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ORIGINAL ARTICLE

Utilisation of Cardiac Holter monitoring and Echocardiography following Acute Ischemic Stroke or Transient Ischemic Attack

Julia Darmanin, Maria Zarb, Ruth Galea, Malcolm Vella

Background: The audit was conducted at Mater Dei Hospital in Malta, assessing the adherence to guidelines and the effectiveness of current practices. The audit aimed to evaluate the time interval between stroke events and outpatient cardiac holter monitoring and transthoracic echocardiography (TTE), as well as scrutinize the detection of subclinical atrial fibrillation (AF) in secondary stroke prevention, as per European Stroke Organisation (ESO) recommendations.

Methodology: Retrospective data was obtained from patient records, documenting the number of patients with an ordered outpatient cardiac holter and/or outpatient TTE following an ischaemic stroke or TIA.

Results: The findings reveal that a significant number of patients are experiencing prolonged waiting times. Of the 63 scheduled holters, 71% of patients waited for over 200 days. This delay is concerning, especially considering the high contribution of AF to stroke-related morbidity and mortality. Of the 71 scheduled TTEs, 53.5% of patients waited over 100 days. The audit discovered that, from the 54 performed outpatient cardiac holters, no patients were identified with previously undiagnosed AF during monitoring and from the 71 performed outpatient TTEs 1 identified new onset AF. This emphasizes the potential benefits of extended monitoring durations.

Conclusion: This audit highlights the necessity for enhanced strategies in outpatient cardiac monitoring and echocardiography following ischemic stroke or TIA. Implementing the provided recommendations can significantly enhance AF detection, mitigate the risk of recurrent strokes, and ultimately lead to improved patient outcomes.

Dr Julia Darmanin, MD, MRCP(UK)
Department of Medicine,
Mater Dei Hospital,
Msida, Malta

Dr Maria Zarb, MD
Department of Medicine,
Mater Dei Hospital,
Msida, Malta

Dr Ruth Galea, MD, MRCP(UK), FEBN
Department of Neurosciences,
Mater Dei Hospital,
Msida, Malta

Dr Malcolm Vella, MD, FEBN, FRCP
Department of Neurosciences,
Mater Dei Hospital,
Msida, Malta

Acute ischemic stroke stands as one of the foremost contributors to global morbidity and mortality, imposing a substantial burden on healthcare systems.[1] It is estimated that stroke affects approximately 1.1 million individuals in Europe annually [2]and ranks as the second leading cause of death across the continent.[3] The ramifications of stroke are not only profound for patients but also strain healthcare systems, a pressure that is anticipated to intensify over time due to the ageing population.[4]

According to the 2020 report "The Burden of Stroke in Europe" conducted by King's College London, the healthcare cost attributed to stroke in Malta approximates 8.8 million euros. This is coupled with an estimated annual incidence of 325 diagnosed stroke cases and a mortality rate of 272 stroke-related deaths. Projections also indicate a foreseen 66% surge in incidence by the year 2035[5]

Given this landscape, it becomes imperative for the healthcare system to proactively engage in stroke prevention and execute robust measures for secondary prevention. Ischemic stroke can arise from various factors, including thrombosis, hypoperfusion, and embolic phenomena [6] . Among these, embolic stroke can be categorised into artery-to-artery embolism and non-artery-to-artery sources. The evaluation of non-artery-to-artery sources necessitates a comprehensive investigation into potential embolic sources, typically encompassing cardiac monitoring and a transthoracic echocardiogram (TTE). TTE is the first line imaging used in Malta in view of its high sensitivity (95%) and specificity (85-90%) for detection of left ventricle (LV) thrombi.

A substantial proportion of ischemic strokes can be attributed to embolic phenomena associated with atrial fibrillation (AF) [7,8] , underscoring its significant contribution to stroke-related morbidity and mortality.[9,10] European population estimates suggest a prevalence of atrial fibrillation in the range of 1% to 2%.[11] This risk of stroke, secondary to AF, rises dramatically to 23.5% in patients aged 80 to 89.[8] Remarkably, around 25% of ischemic strokes are linked to AF, yet this figure is likely an underestimate due to the substantial undiagnosed cases of AF.[12]

Given the intermittent nature of AF, a considerable number of affected patients exhibit normal sinus rhythm on electrocardiogram (ECG) readings during their hospital stay, leading to undetected cases. The optimal secondary prevention strategy for embolic stroke arising from AF involves anticoagulation. However, initiating anticoagulation necessitates the prior detection and documentation of AF on an ECG.[13,14] Thus, timely identification of AF becomes a pivotal element in secondary stroke prevention, facilitating the timely initiation of anticoagulation treatment and ultimately reducing the risk of recurrent ischemic strokes [15,16.] Anticoagulation is superior to aspirin or clopidogrel and decreases the risk of embolisation by 70%[6]

Owing to the paroxysmal nature of AF, ESO guidelines recommend that inpatient cardiac monitoring is performed followed by outpatient cardiac monitoring after discharge. Holter monitoring is the most widely used diagnostic tool for non-invasive continuous cardiac monitoring in stroke patients.

This study aims to audit the time interval between stroke event and outpatient cardiac holter monitoring and TTE, while also scrutinising adherence to recommendations by the latest ESO guidelines regarding the detection of subclinical AF in the secondary prevention of stroke/TIA.

MATERIALS AND METHODS

The clinical audit was conducted at Mater Dei Hospital in Malta. Inclusion criteria encompassed patients admitted to the NeuroMedical ward with a diagnosis of ischemic cerebrovascular accident (CVA) or TIA between January 1, 2022, and June 30, 2022, who had either an outpatient TTE or a cardiac holter booked. Retrospective data was obtained from patient records including iCM, CVIS, electronic case summaries. Demographic data and the number of days between the booking and performance of the TTE and/or cardiac Holter were documented using a Microsoft Excel spreadsheet.

The audit encompassed 63 patients with a scheduled outpatient cardiac holter and 71 patients with a scheduled outpatient TTE, aiming to assess potential embolic sources post-stroke. Patients admitted for CVA/TIA within the study's six-month duration who did not meet the inclusion criteria were excluded.

By thoroughly reviewing electronic patient records, the resultant report of the local utilization of outpatient cardiac monitoring and TTE after ischaemic stroke/TIA was compared to evidence based recommendations by the European Stroke Organisation (ESO).

In compliance with data protection regulations, necessary clearance was obtained from Mater Dei Hospital to access patient data. All accessed patient data adhered to the relevant data protection and privacy regulations. Furthermore, all data was analysed in an anonymized format to ensure confidentiality and privacy.

RESULTS

Holter Monitoring

A total of 63 outpatient cardiac Holter monitors were scheduled following ischemic stroke or TIA during the audit period. Five patients did not attend their appointments and were not offered alternative dates, while four patients had Holter monitoring requested but were not assigned a specific appointment date. As shown in **Figure 1**, 71% of patients experienced waiting times exceeding 200 days before monitoring was performed. Notably, two patients who were awaiting their outpatient Holter appointment were admitted with new-onset atrial fibrillation prior to their scheduled investigation.

Of the 63 scheduled holter monitors, 54 were ultimately performed. None of these investigations detected previously undiagnosed atrial fibrillation (**Figure 2**). It is pertinent to mention that all of these holter monitors were configured as 24-hour monitors. Of note, three patients with previously diagnosed atrial fibrillation were also scheduled for outpatient Holter monitoring.

Echocardiography

Figure 3 demonstrates that 8.45% of patients underwent TTE as inpatients, whereas the majority (33.8%) waited between 100 and 149 days for an outpatient TTE appointment.

A total of 71 echocardiograms were performed (**Figure 4**), of which 15 demonstrated high-risk findings according to the National Clinical Guidelines for Stroke for the UK and Ireland. These included

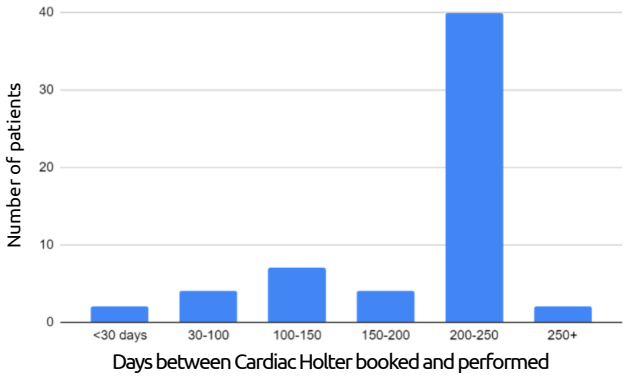

Figure 1 *Days between Cardiac Holter booked and performed*

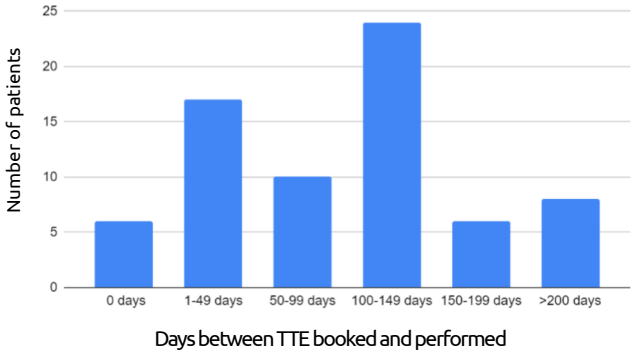

Figure 2 *Days between TTE booked and performed*

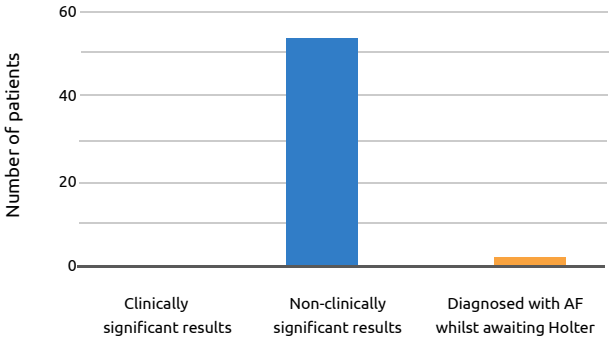

Figure 3 *Outcome of performed Cardiac Holter Monitoring*

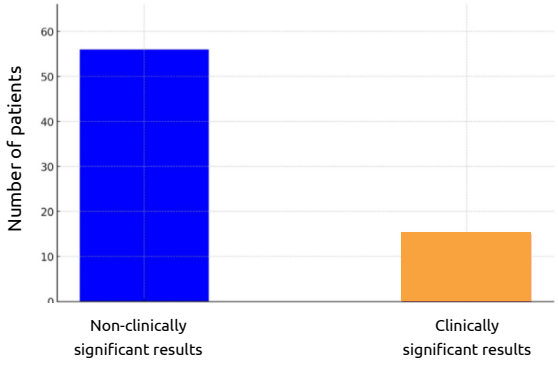

Figure 4 *Outcome of performed TTE's*

atrial fibrillation, valvular pathology, left ventricular outflow tract obstruction, frequent ventricular ectopy, and impaired global left ventricular systolic function. Overall, 21.12% of investigations yielded clinically relevant findings.

Among the 38 patients with a waiting time exceeding 100 days for TTE, 31.6% demonstrated significant findings.

Nineteen patients in the cohort were under the age of 55 years. Of these, only five underwent a bubble study, with one study demonstrating a patent foramen ovale (PFO). One patient did not undergo a bubble study as a previously documented PFO had been identified during prior admissions.

DISCUSSION

This audit evaluated the utilisation and timing of cardiac Holter monitoring and TTE following ischemic stroke or TIA, highlighting significant delays in access to these investigations and potential implications for secondary stroke prevention.

A key finding was the prolonged waiting time for outpatient cardiac Holter monitoring, with the majority of patients waiting more than 200 days before monitoring was performed. Such delays may hinder the timely detection of AF, a major cause of cardioembolic stroke. Early identification of AF is essential to allow prompt initiation of anticoagulation therapy and reduce the risk of recurrent stroke. The observation that two patients were admitted with new onset AF while awaiting Holter monitoring further emphasises the clinical significance of these delays.

Despite 54 outpatient Holter monitors being performed, no cases of previously undiagnosed AF were detected. This low detection rate may partly reflect the exclusive use of 24-hour monitoring in this cohort. Increasing evidence demonstrates that prolonged cardiac monitoring improves AF detection rates in patients with cryptogenic stroke. A recent randomised study focused on stroke survivors without known AF demonstrated that employing a 10-day Holter after a stroke increased the AF detection rate to 13.5%. In comparison, a group of patients subjected to 24-hour ECG holter monitoring exhibited a detection rate of 4.5%.[17] However, determining the optimal monitoring duration remains challenging, as excessively prolonged monitoring may not always be feasible or cost-effective.

Additionally, the audit highlighted the need for adherence to ESO guidelines, particularly for patients above 55 years of age. ESO guidelines recommend that patients older than 55 years undergo early inpatient ECG monitoring, followed by outpatient cardiac monitoring exceeding 48 hours. Interestingly, our study encompassed 41 patients aged 55 and above, yet none of them received outpatient cardiac monitoring exceeding 48 hours, raising concerns about the efficacy of the current monitoring practices in this population. The guidelines further advocate for the use of implantable monitoring devices, particularly for patients above 55 with cryptogenic stroke, as opposed to non-implantable devices, to enhance the detection of paroxysmal AF. However, this study did not gather data on the utilisation of implantable cardiac monitoring. Although implantable devices exhibit an elevated AF detection rate when compared to external loop recorders, this discrepancy appears to be attributed to the longer monitoring duration rather than an increased capacity of the device to detect AF.

Potential inefficiencies in resource utilisation were also identified, as three patients with an established diagnosis of AF were scheduled for outpatient Holter monitoring.

The implications of over 70% of patients enduring waiting times exceeding 200 days for outpatient cardiac holter monitoring subsequent to an ischemic CVA/TIA are twofold. Primarily, this delay hinders the timely initiation of appropriate AF treatment, namely anticoagulant therapy. During this interim period, patients are susceptible to developing recurrent strokes or other complications associated with AF. Secondly, for those individuals whose AF is detected more than 200 days following the cerebrovascular event, the substantial passage of time raises questions about whether AF was indeed the cause of the initial stroke or a subsequent discovery.

Delays were similarly observed in the utilisation of TTE following stroke or TIA, with many patients experiencing waiting times exceeding 100 days. Echocardiography is important in identifying structural cardiac abnormalities and potential

cardioembolic sources that may influence management. Among the 38 participants subjected to a TTE waiting time of >100 days, 31.6% exhibited significant findings. Hence, in these 31.6% there was a delay in initiation of anticoagulation as observed when applying the '1-3-6-12 days rule' [20], introduced by the European Heart Rhythm Association of the European Society of Cardiology in 2013.[21] This rule recommends the commencement of anticoagulants one day after TIA, three days after minor stroke (NIHSS score <8), six days after mild stroke (NIHSS score 8-15), and twelve days after moderate-to-severe stroke (NIHSS >15).

The most clinically significant management step following TTE findings is the initiation of oral anticoagulants upon detecting atrial or ventricular thrombi.[22] Patients with known AF and/or who are already on anticoagulation, do not gain additional benefit from post CVA TTE.[23] In Malta, this practice is reflected as outpatient TTE are not scheduled for patients previously anticoagulated. Conversely, an article by the 'Journal of the American Heart Association' emphasizes the significance of also performing a TTE in patients already on direct oral anticoagulant therapy to assess comorbid cardiovascular conditions and to understand the primary event.[22]

TTE has limited sensitivity for detecting left atrial thrombi, a common cardioembolic source associated with AF.[19] TOE offers greater sensitivity and specificity and may be considered when TTE images are suboptimal or clinical suspicion remains high despite a negative TTE. However, clear guidance on when TOE should be preferred over TTE in post-stroke evaluation remains lacking.

PFO is recognized as a predisposing factor for TIA or stroke, serving as a conduit for paradoxical emboli or thrombi of fat or air from venous to arterial circulation.[18] The audit encompassed 19 patients who were less than 55 years, however only 5 of these patients had a bubble study performed. In Malta, bubble studies are performed in patients less than 55 years. A limitation of our study is the lack of active tracking of the number of bubble studies scheduled and the associated clinical indications. However, only bubble studies which were incidentally found when looking up software data collection on echocardiograms were documented. Moreover, this data emphasises the importance of enforcing the use of bubble studies in patients less than 55 years who sustained an ischemic stroke or TIA.

Limitations of the audit

Retrospective Design: The audit relied on retrospective data from patient records, which may be subject to incomplete or inconsistent documentation. This could introduce bias or inaccuracies in the analysis, impacting the reliability of the results.

Small Sample Size: The audit included a limited number of patients within a specific timeframe. A larger sample size might provide more robust conclusions and better representation of the target population.

Resource Limitations: The audit did not explore resource constraints within the healthcare system that could contribute to delays in outpatient monitoring. Factors such as staffing shortages, equipment availability, or administrative processes might influence the timeliness of appointments and affect the feasibility of implementing certain recommendations.

Limited Understanding of Patient Non-Attendance: The audit did not explore the reasons why some patients did not attend their scheduled outpatient holter or TTE appointments. Similarly, the audit did not investigate why alternative dates were not offered to patients who missed their appointments

Recommendations

The findings of this audit underscore the critical need for refinement in the utilisation and timing of outpatient cardiac monitoring and echocardiography following ischemic stroke or TIA. Based on the evidence gathered, several key recommendations emerge:

- Appointment scheduling should be optimised to ensure timely cardiac monitoring following stroke or TIA. A vetting system could prioritise outpatient Holter monitoring and TTE for these patients while ensuring appropriate utilisation by excluding those already anticoagulated or with contraindications to anticoagulation.

- Extended monitoring duration: Cardiac monitoring should be extended beyond 24 hours, aligning with ESO recommendations of ≥48-hour outpatient monitoring in patients >55 years.
- Implantable Monitoring Devices: Given the increased detection rates observed with implantable monitoring devices in patients above 55 years, healthcare facilities should explore the integration of these devices into their monitoring protocols.
- Consider TOE in selected cases where TTE is inconclusive or when clinical suspicion remains high despite a negative TTE.

CONCLUSION

This audit highlights significant delays in the utilisation of outpatient cardiac holter monitoring and transthoracic echocardiography following ischemic stroke or transient ischemic attack, with waiting times exceeding 200 days and 100 days respectively in a substantial proportion of patients. These delays may limit timely identification of cardioembolic sources and opportunities for secondary stroke prevention.

Improving appointment scheduling and introducing a structured vetting system could prioritise post-stroke/TIA patients while ensuring investigations are appropriately allocated. In addition, local practice should consider extending cardiac monitoring beyond the conventional 24-hour period, in line with the recent ESO recommendations supporting at least 48 hours of monitoring in patients over 55 years, and exploring the role of implantable monitoring devices to improve atrial fibrillation detection.

Overall, optimising access to and selection of cardiac investigations has the potential to improve secondary stroke prevention and patient outcomes.

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