

**Temporal trends in EMS and general practitioner use for acute stroke following
Australian public education campaigns.**

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ABSTRACT

Background and purpose –The Australian Stroke Foundation ran annual paid advertising between 2004 and 2014, using the FAST campaign from 2006 and adding the message to call Emergency Medical Services (EMS) in 2007. In this study, we examined temporal trends in EMS use and referrals from general practitioners (GPs) in the Australian state of Victoria to evaluate the impact of these campaigns.

Methods –Using data from 33 public emergency departments (EDs), contributing to the Victorian Emergency Minimum Dataset (VEMD), we examined trends in ED presentations for 118,000 adults with an emergency diagnosis of stroke or transient ischaemic attack (TIA) between 2003 and 2015. Annual trends were examined using logistic regression using a pre-campaign period (January 2003-August 2004) as reference and adjusting for demographic variables.

Results - Compared to the pre-campaign period, significant increases in EMS use were seen annually between 2008 and 2015 (all $p < 0.001$, e.g. 2015 AOR=1.16 [95% CI: 1.10 to 1.23]). In contrast, a decrease was seen in patients presenting via GPs across all campaign years (all $p < 0.001$, e.g. 2015 AOR=0.48 [0.44 to 0.53]).

Conclusions - Since the Stroke Foundation campaigns began, a greater proportion of stroke and TIA patients are presenting to hospital by EMS and appear to be bypassing their GPs.

Since 2004, the Stroke Foundation has attempted to improve the Australian public's recognition and response to stroke through annual, educational, mass media campaigns – using the FAST (Face, Arm, Speech, Time) message since 2006.¹ Previous evaluations of these campaigns have found high public awareness of the campaigns, associated improvements in Australians' knowledge of stroke symptoms and increases in calls to emergency medical services (EMS) for stroke.^{1,2} However, whether these campaigns have changed behaviour in Australian stroke patients remains unknown.

The aim of this study was to explore the impact of the Stroke Foundation's campaigns through examining annual trends in emergency department (ED) presentations by EMS and via general practitioners (GPs) in the Australian state of Victoria.

METHODS

This retrospective, observational study used data from the Victorian Emergency Medical Dataset (VEMD) provided by the Victorian Department of Health and Human Services. The study was approved by the Monash University Human Ethics Committee. All data were fully anonymised, and no participant consent was required. Full details of the setting, data source, sample, campaigns and analysis are reported in the online supplementary material. The Stroke Foundation campaigns are detailed elsewhere¹, and are briefly described in Table I. The data used in this study is only available on request from the Victorian Department of Health and Human Services.

We received data for ED presentations to Victorian public hospitals between 2003 and 2015. Data was not provided for five speciality EDs, and one rural ED that did not contribute data for the whole study period. We included all adult (aged ≥ 20 years) ED presentations with VEMD diagnostic codes for stroke and transient ischemic attack (TIA).

We used multivariable logistic regression to examine the average annual trends following each campaign for the two main outcome measures: 1) ED presentations by EMS and 2) patients presenting to EDs via GPs. In the models, the pre-campaign period (January 2003 to August 2004) was used as the reference, for comparison to each campaign year and the calendar year of 2015 (no campaign).

RESULTS

Over the 13-year study period there were 14,997,732 emergency presentations to the 33 included EDs, with 140,068 (0.93%) VEMD diagnoses of stroke or TIA. Of these 118,000 (84%) met inclusion criteria (stroke n=73,607 and TIA n=44,393).

The demographics of the included cohort are given in Table II. The demographics of the cohort changed over the study period: with increases seen in those aged 45-64 years (22% vs. 26%) and those living alone (7% vs. 11%); and decreases in those aged 65 years and older (72% vs. 67%) and in residents of major cities (74% vs. 63%).

When compared to the pre-campaign period, EMS use significantly increased in stroke and TIA patients in every campaign year from 2008, the year after calling EMS was added to campaign materials. This effect remained constant between 2009 and 2014, with maximum gain seen when the FAST campaign featured visualisations, and continued in 2015 in which no paid campaign ran (Table 1 and Figure 1).

ED presentations via GP referral decreased over the study period, halving between 2003 and 2009, and then remained constant (Figure 1). Patients with TIA were more likely to present to ED via a GP (AOR=1.15 [1.10 to 1.20], $p<0.001$). On average, 26% of patients referred by GPs presented to hospital by EMS (29% in stroke and 20% in TIA), and this was seen to decrease over the study period (30% in 2003 vs. 18% in 2015, $p<0.001$).

Results of sensitivity analysis and full model results are given in the Online Supplementary Materials.

DISCUSSION

Across our population of almost 6 million people, changes over time were seen in EMS use and presentations via GPs in patients with an ED diagnosis of stroke or TIA. Specifically, EMS use significantly increased in years following the addition of the message to call EMS to the FAST campaign, and ED presentations via GPs decreased in the early campaign years when stroke was highlighted as a medical emergency. These effects were sustained in subsequent years and through 2015 when no campaign ran.

Our findings support our previous studies of the Stroke Foundation's Australian campaigns, which showed increased symptom knowledge¹ and calls to EMS for stroke.² International stroke campaigns have showed mixed impact on EMS use.³⁻⁵ However, many of these studies reported unadjusted changes, were not population-based, did not measure the awareness of the campaigns in their region and examined only one campaign. Two population-based studies evaluating the United Kingdom FAST campaign reported similar changes in EMS⁶ and GP use^{6,7} to our results.

The lack of EMS use in patients presenting from their GPs requires further study. A high proportion of these patients are probably minor strokes and TIAs, who tend to report lower rates of "FAST" symptoms and may misinterpret the cause of their symptoms.⁸ However, whether these patients require an emergency response is unknown. Given the risk of recurrent stroke⁹, careful triage by GPs is required. The development of TIA clinics may explain some of changes seen in ED presentations via GPs in our study. However, GP referrals to TIA

clinics in our region are low¹⁰ and due to waiting times for appointments are not suitable for acute patients.

Our study suggests that improvements in health-seeking behaviour for stroke symptoms are possible with public education. We believe the sustained effect seen in our population relates to the regularity of the campaigns, as well as the continued use and simplicity of the FAST message. There have also been modifications to symptoms descriptions and visualizations to aid recall.¹ However, our data suggests the campaigns may have reached a ceiling, and new methods may be required for further improvements. While the trends seen in our data were also seen across different demographics, future interventions need to concentrate on groups who do not call EMS; namely younger adults, those residing outside metropolitan regions, and those from non-English speaking backgrounds. It may be possible that subsections within these demographic groups may not relate to the advertising or the FAST message itself. For example, the FAST message may be lost on residents from countries with other alphabets.¹¹

Due to restricted funding, paid Australian campaigns have not run since March 2014; and although the effects were sustained throughout 2015, there may be a need to examine their long term effectiveness in the future.

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Conflict of interest

JEB and CB have provided in-kind consultation to the Stroke Foundation.

REFERENCES

1. Bray JE, Johnson R, Trobbiani K, Mosley I, Lalor E, Cadilhac D. Australian public's awareness of stroke warning signs improves after national multimedia campaigns. *Stroke*. 2013;44:3540-3543.
2. Bray JE, Straney L, Barger B, Finn J. Effect of public awareness campaigns on calls to ambulance across australia. *Stroke*. 2015;46:1377-1380.
3. Denti L, Caminiti C, Scoditti U, Zini A, Malferrari G, Zedde ML, et al. Impact on prehospital delay of a stroke preparedness campaign: A sw-rct (stepped-wedge cluster randomized controlled trial). *Stroke*. 2017;48:3316-3322.
4. Mikulik R, Goldemund D, Reif M, Brichta J, Neumann J, Jarkovsky J, et al. Calling 911 in response to stroke: No change following a four-year educational campaign. *Cerebrovasc Dis*. 2011;32:342-348.
5. Chen S, Sun H, Zhao X, Fu P, Yan W, Yilong W, et al. Effects of comprehensive education protocol in decreasing pre-hospital stroke delay among chinese urban community population. *Neurol Res*. 2013;35:522-528.
6. Wolters FJ, Paul NL, Li L, Rothwell PM, Oxford Vascular S. Sustained impact of uk fast-test public education on response to stroke: A population-based time-series study. *Int J Stroke*. 2015;10:1108-1114.
7. Flynn D, Ford GA, Rodgers H, Price C, Steen N, Thomson RG. A time series evaluation of the fast national stroke awareness campaign in england. *PLoS One*. 2014;9:e104289.

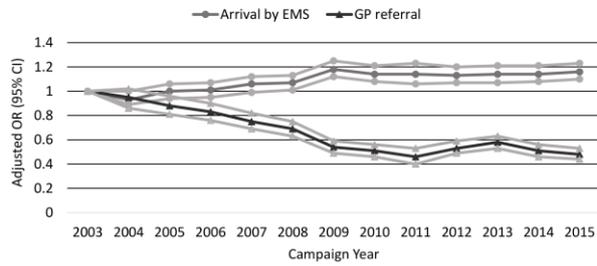
8. Wilson AD, Coleby D, Taub NA, Weston C, Robinson TG. Delay between symptom onset and clinic attendance following tia and minor stroke: The beats study. *Age Ageing*. 2014;43:253-256.
9. Amarenco P, Lavallee PC, Labreuche J, Albers GW, Bornstein NM, Canhao P, et al. One-year risk of stroke after transient ischemic attack or minor stroke. *N Engl J Med*. 2016;374:1533-1542.
10. Lee W, Frayne J. Transient ischaemic attack clinic: An evaluation of diagnoses and clinical decision making. *J Clin Neurosci*. 2015;22:645-648.
11. Zhao J, Eckenhoff MF, Sun WZ, Liu R. Stroke 112: A universal stroke awareness program to reduce language and response barriers. *Stroke*. 2018;49:1766-1769.

FIGURE LEGEND

Figure 1. Adjusted annual EMS use and referrals from GPs for each campaign year in patients with VEMD diagnoses of stroke and TIA (odds ratios and 95% CIs).

Table 1: Adjusted odd ratios for arrival by EMS and referrals via general practitioners (GPs).

Year Advertising dates	Arrival by EMS		Referral via GPs	
	AOR (95% CI)	P value	AOR (95% CI)	P value
2004 Missing Out	0.94 (0.89 to 1.00)	0.07	0.94 (0.86 to 1.02)	0.13
2005 18 September- 31 October	1.00 (0.94 to 1.06)	0.92	0.88 (0.81 to 0.96)	0.004
2006 17 September- 30 October	1.01 (0.95 to 1.07)	0.68	0.83 (0.76 to 0.90)	<0.001
2007 16 September- 28 October	1.06 (0.99 to 1.12)	0.07	0.75 (0.69 to 0.82)	<0.001
2008 14 September- 22 November	1.07 (1.01 to 1.13)	0.02	0.69 (0.63 to 0.75)	<0.001
2009 13 September- 15 November	1.18 (1.12 to 1.25)	<0.001	0.54 (0.49 to 0.59)	<0.001
2010 5 September- 10 October	1.14 (1.08 to 1.21)	0.001	0.51 (0.46 to 0.56)	<0.001
2011 2-23 October	1.14 (1.06 to 1.23)	<0.001	0.46 (0.40 to 0.53)	<0.001
2012 4-24 March 7-28 October	1.13 (1.07 to 1.20)	<0.001	0.53 (0.49 to 0.59)	<0.001
2013 3-31 March	1.14 (1.07 to 1.21)	<0.001	0.58 (0.53 to 0.63)	<0.001
2014 1 February-31 March	1.14 (1.08 to 1.21)	<0.001	0.51 (0.46 to 0.56)	<0.001
2015 No campaign	1.16 (1.10 to 1.23)	<0.001	0.48 (0.44 to 0.53)	<0.001



2003 (No campaign)
 2004 (Missing out)
 2005 (It's only)
 2006 (FAST)
 2007-8 (FAST + call EMS)
 2009-10 (FAST visuals)
 2011-14 (Fire in the Brain)
 2015 (No campaign)

SUPPLEMENTAL MATERIAL

Temporal trends in EMS and general practitioner use for acute stroke following Australian public education campaigns.

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METHODS

Setting

Over the study period, the Victorian population grew from 4.9 million to 5.9 million. Ambulance Victoria is the sole provider of EMS across the state. At the time of this study, the EMS system was provided in a user pays system for those not covered by a government pension, health insurance or EMS subscription (over half of the population). Public hospital healthcare, including ED visits, is free to all Australian citizens and most permanent residents of Australia. In 2015, there were 50 EDs (34 public, 5 public specialities and 11 private) in the state of Victoria—however the majority (~93%) of emergency presentations are made to public EDs. In 2015, acute suspected stroke patients presenting by EMS were transported to one the 28 (26 public and 2 private) hospitals offering acute stroke treatments.

Sample

We decided to include ICH and TIA in the sample following the coding issues between stroke subtypes identified in the validation. As we wanted to gauge the public impact of the campaign we only included presentations from patients residing in private residences at the time of the admission; and as the campaign exposure was inconsistent in other Australian regions, we excluded ED admissions for non-Victorian residents.

Campaigns

The Stroke Foundation ran 11 campaigns with paid advertising (e.g. print, radio, billboards and television) in Victoria annually between 2004 and 2014—with the exception of 2012 when two paid campaigns ran. These campaigns initially occurred in September and October, but moved to March in later campaigns. Exposure to campaign materials outside these periods is unknown. Campaigns from 2006 used the FAST (face, arm, speech, time) message. From 2007, the message was changed from “Time to act FAST -seek medical attention” to “Time to act FAST -call 000”. Initially the FAST campaign materials contained written descriptions of symptoms and action, with pictures visualising the symptoms and to call EMS added from 2009. An Australian version of the British FAST campaign (“Fire in the Brain”) was used between 2012 and 2014.

Data sources and validation

The Department of Health and Human Services requires every Victorian public ED to provide a minimum dataset for every emergency presentation—known as the Victorian Emergency Minimum Dataset (VEMD). The VEMD includes categorised demographic, administrative and clinical variables—including mode of arrival (e.g. EMS), who referred the patient (e.g. GPs) and final ED diagnosis. To maintain patient privacy, data from the 33

included EDs was provided in a de-identified format (e.g. no identifiers, and date of presentation is converted to month and year).

As there are no published validations of the VEMD data in stroke patients, we first validated the accuracy of key VEMD variables for this study. To do this we reviewed the medical records of a random sample of 123 (35%) cases admitted to a major metropolitan hospital between July and December 2016 with a VEMD diagnosis of “stroke/cerebral vascular accident”, “cerebral infarction”, “intracerebral haemorrhage” or “transient ischemic attack”. VEMD data was compared to data in the medical record using only information available to the point of ED discharge. We also collected diagnosis at hospital discharge. We found 87% of cases with a VEMD diagnosis of stroke/TIA had a recorded ED medical diagnosis of stroke/TIA (the remainder were all stroke mimics¹) and 76% had a final hospital diagnosis of stroke/TIA. There were misclassifications of stroke subtypes in the VEMD in 9% of cases when compared to the ED medical diagnosis. Other key variables were mostly correct: mode of arrival (98%), current residence (95%) and referral source (87%).

Statistical Models

As the exact date of ED presentation was not provided in the VEMD data, we first divided the data into campaign years using the starting month of each campaign as the first month and the month before the next campaign as the last month (Table I). The two campaigns occurring in 2012 were treated as one campaign year, and 2015 when no campaign ran was treated as a calendar year.

No significant trends were seen across the pre-campaign period when each outcome was examined by month. Models were adjusted for age, female sex, residence in a major city (Australian Bureau Statistics classification), ED presentation during winter³, lives alone and English as preferred language. We also conducted sensitivity analyses, repeating the models separately for stroke and TIA, and subgroup analyses by major demographic groups in the VEMD. In the EMS model we also examined the effect of removing patients presenting via GPs as a surrogate exploration of acute patients. We also conducted a sensitivity analysis by randomly misclassifying 10% of referral statuses in either direction and repeating the regression analyses.

Data is presented as adjusted odds ratios (AOR) and 95% confidence intervals (95% CI). P values <0.05 were considered statistically significant. Statistical analyses were performed using Stata software (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX).

RESULTS

Sensitivity analysis

There was no change in the direction or significance of trends when: 1) stratified by stroke or TIA diagnoses, or by major demographic groups; 2) when patients presenting via GP are removed from the EMS model; and 3) when allowing for a 10% misclassification of GP referrals (data not shown).

Full models

Other factors associated with increased EMS use were: increasing age (45-64 years AOR=1.44 [95% CI: 1.37 to 1.52], $p<0.001$; >64 years AOR=3.87 [95% CI: 3.68 to 4.06], $p<0.001$), female sex (AOR=1.06 [95% CI: 1.04 to 1.09], $p<0.001$), English as preferred language (AOR=1.20 [95% CI: 1.15 to 1.25], $p<0.001$), living alone (AOR=1.23 [95% CI: 1.18 to 1.28], $p<0.001$), and admission during winter (AOR=1.11 [95% CI: 1.07 to 1.14], $p<0.001$).

Older patients (45-64 years AOR=1.07 [95% CI: 0.99 to 1.16], $p=0.08$; >64 years AOR=0.74 [95% CI: 0.69 to 0.80], $p<0.001$), residents of major cities (AOR=0.72 [95% CI: 0.69 to 0.75], $p<0.001$) and those with English as preferred language (AOR=0.88 [95% CI: 0.82 to 0.94], $p<0.001$) were less likely to present to ED via a GP.

DISCUSSION

Limitations

Our large study is the longest temporal evaluation of a stroke campaign to date, and is one of the few population-based studies. However, to conduct this study we used a design that cannot attribute causation. Therefore our results must be interpreted with some caution, as there may have been other factors contributing to the changes seen in our data. For example, it is possible that the public may have also received stroke information from other smaller initiatives.

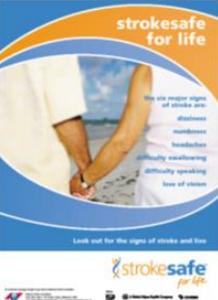
Other limitations of the study related to use of the VEMD—an administrative dataset not designed for research. The accuracy of data in stroke/TIA patients across the health care system is unknown. Our small validation of the VEMD data at one hospital suggests some inaccuracy; particularly in GP attendances prior to ED and diagnoses, and it is possible that the results of the validation may not apply across the whole dataset. It is also likely that there are cases of stroke/TIA that had other VEMD codes, and were not included in our dataset. We were also unable to determine whether the diagnosis of stroke changed over the study period, or whether referrals were from patients calling or visiting their GPs. The VEMD is also restricted to public hospitals, and our results do not apply to the small proportion of cases (~7%) presenting to private EDs.

The VEMD also does not contain important clinical data to enable the study of other important outcomes, such as improvements in presentation times and thrombolysis rates. A small study from our region suggests those who saw the FAST campaign presented to hospital faster.² Furthermore, thrombolysis rates have improved over time in our region (currently 18%),³ and some of this improvement is likely to be attributed to the campaigns through patients reacting faster and using EMS to ensure transport to a thrombolysis center.

We also chose to examine annual trends, rather than restrict the analysis to campaign periods and use a time-series analysis. We did this because of the sustained exposure of the campaigns in our population, the nature of the data provided, the varied exposure of campaign materials outside the periods of paid advertising and the moderate awareness of the campaigns across our population.⁴ Lastly, we are unable to report on clinical outcomes, however given the impact of EMS and GP use on prehospital times eligibility for acute stroke treatments is likely to have improved.

1. Hankey GJ and Blacker DJ. Is it a stroke? *BMJ*. 2015;350:h56.
2. J.E. B, Cui J, O'Connell B, Gilligan A, Livingston PM and Bladin C. An examination of factors related to patient's delay in presenting to hospital for stroke symptoms. *International Journal of Stroke*. 2010;5:24.
3. National Stroke Foundation. National Stroke Audit – Acute Services Report 2017. <https://informmeorgau/en/stroke-data/Acute-audits>. 2017:Last accessed: 11/09/2018.
4. Bray JE, Johnson R, Trobbiani K, Mosley I, Lalor E and Cadilhac D. Australian public's awareness of stroke warning signs improves after national multimedia campaigns. *Stroke; a journal of cerebral circulation*. 2013;44:3540-3.

Table I: Details of campaigns (Posters provided by Stroke Foundation and Reprinted with permission).

Year Advertising dates	Campaign name Aim	Examples of campaign posters
2004 20 September-30 October	Missing Out Strokesafe for Life/ <i>Focused on the reality that many Australians do not know the signs of stroke and if they did, they might have been able to avoid a stroke or achieve better recovery</i>	
2005 18 September-31 October	It's Only/ <i>Designed to highlight the significant signs of stroke and not to ignore them</i>	
2006 17 September-30 October	FAST (Face, Arm, Speech, Time) – seek immediate attention/ <i>To provide an easy way to recognize the signs of stroke and acting FAST</i>	
2007 16 September-28 October	FAST–call EMS/ <i>Focused on the FAST symptoms and the need to call EMS</i>	
2008 14 September-22 November	FAST–call EMS <i>Focused on the FAST symptoms and the need to call EMS</i>	
2009 13 September-15 November	FAST–with visual <i>Used images to depict FAST symptoms and calling an EMS “000” with the aim of reaching more members of the community.</i>	

Year Advertising dates	Campaign name Aim	Examples of campaign posters
2010 5 September- 10 October	FAST—with visual	
2011 2-23 October	Fire in the Brain/FAST <i>Adapted the UK campaign with the aim of showing the onset of symptoms and the need for immediate attention.</i>	
2012 4-24 March 7-28 October	Fire in the Brain/FAST	
2013 3-31 March	Fire in the Brain/FAST	
2014 1 February-31 March	Fire in the Brain/FAST	
2015	No campaign	

Table II: The characteristics of patients with VEMD diagnosis of stroke and TIA (n [%]).

Characteristic, n (%)	Stroke and TIA n=118,000	Stroke n=73,607	TIA n=44,393
Age (years)			
18-44	7,905 (7)	4,529 (6)	3,376 (8)
45-64	29,295 (25)	16,707 (23)	12,588 (28)
65 and older	80,800 (68)	52,371 (71)	28,429 (64)
Female sex	56,279 (48)	34,561 (47)	21,718 (49)
Born in Australia	72,119 (61%)	142,977 (58)	29,142 (66)
English as preferred language	105,998 (90)	64,741 (88)	41,257 (93)
Resident of major city	78,006 (66)	50,725 (69)	27,281 (61)
Lives alone	12,556 (11)	8,116 (11)	4,440 (10)
Presentation in winter	29,703 (25)	18,724 (25)	10,979 (25)

TIA: transient ischaemic attack