# DETERMINANTS OF PRE-HOSPITAL TIMINGS FOR ACUTE STROKE: DATA FROM THE SENTINEL STROKE NATIONAL AUDIT PROGRAMME (SSNAP)

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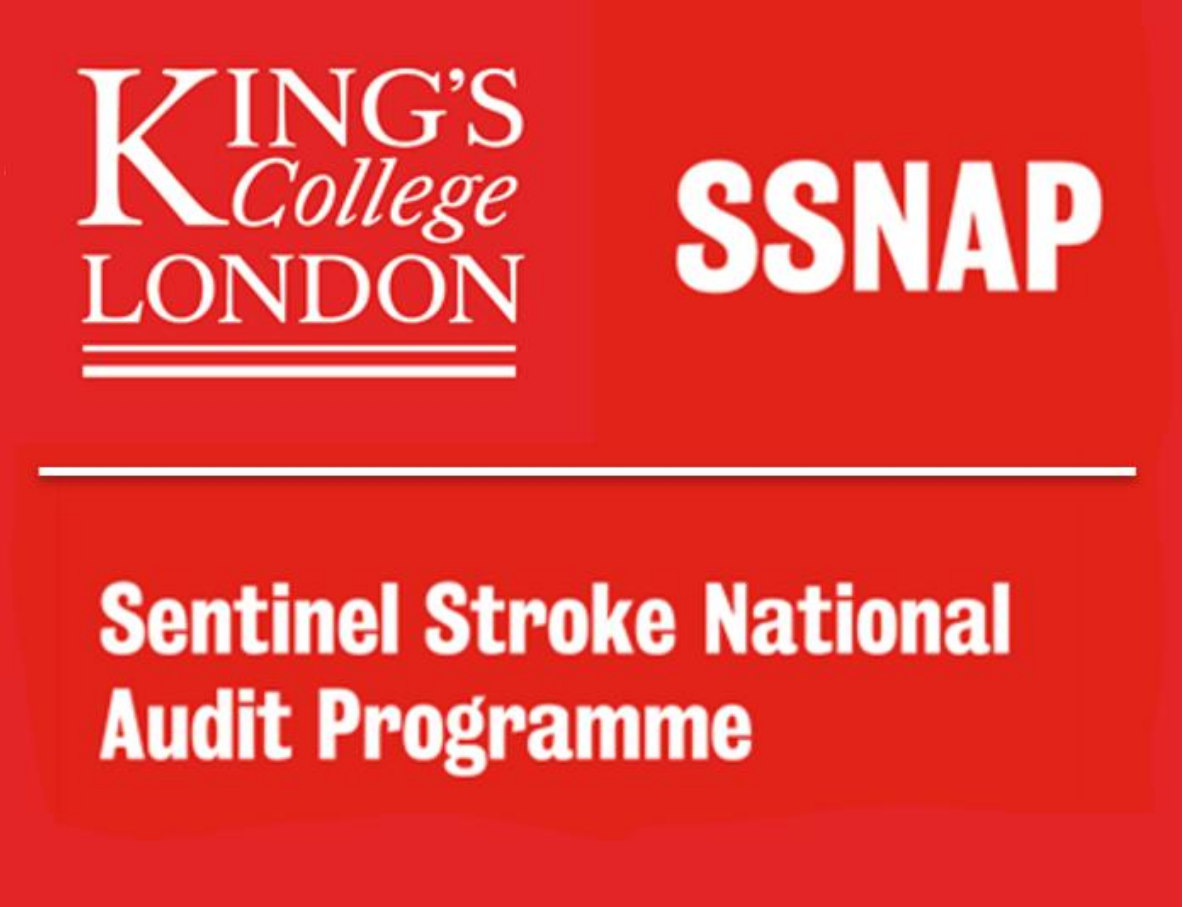
BACKGROUND

Over the last 5 years through 2019-2023 prehospital data extracted from the Sentinel Stroke National Audit Programme (SSNAP) and submitted by acute hospital trusts and the 11 regional ambulance services in England has shown the median onset-to-arrival time to have increased significantly from 168 to 201 minutes (figure 1). Our initial analysis promoted further investigation into the demographic and clinical variables affecting each component of the prehospital pathway (figure 2) across this large national audit dataset.

METHODS

We retrospectively investigated the prehospital pathway components of onset-to-call, call-to-scene, time-at-scene and scene-to-hospital. 381,960 ambulance records between Jan 2019-December 2023 were extracted from SSNAP and analysed. Continuous variables were analysed using the Kruskal-Wallis rank sum test, and categorical variables (age, sex, ethnicity, co-morbidities, stroke type and severity [NIHSS at hospital arrival]) analysed using Pearson's chi-squared test. The overall national pathway medians (onset to call 87mins, time on scene 32mins and scene to hospital at 18mins) were extracted and either side of these compared for any significant variable differences to more timely care. For call to location the median was not used in this instance and the evidenced target of 18 minutes preferred in line with the category 2 emergency 999 response that most stroke patients will fall within, after ringing the emergency services.

Figure 1: National Quarterly Median Pre-hospital timings (Jan 2019-Dec 2023)

RESULTS

Onset to call – Age (76 v 77yrs median) (weighted by those <aged 60), stroke severity (moderate, severe and very severe), haemorrhagic stroke (15% v 11%), reduced levels of consciousness, no pre-stroke disability (0 modified Rankin scale score, mRS) and atrial fibrillation (AF) prior to stroke (20% v 18%) were all significantly associated to timelier 999 contact (p<0.0001). Hypertension prior to stroke was noted with a % increase in delayed calls. Within the timelier call group 73% presented as FAST+, 97% arrived within onset of 4 hours, 33% had intravenous thrombolysis (IVT) and 7% had intra-arterial thrombectomy (IAT).

Call to location – Overall no difference in age noted at 77yrs. Those of Asian and mixed background, no pre-stroke disability (mRS of 0), increased stroke severity (severe and very severe) and those non alert on assessment (AVPU) were all significantly associated with a timelier 999 response under 18 minutes (p<0.0001). Within the quicker response group 67% presented as FAST+, 49% arrived within onset of 4 hours, 17% had IVT and 5% had IAT.

Time on scene - Age (75 v 79yrs median) (weighted by <60 and those between 60-69), Males (56% v 50%), no pre-stroke disability (mRS of 0), increased stroke severity (Moderate, severe and very severe) all significantly associated with less time on scene. Patients presenting with a comorbidity or taking anticoagulants prior to stroke all stay on scene longer. Within the group spending less time on scene 71% presented as FAST+, 54% arrived within onset of 4 hours, 21% had IVT and 5% had IAT.

Leaving scene to hospital – Age (77 v 78) weighted by those aged <60, no pre-stroke disability (mRS of 0), increased stroke severity (Moderate, severe and very severe) all significantly associated with quicker transportation to hospital. Within the quicker transportation group 66% presented as FAST+, 49% arrived within onset of 4 hours, 17% had IVT and 4% had IAT.
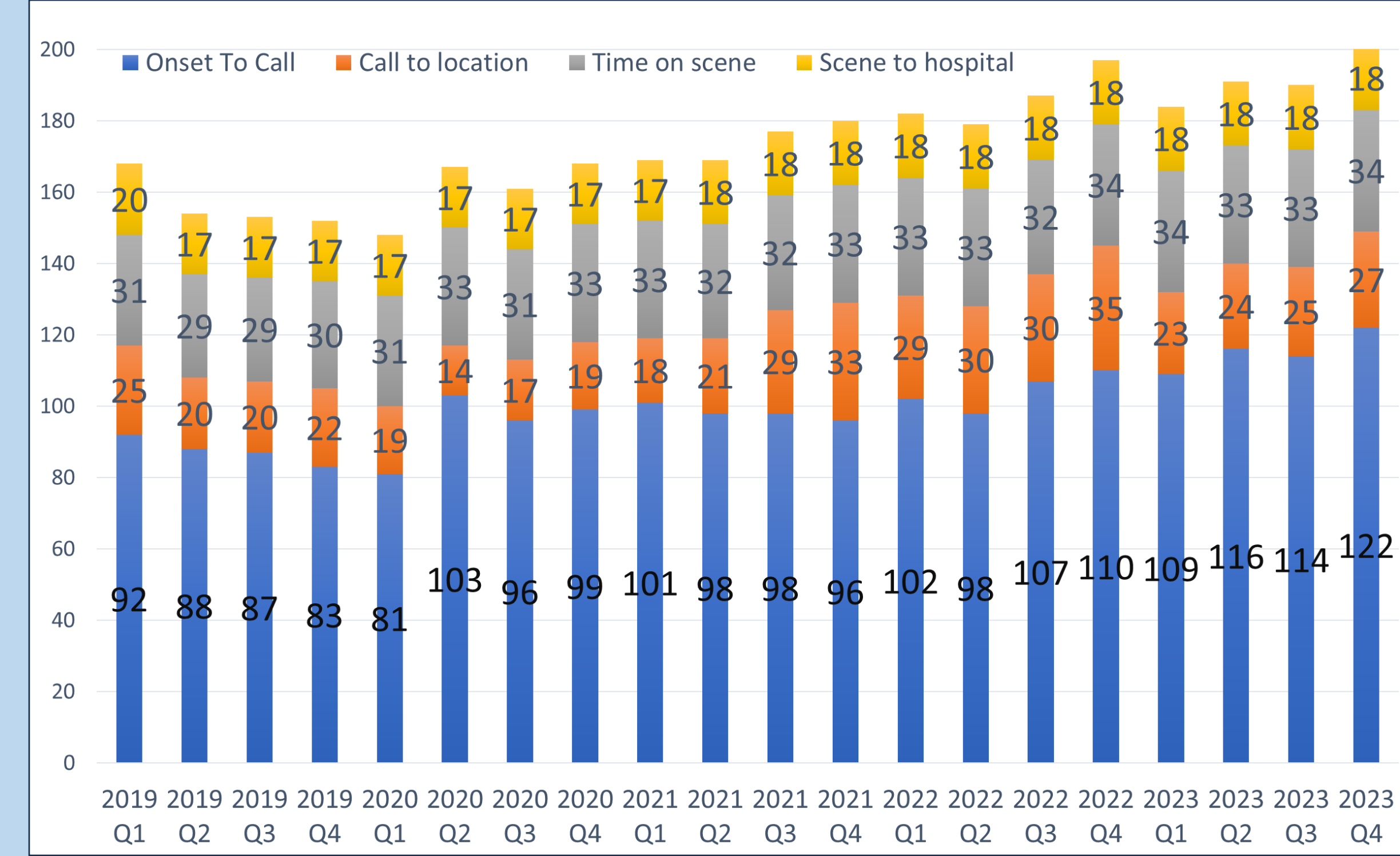

Figure 2: Breakdown of the pre-hospital pathway elements

		Onset to call				Call to location				Time on scene				Leaving scene to hospital			
	variable	<87 mins	>87 mins	Total	P Value	<18 mins	>18 mins	Total	P Value	<32 mins	>32 mins	Total	P Value	<18 mins	>18 mins	Total	P Value
	Total	143317 (47%)	158458 (53%)	301775 (100%)	n/a	143879 (38%)	238081 (62%)	381960 (100%)	n/a	183337 (48%)	198623 (52%)	381960	n/a	189419 (50%)	192541 (50%)	381960 (100%)	n/a
Age	Min / Max	16.0 / 111.0	16.0 / 108.0	16.0 / 111.0	p-value: <0.0001	16.0 / 110.0	16.0 / 113.0	16.0 / 113.0	p-value: <0.0001	16.0 / 113.0	16.0 / 110.0	16.0 / 113.0	p-value: <0.0001	16.0 / 113.0	16.0 / 110.0	16.0 / 113.0	p-value: <0.0001
Age	Med [IQR]	76.0 [66.0,84.0]	77.0 [67.0,84.0]	77.0 [67.0,84.0]	p-value: <0.0001	77.0 [66.0,85.0]	77.0 [68.0,85.0]	77.0 [67.0,85.0]	p-value: <0.0001	75.0 [64.0,83.0]	79.0 [70.0,86.0]	77.0 [67.0,85.0]	p-value: <0.0001	77.0 [66.0,84.0]	78.0 [68.0,85.0]	77.0 [67.0,85.0]	p-value: <0.0001
Age brackets	age<60	22026 (15%)	21371 (13%)	43397 (14%)	p-value: <0.0001	21332 (15%)	30900 (13%)	52222 (14%)	p-value: <0.0001	31172 (17%)	21050 (11%)	52222 (14%)	p-value: <0.0001	28739 (15%)	23483 (12%)	52222 (14%)	p-value: <0.0001
Age brackets	age_60_69	22811 (16%)	25739 (16%)	48550 (16%)	p-value: <0.0001	23436 (16%)	36439 (15%)	59875 (16%)	p-value: <0.0001	33277 (18%)	26598 (13%)	59875 (16%)	p-value: <0.0001	31037 (16%)	28838 (15%)	59875 (16%)	p-value: <0.0001
Age brackets	age_70_79	40940 (29%)	45424 (29%)	86364 (29%)	p-value: <0.0001	39259 (27%)	68641 (29%)	107900 (28%)	p-value: <0.0001	52897 (29%)	55003 (28%)	107900 (28%)	p-value: <0.0001	51906 (27%)	55994 (29%)	107900 (28%)	p-value: <0.0001
Age brackets	age_80_89	43491 (30%)	49905 (31%)	93396 (31%)	p-value: <0.0001	44709 (31%)	76641 (32%)	121350 (32%)	p-value: <0.0001	51183 (28%)	70167 (35%)	121350 (32%)	p-value: <0.0001	58083 (31%)	63267 (33%)	121350 (32%)	p-value: <0.0001
Age brackets	age>90	14049 (10%)	16019 (10%)	30068 (10%)	p-value: <0.0001	15153 (11%)	25460 (11%)	40613 (11%)	p-value: <0.0001	14808 (8%)	25805 (13%)	40613 (11%)	p-value: <0.0001	19654 (10%)	20959 (11%)	40613 (11%)	p-value: <0.0001
Gender	F	66191 (46%)	74624 (47%)	140815 (47%)	p-value: 0.8945	68140 (47%)	112806 (47%)	180946 (47%)	p-value: 0.8945	81437 (44%)	99509 (50%)	180946 (47%)	p-value: 0.9302	89720 (47%)	91226 (47%)	180946 (47%)	p-value: 0.9302
Gender	M	77126 (54%)	83834 (53%)	160960 (53%)	p-value: 0.8945	75739 (53%)	125275 (53%)	201014 (53%)	p-value: 0.8945	101900 (56%)	99114 (50%)	201014 (53%)	p-value: 0.9302	99699 (53%)	101315 (53%)	201014 (53%)	p-value: 0.9302
FAST- on assessment	Y	12416 (8.66%)	22016 (13.9%)	34432 (11.4%)	p-value: <0.0001	16787 (11.7%)	34021 (14.3%)	50808 (13.3%)	p-value: <0.0001	14905 (8.13%)	35903 (18.1%)	50808 (13.3%)	p-value: <0.0001	21658 (11.4%)	29150 (15.1%)	50808 (13.3%)	p-value: <0.0001
FAST+ on assessment	Y	104654 (73.0%)	106275 (67.1%)	210929 (69.9%)	p-value: <0.0001	96257 (66.9%)	154523 (64.9%)	250780 (65.7%)	p-value: <0.0001	130612 (71.2%)	120168 (60.5%)	250780 (65.7%)	p-value: <0.0001	125685 (66.4%)	125095 (65.0%)	250780 (65.7%)	p-value: <0.0001
Ethnicity	Asian	5893 (4%)	5797 (4%)	11690 (4%)	p-value: <0.0001	6760 (5%)	7922 (3%)	14682 (4%)	p-value: <0.0001	8180 (4%)	6502 (3%)	14682 (4%)	p-value: <0.0001	10222 (5%)	4460 (2%)	14682 (4%)	p-value: <0.0001
Ethnicity	Black	2650 (2%)	3443 (2%)	6093 (2%)	p-value: <0.0001	3352 (2%)	4546 (2%)	7898 (2%)	p-value: <0.0001	3936 (2%)	3962 (2%)	7898 (2%)	p-value: <0.0001	5282 (3%)	2616 (1%)	7898 (2%)	p-value: <0.0001
Ethnicity	Ethnicity unknown	12687 (9%)	12765 (8%)	25452 (8%)	p-value: <0.0001	13452 (9%)	21546 (9%)	34998 (9%)	p-value: <0.0001	17350 (9%)	17648 (9%)	34998 (9%)	p-value: <0.0001	14746 (8%)	20252 (11%)	34998 (9%)	p-value: <0.0001
Ethnicity	Mixed	630 (0.4%)	732 (0.5%)	1362 (0.5%)	p-value: <0.0001	779 (1%)	1040 (0.4%)	1819 (0.5%)	p-value: <0.0001	944 (1%)	875 (0.4%)	1819 (0.5%)	p-value: <0.0001	1138 (1%)	681 (0.4%)	1819 (0.5%)	p-value: <0.0001
Ethnicity	Other	2533 (2%)	2895 (2%)	5428 (2%)	p-value: <0.0001	2512 (2%)	4017 (2%)	6529 (2%)	p-value: <0.0001	3528 (2%)	3001 (2%)	6529 (2%)	p-value: <0.0001	3152 (2%)	3377 (2%)	6529 (2%)	p-value: <0.0001
Ethnicity	White	118924 (83%)	132826 (84%)	251750 (83%)	p-value: <0.0001	117024 (81%)	199010 (84%)	316034 (83%)	p-value: <0.0001	149399 (81%)	166635 (84%)	316034 (83%)	p-value: <0.0001	154879 (82%)	161155 (84%)	316034 (83%)	p-value: <0.0001
Rankin Before Stroke	0	74924 (52%)	74004 (47%)	148928 (49%)	p-value: <0.0001	71045 (49%)	112505 (47%)	183550 (48%)	p-value: <0.0001	99531 (54%)	84019 (42%)	183550 (48%)	p-value: <0.0001	92325 (49%)	91225 (47%)	183550 (48%)	p-value: <0.0001
Rankin Before Stroke	1	25779 (18%)	31380 (20%)	57159 (19%)	p-value: <0.0001	26643 (19%)	46130 (19%)	72773 (19%)	p-value: <0.0001	34982 (19%)	37791 (19%)	72773 (19%)	p-value: <0.0001	35265 (19%)	37508 (19%)	72773 (19%)	p-value: <0.0001
Rankin Before Stroke	2	14940 (10%)	19799 (12%)	34739 (12%)	p-value: <0.0001	16673 (12%)	29669 (12%)	46342 (12%)	p-value: <0.0001	19236 (10%)	27106 (14%)	46342 (12%)	p-value: <0.0001	22180 (12%)	24162 (13%)	46342 (12%)	p-value: <0.0001
Rankin Before Stroke	3	17215 (12%)	21686 (14%)	38901 (13%)	p-value: <0.0001	18292 (13%)	32508 (14%)	50800 (13%)	p-value: <0.0001	19690 (11%)	31110 (16%)	50800 (13%)	p-value: <0.0001	25259 (13%)	25541 (13%)	50800 (13%)	p-value: <0.0001
Rankin Before Stroke	4	8482 (6%)	9412 (6%)	17894 (6%)	p-value: <0.0001	8985 (6%)	14107 (6%)	23092 (6%)	p-value: <0.0001	8144 (4%)	14948 (8%)	23092 (6%)	p-value: <0.0001	11519 (6%)	11573 (6%)	23092 (6%)	p-value: <0.0001
Rankin Before Stroke	5	1977 (1%)	2177 (1%)	4154 (1%)	p-value: <0.0001	2241 (2%)	3162 (1%)	5403 (1%)	p-value: <0.0001	1754 (1%)	3649 (2%)	5403 (1%)	p-value: <0.0001	2871 (2%)	2532 (1%)	5403 (1%)	p-value: <0.0001
Atrial Fibrillation prior to stroke	Y	28955 (20%)	29123 (18%)	58078 (19%)	p-value: <0.0001	28132 (20%)	46012 (19%)	74144 (19%)	p-value: 0.0866	31726 (17%)	42418 (21%)	74144 (19%)	p-value: <0.0001	36502 (19%)	37642 (20%)	74144 (19%)	p-value: 0.0289
Hypertension prior to stroke	Y	79425 (55%)	92062 (58%)	171487 (57%)	p-value: <0.0001	81808 (57%)	136950 (58%)	218758 (57%)	p-value: 0.0001	101353 (55%)	117405 (59%)	218758 (57%)	p-value: <0.0001	108952 (58%)	109806 (57%)	218758 (57%)	p-value: 0.0022
Stroke or TIA prior to stroke	Y	36336 (25%)	41023 (26%)	77359 (26%)	p-value: 0.0008	37059 (26%)	61007 (26%)	98066 (26%)	p-value: 0.3634	44472 (24%)	53594 (27%)	98066 (26%)	p-value: <0.0001	48266 (25%)	49800 (26%)	98066 (26%)	p-value: 0.0067
Heart Failure prior to stroke	Y	7425 (5%)	8201 (5%)	15626 (5%)	p-value: 0.9475	8023 (6%)	12943 (5%)	20966 (5%)	p-value: 0.0660	8584 (5%)	12382 (6%)	20966 (5%)	p-value: <0.0001	10649 (6%)	10317 (5%)	20966 (5%)	p-value: <0.0001
Taking Anticoag prior to stroke	Y	23271 (16%)	24932 (16%)	48203 (16%)	p-value: <0.0001	22937 (16%)	38196 (16%)	61133 (16%)	p-value: <0.0001	26199 (14%)	34934 (18%)	61133 (16%)	p-value: <0.0001	29837 (16%)	31296 (16%)	61133 (16%)	p-value: <0.0001
Stroke Type	Isc	121115 (85%)	141571 (89%)	262686 (87%)	p-value: <0.0001	125031 (87%)	207993 (87%)	333024 (87%)	p-value: <0.0001	160266 (87%)	172758 (87%)	333024 (87%)	p-value: <0.0001	169058 (88%)	169056 (88%)	333024 (87%)	p-value: <0.0001
Stroke Type	PIH	22117 (15%)	16736 (11%)	38853 (13%)	p-value: <0.0001	18670 (13%)	29767 (13%)	48437 (13%)	p-value: 0.0001	22236 (12%)	25598 (12.9%)	48437 (13%)	p-value: 0.0003	25251 (13%)	23186 (12%)	48437 (13%)	p-value: <0.0001
Stroke severity (NIHSS)	No deficit	7529 (5%)	9265 (6%)	16794 (6%)	p-value: <0.0001	9206 (6%)	16528 (7%)	25734 (7%)	p-value: <0.0001	8890 (5%)	16844 (8%)	25734 (7%)	p-value: <0.0001	11457 (6%)	14277 (7%)	25734 (7%)	p-value: <0.0001
Stroke severity (NIHSS)	Mild	42838 (30%)	65155 (41%)	107993 (36%)	p-value: <0.0001	48506 (34%)	90457 (38%)	138963 (36%)	p-value: <0.0001	63920 (35%)	75043 (38%)	138963 (36%)	p-value: <0.0001	63634 (34%)	75329 (39%)	138963 (36%)	p-value: <0.0001
Stroke severity (NIHSS)	Moderate	61588 (43%)	63798 (40%)	125386 (42%)	p-value: <0.0001	57097 (40%)	97849 (41%)	154946 (41%)	p-value: <0.0001	77356 (42%)	77590 (39%)	154946 (41%)	p-value: <0.0001	78934 (42%)	76012 (39%)	154946 (41%)	p-value: <0.0001
Stroke severity (NIHSS)	Severe	15987 (11%)	10590 (7%)	26577 (9%)	p-value: <0.0001	13734 (10%)	17827 (7%)	31561 (8%)	p-value: <0.0001	17229 (9%)	14332 (7%)	31561 (8%)	p-value: <0.0001	17640 (9%)	13921 (7%)	31561 (8%)	p-value: <0.0001
Stroke severity (NIHSS)	Very Severe	15375 (11%)	9650 (6%)	25025 (8%)	p-value: <0.0001	15336 (11%)	15420 (6%)	30756 (8%)	p-value: <0.0001	15942 (9%)	14814 (7%)	30756 (8%)	p-value: <0.0001	17754 (9%)	13002 (7%)	30756 (8%)	p-value: <0.0001
Consciousness on assessment	Alert	122679 (86%)	142257 (90%)	264936 (88%)	p-value: <0.0001	121493 (84%)	212005 (89%)	333498 (87%)	p-value: <0.0001	161294 (88%)	172204 (87%)	333498 (87%)	p-value: <0.0001	162758 (86%)	170740 (89%)	333498 (87%)	p-value: <0.0001
Consciousness on assessment	Responds to pain	4337 (3%)	3376 (2%)	7713 (3%)	p-value: <0.0001	5273 (4%)	5153 (2%)	10426 (3%)	p-value: <0.0001	4439 (2%)	5987 (3%)	10426 (3%)	p-value: <0.0001	5942 (3%)	4484 (2%)	10426 (3%)	p-value: <0.0001
Consciousness on assessment	Responds to voice	14069 (10%)	11409 (7%)	25478 (8%)	p-value: <0.0001	13950 (10%)	18818 (8%)	32768 (9%)	p-value: <0.0001	15457 (8%)	17311 (9%)	32768 (9%)	p-value: <0.0001	17599 (9%)	15169 (8%)	32768 (9%)	p-value: <0.0001
Consciousness on assessment	Unconscious	2232 (2%)	1416 (1%)	3648 (1%)	p-value: <0.0001	3163 (2%)	2105 (1%)	5268 (1%)	p-value: <0.0001	2147 (1%)	3121 (2%)	5268 (1%)	p-value: <0.0001	3120 (2%)	2148 (1%)	5268 (1%)	p-value: <0.0001
Thrombolysis	Y	46716 (33%)	8039 (5%)	54755 (18%)	p-value: <0.0001	24483 (17%)	30480 (13%)	54963 (14%)	p-value: <0.0001	38343 (21%)	16620 (8%)	54963 (14%)	p-value: <0.0001	31947 (17%)	23016 (12%)	54963 (14%)	p-value: <0.0001
Thrombectomy	Y	9889 (7%)	4055 (3%)	13944 (5%)	p-value: <0.0001	6575 (5%)	8201 (3%)	14776 (4%)	p-value: <0.0001	9987 (5%)	4789 (2%)	14776 (4%)	p-value: <0.0001	8186 (4%)	6590 (3%)	14776 (4%)	p-value: <0.0001
Onset to hospital arrival <4 hours	Less_than_4h	139033 (97%)	29400 (19%)	168433 (56%)	p-value: <0.0001	70692 (49%)	95555 (40%)	166247 (44%)	p-value: <0.0001	98109 (54%)	68138 (34%)	166247 (44%)	p-value: <0.0001	92414 (49%)	73833 (38%)	166247 (44%)	p-value: <0.0001

Table 1: Quarterly Median National Pre-hospital pathway timings (Jan 2019-Dec 2023)

CONCLUSION

In this very large national prehospital audit dataset, multiple demographic and clinical variables appear to affect the timeliness of all components of the prehospital stroke pathway. More variables appear to be evident in the "Onset to call" (patient/bystander behaviour) and "Time on scene" windows. Improving the timeliness of stroke care windows is pivotal to patient groups accessing stroke interventions and reducing both disability and death. These findings in the future may influence national public health stroke awareness campaigns with more targeted messaging at specific groups, improve ambulance triage protocols and help response programmes of the future understand the relevance to the current category 2 response target, educate pre-hospital clinicians in allowing them to understand where they may spend longer on scene with different groups of patients and finally assist in the design of potential national or local pre-alert pathways for more critical groups of patients having longer transportations at present. Further studies are promoted to understand where confounding variables may be present on one another in these groups i.e young, severe, haemorrhagic strokes etc……….