ICD9 Codes Cannot Reliably Identify Hemorrhagic Transformation of Ischemic Stroke

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A major objective of inpatient stroke care is the prevention of medical and neurological complications, although rare, hemorrhagic transformation (HT) of an ischemic stroke (IS) can cause neurological deterioration and is associated with an increased risk of death.1 If HT can be reliably identified in administrative data, it could become a component of hospital quality benchmarks. Previous studies have used administrative data to define HT of IS; however, the accuracy of International Classification of Diseases, Ninth Revision (ICD9) coding for this condition is unknown.2-4 Coding algorithms used in previous studies have varied, but all have required a discharge diagnosis of IS, defined by ICD9 code or Clinical Classification Software code, and a discharge ICD9 for intracranial hemorrhage. We aimed to determine the accuracy of ICD9 coding for HT after IS using the Greater Cincinnati/Northern Kentucky Stroke Study (GCNKSS).

Methods

The purpose of the GCNKSS is to ascertain all strokes among a 5-county region that includes Cincinnati. Study personnel identified potential cases from January 1, 2005, through December 31, 2005, by screening emergency department encounters and inpatient admissions at 17 acute care hospitals for discharge ICD9 codes for stroke (430–436). Data are collected for all cases of IS, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage. Potential cases were excluded if they had a discharge/autopsy diagnosis or neuroimaging with stroke but no clinical history consistent with stroke or if they had a clinical diagnosis of stroke and died within 24 hours of symptom onset without focal neurological deficit or confirmatory neuroimaging/autopsy. Detailed methods of the GCNKSS have been published previously.5

For all potential cases, a research nurse abstracted history, physical examination, and diagnostic testing data, including neuroimaging. Study physicians reviewed the abstracted data and determined whether a stroke occurred, type of stroke, stroke mechanism, and whether HT was present. HT was characterized as asymptomatic or symptomatic (any neurological deterioration). For each HT case, hospital discharge ICD9 codes were examined. Our primary expectation was that HT cases would have an ICD9 code for both IS (433.x1, 434.x1, 436) and ICH (431). We looked separately at cases that were treated with recombinant tissue plasminogen activator and evaluated the combination of ICD9 codes for IS with any ICD9 code for intracranial hemorrhage (430, 431, 432).

Results

The GCNKSS identified 2159 cases of IS through hospital discharge screening, of which 102 had HT (symptomatic or asymptomatic). Among HT cases, 26 (25%) had an ICH code (431), and only 3 (3%) had codes for both IS (433.x1, 434.x1, 436) and ICH. HT was symptomatic in 38 patients, of whom 12 (32%) had a code for ICH, but none had both IS and ICH codes. Among the 102 cases of HT, 15 were treated with recombinant tissue plasminogen activator. There were 3 (20%) with an ICH code, but only 1 (7%) had both IS and ICH codes. From the 38 cases of symptomatic HT, 9 were treated with recombinant tissue plasminogen activator. One of these patients had an ICH code; this patient did not have an IS code.

A broader definition for HT, which used all of the intracranial hemorrhage ICD9 codes (430, 431, 432), identified 34 (33%) of the HT cases, although only 3 (8%) also had an IS code. The broader definition identified 17 (45%) of the symptomatic HT cases, although only 3 (8%) also had an IS code. Full results are presented in the Table.

Discussion

HT after IS is an appealing quality metric. HT can cause neurological deterioration and death.1 High rates of HT are associated with recombinant tissue plasminogen activator protocol deviations, and HT rates can be lowered by quality improvement initiatives.6,7 To identify HT in administrative data sets ICD9 codes for both IS and ICH must be present. Although ICD9 codes from administrative databases have been used to identify HT after IS in previous studies, the accuracy of these codes was not verified. Our results demonstrate that ICD9 codes cannot accurately identify HT after IS. Three fourths of patients with HT of an IS did not receive an ICH ICD9 code at hospital discharge, and few of the HT cases received ICD9 codes for both IS and ICH. Current ICD9 guidelines do not address coding HT after IS. Improved identification of HT will likely require the creation of a dedicated code, or modifier code, as well as physician and coder education.

This study has several limitations. HT was rare, and the number of symptomatic cases was small. ICD9 codes...
performed so poorly, it is unlikely that adding cases would change the conclusion. In this study, we do not know the order of ICD9 codes and are unable to differentiate between principal and secondary diagnosis codes. Some previous studies of HT have required IS to be the principal discharge diagnosis and ICH to be a secondary diagnosis. This added constraint would likely make ICD9 coding less accurate for identifying HT. ICD9 coding may vary across institutions. All of the data in the present study come from hospitals affiliated with the GCNKSS. Because this study includes cases from 17 different hospitals, the results still have substantial generalizability. We are unable to assess the accuracy of ICD10 coding. Because there is no specific code for HT in ICD10, it is also likely to be unreliable.

**Conclusion**

ICD9 codes cannot accurately identify HT in patients with IS. HT cannot be reliably identified in administrative data sets.

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**References**

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