A systematic review of ethnic differences in the rate of renal progression in CKD patients

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Introduction

Chronic kidney disease (CKD) is a public health problem of increasing importance, consuming a growing proportion of health care resources. It is estimated that, in the United States, there are 19.2 million individuals with CKD [1], and this figure is expected to increase in parallel to the rising prevalence of hypertension and diabetes. By 2010, the projected number of end-stage renal disease (ESRD) patients will climb to over 650,000 [2], with a further predicted increase to 2.24 million by 2030 [3]. Therefore, improved understanding of the predictors of GFR decline is essential. Information about predictors would allow nephrologists to accurately predict those CKD patients at risk of progressing to ESRD, which would help to individualize patient care, allowing for optimal planning for renal replacement therapy (RRT), reduce the need for urgent dialysis and ultimately allow for more efficient allocation of scarce health care resources. In addition, the recognition of novel risk factors for progression may lead to the development of new therapies capable of altering the trajectory of the disease.

It has been recognized that the incidence of ESRD is higher in ethnic minorities; however, the reasons for this have not been well defined. For example, American blacks are four times more likely to require dialysis than whites [4]. An increased burden of ESRD has also been shown to affect Hispanics and Asians [5]. Conversely, ethnic minorities tend, paradoxically, to have improved outcomes once started on haemodialysis [5,6].

Several mechanisms have been suggested to explain such differences, though these have not been proven. For example, a higher prevalence of co-morbidities, lower socioeconomic status and comparatively worse access to health care among ethnic minorities have been cited as reasons for the higher incidence of ESRD [7–9]. Such reasoning holds that the incidence of ESRD is dependent on the number of CKD patients at risk of progressing, and the higher prevalence of diabetes and hypertension in blacks may result in greater CKD [4]. Similarly, lower socioeconomic status in minorities may create inequalities in access to health care resources and thus reduce delivery of medical management known to slow the progression of renal dysfunction [10,11]. A second explanation is that a higher death rate amongst CKD patients in one ethnic group would leave fewer patients alive to require RRT, thus affecting the observed incidence rate of ESRD. Different thresholds for starting RRT would also affect the measured incidence of ESRD. Finally, the higher incidence of ESRD amongst ethnic minorities may in fact be due to a faster rate of GFR decline and more rapid progression of renal disease.

The purpose of this review is to summarize the available evidence on ethnic differences in the rates of CKD progression towards ESRD. Ideally, available studies would directly observe rates of GFR decline in CKD cohorts of different races. This would avoid such confounders as CKD prevalence, the competing risk of death and varying thresholds for starting RRT. Alternatively, in studies examining the incidence rates of ESRD, inferences can be made regarding progression rates only if attempts are made to account for differences in the baseline prevalence of CKD and in longitudinal mortality rates.

Methods

MEDLINE, EMBASE and the Cochrane Database of Systematic Reviews were searched by separately combining the keywords ‘chronic kidney disease’ with each of the keywords ‘race’ and ‘ethnicity’ using the Boolean operator ‘and’, and for the MEDLINE search, with the Medical Subject Heading term ‘ethnic groups’. The search was limited to English papers in adult humans, with no limits placed on the date range. Titles and abstracts were screened, and when indicated, the content of the papers was searched to meet our inclusion criteria. The reference lists of included papers were searched for appropriate studies. Our inclusion criteria were prospective cohort studies that directly observed the rates of renal progression in different ethnic groups with known all-cause CKD (as measured by rates of ESRD or changes in creatinine or measured or estimated GFR over time) or cross-sectional studies that compared the incidence of all-cause ESRD in different ethnic groups while adjusting for the prevalence of CKD. Studies were excluded if they addressed only specific causes of renal disease, were non-English, were case reports or case series or looked at pac-
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<tr>
<td>Brazy and Fitzwilliam [12]</td>
<td>200, observational cohort</td>
<td>Patients from a VA nephrology medical centre in North Carolina from 1979 to 1988 with CKD (Cr &gt; 1.5 mg/dL), and who had documented renal progression (20% change in inverse creatinine)</td>
<td>Black, white</td>
<td>Rate of change of inverse creatinine (dL/mg/month)</td>
<td>38 months</td>
<td>Rate of change in renal function was similar in blacks and whites. Multiple regression analyses revealed only diastolic blood pressure, age and type of blood pressure treatment had an effect on rate of renal progression, not race or aetiology of CKD</td>
<td>Cohort of male VA patients selected for declining renal function limits generalizing the results. No confounding due to health care access as all patients were treated in the same clinic. Small study</td>
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<tr>
<td>Choi et al. [13]</td>
<td>2 015 895, observational cohort</td>
<td>Black or white VA veterans with one or more creatinine measured at a VA facility from 2000 to 2001</td>
<td>Black, white</td>
<td>Rate of eGFR decline. Incidence of ESRD</td>
<td>3.7 years</td>
<td>Annual change in eGFR by levels of baseline eGFR in whites versus blacks: 45–60: −0.4 versus −0.5 30–45: −0.4 versus −0.9 15–30: −0.5 versus −1.6</td>
<td>Cohort of mostly male VA patient limits generalizing the results. Confounders: access to health care</td>
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<td>Hallan et al. [14]</td>
<td>HUNT II: 65 181; NHANES III: 15 488. Cross-sectional observational at two points in time</td>
<td>CKD population from HUNT II data from 1995 to 1997 in Norway, and NHANES III data (midpoint of 1991) in the U.S. ESRD incidence from USRDS in US and Norwegian database in Norway</td>
<td>Norway white, US white</td>
<td>Incidence of ESRD standardized to the prevalence of CKD. Prevalence of CKD in Norway was age and gender standardized to the US 1991 population</td>
<td>Not applicable</td>
<td>CKD prevalence age/gender standardized to US 1991 population were similar in Norway and US. Relative risk of US Whites versus Norwegian Whites in incidence of ESRD standardized to prevalence of CKD was 2.5. eGFR at the time of dialysis start were similar. Markers of pre-dialysis care were better in Norwegians</td>
<td>Patients were not observed to progress to ESRD. CKD population at risk is based on an estimated time of progression from CKD to ESRD, which is not known. Confounders: access to health care (which was shown to be different), competing risk of death</td>
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<td>Hsu <em>et al.</em> [15]</td>
<td>NHANES III: 3,894,000; USRDS: 60,323.</td>
<td>Cross-sectional observational at two points in time</td>
<td>Black, white</td>
<td>Incidence of ESRD divided by the number of CKD patients 5 years prior</td>
<td>5 years prior</td>
<td>Purpose was to control ESRD rates for the prevalence of CKD. No difference in CKD prevalence in blacks compared to whites in 1991. Relative risk of incidence rates of ESRD per number of at risk CKD patients in blacks compared to whites was 4.8. Similar trend when USRDS ESRD data was used from a time gap varying between 3 and 8 years post-NHANES III midpoint (i.e. 1994–99)</td>
<td>Patients were not observed to progress to ESRD. CKD population at risk is based on an estimated time of progression from CKD to ESRD, which is not known. Confounders: access to health care, competing risk of death</td>
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<td>Peralta <em>et al.</em> [16]</td>
<td>39,550, observational cohort</td>
<td>CKD patients insured by KP in northern California with at least one outpatient creatinine measurement and eGFR 15–50 between 1996 and 2002, excluded ESRD patients</td>
<td>Hispanic, white</td>
<td>Incidence of ESRD</td>
<td>3.83 years</td>
<td>Age-adjusted incidence rate of ESRD per 100 person-years: Hispanics 1.22 Whites 0.67 HR for ESRD adjusted for demographics, socioeconomic factors, baseline GFR, DM, hypertension, proteinuria, medications used, co-morbidities compared to Whites: Hispanics 1.33 Adjusted HR for all-cause mortality compared to Whites: Hispanics 0.71</td>
<td>Cohort of KP patients is known to differ from the general population, limits generalizing the results. Confounders: access to health care, competing risk of death (Hispanics shown to have a lower mortality rate)</td>
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GFR in millilitres per minute per 1.73 m².  
VA, Veterans Affairs; DM, diabetes; KP, Kaiser Permanente.
Table 2. Summary of the studies found to address the topic of ethnic progression but did not meet the inclusion criteria, however, in the authors’ opinions, are still worthy of discussion

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<td>Hall et al. [17]</td>
<td>299 168, observational cohort</td>
<td>Patients insured by KP in northern California from 1964 to 1985 with age &gt;18 and at least one measurement of blood pressure, creatinine, dipstick urinalysis, height and weight. Excluded patients with ESRD</td>
<td>Asian, white, black</td>
<td>Incidence of ESRD</td>
<td>26.2 years</td>
<td>Age-adjusted ESRD rates per 100 000 person-years: Whites 7.9 Asians 14.0 Blacks 43.4 HR for ESRD compared to whites when adjusted for age, gender, education, DM, cardiac disease, baseline creatinine, blood pressure, proteinuria, haematuria: Asians 1.68 Blacks 3.69</td>
<td>Included those with and without CKD. Cohort of KP patients is known to differ from the general population, limits generalizing the results. Confounders: access to health care, competing risk of death</td>
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<tr>
<td>Karter et al. [18]</td>
<td>62 432, observational cohort</td>
<td>KP-insured diabetic patients in northern California in a diabetic registry from 1994 to 1996, age &gt;19</td>
<td>Black, Latino, Asian, white</td>
<td>Incidence of ESRD</td>
<td>2.5 years</td>
<td>ESRD HR compared to whites when adjusted for age, sex, SES, modifiable factors and clinical factors: Blacks 2.03 Asian 1.85 Latino 1.6 Significant baseline differences in SES</td>
<td>Included those with and without CKD. Includes only diabetics, and likely reflects mostly diabetic nephropathy. Selection bias (those who filled out a questionnaire) limits generalizing the results. Cohort of KP patients is known to differ from the general population, limits generalizing the results. Confounders: access to health care, competing risk of death</td>
</tr>
<tr>
<td>Klag et al. [19]</td>
<td>332 544, observational cohort</td>
<td>Subset of patients screened for the MRFIT trial, all men aged 35–57 years from 1973 to 1975. MRFIT trial included men 35–57 years at increased cardiovascular risk (smoking, high cholesterol or hypertension), excluded creatinine &gt;178 μmol/L</td>
<td>White, black</td>
<td>Incidence of ESRD</td>
<td>16 years</td>
<td>Age-adjusted incidence of ESRD 3.2 times higher in blacks compared to whites. Sequential adjustments for age, blood pressure, cholesterol, smoking, income, DM, coronary artery disease reduced relative risk to 1.87. Did not control for baseline renal function; therefore, did not control for the incidence of CKD</td>
<td>Included those with and without CKD. Population of young men limits generalizing the results. Confounders: access to health care, competing risk of death</td>
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<tr>
<td>Li et al. [20]</td>
<td>1,055,236, observational cohort</td>
<td>A random 5% sample from Medicare-insured patients (above 65 years old) from 1997 to 1998</td>
<td>White, black</td>
<td>Incidence of ESRD, sequentially adjusted for predictors of disease progression</td>
<td>2.66 years</td>
<td>Incidence rates of ESRD in Blacks compared to Whites Unadjusted 3.3 Adjusted 2.11 Adjustments made for age, sex, SES, co-morbidities, aetiology of kidney disease, level of health care received</td>
<td>Included those with and without CKD. Population of elderly Medicare patients limits generalizing the results. Confounders: access to health care (shown to be lower in blacks), competing risk of death</td>
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<td>Perry et al. [21]</td>
<td>11,912, observational cohort</td>
<td>Male hypertensive patients seen in VA hypertension clinics from 1974 to 1976</td>
<td>Black, non-black</td>
<td>Incidence of ESRD</td>
<td>15 years</td>
<td>Relative risk for incidence of ESRD was 2.07 for blacks compared to non-blacks</td>
<td>Included those with and without CKD. Cohort of male VA patient limits generalizing the results. Confounders: access to health care, competing risk of death</td>
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<td>Walker et al. [22]</td>
<td>5,524, observational cohort</td>
<td>Subset of patients included in MRFIT trial with diastolic blood pressure &gt;90 mmHg, but not taking hypertensive medications. MRFIT trial included men 35–57 years at increased cardiovascular risk (smoking, high cholesterol or hypertension), excluded creatinine &gt;78 μmol/L</td>
<td>Black, non-black</td>
<td>Rate of change of inverse creatinine</td>
<td>6 years</td>
<td>At baseline, renal function similar in blacks and non-blacks (creatinine 97.2 μmol/L). At 6 years, creatinine increased by 3.1 μmol/L in blacks versus 0.1 μmol/L in non-blacks, with a significantly faster drop in renal function in blacks (comparing rate of change of inverse creatinine)</td>
<td>Included those with and without CKD. There was very little renal progression over the follow-up period. Population of young men with untreated isolated diastolic hypertension limits generalizing the results. Confounders: access to health care</td>
</tr>
<tr>
<td>Xue et al. [23]</td>
<td>1,306,825, observational cohort</td>
<td>A random 5% sample from Medicare-insured patients (above 65 years old) who made a claim in 1992</td>
<td>White, black</td>
<td>Incidence of ESRD in patients with baseline DM or hypertension or who developed these during follow-up</td>
<td>10 years</td>
<td>Relative risk of ESRD for blacks compared to whites in the following groups: Baseline DM 2.4 Developed new DM 2.7 No DM 2.8 Baseline hypertension 2.5 Developed new hypertension 2.9 No hypertension 3.1</td>
<td>Included those with and without CKD. Population of elderly Medicare patients limits generalizing the results. Analysis was restricted to the presence of DM or hypertension, limits generalizing the results. Confounders: access to health care, competing risk of death</td>
</tr>
<tr>
<td>Choi et al. [24]</td>
<td>2,015,891, observational cohort</td>
<td>Registrants in a VA health care system database aged 18–100, black or white, with at least one outpatient creatinine measurement, and not currently ESRD</td>
<td>Black, white</td>
<td>Incidence of ESRD by HIV and DM status</td>
<td>3.7 years</td>
<td>Incidence of ESRD 12.7 versus 22.3 per 1000 person-years for whites versus blacks (summation from Table 2) For blacks compared to whites: HR 2.01 for HIV−/DM− HR 5.97 for HIV+ HR 2.33 for HIV+/DM+</td>
<td>Included those with and without CKD. Cohort of mostly male VA patient limits generalizing the results. Confounders: access to health care, competing risk of death</td>
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GFR in millilitres per minute per 1.73 m². KP, Kaiser Permanente. VA, Veterans Affairs; DM, diabetes; SES, socioeconomic status.
Results

The MEDLINE search yielded 1252 results, EMBASE yielded 462 results and the Cochrane Database of Systematic Reviews yielded 7 results, for a total of 1721 potential studies. After review, 21 studies were selected. Of these, on careful review of the manuscripts, 16 studies were excluded. In total, five studies were found to have met our inclusion criteria, and are summarized in Table 1 [12–16]. Several of the studies were found to address the topic of ethnic progression, but did not meet our inclusion criteria due to methodological issues. Those studies that were excluded from the systematic review but are cited frequently in the literature are summarized in Table 2 [17–24] in order to ensure completeness in this paper.

Cohort studies

Brazy and Fitzwilliam provided one of only two studies that measured renal function decline over time in ethnic cohorts with CKD [12]. This small study analysed 200 black and white patients with CKD who were followed up at a Veterans Affairs (VA) nephrology clinic from 1979 to 1988. The rate of renal function decline (assessed by the slope of the inverse creatinine concentration versus time) was similar in the black and white cohorts over a 38-month follow-up period, leading the authors to conclude that, once kidney disease has developed, similarly treated black and white patients demonstrate comparable rates of decline. This study design has several advantages in that all patients had the same access to health care, were all followed up by nephrologists and the results are independent of the mortality rate or thresholds for starting RRT. One major limitation to this study is that the authors included only those patients who had at least a 20% increase in their serum creatinine. Therefore, the results can only be generalized to male CKD patients who were specifically selected for having an established tendency toward progressive decline in renal function.

The 2009 study by Choi et al. [13] used a cohort of white and black VA patients with at least one outpatient creatinine measurement. Although the majority of patients had normal renal function, 22% of whites and 13% of blacks had estimated GFR (eGFR) <60 mL/min/1.73 m². Because of the large size of the overall cohort, this forms a significant group of CKD patients that were followed up for 3.7 years and showed a faster rate of eGFR decline in blacks compared to whites. In addition, the rate of ESRD was higher in blacks at all levels of initial eGFR, with a higher mortality rate in blacks arguing against a competing risk of death. This study suggests that, in a population of mostly male VA patients, the rate of renal function decline in those with CKD is faster in blacks compared to whites and that a competing risk of death does not explain differences in ESRD rates. This study design has the advantage of following up patients over time; however, the results may not be generalized outside of the specific population studied and the results may be confounded by both level of ancillary health determinants (socioeconomic factors) and additional health care services available to the white patients who were of higher socioeconomic status.

The study by Walker et al. [22] also measured creatinine changes in cohorts of hypertensive black and non-black patients in a subgroup of the MRFIT trial, showing that black patients had a more rapid decline in renal function. However, the study included mostly patients with normal renal function at baseline and, therefore, the observed decline in renal function in blacks is dependent on both the rate of developing CKD and the rate of renal progression through CKD.
counterparts to drop out of the health care plan during the follow-up period [16]. The impact of variable health care access among ethnicities represents a strong confounder in analysing such studies and only those that take careful measures to control for this may be interpreted correctly.

Of the cohort studies that only used incidence rates of ESRD (as opposed to measured changes in GFR) as their outcome measure, only the study by Peralta et al. assessed a cohort of patients with established CKD [16]. Nearly 40,000 Hispanic and non-Hispanic whites insured by KP in northern California with cotinine measurements recorded between 1996 and 2002 and baseline eGFR between 15 and 59 mL/min/1.73 m² were followed up for a mean of 3.83 years. The unadjusted hazard ratio (HR) for incident ESRD in Hispanics versus whites was 1.99. After sequential adjustments for age, gender, socioeconomic status, co-morbidities and known predictors of renal progression (proteinuria, hypertension, diabetes, baseline GFR and medication use), the higher risk of ESRD in Hispanics was attenuated but not completely explained (adjusted HR of 1.33). Baseline cotinine and eGFR distribution were qualitatively similar between the groups, suggesting that the study was not biased because of a higher prevalence of CKD in one cohort. The authors concluded a faster rate of progression towards ESRD in Hispanic compared to white CKD patients. However, the mortality rate was lower among Hispanics, raising the possibility of a competing risk of death in whites leaving more Hispanics alive to progress to ESRD. The degree to which other potential predictors of renal progression that were not measured (such as BMI, smoking, haemoglobin A1C or acidosis) may explain the residual adjusted risk in Hispanics is not known. The insured group of KP patients in northern California is known to differ from the general population at the extremes of income and in unemployed individuals [17], which must be considered when generalizing the study results.

Several cohort studies either did not measure baseline renal function or included patients with normal renal function, limiting their utility in describing ethnic differences in rates of progression through CKD. In the studies by Choi et al. [24] and Hall et al. [17], baseline renal function was assessed and included some patients with abnormal GFR; however, a large percentage of enrolled patients had normal renal function. Both studies found the incidence of ESRD to be higher in the ethnic minority groups (blacks and Asians) compared to whites. In such a study design, the incidence of ESRD is dependent on the risk of developing CKD, the rate of progression through CKD, the threshold for starting RRT and hence ‘counting’ as ESRD and the competing risks of death or loss to follow-up during the study period. It is not possible to differentiate the effects of developing CKD from the rates of progression once CKD has started. In the remaining cohort studies, which we excluded from the main analysis, baseline renal function was not assessed [18–21, 23]; therefore, the universal finding of higher ESRD incidence in the ethnic minority cohorts cannot be adjusted for differences in CKD prevalence, making conclusions about CKD progression rates impossible.

Cross-sectional studies

There are two cross-sectional studies that looked at the incidence of ESRD while attempting to adjust for the prevalence of CKD. The first, by Hsu and colleagues [15], looked at black and white CKD patients (estimated GFR 15–59 mL/min/1.73 m²) aged 20–74 years from the NHANES III data (the midpoint of which was in 1991). To capture the rate of progression from CKD to ESRD, the authors assumed that it would take 5 years to progress to RRT and thus assessed the incidence of ESRD using the United States Renal Data System (USRDS) data from 1996 for patients aged 25–79 years. The analysis was repeated, assuming anywhere from 3 to 8 years to progress, and showed consistency of results. The study found no difference in the prevalence of CKD between blacks and whites (using the above gGFR definition based on the MDRD formula); however, the incidence of age-, sex- and diabetes-adjusted ESRD was almost five times more common in blacks. The conclusion that blacks must progress faster through CKD is at best speculative. The patients were not observed to progress to ESRD; instead, this was deduced from data taken at two points in time. There are many confounders which may explain this trend, including unequal access to health care, the competing risk of death or inappropriate assumptions in the study design. In addition, the black CKD patients in the NHANES III data had worse hypertension and proteinuria, the extent to which this contributed to their higher ESRD rate is unknown. Other than age, sex and diabetes, no other known risk factors for renal disease progression were assessed for their effects on the observed trend.

The second such study by Hallan et al. [14] used data from the HUNT II survey in Norway taken from 1995 to 1997, comprised largely of whites in a country with a fully universal health care system and compared them to American whites. The prevalence of CKD was based on a definition consistent with the K/DOQI guidelines [2] and was taken from the HUNT II data set (age and gender standardized to the US population in 1991) and the NHANES III data with a midpoint of 1991. The incidence of ESRD was taken from the USRDS data and the Norwegian Renal Registry from 1995 to 1997. The prevalence of CKD was similar between Norwegian and American whites, including when stratified for age, gender, diabetes, hypertension and CKD stage. Despite this, the incidence of ESRD was 2.5 times higher in American whites than their Norwegian counterparts. The eGFR at the time of RRT was similar in the two groups, suggesting similar thresholds for starting dialysis. However, markers of pre-dialysis care (such as visits to nephrologists, presence of AV fistulae, use of erythropoietin-stimulating agents and haemoglobin and albumin levels) all indicated better access to appropriate CKD care in Norwegian whites. This underscores the potential importance of health care access and its confounding in observational studies. Similar to the study by Hsu and colleagues, the progression to ESRD was deduced and not observed and, therefore, subject to the same limitations. In addition, the use of two different data sets in two different countries taken at different points in time to define each of CKD and ESRD introduces many sources
be associated with genetic differences in inflammatory or fibrotic pathways, renal response to injury, sensitivity to salt, toxins and medications, haemodynamic autoregulation or other factors involved in the progression of renal disease. Recently, the increased risk of non-diabetic ESRD in African Americans compared to European Americans has been linked to a gene encoding non-muscle myosin heavy chain type II isoform A; however it is unclear how this protein affects renal function decline [26]. Ultimately, such information regarding risk factors for progression to ESRD will serve to focus ongoing and future research efforts. It will also guide the allocation of health care resources to those patients who are more likely to progress to ESRD and reassure those patients who are not.

Conflict of interest statement. None declared.

References
Socio-cultural ‘change’: impact on nephrology

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The German word ‘Wandel’ stands for change in a slow, relaxed way, including stop and go, and time to think and react. Socio-cultural change in the German society, and probably in most European societies, was no ‘Wandel’: it was fast and drastic. At least, it did not leave enough time to adapt health care laws and structures in an adequate way. To prove this hypothesis, we will discuss socio-cultural changes of recent years and their impact on nephrology, today and in the future.

Some of these developments have been discussed in detail earlier, and additional socio-cultural events remain unmentioned. However, the following points appear to be the most relevant, and taking them together, they appear to have considerable consequences for the future of European health care systems and nephrology.

Demographic and epidemiological development

The proportion of the German population above the age of 65 will grow from ~18% to ~30% by 2050, while the proportion of the population (aged 0–14) will decrease from 15% to 12% [1].

Already today, the costs for pharmaceuticals (as index for the health care costs in total) for people below the age of 60 are approximately €205 per person per year, which is much lower than the €725 estimated for those over the age of 60. Expenditures for drugs increase continuously up to the age of 80; only in the octogenarians, do doctors prescribe pills less frequently [2].

This development is reflected by changes in the patient population profile in European dialysis centres. In the German KfH centres, with a total of 13 456 dialysis patients in 1998 and 15 234 in 2008, the proportion of patients aged >65 years increased dramatically from 38.9% to 56.4% during this short period of time [3]. In our own unit (189 dialysis patients), in 2008, patients >65 years of age made up 85% of the total days patients spent in hospital. Along with the growing morbidity of elderly dialysis patients, the need for diagnostic and therapeutic interventions increases, too.

The consequences of the demographic development for the financial situation of the health care systems are aggravated by dramatic epidemiologic developments. Worldwide, in 1994, the number of diabetics was 110 million, and the number will have increased to 239 million by next year [4]. In 2001, German patients with diabetes caused additional costs of €14.6 billion compared with patients of matching age without diabetes [5].

Again, this development has reached European dialysis centres and the field of nephrology. Up to 34% of the dialysis population suffers from diabetes, mostly associated with hypertension and cardiovascular diseases; up to 29% are on dialysis because of diabetic nephropathy [6]. The diabetic dialysis patients have the highest number of comorbidities and hospital stays.