

# BMJ Open Quality Implementation of a prealert to improve in-hospital treatment of anticoagulant-associated strokes: analysis of a prehospital pathway change in a large UK centralised acute stroke system

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## INTRODUCTION

Intracerebral haemorrhage (ICH) has the worst outcomes of all stroke subtypes, with a case fatality at 1 month of 30%–40% and only 20% regaining independence.<sup>1</sup> Improving the implementation of existing evidence-based and guideline-recommended interventions may lead to improved outcomes.<sup>2</sup> 10%–20% of acute ICH occurs in patients taking oral anticoagulants and this is associated with a high risk of early haematoma expansion.<sup>3 4</sup> Rapid treatment to normalise coagulation reduces this risk and may improve outcomes.<sup>4 5</sup> The first critical step in achieving this is for suspected stroke patients on anticoagulants to undergo immediate brain imaging, allowing ICH to be identified quickly and anticoagulant reversal therapy initiated. Our regional centralised acute stroke system within Greater Manchester and Eastern Cheshire serves a population of 2.85 million and although suspected stroke patients collected by ambulance <48 hours post onset are transported to a hyperacute stroke unit (HASU), only those within 4 hours of onset are prealerted. We conducted a service evaluation to determine whether an additional prealert and emergency transport for suspected stroke on anticoagulants 4–48 hours post onset facilitated rapid imaging and hence reversal of anticoagulation after ICH on HASU arrival. A proposed prealert for anticoagulant-associated suspected strokes was agreed by the Greater Manchester Stroke Operational Delivery Network and introduced on 13 March 2018. The change in practice was disseminated by the North West Ambulance Service (NWAS) to all prehospital clinicians.

## METHODS

Salford Royal Hospital is one of three HASUs in Greater Manchester receiving patients who had an acute stroke from NWAS. Currently within Greater Manchester HASUs, the stroke specialist assessment teams meet only prealerts on arrival at hospital. All HASUs participate in the Sentinel Stroke National Audit Programme (SSNAP). We extracted data on anticoagulant use and onset, arrival and scan times from SSNAP from 1 March 2016 to 31 May 2019. We estimated the effect of introducing the prealert on the door-to-scan times for suspected stroke patients on anticoagulants arriving 4–48 hours post onset by summarising the door-to-scan times as bimonthly medians, then comparing with suspected stroke patients not on anticoagulants arriving 4–48 hours post onset, before and after prealert implementation, using a regression model incorporating time trends, in a difference-in-difference design. Potential negative impacts on other ‘untreated’ groups were evaluated to understand the dependencies between the groups on the door-to-scan times. We also compared door-to-reversal times for patients with anticoagulant-associated ICH that are 4–48 hours post onset against those <4 hours from onset, using our hospital ICH registry. Reversal time was defined as the time at which prothrombin complex concentrate was commenced.

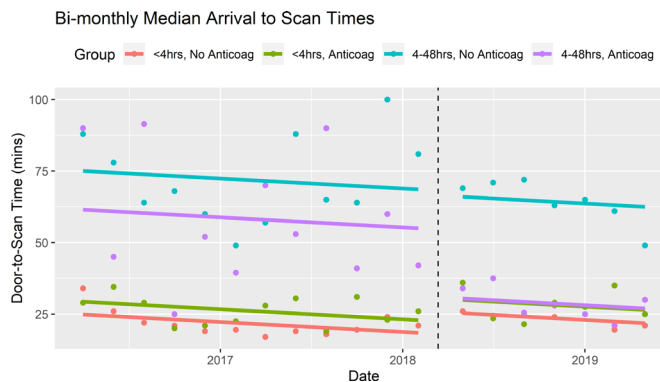
## RESULTS

For patients with anticoagulant-associated ICH >4 hours from onset in the ICH registry (n=49), door-to-reversal time fell from 168 min (IQR: 105–253 min, n=32, missing=3) during the period prior to the prealert (1

**Table 1** Baseline characteristics of patients who had a stroke and care between 1 March 2016 and 31 May 2019 from Sentinel Stroke National Audit Programme extract

|                             | <4 hours, no anticoag (n=1861) |                  | <4 hours, anticoag (n=282) |                  | 4–48 hours, no anticoag (n=3970) |                        | 4–48 hours, anticoag (n=501) |                  |
|-----------------------------|--------------------------------|------------------|----------------------------|------------------|----------------------------------|------------------------|------------------------------|------------------|
|                             | Pre (n=1239)                   | Post (n=622)     | Pre (n=152)                | Post (n=130)     | Pre (n=2560)                     | Post (n=1410)          | Pre (n=255)                  | Post (n=246)     |
| Age, mean (IQR)             | 71.3 (62.0–82.0)               | 70.9 (61.0–82.0) | 77.1 (73.0–83.3)           | 77.7 (73.0–85.0) | 71.2 (61.8–85.0)                 | 71.0 (61.0–82.0)       | 79.8 (75.0–86.0)             | 77.7 (71.3–86.0) |
| Onset to door, median (IQR) | 113 (81–164)                   | 119 (85–170)     | 121 (86–182)               | 117 (83–182)     | 908 (516–1932)                   | 843 (510–1529)         | 890 (528–1707)               | 761 (429–1368)   |
| ICH, n (%)                  | 160 (12.9%)                    | 89 (14.3%)       | 23 (15.1%)                 | 22 (16.9%)       | 193 (7.5%)                       | 95 (6.7%)              | 40 (15.7%)                   | 25 (10.2%)       |
| Door to scan, median (IQR)  | 21 (13–42, 1 missing)          | 24 (15–41)       | 25 (14–45)                 | 29 (18–42)       | 70 (19–138, 4 missing)           | 65 (15–136, 1 missing) | 66 (13–127)                  | 30 (13–66)       |

ICH, intracerebral haemorrhage.



**Figure 1** Time series of the bimonthly median door-to-scan times for patients arriving with a suspected stroke from 1 March 2016 to 31 May 2019.

March 2016 to 12 March 2018) to 131 min (IQR: 88–237 min, n=12, missing=2) after the prealert (13 March 2018 to 30 April 2019), but these changes were not statistically significant. The bootstrapped (n=1000) reduction in median door to reversal was 29 min (95% CI –99 to 150; p=0.758). Across all groups, 4206 patients were admitted before implementation and 2408 patients after (table 1). Difference-in-difference analysis demonstrated a highly significant 31.4 min (95% CI –46.8 to –16.1; p<0.0001) reduction in the bimonthly median door-to-scan time for patients on anticoagulants 4–48 hours post onset following implementation of the prealert (figure 1). For those not directly affected by the prealert (not on anticoagulants or <4 hours post onset), the door-to-scan time change was not significant (table 1).

## DISCUSSION

We have demonstrated that the new prealert procedure caused a highly significant reduction in door-to-scan time for suspected stroke patients on anticoagulants 4–48 hours post onset in our large urban UK centralised acute stroke pathway. Our analysis benefits from a large number of cases and a stable centralised system of acute stroke care. The change was made on a specific date (13 March 2018) for all of the regional ambulance service so implementation was clear cut and complete. We have also adjusted for secular trends that may influence door-to-scan times through difference-in-difference analysis. Within the UK, the Joint Royal Colleges Ambulance Liaison Committee clinical guidelines advise clinicians to follow locally agreed protocols regarding prealert for suspected stroke, with no nationally agreed window given and no special recommendations for patients on anticoagulants.<sup>6</sup> In a recent survey of UK prehospital stroke pathways, most did not admit directly to a specialist stroke service beyond 6 hours from symptom onset and none specify special management of patients on anticoagulants.<sup>7</sup> Our findings show that introducing a prealert for all patients transported to HASUs as suspected stroke and prescribed anticoagulants is likely to facilitate rapid brain imaging and identification of ICH, speed up anticoagulant reversal therapy, reduce

the risk of further haematoma expansion and ultimately improve outcomes for this subgroup of patients who had a stroke.

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