Renal function is associated with one-month and one-year mortality in patients with intracerebral hemorrhage

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Abstract

Background: This study evaluated short-term (1-month) and long-term (1-year) mortality risks associated with kidney function measured by estimated glomerular filtration rate (eGFR) levels at admission for patients with intracerebral hemorrhage. Methods: From the Taiwan Stroke Registry data, we identified and stratified patients with intracerebral hemorrhage into 5 subgroups by the eGFR levels at admission: [?] 90, 60-89, 30-59, 15-29, and < 15 mL/min/1.73m2 or on dialysis from April 2006 to December 2016. Risks of 1-month mortality and 1-year mortality rates after intracerebral hemorrhage were investigated by the eGFR levels. Results: Both the 1-month mortality and 1-year mortality rates increased as the eGFR level decreased. The 1-month mortality rate was over 5-fold greater in patients with eGFR < 15 mL/min/1.73m2 or on dialysis than in patients with eGFR levels [?] 90 mL/min/1.73m2 (8.31 versus 1.50 per 1000 person-days), with an adjusted hazard ratio (HR) of 4.59 [95% confidence interval (CI) = 2.71-7.78]. Similarly, the 1-year mortality rate was 7.5-fold greater in patients with eGFR < 15 mL/min/1.73m2 or on dialysis than in patients with eGFR [?] 90 mL/min/1.73m2, with an adjusted HR of 4.54 (95% CI 2.95-6.98). Conclusion: The eGFR level can be an indicator of prognosis for patients with intracerebral hemorrhage.

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Running title: eGFR and intracerebral hemorrhage

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Key words: estimated glomerular filtration rate, intracerebral hemorrhage, mortality, predictor, renal function

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Abstract

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with intracerebral hemorrhage. **Methods:**From the Taiwan Stroke Registry data, we identified and stratified patients with intracerebral hemorrhage into 5 subgroups by the eGFR levels at admission: [?] 90, 60-89, 30-59, 15-29, and $<$ 15 mL/min/1.73m^2 or on dialysis from April 2006 to December 2016. Risks of 1-month mortality and 1-year mortality rates after intracerebral hemorrhage were investigated by the eGFR levels.**Results:** Both the 1-month mortality and 1-year mortality rates increased as the eGFR level decreased. The 1-month mortality rate was over 5-fold greater in patients with eGFR $<$ 15 mL/min/1.73m^2 or on dialysis than in patients with eGFR levels [?] 90 mL/min/1.73m^2 (8.31 versus 1.50 per 1000 person-days), with an adjusted hazard ratio (HR) of 4.59 [95% confidence interval (CI) = 2.71-7.78]. Similarly, the 1-year mortality rate was 7.5-fold greater in patients with eGFR $<$ 15 mL/min/1.73m^2 or on dialysis than in patients with eGFR [?] 90 mL/min/1.73m2, with an adjusted HR of 4.54 (95% CI 2.95-6.98).**Conclusion:** The eGFR level can be an indicator of prognosis for patients with intracerebral hemorrhage.

What's already known about this topic?

Renal dysfunction is one of the risk factors for the development of cardiovascular disease, including stroke, and death. It is uncertain whether renal dysfunction could be a poor prognostic factor in patients with intracerebral hemorrhage.

What does this article add?

The eGFR level could be used as an early biomarker to identify high mortality risks for patients with intracerebral hemorrhage. Patients with intracerebral hemorrhage and a low eGFR deserve more clinical attention and closer follow-up monitoring.

Introduction

Stroke is one of major causes of death and disability worldwide and it has become the fourth leading cause of death in the US.[1] The impacts of stroke on quality of life, productivity, and health care costs are tremendous. Because of the high social and financial burden, it is important to study the prognostic factors after stroke.

Renal dysfunction is one of the risk factors for the development of cardiovascular disease, including stroke, and death.[2-5] On the other hand, renal function impairment is highly prevalent in patients with stroke. Up to 50 % of stroke patients have preexisting renal dysfunction.[6,7]Previous studies have shown that the renal dysfunction predicts the risks of both mortality and new cardiovascular events in patient with stroke.[7-9] There is a graded relationship between renal dysfunction and cardiovascular outcomes, including deaths in these patients. In our previous studies, we also found that the estimated glomerular filtration rate (eGFR) is associated with risks of both 1-month and 1-year mortality and of recurrence in patients with acute ischemic stroke.[10,11] Intracerebral hemorrhage is a more devastating stroke than ischemic stroke, carrying a higher risk of subsequent morbidity and mortality.[12,13] Renal dysfunction has been found to be a poor prognostic factor in patients with intracerebral hemorrhage.[14-18] However, other studies failed to show renal dysfunction as a significant predictor of mortality in patients with intracerebral hemorrhage.[8,19] Because of previous inconsistent results, this study investigated whether the risks of 1-month and 1-year mortality are associated with eGFR levels in patients with intracerebral hemorrhage using the Taiwan Stroke Registry (TSR) database.

Methods

Data source

TSR, launched in 2006, is a multi-center stroke registry system with participation of 38 hospitals (16 medical centers, 20 regional hospitals, and 2 local hospitals) in Taiwan[20]. Trained personals at participation hospitals were in charge of registry tasks and the follow-up data collection. The registration data contained demographic profiles, information on National Institute of Health Stroke Scale (NIHSS), hospitalization records, and discharge information. Telephone contacts were performed at 1, 3, 6, and 12 months after stroke to collect follow-up information, including deaths. The informed consents were obtained from all patients before being included in the registry program. This study was performed in compliance with guidelines of the

Declaration of Helsinki and approved by the Institutional Review Board [CMUH102-REC1-086 (CR3)].

Study Population

Among a total of 105,994 stroke patients registered from 2006 to 2016 in the TSR, 15,031 were patients with intracerebral hemorrhage (Figure 1). Patients with intracerebral hemorrhage caused by trauma or brain tumors were not registered in this database. We excluded patients younger than 18 years old, and patients without information on dialysis status, body mass index (BMI), systolic blood pressure levels, hemoglobin (Hb) levels, serum cholesterol levels, or serum creatinine levels. Patients who died during hospitalization were not excluded. A total of 4,036 hemorrhagic stroke patients were included in this study and divided into five subgroups by the level of estimated glomerular filtration rate (eGFR): [?] 90 ml/min/1.73 m^2, 60-89 ml/min/1.73 m^2, 30-59 ml/min/1.73 m^2, 15-29 ml/min/1.73 m^2, and $<$ 15 ml/min/1.73 m^2 or on dialysis. The eGFR was calculated by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation for each non-dialysis patient[21]. The CKD-EPI equation, expressed as a single equation, is GFR = 141 $\times$ min (Scr/$\varkappa$, 1)$^{\alpha}$ $\times$ max (Scr/$\varkappa$, 1)$^{-1.209}$ $\times$ 0.993$^{\text{Age}}$ $\times$ 1.018 [if female] $\times$ 1.159 [if black], where Scr is serum creatinine, $\varkappa$ is 0.7 for females and 0.9 for males, α is -0.329 for females and -0.411 for males, min indicates the minimum of Scr/$\varkappa$or 1, and max indicates the maximum of Scr/$\varkappa$ or 1. The etiologies of intracerebral hemorrhage were classified into hypertension and non-hypertensive causes. One-month and one-year mortality rates after intracerebral hemorrhage were evaluated by the eGFR levels.

Statistical analysis

Distributions of baseline characteristics were compared among five eGFR groups, including sex, age, BMI, smoking, comorbidity, clinical characteristics, medication use prior to admission, and the 1-month, and 1-year mortality rates. Data of continuous variables were expressed as median and 25th percentile to 75th percentile and examined using the Kruskal-Wallis test for continuous variables that were not normally distributed. Categorical variables were expressed as frequencies and examined using the Chi-square test.

The cumulative incidence curves of mortality were computed for the 5 subgroups of eGFR levels by the Kaplan–Meier method and tested using the log-rank test. The 1-month and 1-year mortality rates (per 1000 person-days) after intracerebral hemorrhagic were calculated by the eGFR levels. We further used the Cox proportional hazards regression analysis to estimate the hazard ratio (HR) of mortality and 95% confidence interval (CI) associated with eGFR levels at admission for patients with intracerebral hemorrhage, using patients with eGFR [?] 90mL/min/1.73 m^2 as references. We also used the receiver operating characteristic (ROC) curve to assess the predictive performance of eGFR levels with regard to one-month mortality and one-year mortality after intracerebral hemorrhage. All statistical analyses were performed using SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC). Statistical significance was defined using two-tailed tests ($P < 0.05$).

Results

Of the 4,036 patients with intracerebral hemorrhage, 2887 (71.5%) had eGFR $<$ 90 mL/min/1.73 m^2 (Figure 1). 169 (4.2%) patients were in the group with eGFR $<$15 mL/min/1.73 m^2 or on dialysis.

Table 1 shows that more than two third (n=2677) of the patients with intracerebral hemorrhage were men. With a median age of 61.4 years, the age of study population increased as the eGFR level decreased. In general, prevalence rates of comorbidities, scores of NIHSS, systolic blood pressure and medication use prior to admission tended to be higher in groups with lower eGFR, whereas Hb levels were lower in groups with lower eGFR. Of the baseline comorbidities in all study patients, hypertension was the most prevalent comorbidity (86.6%), followed by diabetes mellitus, previous stroke, ischemic heart disease, atrial fibrillation, and congestive heart failure (1.21%).

The cumulative incidence rates of overall mortality in one year in patients with intracerebral hemorrhage increased as the eGFR level declined ($P < 0.001$). The proportional mortality rate was 38% greater in those with an eGFR of $<$ 15 ml/min/1.73 m^2 than in those with eGFR levels [?] 90 mL/min/1.73m^2 (Figure 2).

Both one-month mortality (N = 258) and one-year mortality (N=394) rates of patients with intracerebral hemorrhage were negatively associated with their eGFR levels at admission (Table 2 and 3). The one-month mortality rate increased as the eGFR levels decreased, from 1.5 per 1000 person-days in patients with eGFR levels [?] 90 to 8.31 per 1000 person-days in patients with eGFR levels < 15 ml/min/1.73 m^2. The adjusted HR was 4.59 (95% CI = 2.71, 7.78) for patients with eGFR levels < 15 ml/min/1.73 m2 compared to those with eGFR levels [?] 90 mL/min/1.73m^2. The corresponding adjusted HR of one-year mortality increased to 4.54 (95% CI = 2.59, 6.98) for those with eGFR levels < 15 ml/min/1.73 m^2. Other risk factors associated with one-year mortality after intracerebral hemorrhage included female, age, non-hypertensive cause, atrial fibrillation, systolic blood pressure, NIHSS score at admission, warfarin use prior to admission (Table S1).

The area under the ROC curves for the eGFR level in predicting one-month mortality, and one-year mortality were 0.64 (Figure 3A), and 0.66 (Figure 3B) in patients with intracerebral hemorrhage, respectively.

Discussion

Our study found that there was an independent graded association between eGFR levels and risks of both 1-month and 1-year mortalities in patients with intracerebral hemorrhage after adjusting age, stroke severity and comorbidities. The risk of mortality increased as the eGFR declined.

Renal dysfunction is a known independent risk factor for mortality after stroke. A Scotland study followed 2042 stroke patients for 7-year and found that reduced creatinine clearance (<51.27 ml/min) and raised serum creatinine ([?]1.35 mg/dL) could predict deaths in patients with acute stroke[8]. But, the study failed to show renal function as a significant predictor of mortality in hemorrhagic stroke because of small size of fatal events.[8] A recent study from Taiwan found renal function could play a highly significant role in predicting mortality among ischemic stroke patients.[11] An Israel study assessed risk factors associated with deaths for patients with acute stroke during one-year follow-up.[7] Results demonstrated that eGFR was a strong predictor of mortality and poor functional outcomes, such as nursing home dwelling and Barthel index [?]75. Hao et al. reported that an eGFR of < 60 ml/min/1.73 m^2 was a strong predictor of mortality and disability for hemorrhagic stroke but not for ischemic stroke.[18] Molshatzki revealed that presence of moderate to severe reduction of eGFR (< 45 ml/min/1.73 m^2) was associated larger, lobar hematomas and hence higher one-year mortality in patients with intracerebral hemorrhage.[16] Data from the GET WITH The Guidelines-Stroke (GWTG-Stroke) program showed that, after intracerebral hemorrhage, patients had an increasing risk of in-hospital mortality with declining eGFR.[17] On the contrary, a study analyzing China National Stroke Registry found that low eGFR (< 45 ml/min/1.73 m^2) was independently associated with an increased risk of mortality in diabetic patients with ischemic events, but not in those with hemorrhagic stroke[19]. Our study focused on patients with intracerebral hemorrhage and found that eGFR levels could predict the risk of mortality in a graded relationship. This finding both confirms the results of previous studies and provides new information on the mortality prediction for intracerebral hemorrhage.

Decline in renal function is associated with anemia, increased oxidative stress, abnormal apolipoprotein levels, inflammation, calcium-phosphate derangement, elevated uremic toxins, hypercoagulability, and impaired immunity.[4,22-24] All these factors may contribute to the increased risks of adverse outcomes such as cardiovascular events, infection episodes, and deaths. These mechanisms may explain the graded association between impaired renal function and the risk of death in patients with hemorrhagic stroke. Our data also showed that most of the baseline comorbidities were reversely associated with eGFR levels, indicating that patients with low eGFR levels were more critically ill. In addition, patients with a lower eGFR also had a higher NIHSS score, indicating that impaired renal function could be associated with stroke severity.

The strength of this study is using a large sample size from stroke registry data with a representative group of stroke patients in Taiwan. Thus, we could estimate the real world prognosis of patients with intracerebral hemorrhage in Taiwan. In addition, we used the CKD-EPI equation to estimate the eGFR as it is better than the MDRD equation for Asian people.[25] However, there are several limitations in this study. First, there is no data regarding to the quantity of proteinuria in the TSR database. We were unable to evaluate eGFR and proteinuria simultaneously. Proteinuria is an important and independent risk factor for cardiovascular

disease.[5,26] Second, serum creatinine was measured and recorded once at the time of admission and it was confounded by acute illness. Therefore, it is difficult to determine the chronicity of renal dysfunction. Furthermore, some patients were excluded from analysis because of missing information. The precision of measurement might be affected. However, the demographic characteristics, the prevalence of comorbidities, the values of laboratory data, and the percentage of people using medication prior to admission were similar between the selected and excluded patients (Table S2). Moreover, although data on hematoma volume, location, and the type of intracerebral hemorrhage were unavailable in this database, the NIHSS score as stroke severity was adjusted in the multivariate analysis. In addition, the use of direct oral anticoagulant was not recorded in this database. This is a limitation for external validity.

Conclusion

There is an independent graded negative association between levels of eGFR levels at admission and mortality in patients with intracerebral hemorrhage. Patients with intracerebral hemorrhage and eGFR levels <15 ml/min/1.73 m^2 have a near 4-fold increased hazard of deaths compared to those with intracerebral hemorrhage and eGFR levels [?] 90 mL/min/1.73m^2. The eGFR level could be used as an early biomarker to identify high mortality risks for patients with intracerebral hemorrhage. Patients with intracerebral hemorrhage and a low eGFR deserve more clinical attention and closer follow-up monitoring.

Disclosures

None declared

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Legends

Figure 1. Flow chart for identifying patients with intracerebral hemorrhage by eGFR levels at admission

Figure 2. The cumulative incidence of mortalities after intracerebral hemorrhagic by eGFR levels at admission

Figure 3. The area under the receiver operating characteristic curves for eGFR levels at admission in predicting one-month mortality (A) and one-year mortality (B) in patients with intracerebral hemorrhage.

Table 1. Baseline characteristics of patients with intracerebral hemorrhage at admission by eGFR levels at admission

Variable	eGFR mL/min/1.73 m^2 Total N=4036		eGFR ml/1.73 m^2 Total N=4036		eGFR ml/1.73 m^2 [?]90 N=1149 (28.5%)		eGFR ml/1.73 m^2 [?]90 N=1149 (28.5%)		eGFR ml/1.73 m^2 [?]90 N=1149 (28.5%)		eGFR ml/1.73 m^2 60-89 N=1746 (43.3%)		eGFR ml/1.73 m^2 60-89 N=1746 (43.3%)		eGFR ml/1.73 m^2 60-89 N=1746 (43.3%)		eGFR ml/1.73 m^2 30-59 N=837 (20.7%)		eGFR ml/1.73 m^2 30-59 N=837 (20.7%)		eGFR ml/1.73 m^2 30-59 N=837 (20.7%)		eGFR ml/1.73 m^2 15-29 N=135 (3.34%)		eGF ml/ 15- 29 N=1 (3.3
Men, N (%)	2677	(66.3)	749	749	(65.2)	(65.2)	1174	1174	(67.2)	(67.2)	573	573	(68.5)	(68.5)	82	82	(60.7									
Age, year, median (Q1, Q3)	61.4	(51.7,72.0)	(51.7,72.0)	54.2	54.2	(46.1,61.4)	(46.1,61.4)	63.3	63.3	(53.2,74.1)	(53.2,74.1)	71.0	71.0	(58.7,80.2)	(58.7,80.2)	72.0	70.0									
BMI, kg/m^2, median (Q1, Q3)	24.4	(21.8,27.1)	(21.8,27.1)	24.7	24.7	(22.1,27.6)	(22.1,27.6)	24.4	24.4	(22.0,24.2)	(22.0,24.2)	24.2	24.2	(21.5,27.1)	(21.5,27.1)	24.0	24.0									
Smoking																										
Current	1061	(26.3)	(26.3)	384	384	(33.4)	(33.4)	450	450	(25.8)	(25.8)	164	164	(19.6)	(19.6)	29	29									
Past	408	(10.1)	(10.1)	92	92	(8.01)	(8.01)	185	185	(10.6)	(10.6)	105	105	(12.5)	(12.5)	13	13									
Etiology																										
Hypertensive	3351	(83.0)	(83.0)	936	936	(81.5)	(81.5)	1458	1458	(83.5)	(83.5)	697	697	(83..3)	(83..3)	112	112									
Non-hypertensive	685	(17.0)	(17.0)	213	213	(18.5)	(18.5)	288	288	(16.5)	(16.5)	140	140	(16.7)	(16.7)	23	23									
Comorbidity, N (%)																										
Hypertension	3496	(86.6)	(86.6)	943	943	(82.1)	(82.1)	1517	1517	(86.9)	(86.9)	757	757	(90.4)	(90.4)	120	120									
AF	102	(2.53)	(2.53)	18	18	(1.57)	(1.57)	36	36	(2.06)	(2.06)	32	32	(3.82)	(3.82)	13	13									
Previous stroke history	739	(18.3)	(18.3)	140	140	(12.2)	(12.2)	333	333	(19.1)	(19.1)	197	197	(23.5)	(23.5)	38	38									
Ischemic heart disease	298	(7.38)	(7.38)	47	47	(4.09)	(4.09)	108	108	(6.19)	(6.19)	99	99	(11.8)	(11.8)	18	18									

Congestive heart failure	49	(1.21)	(1.21)	7	7	(0.61)	(0.61)	12	12	(0.69)	(0.69)	15	15	(1.79)	(1.79)	9	9
Diabetes mellitus	1048	(26.0)	(26.0)	259	259	(22.5)	(22.5)	384	384	(22.0)	(22.0)	254	254	(30.4)	(30.4)	66	66
Systolic blood pressure, mmHg	177.0	(153.0, 203.0)	(153.0, 203.0)	170.0	170.0	(148.0, 196.0)	(148.0, 196.0)	179.0	179.0	(155.0, 202.0)	(155.0, 202.0)	181.0	181.0	(157.0, 215.0)	(157.0, 215.0)	184.0	184.0
Laboratory data, median (Q1, Q3)																	
Cholesterol, mg/dl	150.0	(104.0, 194.0)	(104.0, 194.0)	156.0	156.0	(112.0, 172.0)	(112.0, 172.0)	148.0	148.0	(100.0, 192.0)	(100.0, 192.0)	146.0	146.0	(100.0, 187.0)	(100.0, 187.0)	145.0	145.0
Hb, g/dl	14.2	(12.7, 15.4)	(12.7, 15.4)	14.6	14.6	(13.3, 15.6)	(13.3, 15.6)	14.4	14.4	(13.2, 15.2)	(13.2, 15.2)	13.7	13.7	(12.3, 15.2)	(12.3, 15.2)	11.8	11.8
NIHSS score at admission, median (Q1, Q3)	8.00	(3.00, 17.0)	(3.00, 17.0)	8.00	8.00	(3.00, 16.0)	(3.00, 16.0)	8.00	8.00	(3.00, 15.0)	(3.00, 15.0)	9.00	9.00	(3.00, 21.0)	(3.00, 21.0)	12.0	12.0
Medicine use prior to admission, N (%)																	
Antiplatelet drugs	367	(9.09)	(9.09)	63	63	(5.48)	(5.48)	162	162	(9.28)	(9.28)	103	103	(12.3)	(12.3)	20	20
Warfarin	81	(2.01)	(2.01)	11	11	(0.96)	(0.96)	31	31	(1.78)	(1.78)	27	27	(3.23)	(3.23)	9	9
Lipid lowering drug	204	(5.05)	(5.05)	42	42	(3.66)	(3.66)	78	78	(4.47)	(4.47)	52	52	(6.21)	(6.21)	18	18

*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test	*Chi-square test, and Kruskal Wallis test
eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;	eGFR, estimated glomerular filtration rate;
Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;	Q1, 25th percentile;
Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;	Q3, 75th percentile;
SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;	SD, standard deviation;
BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;	BMI, body mass index;
AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;	AF, atrial fibrillation;
Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;	Hb, hemoglobin;
NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale	NIHSS, National Institutes of Stroke Scale

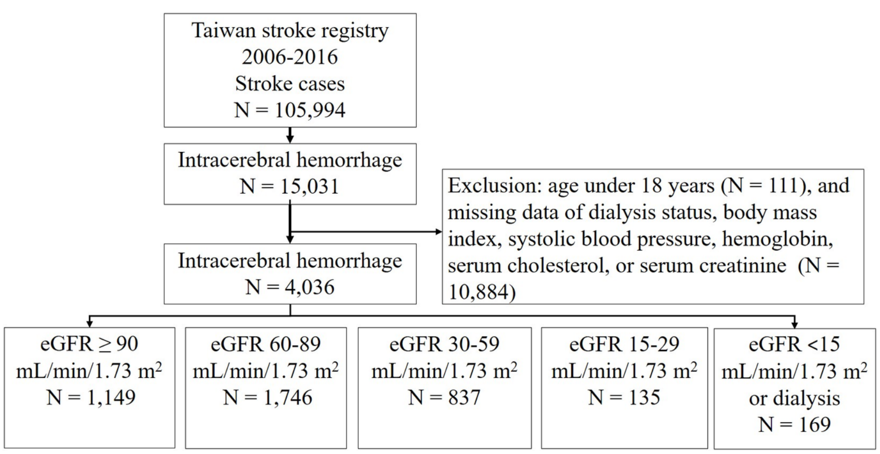
Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission	Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission Mortality N=258	Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission Person-days	Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission Rate^{++}	Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission Crude HR (95% CI)	Table 2. Incidence and hazard ratios of mortality at one-month after intracerebral hemorrhage by eGFR levels at admission Adjusted HR (95% CI)[a]
eGFR mL/min/1.73 m^2	n				
[?] 90	43	28667	1.50	1.00	1.00
60-89	93	43836	2.12	1.42(0.89, 2.04)	1.54(1.05, 2.27)*
30-59	74	20265	3.65	2.42(1.66, 3.53)**	2.24(1.48, 3.38)***
15-29	16	3332	4.80	3.22(1.81, 5.71)**	2.22(1.20, 4.12)*
<15 or dialysis	32	3849	8.31	5.40(3.42, 8.54)**	4.59(2.71, 7.78)***
P for trend			< 0.001	< 0.001	< 0.001

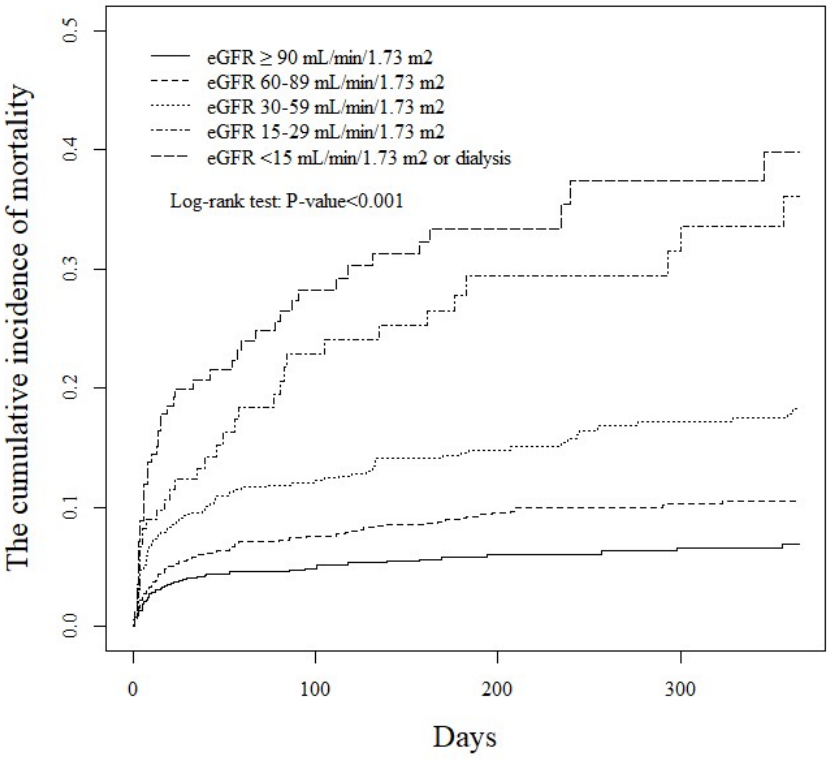
++per 1000 person-days [a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use prior to admission *p < 0.01, **p <0.001

Table 3. Incidence and hazard ratios of mortality at one year after intracerebral hemorrhage by eGFR level at admission

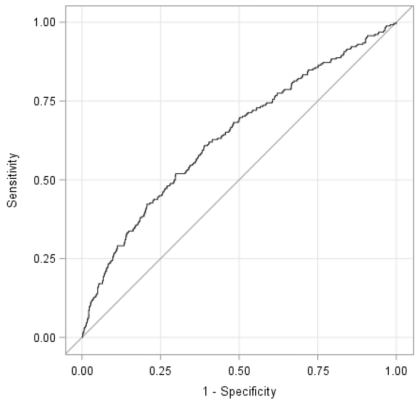
eGFR mL/min/1.73 m^2	Mortality N=394	Person-days	Rate++	Crude HR (95% CI)	Adjusted HR (95% CI)[a]
[?] 90	59	187392	0.31	1.00	1.00
60-89	139	299308	0.46	1.52(1.12, 2.06)*	1.49(1.08, 2.04)*
30-59	112	134013	0.84	2.66(1.94, 3.65)**	2.06(1.47, 2.89)***

15-29	34	19728	1.72	5.12(3.36, 7.81)**	3.02(1.91, 4.77)***
<15 or dialysis	50	21375	2.34	6.48(4.44, 9.44)**	4.54(2.95, 6.98)***
P for trend			< 0.001	< 0.001	< 0.001
++per 1000 person-days	++per 1000 person-days	++per 1000 person-days	++per 1000 person-days	++per 1000 person-days	++per 1000 person-days
[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001	[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001	[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001	[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001	[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001	[a]Adjusted for age, gender, body mass index, smoking, etiology of intracerebral hemorrhage, hypertension, atrial fibrillation, previous stroke history, ischemic heart disease, congestive heart failure, diabetes mellitus, systolic blood pressure, hemoglobin, cholesterol, NIHSS score at admission and medicine use *p < 0.01, **p <0.001





(A)



(B)