Background

Acute stroke is defined as a neurological disorder categorised by the sudden loss of blood flow to an area of the brain, resulting in the loss of neurological function. The three main classifications of acute stroke are ischaemic, haemorrhagic, and transient (Kuriakose et al, 2021). Clinical guidelines (NICE, 2022) state that acute stroke is the leading cause of death and disability, affecting over 100,000 people and the cause of 38,000 deaths within the United Kingdom (UK) each year. Aetiology of stroke is influenced by detrimental lifestyle choices resulting in hypercholesterolaemia, leading to atherosclerosis and hypertension, and patients diagnosed with cardiac arrhythmias having an increased risk of embolisms leading to acute stroke (NICE, 2019).

Posterior circulation Stroke (PCS) represents up to 25% of ischaemic strokes and affects more than 20,000 people annually within the UK (Banerjee et al, 2018). Affecting the brain stem structures supplied by the vertebrobasilar arterial system, PCS is caused by a narrowing or blockage of one or more of the arteries that supply the brainstem, which can result in vestibular symptoms (Gulli et al, 2009). Patients presenting with PCS symptoms in the pre-hospital setting require the same emergency admission to hospital as the other classifications of acute stroke (JRCALC and AACE, 2021).

Clinical practice guidelines (NICE, 2019; JRCALC and AACE, 2021) recommend the use of a validated stroke screening tool for the assessment of all patients presenting with stroke symptoms, such as the ‘Face, Arms, Speech, Time’ [FAST] tool. Public health campaigns have recently been reinstated to increase public awareness of this tool (PHE, 2021). An onset time of symptoms to hospital admission

of less than six hours is associated with favourable outcomes for patients presenting with acute stroke (Matsuo et al, 2017; ISWP, 2023). Paramedics must make every effort to minimise time on-scene and ensure that there are no unnecessary procedures performed that do not add value to patient assessment (Matsuo et al, 2017; ISWP, 2023).

The FAST tool is used by all United Kingdom (UK) ambulance services for the assessment of acute stroke symptoms (McClelland et al, 2018). This practice is based upon clinical guidelines recommendation (NICE, 2019) that pre-hospital assessment of acute stroke should be executed using a validated stroke screening tool, with FAST being specifically stated. Relevant healthcare professional clinical guidelines (JRCALC and AACE, 2021) agree with this recommendation. The 'FAST' tool is deemed to have high sensitivity (Chen et al, 2022) and moderate specificity (Perrucker et al, 2014) in the recognition of Ischaemic stroke. Yet there is evidence within the literature determining that the 'FAST' tool is not adequate for pre-hospital screening of PCS, leading to misdiagnosis, treatment delay, and severe life-limiting deficits or death (Sommer et al, 2016; Krishnan et al, 2019).

Typical stroke symptoms, such as face and limb weakness, are rapidly assessed using the 'FAST' tool (PHE, 2021). However, with PCS, patients may present with vestibular symptoms, which cannot be detected with 'FAST' (Rowe et al, 2020). Furthermore, over one-third of patients with PCS are delayed or misdiagnosed due to a lack of 'typical' acute stroke symptoms displayed (Merwick and Werring, 2014). High mortality from PCS has been linked to an inappropriate assessment tool applied by clinicians, leading to incorrect triage, treatment, and management (Rowe et al, 2020). Prehospital clinical guidelines recommend that paramedics have a high suspicion when patients present with vestibular symptoms, warning that not all stroke

symptoms can be identified using the ‘FAST’ tool (JRCALC and AACE, 2021). Furthermore, Rowe et al. (2020) pre-alerting a receiving hospital was the most influential factor for timely assessment of patients presenting with acute stroke. However, within this study it was identified that hospitals were only pre-alerted by paramedics using ‘FAST’ when stroke symptoms were detected. A more appropriate stroke screening tool used for stroke assessment, such as ‘BEFAST’ (Aroor et al, 2017), coupled with improved paramedic awareness of PCS symptoms and stroke mimics, will directly improve PCS management (Oostema et al, 2019).

Recent changes to practice have occurred within American clinical guidelines, based upon the recommendation of the American Heart Association, following research conducted surrounding the ‘BEFAST’ stroke screening tool. Aroor et al. (2017) study identifies that the addition of balance and eye assessments to ‘FAST’ improves the detection of PCS symptoms. Furthermore, although ‘BEFAST’ is not fully validated, it was discovered that additions to an already validated stroke screening tool forms a loophole to its use within clinical practice (Aroor et al, 2017). ‘BEFAST’ is now commonly used within prehospital and in-hospital centres throughout America due to its efficiency in identifying PCS symptoms (Ammar et al, 2020; Gulli and Markus, 2012; Meyran et al, 2020. Several other research studies have found that vision and balance assessments can be valuable for improving pre-hospital detection of PCS and have produced positive results (Ammar et al, 2020; Jones et al, 2021). Additionally, current research (McClelland et al, 2018) suggests there are three UK ambulance services now using additional physical assessments alongside the 'FAST' tool based upon current research.

Aim

The aim of this literature search was to evaluate how the use of the additional neurological assessment could be used, alongside the validated 'FAST' tool, within the pre-hospital setting for the improved paramedic detection of PCS.

Methods

Search strategy and study selection

An extensive review of the literature was undertaken using a variety of keywords; BEFAST, "stroke screening tools", paramedic*, prehospital* and "posterior stroke". Initially the search was conducted using Academic Search Complete, Medline, and CINAHL databases from 2012 to 2022, to ensure contemporary evidence was sourced, followed by further analysis of other secondary searches, such as Google Scholar and Trip database, and a scrutiny of reference lists. Boolean operators AND and OR were used within the search strategy to improve sensitivity and specificity of the results and to retrieve focused evidence. A total of 46 articles were selected for review. The inclusion criteria were assessment of stroke patients by any health professional, including in-hospital and paramedics or technicians within the pre-hospital setting and data sets reporting on accuracy of detection of stroke screening tools and/or signs and symptoms. Studies were included if published in English, peer reviewed and available as full text. Exclusion criteria included duplication, non-English translated, no full text available, no direct link to posterior stroke and non-stroke assessment.

Review method

Results were analysed and combined within a PRISMA analysis (Image 1) to locate the most appropriate evidence to answer the researchable question. Seventeen articles were found of use to this literature review, with six pieces of evidence chosen to comprehensively evaluate. The primary six pieces of evidence were placed into an annotated literature to analyse the evidence for inclusion within the review (Table 1). The Critical Appraisal Skills Programme [CASP] systematic literature review checklist and CASP cohort study checklist were used to validate evidence quality (CASP, 2023).

Results

A total of forty-six studies were identified within the search strategy. Following the removal of duplicates and outdated/non-English translation, thirty studies were screened. Post abstract screening, twenty studies were eligible for complete article analysis. Seventeen studies met the inclusion criteria, with six identified as being directly linked to the research question. Of the six studies chosen to create the main themes for discussion, five studies were United Kingdom based, with one study from America. The methodology of each article was scrutinised; retrospective studies (n=3), prospective studies (n=2) and systematic literature review (n=1). Although not a primary study, the systematic literature review included significant underpinning themes and evidence for inclusion and directly linked to the research question and topics being analysed. Four studies were pre-hospital based and two studies were in-hospital based, thematic analysis identified studies focusing on comparison and

evaluation of FAST versus other stroke screening tools (n=4) and consideration of additional assessments of stroke patients within stroke screening tools (n=5).

Discussion

A revised pre-hospital screening tool for improved PCS detection

A positive outcome for PCS relies heavily on early activation of the stroke 'chain of survival,' by both pre-hospital and in-hospital staff (Herpich and Rincon, 2020). Atypical stroke presentation may lead to misidentification by paramedics, therefore, treatment and transport to Hyperacute Stroke Unit [HASU] may be delayed, which further exacerbates the potential for life-altering and life-threatening consequences of PCS (Hoyer and Szabo, 2021). The key to rapid recognition in the pre-hospital setting is efficient patient history taking, symptom analysis, and the use of an adequate stroke screening tool, whilst maintaining a high index of suspicion for PCS when a patient presents with vestibular symptoms (Merwick and Werring, 2014).

The 'FAST' tool has been used within all UK pre-hospital clinical guidelines since its introduction in 2009, due to the tool's high sensitivity and moderate specificity in the recognition of Ischaemic stroke (Perrucker et al, 2014). There are several other stroke screening tools commonly used to assess and identify acute stroke, such as the Recognition of Stroke in the Emergency Room [ROSIER] scale (Nor et al, 2005) and the American National Institute of Health Stroke Scale [NIHSS] (Brott et al, 1989). Evidence suggests that both stroke screening tools are stepwise, easy to use, and have high sensitivity for ischaemic stroke (Fothergill et al, 2013). However, both tools have been designed for in-hospital use and research has deemed both tools

underestimate and determine false negative results for patients with PCS (Alemseged et al, 2022).

The lack of an appropriate stroke screening tool for the detection of PCS has led to several primary studies being conducted to develop a stroke screening tool that has an increased sensitivity to PCS symptoms. Aroor et al. (2017) aimed to determine whether the 'BEFAST' tool would be a more appropriate tool for the detection of all patients presenting with stroke symptoms, with the focus placed on improved PCS detection. It was determined that fewer ischaemic strokes, including PCS, were missed with the addition of balance and vision assessments to 'FAST'. Similarly, Alemseged et al. (2022) developed a modified 'NIHSS' scale to include balance, vision, and swallowing assessments for in-hospital patients. The results of this study determined a higher prognostic accuracy compared with 'NIHSS' alone. This evidence bolsters the rationale for change to a revised stroke screening tool for use in the pre-hospital setting.

The most valuable piece of evidence located is Jones et al. (2021) systematic literature review. The reviews aim was to identify the characteristics of acute stroke presentations that are incorrectly documented by paramedics. Findings suggest that there has been no overview describing the non-classical symptoms of stroke inaccurately detected by paramedics, and no consensus on a pre-hospital stroke assessment tool to determine these symptoms. This review highlights several themes for discussion of value to this review, including the different stroke symptoms reported with PCS and the importance of rapidly identifying these symptoms. Furthermore, this

review located several studies which agreed that there is limited detection of PCS within the pre-hospital setting using the currently advocated ‘FAST’ tool, with the recommendation that additional assessments to ‘FAST’ are required. This article provides evidence that existing stroke assessment tools are unreliable in identifying common PCS symptoms, which supports a movement to including additional assessments for the improved detection of PCS.

Additional assessments of balance and eyes alongside ‘FAST’

Aroor et al. (2017), Rowe et al. (2020), and Oostema et al. (2019) concluded that the inclusion of additional assessments of balance and vision to the validated ‘FAST’ tool improved sensitivity for PCS symptoms. However, it was acknowledged that these studies could not determine the specificity of the additions towards PCS symptoms and the exclusion of stroke mimics. Comparatively, within Pickham et al. (2018) study there was no benefit found in the additional assessment elements of’ ‘BEFAST’. Findings with the study suggest that stroke detection accuracy was comparable, with facial droop and arm weakness named independent predictors of acute ischaemic stroke.

However, on closer analysis, several limitations were identified. The study was conducted within a single centre consisting of a small sample size, and it is clear within the methodology that the ‘BEFAST’ tool was only applied on patients presenting with presumed stroke symptoms within six hours of neurological deficits. Evidence suggests that outcome reporting bias, where there is selective non-reporting of data or only a subset of evidence is reported, is a critical issue within the assessment of

health-related interventions and can affect the overall outcome of the study (McGuaran et al, 2010). This leads to question whether there is outcome reporting bias present within this article, as there may have been patients who had neurological deficits outside of this time criteria, the initial emergency call-taker may not have coded the incident as query stroke, and the paramedics may have inadvertently missed PCS symptoms. Furthermore, this study aimed to detect the prognostic accuracy of acute stroke using the 'BEFAST' tool and not specifically to assess PCS detection.

The consensus on stroke assessment within American ambulance services has made a distinct change by using the 'BEFAST' tool based upon the recommendations of the American Heart Association (AHA). Aroor et al. (2017) study was the catalyst for change within the American stroke guidelines. The results of this study are statistically important (95% confidence interval and a P-value of <0.05) with 14% of stroke diagnoses missed with 'FAST' alone, reduced to 4% with 'BEFAST' applied. Results concluded that the addition of balance and vision assessments leads to a reduction in missed acute stroke, with no risk to patient safety and no increase in ambulance on-scene time. However, American ambulance services configuration is different in structure to UK ambulance services, therefore, the generalisability of results needs to be considered before a step-change is made, if based upon this evidence.

Identifying additional assessment inclusion

An essential aspect of this literature review is to identify which physical assessments should be included within the additional neurological assessments, and

what additional skills are required for paramedics. Within current practice, neurological assessment of patients includes assessing limb weakness, strength and grip, level of consciousness, facial symmetry, pupillary response, blood glucose measurement, and mobility assessment (Blaber, 2021; JRCALC and AACE, 2021). Extended clinical assessments require consideration of the paramedic scope of practice, with Jarva et al. (2021) identifying that some additional stroke assessments require strong clinical competency. Any assessments included for improved PCS detection must align with current paramedic skills or be deemed appropriate for the paramedic scope of practice and would require increased education for paramedics to improve understanding of the altered neurological anatomy and physiology of PCS patients.

Krishnan et al. (2019) examined the accuracy of 'HINTS' examination for the assessment of patients presenting with vestibular symptoms associated with PCS. With dizziness, vertigo symptoms, and ataxia, commonly found with PCS, the 'HINTS' examination assesses nystagmus, head impulse, and skew deviation of the eyes. This assessment was deemed to improve the accuracy of PCS detection, however, for seriously ill, highly nauseated patients, or those with severe neurological deficits, the 'HINTS' examination would be difficult to perform. Furthermore, this tool is primarily used within the in-hospital setting and performed by senior specialist physicians with neuro-ophthalmology training due to the specialist techniques required, therefore not appropriate for the pre-hospital setting.

Similarly, Alemseged at al. (2022) included the assessment of ataxia, visual acuity, nystagmus, dysphagia, and tongue deviation. The additional assessments to

the ‘NIHSS’ stroke scale demonstrated improved prognostic accuracy of PCS. However, this assessment tool was produced for in-hospital assessment, where specialist training in dysphagia and oral examination is standard, alongside radiological imaging. Upon reflection, several of the assessments included in ‘HINTS’ and ‘NIHSS’ would require in-depth specialist training and expertise that is beyond the scope of practice for paramedics and if implemented would greatly increase on-scene assessment. Furthermore, these tools would require extensive staff education and training to be used correctly. However, pupillary constriction and visual acuity assessment could be readily conducted by paramedics with limited additional training required.

Rowe et al. (2020) included an additional two-minute vision test to ‘FAST’ noting reading ability, eye position and movement, visual field assessment, and visual extinction assessment. Similarly, Huwez and Casswell (2013) utilised the assessment of blindness, diplopia, and pupillary abnormalities, plus an assessment of ataxia. According to the study’s findings, 83% of the patients with additional examinations were diagnosed with stroke, compared to 66% with 'FAST' alone. Aroor et al. (2017) study included the assessment of gait imbalance, visual acuity, and pupillary abnormalities, noting an improved recognition of acute stroke, due to the identification of vestibular symptoms associated with PCS. However, limitations were noted within each of these studies, it was concluded that the vision test had limited specificity due to false positives and were unable to determine whether the visual deficits were new visual presentations (Aroor et al, 2017; Huwez and Casswell, 2013). The overarching conclusion from the evidence located suggests that adding visual and ataxia assessments alongside ‘FAST’ could be readily applied to patients within the pre-

hospital setting, noting reading ability, eye movement, and visual field assessment for improved PCS detection.

The studies discussed above provide confidence in applying additional assessments within the pre-hospital field, concluding that the assessment of gait, visual acuity, and pupillary constriction could be incorporated into the existing FAST screening tool structure for improved detection of PCS. There may be a small extension to on-scene time, yet this needs to be balanced with the benefits of improved PCS detection. It is foreseen that these physical assessments will not require any major deviation from current paramedic skills and remain within the paramedic scope of practice.

Review limitations

This review's limitations include the author's interpretation and decision-making regarding the included material, data abstraction, critical analysis, and synthesis for evaluation. Additionally, since this is not a systematic literature review, there may be other primary evidence not sourced within the searching process.

Conclusion

The evidence examined demonstrates a gap in practice, whereby a combination of a lack of education coupled with poor understanding of PCS is affecting pre-hospital PCS detection. Further assessments of balance and eyes, alongside the validated 'FAST' stroke screening tool, could improve paramedic detection of PCS and the inclusion of gait assessment, visual acuity and pupillary constriction would sit

within the current paramedic scope of practice. Further research is needed into this topic with regards to the education requirements for paramedics, and the formulation and implementation of a new pre-hospital stroke screening tool for improved PCS detection.

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