# Accuracy of Stroke and TIA Diagnosis by Acute Stroke Nurses

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# Outline

- **Recap of diagnostic terminologies**

- **Challenges in diagnosing stroke at the front end**

- **Audit and reaudit findings of diagnostic accuracy of ASN diagnosis of stroke and TIA**

- **Discussion**

**Diagnosing acute stroke syndromes is challenging given a <span style="color:red">high proportion of stroke mimics and chameleons.</span>**

**The role of specialist acute stroke nurses (ASN) in the frontline is well-established, <span style="color:red">but literature on their diagnostic accuracy is sparse.</span>**

**Specialist stroke nurses develop experience in stroke but traditionally <span style="color:red">have not undertaken specific diagnostic training</span> unlike medical professionals**

# ACUTE STROKE NURSE ASSESSMENT

- **Pre-alert and FAST**

- **History taking**

- **ROSIER**

- **NIHSS**

# Practical and easy definitions

- **Sensitivity** =Probability of a test correctly identifying stroke in stroke patients

- **Specificity** =Probability of a test correctly diagnosing non-strokes in non-stroke patients

- **PPV (positive predictive value)** = If a diagnosis of stroke is made by a test, what is the probability that that person has stroke?

- **NPV (negative predictive value)** = If a diagnosis of non-stroke is made by a test, what is the probability that the person does not have stroke?

| | | Disease | | Predictive Value | |
|---|---|---|---|---|---|
| | | $\oplus$ | $\ominus$ | | |
| Test | $\oplus$ | A<br>True Positive (TP) | B<br>False Positive (FP) | Positive Predictive Value (PPV)<br>$\frac{TP}{TP+FP} = \frac{A}{A+B}$ | Total Positive Results (A + B) |
| | $\ominus$ | C<br>False Negative (FN) | D<br>True Negative (TN) | Negative Predictive Value (NPV)<br>$\frac{TN}{FN+TN} = \frac{D}{C+D}$ | Total Negative Results (C + D) |
| Sensitivity & Specificity | | Sensitivity<br>$\frac{TP}{TP+FN} = \frac{A}{A+C}$ | Specificity<br>$\frac{TN}{FP+TN} = \frac{B}{B+D}$ | | |
| | | All diseased patients (A + C) | All non-diseased patients (B + D) | | |

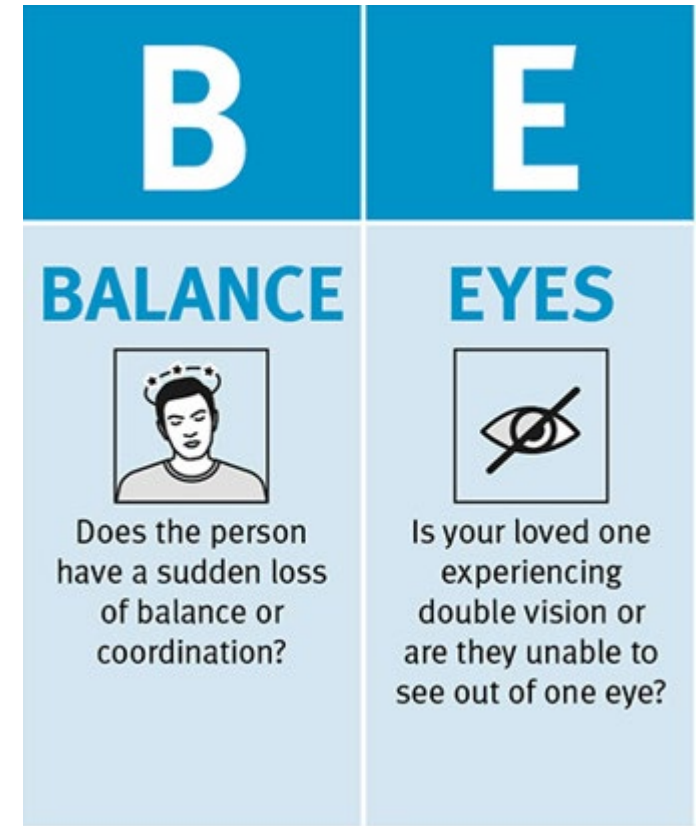# Receiver Operating Characteristic Curve



AUROC 0.93
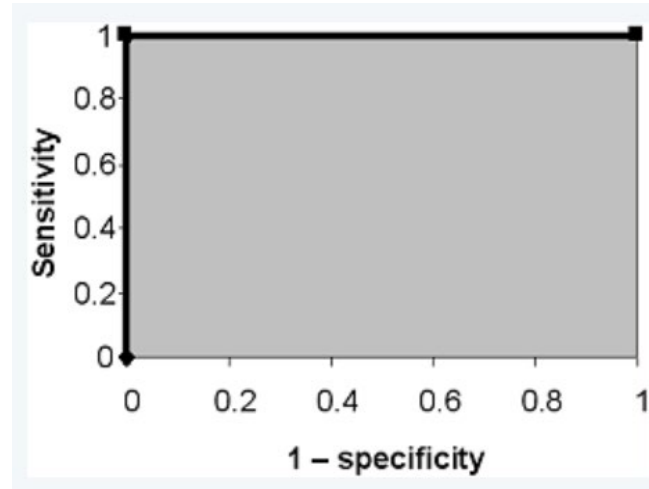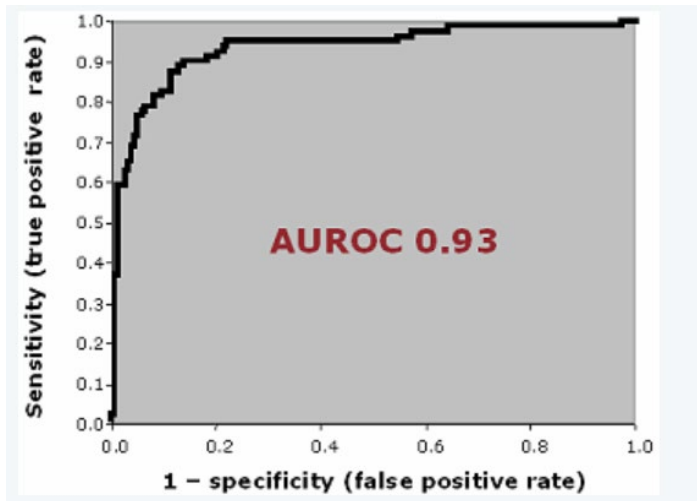


Perfect test
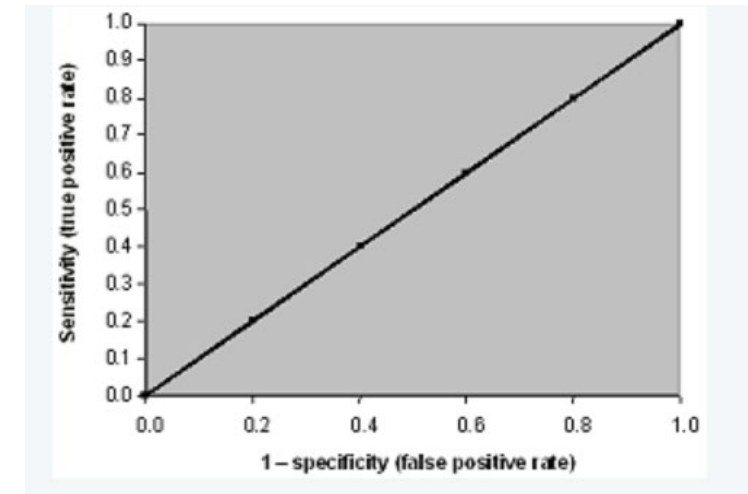


Worthless test

| AUROC | Category |
|---|---|
| 0.9-1.0 | Very good |
| 0.8-0.9 | Good |
| 0.7-0.8 | Fair |
| 0.6-0.7 | Poor |
| 0.5-0.6 | Fail |

# F.A.S.T.

- **Pre-alerts are based on FAST positive.**

- **A total of 9 studies, including 6,151 participants, were analyzed.**

- **FAST**: Sensitivity 0.77 [95% *CI* (0.64–0.86)], specificity 0.60 [95% *CI* (0.38–0.78)]

- **BEFAST**: Sensitivity 0.68 [95% *CI* (0.23–0.93)], specificity 0.85 [95% *CI* (0.72–0.92)]



**B BALANCE** — Does the person have a sudden loss of balance or coordination?

**E EYES** — Is your loved one experiencing double vision or are they unable to see out of one eye?

# ROSIER

**Table 2. ROSIER score stroke tool**

| Questions | Responses | |
|---|---|---|
| Is there loss of consciousness or syncope? | Yes (1) | No (0) |
| Has there been seizure activity? | Yes (1) | No (0) |
| **Is there NEW ACUTE onset?** | | |
| Asymmetrical facial weakness | Yes (1) | No (0) |
| Asymmetrical arm weakness | Yes (1) | No (0) |
| Asymmetrical leg weakness | Yes (1) | No (0) |
| Speech disturbance | Yes (1) | No (0) |
| Visual field defect | Yes (1) | No (0) |
| **Total score: -2  -  +5** | | |

If score >0 stroke is likely

If score </= 0 stroke is unlikely but not completely excluded!

**Recognition of Stroke in the Emergency Room**

- **For use by ED staff**

- **A total of 14 studies incorporating 15 datasets were analysed**

- **pooled sensitivity 0.88 (95% CI: 0.83–0.91), specificity of 0.66 (95% CI: 0.52–0.77).**

**Table 3** Diagnostic accuracy values of clinical tools for selecting subjects with acute stroke and stroke-mimicking conditions

| Clinical tool | Target condition | Se | Sp | PPV | NPV | AUC |
|---|---|---|---|---|---|---|
| CPSS [15] | Acute stroke | 0.83 | 0.69 | 0.50 | 0.91 | – |
| FABS≥3 [22] | Stroke mimic | 0.90 | 0.91 | 0.87 | 0.93 | – |
| FAST [12, 15] | Acute stroke | 0.76–0.85 | 0.64–0.68 | 0.50–0.93 | 0.30–0.92 | 0.70 |
| GZSS≥1.5 [12] | Acute stroke | 0.83 | 0.74 | 0.95 | 0.42 | 0.87 |
| LAPSS [12] | Acute stroke | 0.56 | 0.88 | 0.97 | 0.25 | – |
| LAPSS 1998 [15] | Acute stroke | 0.44 | 0.98 | 0.87 | 0.82 | – |
| LAPSS 2000 [15] | Acute stroke | 0.49 | 0.97 | 0.87 | 0.84 | – |
| MASS [15] | Acute stroke | 0.63 | 0.94 | 0.79 | 0.87 | – |
| Med PACS [15] | Acute stroke | 0.71 | 0.92 | 0.76 | 0.90 | – |
| MPDS [23] | Acute stroke | 0.86 | 0.27 | 0.20 | 0.90 | – |
| ROSIER [12, 15] | Acute stroke | 0.78–0.80 | 0.71–0.79 | 0.59–0.94 | 0.34–0.91 | 0.77 |
| sNIHSS-EMS [24] | Acute stroke | 0.91 | 0.52 | 0.43 | 0.93 | – |
| TriAGe+ ≥ 10 [11] | Acute stroke | 0.78 | 0.72 | 0.57 | 0.87 | 0.78 |

Abbreviations: *AUC* area under the curve, *NPV* negative predictive value, *PPV* positive predictive value, *Se* sensitivity, *Sp* specificity

Diagnostic accuracy of clinical tools for assessment of acute stroke: a systematic review (abdn.ac.uk)

## INITIAL AUDIT: September 2021

**Aim**: To compare the diagnostic accuracy with final validated diagnosis by stroke consultants

## Methodology

- **Sept 2021**
- **All acute stroke nurse assessments are included**
- **Total of 166 patients (all repeat assessments were excluded)**
- **ASN diagnosis was compared with final validated diagnosis**

# Recap - Practical and easy definitions

- **Sensitivity** =Probability of specialist nurse correctly identifying stroke in stroke patients

- **Specificity** =Probability of specialist nurse correctly diagnosing non-strokes in nonstroke patients

- **PPV (positive predictive value)** = If a diagnosis of stroke is made by Specialist nurse, what is the probability that that person has stroke?

- **NPV (negative predictive value)** = If a diagnosis of non-stroke is made by stroke nurse, what is the probability that the person does not have stroke?

|  |  | Disease | | Predictive Value | |
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| Sensitivity & Specificity | | Sensitivity $\frac{TP}{TP+FN} = \frac{A}{A+C}$ | Specificity $\frac{TN}{FP+TN} = \frac{B}{B+D}$ | | |
|  | | All diseased patients (A + C) | All non-diseased patients (B + D) | | |

# INITIAL AUDIT: September 2021

## FINDINGS

- **Ambulance Pre alert** sensitivity was *less* (0.67 vs 0.77) when compared to literature. AUC 57%

- **ROSIER score** with sensitivity of 71%, NPV of 80% *below* the levels seen in the literature (Literature sensitivity is 0.88) AUC 68%

- **ASN diagnosis** (stroke & TIA combined) had a sensitivity of 84% and NPV of 86%. AUC 81%

## INITIAL AUDIT: September 2021

## INTERVENTIONS

- **Regular review and feedback by Advanced Nurse Practitioner and stroke consultants**

- **Periodic specialist nurse meetings and educational sessions**

- **External training**

## POTENTIAL TRAPS

- Unilateral positive sensory symptoms (think of thalamic)
- Sudden onset of ataxia or dizziness or falls (Examine gait)
- Acute vertigo
- Acute confusion with no signs of infection (aphasia)
- Acute onset of mild dysarthria or dysphagia
- Lateral medullary syndrome
- Localised limb weakness and cortical infarcts
- Unilateral involuntary movements
- NIHSS of 0
- Dissection presentations – Horner's, acute pulsatile tinnitus, lower cranial nerve palsies
- Functional

# PEARLS AND PITFALLS

Sudden onset

Sudden onset of focal neurological symptoms are as sensitive as focal signs

Symptoms/signs localisable to vascular territory

The higher the NIHSS score, the more likely the stroke

Examine for Gait

Don't diagnose hemiplegic migraine

Focus on change in functional status of the patient

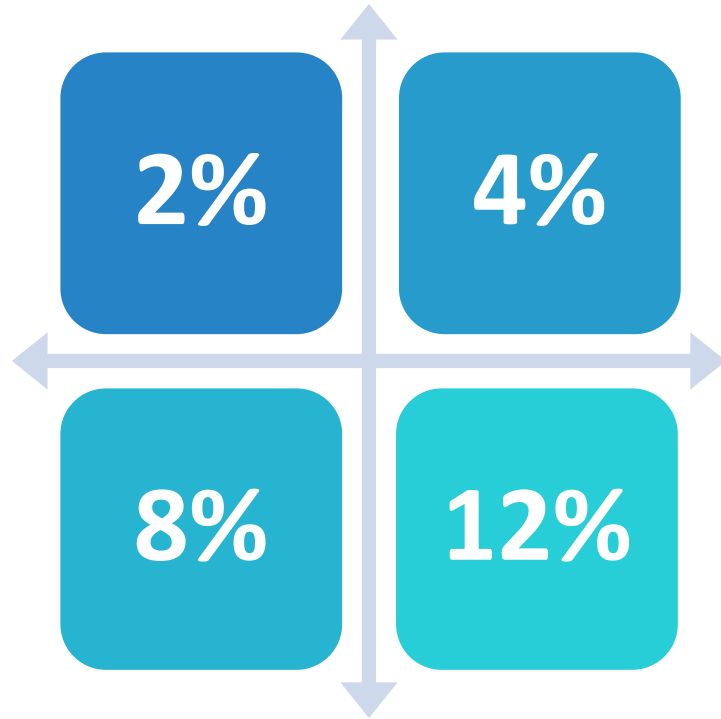Migraine with Motor aura is rare – Beware with any significant weakness

First time diagnosis of migraine with aura requires significant caution
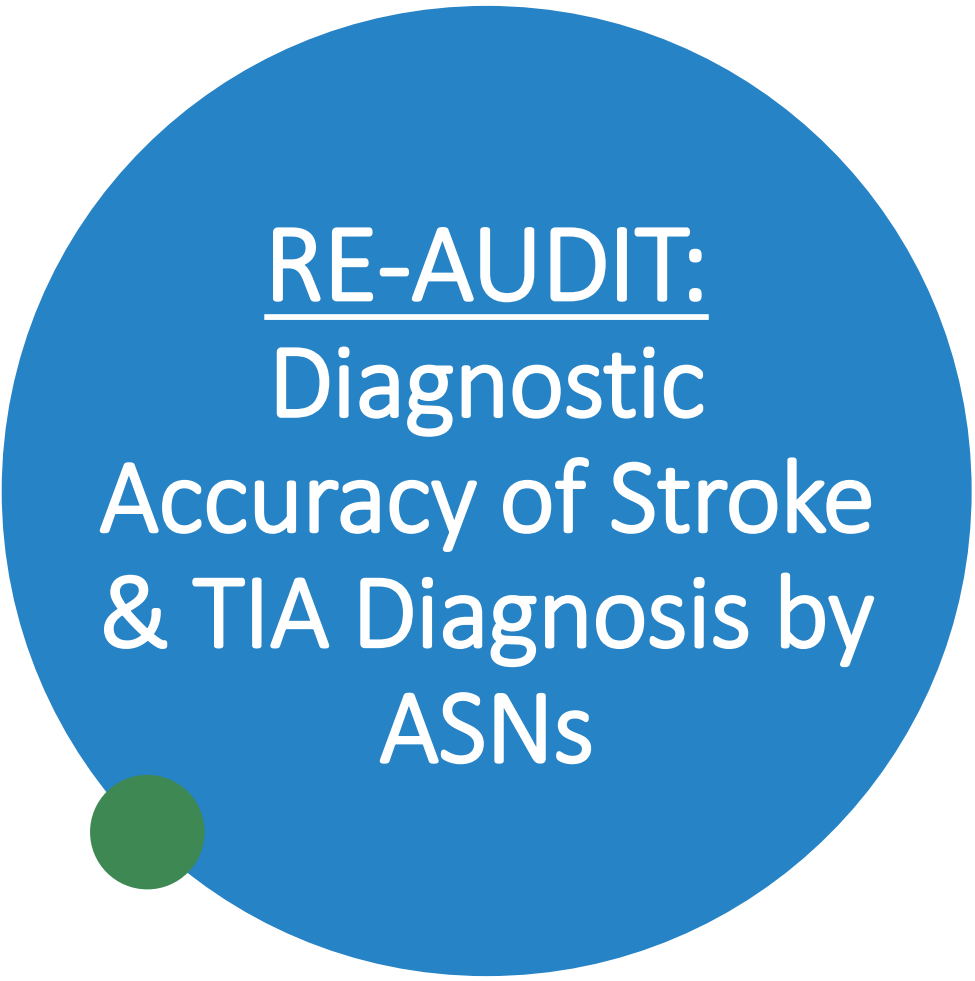
Avoid cognitive biases – anchoring, premature closure

# What proportion of strokes have a NIHSS of 0?

*(based on SSNAP data)*

## RE-AUDIT:
## Diagnostic Accuracy of Stroke & TIA Diagnosis by ASNs

**AIM**

To compare the diagnostic accuracy with final validated diagnosis by stroke consultants

**METHODOLOGY**

- Sep-Nov 2022
- All acute stroke nurse assessments
- Total of 485 patients (all repeat assessments were excluded)
- ASN diagnosis was compared with final validated diagnosis

# PRE-ALERT

- **Out of 485 records/patients, 282 were conveyed by paramedics.**

| PRE-ALERT (*n=282* ) | | | | | |
|---|---|---|---|---|---|
| | **Stroke +** | **Stroke -** | **Row Total** | | |
| **Pre-alert +** | 77 | 85 | 162 | **PPV** | 0.597 |
| **Pre-alert -** | 30 | 90 | 120 | **NPV** | 0.647 |
| **Column Total** | 107 | 175 | 282 | | |
| | **Sensitivity** | **Specificity** | | **AUC** | 0.617 |
| | 0.72 | 0.51 | | | |

**35% are falsely negative
(not pre-alerted as stroke by paramedics)**

# ROSIER

*Only for assessments for stroke (excluded all TIA at time of assessment and diagnosis)*

| ROSIER (*n=417*) | | | | | |
|---|---|---|---|---|---|
| | **Diagnosis +** | **Diagnosis -** | **Row Total** | | |
| **Test positive (score >0)** | 133 | 111 | 244 | **PPV** | 0.667 |
| **Test negative (score ≤0)** | 23 | 150 | 173 | **NPV** | 0.796 |
| **Column Total** | 156 | 261 | 417 | | |
| | **Sensitivity** | **Specificity** | | **AUC** | 0.714 |
| | 0.85 | 0.57 | | | |

**20% of ROSIER negative patients are false negative strokes (strokes with negative ROSIER)**

# ASN DIAGNOSIS

| STROKE AND TIA *(n=485)* | | | | | |
|---|---|---|---|---|---|
| | **Diagnosis +** | **Diagnosis -** | **Row Total** | | |
| **Test positive** | 190 | 68 | 258 | **PPV** | 0.79 |
| **Test negative** | 17 | 210 | 227 | **NPV** | 0.902 |
| **Column Total** | 207 | 278 | 485 | | |
| | **Sensitivity** | **Specificity** | | **AUC** | 0.837 |
| | 0.92 | 0.76 | | | |

**10% strokes "missed" by ASNs**

# RESULTS AND CONCLUSIONS

| TEST | PARAMETER | AUDIT 1 (2021) | AUDIT 2 (2022) | |
|------|-----------|----------------|----------------|---|
| **PRE-ALERT** | Sensitivity | 67% | 72% | |
| | Specificity | 47% | 51% | |
| | PPV | 47% | 59% | |
| | NPV | 67% | 64% | |
| | AUC | 68% | 61% | |
| **ROSIER** | Sensitivity | 71% | 85% | |
| | Specificity | 66% | 57% | |
| | PPV | 53% | 67% | |
| | NPV | 80% | 80% | |
| | AUC | 68% | 71% | |
| **ASN DIAGNOSIS (STROKE & TIA COMBINED)** | Sensitivity | 84% | 92% | ⬆ |
| | Specificity | 78% | 76% | ⬇ |
| | PPV | 75% | 79% | ⬆ |
| | NPV | 86% | 90% | ⬆ |
| | AUC | 81% | 84% | ⬆ |

# RESULTS AND CONCLUSIONS

## ASN diagnosis

- AUC 84% is acceptable (*below an ideal level of 0.9)*
- Sensitivity Improved in Audit 2 but specificity reduced. This could have been due to increased awareness not to miss stroke.

Ongoing review and training is needed to improve the accuracy of ASN diagnosis

# DISCUSSION

**The case mix of North East Essex is significantly different:**
    **- High incidence of frailty and comorbidity**

**Almost all the cases missed by ASNs were either posterior circulation strokes or those with multiple infarcts (e.g. cardioembolic cause)**

| "Missed strokes" | |
|---|---|
| Multiple infarcts | 5 |
| Thalamic | 5 |
| Bilateral cerebellar | 1 |
| PCA | 1 |
| CRAO* | 1 |

# RECOMMENDATIONS

The team should continue to highlight challenging cases to ASN and continue the journey of reflective learning, training and improvement

- Continuous breach reviews

- Feedback from lead nurse and consultants

- Additional teaching sessions

Thank you