtained for serum albumin in a "standard" reference population (Stpop) from the existing literature.[15] Secondly, the serum albumin values of the patients from each center were centered and categorized by the serum albumin reference range given by the laboratory of that center. In the final step, the reference interval given by the center was applied to the "standard" reference range according to the following calculation:

Serum albumin standardized value of the patients =
mean of standard reference Stpop +
(value of given value of serum albumin for the patients –
mean of the center reference Stpop)
¥ (range of standard reference Stpop /reference range of the center)

Were standard reference Stpop range = 3.5-5.0; Mean standard reference Stpop = (3.5 + 5.0)/2 = 4.25; and mean center reference Stpop = (low value + high value of the center reference range)/2. The standardized values of patients' serum albumin were used in some of the statistical analyses to investigate the sensitivity of the results of the standardization carried out at the laboratory.

Statistical analysis

Cox's proportional hazard models were used to calculate the relative mortality risk in all patients falling outside the above-mentioned guidelines using the data from DOPPS I and DOPPS II. These models were stratified by country and study phase. The data corresponding to the time at which the patient decided to participate in DOPPS were modeled for each one of the six HD practices separately, as follows: single compartment Kt/V < 1.2 vs. ≥ 1.2; PO_4 > 1.5 mmol/L vs. 1.1-1.5 mmol/L (adjusted for PO_4 < 1.1 mmol/L); Ca > 2.4 mmol/L vs. 2.1–2.4 mmol/L (adjusted for Ca < 2.1 mmol/L); albumin < 40 g/L vs. ≥ 40 g/L; hemoglobin < 110 g/L vs. ≥ 110 g/L; current sporadic use of catheters at the center > 10% vs. ≤ 10%. In all models, calcium values were adjusted for serum albumin. For phosphate and calcium, the risk should be interpreted as the relative mortality risk for those patients falling above the target interval as compared with those falling within that interval, with an adjustment for those patients falling below the target values. A separate Cox survival model was used to simultaneously adjust the

six hemodialysis practices in order to explain the correlations that might exist between some practices in the centers. All models were adjusted to consider factors such as age, gender, ethnicity, time on ESRD, country and comorbid conditions summarized as: coronary heart disease, congestive heart failure, other cardiac disease, peripheral vascular disease, hypertension, cerebrovascular disease, diabetes mellitus, pulmonary disease, history of cancer (active or inactive, excluding skin cancer), gastrointestinal bleeding within the 12 months before the study, neurological disease, psychiatric disease, HIV/AIDS, and recurrent skin disease (including gangrene). The value of single compartment Kt/V was calculated by the Daurgidas' formula.[16] The observation period was censored at the time the different possibilities occurred first: the patient leaving the center, the end of the study phase (DOPPS I or II), or the date of the last known follow-up visit. All models used a robust estimator of variance matrixes[17] to take into account the grouping effect of the centers. All statistical analyses were performed by using SAS version 9.1 (SAS Institute, Cary, North Carolina, USA).

Calculation of the attributable person-years

Attributable person-years were calculated for each one of the six practices and are presented here as potential person-years obtained. To calculate the expected increase in person-years, the five-year survival curve of the Spanish patient population submitted to HD (based on real mortality rates) was compared to expected five-year survival curve of the Spanish patient population submitted to HD provided that all patients had fulfilled the six practice guidelines. As an approach, each survival calculation was based on a constant mortality rate for the population, either real or expected. This assumption is based on previous DOPPS analyses indicating that an approximation can be done between the population mortality rate for HD patients and a constant exponential mortality rate. To take into account that the changes in dialysis practices would not significantly affect survival after transplantation, the calculation is limited to person-years for patients submitted to HD taking into account an annual loss rate of 0.009% to other therapies such as transplantation or peritoneal dialysis. This loss rate is based on DOPPS II data gathered between 2002 and 2004. The equation for the calculation of attributable person-years (potential increase of person-years) used the methodology of "area under the survival curve", as follows:

$$PY = [(N_o/L)*FD] + [(N_1/L)*(t - (FD/L))]$$

Where PY = total expected person-years for HD patients added throughout the five-year analysis period (t = 5 years); $FD = (1 - e^{-Lt})$ = proportion of patients still on HD at t time; L = annual loss rate of Spanish patients submitted to HD as compared with the HD population lost due to death, transplantation, or transfer to peritoneal dialysis. We calculated L = 0.170 if there was no change as compared with the current population of patients falling outside the target intervals, and L = 0.099 if all patients falling outside the target intervals for the six HD practices would fall within these same intervals. Besides, N_o = 20,920 is the number of current patients submitted to HD in Spain at the beginning of the five-year period, and N_1 = 4,902 is the number of new patients adding to the patient population submitted to HD each year.

RESULTS

Attributable Person-years

Table 1 shows the proportion of patients not reaching the six practice targets in Spain and the relative mortality risk associated to the fact of not reaching these goals. These two measures were the base for all the person-years estimations. Table 2 shows the expected number of patients and person-years of dialysis patients during the five-year period (2006-2010), and also contains estimations on the life years that could potentially be achieved provided that the six goals were met, both for each individual practice and all six practices.

The comparison of the estimations for each individual guideline shows that practices leading to the highest increases in person-years were albumin levels > 40 g/L and the reduction of catheter use below 10% at the centers. In Spain, if all patients with albumin levels < 40 g/L would fall above the target level an increase in approximately 9,269 person-years could be achieved. This represents a 7.9% increase in the total number of expected person-years between 2006 and 2010. Similarly, if all centers could reduce the use of catheters to less than 10%, 2,842 additional person-years could be achieved, increasing in this way the total number of life years by 2.4%.

Since the "normal" reference intervals and the type of assays used to measure albumin vary from one laboratory to another, albumin values presented by the laboratory at each center were standardized in order to obtain a common reference range. By using these standardized values, the expected life years obtained due to albumin management in Spain are

5,458, as compared with 9,269 if not standardized values are used.

Although it may be a nonrealistic objective, if all Spanish patients currently falling outside the guidelines would achieve the six target levels, and if the observed RR for mortality were totally causative, approximately 17,300 life years could be achieved for the next five years. This would represent a 15% increase in the total number of expected person-years between 2006 and 2010. However, such a dramatic reduction is unlikely since only 1.5% of the current HD patients in Spain fall within the six practice guidelines. In fact, very few Spanish patients (8.4%) reach the goals for five or six indicators. Most of them (84.2%) reach the goals for 2 to 4 indicators, and 7.4% of them reach the goals for just one or no indicator.

In order to observe the effect of the most achievable goals, we calculated the life years obtained if only 50% of the patients currently not meeting the targets would do so. If this were to happen in Spain, we calculated that 9,266 life years could be obtained. Considering this result from a different perspective, if the causality between this practices and mortality were only partial (50%) and 100% of the patients would fall within the guidelines, the same number of life years (9,266) could be obtained.

It is important to observe that when the regression model is adjusted simultaneously for the six practices, the potential number of life years obtained (17,300) is 19% lower than that obtained by simple addition of the person-years obtained taking all six practice guidelines individually and modeled independently between one each other (21,415). The difference between the number of years obtained by the combined model, which is simultaneously adjusted for all six practices, and that obtained with the individual models indicates a degree of colinearity between HD practices and their associations to the mortality. The main factors determining the magnitude of the potential life-years obtained for any of these HD practices are the percentage of patients falling outside the practice guideline being considered and the magnitude of the mortality risk associated to the fact of falling outside the target range.

ANALYSIS

This study indicates the proportion of a representative sample of 10,974 patients submitted to HD that fell outside the 2002 guidelines and the magnitude of the associated mortality risk for these patients in relation to all patients participating in the DOPPS study.

The present study has limitations since it assumes that there is a total or partial causality. Observational studies have not shown this causality, not even after adjusting for a number of comorbid conditions.[18] The studies evaluating the results in an individual manner for each patient and for each center have shown that the mortality risk per patient was similar to the

Table I. Guideline- or practice parameter-adjusted relative mortality risk (DOPPS I and DOPPS II; international) and percentage of Spanish patients falling outside each selected guideline or practice parameter (only DOPPS II data from Spain)

Modifiable practice parameter	Mortality RR[1]		Patients outside the interval[2]
	RR	Valor p	
Dialysis dose*			
Single compartment Kt/V < 1,2	1.13	0.0023	22.7%
Anemia management*			
Hemoglobin < 110 g/L	1.20	< 0.0001	30.4%
Mineral metabolism			
PO_4 > 1.5 mmol/L**	1.11	0.001	63.5%
Calcium > 2.4 mmol/L*	1.12	< 0.0001	74.9%
Nutrition*			
Albumin < 40 g/l	1.46	< 0.0001	71.4%
Vascular access*			
Catheter use at the centers > 10%	1.20	< 0.0001	42.8%

RR = Relative risk.
[1] Relative mortality risk determined among patients from DOPPS I (7 countries) and DOPPS II (12 countries) studies. Stratified by country and study phase. Adjusted to take into account factors such as age, ethnicity, years on ESRD, and 14 summarized comorbid conditions.
[2] For phosphate and calcium, the relative risk and percentage of falling outside the range patients refers only to patients whose values are above the target interval.
* Based on KDOQI guidelines.
** Based on expert opinion on usual practice.

Table II. Expected patients' life years obtained for all HD patients by means of better adherence to guidelines and practice parameters in Spain during a five-year period (2006-2010)

Parameter	Current statistics	1 Kt/V ≥ 1.2	2 hemoglobin ≥ 110 g/L	3 PO_4 1.1-1.5 mmol/L	4 Calcium 2.1-2.4 mmol/L	5 Albumin ≥ 40 g/L	6 Catheter use at the centers ≤ 10%	Total[1] (sum 1-6)
Annual mortality rate per person-year)	0.161	0.157	0.152	0.151	0.144	0.121	0.149	0.090
Other loss annual rate[2]	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Total loss rate	0,170	0.165	0.161	0.160	0.153	0.130	0.157	0.099
Person-years (total)	117,499	118,520	119,554	119,845	121,381	126,768	120,341	134,798
Person-years obtained provided that 100% reach the goals (% total years)[5]	–	1,021 (0.9%)	2,055 (1.7%)	2,346 (2.0%)	3,882 (3.3%)	9,269 (7.9%)	2,842 (2.4%)	17,300[3,4] (14.7%)
Person-years obtained provided that 50 % reach the goals % total years)[5]	–	509 (0.4%)	1,021 (0.9%)	1,164 (1.0%)	1,917 (1.6%)	4,502 (3.6%)	1,408 (1.2%)	9,266[3] (7.9%)

Each model is based on 17,167 current patients at the study beginning (figure extrapolated from SEN data fro the year 2002) and on 4,902 patients added per year, during five years, which totals 117,499 person-years.

[1] Adjusted for factors shown in columns 1-6 plus age, gender, ethnicity, years submitted to dialysis, and 14 summarized comorbid conditions. It should be noticed that only 1.5% of the patients fell within the six guidelines.

[2] "Other losses" includes transplant recipient and switch to peritoneal dialysis.

[3] The total is lower than the sum of columns 1-6 because it takes into account correlated results.

[4] The potential increase in en person-years of 17,300 represents the difference between 134,798 and 117,499.

[5] It assumes that causality exists for the association of the RR and each parameter.

standardized mortality relationship of the dialysis centers based on the percentage of patients with low hematocrit or Kt/V levels, and on the high percentage of patients from centers using a venous catheter as the vascular access.[19,20]

Besides, Wolfe *et al.*[21] have shown that after adjusting for patients mixing, the measures of practice patterns accounted for 38% of the remaining variability in adjusted mortality for patients submitted to HD in the United States. Random tests may indicate causality since it is assumed that with randomization "everything else is the same". However, sometimes these tests are not feasible due to ethical reasons; for instance, studies on choric hyperphosphatemia may not be justified by means of randomization of dialysis patients to a control group with deficient phosphate management. Further studies will focus on the assessment of the changes taking place during dialysis therapy and their associated results; for instance, by comparing centers in which most of the patients adhere to guidelines with those in which a proportion of patients fall outside the guidelines barely show any change.

About Kt/V and anemia, Wolfe *et al.*[22] were able to better clarify the causal relationship with mortality when they analyzed the outcomes of changes in the level of guidelines adherence during a three-year period at a dialysis unit. Those centers showing higher improvement in adherence to Kt/V and hemoglobin also showed higher improvement in standardized mortality with time, whereas those centers showing little improvement in guidelines adherence did not virtually show any improvement in mortality.

One weak point of current calculations is that causality has not definitively been shown with any of the objective factors. The DOPPS study allows doing better adjustment than usually so that the details of case mixing may be taken into account to try that everything else is the same. We offer a more conservative estimation indicating a partial causality or a partial correction of guidelines.

Absolute numbers of person-years for the following five years may be a matter of debate since they are an extrapolation of the trends during the last decade. So for, person-years should be considered just estimations.

Life years analysis could be improved by the use of multiple laboratory ranges and associated risks instead of single cut-off values that are mostly based on guidelines rationale. It may also be observed that the level of the cut-off value used has an influence on life years estimation. For instance, KDOQI guidelines recommend albumin levels ≥ 4.0 g/dL, and many patients fall below this value. If a cut-off value > 3.5 g/dL were used, the revised RR would be only applied to few patients, thus producing a much lower number of life years. The same principle may be applied to the percentage of patients using a catheter, which in our study has been established at 10%. The wide interval higher than 10% is associated with an increasing range of risks. Further investigations are expected to be done with the data from the DOPPS study so that more detailed analyses can be performed.

An important strength of this study is that it allows performing a qualitative comparison of the impact of different modifiable factors on life years that may potentially be obtained with greater goal achievement. Those factors showing higher deviation or those being associated to a considerably high relative risk offer comparably higher possibilities for saving lives. About factors showing the higher correlation with life years, such as albumin and the use of catheters, it is likely that it will be difficult to increase albumin levels above 4.0 g/dL in most of the patients, whereas discontinuation of catheter use seems to be a important modifiable therapeutic option. These analyses seem to indicate that the vascular access is paramount, whereas each one of the remaining factors also has an substantial association with life years. A categorical effort should be done, especially in Spain where catheter use increased by 6% between DOPPS I and II studies, to revert this trend in order to improve patients' survival.

To conclude, this analysis makes one think that there are great opportunities for improvement HD patients' care in Spain. Life years obtained by adhering to the six potentially modifiable practice patterns were compared in this study. Achievement of albumin target levels could save about 4,502 life years (or up to 9,269). Similarly, by the year 2010, 1,408 life years (or up to 2,842) could be saved provided that target goals for vascular access were reached. Although these estimations contain several assumptions, they may be a starting point for continuous improvement in patient care by adhering to published guidelines that are endorsed by international observational data from the DOPPS study.

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