ORIGINAL SCIENTIFIC PAPER

SYSTEMATIC REVIEW

Diagnosis and management of transient ischemic attacks in primary care: a systematic review

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ABSTRACT

INTRODUCTION: Many patients who suffer a transient ischaemic attack (TIA) present to their general practitioner (GP). Early identification and treatment reduces the risk of subsequent stroke, disability and mortality.

AIM: To review the accuracy of TIA diagnosis in primary care, immediate management and interventions to assist GPs with the condition.

METHODS: This study included the search of Medline, Embase, Web of Science and Scopus databases (1995–2015). Relevant titles and abstracts were obtained using structured criteria (diagnosis, immediate management or intervention of TIAs in primary care), with full review and data extraction for eligible publications.

TWO reviewers independently assessed quality and extracted information from the 24 eligible studies. The studies had heterogeneous methodology rendering meta-analysis inappropriate, so a narrative synthesis was undertaken.

RESULTS: Most studies found limitations in GPs' knowledge and ability to diagnose TIAs to varying extent over time and between countries. GPs tended to over-interpret non-specific symptoms (e.g. isolated vertigo) when considering a TIA diagnosis. Reported referral behaviour varied between countries, with some favouring admission and others preferring outpatient management. Consistent under-referral and under-use of effective medication was reported. However, GPs may refer some patients to exclude rather than confirm a final diagnosis. This, alongside evidence of under-referral, suggests the need for education and decision support tools to enhance referral patterns. Intervention studies suggested that electronic decision support may increase referrals and timely management.

CONCLUSION: This review revealed deficiencies in knowledge and clinical practice, and identified potential avenues to addressing these. Issues for future research were also identified.

KEYWORDS: TIA; diagnosis; management; primary care; systematic review

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Introduction

Transient ischaemic attacks (TIAs) are defined as temporary episodes of focal brain dysfunction of presumed vascular aetiology, lasting <24 h, with no evidence of cerebral infarction.[1] Several conditions may mimic a TIA, including migraine, partial seizure, vestibular disorders, syncope, intracranial lesions and psychogenic illness.[2]

Precise estimates of TIA incidence are difficult to determine, mainly due to the varying criteria used to identify a TIA. Despite this, many studies have attempted to provide reliable data on the

true incidence of TIA in several countries. The annual incidence of TIA in the UK is estimated at 0.51 per 1000 population,[3] 0.80 in Spain,[4] 0.37–1.1 in the United States (US)[5] and 0.40 in New Zealand.[6]

Accurate diagnosis is important, as the early identification and treatment of TIA substantially reduces patients' risk of subsequent stroke and consequent disability and mortality.[7] Additionally, in France, it was reported that early assessment and management of TIA and minor stroke resulted in ~80% reduction of recurrent stroke at 3 months from initial TIA.[8]

In England and Wales, the National Institute of Health and Care Excellence guidelines recommend that TIA patients at high risk of stroke should be seen within 24 h, and lower risk cases within a week. New Zealand guidelines also recommend that patients at high stroke risk should be assessed by a specialist and all investigations completed within 24 h.[9] The European guidelines recommend that patients with suspected TIA should be referred without delay (preferably within 48 h) to a TIA clinic or to a stroke unit where expert evaluation and immediate treatment can be provided.[10]

In Italy, timely hospital referral of a recent (within 1 week) TIA is advised, and hospital admission is generally recommended if duration of symptoms is >1 h.[11] However, despite the establishment of 'rapid access' clinics, these targets are not being achieved[12] due to the lack of capacity for clinics to assess the high number of referred patients, over half of whom are eventually confirmed not to have had a stroke or TIA.[2,13] This suggests that general practitioners (GPs) could be more selective when referring patients to specialist services.[14]

There is some evidence that GPs may under-use medication such as aspirin, which could reduce the early risk of stroke.[15] Furthermore, under-use of medication (aspirin and statins) is an issue associated with most cardiovascular health-related problems in New Zealand, as prescribing often does not appear to be guideline-based.[16] A comparison of European and Japanese guidelines found that recommended doses of antiplatelet medicines, especially aspirin and ticlopidine, are lower in Japan.[17]

WHAT GAP THIS FILLS

What is already known: Patients suspected of suffering from a TIA are at increased risk of recurrent stroke, and are therefore recognised as medical emergencies requiring urgent evaluation and treatment to reduce the risk of recurrent stroke. Several studies have shown GPs find it difficult to diagnose and manage suspected TIA patients.

What this study adds: This is the first systematic review to synthesise the literature on the diagnosis and management of TIA in primary care and to obtain a comprehensive account of current knowledge on the topic. It confirms that GPs have difficulties making the diagnosis and that many patients who could benefit from specialist assessment are not referred. Conversely, only approximately half of patients referred to specialist clinics have the diagnosis confirmed. There is evidence that electronic decision support may improve referral practices.

The objectives for this study were, therefore, to review the diagnostic accuracy of TIA in primary care, review immediate management (including referral and medication) and identify interventions to assist GPs in the diagnosis and management of TIA.

Methods

Search strategy

Medline, Embase, Web of Science and Scopus databases were searched in September 2015. Search strategies were customised for each database (Appendix 1, available as Supplementary Materials at journal's website). Both medical subject headings (MeSH) and text words were used as search terms. Additional studies were identified by searching the references of included studies. The key terms were 'TIA', 'TNA' (transient neurological attack), 'general practitioner' and 'primary care'. Additional search terms were included to ensure that the search was sufficiently sensitive (Appendix 2, available as Supplementary material). The search was limited to the past 20 years (1995–2015) to exclude out-of-date practices and acknowledge rapid advances in TIA management (Appendix 2, available as Supplementary material).

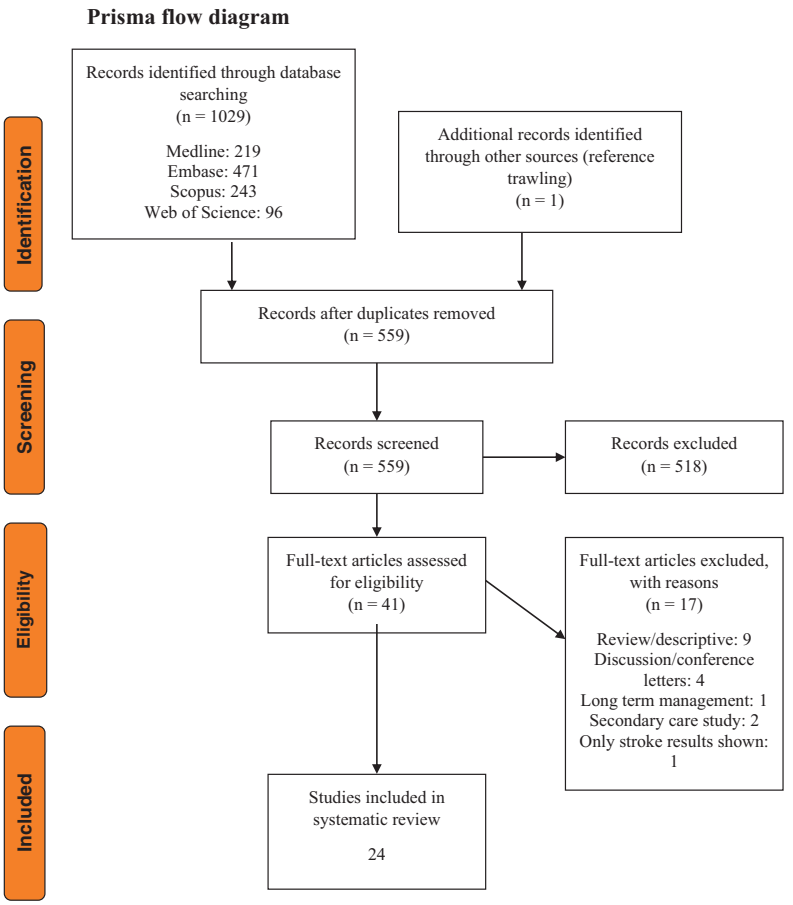
Inclusion and exclusion criteria

Published full-text, peer-reviewed journal articles reporting empirical studies and systematic reviews were included. There was no restriction on language or study design.

Exclusion criteria included papers restricted to stroke and long-term management, as well as editorials, letters, opinion pieces, conference abstracts, case reports and non-systematic reviews.

Participants were GPs, family doctors, family physicians (subsequently referred to as GPs) and patients with TIA presenting to primary care. Exclusions included paramedics, emergency department and secondary care physicians, and studies of long-term management or secondary prevention.

Figure 1. PRISMA flow diagram



Data extraction

The titles and abstracts of all publications were read and the eligibility criteria were applied by PB and AW. If titles and abstracts had insufficient information to apply the criteria, the full text was obtained. The search process is shown in Figure 1.

A standard data extraction form was used (Appendix 3, available as Supplementary material). Studies used a range of methods and instruments so meta-analysis was inappropriate and a narrative synthesis was undertaken.

Quality assessment

The methodological quality of each study was assessed using the Mixed Methods Appraisal Tool[18] (Appendix 4, available as Supplementary material). Two review authors assessed the methodological quality independently and resolved disagreements through discussion or with arbitration by a third author. The protocol was registered on Prospero on 08 January 2016 (registration number: CRD42016032995).

Results

Of the 1029 papers identified, 24 were included, as shown in Figure 1. Table 1 shows the countries where the research was conducted, and Figure 1 shows the reasons for excluding papers. Included studies were categorised according to the categories shown in Box 1: knowledge-based

Table 1. Number of included studies, by Country

Country	Number of studies
Australia	4
Egypt	1
France, Spain, Italy, United States and Germany	1
Germany	1
Netherlands	1
New Zealand	4
Poland	2
Spain	1
United Kingdom	7
United States	2

studies (Table 2), actual practice studies (Table 3) and intervention studies (Table 4). There were three management subcategories: diagnosis and prognosis (4 studies), recognition of urgency (16 studies) and immediate prescription or preventive medication (6 studies). Several studies contributed to more than one subcategory (Appendix 5, available as Supplementary material).

Box 1. Three main categories of research

Knowledge or reported practice	Actual practice	Intervention studies
These studies used questionnaires or case vignettes administered by post or telephone	Methods included cohort studies recruited in secondary care and a general practitioner database study	Studies included intervention development, and observational and interventional designs

Diagnosis and prognosis

Data from four studies indicated variable awareness among GPs about the traditional definition of TIA symptom duration (<24 h): 100% (40/40 GPs) in the UK,[19] 90% (124/138) in Spain[20] and 63% (60/95) in Egypt.[21] In the US, 57% (114/200) thought symptoms of longer duration were compatible with TIA diagnosis.[22]

There was generally high awareness that TIA was a risk factor for a subsequent stroke,[23] but variable knowledge of the magnitude of risk.[20,24] Diagnostic accuracy was also variable. In surveys presenting typical cases, the proportion correctly identified with TIA was 62% in 2003,[22] 76% in 2013[25] and 100% in 2008 and 2012.[19,24] GPs were more likely to diagnose TIA in patients with known risk factors and in the elderly.[26] Several studies found that GPs tended to consider a diagnosis of TIA when symptoms were non-specific. For example, isolated vertigo was considered a possible symptom by 75% (30/40) of GPs in the UK,[19] 47% (94/200) in the US,[22] 37% (35/95) in Egypt[21] and 34% (47/138) in Spain.[20]

Real world accuracy of TIA diagnosis is difficult to assess. The most direct assessment used a UK GP database in 2001 to identify patients with a new diagnosis of TIA.[27] In a sample of 27 cases, the medical record was reviewed by a specialist, who diagnosed TIA in 13 (48%) and stroke in five (19%), giving a cerebrovascular diagnosis in 18 (67%). The most common non-TIA diagnoses were cardiac dysrhythmia, postural hypotension and 'psychological'. In a 2014 Australian study, 120 GP-diagnosed TIA cases were reviewed by an expert panel, who concluded that 49 (41%) had a cerebrovascular diagnosis; the most common other diagnosis being migraine. This study also found that assessment of absolute cardiovascular risk did not improve diagnostic accuracy.[28]

Three studies examined the proportion of patients referred to TIA (or similar) clinics who had a diagnosis of TIA or stroke confirmed. The GP database study found that only 19% of patients with new TIA diagnoses were referred in 2001.[27] In an Australian study of 127 patients referred with possible TIA, 23% were confirmed with TIA, 17% with stroke, 50% non-stroke and 10% were unclassified.[29] In a smaller UK study, a diagnosis of TIA was confirmed in two of four patients.[30] As part of assessing the Dawson score,[31] all referrals to a vascular clinic from nine practices in the UK were examined and 41% (209/513) had a diagnosis of TIA confirmed.[32]

Recognition of urgency

Case vignettes and surveys reported variation in admitting patients with TIA as medical emergencies. In Spain, 78% (107/138) of GPs would send TIA patients to hospital.[20] In Egypt, 34% (32/95) of GPs referred TIA patients as emergencies, while 27% (26/95) referred patients to hospital if they had a TIA history.[21] In Germany, 85% (335/395) of GPs classified TIA as an emergency and 33% (132/395) would admit patients.[33] In the UK, a study using vignettes found that GPs would not refer 22–40% of TIA cases.[25] An earlier UK survey found that median reported referral rates were 50%, with substantial variation between GPs.[34] Similar rates were reported in Poland.[35] Several surveys found that referral decisions were affected by symptom and patient characteristics, especially age.[19,26,35,36]

Two studies surveyed reasons for outpatient management and barriers to admitting stroke or TIA patients. In a German survey, 33% (133/395) of GPs chose outpatient management because of perceived lack of therapeutic benefit from hospital admissions, and 37% (147/395)

Table 2. Knowledge-based studies

Reference	Country	Methods and Aim	GP details	Key findings	Type of study MMAT score	Diagnosis (D) Referral ® Prescription (P)
Mead *et al.* (1996)[34]	United Kingdom	Cross-sectional survey: questionnaire. Aim: to assess how GPs manage patients at risk of TIA/stroke.	Setting: all GPs in Greater Manchester. Response rate: 294/640 (46%). Sample: 294 GPs.	Median percentage of patients referred to a specialist: 50% (range 0–100%) 188 GPs (64%) would refer to general physicians 175 (60%) to geriatricians 65 (22%) to vascular surgeons 290 GPs (99%) would commence aspirin	Quantitative (non-randomised) 67%	R & P
Wiszniewska *et al.* (2000)[35]	Poland	Cross-sectional survey: questionnaire. Aim: to assess GPs management of TIA/stroke.	Setting: all GPs practicing in four cities in Poland. Response rate: 159/300 (53%). Sample: 159 GPs. Age: 27–66 years (average age: 42.2 years).	GPs would refer 50% of patients.65% were referred if they had speech problems. 64% of doctors referred patients with motor impairments. 54% of doctors referred patient with vision impairment. 11% of GPs did not refer patients who already had a TIA. 16% of doctors prescribed antiplatelet therapy. 21% prescribed vitamin B. 55% prescribed sedative drugs.	Quantitative (non-randomised) 67%	R & P
Middleton *et al.* (2003)[23]	Australia	Cross-sectional survey: questionnaire. Aim: to examine GP knowledge about TIA/ stroke and risk factors.	Setting: practicing GPs from New South Wales, Australia. Response rate: 296/490 (60%). Sample: 208 Male (70%); 88 Female (30%). Age (median): 47 years (range: 28–81years).	34 of GPs (12%) correctly estimated the risk of stroke. 279 (94%) of GPs correctly identified modifiable stroke risk factors. GPs responding highly likely (54%); 32% responded somewhat unlikely to prescribe aspirin.	Quantitative (non-randomised) 100%	D & P
Nguyen-Huynh *et al.* (2003)[22]	United States	Cross-sectional survey: structured telephone interviews. Aim: to assess knowledge and reported management of TIA by primary care physicians (PCPs).	Setting: PCP in continental US. Sample: 200. Response rate: 1289/2978. Gender: 185 (93%) male. Years in practice (s.d.): 20 (11). Patients seen monthly: 457 (243). TIA patients seen monthly: 14 (17).	Correctly identified five TIA symptoms: 44 (22%). Only 86 (43%) recognised that TIA symptoms should resolve within 24 h. Correctly diagnosed: 62%. Incorrectly identified vertigo as a symptom: 47%. 98–100% was aware of risk factors. Referred to neurologist: 37% GPs.	Quantitative (non-randomised) 67%	D & R

Table 2. (Continued)

Tomasik *et al.* (2003)[26]	Poland	Cross-sectional survey: case vignettes, written questionnaire. Aim: to assess the competence of Polish (PCPs) in diagnosing and managing patients with TIAs. Also, to assess the effect of age and type of TIA (mono-ocular blindness vs. hemispheric) on management.	Setting: one healthcare district of Warsaw. Response rate: 89/100 (89%). Sample: 89 GPs; 75% female. Age (Mean, s.d.): 43 (12). Years in practice: 17.	63 (71%) GPs made correct diagnosis of Monocular blindness. Hemispherical ischaemia 52 (58%). No significant difference was found. For hemispheric ischaemia, correct diagnosis was more likely if the patient was aged >65 years (86, 97%) than <65 years (74, 87%). More GPs would refer patients to a neurologist with symptoms of hemispheral ischaemia than with monocular blindness: 61 (70%) vs. 31 (35%) $P \leq 0.05$.Antiplatelets given in 7% of monocular blindness and 8% of hemispheral ischaemia.	Quantitative (non-randomised) 100%	D, R & P
Roebers *et al.* (2007)[33]	Germany	Cross-sectional survey: PCPs current practice, five case scenarios. Aim: to assess PCP attitudes and practices of suspected stroke patients and influences on decisions to admit patients with stroke symptoms.	Setting: all PCP in four regions of North Rhine-Westphalia, Germany. Response rate: 395/714 (55%). Sample: 395 GPs. Number of stroke patients/year in practice: 0–5: 88 (22%) 6–10: 109 (28%) 11–20: 97 (25%) >20: 69 (18%)	85% (335/395) classified TIA as an emergency. 132/395 (33%) of PCP would admit patients. Reasons for outpatient management:severe co-morbidities (36.7%). Lack of therapeutic consequences of hospital admission (32.9%).	Quantitative (non-randomised) 67%	R
Jagadesham *et al.* (2008)[19]	United Kingdom	Cross-sectional survey: postal questionnaires. Aim: to assess GPs and hospital trainees' knowledge about TIA management.	Setting: General Royal Infirmary, Leeds. GPs sampled from trust database. Response rate: 40/60 GPs (66%).	All GPs correctly identified that TIA was an abbreviation for a transient ischaemic attack, and that this lasted < 24 h. Risk of stroke underestimated: 23% of GPs. GP considered vertigo (75%) and confusion (70%) to suggest a TIA. 20% would refer patients with motor or sensory deficits. 22–40% of TIA patients would not be referred by GPs. All drs were more likely to prescribe antiplatelet therapy with monocular visual loss. GPs less likely to initiate antiplatelets or statins than medical specialist registrars ($P < 0.01$). 5–10% of GPs thought a carotid duplex ultrasound following a TIA was appropriate investigation and were likely to request blood tests ($P < 0.05$).	Quantitative (non-randomised) 100%	D, R & P

(Continued)

Table 2. (Continued)

Reference	Country	Methods and Aim	GP details	Key findings	Type of study MMAT score	Diagnosis (D) Referral ® Prescription (P)
Purroy *et al.* (2011)[20]	Spain	Cross-sectional survey: questionnaire. Aim: to assess the knowledge of doctors in primary care centres about TIA (definition, symptoms, diagnosis, management and risk of recurrence).	Setting: all medical staff in 24 primary care centres in one health area of Spain. Response rate: 138/258 (53%). Sample: 138 GPs.Gender: 81 (59%) female.Age (s.d.): 43 (8.4) years.	124 (90%) GPs correctly identified the definition of TIA: 43 (31%) answering <1 h 81 (59%) answering <24 h. 59 PCPs (43%) recognised the risk of stroke recurrence. 65 (47%) suggested the risk to be the same as for an established stroke, 59 (43%) said the risk > stroke and 14 (10%) suggested the risk was < stroke. Low awareness of visual symptoms: (94, 68%). Isolated vertigo incorrectly listed as symptom: 47 (34%)Referral to ED: (108, 78%)	Quantitative (non-randomised) 75%	D & R
Edwards *et al.* (2012)[39]	United Kingdom	Qualitative: face-to-face interviews with GPs. Aim: to understand how GPs use the ABCD2 sore.	Setting: UK (West Mids and Cambs) area, recruited from mailing lists of local research networks. Sample: Nine GPs (6 used the score).	Score used in multiple ways, beyond its original remit. Seen as boundary object to facilitate communication between GP and hospital. Used for evaluation and swift referral, as a diagnostic and prognostic tool and for educating GPs and patients.Some GPs unaware of score and thought it was unnecessary.	Qualitative 75%	R
Jackel *et al.* (2012)[40]	France, Spain, Italy, US, Germany	Cross-sectional survey: telephone interviews. Aim: to identify global trends in the current clinical pathways underling the management of patients with TIA.	Setting: primary care group practices in France, Germany, Italy, Spain, UK and US working in group practices of at least two (Europe) or five (US) physicians.Sample: 24 GPs. Europe = 20, US = 4. Years qualified (mean): Europe: 17 (5–25)US: 21 (14–25) Number of patients with TIA per month, mean (range): Europe: 6 (3–20) (*n* = 18) US: 34 (10–50)	In US, different medications were prescribed according to risk level, unlike UK, France and Germany.	Quantitative (non-randomised) 100%	P

Table 2. (Continued)

Leung *et al.* (2012)[24]	Australia	Cross-sectional survey: questionnaire. Aim: to identify GP knowledge of TIA assessment, and management and perceived barriers to tailor GP education.	Setting: GPs (Adelaide Western general practice network). Response rate: 32/202 (16%). Sample: 16 (52%) female. Years in practice: 0–10: 4 (13%) 11–20: 11 (36%) 21–30: 10 (32%) 31–40: 4 (13%) > 41: 2 (7%)	All (*N* = 32) correctly identified early risk of stroke and made correct diagnosis. Barriers to effectively manage potential TIA cases were: 13 identified difficulty accessing neurological expertise or acute stroke units (41%). Six lack of knowledge by GPs (19%). Five lack of consultation time (16%).15/32 (47%) correctly responded to anti-hypertensive treatment. 20/32 (63%) correctly responded to managing hyperlipidaemia.	Quantitative (non-randomised) 67%	D, R & P
Ismail and Negm (2013)[21]	Egypt	Cross-sectional survey: structured interview questionnaire. Aim: to assess knowledge and practices of primary care physicians on TIA.	Setting: primary health care physicians in Ismailia Governorate. Response rate: 95/130 (73%). Sample: 53.7% female.	21% identified duration of symptoms of TIA (within 1 h).42% defined (within 24 h).37% answered incorrectly.35% chose symptoms not consistent with TIA: 38% isolated hand numbness 37% isolated vertigo33.7% referred as emergencyPatient with history of TIA: 27% referred to hospital. 86.3% referred to neurologist. 14% did not refer. 57% antiplatelet therapy. 22% anti-coagulants. 26% inappropriate treatment (brain stimulants/anti-oxidants). 2% no prescribed treatment.	Quantitative (non-randomised) 100%	D, R & P
Ranta and Cariga (2013)[25]	New Zealand	Case vignettes. Aim: to assess guideline adherence and the potential role of software (EDS tool) to support referral to specialist.	Setting: GPs, general physicians, stroke specialists.Sample: 10 GPs, 12 physicians; 12 stroke specialists.	Stroke specialist care achieves higher guideline adherence than GPs and general physicians;GP diagnostic accuracy 76% (45–100%) vs. general physician accuracy 79% (33–100%). 15 (5%) made a cardiology referral.Similar rates when recommending antiplatelet, statins and antihypertensive treatment between GP and general physicians was found: (27% and 31%) compared with stroke specialists (92%).	Quantitative (non-randomised) 75%	D, R & P

GPs (general practitioners); TIA (transient ischaemic attack); MMAT (mixed-methods appraisal tool); PCPs (primary care physicians); ABCD2 (age, blood pressure, clinical features, duration and diabetes).

because of severe co-morbidities in patients.[33] In Australia, 19% (6/32) of GPs suggested lack of knowledge and 16% (5/32) lack of time in consultations as barriers to referral.[24]

The specialist to whom patients with TIA were referred differed between countries. In the Netherlands, most GPs would refer to a neurologist,[36] in the US and New Zealand a cardiologist or neurologist,[22,25,37] and in the UK, a physician, geriatrician or vascular surgeon.[34]

A qualitative study in the UK examined GPs' views of the ABCD2 score in influencing referrals.[38] Although GPs liked the score as a '*substantial means to navigate the referral system*',[39] the score was used beyond its original remit (as a diagnostic, prognostic and educational tool for GPs and patients) and has been criticised with regards to disagreement between referred and specialist ABCD2 scores.[39]

Only two studies examined actual referrals from general practice. An Australian cohort study found that 36% of TIA suspects were referred to an emergency department or clinic.[28] The UK GP database study (conducted from 1992 to 1996) showed that only 19% of TIA cases were referred.[27]

Immediate prescription or preventive medication

In the US, GPs prescribe according to patients' risk level, unlike in the UK, France and Germany.[40] In the UK, GPs were more likely to prescribe anti-platelet therapy with monocular visual loss than other symptoms ($P = 0.03$).[19] Patient factors associated with medication use were: age over 65 years; antiplatelet use; 7% of cases of monocular blindness versus 8% of hemispherical ischaemia; and prescription of peripheral vasodilators.[26]

Studies of actual practice confirmed under-use of effective medication. In the US, an audit of medical records found 47% of patients with TIA who were not hospitalised or with no diagnostic test performed were prescribed antiplatelet therapy.[37] In the Netherlands, a study asking GPs how they managed their last patient with TIA found 74% received aspirin,[36] and a UK database study found that prescription rates within 7 days of onset of TIA were 38% for antiplatelet and 1.3% for anticoagulants.[27] Further details of medication use by country are shown in Table 5.

Intervention studies

A UK trial included 76 general practices examining the effect of guidelines to manage TIAs.[41,42] It found that guidelines led to a non-statistically significant increase in referrals of patients with confirmed TIA, but had no effect on prescribing antiplatelets (odds ratio (OR) 0.9 (95% CI 0.4, 1.8) $P = 0.714$).[41,42]

Three studies examined the electronic decision support that aids GPs to accurately diagnose and manage TIA and stroke patients in accordance with the New Zealand guidelines.[43–45]

A prospective study of the effect on process of care following the implementation of electronic decision support reported significant increases in the rate of initiating best medical therapy and behavioural counselling; for example, smoking cessation, diet, exercise and driving.[44] The study also reported that the median time to a specialist review was 3 days (intervention) and 4 days (control). The main trial reported that the decision support tool improved guideline adherence and may reduce risk of a subsequent event (stroke, TIA, vascular event or death).[45] In an audit of the electronic decision support tool, no safety issues were found.[43]

The Dawson score was developed in secondary care and is the only published diagnostic tool for diagnosing TIA.[31] It includes nine variables: age, history of stroke or TIA, and presence of seven clinical features (headache, loss of consciousness, seizure, diplopia, speech disturbance, unilateral facial and limb weakness). Its potential for use in primary care was tested in patients referred to a TIA clinic by comparing the score derived for primary care data with the score derived from hospital clinic data.[32] The score had greater accuracy in diagnosing TIA in specialist assessments than in primary care assessments. Both primary and secondary care scores had similar sensitivity in detecting a TIA (92.3% vs. 93.4%), but low specificity (29.3% vs. 18.1%). The authors

Table 3. Actual practice studies

Reference	Country	Methods/Aim	GP details	Key findings	Type of study MMAT score	Diagnosis (D) Referral (R) Prescription (P)
Otten *et al.* (1995)[36]	Netherlands	Cross-sectional survey: questionnaire. Aim: to determine rate of referral to a specialist, and factors predicting referral to a specialist.	Setting: all GPs in the area around the Academic Medical Centre in Amsterdam. Response rate: 308/464 (66%).Sample: 287 GPs, 21 excluded, 165 (57%) female.	Neurology referral: 136 (47%).Cardiology referral: 15 (5%).Younger and independent patients were more likely to be referred. Younger patient (OR 2.5; 95% CI 1.5–4.2). Independent in daily activities (OR 2.2; 95% CI 1.1–4.3).213/287 (74%) prescribed aspirin.	Quantitative (non-randomised) 100%	D & P
Goldstein *et al.* (2000)[37]	United States	Retrospective audit of medical records. Aim: to audit outpatient management of first TIA and stroke by Primary Care physicians.	Setting: GPs in 27 primary care practices in two communities in eastern US. Patients: first recorded TIA. Patients: 95.	2% of patients were admitted to ED for evaluation and treatment on the day of the index visit. 14% referred to a neurologist. 13% referred to a cardiologist.6% referred to vascular surgeonAntiplatelets given to 47% and 63% of patients who were not hospitalised or investigated.	Quantitative (non-randomised) 100%	R & P
Gibbs *et al.* (2001)[27]	United Kingdom	Incident examination of GP database (1992–96). Aim: to determine whether initial GP management of stroke and TIA was uniform across the UK and validity of diagnosis.	Setting: UK practices contributing to GPRD. Patients: new diagnosis of stroke and TIA (1992–96).Sample: 27 TIA cases, 25 stroke cases.	Of the GP diagnostic code for TIA in 27 cases, specialists agreed with a cerebrovascular diagnosis in 18 (66%) cases and confirmed as either a TIA or stroke. Of the 25 stroke cases, 20 (80%) were confirmed by a specialist as either a TIA or stroke. Mean 18.8% (range between regions 14–26) referral within 7 days of TIA diagnosis. Prescriptions within 7 days of TIA diagnosis: Antiplatelets: mean 38% (range between regions 30–45%). $P = 0.0008$. Anticoagulants: mean 1.3% (95% CI 0.72. 1.56) range between regions not given.	Quantitative (non-randomised) 100%	D, R & P
McNeill (2008)[30]	United Kingdom	Cross-sectional survey: to assess diagnosis the primary care history was compared to the admitting doctor notes. Aim: to assess the diagnostic accuracy of Primary Care Doctors (PCDs).	Setting: one UK TIA clinic.Referral letters of patients (for presumed acute stroke or TIA). Sample: 72 patients, 68 stroke, four TIA. Gender: 33 (45%) female.	17 (24%) cases examination differed between GP and admission examination (admitting doctor not detecting signs documented by GPs). 22 (30%) referral letters documented speed of onset. 20 (27%) cases where the presumed diagnosis of stroke was correct.Two (3%) cases where a TIA was diagnosed. Of four patients with a presumed diagnosis of TIA, two were diagnosed with TIA.	Quantitative (non-randomised) 50%	D

(Continued)

Table 3. (Continued)

Reference	Country	Methods/Aim	GP details	Key findings	Type of study MMAT score	Diagnosis (D) Referral (R) Prescription (P)
Magin *et al.* (2013)[29]	Australia	Retrospective cohort: all referrals from GPs and EDs first seen at the clinic. Aim: to establish paths to care and outcomes for patients referred by GPs and EDs to an Australian acute access TIA service.	Setting: secondary referral clinic in the Hunter New England Area Health Service, and the John Hunter TIA/minor stroke acute access clinic. Sample: 344 referrals; 300 attendees, 44 non-attendees. 127 referred by GP. 104 referred by ED. Age mean (s.d.) GPs: 64 (16). ED: 67 (14). Total: 65 (15).	231 patients were seen at a clinic: 121(52%) were diagnosed as TIA/stroke. Of the 127 GP referred pts: 21 (17%) stroke. 29 (23%) TIA. 13 (10%) unclassified. 64 (50%) not stroke. Sig prediction of receiving a final diagnosis of TIA/stroke were: higher ABCD2 score on antiplatelet or anticoagulant medication at clinic attendance.	Quantitative (non-randomised) 67%	D
Clarey *et al.* (2014)[28]	Australia	Prospective cohort analysis of patients presenting with possible transient ischaemic attack/minor stroke (TIAMS) or TIAMs mimic. Aim: to evaluate the absolute cardiovascular risk (ACVR) of patients with incident TIAMS and with TIAMS mimics.	Setting: 17 general practices in New South Wales, Australia. Sample: 87 TIAMS; 92 TIAMS mimics. Gender: Males 27 (39%) TIAMS mimics; 42 (61%). TIAMS:Other: 72 (40%) presented to ED. 68 (38%) managed in general practice.	Migraine most common TIAMS mimic reported in 27(29%). Motor symptoms and BMI predicted TIA diagnosis. 120 presented to GP. 68 (64%) exclusively managed in GP. 14 referred to ED. 39 (36%) referred to clinic/ED, Of the 106 not referred to ED, 44 (42%) assessed as TIAMS. Of the 14 referred to ED, five (36%) were assessed as TIAMS. 49 of 120 GP patients (41%) were assessed as TIAMS.	Quantitative (non-randomised) 67%	D & R

GPs (general practitioners); TIA (transient ischaemic attack); ED (emergency department); OR (odds ratio); CI (confidence interval); GPRD (general practice research database); PCD (primary care doctors); BMI (body mass index).

Table 4. Intervention studies

Reference	Country	Methods/Aim	GP and patient details	Key findings	Diagnosis (D) Referral (R) Prescription (P)
Wright *et al.* (2006, 2007)[41,42]	United Kingdom	Randomised controlled trial of diagnostic guidelines, randomisation by Primary Care Trusts.Aim: to evaluate effectiveness of guidelines to improve management of TIA.	Setting: GP practices in three Bradford Trusts. Sample: 76 general practices. Intervention: 43. Control: 33. Patients: Total = 375. Intervention: 230. Control: 145.	No statistically significant increase in referrals to the TIA clinic in intervention practice. Guideline adherence (antiplatelets), comparison of intervention and control (OR = 0.9, 95% CI: 0.4, 1.8, $P = 0.714$).	R & P
Lavin and Ranta (2014)[43]	New Zealand	Retrospective cohort:diagnostic tool: an electronic TIA/Stroke decision support tool.Aim: to assess the safety of a TIA/Stroke, the Electronic Decision Support tool was intended to aid GPs in the timely management of TIAs.	Setting: New Zealand general practices. Patients: managed using decision support tool from August 2009 – October 2010.Sample: 79 patients.	No evidence of harm due to use of tool. Admissions: 22 (28%). Among the 11 TIA/Stroke–related admissions, eight patients at high risk of stroke were immediately admitted to hospital via the EDS tool.Three patients were triaged by the EDS to less urgent outpatient assessment because of a low-risk assessment, or initial management, as recommended by the TIA/Stroke EDS tool, had no adverse outcome. No admissions for patients resulted when the EDS tool rejected a diagnosis of stroke.	D
Ranta *et al.* (2014)[44]	New Zealand	Before and after study of the effect on process of care of electronic decision support assisting TIA management in primary care.Aim: to assess TIA guideline adherence and patient safety, and to assess if EDS was associated with a safe reduction of avoidable delays.	Setting: patients referred to TIA clinic or inpatient care with diagnosis of TIA. Sample: patients Before EDS: 130. After EDS:139. Patient characteristics: baseline characteristics similar except more with IHD and fewer smokers in the before group.	Time to specialist review (median) intervention group: 3 days, control group: 10 days. Hazard ratio: 1.45 (95% CI 1.13, 1.86). Results for comparison between groups; best medical therapy within 24 h. Relative risk (RR): 1.33 (1.02, 1.71). P 0.04 and behavioural counselling: RR 1.68 (1.31, 2.16), $P < 0.0001$.	R & M

(Continued)

Table 4. (Continued)

Reference	Country	Methods/Aim	GP and patient details	Key findings	Diagnosis (D) Referral (R) Prescription (P)
Lasserson *et al.* (2015)[32]	United Kingdom	Cross-sectional study: clinical and research records used to populate the Dawson tool.Aim: to examine the potential utility in primary care of the Dawson Score to compare the performance of the Dawson Score in primary and secondary care.	Setting: all vascular events in 92,000 patients registered at nine general practices in Oxfordshire. Sample: 513/92,000 with TIA: 209. Non-vascular: 304. Mean age (years, s.d.): TIA: 73 (12.8). Non-vascular: 65.2 (1.6). *P* ≤0.001. % male: TIA: 42. Non-vascular cause: 47. Mean (s.d.) Dawson primary care score: TIA: 7.2 (1.2). Non-vascular: 6.3 (1.1). Mean (s.d.) Dawson secondary care score: TIA: 7.48 (1.3). Non-vascular: 6.01 (1.0).	209/513 (40.7%) Mean (s.d.) age: 68.5 (15.6) years had a final TIA diagnosis. Patients with TIA were older (73.2 years (12.8) vs. 65.2 (1.6)) and had a higher Dawson score (primary 7.21 (1.2) vs. 6.34 (1.1); secondary 7.48 (1.3) vs. 6.01 (1.0)). Dawson score more accurate in diagnosing TIA in specialist than primary care assessments; (c statistics 0.80 vs. 0.70 *P* < 0.0001) and performed poorly in primary care for detecting posterior circulation territory TIA. The cut-off point was 5.4. Both primary and secondary care scores had similar sensitivity in detecting TIA; 92.3% vs. 93.4%. Specificity was higher in secondary care scores; 29.3% vs. 18.1%.	D
Ranta *et al.* (2015)[45]	New Zealand	Diagnostic tool: multicentre, single-blind, parallel-group, cluster randomised, controlled trial comparing TIA/stroke electronic decision support with usual care.Main outcomes: guideline adherence and 90-day stroke risk. Secondary outcomes: cerebrovascular and vascular events, death.	Setting: General practices in 4 health districts of New ZealandPatients: presenting to GP with symptoms interpreted as stroke/TIA by the GP.Sample: 56 practices. 29 intervention. 27 control. Patients: Intervention: 172. Control: 119. Patient characteristics: Mean age 69.8 (I) 72.3 (C). No differences in demography, past history, medication history, ABCD2 score.	Tool improves guideline adherence and might reduce stroke risk stroke: 90-day TIA or stroke occurrence was lower in the intervention group, 4/172 (2.3%) compared to 10/119 (8.5%) control; adjusted OR: (0.26; 95% CI 0.70–0.97; *P* = 5 0.045). Fewer vascular events and deaths occurred in intervention (6/172 (3.5%)) than in control patients (14/119 (11.9%)); adjusted OR: (0.27; 95% CI 0.09–0.78; *P* = 5 0.016).	D

GP (general practitioner); TIA (transient ischaemic attack); OR (odds ratio); CI (confidence interval); EDS (electronic decision support tool); IHD (ischemic heart disease); ABCD2 (age, blood pressure, clinical features, duration and diabetes).

concluded that the score was of limited use in primary care, and that there was a need for a score derived from primary care data.

Discussion

This systematic review synthesises the evidence on the diagnosis and management of TIA in primary care. Most studies demonstrated significant knowledge gaps for TIA, although to varying degrees. Overall, there was no clear evidence of changes in diagnosis and management over time in the period examined, but the number of comparable studies was small. Most studies highlighted a need for more education on the specific symptoms of TIA. There is also consistent evidence that many patients who could benefit from specialist referral are not referred, and that only approximately half of referred patients have the TIA diagnosis confirmed. Further studies on decision support tools are needed to improve diagnostic and referral practices.

Diagnosis

Most studies found limitations in GPs' knowledge and abilities to diagnose TIA. Only one study attempted to validate all TIA diagnoses made by GPs, and this suggested the diagnosis was correct in approximately two-thirds of cases (although diagnostic agreement between specialists is not perfect).[46] One reason for overdiagnosis, suggested by questionnaires and case vignette studies, is that GPs tend to put emphasis on non-specific symptoms such as isolated vertigo.[19–22] It is difficult to infer much about diagnostic accuracy from studies examining patients referred to TIA clinics due to selection bias (inclusion of patients with higher clinical suspicion of TIA, and exclusion of patients not referred). Attempts to improve GP diagnosis have been limited. The Dawson score appears to be insufficiently specific, and although the electronic decision support tool improved management, its impact on diagnosis has not been reported.

Referral and management

Unsurprisingly, reported referral behaviour varied between countries, with no consistency in management strategies; some favour admission of high-risk cases[20,21,33] and others advocate outpatient management.[24,33] There is consistent evidence of under-referral in studies of reported and actual practice in Australia, United States, New Zealand, Netherlands and the UK. Only two studies examined actual referral rates. In the UK, this was found to be only 19%, but the study was conducted in the 1990s when the benefits of specialist intervention were not well recognised. In a smaller Australian study, 36% of TIA suspects were referred. In part, this apparently low rate could be because GPs have direct access to imaging, so management can be optimised without specialist assessment. More research is needed to investigate whether under-referral remains a problem in current practice.

Conversely, there is consistent evidence that approximately half of patients who are referred have a cerebrovascular diagnosis confirmed, and that in some countries, this militates against services reaching their target for assessing patients promptly. GPs may well refer some patients to exclude rather than confirm a putative diagnosis, but this finding, together with evidence of under-referral, emphasises the need for education and decision support tools to optimise referral patterns. The intervention studies included in this review suggested that electronic decision support may increase referrals and timely management.

Methodological issues

Most of the reviewed studies used questionnaires or case vignettes to examine GP practice. There are inherent limitations to this approach, including the validity of questionnaires and whether responses reflect actual practice. In the quality assessment tool we used, an adequate survey response rate was defined as ≥60%, which was achieved in five studies. The reason for low response rates in studies using telephone interviews may be due to the time-consuming method, in comparison to postal questionnaires. The overall response rates were higher in studies using case vignettes, suggesting that this approach is more acceptable than 'exam style' questions. Low response rates increase the risk of bias. Previous research has shown that in GP surveys, non-responders are more likely to be older, more experienced, solo practitioners, and

Table 5. Examples of medication use by country

Country	Year	Medication
UK	1996	99% (148/294) of GPs would consider aspirin.[34]
Poland	2000	16% (26/159) of GPs reported prescribing antiplatelets, but 20% (32/159) prescribed vitamin B and 55% (87/159) prescribed sedative drugs.[35]
Australia	2003	54% (160/296) of GPs were 'highly likely' to prescribe aspirin.[23]
Australia	2012	47% (15/32) GPs would start anti-hypertensive treatment. 63% (20/32) would manage hyperlipidaemia.[24]
New Zealand	2013	Used vignettes studies. Reported variability in terms of GPs prescribing medication; (27%).[25]
Egypt	2013	57% (54/95) of GPs would prescribe medication, with many prescribing inappropriate treatments.[21]

GP (general practitioner).

have fewer qualifications than responders.[47] It is likely that responders to surveys about TIA are more interested and have a higher awareness of the topic, which implies that our results overestimate GP knowledge and good practice.

A comprehensive search strategy including all languages and countries was applied. Papers from several countries were included, providing insight from different health systems. Additionally, both qualitative and qualitative study design was considered in the search strategy, and a quality tool applicable to all study designs was used.

A limitation was that the search terms focused on diagnosis. Thus, some papers about management, which did not include diagnosis, may have been missed. Additionally, it was difficult to differentiate between stroke and TIA in some studies that included both. However, both TIA and minor strokes have similar prognosis and management strategies, so it is reasonable to consider these together. Finally, some studies were old and predated current guidelines so may not reflect current levels of knowledge and practice. Perhaps future reviews should consider a shorter time interval in accordance with the rapid changes in knowledge and management of TIA.

Future research

This study has identified a need for further education and practical guidelines for GPs to improve knowledge and practice with respect to diagnosis, management and referral pathways. Although ABCD2 is often perceived as a tool to aid diagnosis, it was designed as a prognostic tool only. Its diagnostic utility has been studied and found inadequate to guide referral decisions.[32] Recent guidance in the UK now excludes risk stratification using this tool (updated in 2017).[12] Further work is needed to explore the potential utility of electronic decision support systems, building on initial work undertaken in New Zealand. This should include larger sample sizes and explore utility in other health systems.

A limitation of several studies that observed practice is potential selection bias. Therefore, there is a need to examine larger and more representative samples from primary care, which are now possible using routine GP databases.

There remains significant potential for the development of diagnostic tools for primary care, which should be derived and validated in primary care. A first step could be further work to assess the performance of the Dawson score using data collected in primary care. Since the completion of this systematic review, the diagnosis of TIA (DOT) score has been developed.[48] The relative merits and clinical utility of both scores deserves further prospective study using primary care data.

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