A cute stroke is a medical emergency and one of the biggest causes of death in the United Kingdom.1 The benefits of rapid assessment and intervention, including brain imaging and thrombolysis where appropriate, are well documented.2–4 As the outcome of stroke depends on the timing of intervention, early and accurate diagnosis is essential for a positive outcome.

For many patients the first point of contact for medical help after a stroke is the Ambulance Service. This places ambulance clinicians in a unique position to recognize the symptoms of stroke and initiate timely access to specialist care. In the United Kingdom, ambulance clinicians are playing an increasingly important role in determining where patients should be taken; they can bypass the nearest emergency department (ED), transferring patients directly to specialist stroke units for immediate brain imaging and specialist treatment. Although the journey may take longer, treatment in a stroke unit is proven to enhance stroke victims’ chances of survival and full recovery.1 For ambulance services to respond quickly to the needs of patients with stroke and make appropriate decisions about where to take them, the use of a tool facilitating accurate identification of stroke is pivotal. A useful prehospital stroke assessment tool must enable ambulance clinicians to rule out nonstrokes effectively to prevent overdiagnosing, placing an unnecessary burden on stroke units, and delaying patients’ eventual treatment in the ED. A successful prehospital stroke assessment tool also needs to be quick and easy to use, allowing efficient and effective assessment at the site of a medical emergency.

Currently, all UK ambulance services assess patients with suspected stroke using the Face Arm Speech Test (FAST). The Recognition Of Stroke In the Emergency Room (ROSIER) tool has been shown superior to the FAST in identifying strokes in emergency departments but has not previously been tested in the ambulance setting. We investigated whether ROSIER use by ambulance clinicians can improve stroke recognition.

Methods—Ambulance clinicians used the ROSIER in place of the FAST to assess patients with suspected stroke. As the ROSIER includes all FAST elements, we calculated a FAST score from the ROSIER to enable comparisons between the two tools. Ambulance clinicians’ provisional stroke diagnoses using the ROSIER and calculated FAST were compared with stroke consultants’ diagnosis. We used stepwise logistic regression to compare the contribution of individual ROSIER and FAST items and patient demographics to the prediction of consultants’ diagnoses.

Results—Sixty-four percent of strokes and 78% of nonstrokes identified by ambulance clinicians using the ROSIER were subsequently confirmed by a stroke consultant. There was no difference in the proportion of strokes correctly detected by the ROSIER or FAST with both displaying excellent levels of sensitivity. The ROSIER detected marginally more nonstroke cases than the FAST, but both demonstrated poor specificity. Facial weakness, arm weakness, seizure activity, age, and sex predicted consultants’ diagnosis of stroke.

Conclusions—The ROSIER was not better than the FAST for prehospital recognition of stroke. A revised version of the FAST incorporating assessment of seizure activity may improve stroke identification and decision making by ambulance clinicians. (Stroke. 2013;44:3007-3012.)

Key Words: ambulances ■ diagnosis ■ emergency medical services ■ sensitivity and specificity ■ stroke ■ triage
accuracy, but is not without limitation. Nor et al. found that the FAST did not detect 38% of posterior cerebral circulation strokes. Harbison et al. recommended that prehospital stroke assessment tools assess visual disturbance to improve posterior circulation stroke recognition.

In 2005, the research group who created the FAST developed and validated the Recognition of Stroke in the Emergency Room (ROSIER) tool for use by ED physicians. This tool incorporates all FAST items and additionally examines visual field deficit, leg weakness, loss of consciousness or syncope, and seizure activity. When compared with the FAST, ROSIER use in the ED provided an 11% increase in sensitivity and significantly reduced nonstroke referrals to the stroke team.

Given the increasing importance of and reliance on ambulance services’ ability to recognize stroke accurately, the limitations of the FAST, and the reported superiority of the ROSIER over of the FAST, there is merit in exploring whether the ROSIER could enhance the accuracy of ambulance clinicians’ stroke recognition. Furthermore, with an increasing role of the ambulance service in providing direct access to treatment, the time is right to consider whether a more comprehensive stroke recognition tool could enhance decision making.

The use of the ROSIER as a stroke recognition tool by ambulance clinicians has not previously been examined. The primary aim of this study was to test whether the ROSIER could improve the accuracy of ambulance clinicians’ stroke recognition compared with the FAST. Our secondary aim was to examine the contribution of individual ROSIER and FAST items, plus demographic characteristics, to the diagnosis of stroke to contribute to the future development of a comprehensive stroke decision-making tool for ambulance service use.

Methods

Study Design

This was a prospective study in which patients with suspected stroke were assessed by ambulance clinicians using the ROSIER instead of using the FAST. The study used each participant as his or her own control by calculating both ROSIER and FAST scores for each.

Ethical approval was received from the South East Research Ethics Committee. Approval was granted by the National Information Governance Board to use patient-identifiable information without explicit consent on the condition that the patients or their carers were given an opportunity to opt out.

Setting

Greater London covers a geographical area of 1580 km² (610 m²) with a population of 8.2 million people served by the London Ambulance Service National Health Service (NHS) Trust. The London Ambulance Service responds to ≈1.6 million calls annually, attending >1 million incidents. In 2011–2012, the London Ambulance Service treated 8680 patients with suspected stroke, representing 106 patients per 100,000 population. Emergency medical help is accessed by dialing 999. Calls are triaged by Emergency Medical Dispatchers who allocate the fastest ambulance response to patients with suspected stroke (with symptom onset within 2 hours), with a target of reaching them within 8 minutes. Patients are treated by ambulance clinicians trained to recognize the signs and symptoms of stroke using the FAST to aid stroke recognition.

Patient Population

We included patients aged >18 years if they presented with symptoms of stroke, were assessed by participating ambulance clinicians using the ROSIER, and conveyed to the Royal London Hospital. We did not include those who were <18 years, not assessed using the ROSIER, or transferred to another hospital.

ROSIER Stroke Assessment Tool

The ROSIER is a 7-item stroke tool that incorporates the FAST elements (facial weakness, arm weakness, and speech disturbance) plus leg weakness and visual field deficit. These symptoms are indicative of a stroke and, if present, each receives a score of 1. The ROSIER also includes assessment of loss of consciousness or syncope and seizure activity both of which reduce the likelihood of a stroke and, if present, receive a score of −1. A ROSIER score, the total of all 7 items, of ≥1 suggests a stroke or transient ischemic attack (TIA), whereas a ROSIER score of ≤0 indicates nonstroke. An option of unable to assess was made available on our modified ROSIER proforma (Figure 1). We asked ambulance clinicians to indicate whether they thought the patient was having a stroke based on their ROSIER assessment (Figure 1).

Face Arm Speech Test

The FAST is a 3-item stroke assessment tool that assesses facial weakness, arm weakness, and speech disturbance. The presence of ≥2 items suggests a stroke or TIA. A FAST score was calculated for each patient by extracting the scores relating to the 3 FAST elements from the ROSIER proforma to yield a provisional diagnosis if the FAST had been applied to the patient.

Reference Standard

The reference standard was the final diagnosis (stroke, TIA, or nonstroke) made by a stroke consultant or other senior medical physician caring for the patient within 72 hours of the patient’s admission to hospital. We used routine tests, including computerized tomography and MRI scans, undertaken by the clinical team to confirm whether the patient had a stroke. The final diagnosis was confirmed by a senior stroke consultant (P.G.). Stroke clinical types were classified according to the Oxford Community Stroke Project categories.

Because ambulance clinicians are unlikely to distinguish between stroke and TIA, and both types of patients receive the same prehospital treatment, we describe all positive diagnoses of stroke or TIA as strokes and all other diagnoses as nonstrokes.

Training and Procedure

Two hundred forty-three ambulance clinicians received a 1-hour stroke education program. The scenario-based program demonstrated use of the ROSIER in prehospital clinical practice and included instructions on completing the ROSIER proforma. A 15 minute educational DVD summarizing the education program, including ROSIER use, was distributed to each trained member of staff along with trial documentation.

From January 4, 2010 to March 31, 2011 participating clinicians used the ROSIER in place of the FAST to assess the likelihood of suspected stroke. All other aspects of clinical care remained unchanged and patients were managed in accordance with standard ambulance clinical guidelines. A ROSIER proforma and a standard clinical patient record were completed by the attending ambulance crew for each patient.

Data Collection

Individual scores for ROSIER items and ambulance clinicians’ provisional diagnoses were extracted from the ROSIER proforma. Additional prehospital data including patient demographics, vital signs, chief complaint, date and time of symptom onset, and medical history were extracted from the ambulance clinical record. We retrieved participants’ final diagnoses from the Royal London Hospital’s clinical records. In collecting data we complied with all relevant legislation governing the use of patient data.
Data Analysis

We compared ambulance clinicians’ provisional diagnoses and stroke consultants’ final diagnoses. We summarized the accuracy of stroke identification by calculating sensitivity, specificity, positive predictive value, and negative predictive value for the ROSIER and FAST. We used stepwise logistic regression to investigate the contribution of individual ROSIER and FAST items, plus patient demographics, to the prediction of the final diagnosis. Correlations were used to summarize the relationships between potential predictors of stroke. We analyzed data using IBM SPSS Statistics version 19.0. We considered type 1 errors <5% \((P<0.05)\) to be statistically significant.

Results

Participants

During the 15-month recruitment period, 312 patients with suspected stroke were assessed with the ROSIER and conveyed to the Royal London Hospital. Another 32 patients were treated by study-trained ambulance clinicians, but as ROSIER assessment was not undertaken, they were not included in the study.

Hospital diagnoses could not be retrieved for 17 of 312 patients because the key identifying information (name and date of birth) was not documented on the ambulance record. Results are based on 295 patients for whom a definitive diagnosis was retrieved. Figure 2 illustrates the design of the study and the number of participants at each stage.

Fifty-three percent of patients included in the study were men and 47% were women. The average age was 65 years, ranging from 20 to 95 years. In total, 177 patients received a consultant’s diagnosis of stroke and 118 received a diagnosis of nonstroke. The most commonly diagnosed stroke type was stroke due to an infarct (n=100; 71%) followed by stroke caused by a bleed (n=33; 23%). Of the infarcted strokes, a partial anterior circulation stroke accounted for 27%, total anterior circulation stroke for 24%, lacunar strokes for 17%, and posterior circulation stroke for 4%. Type of infarct was not recorded in 28% of cases. No patients presented with either isolated leg or visual field deficits.

Comparison of the ROSIER and FAST

Of the stroke cases identified by ambulance clinicians using the ROSIER, 64% were confirmed as stroke by a stroke consultant (n=171/268). The ROSIER, however, did not demonstrate superiority over the FAST, with a similar proportion of stroke cases being confirmed (62%; n=171/274; Table 1).

Of cases deemed by ambulance clinicians to be nonstrokes using the ROSIER, 78% were confirmed as nonstroke by a stroke consultant (n=21/27). The ROSIER showed little improvement on the FAST, with 71% of nonstrokes identified by the FAST confirmed by a stroke consultant (n=15/21).

The rate of false-positives—those initially identified as stroke but later found not to be strokes—was similar for the
There was little variation in the diagnoses breakdown of false-positives (stroke mimics; Table I in the online-only Data Supplement; Table 1).

There was also little difference between the ROSIER and FAST in the proportion of false-negatives—patients classified as nonstroke who actually experienced a stroke (22%; n=6/27 and 29%; n=6/21, respectively).

The ROSIER and FAST demonstrated similar sensitivity and positive predictive value, whereas specificity and negative predictive value were marginally higher for the ROSIER than the FAST (Table 2). The likelihood ratio for a positive test was similar for the two measures, whereas the likelihood ratio for a negative test was slightly higher for the FAST than the ROSIER.

Table 2. Accuracy of Stroke Identification by the ROSIER and the Extracted FAST

<table>
<thead>
<tr>
<th></th>
<th>ROSIER (95% CI)</th>
<th>FAST (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>97% (92–99)</td>
<td>97% (92–99)</td>
</tr>
<tr>
<td>Specificity</td>
<td>18% (12–26)</td>
<td>13% (8–20)</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>64% (58–70)</td>
<td>62% (56–68)</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>78% (57–91)</td>
<td>71% (48–88)</td>
</tr>
<tr>
<td>Likelihood ratio for a positive test</td>
<td>1.18 (1.08–1.28)</td>
<td>1.11 (1.03–1.19)</td>
</tr>
<tr>
<td>Likelihood ratio for a negative test</td>
<td>0.19 (0.08–0.45)</td>
<td>0.27 (0.11–0.66)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; FAST, Face Arm Speech Test; and ROSIER, Recognition Of Stroke In the Emergency Room.

Prediction of Consultant’s Diagnosis

Regression analysis found that 3 ROSIER items significantly predicted stroke final diagnosis: facial weakness, arm weakness, and seizure activity (Table 3). Participants with facial weakness were more than twice as likely as those without to receive a diagnosis of stroke. Similarly, participants with arm weakness were more than three times as likely as those without to be diagnosed with stroke. Those with no seizure activity were almost four times more likely to be diagnosed with stroke than participants with seizure activity. For each year increase in age, participants were 3% more likely to be diagnosed with stroke. Men were almost twice as likely as women to be diagnosed with stroke.

The ROSIER and FAST items that did not significantly predict diagnosis were significantly correlated with those items that did (Table 4). Speech disturbance was positively correlated with facial weakness. Loss of consciousness was positively correlated with seizure activity. Leg weakness was positively correlated with both facial and arm weakness. Visual field defect was positively correlated with facial and arm weakness and negatively correlated with seizure activity.

Discussion

Early recognition of stroke by ambulance services is critical to rapid treatment and positive outcome for patients. This study examined whether the ROSIER, a more comprehensive stroke recognition tool than the currently used FAST, could enhance prehospital stroke recognition. It is the first to investigate use of the ROSIER by ambulance clinicians.

Stroke consultants subsequently confirmed 64% of strokes and 78% of nonstrokes identified by ambulance clinicians using the ROSIER. However, the proportion of cases accurately identified by the extracted FAST was similar, suggesting that stroke recognition by our clinicians would have been just as good with the FAST. Sensitivity was identical for the two assessment tools, and specificity, positive predictive value, negative predictive value and likelihood ratios were relatively similar, indicating that the ROSIER did not notably improve prehospital stroke recognition. Therefore, we cannot recommend that ambulance clinicians use the ROSIER in place of the FAST.

Previous research in an ED7 reported a significant increase in sensitivity of the ROSIER over of the FAST (93% ROSIER versus 82% FAST). In the present study, sensitivity of the FAST was excellent (97%), leaving little room for improvement by
the ROSIER. A more recent study in an ED by Whiteley et al supports our findings by reporting no detectable differences between the ROSIER and FAST in the identification of stroke.

With more elements than the FAST, the ROSIER takes longer to complete, potentially increasing time spent on scene and prolonging time to specialist treatment. Although any such increase may be only a few minutes, millions of neurons are lost during each minute that treatment is delayed. Such delays are not outweighed by the performance of the ROSIER in this study. The FAST would be quicker to complete and equivalent in performance to the ROSIER, which supports the continued use of the FAST by ambulance services.

Face weakness, arm weakness, and absence of seizure activity significantly predicted a diagnosis of stroke. All elements that did not predict stroke diagnosis (speech disturbance, loss of consciousness or syncope, leg weakness, and visual field deficit) were correlated with ≥1 of those that did. Seizure activity was the only ROSIER item not already captured by the FAST that significantly predicted a stroke. The development and testing of a revised FAST including an assessment of seizure activity is worth consideration. There is evidence that speech disturbance is the most commonly reported stroke symptom by people calling the ambulance service for emergency medical assistance. Although the speech element of the FAST was not predictive of a stroke, it may help emergency medical call takers to identify potential strokes.

The assessment of visual disturbance by ambulance clinicians has been suggested as a possibility for enhancing the detection of posterior circulation strokes. However, in this study, the ROSIER visual field element did not significantly predict stroke diagnosis. Because visual field deficit significantly correlated with all predictors of a stroke (face weakness, arm weakness, and absence of seizure activity), we judge that these 3 measures may act as proxies for visual field assessment. It is possible that the number of patients with a posterior circulation stroke (4%) may have been too low to detect any possible benefit of visual field assessment. Other studies have reported equally low numbers of posterior circulation infarctions treated by ambulance clinicians. With such low numbers of posterior strokes, the benefit of an additional element needs to be balanced against an increased time spent on the scene. The FAST developers concluded that the addition of a visual disorder element would lengthen paramedic assessment time and could greatly increase the number of false-positive diagnoses without greatly increasing the sensitivity of the instrument.

Although ambulance clinicians were good at identifying positive cases of stroke (97%), the recognition of nonstroke was poor with low specificity for both tests (13%–18%). A similar contrasting pattern has been reported previously with doctors and nurses, although specificity figures in our study were much lower. The ability to detect people with nonstrokes accurately is critical to appropriate referral decisions. Nonstroke patients who are taken directly to a stroke unit may experience delays to their eventual treatment in the ED and risk overburdening the specialist unit. These findings emphasize the need to improve prehospital recognition

### Table 3. Results of the Stepwise Logistic Regression Investigating the Prediction of Consultant's Diagnosis of Stroke/TIA

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>β</th>
<th>SE</th>
<th>df</th>
<th>P Value</th>
<th>Exp(β) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAST items</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facial weakness</td>
<td>0.889</td>
<td>0.294</td>
<td>1</td>
<td>0.002</td>
<td>2.433 (1.368–4.326)</td>
</tr>
<tr>
<td>Arm weakness</td>
<td>1.279</td>
<td>0.301</td>
<td>1</td>
<td>&lt;0.001</td>
<td>3.593 (1.993–6.478)</td>
</tr>
<tr>
<td><strong>Additional ROSIER items</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizure</td>
<td>1.295</td>
<td>0.535</td>
<td>1</td>
<td>0.016</td>
<td>3.652 (1.279–10.426)</td>
</tr>
<tr>
<td><strong>Demographic variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Age</td>
<td>0.027</td>
<td>0.008</td>
<td>1</td>
<td>0.001</td>
<td>1.028 (1.011–1.045)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.601</td>
<td>0.278</td>
<td>1</td>
<td>0.029</td>
<td>1.824 (1.063–3.130)</td>
</tr>
</tbody>
</table>

β indicates constant coefficient; CI, confidence interval; df, degrees of freedom; Exp(β), exponentiation of the β coefficient; FAST, Face Arm Speech Test; ROSIER, Recognition Of Stroke In the Emergency Room; and TIA, transient ischemic attack.

### Table 4. Correlations Between the ROSIER and FAST Items

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial weakness</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm weakness</td>
<td>0.329†</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech disturbance</td>
<td>0.364†</td>
<td>0.082</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of consciousness/syncope</td>
<td>0.010</td>
<td>−0.022</td>
<td>−0.004</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizure activity</td>
<td>−0.129*</td>
<td>−0.085</td>
<td>−0.089</td>
<td>0.250‡</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg weakness</td>
<td>0.252‡</td>
<td>0.762‡</td>
<td>0.074</td>
<td>−0.019</td>
<td>−0.058</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Visual field deficit</td>
<td>0.177†</td>
<td>0.244‡</td>
<td>0.247‡</td>
<td>−0.169‡</td>
<td>−0.260‡</td>
<td>0.226‡</td>
<td>1</td>
</tr>
</tbody>
</table>

FAST indicates Face Arm Speech Test; and ROSIER, Recognition Of Stroke In the Emergency Room.

*P<0.05; †P<0.01; ‡P<0.001.
of nonstroke cases, or stroke mimics, to ensure that patients quickly receive the care that is appropriate for their condition. The introduction of advanced technologies such as acoustic brain monitoring (assessing blood flow around the brain) may enhance ambulance clinicians’ ability to distinguish between strokes and nonstrokes and warrants further investigation. Comparison of ROSIER assessment by ambulance clinicians with that undertaken at hospital is also a consideration for future research. The ROSIER may have failed to out-perform the FAST due to certain signs of stroke not being present during prehospital assessment or not being recorded by ambulance clinicians; this will be the subject of a further publication by the authors of this article.

The main limitation of this study is that FAST results were extracted from the ROSIER. However, given the condition under investigation and the study environment, this pragmatic approach was necessary and reasonable. It would have been neither appropriate nor ethical to apply the FAST and the ROSIER separately to the same time-critical patient in an out-of-hospital emergency setting, given the resulting delay to treatment. As the ROSIER incorporates all FAST elements, the assessment of each element is unlikely to have been influenced by the type of tool being applied, and we are confident that the extracted FAST provides a realistic reflection of assessment with the FAST. Furthermore, ambulance clinicians in this study completed the ROSIER in the same way they would normally complete the FAST, in conjunction with the standard clinical record, other assessments, and history taking.

Another limitation of the study is that ambulance clinicians applied the ROSIER only to patients with suspected stroke rather than any patient with a neurological symptom, which may account for the high sensitivity and low specificity observed. It is not known what impact our study training may have had on ambulance clinicians’ decisions to apply a stroke recognition tool. However, the guidelines used for administering the ROSIER in this study are in keeping with standard practice for the use of the FAST.

Finally, hospital diagnoses were not retrieved for 17 patients who could not be found on the hospital system because of missing/incomplete information on the ambulance record. We have no reason to suspect that these patients were clinically different from those for whom diagnosis data were available and so do not expect the missing data to have biased the results.

Conclusions

In summary, our findings do not support the use of the ROSIER in preference to the FAST by ambulance clinicians. Ambulance clinicians were good at identifying positive cases of stroke, but the exclusion of nonstrokes needs improvement. Our findings indicate that a revised version of the FAST incorporating seizure assessment may enhance prehospital stroke recognition and decision making, thus improving patient outcomes.

Acknowledgments

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Disclosures

None

References

Does Use of the Recognition Of Stroke In the Emergency Room Stroke Assessment Tool Enhance Stroke Recognition by Ambulance Clinicians?
Rachael T. Fothergill, Julia Williams, Melanie J. Edwards, Ian T. Russell and Patrick Gompertz

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### Table I. Breakdown of stroke mimics detected by the ROSIER and extracted FAST

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>ROSIER (n=97)</th>
<th>FAST (n=103)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seizure</td>
<td>11 (11.3%)</td>
<td>12 (11.7%)</td>
</tr>
<tr>
<td>Syncope</td>
<td>8 (8.2%)</td>
<td>10 (9.7%)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>18 (18.6%)</td>
<td>18 (17.5%)</td>
</tr>
<tr>
<td>Somatisation</td>
<td>13 (13.4%)</td>
<td>14 (13.6%)</td>
</tr>
<tr>
<td>Space occupying lesion</td>
<td>9 (9.3%)</td>
<td>9 (8.7%)</td>
</tr>
<tr>
<td>Other diagnosis</td>
<td>38 (39.2%)</td>
<td>40 (38.8%)</td>
</tr>
</tbody>
</table>