One-Year Mortality of Patients with Chronic Kidney Disease After Spinal Cord Injury: A 14-Year Population-Based Study

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OBJECTIVE: **Chronic kidney disease (CKD) has become a global public health burden because of its increasing incidence, high risk of progression to end-stage renal disease (ESRD), and poor prognosis. We aimed to investigate the 1-year mortality of patients with spinal cord injury (SCI) with CKD and ESRD, and compare it with that of patients with SCI without CKD by reviewing a large Taiwanese population data set.**

METHODS: **In this 14-year retrospective cohort study, the study group (SCI with CKD group, *n* = 3315) and comparison group (SCI without CKD group, *n* = 6630) were matched at a 1:2 ratio with propensity score matching by age, sex, comorbidities, length of intensive care unit stay, and length of stay. The 1-year mortality and the relative risks of mortality were calculated. Mortality stratified by age, sex, and comorbidities was also analyzed.**

RESULTS: **The SCI with CKD group had a significantly shorter survival period (10.13 vs. 10.97 months), higher 1-year mortality (17.65% vs. 8.54%), and higher risk of mortality than did the comparison group (adjusted hazard ratio, 2.25). Furthermore, patients with CKD with ESRD had a 7.71-fold higher risk of mortality than did patients with SCI without CKD for ages <50 years. The presence of comorbidities was a risk factor for mortality among patients with SCI CKD or ESRD in contrast to patients with SCI without CKD.**

CONCLUSIONS: **Patients with SCI with CKD, especially those with ESRD, have a higher risk of mortality than do patients who do not have CKD. Therefore, patients with CKD should have carefully monitoring for the development of 1-year mortality after SCI, especially for ESRD.**

INTRODUCTION

Spinal cord injury (SCI) and chronic kidney disease (CKD) are both crucial public health issues in Taiwan and worldwide. SCI is a kind of neurotrauma and traumatic injury that often results from traffic accidents, working injuries, or falls and may lead to physical impairments or dysfunctions (e.g., paraplegia and tetraplegia). Traumatic injuries are the leading cause of death, accounting for up to 10% of death in individuals aged 5–44 years in developed countries. For people with spinal injuries, the overall mortality is reported to be 17% in the literature,[1] which affects not only the individuals but also their families and society.

CKD has become a global public health burden because of its increasing incidence, high risk of progression to end-stage renal

Key words
- Chronic kidney disease
- End-stage renal disease
- Mortality
- Population-based study
- Spinal cord injury
- Taiwan

Abbreviations and Acronyms
CI: Confidence interval
CKD: Chronic kidney disease
CVD: Cardiovascular disease
ESRD: End-stage renal disease
HR: Hazard ratio
ICD-9-CM: *International Classification of Diseases, Ninth Revision, Clinical Modification*
ICU: Intensive care unit
SCI: Spinal cord injury

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disease (ESRD), and poor prognosis in terms of morbidity and mortality.[2,3] Clinicians and caregivers may increasingly encounter patients with SCI problems who have varying preexisting CKDs. The relationship of SCI and CKD shows the importance and necessity of focusing on this topic. According to previous studies, patients with SCI have a significant degree of morbidity and mortality as a result of renal disease.[4-7] However, most of these studies investigated patients with SCI after CKD. For example, in a study of 219 patients with chronic SCI, those who developed kidney disease, defined as kidney damage and/or decreased kidney function, were reported to have increased mortality.[8] Overall, the risk of mortality among patients with SCI with preexisting CKD is still unclear.

Thus, the purpose of our study was to review the 1-year mortality and relative risk of patients with SCI with preexisting CKD, including those with and without ESRD, with respect to the general population using a Taiwanese population database.

In Taiwan, the prevalence of CKD was estimated to be 9.83%–11.9% lower than that in the United States.[9,10] However, Taiwan has the highest incidence and prevalence of ESRD worldwide according to the U.S. Renal Data.[11] The incidence of SCI was high, estimated at approximately 2.46 per 10,000 person-years in Taiwan.[2] The economic burden of SCI is also an important factor to consider, both in terms of lost work productivity as well as the cost of hospital care and rehabilitation. The estimated cost is approximately 900 billion U.S. dollars if the patient cannot recover and come back to live in the community.[12] For these reasons, Taiwan is suitable for study of the relationship of these 2 diseases.

METHODS

Database

In this 14-year retrospective cohort study, we applied inpatient medical claims data from 1999 to 2013 that were retrieved from the National Health Insurance Research Database, which was released for research purposes by the National Health Research Institute in Taiwan. The National Health Insurance Research Database contained data from 99% of inpatient and outpatient medical beneficiaries from the Taiwanese population (about 23 million individuals). Details of the patients, such as sex, patient identification numbers, and date of birth, were retrieved from the database. However, all data were de-identified to prevent possible ethical violations. Institutional review board (no. 10307-E01) approval was not required by Chi Mei Medical Center.

Definition of Study Samples

The study group (SCI with CKD group) was defined as patients who were hospitalized for the first time between January 1, 1999 and December 31, 2013 for SCI and who had a history of CKD. Based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes, patients with SCI were defined as those with fracture of the vertebral column with SCI (*ICD-9-CM* code 806) or those with SCI without evidence of spinal bone injury (*ICD-9-CM* code 952). The individuals were recorded as patients with CKD by medical professionals using the following codes: 580-589 (nephritis, nephritic syndrome, and nephrosis), 250.4 (diabetes mellitus with renal manifestations), 274.1 (gouty nephropathy), 403 (hypertensive CKD), 404 (hypertensive heart and CKD), 440.1 (of the renal artery), 442.1 (of the renal artery), 447.3 (hyperplasia of the renal artery), 591 (hydronephrosis), 753 (congenital anomalies of the urinary system), 752.4 (hepatorenal syndrome), and 642.1-642.2 (hypertension secondary to renal disease, other preexisting hypertension).

Patients with SCI with CKD were divided into 2 groups (ESRD and non-ESRD groups) to examine the differences according to disease severity. The patients with CKD with ESRD were those who underwent hemodialysis for more than 3 months and could apply for a catastrophic illness card.

The comparison group (SCI without CKD group) was randomly selected from the inpatient medical claims database within the same study period as the study group. The study group and comparison group were matched at a 1:2 ratio with propensity score matching by age, sex, comorbidities (hypertension, *ICD-9-CM* 362.11, 401-405, 437.2; diabetes mellitus, *ICD-9-CM* 250, 357.2, 362.0, 366.41; coronary artery disease, *ICD-9-CM* 414; stroke, *ICD-9-CM* 430-438; and heart failure, *ICD-9-CM* 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 422, 425, 428), length of intensive care unit (ICU) stay, and length of stay.

Exclusion Criteria

Patients with SCI with CKD who were aged less than 18 years were excluded from the present study. Because the presence of preexisting ESRD could have affected the risk of mortality, patients who had a catastrophic illness card before the date at which SCI was diagnosed were also excluded from the present study.

Outcome

To examine the effect of CKD in patients with SCI, we calculated and compared 1-year mortality in the SCI with CKD group with that in the SCI without CKD group. The definition of 1-year mortality was death occurring from the date that SCI was diagnosed until 1 year after diagnosis. In addition, we investigated the survival conditions among the most severe patients with CKD with SCI by dividing them into ESRD or non-ESRD groups. We also analyzed the risk of mortality stratified by age, sex, and comorbidities.

Statistical Analysis

A Pearson χ^2 test was used to compare the categorical variables between the SCI with CKD group and SCI without CKD group, including age, sex, medical comorbidities, length of ICU stay, length of stay, and outcome. Age was divided into the following categories: 18–49, 50–64, 65–79, and ≥80 years. Student *t* test and Wilcoxon rank-sum test were performed to compare age at the first date of diagnosis during the study period and time to death, respectively. Kaplan-Meier curves were estimated and a log-rank test was used to compare the 1-year mortality between the study group and comparison group, and between the ESRD and non-ESRD groups. Cox regression analysis was conducted to evaluate the relative risk of mortality, which was adjusted for potential confounding variables such as age, sex, and comorbidities. The Kaplan-Meier curves were drawn using Stata 12 software (Stata Corp., College Station, Texas, USA). The significance level was set at $P < 0.05$. All data processing and statistical analyses