AJKD
Original Investigation

Survival Trends in ESRD Patients Compared With the General Population in the United States

Carl van Walraven, MD, MSc, FRCPC,[1,2,3] *Douglas G. Manuel, MD, MSc, FRCPC,*[1,2,3] *and Greg Knoll, MD, MSc, FRCPC*[1,2]

Background: Health care resources expended on patients with end-stage renal disease (ESRD) have increased extensively, with uncertain changes in outcomes. In this study, we examined survival trends in the United States in patients with ESRD receiving renal replacement therapy with long-term dialysis or transplantation relative to the general population.

Study Design: Secondary analysis of records from the US Renal Data System.

Setting & Participants: American adults receiving renal replacement therapy in 1977, 1987, 1997, and 2007.

Predictor: Year.

Outcome: 1-year survival.

Measurements: Abridged period life tables were created for each cross-sectional patient group and were compared with general US population life tables to measure relative survival, calculated as differences in average survival between the general US and the ESRD populations.

Results: From 1977 to 2007, ESRD patient groups became significantly older (mean age increased from 47 to 58 years) and sicker (ESRD due to diabetes increased from 9.1% to 38.2%; patients with a high death risk increased from 36.8% to 50.7%). Unadjusted age-specific survival improved (for 50-year-olds, average life expectancy increased 8% from 7.3 years in 1977 to 7.9 years in 2007), but age-specific survival increased more extensively in the general US population (from 27.5 years in 1977 to 30.9 years in 2007; 12% improvement). Accounting for this, age-specific relative survival in patients with ESRD decreased (for 50-year-olds, 20.2 life-years lost in 1977 vs 23.0 life-years lost in 2007).

Limitations: Our analysis controlled for neither patient comorbid conditions nor initial glomerular filtration rate at the start of renal replacement therapy.

Conclusions: Over the past 4 decades, age-specific survival in patients with ESRD has improved, but has not kept pace with that of the general US population. To be complete, future survival studies in patients with ESRD should focus on both temporal changes in survival within this group and changes relative to the general population.

Am J Kidney Dis. 63(3):491-499.

INDEX WORDS: End-stage renal disease (ESRD); renal replacement therapy (RRT); survival; life expectancy; mortality rate; renal failure; survival trend; kidney disease outcome.

The number of patients who require treatment for permanent kidney failure has increased significantly in the United States and around the world.[1] In 2010, there were 594,374 patients in the United States who received life-sustaining therapy with either dialysis or kidney transplantation.[1] This count has increased more than 5-fold since 1985, when only 113,203 patients with chronic kidney failure received treatment.[2] Medicare and non-Medicare expenditures for end-stage renal disease (ESRD) care in the United States are extensive, reaching $47.4 billion in 2010.[1] Patients with ESRD account for 1.3% of all Medicare beneficiaries, but consume 7.9% of its budget.[3]

Given the considerable use of health care resources, concerns have been expressed about outcomes—primarily survival—in patients with ESRD.[4] Short-term survival of incident patients with ESRD has not changed; 1-year survival of patients with ESRD (including both incident dialysis and kidney transplantation) was 78% in both 1985 and 2009.[1] However, mortality rates beyond the first year for patients with established ESRD have decreased 16% during the same period.[1] Despite this improvement, only 51% of dialysis patients remain alive after 3 years of treatment.[1] Survival comparisons over time are difficult to interpret given the dramatic changes in the patient population; for example, the proportion with diabetes as the cause of ESRD increased from 28.5% in 1985 to 44.1% in 2010.[1] Similarly, the proportion of new patients with ESRD who are older than 65 years was only 36% in 1985, but has increased to 48.8% in 2010.[1]

From the [1]Faculty of Medicine, University of Ottawa; [2]Ottawa Hospital Research Institute; and [3]ICES@uOttawa Health Services Research Facility, University of Ottawa, Ottawa, Canada.

Received July 18, 2013. Accepted in revised form September 6, 2013. Originally published online November 8, 2013.

Address correspondence to Carl van Walraven, MD, MSc, FRCPC, The Ottawa Hospital, 1053 Carling Avenue, Administrative Services Building, 1st Floor, Room 1-003, Ottawa ON, K1Y 4E9, Canada. E-mail: carlv@ohri.ca

0272-6386/$36.00
http://dx.doi.org/10.1053/j.ajkd.2013.09.011

Comparisons using national registries have shown that the ESRD population in the United States has a substantially higher mortality rate compared with patients with ESRD in Europe and Japan.[5,6] Several reasons have been proposed to explain the variation in outcomes, including differences in case mix, data ascertainment, completeness of data, and practice patterns, such as vascular access use.[7,8] However, even with uniform data collection and detailed adjustment of case mix, the United States had a 3-fold higher risk of death compared with Japanese and a 33% higher risk of death compared with European dialysis patients.[5] Differences in ESRD mortality also have been attributed to differences in the underlying mortality of the general population.[7-9] Using data from the World Health Organization and 25 national ESRD registries, Yoshino et al[9] identified a strong correlation between all-cause mortality rates in the general population and that in the corresponding dialysis population.

These data suggest that studies of survival and survival trends within particular disease groups also should consider corresponding data for the entire population from which that group is sampled. Such comparisons allow changes in the disease group to be interpreted in the context of its source population. In this study, we hypothesized that long-term survival of patients with ESRD, adjusted for patient age and overall sickness, would improve over time, but the magnitude of benefit would be less than that of the general population. To test this hypothesis, we compared the survival of patients with ESRD in 4 different periods (1977, 1987, 1997, and 2007) relative to the US general population.

METHODS

Data Source

This study used data from the US Renal Data System (USRDS). The USRDS is a national reporting system that captures information about all Americans with ESRD who receive renal replacement therapy or are awaiting kidney transplantation. Reporting to the USRDS is mandatory for all centers treating such patients and is required for payment by Medicare & Medicaid Services of treatment costs. This study was approved by the Ottawa Hospital Research Ethics Board.

Study Patients

Our study included 4 cross-sectional patient groups from 1977, 1987, 1997, and 2007. These years were chosen because 2007 was the latest year for which US life tables were available at the time of the study. We receded from 2007 in decade-long intervals to identify important population trends. To be included in a particular year's cross-sectional patient group, patients had to be 20 years or older and registered in the USRDS on January 1 of the observation year. We determined the treatment modality each patient was using on this date. Patients were excluded if they died within the first 90 days of renal replacement therapy initiation (this exclusion ensured that only patients with chronic kidney failure were included in the analysis) or were either lost to follow-up during the observation year or had complete renal recovery. No patient was excluded because of missing data.

Life Table Construction

To describe patient survival, we constructed abridged period life tables for each of the 4 patient groups (1977, 1987, 1997, and 2007) using the methods described by Chiang.[10] Patients were clustered into 5-year age strata up to 84 years. The completed life table returned the mean expected life duration in years for each age strata. We constructed other life tables that were stratified by the following: sex, race, age category (defined as <50, 50-65, and >65 years), baseline kidney disease, renal replacement therapy (peritoneal dialysis, hemodialysis, and kidney transplantation), and expected risk of death (see the following section for explanation). Analysis by race was limited to white or black race because race-specific life-table estimates were available, until recently, for these races alone.

Mortality Risk Stratification

The case mix of patients receiving renal replacement therapy has changed over time, with older patients and those with more extensive comorbid conditions receiving treatment.[1,11] Because of this secular change in patient characteristics, we hypothesized that death risk in patients with ESRD would increase with time. To adequately compare outcomes over time, we needed to adjust for this increasing risk. To do this, we summarized this risk by developing a risk score for the annual death risk using data from the USRDS that were available for all patients. We used generalized estimating equation methods (using a binomial link function) when constructing our risk model to account for potential lack of independence between cohorts because the same patient could be represented in different cohort years.[12] Although the risk model adjusted for patient age and year, these factors were not included in the final index score because age and year were accounted for, by stratification, in the life tables. Information about comorbid conditions was not available for all patients and therefore was not included in the model. Risk scores were categorized into 3 groups based on crude event rates: low-risk patients (risk score, less than -11 points) had an annual mortality risk of 3.8%, medium-risk patients (risk score, -11 to 2 points) had an annual mortality risk of 14.9%, and high-risk patients (risk score, ≥ 3 points) had an annual mortality risk of 23.2%. More information about the risk model and risk index is given in Table S1 (provided as online supplementary material).

Analysis

Life tables for the 4 patient groups (1977, 1987, 1997, and 2007) were compared with those of the general US population (accessed from the Centers for Disease Control and Prevention[13]). Standard methods were used to collapse (ie, abridge) US life tables to ensure that age categorization in the patient and general US life tables were identical.[14] Annual life-table estimates specific to black Americans were not reported prior to 1980; therefore, life-table estimates for black Americans in 1977 were taken from decennial life tables that were produced in 1980.

To compare average survival in each patient group relative to the general population, we calculated age-specific differences in average years of life expectancy between the US population and patients with ESRD. These differences were weighted by the proportion of that year's patient group within each age stratum. These weighted differences then were summed to calculate average life-years lost for the entire patient group in that year. This statistic measured relative survival in the patient group and was influenced by both absolute values for age-specific life-years lost and the age distribution of the patient group. Bootstrap methods (using 1,000 random samples, with replacement, of size equal to the original patient groups) were used to generate confidence intervals (CIs) using the percentile method. We repeated the analysis after stratifying the population based on age category, sex, race, baseline disease, treatment, and risk group.