

# Quality Improvement in Atrial Fibrillation detection after ischaemic stroke (QUIT-AF)

Authors: Amit K Kishore,<sup>A</sup> Susan Fletcher,<sup>B</sup> Denise Mason,<sup>C</sup> Christopher Ashton,<sup>D</sup> Jane Molloy<sup>E</sup> and Alan Fitchet<sup>F</sup>

## ABSTRACT

### Background

Paroxysmal atrial fibrillation (PAF) is a frequent cause of recurrent stroke but can be difficult to detect because of its episodic and often asymptomatic nature. We sought to improve rate of PAF detection through a quality improvement project (QIP) to deliver early prolonged inpatient cardiac monitoring on the stroke unit (SU).

### Methods

A structured protocol for cardiac monitoring using 5-day event recorders was established. 'In-house' cardiac monitoring was implemented. Performance data on this change in service was analysed prospectively and summary statistics obtained.

### Results

One-hundred and two ischaemic stroke (IS) patients undertook 5-day event recorder monitoring. Provision of monitors as an inpatient (IP) increased from 20% (pre-QIP pilot 2018) to 65.7% (during QIP). New AF was detected in 15 patients (14.7% vs 8.6% pre-QIP pilot 2018) with majority of new AF (13 patients; 19%) detected when monitors applied early (IP) after IS.

### Conclusion

Although this study had a number of limitations, it did demonstrate that early and prolonged non-invasive IP cardiac monitoring could be delivered 'in-house' on the SU and improve AF detection rates.

**KEYWORDS:** Ischaemic stroke, paroxysmal atrial fibrillation, cardiac monitoring, anticoagulation

**DOI:** 10.7861/clinmed.2020-0322

**Authors:** <sup>A</sup>consultant and honorary senior lecturer in stroke medicine, Greater Manchester Comprehensive Stroke Centre, Salford, UK and University of Manchester, Manchester, UK; <sup>B</sup>advanced clinical practitioner in stroke medicine, Greater Manchester Comprehensive Stroke Centre, Salford, UK; <sup>C</sup>senior cardiac physiologist, Salford Royal NHS Foundation Trust, Salford, UK; <sup>D</sup>network coordinator, pre-hospital stroke group and associate lecturer, Greater Manchester Stroke Operational Delivery Network (GMSODN), Salford, UK; <sup>E</sup>consultant neurologist and clinical lead for GMSODN, Greater Manchester Comprehensive Stroke Centre, Salford, UK; <sup>F</sup>consultant cardiologist, Salford Royal NHS Foundation Trust, Salford, UK

### Background

Cardioembolism accounts for at least a quarter of all ischaemic strokes (IS), mainly due to atrial fibrillation (AF).<sup>1,2</sup> Detecting paroxysmal AF (PAF), however, is challenging given its intermittent and often asymptomatic nature.<sup>3</sup> Recurrent stroke risk is highest in the first 30 days after stroke (12%) and as high as 8% in the first week, suggesting the need for early evaluation of stroke patients for detection of AF.<sup>4</sup> If AF is detected, treatment with oral anticoagulants is recommended at or within 2 weeks of IS, to reduce the risk of further events.<sup>5</sup>

Twelve-lead electrocardiography (ECG) has poor sensitivity in detecting PAF but recent meta-analyses suggest prolonged cardiac monitoring (>24 hours) and/or sequential monitoring strategies increase PAF detection in acute ischaemic stroke patients.<sup>6,7</sup> In the UK, current stroke secondary prevention guidance (RCP, 2016) acknowledges that a longer duration of ECG monitoring (>24 hours) in selected patients after IS is likely to yield a higher frequency of PAF detection, but does not specify 'how long', 'when', 'where' or 'how' to monitor such patients.<sup>5</sup> In addition, provision of prolonged cardiac monitoring acutely in stroke patients will have logistical and resource implications, yet extended ECG monitoring up to 7 days or even longer has been shown to be cost-effective.<sup>8,9</sup> A recent survey of stroke physicians across the UK identified wide spread variation and significant delays in delivery of prolonged cardiac monitoring after IS suggesting an urgent need to develop a consensus and a protocolled approach.<sup>10</sup>

The purpose of this project was to improve rates of detection of PAF at Salford Royal NHS Foundation Trust (SRFT) by delivering early prolonged cardiac monitoring after an acute IS.

Our primary aim was that by 31 July 2019, 90% of inpatient (IP) acute IS patients, suitable for long-term anticoagulation and within the Salford area, would receive 5 days of cardiac monitoring using event recorders within 14 days of their acute IS.

### Methods

The project was conducted from 01 July 2018 to 31 July 2019 with guidance from 'Haelo', an innovative NHS improvement science centre based in Salford, who support, design and deliver quality improvement programmes.<sup>11</sup> It was reported using the revised Standards for Quality Improvement Reporting Excellence guidelines.<sup>12</sup>

Context

This single-centre study was based at SRFT, the Greater Manchester Comprehensive Stroke Centre. It included the Salford catchment area and was conducted across the hyperacute and acute stroke units (39 beds) and a stroke rehabilitation unit (15 beds). A collaborative approach was chosen and the key members involved in design and delivery of the project were either experienced in managing stroke patients, had previous quality improvement training or were experts in the field of atrial fibrillation. In addition, members of the Stroke Service multidisciplinary team (MDT) were involved in the plan, do, study, act (PDSA) cycles and project delivery (including stroke flow and discharge coordinators; ward managers; and SU nurses).

Strategy

The interventions were designed to address the issues of ‘where’, ‘how’ and ‘when’ to ECG monitor suitable stroke patients. PDSA cycles were used to trial the components of the improvement intervention as they were implemented in order to achieve the primary aim.

Pre-intervention stage

Process mapping (Fig 1) was undertaken (August 2018) to understand the logistics behind the delivery and interpretation of cardiac monitoring for this patient group. In addition, pilot data was collected over a period of 3 months from 01 April 2019 to 30 June 2019 to provide recent context and baseline data.

Intervention stage

PDSA cycle 1

- > ‘How’ and ‘when’ to monitor: A standard protocol for IP cardiac monitoring requests (Fig 2) was established. Five days of cardiac monitoring with a Novacor R Test event recorder, an ambulatory ECG monitor, utilising AF detection software was chosen as this device had been validated previously in a randomised controlled study among acute ischaemic stroke patients.<sup>13</sup> Clinicians involved in stroke patient care were advised to request the 5-day monitoring as soon as possible and within 48 hours of admission. Posters were placed across the units to publicise and instruct staff.
- > ‘Where’ to monitor: Four event recorders were ‘loaned’ from the cardiology department such that stroke unit (SU) staff could apply monitoring directly to IS patients – an ‘in-house’ approach. Training was initially delivered face-to-face, by a member of the core QIP team from the cardiorespiratory investigations (CRI) unit to the stroke clinical team (flow coordinators, ward managers). This involved training from the user manual for the Novacor R.Test device and a ‘hands on’ patient demonstration. In particular, choice of leads, inserting new batteries, initialising the unit, connecting patient cable to the monitor and placing the electrodes on the patient were all described and demonstrated. The user manual was made available on the wards and CRI team assistance was available as necessary. This training was cascaded down to the wider members of the stroke MDT (including nursing staff and health care assistants) for implementation on a day-to-day basis over a 2-week period. The flow-coordinators were vital in identifying

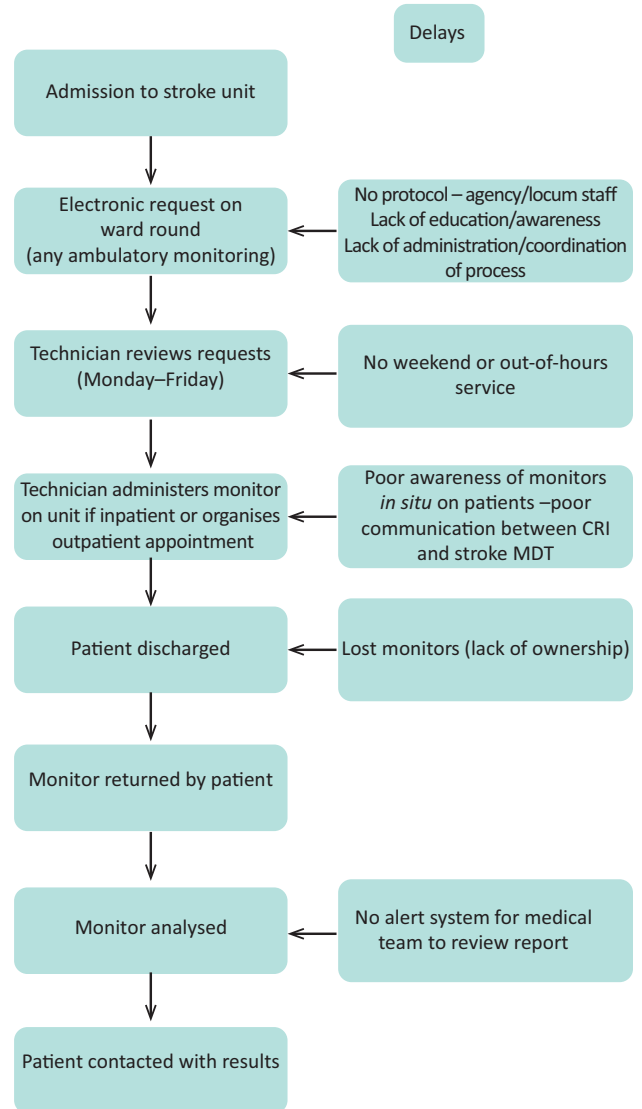


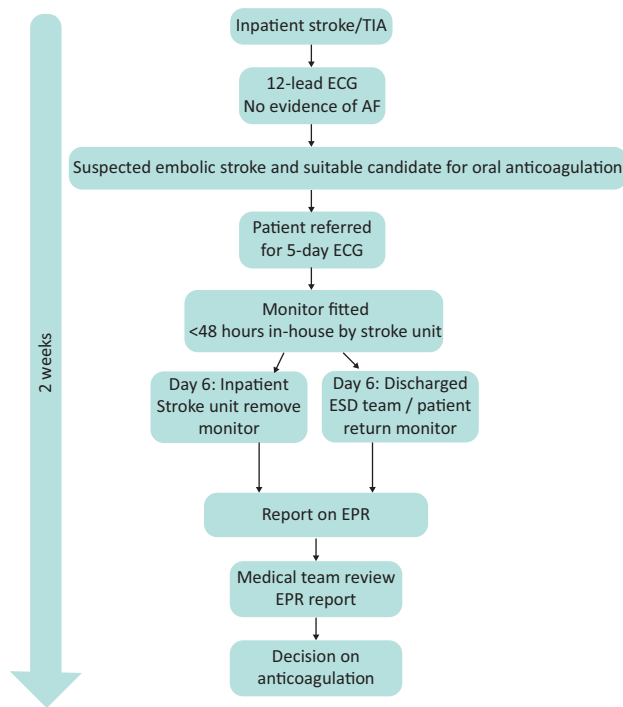
Fig 1. Process map to understand the logistics behind the delivery and interpretation of cardiac monitoring. CRI = cardiorespiratory investigations unit; MDT = multidisciplinary team.

patients across the stroke wards requiring ECG monitoring. All members of the MDT could apply monitors as and when necessary.

Novacor arrhythmia detection software was installed on the SU computers to facilitate device data download and subsequent confirmation of analysed data by CRI physiologists. The overall responsibility of ensuring sufficient training and transcription of the results lay with core members of QIP.

PDSA cycle 2

The stroke flow coordinators were tasked with identifying patients requiring 5-day cardiac monitoring at the daily SU MDT meetings. The community-based early supported discharge (ESD) team members, who see patients within a week of discharge, were engaged to retrieve cardiac monitors from patients for prompt return and analysis.



**Fig 2. Standard protocol for inpatient cardiac monitoring requests after acute ischaemic stroke or transient ischaemic attack.** AF = atrial fibrillation; ECG = electrocardiography; ESD = early supported discharge; EPR = electronic patient record; TIA = transient ischaemic attack.

## Study of the interventions

Primary outcome data included process of care, time to monitor patients and AF detection rates. Data from the Stroke Sentinel National Patient Audit (SSNAP) database, which records pseudo-anonymised data of all stroke admissions in the UK along with relevant electronic patient records, were used to extract data.<sup>14</sup> Data were prospectively collected from 22 January 2019 to 31 July 2019.

## Measures

The measures that were considered were time from stroke to administer monitoring, time to ECG analysis, proportion of IP vs outpatient (OP) requests, and rate of new AF detection. Data were analysed descriptively using summary statistics. In addition, comparison of proportions (PAF detection) between IP and OP monitoring was undertaken using 'N-1' chi-squared test. StatsDirect software for MS Windows was used for statistical analysis. Statistical significance was set at  $p=0.05$ .

## Results

A total of 158 ischaemic stroke patients were admitted during the period of QIP. Eleven patients died during admission and 21 patients had known or new AF on 12-lead ECG (18 patients) or an alternate aetiology (one carotid artery disease and two lacunar non-embolic strokes). Twelve patients were considered unsuitable for anticoagulation or cardiac monitoring by the treating clinician because of advanced dementia, clinical frailty or they already had

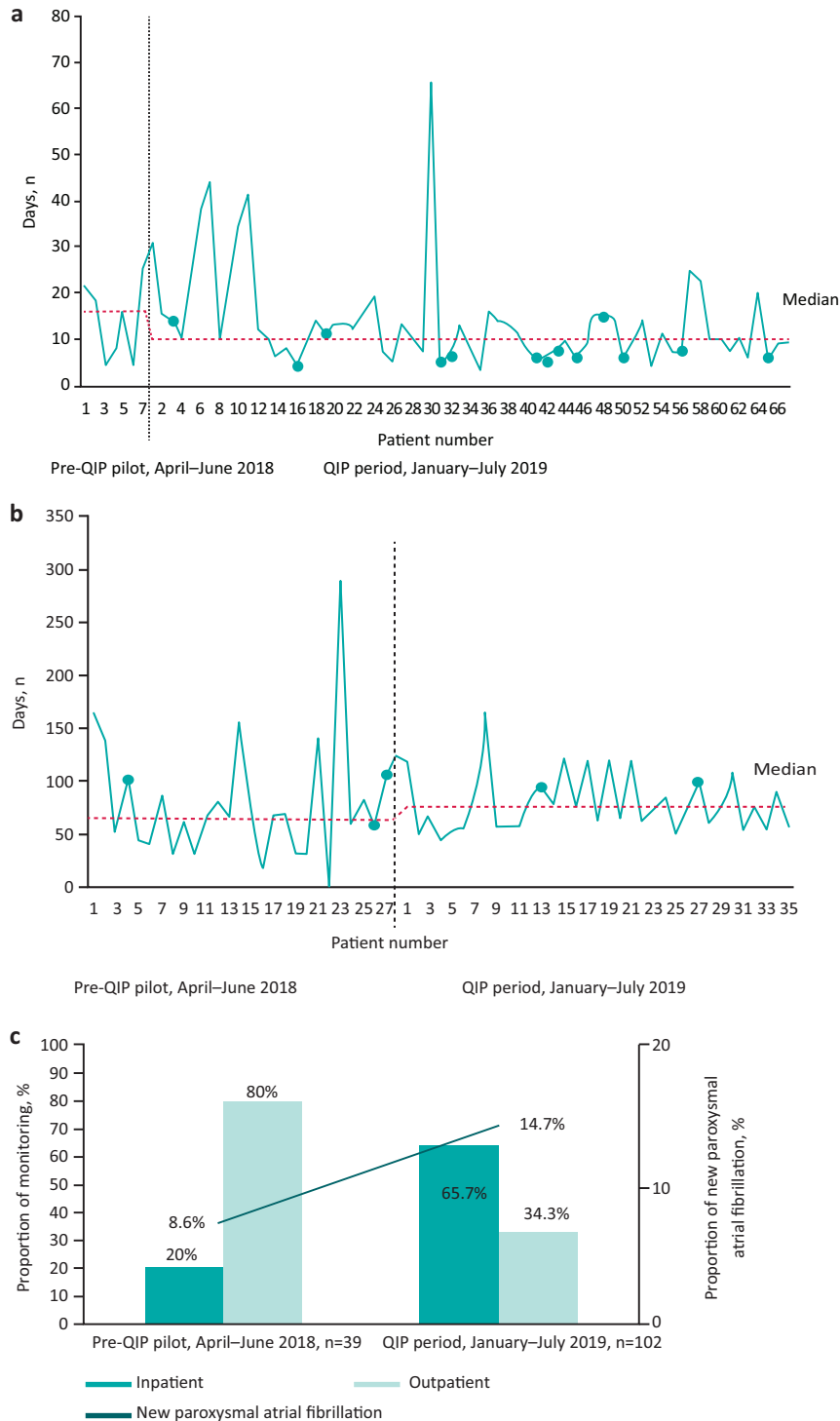
a pacemaker which was interrogated for AF. Six patients did not attend OP appointments for cardiac monitoring. In 8 patients, no request was made for the event recorder monitoring. One-hundred and two patients underwent 5-day event recorder monitoring; of these, 65.7% (20% pre-QIP pilot 2019) had IP monitoring ( $n=67$ ; Fig 3a) with a median time to data transcription of 11 days (range 4–46), and 34.3% (80% pre-QIP pilot 2019) had OP monitoring ( $n=35$ ; Fig 3b) with a median time to data transcription of 74 days (range 53–176). Study and patient characteristics during the quality improvement period are detailed in Table 1.

Delivering monitoring 'in-house' on the SUs resulted in 100% of patients receiving only one form of monitoring ie with an event recorder. The overall proportion of new AF detection increased from 8.6% (pre-QIP 2019) to 14.7% with 15 new AF detected. Nineteen per cent ( $n=13$ ) were detected with IP monitoring, 5.8% ( $n=2$ ) were detected with OP monitoring ( $p=0.07$ ; 95% confidence interval –1.8% to 24.9%). All patients diagnosed with new AF received oral anticoagulation for secondary prevention. Of those anticoagulated, there were no readmissions. Three IP monitoring (4.5%) and one OP monitoring (2.8%) patients were readmitted with recurrent ischaemic strokes of unexplained aetiology within 12 months. No monitors were lost during the process (Table 2).

## Discussion

Quality Improvement in Atrial Fibrillation detection after ischaemic stroke (QUIT-AF) aimed to address an unmet need in secondary prevention after an acute ischaemic stroke and demonstrated the feasibility of delivering timely ambulatory ECG monitoring in acute stroke IPs in a real world setting. Detecting PAF is a vital component of secondary prevention management after stroke, yet there remains a lack of robust guidance for stroke physicians in this regard. Enhanced cardiac monitoring (>24 hours) is generally recommended in most societal guidelines.<sup>5,15</sup> While delivering enhanced cardiac monitoring has implications for resource and logistics, this project highlights that having a structured cardiac monitoring protocol and delivering 'in-house' cardiac monitoring using a multidisciplinary model can overcome some of these challenges. Studies focusing on insertable loop recorders in cryptogenic stroke patients have largely used delayed and insufficient cardiac monitoring methods such as 24-hour Holter monitors during initial screening.<sup>6,16</sup> Delivery of early prolonged ECG monitoring 'in-house' could reduce the need for these invasive and expensive procedures. Results from this QIP suggest patients undergoing IP cardiac monitoring had higher proportion of comorbidities and more severe strokes (Table 1). The high AF yield is unsurprising in this group as AF-related strokes are associated with severity and comorbidities and are likely to have a longer IP stay. Conversely, milder strokes and patients with few comorbidities were likely to have been discharged early, prior to initiating IP ECG monitoring, suggesting a missed opportunity in AF detection.

Translating research findings into clinical practice can be challenging, and often requires a multidisciplinary approach to its implementation. PDSA cycle 1 required a mutual understanding of services and consensus agreement between the cardiology and stroke departments with streamlining requests through a structured protocol. It is our view that such an interdepartmental consensual cardiac monitoring strategy is vital. Previously ECG devices were administered and applied by CRI physiologists either on the ward or an OP basis following an electronic request, resulting



**Fig 3.** a) Days to transcription for event recorder inpatient monitoring. b) Days to transcription for event recorder outpatient monitoring. c) Proportion of patients receiving cardiac monitoring and new paroxysmal atrial fibrillation detection. QIP = quality improvement project.

in substantial delay (Table 2). Training members of the stroke team to administer and apply them 'in-house' reduced those delays and provided a reliable and responsive 7-day service. PDSA cycle 2, ensuring staff education and engagement across the wider MDT was an essential improvement to prevent loss of cardiac monitors.

The project had several limitations including the low numbers of available cardiac monitors on the unit. The primary focus of this project was delivery of 5-day cardiac monitoring early

post-ischaemic stroke. It is therefore likely that the stroke population was largely 'unselected' as detailed vascular, biochemical and cardiology investigations were yet to be completed in the vast majority of patients. Further, a small but significant proportion of stroke patients have multiple coexistent risk factors making absolute differentiation of aetiological mechanisms difficult.

ECG monitors were loaned from CRI cardiology services for the duration of this project. Long-term sustainability would require

**Table 1. Study demographics**

	IP monitoring	OP monitoring
<b>Total, n</b>	67	35
<b>Median age, years (IQR)</b>	76 (63.5–83.0)	65.5 (56.5–71.5)
<b>Male, %</b>	55.2	54.3
<b>Modified Rankin score, median (IQR)</b>	1 (0–3)	0 (0–1)
<b>NIHSS, median (IQR)</b>	3 (2–8)	2 (1–4)
<b>Thrombolysis, %</b>	10.5	3
<b>Congestive heart failure, %</b>	4.5	0
<b>Hypertension, %</b>	47.8	34.3
<b>Diabetes, %</b>	20.9	9
<b>Previous stroke / TIA</b>	28.4	17.1
<b>New AF detection, n (%)</b>	13 (19.4)	2 (5.7)
<b>Readmission with ischaemic stroke, n (%)</b>	3 (4.5)	1 (2.9)
<b>Readmissions due to ICH, n</b>	0	0

AF = atrial fibrillation; ICH = intracerebral haemorrhage; IP = inpatient; IQR = interquartile range; NIHSS = National Institutes of Health Stroke Scale; OP = outpatient; TIA = transient ischaemic attack.

further capital investment to purchase dedicated monitors for the stroke service. There remain concerns about scalability of the project at a regional or national level. While resources remain stretched, a close alignment of both cardiology and stroke services across providers' trusts is vital for this to succeed. However, what this project identifies is the possibility of SUs embracing newer technology for PAF detection that could reduce reliance on cardiology services.

An increase in rate and timeliness of AF detection would facilitate early anticoagulation where appropriate. This would likely reduce recurrent strokes, with implied cost savings. Further research is needed to fully assess the cost effectiveness of early prolonged ECG monitoring after acute stroke. However, studies evaluating outpatient monitoring with non-invasive methods in stroke patients at a detection rate of 4.4% new AF found this to be cost-effective ( $\leq$ US\$13,000 per quality-adjusted life-year

**Table 2. Results**

	Pre-QIP pilot (April–May 2018), n=35	During QIP (January–July 2019), n=102
<b>Proportion of IP monitoring, n (%)</b>	7 (20.0)	67 (65.7)
<b>Proportion of OP monitoring, n (%)</b>	28 (80.0)	35 (34.3)
<b>Proportion of ER monitoring, n (%)</b>	33 (94.3)	102 (100.0)
<b>Proportion of new PAF, n (%)</b>	3 (8.6)	15 (14.7)

ER = event recorder; IP = inpatient; PAF = paroxysmal atrial fibrillation; OP = outpatient; QIP = quality improvement project.

(QALY)) and well within the requirements of National Institute for Health and Care Excellence (NICE) technology appraisal guidelines (£20,000–£30,000 per QALY).<sup>8,17</sup> 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. Greater Manchester SUs admit circa 4,500 ischaemic stroke patients each year, of which we estimate, based on our project, that about two-thirds (2,750–3,000) would be potentially suitable for anticoagulation and therefore cardiac monitoring.<sup>18</sup> Assuming a new AF detection yield of 15%, additional 400–425 patients with PAF would be detected. As these patients would have otherwise remained on antiplatelet therapy, identifying AF and treating with anticoagulation could prevent as many as 17 new strokes and seven fewer deaths per year in Greater Manchester (number needed to treat (NNT) with anticoagulation to prevent one AF stroke is 25, based on primary prevention studies).<sup>19</sup>

A further limitation is that we did not specify balancing measures at the initiation of the project. We did consider assessing changes in the number of outpatient cardiology and stroke appointments, but this would be subject to additional confounding factors beyond our control. We did not collect any patient or staff satisfaction feedback. As this project was not designed as a research study we were unable to perform detailed statistical analysis evaluating impact of study design and patient characteristics on PAF detection; however, the increase in frequency of PAF detection (6.2%; Fig 3c) during this project validated the overall objective of improving PAF detection after IS. In addition, there was a difference of approximately 13% in new AF detection between IP and OP monitoring highlighting the benefit of early cardiac monitoring. Although this was a small single centre study, a similar increase in AF detection rates was also seen in randomised controlled studies involving acute stroke inpatients.<sup>13,20</sup> However, there needs to be a cautious interpretation of the statistical results ( $p=0.07$ ) when comparing early (IP) and more delayed (OP) monitoring as we were unable to adjust for all clinical variables that could influence PAF detection. A small proportion of patients (8%) had no ECG monitoring requested during the QIP either as an IP or at the 6-week stroke follow-up clinic; the reasons for this were unclear, again limiting the interpretation of the study.

While we didn't attain our primary aim of 90% achieving IP monitoring (65.7% IP monitoring), we hypothesise that an additional four event recorders could have resulted in achieving the overall aim of the study. Finally, maintaining staff engagement and training new staff remains a challenge, as with most QIPs. The long-term success of the project depends on ongoing involvement of the stroke MDT rather than reliance on a few members of the QIP. In order to ensure sustainability of the project, a business case incorporating need for additional monitoring devices has now been made locally. An AF task and finish group force has now been set up by the operational divisional network in stroke in Greater Manchester to tackle similar issues across other stroke units.

## Conclusion

Timely delivery and reporting of 5-day ECG ambulatory monitoring in stroke patients immediately after an acute stroke is feasible in the real-world but there is an urgent need to develop sustainable protocols as well as a coordinated multidisciplinary effort for its delivery in clinical practice. Potentially, novel monitoring methods

such as ECG patch devices, using AF detection algorithms and artificial intelligence could contribute to solving some of the logistical issues related to cardiac monitoring on an SU. ■

## Funding

Manchester Academic Health Sciences Cardiovascular (MAHSC) domain provided funding for the Haelo workshop. Bayer provided funding for two Novacor R.Test event recorders.

## Acknowledgements

We thank Stuart Clough from Haelo for supporting this project. We would also like to thank Neil Holden who provided data from SSNAP. We also thank the nursing staff, flow managers, early supported discharge team and all the clinical staff on the stroke units at Salford and the cardiorespiratory unit for their support in this project.

## References

- Murtagh B, Smalling RW. Cardioembolic stroke. *Curr Atheroscler Rep* 2006;8:310–6.
- Stroke Association. *State of the Nation: Stroke Statistics*. Stroke Association, 2016. [www.stroke.org.uk/sites/default/files/stroke\\_statistics\\_2015.pdf](http://www.stroke.org.uk/sites/default/files/stroke_statistics_2015.pdf) [Accessed 29 September 2019].
- Lip GYH. Paroxysmal atrial fibrillation. *QJM* 2001;94:665–78.
- Kolominsky-Rabas PL, Weber M, Gefeller O *et al*. Epidemiology of ischemic stroke subtypes according to TOAST criteria: incidence, recurrence, and long-term survival in ischemic stroke subtypes: a population-based study. *Stroke* 2001;32:2735–40.
- Royal College of Physicians. *National clinical guideline for stroke*. London: RCP, 2016. [www.rcplondon.ac.uk/guidelines-policy/stroke-guidelines](http://www.rcplondon.ac.uk/guidelines-policy/stroke-guidelines) [Accessed 29 September 2019].
- Kishore A, Vail A, Majid A *et al*. Detection of atrial fibrillation after ischemic stroke or transient ischemic attack: a systematic review and meta-analysis. *Stroke* 2014;45:520–6.
- Sposato LA, Cipriano LE, Saposnik G *et al*. Diagnosis of atrial fibrillation after stroke and transient ischaemic attack: a systematic review and meta-analysis. *Lancet Neurol* 2015;14:377–87.
- Kamel H, Hegde M, Johnson DR *et al*. Cost-effectiveness of outpatient ECG monitoring to detect atrial fibrillation after ischemic stroke. *Stroke* 2010;41:1514–20.
- Diamantopoulos A, Sawyer LM, Lip GY *et al*. Cost-effectiveness of an insertable ECG monitor to detect atrial fibrillation in patients with cryptogenic stroke. *Int J Stroke* 2016;11:302–12.
- Thomas P, Smith C, Kishore AK. Are we doing enough to detect paroxysmal atrial fibrillation after an acute ischaemic stroke? Survey of ECG monitoring methods among stroke physicians. *Clin Med* 2018;18:264–6.
- Haelo. [www.haelo.org.uk](http://www.haelo.org.uk) [Accessed 20 December 2019].
- Ogrinc G, Davies L, Goodman D *et al*. SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *BMJ Qual Saf* 2016; 25:986–92.
- Higgins P, MacFarlane PW, Dawson J *et al*. Non-invasive ECG event monitoring to detect atrial fibrillation after ischemic stroke. *Stroke* 2013;44:2525–31.
- Stroke Sentinel National Audit Programme. *National results - clinical: 22 January 2019 to 31 July 2019*. SSNAP. [www.strokeaudit.org/results/Clinical-audit/National-Results.aspx](http://www.strokeaudit.org/results/Clinical-audit/National-Results.aspx)
- Fuster V, Ryden LE, Cannom DS *et al*. ACC/AHA/ESC 2006 Guidelines for the Management of Patients with Atrial Fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Revise the 2001 Guidelines for the Management of Patients With Atrial Fibrillation): developed in collaboration with the European Heart Rhythm Association and the Heart Rhythm Society. *Circulation* 2006;114:e257–354.
- Sanna T, Diener HC, Passman RS *et al*. Cryptogenic stroke and underlying atrial fibrillation. *N Engl J Med* 2014;370:2478–86.
- Stroke Sentinel National Audit Programme. *National results - clinical: April 2016 – March 2017*. SSNAP. [www.strokeaudit.org/results/Clinical-audit/National-Results.aspx](http://www.strokeaudit.org/results/Clinical-audit/National-Results.aspx)
- National Institute for Health and Care Excellence. *Technology appraisal processes*. NICE. [www.nice.org.uk/about/what-we-do/our-programmes/nice-guidance/nice-technology-appraisal-guidance/process](http://www.nice.org.uk/about/what-we-do/our-programmes/nice-guidance/nice-technology-appraisal-guidance/process)
- Aguilar MI, Hart R. Oral anticoagulants for preventing stroke in patients with non-valvular atrial fibrillation and no previous history of stroke or transient ischemic attacks. *Cochrane Database Syst Rev* 2005;(3):CD001927.
- Kaura A, Sztrihla L, Chan FK *et al*. Early prolonged ambulatory ECG monitoring in stroke (EPACS): an open-label randomised controlled trial. *Eur J Med Res* 2019;24:25.

**Address for correspondence: Dr Amit K Kishore, Manchester Centre for Clinical Neurosciences, Salford Royal NHS Foundation Trust, Stott Lane, Salford M6 8HD, UK. Email: amit.kishore@manchester.ac.uk**