



Improving detection and management of atrial fibrillation after ischaemic stroke in Glasgow (IMPROVE-AF): A quality improvement project

Fiona C Johnston¹, Alan C Cameron²,
Elizabeth Colquhoun², David L Murdoch³,
Jesse Dawson² and Azmil H Abdul-Rahim⁴

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Abstract

Introduction: The use of cardiac monitoring to detect atrial fibrillation (AF) is routine after ischaemic stroke but is often delayed leaving patients at risk from undetected AF. We sought to improve the detection of AF by delivering early prolonged ‘in-house’ cardiac monitoring.

Patients and methods: We collected 3-months of data of people with stroke/transient ischaemic attack (TIA), but without AF, who underwent cardiac monitoring (Phase 1, pre-quality improvement project (QIP)). We then implemented an ‘in-house’ 7-day cardiac monitoring service for 12 months (Phase 2, during QIP).

Results: We included 244 people in Phase 1 and 172 in Phase 2. In Phase 1, 232 (95%) people completed cardiac monitoring. Of these, new AF was detected in 10 (4%). Median time from stroke/TIA onset to availability of the monitoring report in Phase 1 was 50 (interquartile range (IQR): 24–123) days. In Phase 2, 166 (97%) of people completed 7-day cardiac monitoring, with new AF detected in 17 (10%). Median time from onset to availability of the report in Phase 2 was 12 (IQR: 9–15) days. In people with AF detected, ‘in-house’ monitoring reduced the time of stroke/TIA onset to anticoagulant commencement from 41 (Phase 1) to 14 (Phase 2) days.

Conclusions: The QIP has improved AF detection, reduced delays associated with conventional cardiac monitoring and prompted early initiation of oral anticoagulation.

Keywords

ischaemic stroke, atrial fibrillation, cardiac monitoring, oral anticoagulant, service improvement

Introduction

Atrial fibrillation (AF) is a major risk factor for ischaemic stroke. AF is defined as an atrial arrhythmia characterised by uncontrolled, rapid firing of atrial action potentials, with electrocardiographic characteristics that include (i) irregularly irregular R-R intervals, (ii) absence of distinct repeating P waves and (iii) irregular atrial activations.¹ An episode lasting of at least 30s is diagnostic for clinical AF.¹ AF-related stroke is typically more severe than stroke due to other causes, and people with stroke and AF have a high risk of recurrent ischaemic events.^{2,3} Detection of AF in people with acute ischaemic stroke is of major importance because it is an indication for anticoagulation therapy.^{4,5} Oral anticoagulant therapy leads to a 60–70% relative risk reduction of recurrent strokes in those with AF, compared with placebo and is more effective than antiplatelet

therapy.⁶ Approximately 25% of patients with ischaemic stroke either have a history of AF or AF detected on admission but many more are found to have AF on more detailed investigation.

¹Medical School, University of Glasgow, Glasgow, UK

²Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, UK

³Cardiology Department, Queen Elizabeth University Hospital, Glasgow, UK

⁴Institute of Neuroscience and Psychology, University of Glasgow, Glasgow, UK

Corresponding author:

Fiona C Johnston, Wolfson Medical School, University of Glasgow, Wolfson Medical School Building, University Avenue, Glasgow, G12 8QQ, UK

Email: 2299431j@student.gla.ac.uk.

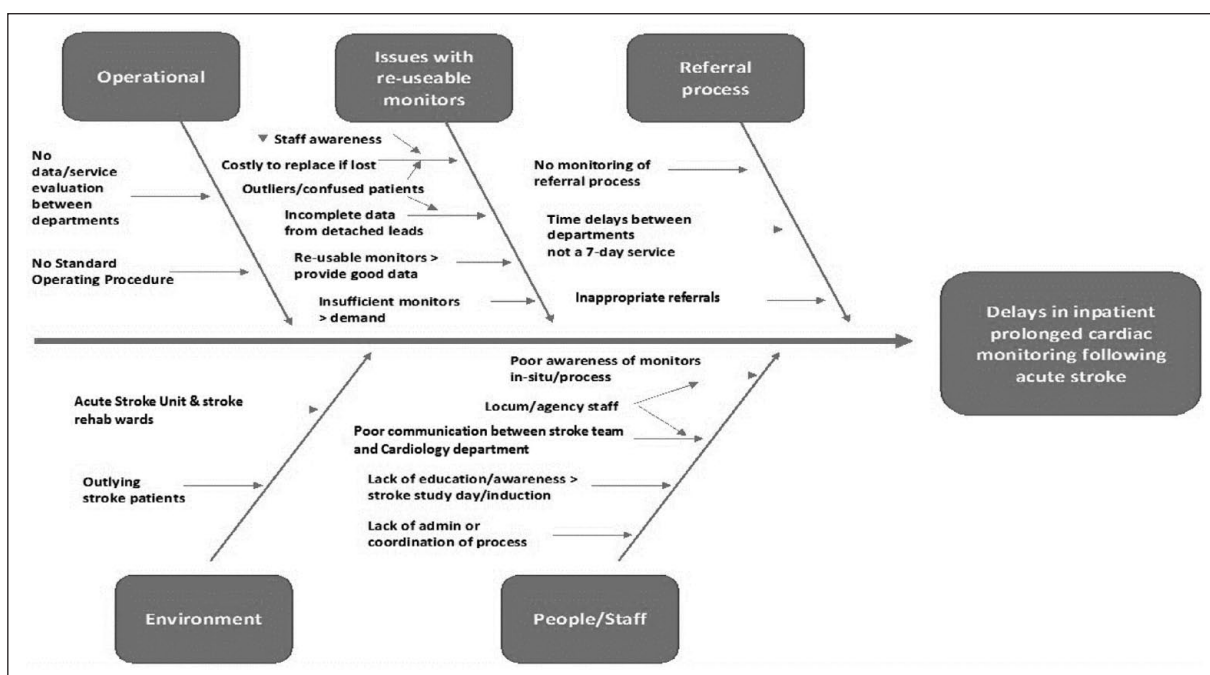


Figure 1. Fish bone analysis – possible root causes for the current delay in inpatient prolonged cardiac monitoring following acute stroke in ASU QEUH.

ASU QEUH: Acute Stroke Unit, Queen Elizabeth University Hospital Glasgow.

Typically, all patients with ischaemic stroke without known AF receive investigation to detect AF and a subset with cryptogenic stroke (ischaemic stroke not clearly attributable to cardio-embolism, large artery atherosclerosis or small vessel disease) undergo more detailed assessment. Latest stroke secondary prevention guidelines from the Royal College of Physicians 2016 acknowledge that longer duration of monitoring (>24 h) after an ischaemic stroke is likely to yield a higher frequency of AF in selected patients, but were unable to provide further precise guidance on ‘how long’ to monitor after an acute ischaemic stroke.⁵ In recent years, clinical trials have demonstrated that more prolonged cardiac monitoring leads to better detection of AF and results in more patients being treated with effective oral anticoagulant treatment.^{7–9}

Recurrent stroke risk is highest in the first 30 days after stroke (12%) and as high as 8% in the first week.¹⁰ The yield from AF monitoring is also greatest early suggesting the need for early investigation for the presence of AF.¹¹ Many clinical services, including our own struggle to deliver this and one of our key service development goals is to address this.^{12,13} All patients with acute ischaemic stroke admitted to Acute Stroke Unit, Queen Elizabeth University Hospital Glasgow (ASU QEUH) receive a 12-lead electrocardiogram (ECG) and inpatient cardiac telemetry. If no AF is detected and there is no obvious cause of stroke, a 3-day Holter monitor is performed. In most patients, this is performed as an outpatient service and there are considerable delays. It is not unusual for these tests to be performed months after stroke. In addition, the latency from stroke onset to prolonged cardiac monitoring had been greatly lengthened with the COVID-19 pandemic. The current local pathway put

patients with acute stroke at a disadvantage for early and optimal detection and management of AF.

We conducted a quality improvement project (QIP) with the aims to deliver a sustainable service to detect new AF in patients with recent stroke and to encourage rapid initiation of oral anticoagulant treatment in the newly diagnosed patients.

Methods

The QIP was conducted from 1st October 2019 to 30th June 2021, under the auspices of an audit and service evaluation. It obtained approval from local Caldicott Guardian board. It was reported using the revised Standard for Quality Improvement Reporting Excellence guidelines.¹⁴

Context

This single-centre study was based at ASU QEUH, Glasgow. It included Glasgow and surrounding catchment areas and was conducted across the acute stroke unit and stroke rehabilitation wards. A collaborative approach was chosen, and the key members involved in design and delivery of the project were experienced in managing stroke patients, had previous quality improvement training or were experts in the field of stroke and AF.

Preliminary preparation

There were various factors that contributed to considerable delays from time to standard inpatient cardiac monitor request and its application, and reporting, offered at ASU

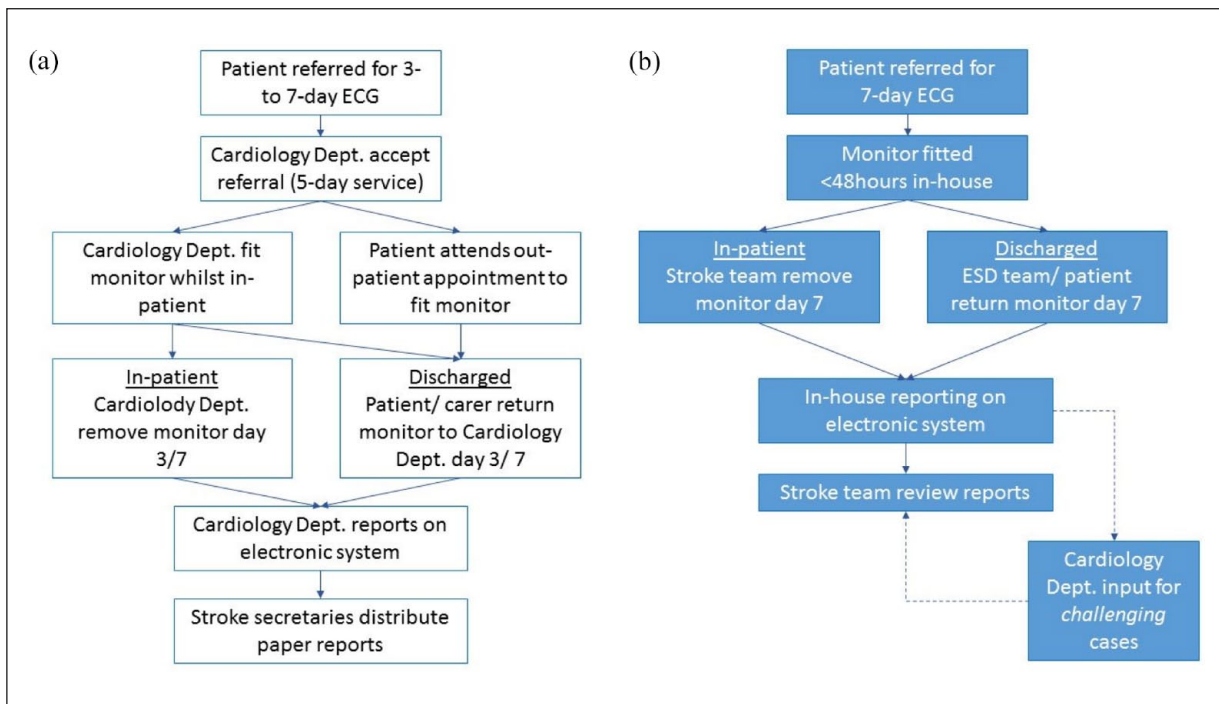


Figure 2. The initial pathway for ECG-monitoring post-stroke compared to proposed QIP pathway in-house: (a) current pathway for ECG monitoring post-stroke and (b) proposed pathway in-house. ECG: electrocardiogram; QIP: quality improvement project.

QEUH (Figure 1 and 2(a)). A fish-bone analysis of the pre-QIP pathway (Figure 1) showed potential delays contributing to a long waiting list. These include a lack of an organised service pathway and insufficient monitors to conduct cardiac monitoring. In some cases, prolonged ECG reports were not available for stroke follow-up clinics leading to subsequent clinics. Such inefficiencies have a great impact on the patient and National Health Service budget, as detailed in the recent Royal College of Physicians (2018) outpatients report.¹⁵ The QIP proposed to streamline the pathway by introducing in-house fitting and analysis of cardiac monitors in patients with recent stroke (Figure 2(b)).

Selection criteria

We included consecutive patients who have experienced recent (<72 h) acute ischaemic stroke/transient ischaemic attack (TIA), admitted to the ASU QEUH, and in whom AF is not identified from history, initial examination, or 12-lead ECG, but who are expected to make a sufficient recovery to justify secondary prevention with antithrombotic treatment. Inclusion of these patients was in line with the RCP Stroke Guidelines 2016 recommendations.⁵

Phases

The QIP was conducted in two phases. The main aim for Phase 1 (pre-QIP) was to provide comparative retrospective data of the standard referral pathway for comparison, in terms of identifying the average time delays (in days) in each step. These include average days to refer, referral to

monitor fitting, days from application to reporting and days from reporting to disseminating the information to the responsible clinician. All patients with stroke/TIA who underwent standard cardiac monitoring (i.e. 3 duration days) were included in the Phase 1 (retrospective) data collection. In Phase 1, all cardiac monitoring was done via the local Cardiology Department. The Phase 2 (during-QIP) was conducted prospectively, over a 1-year period to account for the low numbers of available cardiac monitors that restricted the number of patients that could receive the prolonged monitoring. Patients were included as per the selection criteria.

Phase 1: Pre-QIP – Baseline data. We collected data on patients with acute stroke/TIA admitted to ASU-QEUH who underwent cardiac monitoring, over a period of 3 months from 1st November 2019 to 31st January 2020. This was to provide recent context and baseline data. We followed up these patients as they underwent the pre-QIP referral pathway between stroke team and Cardiology Department.

Phase 2: QIP – 7-day cardiac monitoring. Eligible patients were identified by clinicians who were providing clinical care. Although the cardiac monitoring is part of routine standard of care, patients could ‘opt-out’ of the 7-day cardiac monitoring if they wished and would undergo the standard 3-day cardiac monitor when this could be carried out. Patients were informed of the rationale for the additional cardiac monitoring. We only included patients who were able to provide consent for the prolonged cardiac monitoring, aggregable to anticoagulation if indicated and deemed suitable for anticoagulation if AF detected by treating clinician.

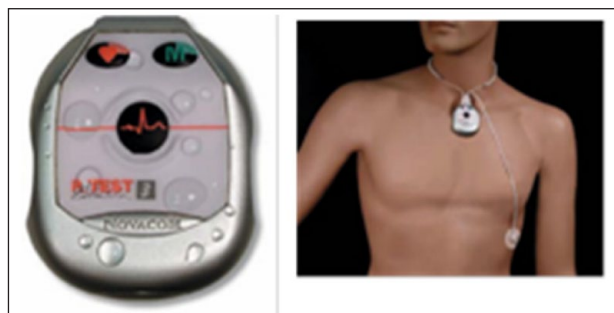


Figure 3. Novacor© R-test Evolution 3 cardiac monitoring device.

The patients received cardiac monitoring by a programmable loop event recorder (Novacor© R-test, Novacor UK Ltd, Lenham, Kent, UK; Figure 3) for up to 7 days, or sooner if AF was detected. An episode lasting of at least 30 s is diagnostic for clinical AF. We used the Novacor© arrhythmia detection software to facilitate device data download and subsequent confirmation of analysed data by core members of the QIP. AF was diagnosed by trained stroke physicians. The team is experienced with non-invasive cardiac monitoring devices, with involvement in previous randomised controlled trials using the Novacor© R-test devices.^{11,16} We informed the treating clinician of the ECG findings. This was a collaborative project with the local cardiology team and a system was in place for cardiology to review cardiac monitoring outputs if necessary. Data were prospectively collected from 1st February 2020 to 30th April 2021 (including 3-month delay due to the COVID-19 pandemic).

Equipment

We used the Novacor© R-Test device to conduct prolonged cardiac monitoring. The device was donated by the local Glasgow stroke research team. The devices were initially used in a previous randomised controlled trial.¹³ Each device weighs <50 g and garners cardiac rhythm data through two electrodes, placed respectively at the sternum and apex. This approximates to a CM5 lead configuration. The R-test device used a loop recording system to capture cardiac rhythm episodes of 30-s duration (the maximum period of dysrhythmia recordable with the R-test device settings used in the study), triggered automatically by possible AF recognition. Ten seconds of rhythm preceding and 20 s after the trigger point were captured.

Measures

The measures that were considered were the time from stroke/TIA to administer monitoring, time to ECG analysis, time to ECG report available to the treating clinician, time to anticoagulation commencement and the proportion of new AF detection. The relevant time points were obtained from electronic medical records. We provided descriptive summary statistics. Unadjusted comparisons of pre-QIP (Phase 1) and QIP (Phase 2) groups were

Table 1. Baseline characteristics for Phase 1 and Phase 2 cohorts.

	Phase 1 (pre-QIP)	Phase 2 (during QIP)	p Value
Total, n	244	172	
Median age, years (IQR)	71 (61–80)	67 (56–78)	$p=0.13$
Male, %	55	58	$p=0.51$
Previous stroke/TIA, %	23	20	$p=0.44$
Congestive heart failure, %	1	1	$p=0.72$
Hypertension, %	63	52	$p=0.02$
Diabetes mellitus, %	27	18	$p=0.03$
Current smoker, %	16	30	$p=0.000536$
NIHSS, median (IQR)	3 (1–6)	4 (2–7)	$p=0.65$
Received IV thrombolysis, %	14	19	$p=0.15$

IQR: interquartile range; IV: intravenous; NIHSS: National Institutes of Health Stroke Scale (on admission); QIP: quality improvement project; TIA: transient ischaemic attack.

conducted using two-sample t test, Mann–Whitney U test, two proportions test or the χ^2 test depending on the distribution and nature of the data.

Results

We included 244 patients with recent stroke/TIA in Phase 1 and 172 in Phase 2. Baseline characteristics for Phase 1 and Phase 2 are displayed in Table 1. Overall, the baseline demographics for Phase 1 and Phase 2 cohorts were comparable, apart from hypertension, diabetes and smoking status. Patients included in Phase 1 were older compared to Phase 2 cohort. In Phase 1, 232 (95%) patients completed cardiac monitoring of variable durations. Of these, new AF was detected in 10 (4%). Median time from stroke/TIA onset to availability of formal monitoring report in Phase 1 was 50 (interquartile range, IQR: 24–123) days (Figure 4).

In Phase 2, 166 (97%) patients completed the 7-day cardiac monitoring. Six patients did not complete the monitoring due to intolerance, lead-monitor detachment or lost device. Of the completely monitored patients, new AF was detected in 17 (10%) ($p=0.02$, difference compared to Phase 1). Median time from onset of stroke to availability of formal report in Phase 2 was 12 (IQR: 9–15) days (Figure 4) ($p<0.01$, difference compared to Phase 1). We also identified five cases of other clinically important arrhythmias that prompted urgent referral to Cardiology (one case of ventricular tachycardia and four cases of heart block).

In patients with new AF detected, the provision of ‘in-house’ monitoring significantly reduced the time of stroke/TIA onset to oral anticoagulant commencement from 41 (Phase 1) to 14 days (Phase 2) (Figure 5), $p<0.01$ compared to Phase 1. Of the 17 new cases in Phase 2, the majority (10) were detected between days 0 and 2 after stroke/TIA (Figure 6).

We delivered training to additional nursing staff and support staff to support fitting of monitors. The liaison with cardiology services worked well and this pathway is now established.

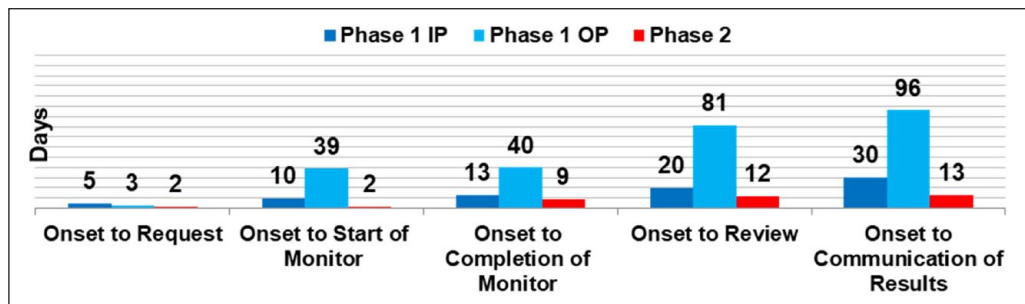


Figure 4. Time taken from onset of stroke/TIA to complete monitoring for Phase 1 and Phase 2. IP: inpatient; OP: outpatient; TIA: transient ischaemic attack.

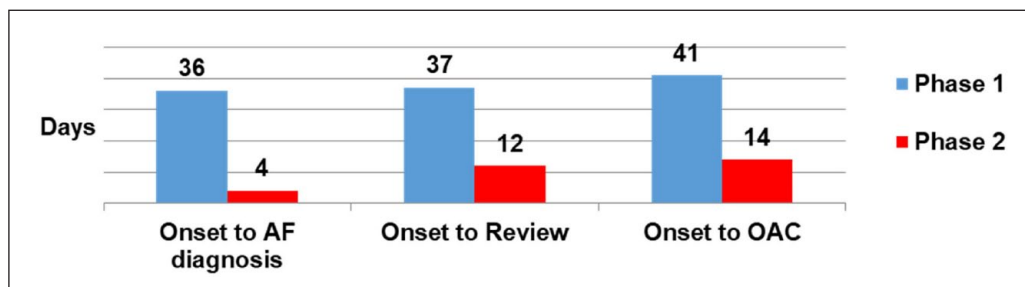


Figure 5. For people with new AF; time taken from onset of stroke/TIA to detect AF, review results and initiate OAC.*** AF: atrial fibrillation; OAC: oral anticoagulant; TIA: transient ischaemic attack.

Discussion

Our QIP-Improving the Detection and Management of Atrial Fibrillation after Ischaemic Stroke in Glasgow aimed to address an unmet need in secondary prevention after an acute ischaemic stroke/TIA and demonstrated the feasibility of delivering timely ambulatory ECG monitoring in acute stroke/TIA patients in a real-world setting. We have shown that an ‘in-house’ cardiac monitoring service has improved AF detection and reduced delays associated with conventional monitoring. It also prompted early initiation of oral anticoagulation.

Our ‘in-house’ AF detection rate is comparable to other studies investigating the detection of AF. In a systematic review involving 5,038 subjects, the detection rate for new AF was 11.5%.¹⁷ This is comparable to our finding of 10%. In addition, our AF detection rate is also comparable to a smaller sized QIP, ‘Quality Improvement in Atrial Fibrillation Detection after Ischaemic Stroke’ study which reported AF detection rate of 14.7%.¹⁰ A higher rate of AF detection was demonstrated with more prolonged cardiac monitoring post-stroke, for example, ‘The 30-Day Cardiac Event Monitor Belt for Recording Atrial Fibrillation after a Cerebral Ischemic Event (EMBRACE)’ trial found AF in 16% of people in the prolonged cardiac monitoring group.⁸

There were 413 patients with stroke/TIA who passed through the acute stroke unit QEUH, with 59% of patients undergoing cardiac monitoring in Phase 1. In Phase 2, approximately 1,200 passed through the stroke unit, with 14% of patients included in the QIP exercise. Patients in Phase 2 were included as per the selection criteria. Phase 2 was also conducted during the COVID-19 pandemic. The

lack of monitors and recruitment difficulties during the pandemic meant that there were less patients in Phase 2 in comparison to Phase 1. However, we were interested in the average time (improvement/delays) in each step, compared to Phase 1. Even though the total number of patients in the two phases were different, the QIP has demonstrated a reduction in the average delays of AF detection post-stroke and time to effective anticoagulation, compared to the standard practice.

We found that there was higher pick-up rate of AF in Phase 2, compared to Phase 1. Patients who received 7-day ‘in-house’ cardiac monitoring had their device fitted quicker than those who received traditional 72-h monitoring via the old pathway. Subsequently, those who received ‘in-house’ monitoring had little delay between detection of AF and prescription of oral anticoagulant.

There is still uncertainty regarding the optimal length of cardiac monitoring post-stroke. In this QIP, 97% of participants completed 7-day monitoring. Kamel et al.¹⁸ demonstrated that when patients received 21-day cardiac monitoring, only 64% of patients completed monitoring with 25% of patients being non-compliant. In EMBRACE-AF (2014), only 62% of participants completed 4 weeks of monitoring.⁸ We found that our 7-day monitoring is well tolerated by patients with high completion rate.

An increase in rate and timeliness of AF detection compared to pre-QIP would facilitate early anticoagulation where appropriate. This would likely reduce recurrent strokes, with implied cost savings. Given that this QIP was not a controlled study, any extrapolation of data to infer cost-effectiveness or number needed to treat would have to be interpreted with caution. Data from the Scottish Stroke

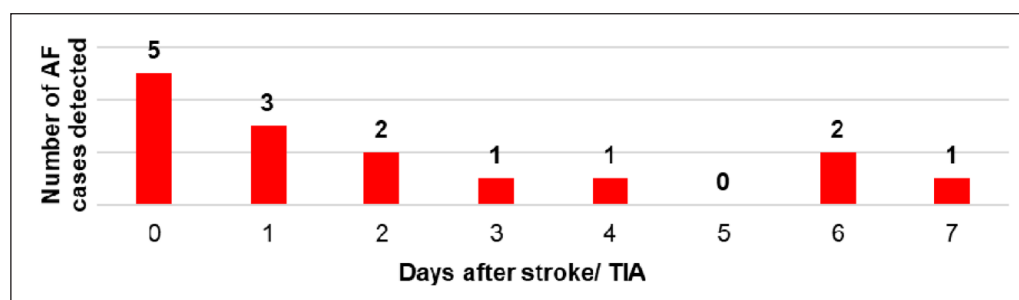


Figure 6. Number of cases of AF detected on each day of monitoring.
AF: atrial fibrillation.

Care Audit indicate that there are approximately 1,200 people with stroke or TIA admitted to the QEUH stroke service per year.¹⁹ Of these, approximately 700–800 are ischaemic stroke survivors. We estimate based on available epidemiological data that approximately 20% of these will have AF detected on history, baseline ECG or inpatient telemetry (5%). Approximately 10% will have large vessel atherosclerosis requiring endarterectomy and some will have a small vessel aetiology (20%). As a result, there will be approximately 400 patients per year in the QEUH who may benefit from more prolonged cardiac monitoring. Assuming a detection yield of 10%, an additional 40 patients with AF would be detected using the QIP pathway. The incidence of recurrent stroke in these patients would depend on the presence of other risk factors but if we assume that patients are at least the age of 65 and have at least one additional risk factor, then the stroke rate will likely range from 4% to 18% per year and the number of strokes in this group could be as high as 7 per year. Effective anticoagulation in these patients is likely therefore to prevent in the region of 4 to 5 strokes per annum.

Incidence of atrial arrhythmia is higher after stroke.⁴ However, in many parts of the world, cardiac monitoring resources are limited. Better patient selection approaches would ensure that patients who are at the highest risk of AF detection receive the appropriate prolonged cardiac monitoring. For example, Hayiroğlu et al.²⁰ showed that P wave morphology could be assessed to select patients for the proposed screening algorithm. In addition, Cameron et al.²¹ identified multimodal biomarkers including P-wave morphology that could help select patients for cardiac monitoring after ischaemic stroke/TIA. In areas where resources are limited this could help pre-select patients who are likely to have AF before prolonged cardiac monitoring.

Limitations

Our project had several limitations including low numbers of available cardiac monitors that restricted the number of patients that could receive the prolonged monitoring. Patients were included if they were able to consent for the prolonged cardiac monitoring and deemed suitable for anticoagulation if AF detected by treating clinician. This may have contributed to a selection bias where only patients with milder stroke were included. AF is more common with advancing age, and stroke due to AF tends to have greater

disability that may impair the ability to consent. Patients who were unable to consent would undergo the standard cardiac monitoring as per local protocol.

There was also a difference in the number of patients in each phase. Phase 1 had 244 participants while Phase 2 had 172 participants. The main reason is that we included all patients who experienced a stroke and cardiac monitoring in Phase 1. In Phase 2, we required patient's consent for inclusion to the QIP. Therefore, by default we included patients with less severe stroke in Phase 2. Patients who were able to consent were likely to have experienced less severe stroke with less associated cognitive deficit. In addition, AF is associated with older age and more severe strokes. However, even with younger patients and less severe strokes in Phase 2, we still demonstrated a higher rate of AF detection and promoted early start of effective anticoagulation treatment, compared to patients in Phase 1.

There was also a difference in clinical characteristics between the two phases. Patients in Phase 1 were older, whereas patients in Phase 2 were younger. This may have impacted on the clinical characteristics of the two groups for several reasons. First, younger patients are more likely to smoke and drink alcohol in comparison to older patients. However, younger patients are less likely to have conditions such as hypertension and diabetes in comparison to older patients. Second, during the pandemic, elderly patients were less likely to present to hospital and therefore less older patients were included in Phase 2. This may explain the difference in clinical characteristics between the two groups.

There were also several logistical challenges associated with the implementation of the QIP pathway. First, the potential loss of re-usable cardiac monitors. For this QIP, we have lost one cardiac monitor and several ECG leads. Second, we had limited administration support. All aspects of the QIP: from putting on the monitors, chasing up the monitors from patients, and reporting and communication of the results were performed by the core team. Third, the COVID-19 pandemic introduced delays in patient selection and reporting of the monitors. It also brought obstacles to effective education and training of staff. The QEUH houses one of the UKs busiest stroke services and the QIP was conducted by members of the local stroke research team that acted as its core staff. However, the proposed service may be much trickier to implement in a district or local hospital that lack core QIP staff.

Conclusion

The QIP has improved AF detection and reduced delays associated with conventional cardiac monitoring. It also prompted early initiation of oral anticoagulation. The change to 'in-house' cardiac monitoring is feasible. There is an urgent need for an investment to develop sustainable protocols as well as a coordinated multidisciplinary effort for its delivery in wider clinical practice.

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Declaration of conflicting interests

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