Effect of Estimated Glomerular Filtration Rate Decline on the Efficacy and Safety of Clopidogrel With Aspirin in Minor Stroke or Transient Ischemic Attack

CHANCE Substudy (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events)

Yilun Zhou, MD, PhD*; Yuesong Pan, MD*; Yu Wu, MD, PhD*; Xingquan Zhao, MD, PhD; Hao Li, PhD; David Wang, DO; S. Claiborne Johnston, MD, PhD; Liping Liu, MD, PhD; Chunxue Wang, MD, PhD; Xia Meng, MD, PhD; Yilong Wang, MD, PhD; Yongjun Wang, MD; on behalf of the CHANCE Investigators†

Background and Purpose—Patients with chronic kidney disease (CKD) are at a particularly high risk for ischemic and bleeding events. Limited data exist as to the efficacy and safety of clopidogrel in stroke patients with renal dysfunction. Therefore, we sought to assess the impact of decreased kidney function on clinical outcomes for stroke patients on clopidogrel–aspirin treatment.

Methods—Patients in the CHANCE trial (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events) were randomized to clopidogrel–aspirin or aspirin-alone treatment. The primary efficacy outcome was new stroke during 90 days, whereas bleeding was the safety outcome. Patients were stratified according to estimated glomerular filtration rate.

Results—Dual clopidogrel–aspirin therapy was associated with a marked reduction in new strokes compared with the therapy of aspirin alone in patients with normal renal function (hazard ratio, 0.77; 95% confidence interval, 0.60–0.98; P=0.02) and mild CKD (hazard ratio, 0.60; 95% confidence interval, 0.45–0.79; P<0.01), whereas in patients with moderate CKD, no significant benefit from clopidogrel therapy was detected (hazard ratio, 1.00; 95% confidence interval, 0.43–2.35; P=0.99). There was no clear difference in bleeding episodes by treatment assignment across categories of renal impairment.

Conclusions—Clopidogrel plus aspirin could decrease new stroke in patients with normal kidney function and mild CKD, but no extra benefit was observed in those with moderate CKD. Bleeding risk from the dual therapy did not seem to increase in mild or moderate CKD patients.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov. Unique identifier: NCT00979589.

(Stroke. 2016;47:2791-2796. DOI: 10.1161/STROKEAHA.116.014761.)

Key Words: chronic kidney disease ■ clopidogrel ■ stroke

Chronic kidney disease (CKD) is associated with a high prevalence of stroke, and reduced estimated glomerular filtration rate (eGFR) can be a strong predictor of higher recurrence, comorbidity, and mortality among patients with acute ischemic stroke. As the backbone of P2Y12 inhibition, clopidogrel is often recommended for preventing stroke, especially in patients with noncardioembolic ischemic stroke. However, specific recommendations for antiplatelet therapy in patients with ischemic stroke.

Received July 14, 2016; final revision received August 19, 2016; accepted September 19, 2016.
From the Department of Nephrology, Beijing Tiantan Hospital (Y.Z., Y.W.), Department of Neurology, Beijing Tiantan Hospital (Y.P., X.Z., H.L., L.L., C.W., X.M., Yilong Wang, Yongjun Wang), and Department of Epidemiology and Health Statistics, School of Public Health (Y.P.), Capital Medical University, Beijing, China; China National Clinical Research Center for Neurological Diseases, Beijing, China (Y.P., X.Z., H.L., L.L., C.W., X.M., Yilong Wang, Yongjun Wang); Center of Stroke, Beijing Institute for Brain Disorders, China (Y.P., X.Z., H.L., L.L., C.W., X.M., Yilong Wang, Yongjun Wang); Beijing Key Laboratory of Translational Medicine for Cerebrovascular Disease, China (Y.P., X.Z., H.L., L.L., C.W., X.M., Yilong Wang, Yongjun Wang); INI Stroke Network, OSF Healthcare System, University of Illinois College of Medicine, Peoria (D.W.); and Dell Medical School, University of Texas at Austin (S.C.J.).

†A list of all CHANCE Investigators is given in the online-only Data Supplement.

Guest Editor for this article was Giuseppe Lanzino, MD.

*Dr Zhou, Pan, and Wu contributed equally.

The online-only Data Supplement is available with this article at http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.116.014761/-/DC1.

Correspondence to Yilong Wang, MD, PhD, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, No 6 Tiantanxili, Dongcheng District, Beijing 100050, China, E-mail yilong528@gmail.com or Yongjun Wang, MD, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, No 6 Tiantanxili, Dongcheng District, Beijing 100050, China, E-mail yongjunwang1962@gmail.com

© 2016 American Heart Association, Inc.

Stroke is available at http://stroke.ahajournals.org

DOI: 10.1161/STROKEAHA.116.014761
stroke plus CKD are not available, although there have been a few investigations in the field of acute coronary syndrome (ACS).

CKD is characterized as a state with a prothrombotic tendency where excessive platelet activation and dysfunction plays a pivotal role. On the contrary, the risk of all-cause major hemorrhage increased in a graded fashion across all stages of CKD.8 Bleeding complications may occur in patients even with a normal coagulation profile or elevated coagulation factors.7 Therefore, assessment of the efficacy and safety of dual antiplatelet therapy with clopidogrel and aspirin for treating and preventing cerebrovascular diseases in the setting of CKD is of great significance.2,9

The CHANCE trial (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events) was designed to determine the protection effect against stroke and bleeding risk of combination therapy of clopidogrel plus aspirin compared with aspirin alone among patients with minor stroke or transient ischemic attack (TIA).10,11 On the basis of the CHANCE trial, we aimed to investigate whether declined eGFR would be associated with altered efficacy and safety of dual antiplatelet therapy.

Methods

Study Population

CHANCE was a randomized, double-blind, placebo-controlled clinical trial conducted at 114 clinical centers in China. Details about the CHANCE study design and results have been published elsewhere.10–12 Within 24 hours after the onset of minor ischemic stroke or high-risk TIA, patients were randomly assigned to either clopidogrel plus aspirin alone with a moderate-to-high risk of stroke recurrence (ABCD2 [scores assessing the risk of stroke on the basis of age, blood pressure, clinical features, duration of TIA, and presence or absence of diabetes mellitus] at the time of randomization ≥4). Other eligibility criteria were provided in the study protocol.10 Venous blood samples were obtained at randomization and were sent for laboratory analysis of creatinine concentration. It should be noted that patients with severe renal dysfunction, defined as serum creatinine >1.5 times of upper limit of normal value, were excluded.

The trial was approved by the ethics committee at each study center. Written informed consent was obtained from all the participants or their legal proxies. This study was registered at ClinicalTrials.gov (registration number NCT00979589).

Calculation of eGFR

eGFR was calculated by the CKD-EPI China equation with adjusted coefficient of 1.1 for the Chinese population13: eGFR$_{\text{CKD-EPI}}^{\text{CN}}$=141×min (SCr/k,1)×max (SCr/k,1)$^{α}$×0.993$^{\text{SCr/k}×1.018}$ (if female)$^{α}$×1.018 (if female)×0.993$^{{\text{SCr/k}×1.018}}$ (if female). Patients were divided into the following groups: eGFR ≥90 mL/min per 1.73 m² (normal renal function), 60 to 89 mL/min per 1.73 m² (mild CKD), and <60 mL/min per 1.73 m² (moderate CKD) based on the NKF-KDOQI guidelines (National Kidney Foundation Kidney Disease Outcomes Quality Initiative).14,15

Table 1. Baseline Characteristics According to eGFR Category

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>eGFR &lt;60 mL/min per 1.73² (n=354)</th>
<th>eGFR 60–89 mL/min per 1.73² (n=2064)</th>
<th>eGFR ≥90 mL/min per 1.73² (n=2732)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, median (IQR), y</td>
<td>73.35 (65.59–77.15)</td>
<td>69.00 (60.15–75.02)</td>
<td>57.52 (51.29–64.12)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female sex, n (%)</td>
<td>158 (44.63)</td>
<td>698 (33.82)</td>
<td>887 (32.47)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medical history, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic stroke</td>
<td>88 (24.86)</td>
<td>473 (22.92)</td>
<td>465 (17.02)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TIA</td>
<td>18 (5.08)</td>
<td>64 (3.10)</td>
<td>91 (3.33)</td>
<td>0.16</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>13 (3.67)</td>
<td>49 (2.37)</td>
<td>34 (1.24)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Angina</td>
<td>20 (5.65)</td>
<td>84 (4.07)</td>
<td>79 (2.89)</td>
<td>0.008</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>10 (2.82)</td>
<td>37 (1.79)</td>
<td>32 (1.17)</td>
<td>0.027</td>
</tr>
<tr>
<td>Known atrial fibrillation</td>
<td>13 (3.67)</td>
<td>60 (2.91)</td>
<td>23 (0.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Valvular heart disease</td>
<td>1 (0.28)</td>
<td>11 (0.53)</td>
<td>2 (0.07)</td>
<td>0.010</td>
</tr>
<tr>
<td>Hypertension</td>
<td>278 (78.53)</td>
<td>1395 (67.59)</td>
<td>1715 (62.77)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>85 (24.01)</td>
<td>431 (20.88)</td>
<td>572 (20.94)</td>
<td>0.39</td>
</tr>
<tr>
<td>NIHSS, median (IQR)</td>
<td>2.00 (0.00–3.00)</td>
<td>1.00 (0.00–2.00)</td>
<td>2.00 (0.00–2.00)</td>
<td>0.21</td>
</tr>
<tr>
<td>eGFR (mL/min per 1.73²), median (IQR)</td>
<td>52.45 (45.81–56.68)</td>
<td>80.06 (71.81–85.76)</td>
<td>100.25 (94.99–106.15)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Qualifying event, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor stroke</td>
<td>258 (72.88)</td>
<td>1494 (72.38)</td>
<td>1964 (71.89)</td>
<td>0.89</td>
</tr>
<tr>
<td>TIA</td>
<td>96 (27.12)</td>
<td>570 (27.62)</td>
<td>768 (28.11)</td>
<td></td>
</tr>
</tbody>
</table>

eGFR indicates estimated glomerular filtration rate; IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale; and TIA, transient ischemic attack.
Efficacy and Safety Outcomes

The primary efficacy outcome was a new stroke event (ischemic or hemorrhagic) within 90 days. The secondary efficacy outcome was a combined vascular event (ischemic stroke, hemorrhagic stroke, myocardial infarction, or vascular death). The safety outcome was mild-to-severe bleeding event. Mild bleeding referred to bleeding not requiring transfusion and not causing hemodynamic compromise requiring intervention (eg, subcutaneous bleeding, mild hematomas, and oozing from puncture sites). Moderate hemorrhage was defined as bleeding that required transfusion of blood but did not lead to hemodynamic compromise requiring intervention. Severe hemorrhage was defined as fatal or intracranial hemorrhage or other hemorrhage causing hemodynamic compromise requiring blood or fluid replacement, inotropic support, or surgical intervention, according to the GUSTO definition (Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries). All reported efficacy and safety outcomes were confirmed by a central adjudication committee that was blinded to the study group assignments.

Statistical Methods

Categorical variables were presented as percentages, whereas continuous variables were presented as medians with interquartile ranges. The study population was divided according to levels of kidney function. Comparisons across groups were calculated by 1-way ANOVA or Kruskal–Wallis test. Kaplan–Meier methods were used to estimate event rates between subgroups based on kidney function and were compared with a log-rank test. Hazard ratios and their corresponding 95% confidence intervals were estimated using Cox proportional hazards models to assess the efficacy and safety of treatment stratified by renal function categories. To exclude impact of confounding factors, baseline characteristics, including age, sex, current or previous smoking, medical history of hypertension, ischemic stroke, TIA, myocardial infarction, angina, congestive heart failure, known atrial fibrillation, valvular heart disease, and hypertension (Table 1).

Results

Baseline Characteristics

A total of 5170 eligible patients were enrolled at 114 medical centers in China. Among them, 5150 (99.61%) subjects with renal parameters and 90-day outcome data were analyzed in this study. Overall, 354 (6.9%), 2064 (40.1%), and 2732 (53.0%) patients had eGFR < 60 mL/min per 1.73² (moderate CKD), 60 to 89 mL/min per 1.73² (mild CKD), and ≥ 90 mL/min per 1.73² (normal renal function), respectively. Baseline eGFR were 52.45 (45.81–56.68), 80.06 (71.81–85.76), and 100.25 (94.99–106.15) mL/min per 1.73² in the moderate CKD, mild CKD, and normal renal function groups, respectively.

Compared with the subjects with mild CKD and normal kidney function, those with moderate CKD were older and more likely to be men and to have history of ischemic stroke, myocardial infarction, angina, congestive heart failure, known atrial fibrillation, valvular heart disease, and hypertension (Table 1).

Clinical Outcomes

Ninety-Day Efficacy Outcomes

As shown in Table 2 and Figure, at 90 days, combination therapy of clopidogrel and aspirin reduced the incidence of new stroke compared with aspirin alone in patients with normal kidney function (8.6% versus 11.2%; hazard ratio, 0.74; 95% confidence interval, 0.58–0.95; P = 0.02) and mild CKD group (7.5% versus 10.1%; hazard ratio, 0.59; 95% confidence interval, 0.44–0.78; P < 0.001). Similarly, in normal renal function group and mild CKD group, clopidogrel–aspirin therapy was associated with significant lower rates of combined vascular events in comparison with the aspirin group.

However, in patients with moderate CKD, no significant benefit from clopidogrel therapy was again found. The new stroke events occurred in 10.1% of patients in the aspirin therapy group and in 9.1% of patients in the clopidogrel–aspirin therapy group (hazard ratio, 1.00; 95% confidence interval, 0.43–2.35; P = 0.99).

Ninety-Day Safety Outcomes

As shown in Table 3, in the subgroup of patients with normal renal function, mild CKD, and moderate CKD, moderate or...
severe hemorrhage occurred in 3 patients (0.22%), 3 patients (0.29%), and 1 patient (0.54%), respectively, on clopidogrel–aspirin therapy and in 4 patients (0.29%), 4 patients (0.38%), and 0 patient on aspirin therapy. There was no significant interaction between eGFR subgroup and antiplatelet therapy in their effects on mild, moderate, and severe bleeding events.

**Discussion**

There are 2 major findings in this post hoc analysis of the CHANCE trial. First, clopidogrel plus aspirin compared with aspirin alone in patients with normal renal function and mild renal insufficiency resulted in a significant reduction in new stroke events and combined vascular events at 90 days of follow-up, but this benefit was not apparent in moderate CKD patients. Second, clopidogrel did not seem to increase bleeding more in mild or moderate CKD patients than it did in those with normal renal function.

In patients with normal renal function and mild renal insufficiency, our results were in accordance with those of the overall cohort of the CHANCE study. The significance of this subgroup study is that even in mild CKD, the combination of clopidogrel and aspirin was superior to aspirin alone for reducing the risk of stroke among patients with minor stroke or TIA in the first 90 days. However, no extra benefit from clopidogrel therapy was observed in those with moderate CKD. To our knowledge, there were no trials that have evaluated the effect of clopidogrel in terms of decreasing the risk of cerebrovascular events in patients with CKD. As opposed to our results, subgroup analysis of the CURE trial (Clopidogrel in Unstable angina to prevent Recurrent Events) showed that clopidogrel add-on resulted in a similar beneficial effect in all 3 groups stratified according to eGFR (<64, 64–81.2, and >81.3 mL/min). Post hoc analysis of the CREDO trial (Clopidogrel for the Reduction of Events During Observation) suggested that clopidogrel did not decrease mortality or improve cardiovascular outcomes in mild or moderate CKD patients with ACS after percutaneous coronary intervention.

The reasons why no benefit of clopidogrel was observed in patients with moderate CKD in the present study were not absolutely clear. Clopidogrel resistance might partly account for this result. Clopidogrel induces antiplatelet effect to be highly variable, and the individuals who have poor antiplatelet effects are defined as clopidogrel resistant. Clopidogrel resistance is a multifactorial phenomenon, and the underlying mechanisms involve clinical, cellular, and genetic aspects. Previous studies have shown that patients with CKD exhibited significantly higher platelet activation and on-treatment residual ADP-inducible platelet reactivity than patients without renal insufficiency. Moreover, a low response to clopidogrel might be an independent predictor of the poorer outcomes in these CKD patients. Nowadays, the use of higher than usual clopidogrel doses (600 mg as loading dose and 150 mg as maintenance dose), longer therapy duration (beyond 12 months), or alternative more potent thienopyridine agents such as prasugrel or ticagrelor have been proposed as ways to overcome the clopidogrel resistance in CKD. However, patients with CKD also have higher bleeding tendency. So special consideration should be given to balance the benefit–risk ratio among CKD patients.

Several previous studies demonstrated that in patients with ACS, CKD increased gastrointestinal bleeding or serious

![Figure](http://stroke.ahajournals.org/)

**Figure.** Probability of survival free of stroke in the subjects based on eGFR levels of ≥90 mL/min per 1.73² (A), 60 to 89 mL/min per 1.73² (B), and <60 mL/min per 1.73² (C).
bleeding in clopidogrel users. Although in another study conducted in patients with end-stage renal disease undergoing dialysis, no association was found between increased hemorrhagic risks and use of aspirin or clopidogrel.\(^5\) In our trial, clopidogrel did not seem to increase bleeding more in mild or moderate CKD patients than it did in those with normal renal function. Although the exact mechanism underlying the conflicting results were not absolutely elucidated, and possible explanations for the difference were as follows. First, populations targeted in these studies were highly heterogeneous, and the definitions and assessment of bleeding outcomes were different. Second, compared with previous studies including patients with more severe strokes, our trial targeted a population at a relative low risk for bleeding. Third, compared with studies conducted in patients with ACS including percutaneous coronary intervention, the treatment paradigm was different in the CHANCE trial. In patients with ACS, the dual antiplatelet therapy was lasted for at least 9 to 12 months under normal circumstances. However, in our trial, clopidogrel plus aspirin was administered for just 21 days, followed by clopidogrel alone for a total of 90 days.

There were several limitations in the study. First, because the patients with creatinine >1.5 times the upper normal limit were excluded from the CHANCE trial and the eGFR of the patients enrolled ranged from 31.8 to 146.2 mL/min per 1.73 m\(^2\), it would be difficult to make generalizations to patients with more severe renal insufficiency such as stage 4 or 5 CKD. Second, the sample size was imbalanced between the defined CKD subgroups, in particular, much less patients in the moderate renal dysfunction group (n=354). Therefore, cautions are needed when we interpret the efficacy and safety of dual antiplatelet treatment in the defined CKD patients plus stroke based on statistical analyses in this study. However, because specific recommendations for antiplatelet therapy in patients with CKD plus ischemic stroke are not available, the present study may provide some valuable information for this special population. A prospective and well-designed study in CKD with stroke would be needed for further evaluation. Third, we did not perform the platelet function test such as residual ADP-inducible platelet reactivity; thus, we could not directly evaluate the relationship between clopidogrel resistance and CKD. However, many investigations have confirmed this relationship in ACS and stroke.

To sum up, the present study is the first to investigate the effect of renal function on efficacy of clopidogrel in the setting of cerebrovascular events. In this cohort of patients with minor ischemic stroke or high-risk TIA in CHANCE, dual antiplatelet therapy was associated with improved outcomes in patients with normal renal function and mild CKD, whereas in those with moderate CKD, no extra benefit was observed. With respect to safety, bleeding risk of the dual therapy did not seem to increase with declined eGFR. Taken together, these observations support the use of dual antiplatelet therapy among patients with minor ischemic stroke or TIA with normal to mild renal insufficiency. While for those with moderate-to-severe CKD, further studies would be needed to explore how to optimize antiplatelet treatment according to renal function to improve the clinical outcomes.

**Sources of Funding**

The CHANCE study (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events) is supported by grants from the Ministry of Science and Technology of the People’s Republic of China (2006BA101A11, 2011BA008B01, 2011BA080B02, 2012ZX09303-005-001, and 2013BA090B03), a grant from the Beijing Biobank Institute for Brain Disorders (BBD-PXM2013_014226_07_000084), and a grant from Beijing high-level talents in healthcare system (2014-3-021).

**Disclosures**

None.

**References**


---

**Table 3. Effects of Combination Therapy of Clopidogrel and Aspirin on 90-d Safety Outcomes Based on eGFR Levels**

<table>
<thead>
<tr>
<th>eGFR ≥90 mL/min per 1.73m(^2) (n=3732)</th>
<th>eGFR 60–89 mL/min per 1.73m(^2) (n=2064)</th>
<th>eGFR &lt;60 mL/min per 1.73m(^2) (n=354)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin –Aspirin Event Rate, %</td>
<td>Clopidogrel –Aspirin Event Rate, %</td>
<td>Aspirin –Aspirin Event Rate, %</td>
</tr>
<tr>
<td>Mild bleeding</td>
<td>7 (0.51)</td>
<td>16 (1.18)</td>
</tr>
<tr>
<td></td>
<td>12 (1.16)</td>
<td>11 (1.07)</td>
</tr>
<tr>
<td>Moderate bleeding</td>
<td>2 (0.15)</td>
<td>2 (0.15)</td>
</tr>
<tr>
<td></td>
<td>2 (0.19)</td>
<td>1 (0.10)</td>
</tr>
<tr>
<td>Severe bleeding</td>
<td>2 (0.15)</td>
<td>1 (0.07)</td>
</tr>
<tr>
<td></td>
<td>2 (0.19)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 (0.54)</td>
</tr>
</tbody>
</table>

eGFR indicates estimated glomerular filtration rate. *P* values for interaction of eGFR subgroup by treatment assignment.

21. Qureshi Z, Hobson AR. Clopidogrel “resistance”: where are we now? 

22. Morel O, El Ghanmu S, Jesel L, Radulescu B, Meyer N, Wiesel ML, 
et al. Cardiovascular mortality in chronic kidney disease patients undergoing 
percutaneous coronary intervention is mainly related to impaired 
P2Y12 inhibition by clopidogrel. _J Am Coll Cardiol._ 2011;57:399–408. 

23. Gremmel T, Müller M, Steiner S, Seidinger D, Koppensteiner R, Kopp 
CW, et al. Chronic kidney disease is associated with increased platelet 
activation and poor response to antiplatelet therapy. _Nephrol Dial Transplant._ 

et al. Prevalence and impact of high platelet reactivity in chronic kidney disease: results from the 
Assessment of Dual Antiplatelet Therapy with Drug-Eluting Stents registry. _Circ Cardiovasc Interv._ 
2015;8:e001683. doi: 10.1161/CIRCINTERVENTIONS.115.001683.

effect of chronic kidney disease on clopidogrel response with high 
loading and maintenance doses of clopidogrel after acute coro-
thromres.2010.08.009.

Outcomes with prolonged clopidogrel therapy after coronary stenting in 

Prasugrel pharmacokinetics and pharmacodynamics in subjects with 
moderate renal impairment and end-stage renal disease. _J Clin Pharm Ther._ 

28. Wiviott SD, Braunwald E, McCabe CH, Montalescot G, Ruzyllo W, 
Gottlieb S, et al; TRITON-TIMI 38 Investigators. Prasugrel versus 

Ticagrelor versus clopidogrel in acute coronary syndromes in relation to 
renal function: results from the Platelet Inhibition and Patient Outcomes 
(PLATO) trial. _Circulation._ 2010;122:1056–1067. doi: 10.1161/ 
CIRCULATIONAHA.109.93796.

of gastrointestinal bleeding in clopidogrel users: a nationwide pop-

31. Palmer SC, Di Micco L, Razavian M, Craig JC, Perkovic V, Pellegrini F, 
et al. Effects of antiplatelet therapy on mortality and cardiovascular and 
bleeding outcomes in persons with chronic kidney disease: a system-

32. Benavente OR, Hart RG, McClure LA, Szychowski JM, Coffey CS, 
Pearce LA. Effects of clopidogrel added to aspirin in patients with recent 

33. Chen CY, Lee KT, Lee CT, Lai WT, Huang YB. Effectiveness and safety of 
antiplaatelet in stroke patients with end-stage renal disease undergoing 
Effect of Estimated Glomerular Filtration Rate Decline on the Efficacy and Safety of Clopidogrel With Aspirin in Minor Stroke or Transient Ischemic Attack: CHANCE Substudy (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events)

Yilun Zhou, Yuesong Pan, Yu Wu, Xingquan Zhao, Hao Li, David Wang, S. Claiborne Johnston, Liping Liu, Chunxue Wang, Xia Meng, Yilong Wang, Yongjun Wang and on behalf of the CHANCE Investigators

*Stroke*. 2016;47:2791-2796; originally published online October 13, 2016; doi: 10.1161/STROKEAHA.116.014761

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2016 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/47/11/2791

Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2016/10/13/STROKEAHA.116.014761.DC1

**Permissions**: Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Stroke* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

**Reprints**: Information about reprints can be found online at:
http://www.lww.com/reprints

**Subscriptions**: Information about subscribing to *Stroke* is online at:
http://stroke.ahajournals.org/subscriptions/
SUPPLEMENTAL MATERIAL

The CHANCE investigators:
Yongjun Wang (BeijingTiantan Hospital, Principal Investigator); S.Claiborne Johnston (Dell Medical School, University of Texas at Austin, Austin, USA, Co-Principal Investigator);
Yilong Wang (BeijingTiantan Hospital, Executive Committee); Xingquan Zhao (BeijingTiantan Hospital, Site Investigator); Zhimin Wang (Taizhou First People's Hospital, Site Investigator); Haiqin Xia (Taiyuan Iron And Steel (Group) Co., Ltd., General Hospital, Site Investigator); Bin Li (Dagang Oilfield Gengeal Hospital, Site Investigator); Guiru Zhang (Penglai People’s Hospital, Site Investigator); Xudong Ren (The Third People’s Hospital Of Datong, Site Investigator); Chunling Ji (The Fourth Central Hospital Of Tianjin, Site Investigator); Guohua Zhang (The Second Hospital Of Hebei Medical University, Site Investigator); Jianhua Li (The First Hospital Of Fangshan District, Beijing, Site Investigator); Bohua Lu (Beijing Puren Hospital, Site Investigator); Liping Wang (Tianjin Ninghe District Hospital, Site Investigator); Shutaof Feng (The People’s Hospital Of Zhengzhou, Site Investigator); Dali Wang (Affiliated Hospital Of North China Coal Medical College, Site Investigator); Weiguo Tang (Zhejiang Zhoushan Hospital, Site Investigator); Jun Tao Li (Han Dan Central Hospital, Site Investigator); Hongtian Zhang (Zhecheng People’s Hospital, Site Investigator); Guanglai Li (Shanxi Medical University Second Hospital, Site Investigator); Baojun Wang (Baotou Central Hospital, Site Investigator); Yuhua Chen (The General Hospital Of Changjiang River Shipping, Site Investigator); Ying Lian (Dalian Economic And Technological Development Zone Hospital, Site Investigator); Bin Liu (First Neurology Department, Affiliated Hospital Of North China Coal Medical College, Site Investigator); Junfang Teng (The First Affiliated Hospital Of Zhengzhou University, Site Investigator); Rubo Sui (First Affiliated Hospital Of Liaoning Medical, Site Investigator); Lejun Li (Lianyungang Municipal Hospital Of TCM, Site Investigator); Zhiling Yuan (Central Hospital In Qiu County, Site Investigator); Dawei Zang (Tianjin First Center Hospital, Site Investigator); Zuneng Lu (Renmin Hospital Of Wuhan University, Site Investigator); Li Sun (Qingdao Central Hospital, Site Investigator); Dong Wang (Baogang Hospital, Site Investigator); Liying Hou (Changzhi City People’s Hospital Of Shanxi Province, Site Investigator); Dongcai Yuan (HaLixun International Peace Hospital, Site Investigator); Yongliang Cao (People’s Hospital Of Linzi District, Zibo, Site Investigator); Hui Li (Yantai City Yantai Mountain Hospital, Site Investigator); Xiuge Tan (Beijing Pinggu District Hospital, Site Investigator); Huicong Wang (Taiyuan Central Hospital, Site Investigator); Haisong Du (Chengde Central Hospital, Site Investigator); Mingyi Liu (Shijiazhuang Central Hospital, Site Investigator); Suping Wang (First Neurology Department, Dalian Municipal Central Hospital, Site Investigator); Qiuwu Liu (Xian 141 Hospital, Site Investigator); Zhong Zhang (Chengdu Third Municipal People’s Hospital, Site Investigator); Qifu Cui (Affiliated Hospital Of Chifeng University, Site Investigator); Runqing Wang (Zhengzhou Central Hospital, Site Investigator); Jialin Zhao (Ningbo City, Zhejiang Province Lihuili Hospital Medical Center, Site Investigator); Jiwen Zhang (Henan Provincial People’s Hospital, Site Investigator); Jianping Zhao (Jinzhong City Second Hospital, Site Investigator); Qi Bi (Beijing Anzhen Hospital, Capital Medical University, Site Investigator); Xiyou Qi (Beijing Huairou District Chinese Medicine Hospital, Site Investigator); Junyan Liu (Hebei Medical University Third Hospital, Site Investigator); Changxin Li (First Affiliated Hospital Shanxi Medical University, Site Investigator); Ling Li (Hebei Provincial People’s Hospital, Site Investigator); Xiaoping Pan (Guangzhou First Municipal Peoples Hospital, Site Investigator); Junling Zhang (Central Hospital In Cangzhou, Site Investigator); Derang Jiao (The Chinese
People’s Armed Police Force Medical School Affiliated Hospital, Site Investigator); Zhao Han (Zhejiang Wenzhou Medical College First Affiliated Hospital, Site Investigator); Dawei Qian (Jilin Central Hospital, Site Investigator); Jin Xiao (Anhui Maanshan Central Hospital, Site Investigator); Yan Xing (Beijing Aviation Industry Central Hospital, Site Investigator); Huishan Du (Luhe Hospital, Tongzhou District, Beijing, Site Investigator); Guang Huang (Beijing Fuxing Hospital, Capital Medical University, Site Investigator); Yongqiang Cui (The 306th Hospital Of P.L.A, Site Investigator); Yan Li (The First Affiliated Hospital Of Tianjin University Of Chinese Medicine, Site Investigator); Liyuan Peng (Baiquien International Peace Hospital Of People’s Liberation Army, Site Investigator); Lianbo Gao (Fourth Affiliated Hospital Of China Medical University, Site Investigator); Bo Xiao (Xiangya Hospital Central - South University, Site Investigator); Yiping Wu (The 1st Hospital In Handan, Site Investigator); Jinfeng Liu (Yangquan Coal (Group) Co., Ltd. General Hospital, Site Investigator); Zhengxie Dong (Nantong First People’s Hospital, Site Investigator); Limin Wang (The 1st Hospital Of Zhangjiakou City, Site Investigator); Rui Li (West China Hospital, Sichuan University, Site Investigator); Xiaoshua Wang (Xiyuan Hospital Of China Academy Of Chinese Traditional Medicine, Site Investigator); Jiandong Jiang (No.2 People’s Hospital East In Lianyungang City, Site Investigator); Chen Wu (The Second Hospital Of Shandong University Of TCM, Site Investigator); Xueying Guo (Fenyang Hospital Of Shanxi Province, Site Investigator); Jingbo Zhang (The First Affiliated Hospital Of Jinan University, Site Investigator); Xiaokun Qi (Navy General Hospital Of P.L.A, Site Investigator); Lei Wang (Beijing Second Artillery General Hospital, Site Investigator); Ming Wang (Beijing Shunyi District Hospital, Site Investigator); Ronghua Dou (The Hospital Combine Traditional Chinese And Western Medicine In Cangzhou, Site Investigator); Dongning Wei (The 309th Hospital Of P.L.A, Site Investigator); Qingwei Meng (Liangxiang Hospital First Hospital Of Tsinghua University, Site Investigator); Fuming Shi (Beijing Chaoyang Hospital, Capital Medical University, Site Investigator); Jiemin Zhang (The Fourth Affiliated Hospital Of Soochow University, Site Investigator); Mei Chen (Zhejiang University Of Chinese Medicine Affiliated First Hospital, Site Investigator); Xiaodong Yuan (Affiliated Hospital Of Kailuan Company Ltd, Site Investigator); Chun Wang (Shanxi Medical University Fourth Hospital, Site Investigator); Fucong Song (Handan City Center Hospital, Site Investigator); Wenli Hu (Beijing Chaoyang Hospital, Capital Medical University, Site Investigator); Zhihui Liu (Affiliated Hospital Of Kailuan Company Ltd, Site Investigator); Zhihui Liu (Affiliated Hospital Of
Weifang Medical University, Site Investigator); Guozhong Li (The First Hospital Of Harbin Medical University, Site Investigator); Xiaohong Li (Dalian Friendship Hospital, Site Investigator); Tingchen Tian (Tianjin Dagang Hospital, Site Investigator).