http://www.harleystreet.sg/heart
Email **enquiries@harleystreet.sg**

DIGITAL HEALTHCARE DEVICE

APPLE HEART STUDY

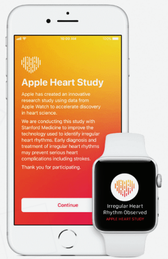
A 59 year old gentleman with a history of dyslipidaemia, hypertension and mild non-obstructive coronary disease under regular follow up requested an urgent consultation. He had been experiencing frequent giddy spells with spontaneous elevations in his heart rate, of up to 150 seen on his Fitbit heart rate monitor. A Holter monitor was requested which showed sinus rhythm throughout; he was asymptomatic throughout the monitoring period. He purchased an Apple watch and returned 1 month later. Atrial fibrillation (AF) was confirmed on multiple recordings (Figure 1) captured by his watch. Appropriate management for paroxysmal atrial fibrillation and stroke prevention was initiated.

Figure 1.

Nearly 80% of the Singaporeans possess a smartphone and 16%, a smartwatch. Increasingly, patients are attending our clinic with wearable technology. Though not FDA approved, the latest generation Apple Watch offers promise as a tool to accurately detect AF. The prevalence of AF is projected to double in the next 40 years in adults older than 55 and there is increasing public awareness of the association of AF to cause a stroke. Detection and diagnosis of AF is important to provide proper management of patients with this arrhythmia such as reduction of burden of symptoms, prevention of severe complications (stroke and heart failure) and improvement of survival. The European Society of Cardiology guidelines for the management of AF recommend screening for AF all patients 65 years and older by pulse palpation and electrocardiogram (ECG) monitoring1.

The Apple Watch and corresponding Heart Study app uses photoplethysmography (designed by Apple) to intermittently measure blood flow activity and detect subtle changes that might indicate an irregular heartbeat. A tachogram is then created and is analyzed by an algorithm. The Apple Heart study2 aimed to identify patients with an irregular pulse watch notification who have AF on a subsequent ambulatory ECG patch. It is one of the largest 'digital health' studies to date. A total of 419,297 people self-enrolled in the study. The majority, 52% of those enrolled were younger than 40 years old. Participants could not have AF or be taking anticoagulants and were required to have an Apple Watch and compatible iPhone.

Detection of five of six repeat tachograms of an irregular pulse within a 48-hour period triggered a notification to be sent via the app. Participants receiving a notification were prompted to contact the study doctor through the app for a video consultation to determine if the participant should wear an ECG patch. The patch was worn for up to 8 days. The primary endpoint was the presence of AF>30 seconds on the ambulatory ECG patch after AF detection on the app. The pulse notification was received by 2,161 participants (0.52%) - which was thought to be quite low. Notification rates were most frequent in participants over age 65 (3.2%) and lowest among those under 40 (0.16%).



Patches were sent to 658 participants and 450 were returned and included in the analysis. AF was identified in 34% of those who received a notification and wore the ECG patch.

The study had several limitations, including reliance on self-reported data from participants. At 90 days, only 57% of those who received notification contacted their healthcare provider. The potential for a high number of false positive heart rhythms could then lead to further unnecessary tests and undue anxiety for patients. Additionally, the target enrollment of 500,000 participants, with 75,000 aged 65 or older, was not reached. In a study with easy, app-based enrollment, the percentage of people who dropped out was high and full follow-through with the research protocol was low. The study tried to exclude enrollees with a history of AF, but some of the detections were in patients who later admitted to a previous diagnosis of atrial fibrillation. The wider question of whether adults with brief episodes of AF that may be detected by current generation wearable technology and the longer-term monitoring it allows, carry similar risks as patient with higher burdens of AF is not at all clear. This issue will require more research and probably large, controlled trials of anticoagulation in low-risk, but worried, populations. Wearable technology will continue to evolve and improve and the lessons from this study provide a foundation for large-scale pragmatic studies in which outcomes or adherence can be reliably assessed with user-owned devices.

References

1. *Kirchhof P. et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. EHJ 2016;37(38):2893-2962*

2. *Perez MV et al. Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation. N Engl J Med. 2019 Nov 14;381(20):1909-1917*

By **Dr. Rohit Khurana**
Senior Consultant Cardiologist
The Harley Street Heart & Vascular Centre

ACCURACY OF DIGITAL HEALTHCARE DEVICE

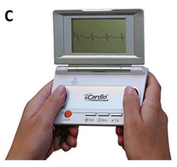
WEARABLE PERFORMANCE DEVICES, CONVENTIONAL CARDIAC MONITORS AND CARDIOVASCULAR HEALTH

Wearable performance devices, such as smart watches, have become increasingly available to the general public in recent years. Athletes and sports enthusiasts often use such devices to routinely track and monitor their progress whilst others thinking of embarking on an exercise regime may use these devices for the first time. In addition, some patients with cardiac conditions or symptoms may use these devices or apps available on their smartphones to monitor their heart rhythm. Improvements in technology have allowed these devices to become smaller, more accessible and user-friendly. The advantages of these devices include promotion of health benefits and exercise among the general public as well as raising the possibility of a cardiac arrhythmia in some individuals. However, these devices may also create a new group of "worried well" individuals who are concerned about their wearable device readings but in fact have no underlying medical problem. As a result, primary care doctors and specialists are seeing more and more patients and concerned individuals who have detected a potential abnormality on their device readings and subsequently seek further medical attention. This article summarises the benefits of wearable performance devices in healthcare and when patients should be referred for formal cardiac evaluation if abnormal readings are detected.

Technology and accuracy: Heart rate (HR) monitors, wearable performance devices and apps essentially use two types of technology- optical sensors (photoplethysmography) and electrical sensors to monitor signals from the heart. These devices have generally shown good accuracy in measuring HR and HR variability at rest, although some differences exist during exercise and in patients with heart conditions. For example, one study of 102 hospitalized patients compared the effectiveness of two smart watches (Fitbit and Apple watch) with continuous ECG monitoring in detecting atrial arrhythmias. There was strong agreement between both watches for patients in sinus rhythm and with atrial flutter, but HR was underestimated by both devices in patients with atrial fibrillation. [Koshy AN et al.; Int J Cardiol. 2018]. Asymptomatic individuals sometimes present to doctors concerned about the finding of excessively low heart rates on their wearable devices at rest- this may be due to sinus bradycardia and increased vagal tone at night (which is often seen in healthy, fit individuals) or the presence of benign ventricular ectopics in which the devices are sometimes unable to detect the ectopic beats and thereby underestimate the true heart rate. These individuals may require further cardiac tests to exclude any underlying cardiac pathology and reassure them.

Medical benefits: Apart from the potential benefits in detecting cardiac arrhythmias in patients (see article in this newsletter by Dr Rohit Khurana), HR measurements using wearable devices and smartphone apps may help doctors to monitor their cardiac patients' activity and intensity of aerobic exercise. This data in turn can be used to guide exercise recommendations and gauge patients' progress during rehabilitation. There is also some evidence that wearable performance devices may have some use in detecting obstructive sleep apnoea if worn during sleep, although this requires further validation and improvement in technology. [Baty F et al. Sensors (Basel). 2020]

When should patients undergo further cardiac investigations? Patients may present to doctors with the finding of heart rates on their performance devices which they perceive as too fast or too slow. If they are otherwise well and asymptomatic and have no cardiac history or risk factors, they may be just require a 12-lead ECG. If normal, they can be reassured accordingly and asked to continue to keep an eye on their heart rate. If they are older than 50 years of age and/ or have any symptoms (such as palpitations, dizziness, breathlessness or syncope) or cardiac risk factors, they may require further cardiac evaluation with an echocardiogram and Holter monitor or cardiac event recorder. A Holter monitor (often 24 or 48 hrs in duration) is a useful test even in asymptomatic individuals as it gives information on the heart rate trend, heart rhythm (including nocturnal) and other parameters such as heart rate variability (which if abnormal can be a sign of cardiovascular disease or autonomic dysfunction). However, if the intention is to try to detect paroxysmal arrhythmias which are infrequent (e.g. occur once every few weeks or months), then a cardiac event recorder may be more useful (see Figure). These devices can be loaned out to patients for up to a few months – the patients will need to keep the recorders close by in order to try to capture the arrhythmia when they next experience palpitations. Some cardiac event recorders allow patients to email their ECG traces to the cardiologist, which is more convenient than the patient having to return to clinic each time they experience any palpitations. If in doubt about the clinical significance of the wearable device readings, the safer option is to refer the patient for further cardiac evaluation.



Summary points:

- *The newest generation of wearable performance devices and smart-watches offer heart rate/ rhythm monitoring technology*
- *Such technology can be used to detect previously undiagnosed arrhythmias, such as atrial fibrillation, and therefore used as a clinically useful and inexpensive diagnostic tool*
- *Despite the advantages, health care professionals should also be aware of the limitations and pitfalls of relying on such technologies*
- *Conventional cardiac monitoring may be needed to help confirm a diagnosis suspected on wearable device readings or further assess the cardiovascular risk of patients*

Figure - Cardiac event recorders used at The Harley Street Heart and Vascular Centre

A) Kardia device, B) Omron event recorder, C) Instant Check event recorder. These devices are medically validated portable cardiac monitors that are more accurate than wearable performance devices in detecting paroxysmal cardiac arrhythmias.

By **Dr. Reginald Liew**
Senior Consultant Cardiologist
The Harley Street Heart & Vascular Centre

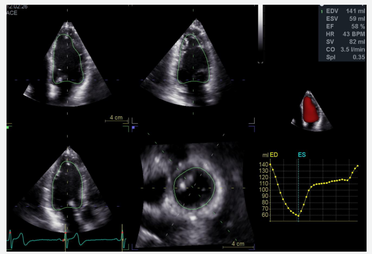
CARDIAC IMAGING

ADVANCES IN CARDIAC IMAGING

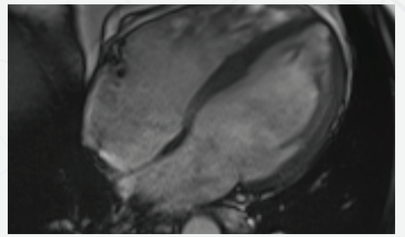
Cardiac imaging forms the cornerstone of cardiac diagnosis and treatment. The pace of innovation that is occurring in cardiac imaging is remarkable. At Harley Street we like to ensure we stay at the forefront of technological advances, adopting new technologies once they have been proven to enhance patient care. We now offer 3D echocardiography and cardiac MRI as part of our service, further advancing our ability to care for patients with heart conditions.

3D echocardiography

Echocardiography is the imaging work-horse of cardiology. It is critical for the diagnosis and monitoring of treatment response; providing real-time imaging of cardiac structure and function. The latest advancement in echocardiography is in 3D imaging. 3D echocardiography allows single beat acquisition, it eliminates the need for geometric modelling that adds error to measurements in conventional 2D echocardiography. Recent advances in software have allowed fully automated endocardial border detection which speeds up the examination time. 3D echocardiography improves accuracy and reproducibility, which is particularly important in areas where echo results impact patient treatment. For example, many cancer drugs are toxic to the heart and can cause a fall in heart function (LVEF). Cancer patients need to have recurrent echocardiography scans during treatment to assess for signs of cardiotoxicity. If there is evidence of cardiotoxicity then chemotherapy needs to be interrupted. 3D echo is now recommended by all international cancer guideline committees as the number 1 technique to assess heart function in chemotherapy patients. The added accuracy of the technique means that fewer patients have drug treatment interrupted unnecessarily. In addition to cardiac function, 3D echocardiography also plays an important role in the management of heart valve disease. 3D datasets allow the cardiologist to view the valve like a surgeon views it, with improved assessment of valve geometry and quantification of severity.



Our new Harley Street clinic at Mt Elizabeth Orchard is the only provider of 3D echo in the hospital, and now provides a cardio-oncology service for cancer patient follow-up.



Cardiac MRI and MRI stress imaging

Cardiovascular MRI scanning is considered the gold standard imaging technique for assessment of cardiac function. Its use has evolved over the last 10 years and rapidly expanded in the USA and Europe but the service is relatively under-developed in Singapore. MRI uses the properties of hydrogen atoms when they are exposed to a magnetic field to produce images. Therefore, patients do not get exposed to ionizing radiation, and there is no need to use iodine-based contrast agents. Cardiac MRI as several advantages over echocardiography.

1) Cardiac detail is increased, allowing incredible accurate assessment of heart volumes and function.
2) You are not reliant on echo windows, so even obese patients can get good quality images.
3) MRI allows detailed tissue characterization. By using various imaging sequences and the para-magnetic contrast agent gadolinium we are able to look at areas of previous myocardial infarction that are so small they can never be picked up on echo or nuclear studies. We can also look for edema and swelling in cases like myocarditis and quantify fibrosis within the heart, which is seen in a number of conditions.

One of the newer applications of this technique is MRI perfusion imaging. This technique allows us to assess for significant blockages in the heart arteries. Instead of using exercise as the stress agent, we use a medication called adenosine. This dilates blood vessels, and when combined with gadolinium injection we are able to see areas in the heart with reduce blood flow. Recent clinical trials have shown MRI perfusion imaging to be the most accurate cardiac stress test, with superior sensitivity and specificity to both nuclear and stress echocardiography. More interestingly, it has also been shown to be non-inferior to an invasive angiography strategy with fractional flow reserve.

Harley Street now offers a cardiac MRI service. I report all the cardiac MRIs myself. Our cardiac perfusion service will be established in Q2 2020.

Summary

Cardiac testing is rapidly evolving. At Harley Street Heart & Vascular Centre we aim to stay at the forefront of technology so that we can offer our patients the highest quality evidence based cardiac care.

By **Dr. Michael MacDonald**
Senior Consultant Cardiologist
The Harley Street Heart & Vascular Centre

QUANTIFYING DVT RISK

QUANTIFYING RISK IN VENOUS THROMBOEMBOLISM

Obesity. Smoking. High blood pressure. Almost everyone knows these are hazards to one's health. But dehydration, a recent pregnancy, prolonged immobility, varicose veins, birth control pills or even a single flight can also trigger a life-threatening condition that kills more people annually than breast cancer and AIDS combined?

In a globally connected world, Changi airport is a key economic artery for Singapore. Almost 70 million passengers passed through last year, though COVID 19 will mean a significant drop this year. But the virus will be conquered, and the passengers will return, and with that the risk of air travel related venous thromboembolism (VTE). Perhaps these extraordinary times of international travel bans are a moment to pause and prepare for the time when travel services resume.

The Global Disease Burden Project measured the incidence of thrombosis for various conditions and estimated VTE has an annual incidence of 115 to 269/ 100,000 population (compared to 139.3 for myocardial infarction, 114.3 for ischemic stroke and 59.5 and 77.5 for atrial fibrillation in males and females respectively). The study reports that deep venous thrombosis and its dreaded complication pulmonary embolism have a mortality rate of 9.4 to 32.3 (*A Wendelboe, G Raskob. Global burden of thrombosis: Circulation Research. 2016;118:1340–134*). Around 1-2% of VTEs result in death and post thrombotic syndrome – a debilitating long term outcome of DVT – occurs in 10-30% of patients.

The major risk factors for VTE include recent hospitalization, recent surgery, cancer, and immobilization. In addition, there are specific thrombophilic genetic conditions that predispose primarily to VTE and account for about for 7% to 22% of the population attributable risk. Air travel constitutes a major risk factor in a connected world and particularly so in travel hubs like Singapore.

An equal opportunity killer, DVT does not discriminate by age, race or gender. Anyone can be affected under the right circumstances, even if they are otherwise healthy and active. Athletes like Serena Williams and politicians like President Richard Nixon, Hillary Clinton, and Dick Cheney all experienced a VTE. DVT is often referred to as "economy-class syndrome" or "traveller's thrombosis" because long flights in coach cabins occasionally have led to DVT-related fatalities. But DVT is not class conscious. President Nixon's DVT was believed to have developed while traveling on Air Force One to China.

The days when the treatment was anti-coagulation regardless of the veins involved, thrombus burden or anatomical variations in the pelvic and iliac veins may be past us. Iliofemoral DVTs require thrombus removal as early as possible via thrombolysis or mechanical thrombectomy, ideally within the first week of presentation, to prevent post-thrombotic syndrome from developing. On the other hand, a DVT limited to veins below the knee needs 3 months of oral anti-coagulation in the absence of a thrombophilia and little else. An urgent vascular referral followed by an assessment by detailed ultrasound duplex scanning to confirm the diagnosis as well as the extent of the DVT is essential. The ultrasound must include information on anatomical compression in the iliac veins, and the integrity of popliteal vein valves is needed to plan intervention if required.

The true risk of DVT and PE in frequent flyers has been studied well, but poorly publicised. A comprehensive review of the topic (*Venous Thromboembolic Complications Following Air Travel: What's the Quantitative Risk? A Literature Review Aryal, K.R. et al. European Journal of Vascular and Endovascular Surgery 2006, Volume 31, Issue 2, 187 – 199*) showed that the quantitative risk of a lower limb venous thrombosis is 5% per long haul flight (8 hours or 5000 miles) for a high risk patient and 1.6% for a low risk patient. A unique cohort study from the Netherlands of corporate employees having to undertake work-related trips for their organisations (familiar to many in Singapore) showed that they had an incidence rate of VTE of 3.2/1,000 PY (person years), as compared to 1.0/1,000 PY in individuals not exposed to air travel (*The absolute risk of venous thrombosis after air travel: a cohort study of 8,755 employees of international organisations. Kuipers S et al; PLoS Med. 2007 Sep;4(9):e290*). The risk increased with exposure to more flights within a short time frame and with increasing duration of flights. The incidence was highest in the first 2 weeks after travel and gradually decreased to baseline after 8 weeks. The risk was particularly high in employees under the age of 30 years, women who used oral contraceptives, and individuals who were particularly short (<150cm), tall (>180cm) or were overweight (BMI >30). Multiple short haul flights are additive in risk, similar to a single long-haul flight (>4 hours in this study).

Whilst literature that specifically grades the risk and interventions needed for various distances and frequencies of air travel is absent, we use a combination of published literature and DVT risk for various patient groups and pre-existing disease states to advise our patients on DVT prevention. Patients are graded as occasional flyers (1 short haul 4-hour flight or less every 8 weeks or 3 long haul flights or less every year) or frequent flyers. Venous function is assessed using light reflex rheography (LRR – Figure 1), a simple 5-7 minute non-invasive office test that measures venous refill time (short refill times under 23 seconds suggest venous incompetence) and calf pump function. Additional risk from previous DVT/ PE, current varicose veins, recent varicose vein surgery, current oral contraception, BMI greater than 30, and a known or a family history of a thrombophilia is then included to create a set of individual recommendations to reduce DVT risk for each patient. These are summarised in table 1.

Table 1. DVT risk assessment for air travel as followed at the Harley Street Vascular Centre (a BMI more than 30 raises risk grade to the next level)

Risk grade	Risk criteria	Recommendation
No additional risk	Occasional flyer, normal venous function	Simple measures to stay hydrated, mobile on a flight
Mild risk	frequent flyer, normal venous function or occasional flyer on OCP/abnormal LRR	Class 1 calf length compression (flight socks), stay hydrated, stay mobile
Moderate risk	Frequent flyer on OCP, abnormal LRR, previous DVT /PE current varicose veins, recent varicose vein surgery or occasional flyer with thrombophilia	Class 2 calf length compression or a compression wrap. Single dose subcut. Clexane (1mg/kg) for each flight section
High risk	Frequent flyer with thrombophilia	Class 2 calf length compression or a compression wrap with oral coagulation as appropriate for thrombophilia.

Venous thromboembolism is largely preventable if the risks are recognised in the appropriate clinical settings. Early referral in suspected acute DVT and PE saves lives and reduces long term morbidity. In patients with a history of limb swelling after flights, or a history of frequent air travel, appropriate risk assessment and preventative measures can significantly reduce VTE events from occurring.

Figure 1. Light Reflex Rheography

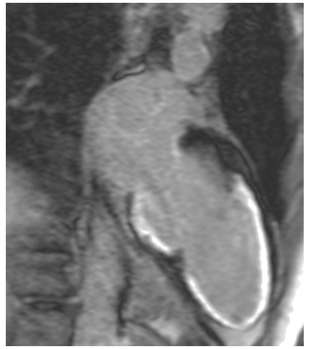
By **Dr. Sriram Narayanan**

Senior Consultant Vascular Surgeon
The Harley Street Heart & Vascular Centre

QUIZ

A 56 year old hypertensive male with well controlled diabetes attended his GP surgery with a 3 month history of shortness of breath. Clinical examination revealed mild peripheral edema. He underwent an ECG which showed loss of R-waves across the chest leads. Cardiac MRI was performed pre (a) and post (b) gadolinium contrast.

(a)



(b)

1. What do the white areas in image b represent?

2. What is the underlying disease process?

Answer is available on our website:
http://www.harleystreet.sg/quiz-answers/medbulletin-April-2020/

By **Dr. Michael MacDonald**

Senior Consultant Cardiologist
The Harley Street Heart & Vascular Centre

Mount Elizabeth Novena Specialist Centre
#05-30, 38 Irrawaddy Road
Singapore 329563

Gleneagles Hospital
#02-38/41 (Annexe Block)
6A Napier Road
Singapore 258500

Mount Elizabeth Medical Centre
#11-07, 3 Mount Elizabeth
Singapore 228510

THE HARLEY STREET HEART & VASCULAR CENTRE

MEDBULLETIN APRIL2020

THE HARLEY STREET HEART & VASCULAR CENTRE

From left to right:
Dr. Sriram Narayanan, Dr. Reginald Liew
Dr. Michael MacDonald, Dr. Rohit Khurana

INTRODUCTION

Our first newsletter of 2020 comes at a particularly difficult time. The COVID-19 outbreak is now a global issue that touches everyone's lives. As healthcare professionals it is at the forefront of our minds on a daily basis, and probably will be for many months to come. It is times like this that force us to adopt new behaviours and new technologies. Understandably, most of the group CME activities for doctors have been cancelled. To offer support, we are launching a series of webinars for general practitioners so that CME can be continued during these difficult times. We will circulate further details of these events shortly.

The focus of this newsletter is on technology in the heart and vascular area. Dr Reginald Liew gives a summary on wearable heart rate trackers. It is increasingly common for patients to attend our surgeries with abnormal readings or warning from their devices. Dr Liew discusses the accuracy of these devices and which patients need referred for further assessment. Dr Rohit Khurana provides an in depth look at the Apple Heart Study. A clinical study using the Apple smart watch that gained huge media attention in 2019. Dr Sriram explores recent updates in the management of deep vein thrombosis. Dr MacDonald will be giving a brief introduction to advances in cardiac imaging. We now offer 3D echo at our Mount Elizabeth Medical Centre clinic and will be commencing a cardiac MRI perfusion service in Q2 2020.

As usual, we have included an interesting and challenging quiz at the end of the newsletter- the answer to the quiz will be posted on our website (www.harleystreet.sg/heart) within a week of the newsletter being sent out. We hope these articles stimulate and challenge your views. Please feel free to contact us (at enquiries@harleystreet.sg) if you would like to provide any feedback or request a specific topic in future editions. We will be sending out further details of our webinar series in the coming days.

From The Harley Street Heart and Vascular Centre

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Email **enquiries@harleystreet.sg**

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