The Regulation and Quality Improvement Authority

Door to Needle Time in Acute Stroke Thrombolysis: Northern Ireland Regional Audit 2013-2016

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Assurance, Challenge and Improvement in Health and Social Care

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Executive Summary

Background/Rationale

Thrombolysis reduces disability following stroke, but the effects are strongly time dependent and better outcomes are associated with treatment administration soon after symptom onset. Providing thrombolysis as quickly as possible to the highest proportion of eligible patients is a challenge for stroke services. Relatively little is known about thrombolysis times and rates on a national basis.

Aims and Objectives

To measure Door-to-Needle-Time for all stroke patients treated with thrombolysis from January 2013 to December 2016 in Northern Ireland and to determine the proportions of stroke patients receiving treatment.

To identify which factors are associated with prolonged door to needle time, using a 60-minute audit target.

To use this information to improve access to rapid and quality care for Stroke patients in the future.

Key findings

The thrombolysis rate increased from 10.7 % in 2013 to 12.4 % in 2016.

The median door-to-needle time was 54 minutes and improved over the audit period, with 60 % of patients receiving thrombolysis within 60 mins from arrival at hospital.

Patients treated outside of normal working hours were significantly less likely to be treated < 60 minutes after arrival, and pre-hospital notification by ambulance services was significantly associated with shorter in-hospital treatment times. Variation in treatment times was also seen according to year, site and method of treatment.

Recommendations

1. There is a need to improve door-to-needle time particularly for patients presenting out-of-hours.
2. As pre-hospital alert is associated with improved in–hospital treatment times; there is a need to encourage and maximise use of pre-hospital notification where possible.
3. There is a need to continue the observed trend of improving door to needle time.
4. Pathways for patients treated via telemedicine require improvement to reduce delays to thrombolysis administration.

Clinical Audit Report

Background/Rationale

The impact of stroke on public health is substantial. Absolute number of stroke cases, stroke related disability and stroke related mortality measurements are increasing.[1] Treatments including revascularisation with intravenous thrombolysis with tissue plasminogen activator (t-PA) and / or endovascular thrombectomy improve the chance of achieving favourable clinical outcomes following acute ischemic stroke (AIS).[2][3] Patient and systemic factors mean that only a proportion of all AIS patients can receive these treatments.[4][5] Even when these therapies are available, the clinical impact of reperfusion is strongly time dependent, with better outcomes consistently being associated with shorter time to treatment administration.[6] AIS is a dynamic process and as increasing amounts of irreversible brain damage accumulate over time after stroke onset , the “time is brain” phrase has become a call to eliminate unnecessary delay in administering t-PA treatment.[7] Accordingly, centres which provide t-PA for AIS are encouraged to administer treatment within a 60 minute door-to-needle (DTN) time after arrival at hospital.[8]

Achieving short DTN times is possible but challenging for stroke services. Recognition of a clinical stroke diagnosis, obtaining and interpreting urgent brain imaging, determining clinical stroke severity, exclusion of possible stroke mimics, exclusion of contraindications to intravenous administration of t-PA and obtaining consent/assent are all required prior to safe treatment. Performance of different centres in terms of DTN time is not uniform, with some centres achieving dramatic reduction in treatment times through service re-organisation.[9] Elsewhere, improvement in DTN times has been more variable even with the adaptation of dedicated stroke thrombolysis improvement programmes.[10]

To date some registries have reported on factors associated with short and prolonged DTN times. Relevant individual patient factors include age, stroke severity and previous

medical history , while hospital factors such as hospital size, volume of stroke admissions, annual number of thrombolysis cases and hospital academic status have also been associated with variation in DTN times.[8][11] A criticism of registries is that they can be associated with selection bias and do not reflect the true performance of DTN times in stroke services. Publications on DTN times across an entire country including both high volume and low volume centres and thus reflecting DTN for all thrombolysis cases have been limited.[12] A key performance index of acute stroke services mandates country-wide assessment of healthcare provision.

The Department of Health in Northern Ireland has undertaken a pre-consultation exercise with a view to re-organisation of stroke services, so that high quality care can be provided to the highest number of patients.[13] Safe and timely administration of intravenous t-PA is critical for any acute stroke service, but the components of the clinical team vary within the working week in the Northern Ireland health service design. The presence of a dedicated stroke nurse as well as senior medical staff is typically routine practice in normal working hours, but smaller clinical teams with less experienced staff are usually tasked with providing intravenous t-PA treatment at night and at weekends, sometimes with remote support from senior team members via telemedicine or telephone. The impact of the different make-up of clinical teams and different hospital sites on stroke treatment regionally is unclear and is not described using current audit methods such as the Sentinel Stroke National Audit Programme (SSNAP).[14]

We therefore sought to perform a countrywide audit in Northern Ireland of all patients with AIS who were treated with intravenous t-PA over 4 years to measure component delays in treatment, to benchmark DTN time against national and international recommendations, and to explore factors influencing DTN times locally to help inform future service configuration.

Aim & Objectives

- To measure DTN time for all AIS patients receiving t-PA in Northern Ireland over a 4-year period from 2013-2016.
- To determine the number and proportion of AIS patients receiving t-PA within the 60-minute DTN time target.
- To identify individual or systemic reasons for prolonged DTN times.
- To compare regional results with international registries measuring DTN time in AIS.

Standards/Guidelines/Evidence Base

- American Heart Association / American Stroke Association Guidelines for the early management of patients with Acute Ischemic Stroke 2013(15)
- Royal College of Physicians National Clinical Guidelines for Stroke 2016(16)
- British Association of Stroke Physicians: Stroke Service Standards 2014(17)

Methodology

Sample

A retrospective medical note and imaging review for all patients treated with intravenous t-PA for AIS in Northern Ireland between 1st January 2013 and 31st December 2016.

Patients were identified from local registries at each of the eight hospitals where AIS patients are admitted regionally.

In addition, hospital coding data was obtained from the Health and Social Care Board to determine volume of stroke admissions at each site (defined using ICD10 codes I61-I64).

Data sources

- Log of all AIS patients treated with t-PA at each hospital
- Individual Medical Notes of treated AIS patients
- Imaging Logs (SECTRA PACS/ Phillips iSITE)
- ICD10 codes I61-I64

Audit type

Retrospective criterion based audit

Methodology – including data collection methods

A team of clinicians, including neurologists and stroke physicians, specialist stroke nurses and audit leads agreed to undertake the audit. A lead stroke clinician at each hospital was identified and agreed to provide audit data. Audit meetings were held regularly throughout the audit period to provide updates on data collection and analysis. Additional meetings involving the audit writing committee and audit statistician were undertaken to perform data analysis.

Recorded data included all individual patients treated for AIS using Intravenous t-PA during the specified audit period.

Data collection

An electronic data collection sheet was created, approved by audit departments, and disseminated to each health trust. Data from medical notes and imaging logs for each patient were recorded retrospectively and transposed onto the electronic data collection sheet.

Data measurements obtained from medical notes and neuroimaging review included age, sex, date of onset of AIS, time of AIS symptom onset (or if not available, time when patient was last known to be well), time of arrival at hospital, method of arrival at hospital, use of pre-hospital notification by ambulance service, clinical stroke risk factors and co-morbidities, clinical stroke severity measured using the National Institute for Health Stroke Scale (NIHSS), brain imaging time and modality, time of administration of

intravenous t-PA, and recording of documented reasons for delay (e.g. clinical fluctuation/ diagnostic uncertainty/ uncontrolled hypertension). Use of remote access via telemedicine to perform clinical assessment prior to thrombolysis treatment was recorded where applicable.

Team members contributing to data collection at each site included specialist stroke nurses, specialist trainee doctors, stroke staff-grade doctors and stroke /neurology consultants. A copy of each site's data collection sheet was anonymised at each hospital before being combined with data from other hospitals by the analysis team. Each case had an individual, anonymous audit number assigned.

Data Analysis

A Microsoft Excel spreadsheet was used to combine all data sheets. The data set was cleaned and converted to SPSS (IBM, version 19) format for analysis.
Time based measurements were calculated from individual time recordings for each patient:

- Door to needle time = (Time of t-PA bolus) – (Time of arrival at hospital)
- Onset to hospital arrival time= (Time of arrival at hospital) – (Time of symptom onset/ time last known to be well if onset not witnessed)
- Onset to treatment time = (Time of t-PA bolus) – (Time of symptom onset/ time last known to be well if onset not witnessed)
- Proportion of AIS patients receiving t-PA= [(n receiving t-PA / n admissions with acute stroke at each centre per year)] *100)

Statistical analysis included the Mann-Whitney test for binary group comparisons, Kruskal-Wallis ANOVA or Chi-squared test for multiple comparators for ordinal and categorical data where appropriate. A binary logistic regression for factors associated with DTN time of < 60 minutes was performed.

Caveats

Where an AIS has occurred in someone who is already an in-patient in hospital, arrival time was considered to be the same as symptom onset time for that individual patient. The denominator used for determining proportion of AIS patients receiving t-PA was taken from ICD10 I61- I64 at each acute hospital, obtained from the Health and Social Care Board from 2013-2016. The audit team is unable to independently verify the numbers of stroke admissions for each hospital.

An out-of-hours admission was defined as any which occurred outside of 9AM- 5PM on Mondays to Fridays, including public holidays.

Treating centres included Royal Victoria Hospital, Altnagelvin Area Hospital, Craigavon Area Hospital, Daisy Hill Hospital, Ulster Hospital, South West Acute Hospital, Causeway Hospital and Antrim Area Hospital. Two hospitals within a single Health and Social Care Trust provided data on a trust-wide rather than site-specific level and is referred to as a single centre for all presented results. Hospitals have been anonymised for presentation of results.

Findings

1201 patients received intravenous t-PA in the audit period across Northern Ireland. There were 10556 admissions with stroke to centres providing intravenous thrombolysis treatment resulting in an overall thrombolysis rate of 11.4 % for the 4-year period. The thrombolysis rate increased from 10.7% in 2013 to 12.4% in 2016. The number of patients treated with intravenous t-PA administration varied between centres, ranging from 88 cases (centre 5) to 369 cases (centre 1). The thrombolysis rate within each centre varied from 9.3 % (centre 4 &6) to 15% (centre 1) (Table 1).

Table 1: Number of thrombolysis treatments, number of admissions, and thrombolysis rate for each centre during audit period

Centre	Thrombolysis cases (n)	Stroke Admissions (n)	% of admissions treated with thrombolysis
1	369	2467	15.0
2	103	947	10.9
3	232	2494	9.3
4	128	1378	9.3
5	88	658	13.4
6	179	1889	9.5
7	102	723	14.1
Total	1201	10556	11.4%

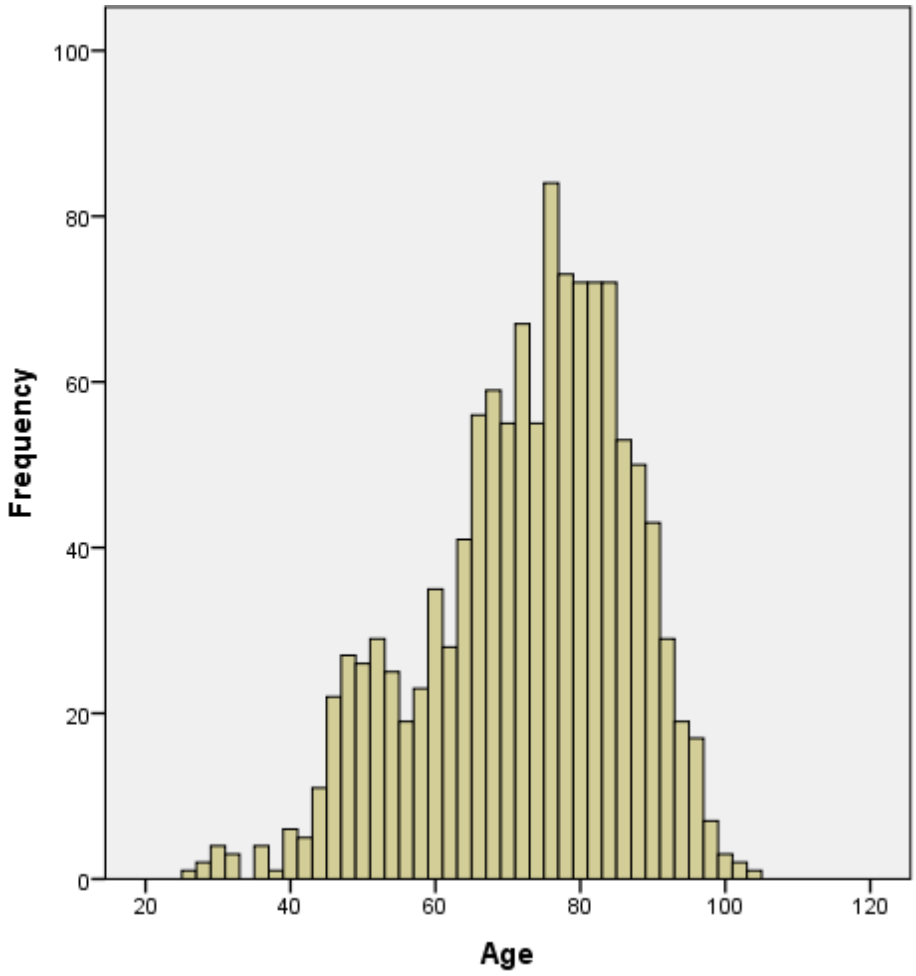
The number of AIS patients treated with intravenous t-PA per year increased over the audit period, from 277 patients in 2013 to 339 patients in 2016 (Table 2).

Table 2: Annual number of thrombolysis cases. (Year of treatment was missing for 1 patient)

Year	Number of Thrombolysis Cases per year
2013	277
2014	291
2015	293
2016	339

The mean age of the AIS patients treated with intravenous t-PA was 72 (SD 14) years (Figure 1).

Figure 1: Age distribution of audit population



615 patients (51%) were male. The median NIHSS for the cohort was 10 (IQR 6-16) indicating a range of moderate to severe strokes clinically. The NIHSS measurement varied between treating centres. The highest stroke severity was seen in centre 5 (median NIHSS 12) while the lowest was seen in centre 6 (median NIHSS 8). The variation in NIHSS between centres was statistically significant (p=0.0019). NIHSS results according to admitting centre are shown in Table 3. Regionally, the median

NIHSS measurement reduced over time. In 2013 and 2014 the median NIHSS measurements were 10 and 11 which reduced to 9 and 8 in 2015 and 2016 respectively. The reduction in clinical severity for treated stroke cases over time (P=0.002) indicated a less severe case-mix in 2015 and 2016 compared to 2013 and 2014 (Table 4).

Table 3: Audit results according to hospital site

	Hospital Site							P
Variable	1	2	3	4	5	6	7	
N (%)	369 (30.7)	103 (8.6)	232 (19.3)	128 (10.7)	88 (7.3)	179 (14.9)	102 (8.5)	-
Door to Needle Time (Mins) (Median +IQR)	49 (35-70)	55 (33-83)	61 (41-88)	55 (41-76)	58 (34-81)	59 (42-86)	33 (19-56)	P<0.001
NIHSS (Median +IQR)	10 (6-16)	11 (7-18)	10 (6-16)	10 (6-17)	12 (6-18)	8 (5-15)	9.5 (6-17)	P=0.019
Onset to Bolus (Median +IQR)	135 (98-180)	126 (100-162)	156 (120-197)	127 (105-169)	139 (101-175)	145 (115-197)	123 (90-155)	P<0.001
Onset to Arrival (Median +IQR)	75 (50-115)	73 (47-95)	88 (63-123)	72 (55-93)	75.5 (56-104)	78 (55-112)	82 (50-118)	P=0.006
DTN < 60 mins? (%)**	233/353 (66.0%)	56/101 (55.4%)	113/227 (49.8%)	93/128 (72.6%)	46/88 (52.3%)	93/178 (52.2%)	83/102 (81.4%)	P<0.001

(** DTN time was not available for 24 patients)

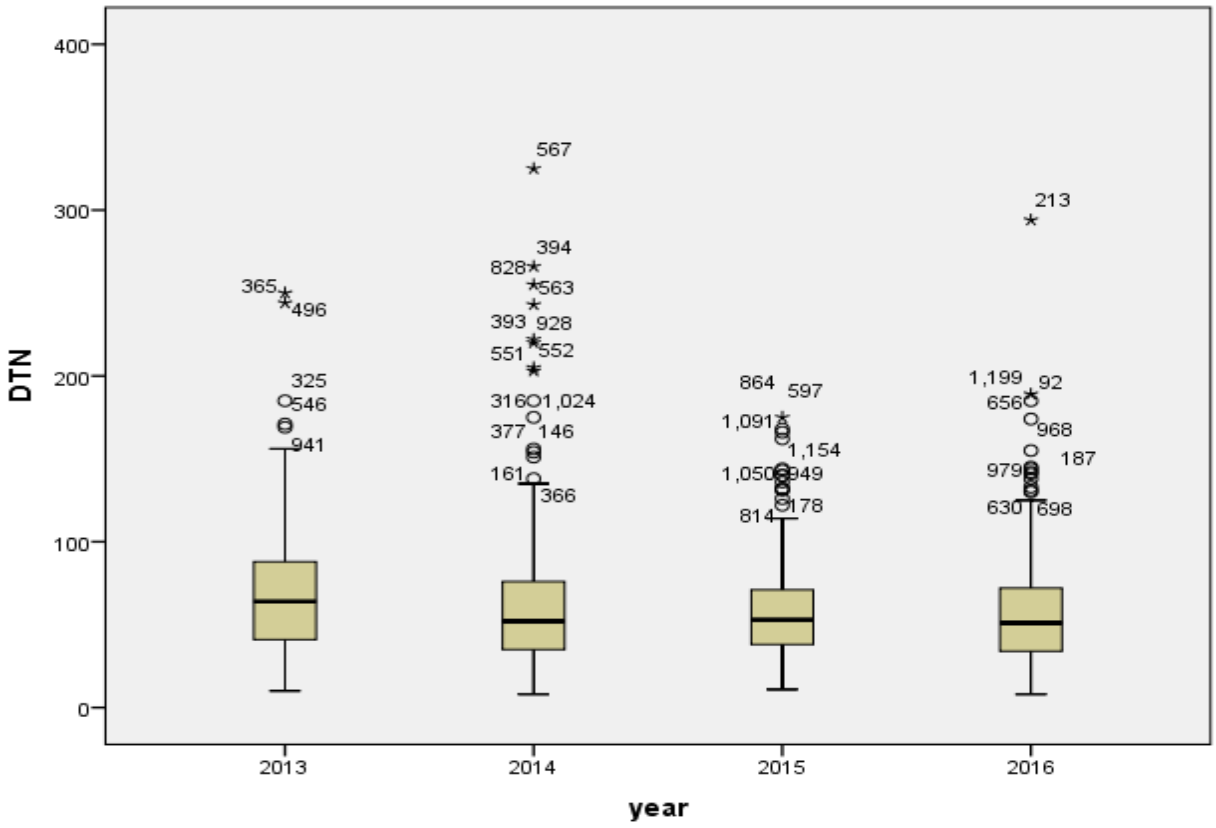
Table 4: Annualised Audit Results

	Year					
Variable	All	2013	2014	2015	2016	P
N (%)	1201 (100)	277 (23.1)	291 (24.2)	293 (24.4)	339 (28.3)	-
Door to Needle Time (Mins) (Median +IQR)	54 (36-77)	64 (41-88)	52 (35-76)	53 (38-72)	51 (34-72)	P<0.001
NIHSS (Median +IQR)	10 (6-16)	10 (6-16)	11 (7-18)	9 (6-16)	8 (5-15)	P=0.002
Onset to Bolus (Median +IQR)	140 (105-182)	145 (110-187)	126 (98-171)	145 (108-185)	135 (101-180)	P=0.019
Onset to Arrival (Median +IQR)	78 (53-111)	73 (48-102)	72 (49-104)	81 (61-119)	83 (55-116)	P=0.001
DTN time <60mins? **	707/1176 (60.1%)	130/274 (47.4%)	179/289 (61.9%)	187/289 (64.7%)	211/324 (65.1%)	P<0.001

(** DTN time not available for 24 patients and year of treatment not recorded for 1)

For 24 patients a DTN time could not be calculated because of missing information. Year of treatment administration was not recorded for 1 case. The median DTN time for the study was 54 mins (IQR 36-77). A statistically significant reduction in median DTN time occurred over the study period, reducing from 64 minutes in 2013 to 51 minutes in 2016 (P<0.001). (Figure 2, Table 4).

Figure 2: Annualised median door to needle time (+ IQR) in minutes



Sixty per cent of AIS patients were treated with a DTN target time of < 60 minutes. The percentage of patients treated with thrombolysis within 60 minutes of arrival in hospital increased from 47.4% in 2013 to 65.1% in 2016 (P<0.001) (Table 4).

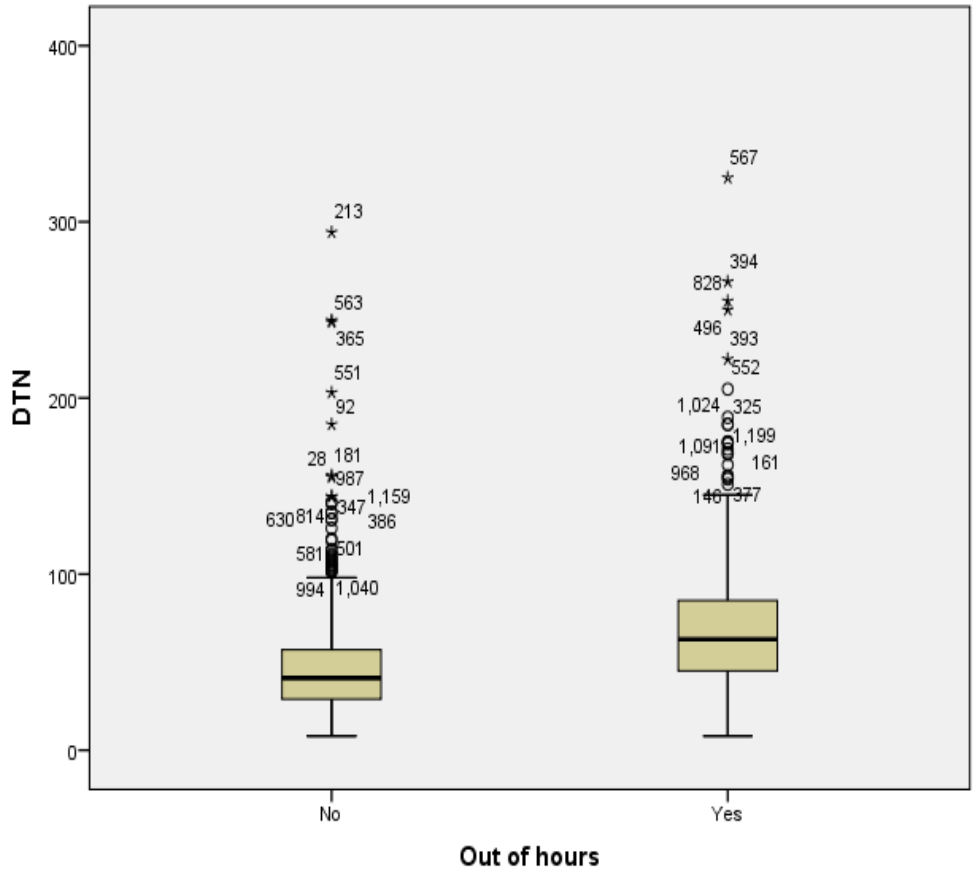
Median DTN time varied between centres. The centre with the shortest DTN times was centre 7, and centre 3 had the longest DTN times (P<0.001) (table 3). Arrival at hospital via ambulance with pre-hospital notification was associated with shorter in-hospital DTN time than use of ambulance without pre-hospital notification. The category entitled Other/Inpatient/Transfer was associated with longer DTN times (P<0.001) (Table 5).

Table 5: DTN time according to arrival method (Door to needle time not recorded for 24 cases)

Method of arrival	N	Door to Needle Time in Minutes (Median + IQR)
Other/Inpatient/Transfer	138	77 (55-113)
Ambulance no pre-alert	181	65 (46-93)
Ambulance with pre-alert	858	49 (34-68)

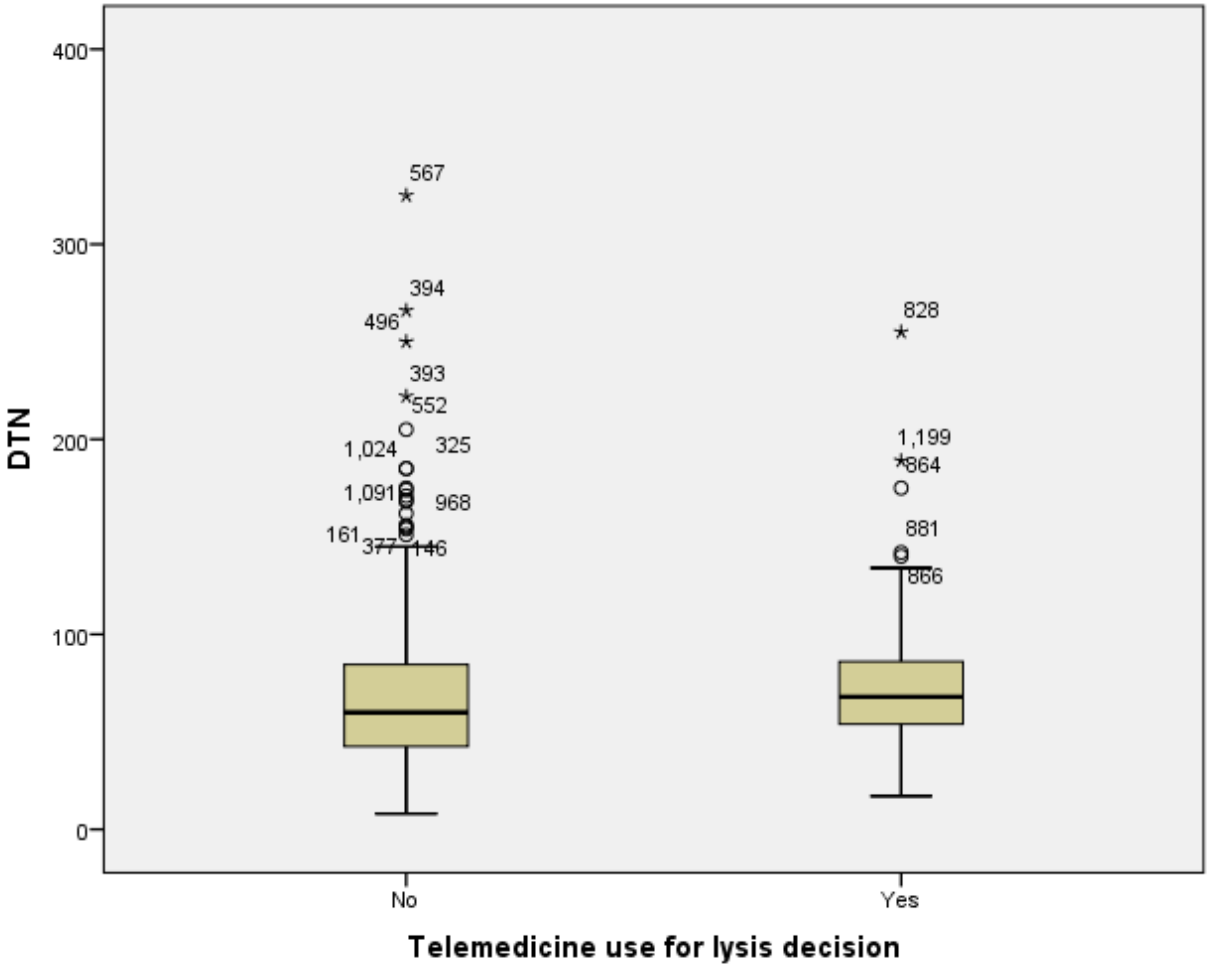
Most intravenous t-PA administration for AIS occurred outside of typical “office hours” (defined as between 9AM and 5PM Monday to Friday) (n=698, 58% of cohort). Patients treated out-of-hours had significantly longer DTN times than those patients treated between 9AM and 5PM on weekdays with a median of 63 (IQR 45-85) and 41(IQR 29-57) minutes respectively (P<0.001, Figure 3).

Figure 3: Comparison of median DTN times in and outside of office hours (9AM-5PM Monday to Friday) (P<0.001)



For patients treated out-of-hours, use of telemedicine consultation was associated with longer median DTN times than face-to-face consultation (median 68 mins, IQR 54-86 and 60 mins, IQR 43-84 mins respectively (P=0.002, Figure 4).

Figure 4: Out-of-hours thrombolysis: Use of telemedicine or otherwise for thrombolysis decisions (Telemedicine =68 mins otherwise =60 mins P=0.002)



A binary logistic regression analysis was performed to determine which factors were associated with achieving a DTN time of 60 minutes or less. Factors which were associated with likelihood for achieving the target of ≤60 minutes were: In-hours versus out-of-hours (OR =0.232 CI 0.173-0.307 P<0.001), arrival with pre-hospital alert or arrival by ambulance (OR = 5.342 CI 3.472-8.219 P<0.001 and OR =2.168 CI 1.288-

3.650, P =0.004), year of treatment (OR=2.318 CI=1.598-3.364P<0.001), and admitting hospital (OR 3.518, CI 1.931-6.410, P<.001). The magnitude of effect for each factor was not uniform. The most significant factor was treatment occurring in-hours rather than out-of-hours, followed by arrival method. Year of treatment and site of treatment had smaller impacts on DTN time than both arriving in-hours and arriving with pre-hospital notification (Appendix 1).

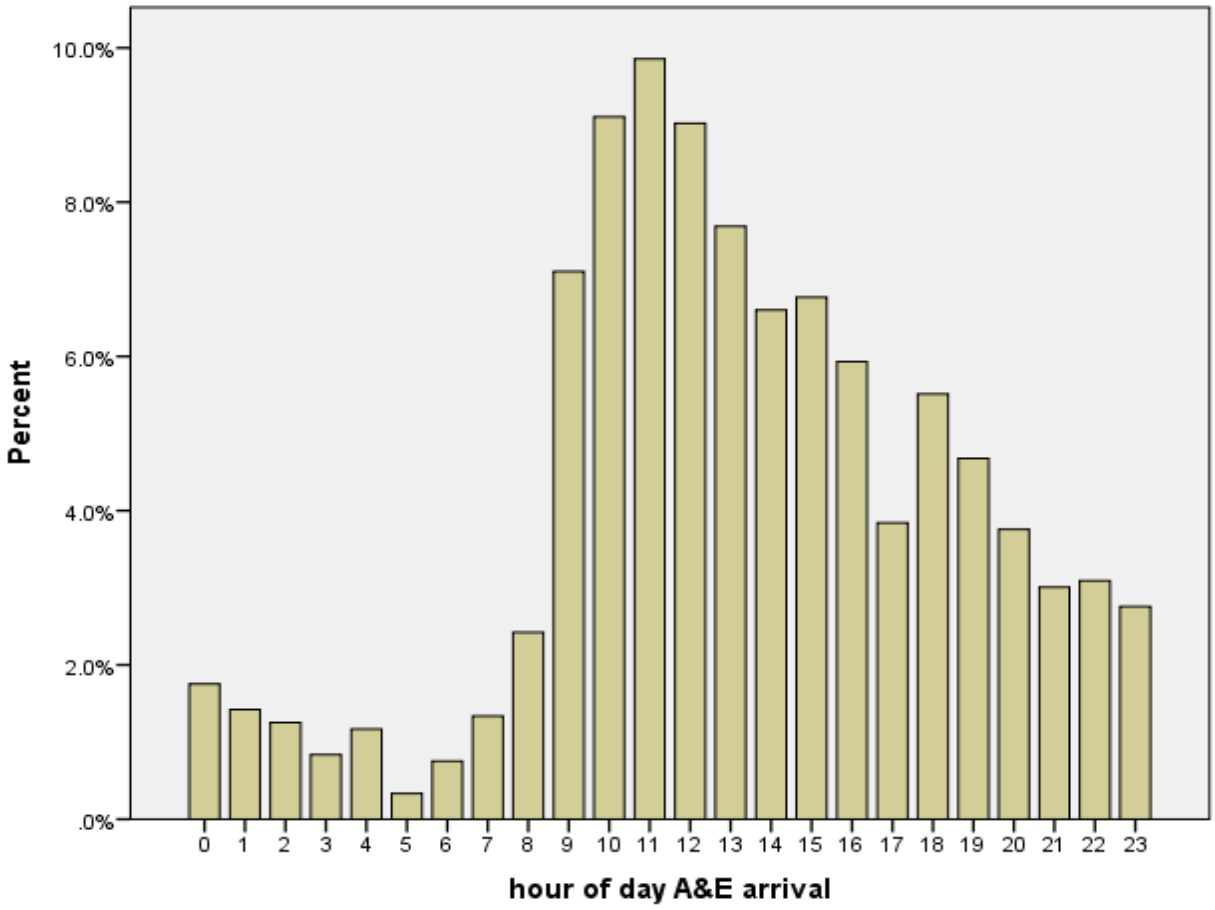
The median time from AIS symptom onset to treatment (OTT) with intravenous t-PA was 140 mins (IQR 105-182). Variation in median OTT time between centres was statistically significant with centre 7 having the shortest OTT at 123 minutes and centre 3 having the longest OTT at 156 minutes (P <0.001, Table 3). Median OTT time reduced slightly from 145 minutes in 2013 to 135 minutes on 2016 (P=0.019) although median OTT times in 2013 and 2015 were similar (Table 4).

Time from symptom onset to hospital arrival (OTH) varied between centres with the longest pre-hospital times seen at centre 3 (88 minutes), while the remainder formed a homogenous group (P=0.006, Table 3).

OTH times showed significant variation over the four years of the audit. AIS patients treated in 2015 and 2016 had longer median OTH time than patients who were treated in 2013 and 2014 (P=0.001, Table 4).

When assessed according to a 24-hour clock period, patients arrived at hospital with AIS symptoms at each hourly period, but the distribution of patient arrival times varied substantially with a peak around late morning and early afternoon. The smallest proportion of cases arrived after midnight and declined until 6-7AM and increased thereafter. (Figure 5, Appendix 2).

Figure 5: Percentage of AIS thrombolysis patients arriving at hospital per hour (0 = midnight)



Areas of good practice

- A high proportion of AIS patients were treated with t-PA during the audit period.
- The absolute number and proportion of eligible cases receiving treatment increased over time.
- The median DTN time and number of patients treated within the 60-minute DTN target compares favourably to international registry data (11).
- There was a trend for shorter DTN times over time.

Areas for improvement

- Patients treated outside of normal working hours, (who represent the majority of t-PA cases) are less likely to achieve short DTN times than patient who present between 9AM and 5PM.
- Pre-hospital stroke care, as measured by the OTH time has not improved in tandem with DTN times and has deteriorated slightly.

Discussion

Patients with AIS have been treated with intravenous t-PA at stroke centres in Northern Ireland according to clinical guidelines and with treatment times that compare favourably to international publications describing intravenous thrombolysis treatment in other populations.

These results show that the absolute number of patients receiving intravenous t-PA for AIS regionally has increased over time from 2013 to 2016 and the proportion of admitted AIS patients being treated with intravenous t-PA has also increased. However, the proportion of AIS patients receiving intravenous t-PA varied between hospitals. The highest proportion of patients receiving thrombolysis treatment was seen in the hospital with the largest absolute number of AIS admissions and intravenous t-PA administrations. This finding is consistent with international trends. [8] However, this audit has demonstrated that smaller hospitals with fewer overall AIS patient admissions and thrombolysis cases were able to achieve high thrombolysis rates and fast DTN times suggesting that variation is not solely related to size of hospital or catchment area. Furthermore, the centre with the shortest median DTN times in this study was one of the smallest centres in terms overall stroke admissions and number of AIS patients treated with intravenous t-PA.

Factors associated with DTN time regionally were not restricted to hospital size or location. Statistically, the single factor with most impact on odds ratio for achieving DTN times of ≤ 60 minutes was the time of day that each patient required treatment. Patients with AIS treated out of normal working hours were less likely to receive timely access to intravenous t-PA. Importantly, this group constituted the majority of patients who are treated with intravenous t-PA and account for a larger portion of the time of day when a stroke may occur.

The members of a stroke thrombolysis team within “office hours” can be very different to other parts of the week. For example, a dedicated stroke nurse with experience in delivering intravenous t-PA as part of a multidisciplinary team is present in most

hospitals during usual “office hours” while nursing staff with less thrombolysis experience and other competing clinical commitments are more likely to attend at other times. Senior medical staff trained in stroke management are not typically present for referrals of AIS patients received out-of-hours but are often present during “office hours”. Emergency department and radiology department staffing levels also show variation according to time of day and each of these departments plays a critical role in the acute stroke thrombolysis pathway.

Given the critical importance of time to stroke treatment in influencing clinical outcome, the major variation seen regionally has important implications for service planning. As approximately 80% of AIS patients were admitted between 8am and 10pm, provision of dedicated stroke teams for longer periods of the day and at weekends requires consideration by service planners (See figure 5/ Appendix 2). Time of day has been associated with DTN time variability in some other populations but not all.[18][19] The fact that out-of-hours admission was not associated with prolongation of DTN time in other NHS hospitals[18] but was a consistent factor in this audit highlights the need for local solutions to inequality in access to rapid t-PA treatment.

Telemedicine is used in some hospitals to permit remote clinical assessment of AIS by a senior clinician and has a proven evidence base for increasing access to t-PA treatment.[20] This audit has shown that telemedicine use can be associated with longer DTN times suggesting that local pathways involving telemedicine may require alterations to minimise delays.

Pre-hospital factors had an important influence on subsequent in-hospital performance and overall time to treatment. DTN time improved over time, but there was a trend towards longer OTH time in 2016 compared to 2013 (Table 4). This has a resultant effect on prolonging OTT time, which is the most relevant measure from the individual patient perspective. Logically any delay in pre-hospital time will counteract the benefits achieved through reducing in-hospital DTN time.

Lack of improvement in pre-hospital triage times has been recorded elsewhere and poses a challenge for stroke service delivery.[21] Novel solutions to pre-hospital care such as mobile stroke ambulances equipped to administer intravenous t-PA for AIS patients are not yet widespread and so far have been limited to large urban populations [22][21]. Patients who were recognised by ambulance teams as potentially presenting as a stroke and had provided advanced notification to hospital benefitted from significantly shorter DTN times compared to patients without pre-alert or other presentations. The impact of pre-hospital services is crucial both in reducing OTT time and influencing in-hospital processes. Further feedback to emergency services to re-enforce the impact that pre-hospital notification has on in-hospital performance is required to maximise the proportion of AIS patients who can receive pre-hospital alert.

AIS patients treated with intravenous t-PA had stroke severity scores consistent with the known trial and meta-analysis data supporting intravenous t-PA use in AIS.[23] There was a trend towards lower NIHSS measurement in treated cases over time. This may show increasing confidence by treating teams in recognising and treating AIS as well as encouragement for delivery of thrombolysis by the Department of Health and individual health trusts. This may also reflect a case-mix of less clinically severe stroke presenting to hospital to account for an increased overall number of AIS patients treated with intravenous t-PA.

Several clinical factors such as past medical history, co-morbidities, uncontrolled hypertension and treatment with medication such as anticoagulants can result in treatment delay for individual patients.[24] These factors were all recorded for this study but did not have a significant impact on treatment times on a national level. Therefore, while individual factors can and will continue to influence treatment time for individual patients, such factors have minimal impact at a population level.

Limitations of this work include lack of recorded outcome after thrombolysis treatment but as our focus was on assessing factors associated with delayed treatment this was not a requirement. This was a retrospective audit and for a small number of patients a

specific DTN time measurement was not recorded due to missing data, but this is a small proportion of all cases. We were unable to analyse imaging data in terms of image interpretation as health and care numbers were not permissible for transfer between trusts. Furthermore, coding data for hospital admissions between centres was not recorded by the study team but was obtained from the Health and Social Care Board and we are unable to verify the number of reported admissions.

This audit has several strengths. We have reported on all AIS patients treated with intravenous t-PA on a national level. Previous registry data publications from selected centres may be associated with selection bias. Other registries suffer from “inflation bias” where cases associated with known reasons for delay are specifically *not* recorded and this can influence how audit results appear.[25][24] The large number of patients in this audit permitted the use of a binary logistic regression analysis permitting a ranking for factors associated with DTN time thereby allowing focus on the areas in most need of investment, namely out of hours and pre-hospital stroke care. By demonstrating the time of arrival for 1201 cases, this analysis can be used to plan for future service delivery, and will also help inform interventional neuroradiology services as most AIS thrombectomy patients will also have been initially eligible for intravenous t-PA therapy.[5]

Conclusion

This audit demonstrates that a high proportion of AIS patients received timely treatment with intravenous t-PA in Northern Ireland from 2013 to 2016. In addition, an increased absolute number and proportion of AIS patients were treated with t-PA over time combined with a trend of reducing DTN time. Variation in treatment times was associated with time of day and arrival method, year and admitting hospital. Specific focus on AIS patients treated out of hours and on pre-hospital services for stroke patients are required to improve DTN time overall and reduce inequality of access to thrombolysis for all AIS patients.

Audit Process Learning Points

Northern Ireland's small geographic size and linked electronic health record and radiology systems offer the potential for similar regional audits and for expanding on this work into the future. However current data protection requirements prevent transfer of health care numbers between trusts. This prevents further analysis particularly on imaging data remotely from the centre where it was obtained. Imaging data can be reviewed remotely from the treating health trust and this is undertaken routinely for clinical purposes but was not permitted for this regional audit. The project team would recommend that a method should be established to improve feasibility for data transfer between trusts for audit, quality improvement and research purposes in the future.

Recommendations

1. There is a need to improve DTN time for patients presenting out-of-hours
2. There is a need to maximise the number of patients with AIS receiving pre-hospital alert from ambulance services where possible
3. Ongoing regular audit of DTN times locally is required to continue the trend of improving door to needle time for all AIS patients seen since 2013
4. Hospitals using telemedicine out-of-hours should investigate local processes to identify any source of unnecessary delay

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Project Team

Name	Job Title/Specialty	Trust	Role within Project (data collection, Supervisor etc)
Project lead			
Dr Ferghal McVerry	Consultant Neurologist	WHSCT	Project Lead. Data collection. Statistical analysis. Write up
Deputy Project Lead			
Dr Mark McCarron	Consultant Neurologist	WHSCT	Project Lead. Data collection. Statistical analysis. Write up
Project Team			
Dr Ivan Wiggam	Consultant Stroke Physician	BHSCT	BHSCT clinical lead for audit. Writing committee.
Annemarie Hunter	Specialist Nurse	BHSCT	Data collection. Communication with all trusts
Dr Michael McCormick	Consultant Stroke Physician	SHSCT	SHSCT Clinical lead for audit Writing committee
Mr Fintan McErlean	Audit manager	BHSCT	Audit over view. Datasheet design. Writing committee
Dr Fiona Kennedy	ST doctor in Neurology	BHSCT	Data collection.
Dr Kevin Dynan	Consultant Stroke Physician	SEHSCT	SEHSCT clinical lead for audit Data collection
Dr Jim Kelly	Consultant Stroke Physician	WHSCT	WHSCT clinical lead for audit Data collection
Dr Djamil Vahdassr	Consultant Stroke Physician	NHSCT	NHSCT clinical lead for audit Data collection.
Dr John Corrigan	Consultant Stroke Physician	WHSCT	WHSCT clinical lead for audit Data collection
Maureen Matthews	Specialist Nurse	SEHSCT	Data collection.
Sheila Grimes	Specialist Nurse	WHSCT	Data collection.

Jacqueline McKee	Specialist Nurse	WHSCT	Data collection.
Dr Pat McCaffrey	Consultant Stroke Physician	SHSCT	Data Collection
Dr Fergal Tracey	Consultant Stroke Physician	NHSCT	Data Collection
Dr Michael Stevenson	Statistician	c/o QUB	Statistical analysis
Emer Hopkins	Regional Stroke Coordinator	HSCB	Data Collection

Appendix 1: Summary of Binary Logistic Regression Model

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Out of hours	-1.467	.146	100.802	1	.000	.231	.173	.307
	Relative to other			68.045	2	.000			
	Ambulance no alert	.774	.266	8.488	1	.004	2.168	1.288	3.650
	Ambulance with alert	1.676	.220	58.107	1	.000	5.342	3.472	8.219
	Relative to 2013			24.657	3	.000			
	2014	.705	.191	13.642	1	.000	2.024	1.392	2.943
	2015	.757	.193	15.310	1	.000	2.131	1.459	3.113
	2016	.841	.190	19.603	1	.000	2.318	1.598	3.364
	Relative to Centre 1			36.187	6	.000			
	Centre 2	.094	.274	.118	1	.731	1.099	.642	1.879
	Centre 3	-.552	.193	8.190	1	.004	.576	.395	.840
	Centre 4	-.026	.243	.012	1	.914	.974	.605	1.569
	Centre 5	-.168	.267	.396	1	.529	.845	.501	1.426
	Centre 6	-.307	.209	2.153	1	.142	.736	.489	1.108
	Centre 7	1.258	.306	16.896	1	.000	3.518	1.931	6.410
	Constant	-.501	.268	3.510	1	.061	.606		

The strongest Factor associated with Door to needle time of < 60 minutes was stroke treatment occurring during normal working hours. Ambulance arrival with / without notification was also a substantial factor for Door to needle time. Year of treatment and centre of treatment were also significant factors but had a smaller relative impact on door to needle time than time of day and arrival method.

Appendix 2: Percentage of cases arriving according to each hour on 24-hour clock

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	21	1.7	1.8	1.8
	1	17	1.4	1.4	3.2
	2	15	1.2	1.3	4.4
	3	10	.8	.8	5.3
	4	14	1.2	1.2	6.4
	5	4	.3	.3	6.8
	6	9	.7	.8	7.5
	7	16	1.3	1.3	8.9
	8	29	2.4	2.4	11.3
	9	85	7.1	7.1	18.4
	10	109	9.1	9.1	27.5
	11	118	9.8	9.9	37.3
	12	108	9.0	9.0	46.4
	13	92	7.7	7.7	54.1
	14	79	6.6	6.6	60.7
	15	81	6.7	6.8	67.4
	16	71	5.9	5.9	73.4
	17	46	3.8	3.8	77.2
	18	66	5.5	5.5	82.7
	19	56	4.7	4.7	87.4
	20	45	3.7	3.8	91.1
	21	36	3.0	3.0	94.2
	22	37	3.1	3.1	97.2
	23	33	2.7	2.8	100.0
	Total	1197	99.7	100.0	
Missing	System	4	.3		
Total		1201	100.0		

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