The incidence of end-stage renal disease in India: A population-based study

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Chronic kidney disease (CKD) and end-stage renal disease (ESRD) are emerging public health problems in developing countries, and need changes in health-care policy. ESRD incidence data are not available from large parts of the developing world including South Asia. We report the ESRD incidence in a large urban population in India. ESRD incidence was estimated for four consecutive calendar years (2002–2005) among 572 029 subjects residing in 36 of the 56 wards of the city of Bhopal. These subjects are beneficiaries of free health care in a hospital established after the 1984 Union Carbide Industrial Accident. Crude and age-adjusted incidence rates were calculated. A total of 346 new ESRD patients were diagnosed during the study period; 86 in 2002, 82 in 2003, 85 in 2004, and 93 in 2005. Average crude and age-adjusted incidence rates were 151 and 232 per million population, respectively. The mean age was 47 years, and 58% were males. Diabetic nephropathy was the commonest (44%) cause of ESRD. This study provides the first population-based ESRD incidence data from India and reveals it to be higher than previously estimated. Diabetic nephropathy is the leading cause of ESRD. Changes are required in health-care policy for optimal care of CKD patients and efficient resource utilization for management of those with ESRD.

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Chronic kidney disease (CKD) and end-stage renal disease (ESRD) have become worldwide public health problems. These conditions increase patient morbidity and mortality risks and put major economic strain on the health-care systems. In US alone, over 30 million people have been diagnosed to have CKD and it is estimated that over 600 000 will need renal replacement therapy by 2010, costing USD 28 billion.[1] The population of India exceeds one billion and is projected to become the major reservoir of chronic diseases like diabetes and hypertension.[2] With 25–40% of these subjects likely to develop CKD, the ESRD burden will rise, and the health-care system would need to take care of these individuals. However, in the absence of any registry, data on incidence of ESRD in India or other countries of South Asia do not exist. A figure of 100 per million population (pmp) per year is often cited, based on estimates from rest of the world, tertiary care center data, and collective experience of experienced nephrologists.[3–5]

Further, it has been estimated that less than 10% of all Indian ESRD patients receive any meaningful renal replacement therapy (RRT).[3–5] As the RRT delivery infrastructure improves, it is imperative that the ESRD incidence for our country be known definitively to plan care for these individuals. This study provides the first estimate of ESRD incidence in a large population base, determines the contribution of diabetes to ESRD, and provides a basis for health-care policy planning.

RESULTS

A total of 346 new patients were diagnosed to have ESRD during the study period. The average annual crude and age-adjusted incidence rates for the period were 151 and 229 pmp, respectively. Table 1 gives the number of new ESRD cases, crude and age-adjusted incidence rates, gender distribution, and proportion of subjects with one of diabetic nephropathy for each year. The laboratory parameters at the time of diagnosis are shown in Table 2. Figure 1 shows the overall and age-specific incidence rates over the 4 years.

The initial dialysis modality was hemodialysis for all subjects. A total of five patients shifted to continuous ambulatory peritoneal dialysis, and 21 underwent living donor transplant. A total of seven patients elected not to start any RRT and withdrew from active treatment.

Table 1 | Number of new cases of ESRD and the incidence data

	2002	2003	2004	2005
New ESRD cases	86	82	85	93
Incidence (pmp)	150	143	149	163
Age-adjusted incidence (pmp)	232	186	317	181
Sex ratio (M:F)	55/45	63/37	65/35	52/48
Age (years)	46±15	50±10	47±13	46±12
Diabetic nephropathy (%)	47	43	40	46

ESRD, end-stage renal disease; F, female; M, male; pmp, per million population.

Table 2 | Subject characteristics at the start of dialysis

	2002	2003	2004	2005
Percentage of cases with				
Systolic BP > 140 mmHg	86	51	65	61
Diastolic BP > 90 mmHg	72	54	61	58
Hemoglobin (g/dl)	8.2±1.7	8.0±2.0	8.6±2.1	9.1±1.7
Blood urea (mg/dl)	228±93	226±102	197±79	191±107
Serum creatinine (mg/dl)	9.8±3.5	9.7±4.5	8.7±3.9	9.2±4.1
CG GFR[a] (ml/min)	7.7±4.3	8.4±3.6	7.9±3.5	8.1±3.7
MDRD GFR[b] (ml/min/1.73 m^2 BSA)	6.7±4.7	6.9±3.5	7.2±2.9	6.9±3.1

BP, blood pressure; BSA, body surface area; CG, chronic glomerulonephritis; GFR, glomerular filtration rate; MDRD, modification of diet in renal disease.
[a]Glomerular filtration rate calculated by Cockroft-Gault formula.
[b]Glomerular filtration rate calculated by the modified MDRD equation.

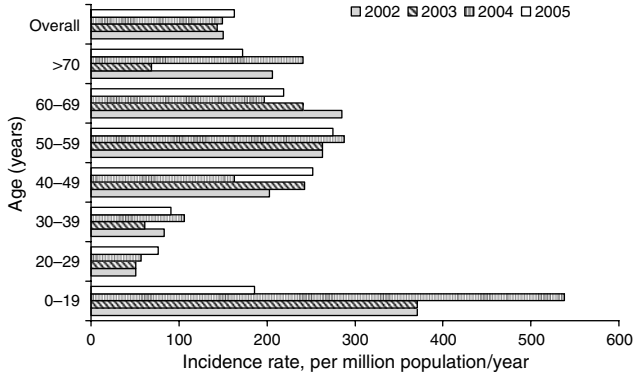

Figure 1 | Overall and age-specific ESRD incidence rates during the study period.

DISCUSSION

This study presents the first population-based ESRD incidence figure from India, the second most populous country in the world, and reveals the previous guesses about the ESRD incidence (approximately 100 pmp) to be gross underestimates. This rate is also higher than the age-adjusted ESRD incidence of 115–123 pmp determined in the 1980s among Indo-Asian immigrants in UK.[6] Higgins *et al.*[7] in 1995 reported overall dialysis take-on rates of 248–497 pmp in Asian/Afro-Caribbean population in the city of Coventry, UK. In both studies, the incidence was 4–5 times higher than that observed in the white population residing in the same areas. We also show that the mean age of patients entering ESRD is lower than that reported in the west.

ESRD incidence is rising worldwide, and developing world is no exception. The economic growth and urbanization has been accompanied by increase in the prevalence of non-communicable diseases like diabetes, hypertension, and atherovascular diseases. The total burden of ESRD faced by the nation remains unknown owing to lack of access to health care, organized chronic disease management programs, and national registries. Thus, the data in this study are of great value for national healthcare policy planning. Assuming the incidence to be uniform in all parts of the country, it can be estimated that approximately 152 000 new ESRD patients require RRT every year in India. The resources and skill for taking care of this large case-load, both in terms of personnel and health-care infrastructure, do not exist currently[3–5,8,9] and would need to be created.

Unlike at the BMHRC, the high treatment cost limits access to RRT for most Indians.[3] It is estimated that >90% of ESRD patients cannot afford long-term RRT and die within weeks to months of diagnosis.[3,8] With the incidence of diabetes and hypertension projected to rise further, ESRD incidence rate is likely to climb, and facilities need to be developed to take care of the increasing number of existing and incident ESRD cases.

Some data are available on the pattern of causes of ESRD in India. Glomerulonephritides (presumably infection-related), interstitial nephritis (thought to be due to potential environmental exposures to nephrotoxins), and stones have been reported to be the most frequent causes.[9–11] This study highlights the emergence of diabetic nephropathy as the major cause of ESRD in India. This finding is consistent with the worldwide trend of steady rise in the contribution of diabetes to ESRD. In a recent population-based survey, diabetes was the cause of CKD in 41% cases.[12] Another study[13] involving several hospitals in India found that 29% of CKD subjects had diabetic nephropathy. Variation can be encountered in prevalence of diabetes depending upon the rural/urban divide, level of economic development, and

genetic background of the population studied. As diabetes is the main cause of ESRD, wide variations could influence ESRD incidence. The exact cause remained unknown in a majority of non-diabetics in this study, probably because of the delayed presentation. The UK study on Indo-Asians with ESRD[6] showed a seven-fold higher incidence of diabetic renal disease compared to whites and a high frequency of patients with advanced kidney failure of unknown etiology and small smooth kidneys.

The ideal method to determine the incidence of a disease is to constitute a healthy representative cohort and follow it up for many years. This study utilized a large population segment in a defined geographic area. Referral bias and population migration may introduce errors, ESRD is not asymptomatic and the care is expensive, making it unlikely that any patient would not have reported to the only hospital in the region that provides free treatment. The large population size and inclusion of subjects irrespective of socioeconomic, educational, or religious status compensates for any limitations. As this population was identified for dispensation of benefits arising out of the compensation of the 1984 Union Carbide methyl isocyanate gas tragedy, it may be argued that methyl isocyanate exposure could have confounded the results. However, extensive studies have not documented any nephrotoxic effect, pulmonary fibrosis being the only proven long-term consequence of methyl isocyanate exposure.[14,15] The year-to-year consistency in the incidence rates, demographics, and laboratory profile also lend credibility to the data. The mean age of subjects in this study is close to the reported figure of patients entering ESRD programs in the subcontinent. Finally, India is a diverse country with a heterogeneous population mix in terms of ethnicities, rural-urban divide, and level of economic development. Although BMHRC is situated in an urban location, the population it serves is heterogeneous, representing all socioeconomic strata living in urban as well as rural areas. Still, finding of a single study coming from a defined geographic area should be generalized to the whole population with appropriate caution.

In summary, this population-based study has for the first time provided an estimate of ESRD incidence in India. The crude and age-adjusted incidence rates of 151 and 232 pmp are significantly higher than the estimates projected so far. Increased efforts are required by the health-care policy-makers to ensure availability and optimum utilization of resources for ESRD care.

MATERIALS AND METHODS

The study was conducted at Bhopal Memorial Hospital and Research Centre (BMHRC), a multi-specialty tertiary care hospital located in the city of Bhopal in Madhya Pradesh, a province in central India. BMHRC was set up in the year 2000 on the direction of the Supreme Court of India to provide health care to a defined population presumed to be potentially affected by the Union Carbide Gas Tragedy of 1984. Every individual residing in 36 of the 56 wards of the city was given a unique identifier document, and became entitled to free medical care through BMHRC and its eight out-reach centers located in the community. The total number of registered beneficiaries is 572 029.

All CKD patients from within this population present either through the out-reach centers or directly to BMHRC. The unique identifier number allotted to each subject prevents any duplication of records or redundancy of referrals. Availability of free health care (including dialysis) ensures presentation of all ESRD patients to BMHRC.

The incidence of new ESRD patients in this defined population was estimated for four consecutive calendar years, that is, 2002–2005. Patients were classified as having ESRD as per the following case definitions: (i) patients starting regular dialysis, (ii) patients those who were advised regular dialysis but decided to withdraw, and (iii) patients who received a renal transplant. Patients dialyzed for acute renal failure, or those CKD patients in whom the renal function improved or recovered (acute-on-chronic renal failure) were excluded. Incidence was expressed as number pmp per year. Age-adjusted incidence rates were calculated using the 2001 population census data.

Basic demographic and clinical profile at the time of dialysis initiation was recorded for all subjects. Glomerular filtration rate at the start of dialysis was estimated by Cockcroft–Gault's formula and by the modified Modification of Diet in Renal Disease equation. Diabetic nephropathy was defined as ESRD in the presence of diabetes, normal-sized kidneys on ultrasonography, and diabetic retinopathy.

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