

# European Journal of Arrhythmia & Electrophysiology

VOLUME 8 • SUPPLEMENT 1



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## ABSTRACTS

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# European Journal of Arrhythmia & Electrophysiology

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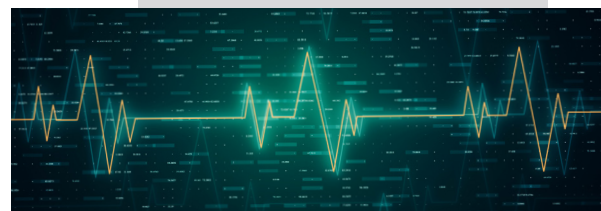
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## Contents – Session



### **Young Investigators Competition**

- 9 Clinical Science
- 12 Basic Scientist

### **Oral Abstracts 1**

- 15 Allied and Service Development
- 21 Arrhythmia Clinical

### **Oral Abstracts 2**

- 27 High-scoring Abstracts
- 33 Arrhythmia Mechanisms/*In Silico* Tools

### **Oral Abstracts 3**

- 39 Devices
- 45 Mapping and Ablation

### **52 Moderated Posters 1**

### **62 Moderated Posters 2**

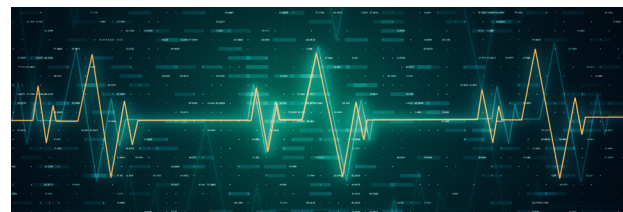
### **72 Posters 1**

### **110 Posters 2**

### **148 Paediatric**

### **149 Index of Presenting Authors**

## Contents – Abstracts



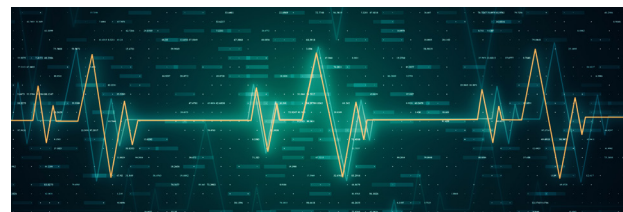
- 9 1/Impact of left ventricular scar burden on acute response to conduction system pacing.
- 10 2/Yield of 12-lead 24-hour ambulatory ECG monitoring in the identification of a spontaneous type 1 Brugada pattern and its prognostic value. A sub-study of the BHF RASE Brugada project
- 11 3/Cardiac resynchronisation therapy acutely alters cardiac metabolic substrate uptake, correlating with improvements in systolic function and long-term reverse remodelling
- 12 4/Selective T-type calcium current block affects action potential dynamics in murine atrial myocytes
- 13 5/Defining the local immune drivers in atrial fibrillation: the role of tissue-resident memory T cells
- 14 6/The effect of radiotherapy on the voltage output of cardiac implantable devices
- 15 7/Outcomes from a ‘low biventricular pacing’ MDT service
- 16 8/Improving adoption of evidence-based implantable cardioverter defibrillator programming – a single-centre experience
- 17 9/Auditing the clinical accuracy of Reveal Linq Interpretation via external analysis provider Focus On™
- 18 10/Incidence and type of alerts for low voltage devices – a 12-month high-volume centre experience from a de novo deployment
- 19 11/Increased activity targets, remote monitoring for all patients, same workforce, no capital funding. How will this device clinic cope?
- 20 12/AF virtual ward – the way forward...
- 21 13/The impact of frailty on atrial fibrillation ablation outcomes
- 22 14/Arrhythmia Alliance Patient Survey: remote care, what is the impact on follow-up?
- 23 15/Artificial intelligence-enabled electrocardiogram to distinguish atrioventricular re-entrant tachycardia from atrioventricular nodal re-entrant tachycardia
- 24 16/Effects of sodium-glucose cotransporter-2 inhibitors on ventricular arrhythmias or sudden cardiac death: a propensity score-matched population-based study
- 25 17/Are consumer-grade ECG devices as good as a 12 lead ECG? A comparison of the Apple Watch Series 6, KardiaMobile 6L and Withings Scanwatch with the 12 lead ECG
- 26 18/Virtual wards – a futuristic insight into atrial fibrillation care
- 27 19/The electrophysiologic substrate of Brugada syndrome patients can be revealed by electrocardiographic imaging
- 28 20/Real-world results of oesophageal protection during left atrial ablation
- 29 21/Silent veins during cryoballoon ablation of atrial fibrillation as a novel and independent predictor of long-term outcome: results from the Middelheim-PVI Registry 2
- 30 22/Predictors and clinical value of late gadolinium enhancement on CMR in patients with premature ventricular contractions and normal echocardiogram
- 31 23/Redefining atrial scar: an analysis using pacing thresholds, electrogram amplitudes and local impedance. Can we improve on 0.05 and 0.5mV?
- 32 24/The effect of His bundle pacing vs conventional biventricular pacing on repolarisation in patient’s with heart failure and reduced ejection fraction and left bundle branch block?
- 33 25/Creating patient-specific atrial fibrillation models from imaging and electroanatomic mapping data
- 34 26/Heart rhythm variability in patients with atrial fibrillation and atrial flutter depending on immune status, systemic inflammation and renin-angiotensin-aldosterone system activity
- 35 27/Artificial intelligence-enabled electrocardiogram to distinguish cavotricuspid isthmus dependence from other atrial tachycardia mechanisms

CONTINUED





## Contents – Abstracts

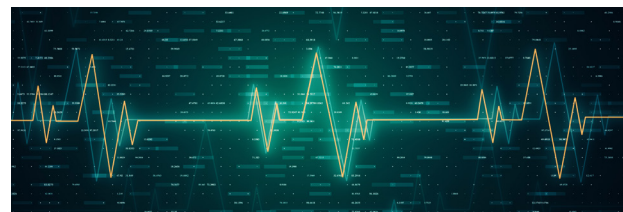


- 36 28/UHF-ECG detected QRS fractionation predicts arrhythmic risk in patients with hereditary arrhythmic conditions
- 37 29/The electrophysiological substrate of HCM and propensity to ventricular fibrillation as measured by ECG imaging
- 38 30/Assessment of scar between atria, rhythms and atrial fibrillation types. Does ultra-high-density mapping offer new insights?
- 39 31/When to measure changes during CRT optimisation. Guidance from computer simulation studies
- 40 32/Syncope in ICD recipients – data from unselected patients in a real-world setting
- 41 33/Predicting permanent pacemaker implantation after transcatheter aortic valve implantation (TAVI) – building a risk score calculator
- 42 34/Cardiac computed tomography prior to cardiac resynchronisation therapy upgrade enhances pre-procedural planning by accurately predicting coronary sinus target vessel localisation and venous access patency
- 43 35/Long-term follow-up and procedural safety of pacemaker implantation in nonagenarians
- 44 36/Optimising pacemaker therapy using multi-point pacing (the OPT-MPP Study)
- 45 37/Patient experience of very high-power short-duration radiofrequency ablation for atrial fibrillation under mild conscious sedation
- 47 38/Integration of structural and functional data in VT ablation
- 48 39/Electroanatomical mapping improves procedural outcomes of cryoballoon pulmonary vein isolation (The Achieve Plus Study)
- 49 40/Electro-architectural differences between septal and non-septal post-infarct ventricular scars identified using ripple mapping
- 50 41/A local impedance-based comparison of IntellaNav MiFi and Stablepoint catheters
- 51 42/RETRO-map: A novel algorithm to map persistent atrial fibrillation shows a reduction in wavefront collision following circumferential pulmonary vein isolation
- 52 43/Immediate inpatient implantable loop recorder implantation for the detection of atrial fibrillation in cryptogenic stroke
- 53 44/First worldwide report of CT/TOE fusion tool to guide electrophysiology procedures
- 54 45/Drug-related atrioventricular conductive disorders – a predictive-oriented approach
- 55 46/Transvenous lead extraction: a single-centre experience of the Tandem procedure
- 56 47/Omnipolar Electrograms are more consistent and improve substrate characterisation in Human Atrial Flutter
- 58 48/Application of the MADIT ICD Benefit Score to a tertiary UK centre primary prevention population
- 59 49/Initial experience of a novel radiofrequency wire-based transeptal puncture system
- 60 50/Patients with severe systolic hypertension requiring pacemaker implantation are more likely to have preserved left ventricular systolic function: an observational study
- 61 51/Assessment of optimal thresholds for ventricular scar substrate characterization
- 62 52/Acute and long-term outcome of radiofrequency ablation for outflow tract ventricular arrhythmias: impact of anatomy and high-density mapping
- 63 53/Improving understanding of lesion parametrics in high-power short-duration ablation
- 65 54/Radiofrequency ablation of the diseased human left ventricle: biophysical and electrogram based analysis
- 66 55/Invasive assessment of haemodynamic compromise and coronary blood flow during simulated VT
- 67 56/Exploiting SMART Pass filter deactivation detection to minimise inappropriate subcutaneous implantable cardioverter defibrillator (S-ICD) therapies: a real-world single-centre experience and management guide
- 68 57/A surface evaluation of single and dual chamber ICD discriminators

CONTINUED



## Contents – Abstracts

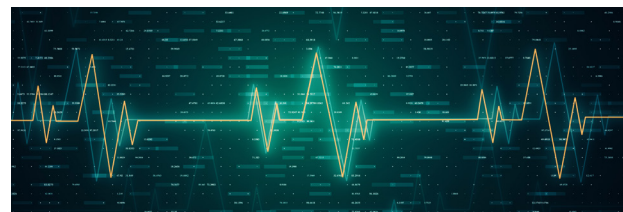


- 69 58/Incidence and predictors of ventricular arrhythmia and mortality in a primary prevention defibrillator cohort in the era of improved heart failure and arrhythmia management
- 70 59/Virtual reality – a new addition to the anxiolytic armamentarium during implantation of cardiac devices
- 71 60/The utility of transoesophageal echocardiography-derived left atrial appendage velocity in predicting postoperative atrial fibrillation in mitral valve surgery patients
- 72 61/ Bariatric surgery partially reverses subclinical proarrhythmic remodelling in obese patients: a non-invasive electrocardiographic imaging study
- 73 62/Enhancing the identification of atrial fibrillation using prescribing records in electronic medical record research
- 74 63/AF Association Patient Survey – remote monitoring and alert-based systems
- 76 64/Inappropriate shocks from an S-ICD
- 77 65/Contemporary CIED complications in a major tertiary centre: insights into rates of bleeding, infection and lead displacement
- 78 66/Efficacy and safety of a remote monitoring program for low-energy devices – 1-year follow-up
- 79 67/Unscheduled downloads from implantable cardiac device home monitoring: benefit or burden?
- 80 68/The application of deep learning methods in S-ICD screening – a promising approach?
- 81 69/Peri-procedural complications and 3-month re-intervention rates associated with cardiac device implantation: our tertiary centre experience
- 82 70/Pilot study of non-contact mapping-guided ablation of atrial fibrillation in high complexity congenital heart disease
- 83 71/Millimetre-scale batteries enable miniaturisation of cardiac implanted sensors
- 84 72/Unsticking the spaghetti of ventricular tachycardia
- 85 73/Automated, high-precision echocardiographic and haemodynamic atrioventricular delay assessment for right ventricular pacing in hypertrophic obstructive cardiomyopathy
- 86 74/Safety and tolerability of inpatient and outpatient initiation of disopyramide for obstructive hypertrophic cardiomyopathy in a referral centre for septal reduction
- 87 75/The development of a Comprehensive Cardiac Devices Service, NHS Forth Valley
- 88 76/Prevalence of arrhythmia among patients attending adult congenital heart diseases clinics
- 89 77/Procedural safety and acute effectiveness of pulsed field ablation for treatment of atrial fibrillation – a report on the first series of cases in the UK
- 90 78/Gender-specific and cardiomyopathy-specific differences in heart rate variability under the aspect of circadian rhythm
- 93 79/In-patient pacemaker implantation for sinus node dysfunction is associated with an increased mortality
- 94 80/Atrial fibrillation organisation correlates with ventricular response regularity in patients with persistent atrial fibrillation undergoing catheter ablation
- 95 81/Sorry we missed you – increasing rates of CIED non-elective battery replacement in the COVID-19 era
- 96 82/Cardiac ablation in premature ventricular contraction-induced cardiomyopathy
- 97 83/A doubly shocking case
- 98 84/Developing a postural orthostatic tachycardia syndrome (POTS) pathway
- 99 85/Impact of a telemetry monitoring sheet on detection and actioning of cardiac events at a tertiary cardiac centre – updating of British Heart Rhythm Society telemetry guidelines
- 100 86/The role of atrioventricular delay shortening and ventricular resynchronisation in achieving the haemodynamic benefit seen in biventricular pacing

CONTINUED

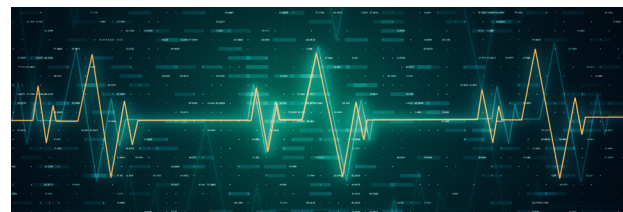


## Contents – Abstracts



- 101 87/The impact of setting up an arrhythmia nurse-led, Kardia monitor loan library
- 102 88/Initial experience using a diamond tip ablation catheter in conjunction with a basket high density mapping system, for the treatment of atrial flutter and ventricular tachycardia
- 103 89/Benefits of support groups for patients living with implantable cardioverter defibrillators: a mixed-methods systematic review and meta-analysis
- 104 90/Loss of capture during pacemaker generator replacement: an unexpected surprise!
- 105 91/Innovative primary care-led community palpitation management and investigation pathway for Wakefield district
- 106 92/Incidence and predictors of permanent pacemaker implant in patients undergoing transcatheter aortic valve replacement: a single-centre retrospective study
- 107 93/Time is brain – remote follow-up (RFU) improves new onset of atrial fibrillation (AF) diagnosis and treatment in the cardiac devices population
- 108 94/Outsourcing management of disconnected remote monitors – collaborating with industry
- 109 95/The Application of Atrial Fibrillation clinical risk scores and differences in AF risk based on ethnicity and sex within the UK Biobank Population Cohort
- 110 96/“Tomorrow I’m going to die”: the role of patient support groups in adapting to life with an implantable cardioverter defibrillator
- 111 97/Biotronik DX lead failure – recency bias or real issue?
- 112 98/Cardiac implantable electronic device infections: multicentre validation of a novel risk score and its cost–utility implications for antimicrobial envelope use
- 113 99/The impact of COVID-19 on amiodarone use in Nottingham University Hospitals DC cardioversion service
- 114 100/COVID-19-associated atrial fibrillation: its incidence and potential implications, a retrospective 1-year study in a UK tertiary care hospital
- 115 101/UK multicentre retrospective study of the learning curve and relative impact on success rates and procedural metrics of the Rhythmia Mapping System
- 116 102/Electroanatomic mapping data analysis using OpenEP
- 117 103/Using transthoracic echocardiogram (TTE) to risk-stratify patients with inherited arrhythmia syndromes (IAS)
- 118 104/An evaluation of the remote follow-up (RFU) service for cardiac pacing devices at Royal Papworth Hospital (RPH) and the impact of this service on patient care during the COVID-19 pandemic
- 119 105/What governs immediate or delayed DC cardioversion of atrial fibrillation?
- 120 106/Implantable cardioverter defibrillators: the prophylaxis of sudden cardiac death in patients with ischaemic and non-ischaemic cardiomyopathy. Contemporary clinical outcomes from a single tertiary centre
- 121 107/Service development of a pathway for generator changes in older adults with frailty
- 122 108/Trauma and syncope: looking beyond the injury
- 123 109/Structural and functional characteristics of the heart after CRT in patients with heart failure
- 124 110/Sotalol and mexiletine in combination are effective in suppressing ventricular arrhythmias in high-risk patients with ARVC: a single-centre experience
- 125 111/Ventricular tachycardia burden between surgical and control group
- 126 112/Consult requests by emergency department (ED) or medical teams due to atrial fibrillation (AF) made to the cardiology ANP service: a review of the reliance on and compounding factors that reduce the accuracy of automated ECG software reports
- 127 113/Left atrial appendage occlusion for atrial fibrillation and bleeding diathesis

## Contents – Abstracts



- 128 114/Adverse LA remodelling is needed to decrease success rates in obese patients with AF: a single-centre retrospective study on RECURrence of Atrial Fibrillation following first time ablation (RECUR-AF)
- 129 115/Conduction system pacing and AV node ablation – Glenfield stepwise approach for perfection
- 130 116/Substrate-based modification in ventricular tachycardia: ablation of the local abnormal ventricular activity only should we focus on LAVA? Learning from a case series
- 131 117/Single-centre retrospective evaluation of procedure time, fluoroscopy time and complication rates of conduction system pacing compared with traditional methods
- 133 118/Things that go 'brady' in the night
- 134 119/The long-term effect of thoracoscopic ablation on atrial fibrillation burden using continuous monitoring
- 135 120/Stridor and dyspnoea after atrial fibrillation catheter ablation: a case report
- 136 121/Temporal trends of catheter ablation for patients with atrial fibrillation: earlier is better
- 137 122/Implementing a service to identify and manage patients with low biventricular pacing
- 138 123/Therapeutic options for syncope: a meta-analysis of blinded and unblinded randomised controlled trials
- 139 124/Evaluation of a novel, digitised pre-procedural assessment pathway
- 140 125/Complex device nurse-led VT clinic – a single-centre experience (OxVT)
- 141 126/The PADIT score and antibiotic decision making for patients undergoing cardiac implantable electronic device (CIEDs) procedures – time for a rethink?
- 142 127/Atrial tachycardia masquerading as inappropriate sinus tachycardia
- 143 128/Service evaluation of the effectiveness and potential benefits of a mobile Kardia clinic for an NHS cardiology department
- 144 129/Taurolidine containing antimicrobial wash to prevent cardiac implantable electronic device infection
- 145 130/130/Arrhythmia Alliance and Mended Hearts Survey – patient understanding and awareness of CIED infection
- 148 131/Late presentation of Wolff–Parkinson–White syndrome in children with previously normal electrocardiogram (ECG) – a case series



## Young Investigators Competition – Clinical Science

### 1/Impact of left ventricular scar burden on acute response to conduction system pacing

Authors: *N Ali* (Presenting Author) – National Heart and Lung Institute, Imperial College London, London; *GD Cole* – National Heart and Lung Institute, Imperial College London, London; *A Miyazawa* – National Heart and Lung Institute, Imperial College London, London; *AD Arnold* – National Heart and Lung Institute, Imperial College London, London; *MJ Shun-Shin* – National Heart and Lung Institute, Imperial College London, London; *D Keene* – National Heart and Lung Institute, Imperial College London, London; *JJ Chow* – Imperial College Healthcare NHS Trust, London; *NS Peters* – National Heart and Lung Institute, Imperial College London, London; *P Kanagrathnam* – National Heart and Lung Institute, Imperial College London, London; *N Qureshi* – National Heart and Lung Institute, Imperial College London, London; *F Ng* – National Heart and Lung Institute, Imperial College London, London; *PB Lim* – National Heart and Lung Institute, Imperial College London, London; *MA Tanner* – St Richards Hospital, University Hospitals Sussex NHS Foundation Trust, London; *N Linton* – National Heart and Lung Institute, Imperial College London, London; *A Muthumala* – St Bartholomews Hospital and North Middlesex University Hospital, London; *D Lefroy* – Imperial College Healthcare NHS Trust, London; *DP Francis* – National Heart and Lung Institute, Imperial College London, London; *ZA Whinnnett* – National Heart and Lung Institute, Imperial College London, London

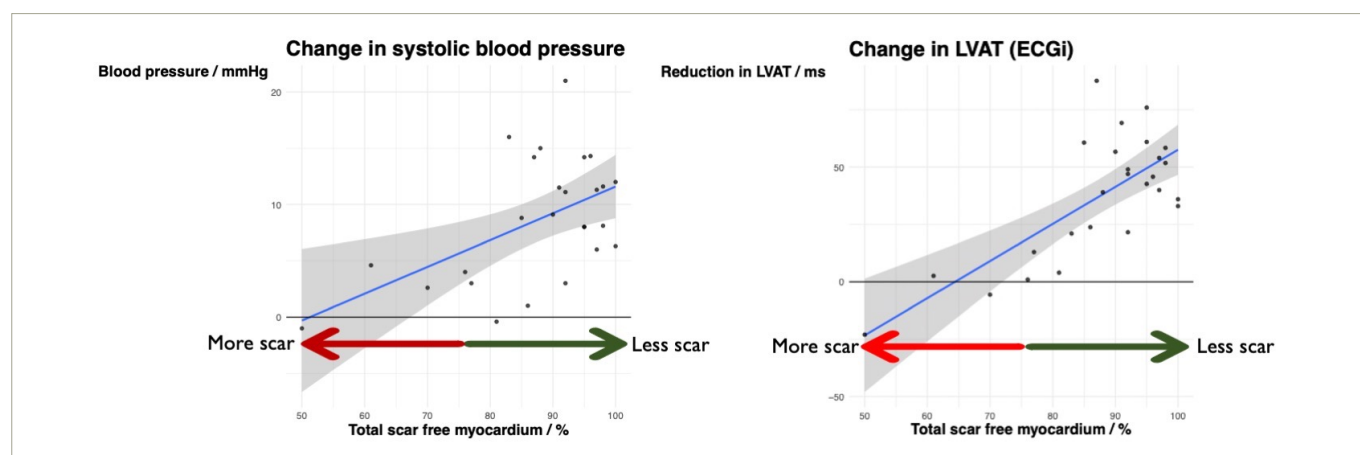
**Introduction:** Conduction system pacing is a novel way for delivering cardiac resynchronisation therapy (CRT). This may deliver more effective ventricular resynchronisation than the gold standard, biventricular pacing (BVP). In BVP scar burden is known to impact response but whether this is true for conduction system pacing is unknown.

**Methods:** Patients with standard CRT indications were recruited. They underwent a pre-procedure cardiac MRI, with late gadolinium enhancement to assess scar. Scar burden was quantified as the percentage of the amount of myocardium for each segment and the whole of the left ventricle (total scar). Conduction system pacing with both His bundle CRT (HB-CRT) and left bundle area CRT (LBA-CRT) was attempted in everyone, and the modality that delivered the narrowest QRS duration was selected. The electrical response was measured using non-invasive mapping (ECGi, CardioInsight, Medtronic). The haemodynamic response was measured with a high precision protocol. We investigated the impact of scar on the electrical and haemodynamic response.

**Results:** A total of 26 patients were recruited, 85% male, mean age  $69 \pm 10$  years, ischaemic cardiomyopathy in 35% and mean QRS duration  $160 \pm 15$ . LGE was observed in 96% of cases, mean total scar burden was  $13 \pm 12\%$  (range 1–39%). We found a significant correlation between amount of scar and both the electrical and acute haemodynamic response (Figure 1). Patients with a lower scar burden obtained a greater improvement in both electrical resynchronisation ( $R=0.55$ , 95% CI 0.21–0.77,  $p<0.01$ , for reduction in left ventricular activation time [LVAT]), and acute haemodynamic response ( $R=0.5$ , 95% CI 0.18–0.76,  $p=0.005$  for increase in acute systolic blood pressure).

**Conclusion:** Conduction system pacing appears to be less effective in patients with a high left ventricular scar burden. We observed a strong correlation between scar burden and both ventricular electrical resynchronisation and acute haemodynamic response. This information may help patient selection for conduction system CRT. Alternative CRT modalities or combinations of modalities warrant further investigation in this challenging group of patients. □

Figure 1



Young Investigators Competition – Clinical Science

**2/Yield of 12-lead 24-hour ambulatory ECG monitoring in the identification of a spontaneous type 1 Brugada pattern and its prognostic value. A sub-study of the BHF RASE Brugada project**

Authors: *C Scrocco (Presenting Author) – St George’s University of London, St George’s Hospital NHS Trust, London; Y Ben-Haim – St George’s University of London, St George’s Hospital NHS Trust, London; C Miles – St George’s University of London, St George’s Hospital NHS Trust, London; M Specterman – St George’s University of London, St George’s Hospital NHS Trust, London; M Tome-Esteban – St George’s University of London, St George’s Hospital NHS Trust, London; M Papadakis – St George’s University of London, St George’s Hospital NHS Trust, London; S Sharma – St George’s University of London, St George’s Hospital NHS Trust, London; ER Behr – St George’s University of London, St George’s Hospital NHS Trust, London*

**Background:** A type 1 Brugada pattern (T1-BrS) is a recognised marker of arrhythmic risk. Twelve-lead 24-hour Holter monitoring with V1 and V2 in standard and high precordial electrocardiogram (ECG) lead (HPL) positions, can identify transient spontaneous T1-BrS pattern in BrS patients with a concealed T1-BrS at presentation.

**Aim:** To investigate the yield and prognostic value of 12-lead 24-hour Holter monitoring with additional high precordial ECG leads (HPL-Holter) in a large single-centre cohort of BrS patients.

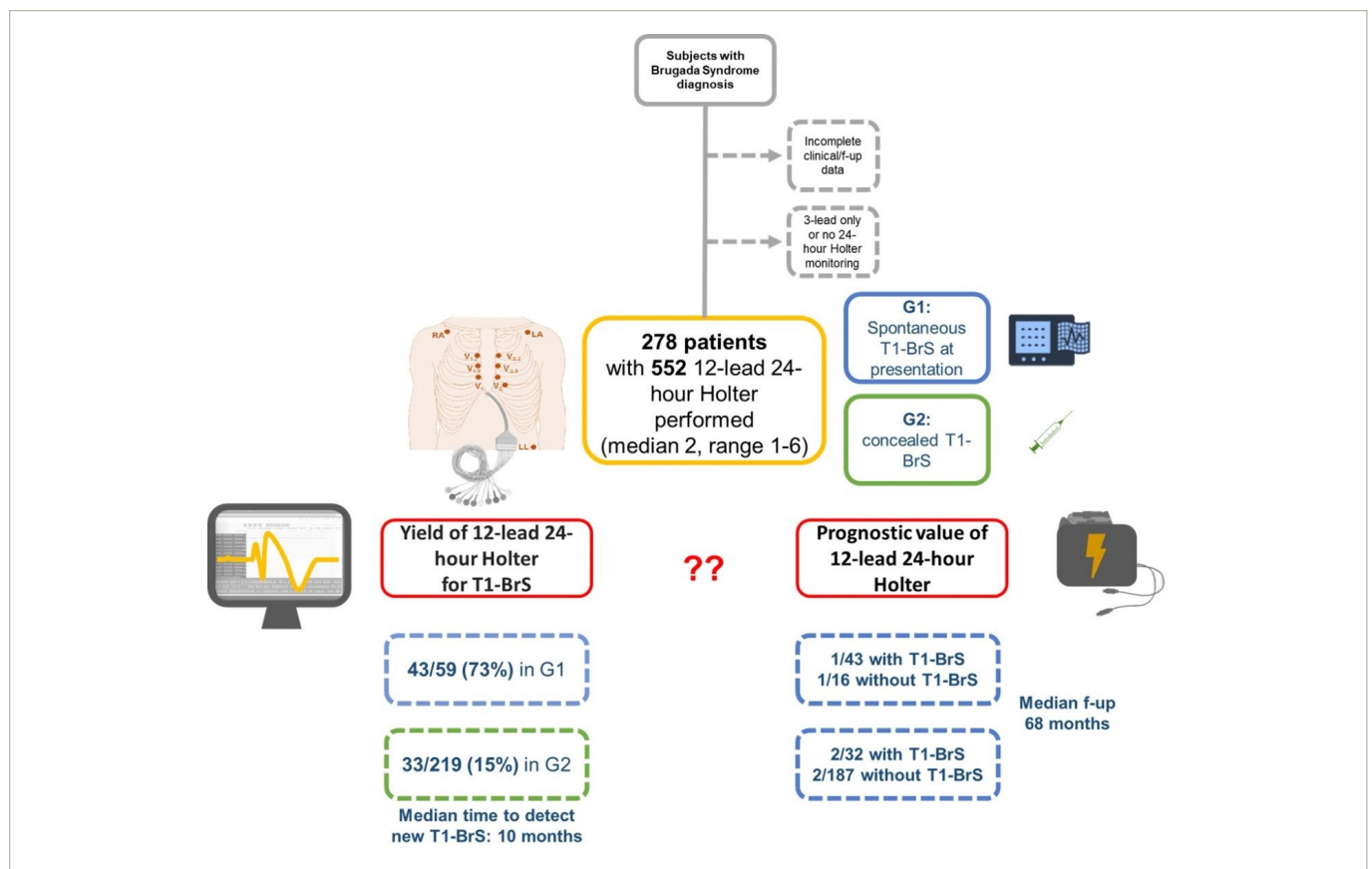
**Methods:** A total of 278 subjects with BrS (56% male, mean age at presentation  $43 \pm 15$  years) were included in this study, for whom complete clinical and follow-up data and HPL-Holter(s) after initial evaluation were available. Of these, 59 had a spontaneous T1-BrS pattern at presentation (Group 1) and 219 did not (Group 2), usually requiring ajmaline provocation testing to confirm the diagnosis.

**Results:** From 2008 to 2022, 552 HPL-Holters were recorded in the study cohort (median 2, range 1–6). In total, 43 (73%) subjects in Group 1 and 32 (15%) in Group 2 showed a T1-BrS pattern during HPL-Holter monitoring at least once; this was evident on the 1st follow-up recording in 95% of cases in Group 1 and 66% in Group 2 (median 10 months, IQR 45,

range 0.5–64), with at least 2 recordings needed in 28% of subjects in this latter group. Patients with a newly identified T1-BrS in Group 2 tended to be older (mean age  $48 \pm 14$  vs  $42 \pm 16$  years;  $p=0.05$ ) and to carry the proband status (56% vs 52%;  $p<0.05$ ) than those without, whereas there were no significant differences in gender, family history of sudden cardiac death and the presence of previous symptoms. Over a median follow-up of 68 months (IQR 64), significant arrhythmic events (appropriate ICD shocks on VT/VF) occurred in 2 subjects in Group 1 (1/43 showing T1-BrS during HPL-Holter monitoring and 1/16 not showing it;  $p=NS$ ) and in 4 subjects in Group 2 (2/32 with newly identified spontaneous T1-BrS and 2/187 without;  $p<0.05$ ).

**Conclusions:** Twelve-lead 24-hour ambulatory ECG monitoring including additional HPLs can identify a transient spontaneous T1-BrS in up to 15% of the subjects without the diagnostic pattern at presentation, most during the first year after the diagnosis. In this group, the presence of a T1-BrS pattern is associated with arrhythmic events. We recommend re-evaluation with high precordial 12-lead Holter monitoring of subjects without spontaneous T1-BrS at presentation once a year for at least the first 2 years post-diagnosis. □

Figure 1



Young Investigators Competition – Clinical Science

**3/Cardiac resynchronisation therapy acutely alters cardiac metabolic substrate uptake, correlating with improvements in systolic function and long-term reverse remodelling**

Authors: *PG Green* (Presenting Author) – University of Oxford, Oxford; *WD Watson* – University of Oxford, Oxford; *GL De Maria* – Oxford University Hospitals NHS Foundation Trust, Oxford; *AJM Lewis* – University of Oxford, Oxford; *OJ Rider* – University of Oxford, Oxford; *N Herring* – University of Oxford, Oxford

**Introduction:** The failing heart is thought to be metabolically inflexible, and oxygen limited, shifting from free fatty acid (FFA) oxidation towards glucose metabolism. Whilst glucose metabolism is more oxygen efficient, fatty acid (FA) metabolism generates more adenosine triphosphate (ATP) per mole of substrate. Cardiac resynchronisation therapy (CRT) acutely improves cardiac haemodynamics in patients with severe heart failure and a left bundle branch block, and subsequently induces long-term reverse remodelling by a process that is unpredictable and poorly understood. We tested the hypothesis that CRT alters metabolic substrate usage, and that its ability to do so correlates with functional improvement and subsequent reverse remodelling.

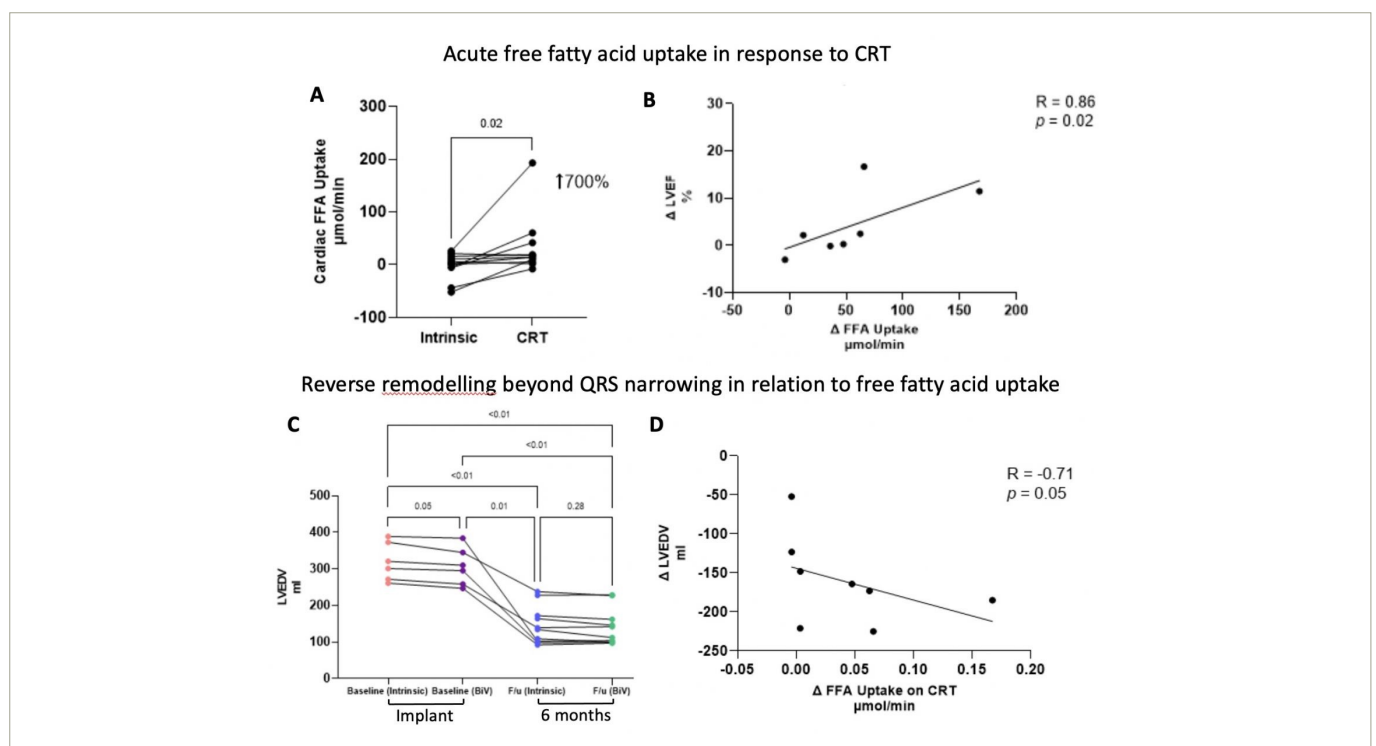
**Methods:** Participants with non-ischaemic cardiomyopathy were started on a hyperinsulinaemic euglycaemic clamp (insulin/dextrose) prior to CRT implant. During implant, measurements of left ventricular (LV) contractility (using a pressure-volume loop catheter), coronary flow (using a Doppler guide wire) and paired arterio-venous blood samples (from the left main stem and coronary sinus) were obtained with and without optimised CRT. All measurements were then repeated on an FFA infusion (20% Intralipid™). Participants had cardiac magnetic resonance imaging (MRI 1.5 T) at 6 months, with and without biventricular pacing in MRI-safe mode, to assess reverse remodelling.

**Results:** Twelve participants were recruited (7 male, median age 64 [IQR 60–71]) all with left bundle branch block (QRS duration 169 [162–183] ms) and severely impaired LV ejection fraction (29% [25–31]). Measures of LV contractility (work and dP/dtmax) were significantly improved by CRT on both infusions, without an increase in myocardial oxygen demand,

resulting in improvement in cardiac efficiency (insulin/dextrose: +7.9%,  $p=0.02$ ; FFA: +31%,  $p=0.02$ ). Metabolic flexibility was therefore retained. On insulin/dextrose, CRT increased cardiac FFA uptake within 2 minutes of pacing (*Figure 1A*), which positively correlated with improvement in LV ejection fraction (LVEF, *Figure 1B*). When FFA uptake was maximised on an FFA infusion, CRT increased ketone uptake, which positively correlated with improvement in cardiac work ( $R=0.55$ ,  $p=0.04$ ). At all points, the heart was a net lactate consumer rather than producer, implying that oxygen supply was not limited. Substantial reverse remodelling was observed at 6 months following implant with significant improvements in ejection fraction (40% [33–50],  $p<0.01$ ) and LV end-diastolic volume (LVEDV), beyond that seen with acute reduction in QRS duration with biventricular pacing (*Figure 1C*). Reverse remodelling strongly correlated with acute changes in FFA (*Figure 1D*) and ketone uptake ( $R=-0.79$ ,  $p=0.05$ ) in response to CRT, but not the degree of shortening in QRS duration at implant ( $p=0.24$ ).

**Conclusion:** CRT improves cardiac efficiency and whilst acute narrowing of QRS duration may be responsible for initiating reverse remodelling, by 6 months significant structural changes have occurred beyond that achievable by QRS narrowing alone. CRT reverses the metabolic phenotype of heart failure towards more physiological lipid-based metabolism and reverse remodelling is strongly correlated with the ability of the heart to acutely increase FFA and ketone uptake. Therapy promoting lipid metabolism may therefore be a useful treatment to promote reverse remodelling in non-ischaemic cardiomyopathy. □

Figure 1



Basic Scientist

4/Selective T-type calcium current block affects action potential dynamics in murine atrial myocytes

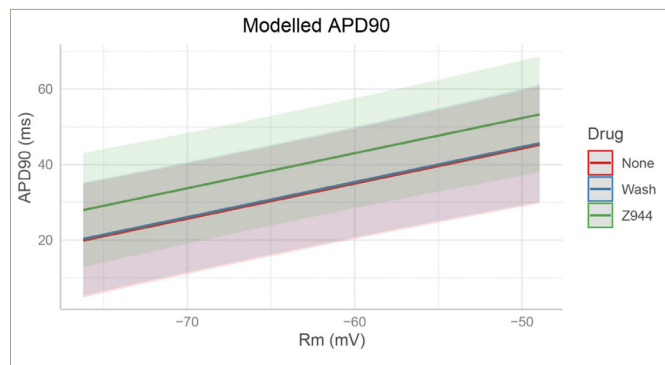
Authors: *AR Jones (Presenting Author) – Queen Mary University London, London; A Tinker – Queen Mary University London, London*

**Introduction:** The T-type calcium current (ICaT) is down-regulated in atrial fibrillation and may be involved in its pathogenesis. Previous attempts to target ICaT pharmacologically have been limited by lack of compounds that specifically antagonise the T-type compared with the L-type. In recent years new compounds have been developed that both open and block the membrane channels that facilitate ICaT and are reported to have improved T-type specificity. The novel compound Z944 has good T-type specificity in primary murine atrial myocytes and may have utility in the treatment of atrial fibrillation. This work investigates the effect of this compound on the murine action potential as any effect is likely to be atrial specific given the lack of T-type expression in healthy ventricle.

**Methods:** Action potentials were recorded from primary wild-type murine atrial myocytes from both atria using the whole-cell ruptured current clamp technique. All animal work was performed according to relevant legislation. Action potentials were stimulated with the injection of 500 pA of positive current for 5 ms following an S1-S2 protocol. Baseline cycle length was 250 ms with the S2 interval starting at 250 ms and reducing to 40 ms in 15 ms steps. Action potentials were recorded under controlled conditions, in the presence of 1  $\mu$ M Z944 and following wash of the compound. The action potentials recorded following S2 were analysed using Matlab (MathWorks Inc). The time taken for 30, 50 and 90 percent repolarisation (APD30, APD50 and APD90) were determined for each action potential. A mixed effects model was used to assess the effect of Z944 on action potential duration (APD). As previous diastolic interval (DI) and resting membrane potential (Rm) also effect APD, these were both added as co-variates in the model.

**Results:** A total of 8 atrial myocytes were included in the mixed-effects model. The presence of 1  $\mu$ M Z944 extended the APD30 by 1.70 ms ( $p < 0.001$ ), the APD50 by 2.75 ms ( $p < 0.001$ ) and the APD90 by 8.07 ms ( $p < 0.001$ ). Cells that had been washed showed no significant increase in

Figure 1



APD compared with control conditions. The APD was sensitive to resting membrane potential with APD30 increasing by 0.12 ms/mV ( $p = 0.006$ ), APD50 increasing by 0.20 ms/mV ( $p < 0.001$ ) and APD90 increasing by 0.93 ms/mV ( $p < 0.001$ ). APD90 showed a reduction with reduced DI ( $p < 0.001$ ) although APD50 and APD30 showed a very small increase ( $p < 0.001$ ). The relationship between resting membrane potential, presence of Z944 and APD90 is illustrated in *Figure 1*.

**Conclusions:** Selective block of the T-type calcium current with Z944 leads to an increase in APD in murine atrial myocytes. The mechanism for this effect has yet to be determined and warrants further investigation. Given the pharmacology of Z944 and the lack of T-type current in healthy ventricle, the effect would be expected to be atrial specific. There is therefore the potential for Z944 to have utility in the management of atrial arrhythmias without the troublesome ventricular pro-arrhythmic effects that plague many other compounds. □



Basic Scientist

5/Defining the local immune drivers in atrial fibrillation: the role of tissue-resident memory T cells

Authors: V Vyas (Presenting Author) – Queen Mary University of London & Barts Health NHS Trust, London; B Sandhar – Queen Mary University of London, London; A Jones – Queen Mary University of London & Barts Health NHS Trust, London; E Wood – Queen Mary University of London, London; H Blythe – Queen Mary University of London, London; M Finlay – Queen Mary University of London & Barts Health NHS Trust, London; MP Longhi – Queen Mary University of London, London

**Introduction:** Increased volume of epicardial adipose tissue (EAT) is now well established as an independent risk factor for all forms of atrial fibrillation (AF). EAT acts as a local compartment of immune cells and mediators that can infiltrate the myocardium given the lack of fascial boundaries between them. However, a comprehensive immune characterization of EAT is currently lacking with human tissue studies sparse and patients typically poorly matched for baseline clinical characteristics. This study sought to systematically define the immunological signature of EAT in a propensity-matched cohort of cardiac surgical patients with a prior history of AF, those in sinus rhythm and patients who developed de novo post-operative AF.

**Methods:** Adult patients with a history of AF and those with no prior history of AF undergoing cardiac surgery were recruited to undergo EAT, blood and subcutaneous adipose tissue (systemic and adipose tissue controls respectively) sampling. Patients were propensity-matched to ensure baseline clinical variables were similar across the groups. Immune cell isolation, flow cytometry and T lymphocyte cell stimulation assays were performed on fresh samples. Bulk RNA and spatial transcriptomic analysis were performed on a cohort of patients to determine both whole tissue and regional differences in RNA expression changes across the tissue. In 2 patients, paired EAT and right atrial appendage (RAA) tissue samples underwent combined single-cell RNA sequencing and T cell receptor sequencing.

**Results:** A cohort of 59 propensity-matched patients was identified (Table 1). T cells were the predominant immune cell type and T-cell subset analysis in a sub-cohort of 18 patients revealed a highly significant increase in both EAT-resident CD4+ (p<0.05) and CD8+ (p<0.001) memory T-cell populations in AF patients. T-cell stimulation assays demonstrated a highly significant correlation with the proportion of tissue-resident memory (TRM) CD4+ T cells in EAT and the cytokines interferon-γ (p=0.0072) and interleukin-17 (p=0.0042). Spatial transcriptomic analysis revealed regional differences in gene expression and higher fibrosis samples exhibiting TRM-specific markers (p<0.05). In contrast, bulk EAT RNA sequencing analysis demonstrated broadly similar immune mediator expression levels between the groups. On a single-cell level, EAT and RAA exhibited comparable immune cell populations with a

Table 1: Summary of the key clinical characteristics of the patient cohort

Variable	Atrial Fibrillation (n=16)	Sinus Rhythm (n=25)	Post-operative Atrial Fibrillation (n=18)	P value
Age (Years)	67.3 ± 7.8	65.6 ± 8.8	70.5 ± 6.8	0.15
Male Gender (%)	14 (78)	17 (65)	15 (79)	0.52
Body Mass Index (kg/m <sup>2</sup> )	26.6 ± 4.5	26.8 ± 3.9	27.8 ± 3.5	0.59
Diabetes (%)	2 (11)	3 (12)	4 (21)	0.60
Hypertension (%)	12 (67)	18 (67)	12 (63)	0.96
Prior Myocardial Infarction (%)	3 (17)	7 (27)	7 (37)	0.38
Left Ventricular Ejection Fraction (%)	59 (55-63)	60 (58-61)	57 (54-60)	0.10
Pre-operative C-reactive protein (mg/L)	0 (0-5)	0 (0-9)	0 (0-16)	0.94
Left atrial size (cm)	4.9 ± 1.5	3.6 ± 0.6	4.1 ± 0.3	0.02*

\*P<0.05

shared core TRM signature and TRM subsets. One of the CD8+ TRM subsets was noted to be specifically elevated in the AF cohort. Finally, T-cell receptor sequencing confirmed the same T-cell clones to be present in the RAA as the EAT.

**Conclusions and implications:** AF exhibits a unique EAT-resident T-cell signature that correlates with the production of the pro-inflammatory cytokines interferon-γ and interleukin-17. Single-cell RNA and T-cell receptor sequencing analysis confirms EAT to be the immune reservoir of the heart with the same T-cell clones noted to be in both EAT and RAA. EAT sampling can thus provide an accurate readout of the immune landscape of the underlying cardiac tissue.

Targeting this local resident T-cell population and the mediators it produces (e.g. using a monoclonal antibody approach) unlocks a novel paradigm in the management of the inflammatory and fibrotic components of AF genesis. □

## Basic Scientist

### 6/The effect of radiotherapy on the voltage output of cardiac implantable devices

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**Purpose:** It has historically been established that radiotherapy can potentially cause cardiac implantable electrical devices (CIEDs) to malfunction. Guidelines were established in 1994 for the management of patients undergoing radiotherapy with CIEDs. They recommend a total dose constraint of 2 Gy to any part of a pacemaker (0.5 Gy for ICDs), and that devices should not be directly in the treatment beam. The most recent review of global research was published in 2017; this proposed a new constraint of a 5 Gy maximum total dose for all devices. At doses higher than this, relocation of the device is recommended. Device malfunctions are suggested to correlate with a beam energy of  $\geq 10$  MV. One malfunction that poses a high risk to patients is a change in voltage output amplitude. This study assessed whether low-energy flattening filter and high energy flattening filter-free photon beam radiation caused a change in the voltage output amplitude of cardiac implantable devices.

**Method:** A total of 40 cardiac implantable devices were divided into two treatment groups and labelled 1–40 (ensuring patient anonymity). They were then irradiated *in vitro* with a cumulative 48 Gy dose of 6 MV radiation at 600 MU/min in 8 fractions or a single fraction 48 Gy dose of 10 MV radiation at 2400 MU/min. The voltage output amplitude of all devices was collected using an oscilloscope and an amplitude change of  $\geq 25\%$  was classed as a clinically significant malfunction.

**Results:** In the 6X treatment group, 0/19 devices showed a clinically significant change. A non-parametric Mann–Whitney test was carried out to assess whether there was a significant difference between the median peak voltage output amplitude before fraction 1 and after fraction 8. No statistical significance was found ( $U=149.5$ ,  $p=0.3733$ ,  $n=19$ ). In the 10

MV treatment group, 2/21 devices showed a clinically significant change. These were devices number 32 and 37, with voltage output amplitude increases of 28.07% and 36.97%, respectively. A non-parametric Mann–Whitney test was carried out for the 10 MV group to assess whether there was a significant difference between the median peak voltage output amplitude before and after radiation. No statistical significance was found ( $U=149.5$ ,  $p=0.0746$ ,  $n=21$ ). The clinically significant results in the 10 MV treatment group represent approximately 9.5% of the total devices. Although insignificant, it is clear that there was a larger change across all devices in the 10 MV compared with the 6X group. Results were not statistically significant between manufacturers, but defibrillators were significantly more likely to malfunction than pacemakers.

**Conclusion:** The recommended dose of radiotherapy for patients with a CIED should be carefully considered on an individual basis. At energies  $\geq 10$  MV, neutrons can be produced, which have a demonstrated effect on electrical components used within the controlling circuits of CIEDs. Future guidelines should take this into consideration, despite its statistical insignificance within this investigation. Based on this limited report it is unlikely that the pacemaker function of CIEDs will be affected by clinically relevant doses of radiotherapy, but it may have long-term implications on battery life. These results could eliminate the risk of increased infection due to relocation of devices, provide patients with optimised treatment at energies up to 6 MV with less conservative dose restrictions and enable a more effective service for improved patient management. □

## Oral Abstracts 1 – Allied and Service Development

### 7/Outcomes from a ‘low biventricular pacing’ MDT service

Authors: *BJ Jones (Presenting Author) – Barts Health NHS Trust, London; JR Ramplin – Barts Health NHS Trust, London; ZC Carter – Barts Health NHS Trust, London; NM Mark – Barts Health NHS Trust, London; PL Lloyd – Barts Health NHS Trust, London; BP Patel – Barts Health NHS Trust, London; SC Cowap – Barts Health NHS Trust, London; HG Granville – Barts Health NHS Trust, London; AM Muthumala – Barts Health NHS Trust, London*

**Introduction:** A greater biventricular pacing percentage (BiVp%) is associated with greater left ventricular reverse remodelling and reduction in all-cause mortality in patients with cardiac synchronisation therapy devices (CRT). A multi-disciplinary team (MDT) service was implemented at Barts Health NHS Trust to discuss patients with low BiVp%, to determine the cause, increase BiVp%, and provide a clear management plan to aid cardiac scientists when responding to remote monitoring alerts.

**Methods:** This retrospective audit followed 121 patients who were referred to the low BiVp% service between June 2020 and July 2021. 106 patients were included in the analysis, of the excluded patients, 11 were deceased at 6 months, 3 had been transferred to another centre and one patient had left ventricular (LV) lead displacement. Baseline characteristics were collected at time of CRT implant and BiVp% and New York Heart Association (NYHA) functional class were collected at the time of MDT and 6-month post MDT. The outcome of the MDT was actioned and documented on patients’ electronic health records.

**Results:** Of the 106 patients, 75% were male, mean age was  $73 \pm 10.6$  years, mean LV ejection fraction (LVEF) at implant was  $33 \pm 11\%$  and 57% were classed as NYHA II. The most common indication for implant was ischaemic heart disease (49%), and the most common QRS morphology was left bundle branch block (58%). The most common outcomes were to continue patient monitoring (35%) and lowering the alert threshold on remote monitoring (27%). In the remaining 40 patients, an active outcome was actioned, most commonly a referral to another cardiology service (19%). The other outcomes are summarised in *Table 1*. These 40 patients had a mean improvement in BiVp% of  $6 \pm 12\%$  over a mean follow-up time of  $5.9 \pm 1.6$  months post-MDT. An improvement of  $\geq 1$  NYHA class was seen in 16 patients (44%), no change in NYHA class was seen for 12 (33%) symptomatic patients (NYHA II-IV), no change in NYHA

Table 1

**Table 1 – Summary of ‘Low BiVp%’ MDT outcomes** – One hundred and six patients were reviewed between June 2020 and July 2021 with having a drop in their biventricular pacing. The outcomes of the MDT are summarised in this table.

Outcome	N=106
Monitor	37 (35%)
Lower alert threshold	29 (27%)
Referral	
Heart failure	15 (14%)
Electrophysiology	5 (5%)
Medication optimisation	9 (8%)
CRT programming optimisation	7 (7%)
Other outcome	4 (4%)

BiVp% - biventricular pacing percentage, MDT- multi-disciplinary team, CRT- cardiac resynchronisation therapy

class was seen in 6 (16%) asymptomatic patients (NYHA I) and 2 patients showed a worsening of  $\leq 1$  NYHA class at a mean follow-up time of  $5.9 \pm 1.6$  months post-MDT.

**Conclusion:** This retrospective audit has demonstrated that in 38% of patients being discussed in a ‘low biventricular pacing MDT’, active changes were made to their clinical care. These patients had an improvement in biventricular pacing and around half had improved NYHA class over a short follow-up period. Changing alert threshold was a useful outcome for cardiac scientists when managing remote monitoring alerts. Future prospective studies should evaluate the outcomes over a longer follow-up duration. □

## Oral Abstracts 1 – Allied and Service Development

### 8/Improving adoption of evidence-based implantable cardioverter defibrillator programming – a single-centre experience

Authors: P Khan (Presenting Author) – King’s College Hospital NHS Trust, London; B Gopinath – King’s College Hospital, London; M Laybourn – King’s College Hospital NHS Trust, London; N Jahagirdar – King’s College Hospital NHS Trust, London; A Cannata – King’s College Hospital NHS Trust, London; D Bromage – King’s College Hospital, London; F Murgatroyd – King’s College Hospital, London; PA Scott – King’s College Hospital, London

**Introduction:** Strategic implantable cardioverter defibrillator (ICD) programming, with the use of high-rate detection zones and long detection times, can significantly reduce non-essential ICD therapy and mortality. Despite the published data and guideline recommendations, the implementation of strategic programming into clinical practice has been modest. Here we describe our approach to improve ICD programming and its impact on the uptake of evidence-based programming in our institution.

**Method:** We introduced 3 specific strategies to improve adherence to evidence-based programming: 1. In late 2013 we introduced institutional ICD programming guidelines based on published data. Guidelines were circulated and compliance encouraged. 2. At the start of 2017 printed summaries of the guidelines were attached to all device programmers in the hospital and displayed on the wall in device clinic. 3. At the start of 2018 a monthly feedback and audit report on guideline compliance was circulated via email within the department. Results from the audit were graphically displayed in the device clinic on a bi-annual basis. In this analysis we included consecutive patients who received a new (or upgrade) ICD for any indication (January 2009 – December 2019) at King’s College Hospital (KCH), London. We evaluated implant programming with respect to KCH guideline compliance and the use of 2 specific evidence-based standards:

- High detection zones (defined as  $\geq 180$  bpm) in primary prevention patients
- Long detection times

We divided patients into 3 groups based on time:

- Baseline – implanted 2009–13 prior to introduction of programming guidelines
- Phase 1 – implanted 2014–16 after KCH programming guideline introduction
- Phase 2 – implanted 2017–19 after KCH guidelines attached to programmers and feedback audit introduced.

Programming was compared between the 3 groups using the chi-squared test.

**Results:** Compared with baseline, introduction of programming guidelines (Phase 1) was associated with a significant increase in the use of high detection zones (97.0% vs 71.8%;  $p=0.0001$ ) and long detection times (93.5% vs 22%;  $p=0.0001$ ) in primary prevention patients, and long detection times (92.7% vs 18.0%;  $p=0.0001$ ) in secondary prevention patients (Table). Following introduction of the printed programming guidelines and the monthly audit (Phase 2), compared with Phase 1 there was a further incremental increase in the use of high detection zones (100% vs 97.0%;  $p=0.03$ ) and long detection times (100% vs 93.5%;  $p=0.0003$ ) in primary prevention patients, and long detection times (100% vs 92.7%;  $p=0.002$ ) in secondary prevention patients.

**Discussion:** The main finding of this study was that the use of a series of simple strategies was associated with a significant increase in the use of evidence-based ICD programming. Introduction of a departmental programming guideline increased the use of high detection zones and long detection times above 90% for new implants, with a further increase to 100% by increasing visibility of the guideline and providing a regular audit of performance. Our study demonstrates that relatively simple measures can make large differences to ICD programming. Furthermore, it is possible that the development of local guidelines achieved greater ‘buy-in’ from implanters than using international guidelines alone and contributed to the high levels of evidence-based programming achieved in our centre. □

Table 1

Variable	Baseline (2009-13)	Phase 1 (2014-16)	Phase 2 (2017-19)	p-Value Baseline vs. Phase 1	p-Value Phase 1 vs. Phase 2
<b>Total implants</b>	430	278	295	-	-
<b>Primary prevention, n (%)</b>	241 (56.0)	168 (60.4)	174 (59.0)	-	-
<b>Overall KCH guideline compliance, n (%)</b>	N/A	188 (67.3)	288 (97.6)*	-	0.0001
<b>Primary Prevention</b>					
Lowest Treatment Zone $\geq 180$ bpm, n (%)	173 (71.8)	163 (97.0)	174 (100)	0.0001	0.03
Long Detection in Zone $\geq 180$ bpm, n (%)	53 (22.0)	157 (93.5)	174 (100)	0.0001	0.0003
<b>Secondary Prevention</b>					
Long Detection in Zone $\geq 180$ bpm, n (%)	34 (18.0)	102 (92.7)	121 (100)	0.0001	0.002

\*The KCH guidelines included both detection and therapy settings, therefore it was possible to meet the audit standards for detection but not be 100% guideline complaint



## Oral Abstracts 1 – Allied and Service Development

### 9/Auditing the clinical accuracy of Reveal Linq Interpretation via external analysis provider Focus On™

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**Introduction:** With the ever-increasing importance of home monitoring for the follow-up of cardiac implanted electronic devices (CIED), emphasised during the COVID pandemic, the workload for CIED follow-up clinics has grown exponentially. The demand on services is exceeding resource, with innovative solutions needed to maximise efficiency, safety and quality. One potential solution has been offered by Medtronic in the form of a third-party triage/interpretation service called Focus On™. This service is linked to the clinic's Carelink™ server, and they receive home monitoring downloads from the entirety or subset of Medtronic devices that are remotely monitored. They triage and interpret this information based on clinical significance. The information is returned to the follow-up clinic, classified as Green, Amber or Red based on clinical relevance, with email and/or telephone alerts to the clinic for Amber and Red alerts. Green alerts are those deemed to have no clinical relevance, with a recommendation that no extra clinic time is spent reviewing these reports. The service is promoted as not only a significant time saver, but also ensuring timely review and actioning of clinically significant data. Articles have been published confirming the same, although, to this author's knowledge, no data have been published regarding the clinical accuracy of the Focus On™ service reports.

**Aims:** To assess the diagnostic accuracy of the Green alerts labelled as such by FocusOn™.

**Methods:** This was a retrospective 6-month audit of Reveal Linq Green alert downloads, which would normally have no secondary review from the device clinic. As all Amber and Red alerts receive clinic review, they were not included in our audit. Within that period, 6750 Green

alert downloads were received (out of a total of 7780 transmissions), although only 3537 of those downloads had interpretable data (other alerts received for device battery RRT/atrial arrhythmia burden/patient downloads with no episodes etc.). A total of 500 downloads were then selected by randomly choosing 2 downloads with data from each patient page (2 out of 25). These downloads were initially reviewed by a highly specialised, IBHRE CCDS accredited cardiac physiologist. Any downloads for which the Focus On™ interpretation accuracy was queried were then anonymised and forwarded to 3 CRM and EP consultants, who were blinded to the audit, for analysis. These analyses were collated and discussed at a wider EP meeting, which involved 2 further EP consultants and EP/CRM physiologists, for a consensus opinion.

**Results:** Of the downloads reviewed, the accuracy of 17 interpretations (3.4%) were disputed by a consensus opinion from consultants and physiologists. A total of 12 of the 17 EGMs showed atrial tachycardia and/or fibrillation, which had been interpreted as sinus rhythm with ectopy; 3 showed junctional rhythm (1 with short sinus arrest), interpreted as sinus bradycardia; 1 showed second degree AV block Mobitz type I, interpreted as sinus bradycardia; 1 showed second-degree AV block type II, interpreted as second-degree AV block type I.

**Conclusion:** The findings of this audit show that the percentage of patients with an abnormal trace among the Green alerts is not inconsequential and can have a bearing on optimal patient management. NHS Trusts already using such services or planning on using this service in future should consider performing their own audit or have mechanisms in place to do so when the service is up and running, to ensure quality of patient care is maintained. □

## Oral Abstracts 1 – Allied and Service Development

### 10/Incidence and type of alerts for low voltage devices – a 12-month high-volume centre experience from a *de novo* deployment

Authors: *ALW Wharmby* (Presenting Author) – Barts Health NHS Trust, London; *CB Butcher* – Barts Health NHS Trust, London; *AN Nogueira* – Barts Health NHS Trust, London; *JC Collinson* – Barts Health NHS Trust, London; *CM Monkhouse* – Barts Health NHS Trust, London; *ZC Carter* – Barts Health NHS Trust, London; *EM Maclean* – Barts Health NHS Trust, London; *SH Honarbakhsh* – Barts Health NHS Trust, London; *AM Muthumala* – Barts Health NHS Trust, London; *PM Moore* – Barts Health NHS Trust, London

**Background:** Remote monitoring (RM) has routinely not been provided to patients with low-energy devices; there are limited data on the service burden, volume of and type of alerts received and their management.

Objective: Collect and analyse data on alert type, service burden and management of alerts in low-voltage devices over 12 months of RM.

**Methods:** All patients implanted (Group 1) or with a scheduled follow-up (Group 2) with a pacemaker (PPM) or cardiac resynchronisation therapy pacemaker (CRT-P) from April to November 2020, were prospectively enrolled. These were followed from the first transmission for 12 months. Patients transferred to another centre were excluded. Alerts were categorised (Table 1) and subsequent intervention assessed.

**Results:** A total of 263 patients were enrolled; 28% males, mean age 75 (SD 14) years, 201 PPM, 62 CRT-P, 63% Group 1 and 37% Group 2. Manufacturers included Abbott (27%), Boston Scientific (53%), Medtronic (20%) and Biotronik (1%). Over 12 months 1,566 alerts were received from 109 patients (41%) of the cohort. This resulted in 160 reports with 41 requiring escalation and clinical action (2.6% of all alerts). There was a median (IQR) of 4 (2–7.5) alerts and 2 (1–3) reports per patient. Alerts were split into clinically significant 893 (57%) and non-clinically significant 673 (43%). Alert breakdown: atrial arrhythmia 43.4%, ventricular arrhythmia 41%, low biventricular pacing 11.9%, intrinsic amplitude 2.5%, threshold 1.1% and impedance 0.2%. Overall Group 1 generated significantly more alerts than Group 2 (1007 vs 559;  $p < 0.001$ ). Clinically significant alerts were also greater in Group 1 (731 vs 162;  $p < 0.001$ ) and resulted in significantly more reports (124 vs 36;  $p < 0.001$ ). Thirty-four patients were escalated with 5 patients escalated more than once. Of these, 30 (73%) came from Group 1; 20 for urgent consideration of anti-coagulation or arrhythmia management (12 and 8, respectively), 4 non-urgent outpatient review and 6 for review in device clinic. The remaining 11 escalations from Group 2 included 4 urgent medical reviews (3 arrhythmia management vs 1 anti-coagulation), 4 non-urgent medical reviews and 3 for device clinic. Of the non-clinically significant alerts, the largest proportion were for atrial arrhythmia duration and/or burden (63.8%) for patients with management plans in place. Inappropriate low biventricular pacing

Table 1

Criteria for defining if an alert is clinically significant or non-clinically significant	
Clinically Significant Alerts	Non-Clinically Significant Alerts
<ul style="list-style-type: none"> <li>New onset AT/AF with requirement for consideration of anti-coagulation</li> <li>Fast AT/AF (&gt;130bpm) with consideration of rate/rhythm control</li> <li>Any lead measurement (RA, RV or LV) outside of general trend (+/-100 ohms, <math>\geq 1V</math> increase in threshold)</li> <li>NSVT- either symptomatic or <math>\geq 10</math> beats</li> <li>New Low BiVp (&lt;95%) due to conducting AT/AF, arrhythmia or PVC's requiring medication/rhythm management consideration</li> <li>Symptomatic SVT's</li> </ul>	<ul style="list-style-type: none"> <li>AT/AF episodes in patients with known PAF/permanent AF who are anti-coagulated and no requirement for rate control</li> <li>Low amplitude R wave in patients with CHB</li> <li>Suspension of atrial auto capture due to AT/AF</li> <li>Drop in P wave amplitude when in AT/AF</li> <li>Low BiVp in patients not programmed to pace</li> </ul>

**Table 1: Criteria for defining if an alert is clinically significant or non-clinically significant.** The table describes characteristics to define if an alert generated is classed as clinically significant or non-clinically significant.  
 AT/AF: Atrial tachycardia/Atrial Fibrillation; PAF: Paroxysmal Atrial Fibrillation RA: Right Atrium; RV: Right Ventricle; LV: Left Ventricle; NSVT: Non-sustained ventricular tachycardia; BiVp: Biventricular pacing; SVT: Supraventricular tachycardia; CHB: Complete heart block.

(BiVp) alerts triggered 62% (109) times in asymptomatic, known low BiVp patients or those who were not programmed to pace. 13.3% were for non-sustained ventricular arrhythmias (<10 beats in duration). Finally, 5% were for out-of-range lead measurements in patients with known complete heart block or those with suspension of automatic atrial thresholds in the presence of known atrial arrhythmia.

**Conclusion:** Home monitoring in patients with low-voltage devices generate a moderate number of alerts over 12 months, with the largest proportion of alerts seen in those with new implants. Low numbers of alerts require clinical escalation. Nearly half of all alerts were inappropriate and non-actionable or were repeat alerts of the same finding. Development of strategies to tailor alerts from implants, or once an alert received is actioned and no longer relevant, is essential to reduce the overall burden of alerts. □

## Oral Abstracts 1 – Allied and Service Development

### 11/Increased activity targets, remote monitoring for all patients, same workforce, no capital funding. How will this device clinic cope?

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In response to COVID-19 at this tertiary cardiac centre, based on triaged risk, the number of patients on remote monitoring (RM) increased 1.75-fold, from 4,000 to 7,000 (55% of the total patient population). Pre-pandemic, this centre gave RM to high-voltage devices only. RM for all device patients aligns with NHS England guidance to reduce outpatient (OP) visits by 25%, increase patient-initiated follow-up (FU) and provide equitable, timely access to care. At this centre, the increase in RM led to a 2.4-fold increase in transmissions (3,600 per month), of which, on average, 50% are non-actionable. Total device clinic activity, face to face (F2F) plus RM, is 110% of 2019 levels and the 2022/2023 104% elective recovery target pushing lab utilisation is also stretching Cardiac Science (CS) resource.

With a national shortage of CS and no capital funding for workforce, a strategy is vital to support demand and the change in practice to RM, whilst maintaining quality of care and staff wellbeing.

The priorities to deliver this are recruitment, training, retention and optimisation of CS resource. To optimise CS time, this centre reviewed RM workflows and identified processes that are now performed by non-clinical staff. This includes checking in transmissions successfully received; contacting patients who have missed their scheduled transmission, and signposting and educating disconnected patients. New patient communication channels have also facilitated access to appropriate guidance. A proposed pilot sees a clinical support worker initiating RM post-implant; this would release 0.5 WTE CS, improve inpatient time to discharge and provide consistent patient education.

Utilising a RM alert-driven FU model has been demonstrated as effective and efficient. Using this strategy with extended routine FU intervals for appropriate patients, we estimate routine OP attendance will reduce to 85%. This in turn reduces carbon emissions, reduces patient and transport cost, and increases capacity for urgent F2F review and specialist device clinics. Specialist device clinics provide individualised patient management, improve patient experience, promote retention of CS and better utilise available medical cover.

Alert-driven FU relies on consistent connectivity so a robust process for minimising the number of disconnected patients is required first; the target to effectively control the risk is <5% disconnected. This centre has reduced disconnection rate from 17% to 10% (700 patients) with data cleaning, contacting disconnected patients and support from industry. Consistent 0.4 WTE clerical support is required to track patients and arrange F2F education for missed transmissions. Eligibility criteria have been created to ensure RM enrolment of appropriate patients.

The next phase focuses on reducing inappropriate transmissions and non-actionable alerts to 20% by: targeting patients with a high volume of unscheduled transmissions; improving patient education; developing guidance on tailoring RM alerts; and reviewing false-positive alerts for each manufacturer. To ensure our approach is evidence-based, this centre is collaborating with industry on data dashboard solutions.

Overall, these projects should release 11% (3.5 WTE) of current CS resource, which can then be used to plug the workforce gap for the expansion of RM and increase in elective activity. □

## Oral Abstracts 1 – Allied and Service Development

### 12/AF virtual ward – the way forward...

Author: *S Armstrong (Presenting Author) – University Hospital Leicester, Leicester*

**Introduction:** Atrial fibrillation (AF) is the commonest sustained cardiac arrhythmia. Acute hospital admissions are rising with significant cost and capacity implications. Recent pathway reviews led to service innovations to provide remote out-of-hospital care for patients with haemodynamically stable AF/atrial flutter (Afl) with fast ventricular response. Patients remain in hospital, attached to a heart monitor until rate control is achieved in the current pathway of care. Virtual wards are novel pathways designed to support patients remotely whilst maintaining safe high quality patient care.

**Methods:** A retrospective analysis of all patients admitted to our centre with a primary diagnosis of AF/Afl between 1 August and 1 September 2021 was carried out. Diagnosis was initially taken from the admission coding system, electronic medical admission records were reviewed and further clarified using medical notes as required. The analysis focused on the number of patients who were haemodynamically suitable, no other indications for hospital admissions or laboratory abnormalities, rendering them candidates for remote management. Patients often present at the emergency department (ED) and are then transferred to the clinical decisions unit (CDU) by ambulance for specialist cardiology support, self-present to CDU or referred by their general practitioner.

**Results and intervention:** Over the 8-week period, 211 primary diagnosis AF patients were admitted to CDU generating 226 admissions. When the proposed virtual ward criteria (i.e. haemodynamically stable, heart rate <140 bpm, no other acute conditions requiring admission) was applied, 51% (n=105) of patients were identified as suitable candidates for an alternative telemedicine based care model. Out of these 105

patients, 50% (n=53) were transferred from EDs located at a different site, requiring ambulance transfer. In the same period, there were 187 ED attendances with primary diagnosis of AF, 43% (n=80) of which met the virtual ward criteria. Out of these patients, 66% (n=53) were transferred to CDU, 2.5% (n=2) were discharged to alternative destinations, 27.5% (n=22) were suitable for discharge home and 3.7% (n=3) self-discharged due to prolonged waiting times. Setting up the virtual ward model: Patients who satisfy the AF virtual ward entry criteria are referred via a dedicated email or by phone. Referrals are triaged and recruited by an Arrhythmia Advanced Clinical Practitioner or Cardiology Registrar. Patients are given an information booklet about the care through the virtual ward along with a single-lead ECG monitoring device (AliveCor), Bluetooth-enabled blood pressure monitor and pulse oximeter. Patients are on-boarded to the digital platform (Dignio), which enables recording of several daily single-lead ECGs, blood pressure, oxygen saturation and a symptom questionnaire. The platform supports video consultations if required. Patients' clinical data are reviewed by the clinical team at least twice daily and medication changes are recommended with the option of home delivery within 48 hours to prevent patients from returning to hospital.

**Conclusions/implications:** This new model of care represents a promising pathway for patients presenting acutely to hospital with a primary diagnosis of AF/AFI, where they can be treated at home with outreach support from a specialist team as a 'Hospital at Home' virtual ward. This can potentially reduce the significant AF-related pressures on the national health services. □



## Oral Abstracts 1 – Arrhythmia Clinical

### 13/The impact of frailty on atrial fibrillation ablation outcomes

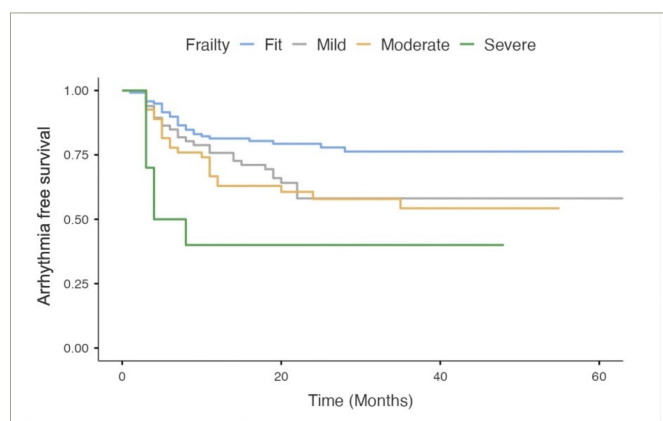
Authors: *CP Uy (Presenting Author) – East Sussex Healthcare, Eastbourne; R Dulai – East Sussex Healthcare, Eastbourne; NR Patel – East Sussex Healthcare, Eastbourne; SS Furniss – East Sussex Healthcare, Eastbourne; N Sulke – East Sussex Healthcare, Eastbourne; RA Veasey – East Sussex Healthcare, Eastbourne*

**Background:** Catheter ablation for atrial fibrillation (AF) has been shown to reduce symptoms and improve quality of life when compared with medical treatment. It is unclear whether frailty impacts on the outcome of pulmonary vein isolation in patients with symptomatic AF. We sought to evaluate the association between frailty as measured by the validated NHS electronic Frailty Index (eFI) and outcomes of AF ablation.

**Methods:** All patients who had undergone second-generation cryoablation between January 2015 and May 2019 and aged  $\geq 65$  at Eastbourne District General Hospital were included in the study retrospectively. The primary endpoint for success was defined as freedom from atrial arrhythmia lasting  $>30$  seconds during the follow-up period beyond the 3-month blanking period. Frailty was based on the eFI and the cohort split into four groups: fit, mild, moderate and severe frailty. Baseline continuous variables were compared using one-way ANOVA between groups and time to arrhythmia between groups was compared using the log rank test.

**Results:** The study included 248 patients with a mean age of  $72.9 \pm 5.16$  years and a mean follow-up of  $25.8 \pm 17.3$  months. 52.8% of patients were female. Frailty was categorised as fit (118/248; 47.6%), mild (66/248; 26.6%), moderate (54/248; 21.8%), and severe (10/248; 4.0%). There was no significant difference in age between the groups ( $p=0.132$ ). Patients with severe frailty had a significantly longer duration of AF pre-ablation than patients who were fit ( $p=0.005$ ) or who had mild frailty ( $p=0.038$ ). Freedom from arrhythmia occurred in 167 of 248 patients (67.3%). Fit patients had a significantly greater freedom from arrhythmia (92/118;

Figure 1: The Kaplan–Meier curve for arrhythmia free survival



78.0%) compared with patients with mild frailty (40/66; 60.6%,  $p=0.020$ ), moderate frailty (31/54; 57.4%,  $p=0.006$ ) or severe frailty (4/10; 40.0%,  $p<0.001$ ). (Figure 1) There was also a significant difference in arrhythmia occurrence between patients with mild frailty and severe frailty ( $p=0.044$ ).

**Conclusion:** Frailty is associated with poorer outcomes in patients undergoing AF ablation. The eFI may be used in the prognostic evaluation of AF ablation outcomes. Further studies are essential to confirm the findings of this study. □

## Oral Abstracts 1 – Arrhythmia Clinical

### 14/Arrhythmia Alliance Patient Survey: remote care, what is the impact on follow-up?

Authors: *T Lobban (Presenting Author) – Arrhythmia Alliance, Stratford Upon Avon; B Sieniewicz – Queen Alexandra Hospital, Portsmouth*

**Background:** Remote monitoring (RM) refers to the ability of a cardiac implantable electronic device (CIED) to monitor both the patient and the CIED system, ‘remote’ from the hospital. Studies have demonstrated the advantages of this approach including early detection of clinically actionable events, a decrease in the frequency and need for inpatient visits and improved patient satisfaction, quality of life and adherence to follow up.

**Purpose:** The primary objective of our study was to analyse patients’ perspectives towards remote monitoring and to review how remote monitoring influences the relationship between health care professionals and patients.

**Methods:** Arrhythmia Alliance (A-A) and University Hospital, Plymouth designed an online patient survey designed to capture patients’ opinions on remote monitoring. The questionnaire was emailed to patients on the A-A patient database.

**Quantitative results:** 88% of respondents were aware that remote monitoring could be undertaken. 74% were actively using remote monitoring with 60% of patients reporting they felt well informed about their remote follow up. 85% of respondents felt confident installing the equipment necessary to undertake remote monitoring independently, without assistance. The majority (52%) of respondents felt that remote monitoring had improved the way they felt about their condition, with just 7% reporting that it had made them feel worse. When asked to rank the potential benefits of remote monitoring, the most popular answer was that patients felt “reassured” (43%) with the next most popular response evenly split between “less trips to hospital” (28%) and improvements in the quality of data available to their healthcare professionals (27%), see Graph 1 below. Technical issues appeared rare, with 53% denying experiencing any issues and a further 27% reporting “very rare” issues. Just under half (45%) of respondents expressed a preference for accessing information about RM via either a website or a mobile app.

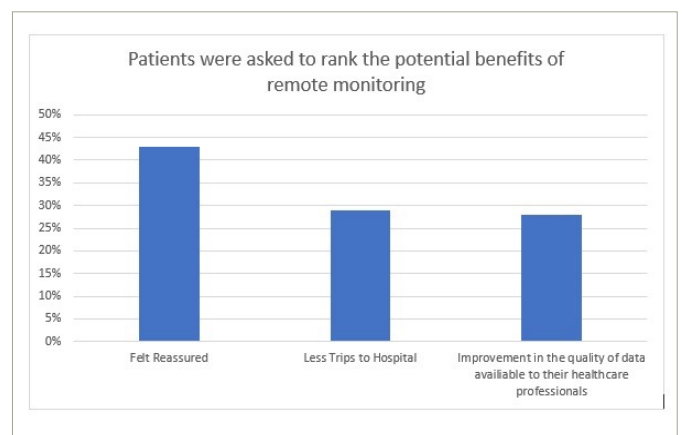
Whilst the majority of respondents did not view their bedside transmitter as a constraint (91%), 62.6% of respondents expressed a preference for transmissions to be conducted via the combination of a smartphone/app than via a standalone transmitter. Smartphone use was widespread in our study with 92% of respondents reporting they owned a smartphone. The majority (85%) admitted to using them at least several times a day. A similar number (91%) admitted to being comfortable downloading apps.

**Conclusions:** Our study set out to undertake a quantitative and qualitative assessment of patients’ perspectives towards RM. We have

**Table 1: The key demographic information, gender and proportion of patient with each type of CIED can be seen below.**

Patients	331
Age, years	0–99
Mean age, years	58.4
Male, n (%)	122 (37)
<b>Type of CIED</b>	
ILR, n (%)	50 (15)
Pacemaker, n (%)	102 (31)
ICD, n (%)	139 (42)
Other (%)	22 (8)
Not responded, n (%)	40 (12)

**Figure 1**



identified that despite the advanced age of the respondents to our survey, there was a high level of awareness and engagement with RM. Respondents reported an overwhelmingly positive experience of RM. The primary benefit observed amongst respondents in our study was greater patient reassurance with additional benefits observed including improvements in the quality of data available to their healthcare team and reductions in the need to travel to hospital.

Smartphone use was near ubiquitous amongst our population and respondents expressed a preference for a smartphone-based communicator over a stand-alone remote monitoring system. □

## Oral Abstracts 1 – Arrhythmia Clinical

### 15/Artificial intelligence-enabled electrocardiogram to distinguish atrioventricular re-entrant tachycardia from atrioventricular nodal re-entrant tachycardia

Authors: *A Sau (Presenting Author) – Imperial College London, London; S Ibrahim – Imperial College London, London; N Qureshi – Imperial College London, London; M Koa-Wing – Imperial College London, London; D Keene – Imperial College London, London; L Malcolm-Lawes – Imperial College London, London; DC Lefroy – Imperial College London, London; NWF Linton – Imperial College London, London; PB Lim – Imperial College London, London; A Varnava – Imperial College London, London; ZI Whinnett – Imperial College London, London; P Kanagaratnam – Imperial College London, London; D Mandic – Imperial College London, London; NS Peters – Imperial College London, London; FS Ng – Imperial College London, London*

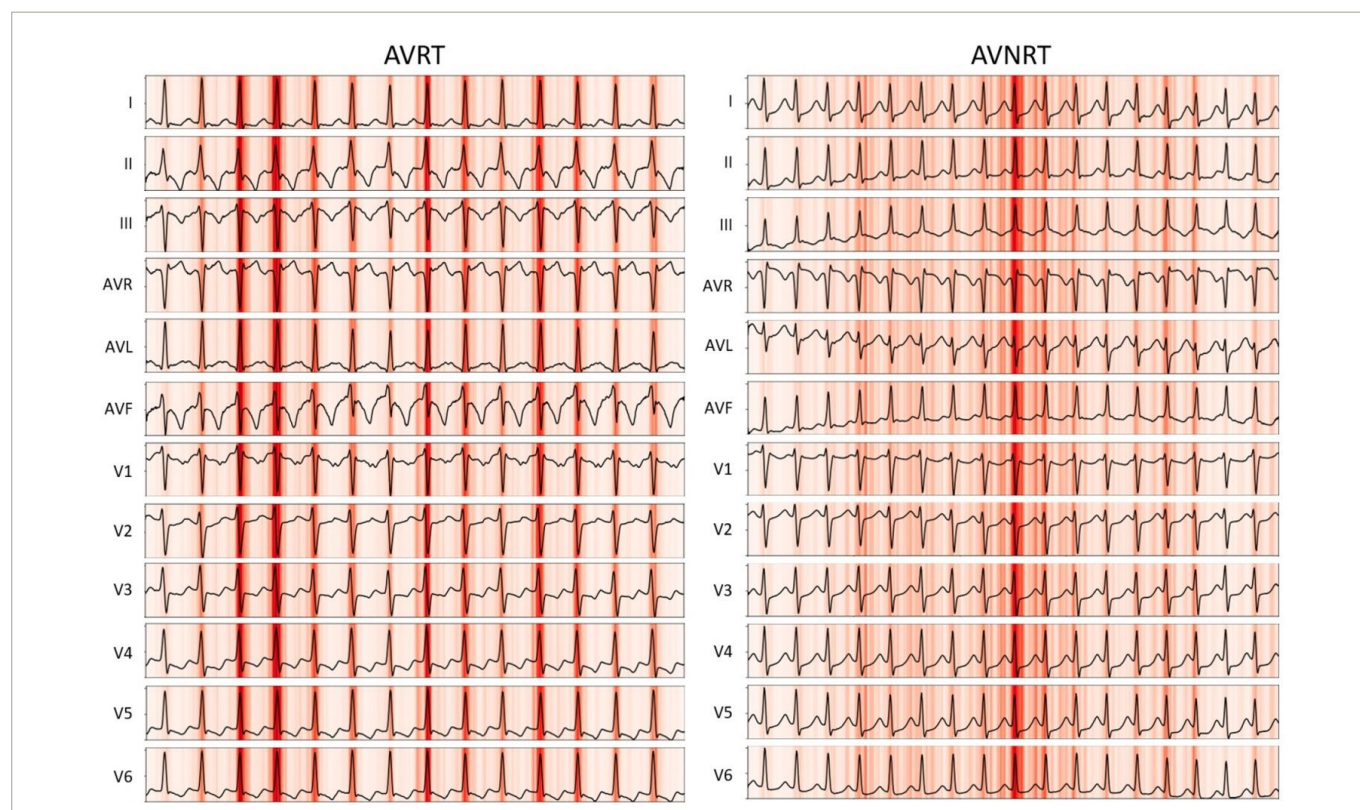
**Background:** Accurately determining arrhythmia mechanism from a 12-lead ECG of supraventricular tachycardia (SVT) can be challenging. Machine learning, with convolutional neural networks (CNNs) in particular, has been used to classify arrhythmias using the 12-lead ECG with great accuracy. However, most studies use human interpretation of the ECG as the ground truth to label the arrhythmia ECGs. Therefore, these neural networks can only ever be as good as expert human interpretation. We hypothesised a convolutional neural network can be trained to classify atrioventricular re-entrant tachycardia (AVRT) vs atrioventricular nodal re-entrant tachycardia (AVNRT) from the 12-lead ECG, when using findings from the invasive electrophysiology (EP) study as the gold standard.

**Methods:** We trained a CNN on data from 124 patients undergoing EP studies with a final diagnosis of AVRT or AVNRT. A total of 4962 5-second 12-lead ECG segments were used for training. Each case was labelled AVRT or AVNRT based on the findings of the EP study. The model performance was evaluated against a hold-out test set of 31 patients.

**Results:** The model had an accuracy of 77% in distinguishing between AVRT and AVNRT. The area under the receiver operating characteristic curve was 0.80. A saliency map can be used to help understand why a CNN predicted a particular outcome. This is achieved by mapping the outcome back to key areas of the input that most influenced the network in producing the classification result. Figure 1 presents the saliency mappings of an example 12-lead ECG for each class of AVRT and AVNRT. The network used the expected sections of the ECGs for diagnoses; these were the QRS complexes which may contain retrograde p waves.

**Conclusion:** We describe the first neural network trained to differentiate AVRT from AVNRT. Our model achieved a reasonable accuracy and demonstrated proof-of-concept. Accurate diagnosis of AVNRT from a 12-lead ECG could allow for empirical slow pathway ablation in cases where dual atrioventricular nodal physiology is present but sustained arrhythmia cannot be induced during the EP study. The current accuracy from our neural network does not yet meet this threshold, but may be improved with a larger training dataset. □

Figure 1



## Oral Abstracts 1 – Arrhythmia Clinical

### 16/Effects of sodium-glucose cotransporter-2 inhibitors on ventricular arrhythmias or sudden cardiac death: a propensity score-matched population-based study

*Authors: K Bin Waleed (Presenting Author) – St George's University Hospital NHS Foundation Trust, London; MM Gallagher – St George's University Hospital NHS Foundation Trust, London; S Lee – Cardiovascular Analytics Group, China-UK Collaboration, Hong Kong; J Zhou – Cardiovascular Analytics Group, China-UK Collaboration, Hong Kong; T Liu – 2nd Hospital of Tianjin Medical University, Tianjin; X Liu – Cardiovascular Analytics Group, China-UK Collaboration, Hong Kong; TTL Lee – Cardiovascular Analytics Group, China-UK Collaboration, Hong Kong; WT Wong – Chinese University of Hong Kong, Shenzhen Research Institute, Hong Kong; BMY Cheung – The University of Hong Kong, Hong Kong; Q Zhang – City University of Hong Kong, Hong Kong; G Tse – 2nd Hospital of Tianjin Medical University, Tianjin*

**Introduction:** Numerous trials have studied the effects of sodium-glucose cotransporter-2 inhibitors (SGLT2Is) on ventricular tachycardia/fibrillation (VT/VF) or sudden cardiac death (SCD), with conflicting findings. However, this has not been explored in population-based real-world studies. We compared the risks of VT/VF/SCD between SGLT2I and dipeptidyl peptidase-4 inhibitors (DPP4Is) in a Chinese population.

**Methods:** This was a retrospective cohort study of SGLT2I/DPP4I users between 1 January 2015 and 31 December 2019 in public hospitals, outpatient/ambulatory care facilities in Hong Kong. The primary outcome was VT/VF/SCD with follow-up until 31 December 2019. Propensity score matching with nearest neighbour search (1:1), inverse probability treatment weighting (IPTW), propensity score stratification and high-dimensional propensity score (HDPS) adjustments were used.

**Results:** A total of 69,128 patients (median age: 65.5 years [standard

deviation (SD): 12.9], 55.5% males; 28,678 SGLT2I vs 40,450 DPP4I users) were included. After matching for demographics, comorbidities, anti-diabetic and cardiovascular drugs, fasting glucose and HbA1c, 100 patients (incidence rate [IR]: 0.46%) developed VT/VF/SCD, with significant difference between SGLT2I (21/10,766; IR: 0.19%) and DPP4I (79/10,766, IR: 0.73%) users ( $p < 0.001$ ). Cox regression showed that SGLT2I use was associated with lower risks of VT/VF/SCD compared with DPP4I use (hazard ratio [HR] 0.43, 95% confidence interval [CI] 0.26–0.70;  $p < 0.0007$ ). IPTW (HR 0.42, 95% CI 0.33–0.71;  $p < 0.0001$ ), propensity score stratification (HR 0.46, 95% CI 0.31–0.65;  $p < 0.0001$ ) and HDPS adjustment (HR 0.43, 95% CI 0.30–0.69;  $p < 0.0001$ ) produced similar results.

**Conclusions and implications:** SGLT2I use was significantly associated with lower risks of VT/VF/SCD compared with DPP4I use amongst patients with type 2 diabetes mellitus. □

## Oral Abstracts 1 – Arrhythmia Clinical

### 17/Are consumer-grade ECG devices as good as a 12 lead ECG? A comparison of the Apple Watch Series 6, KardiaMobile 6L and Withings Scanwatch with the 12 lead ECG

Authors: *S Brown* (Presenting Author) – Musgrove Park Hospital, Taunton; *N Sunderland* – Musgrove Park Hospital, Taunton; *R Wang* – Musgrove Park Hospital, Taunton; *K Venu-Gopal* – University of Plymouth, Plymouth; *M Dayer* – Musgrove Park Hospital, Taunton; *G Furniss* – Musgrove Park Hospital, Taunton

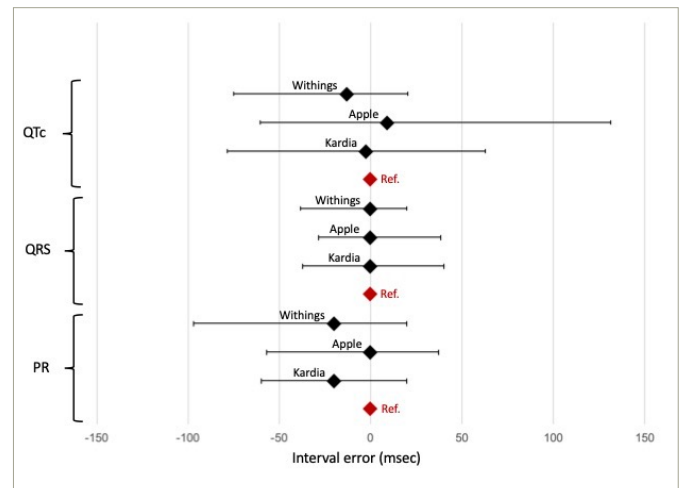
**Introduction:** The use of consumer-grade electronic devices capable of recording an electrocardiogram (ECG) is increasing but there is a lack of comparative data between technologies. We initiated this unsponsored study to compare three consumer-grade devices to the 12-lead (12L) ECG.

**Methods:** A total of 11 healthy volunteers had an ECG recorded consecutively using four devices: Apple Watch Series 6, KardiaMobile 6L, Withings ScanWatch and 12L. The 44 ECGs were anonymised and analysed for heart rate (HR), PR interval, QRS duration (QRSd), uncorrected QT interval and quality (1 – clear trace, 2 – low-frequency variation, 3 – high-frequency variation). Each ECG was analysed by a medical student, senior house officer, cardiology registrar and cardiology consultant who were all provided with a rate ruler. ECG interpreters were blinded to automated machine readings and to whom the ECG belonged but knew which device had been used.

1. Consumer-grade device ECGs were compared with same individual's interpretation of the corresponding 12L ECG.
2. Intra-observer variability was assessed with the intraclass correlation coefficient (ICC) statistic.

**Results:** For PR interval, Apple and Withings ECGs measured within 20 ms of the corresponding 12L in 75% of cases and the Kardia in 70.9% ( $p=0.81$ ). At a 40 ms cut-off, Apple and Kardia ECGs achieved this in 90.9% of cases vs 84.1% of Withings ECGs ( $p=0.52$ ). Finally, 11.4% of Withings traces measured  $>80$  ms vs 0% of Apple ( $p=0.05$ ) and 2.3% Kardia ( $p=0.2$ ). For QRSd, all devices were similar, with 84.1% of Apple and Withings traces  $\leq 20$  ms of the corresponding 12L ECG and 79.5% of Kardia traces ( $p=1$ ). Both Kardia and Apple had 1 ECG (2.3%)  $>60$  ms QRS discrepancy. For QT interval, 63.6% of Withings ECGs and 61.4% of Kardia and Apple ECGs were  $\leq 20$  ms. At  $\leq 40$  ms, the Kardia improved to 81.8%, the Apple watch to 93.2% and the Withings to 88.6%. Finally, 18.2% of Kardia ECGs had a QT discrepancy of  $>60$  ms vs 6.8% Apple ( $p=0.19$ ) and 11.4% Withings ( $p=0.71$ ). Overall, measurements  $\leq 40$  ms for PR/QT and  $\leq 20$  ms for QRSd were achieved in 84.1% of Kardia, 89.4% Apple and 85.6% Withings traces ( $p=0.43$ ). The ICC for Apple ECGs was PR 0.77, QRSd 0.22,

Figure 1: A comparison of ECG intervals measured against the reference 12 lead ECG. Data shown are mean (black diamond) and range (bars)



QT 0.70, HR 0.79; for Kardia ECGs, PR 0.78, QRSd 0.31, QT 0.27, HR 0.89; for Withings ECGs, PR 0.5, QRSd 0.55, QT 0.52, HR 0.94; for 12L ECGs, PR 0.78, QRSd 0.41, QT 0.42, HR 0.97 ( $p<0.05$ ). The mean ECG quality score (QS) was  $1.4 \pm 0.7$  for Apple,  $1.9 \pm 0.5$  for Kardia,  $3.0 \pm 0.3$  for Withings and  $1.0 \pm 0.0$  for 12L ( $p<0.001$ ). Mean discrepancy was  $17.1 \pm 10.7$  ms for QS1 traces,  $22.4 \pm 12.9$  ms for QS2 traces and  $22.3 \pm 11.8$  ms for QS3 traces ( $p=0.21$ ).

**Conclusion:** In this small sample size, the Apple Watch QT measurements were shown to be inaccurate when compared with the 12L ECG, with poor ( $<0.5$ ) or moderate ( $0.5-0.75$ ) intra-observer variability amongst all devices including the 12L, highlighting the challenges of accurate assessment amongst non-specialists. Apple and Kardia ECG traces were the clearest traces, while all Withings traces showed high-frequency variation. □



## Oral Abstracts 1 – Arrhythmia Clinical

### 18/Virtual wards – a futuristic insight into atrial fibrillation care

Authors: *A Kotb (Presenting Author) – University of Leicester, Leicester; S Armstrong – University Hospitals of Leicester, Leicester; I Koev – University of Leicester, Leicester; G Panchal – University of Leicester, Leicester; A Mavilakandy – University of Leicester, Leicester; I Antoun – University of Leicester, Leicester; Z Vali – University of Leicester, Leicester; J Barker – University of Leicester, Leicester; M Ibrahim – University Hospitals of Leicester, Leicester; A Sandilands – University Hospitals of Leicester, Leicester; M Lazdam – University Hospitals of Leicester, Leicester; S Chin – University Hospitals of Leicester, Leicester; R Somani – University Hospitals of Leicester, Leicester; G. Andre Ng – University of Leicester, Leicester*

**Background:** Atrial fibrillation (AF) hospital admissions represent significant national health and economic burden. In the year 2019–2020 our hospital reported 1,333 admissions with a primary diagnosis of AF, with a 10% annual increase. A virtual AF ward providing multidisciplinary care could reshape the future model of AF management.

**Methods:** An AF virtual ward was implemented at our UK tertiary centre, as a proof-of-concept model of care. Patients presenting primarily with AF or atrial flutter (AFL) who were haemodynamically stable, heart rate < 140 bpm and with no other acute conditions, were rendered eligible for remote management. Patients were given access to a single-lead ECG recording device (AliveCor), a Bluetooth integrated blood pressure machine and pulse oximeter with instruction to record daily ECGs, blood pressure readings, oxygen saturations and fill an online AF symptom questionnaire via a smart phone or electronic tablet. Data were uploaded to an integrated digital platform (Dignio) for review by the clinical team who undertook twice daily virtual ward rounds. Medication adjustment was arranged through the hospital pharmacy. Data were collected prospectively for patients admitted to the AF virtual ward between 31 January and 19 April 2022. Outcomes included length of hospital stay, admission avoidance and re-admissions. Re-admission avoidance was assessed using the index admission criteria as parameter for re-admission likelihood. Patients’ satisfaction was assessed using the NHS family and friends’ test (FFT).

**Results:** A total of 20 patients were enrolled, generating 21 admissions. The age on admission was 64 ± 10 years (mean ± SD). The majority of admissions, 95% (n=20) were in AF or AFL, with only admission in sinus rhythm. Mean heart rate on admission and discharge was 119 ± 33 and 83 ± 31, respectively (Table 1). A rhythm control strategy was pursued in 76% (n=16), with half of the admissions 52% (n=11) in sinus rhythm

Table 1

Table (1) Patients characteristics	
Variable	
Male	16 (80%)
Age (years)	65 ± 10
On-boarding Heart Rate* (bpm)	119 ± 33
Off-boarding Heart Rate** (bpm)	83 ± 31
Hypertension	10 (50%)
BMI > 30	12 (60%)
On-boarding Systolic BP* (mmHg)	135 ± 24
Off-boarding Systolic BP** (mmHg)	95 ± 21
SR on discharge from AFVW	11 (52%)

*\*On admission to the virtual ward \*\*on discharge from the virtual ward*  
 BP Blood Pressure; SR sinus rhythm; AFVW Atrial fibrillation virtual ward

on discharge. Initial hospital admission was completely avoided in 24% (n=5), with 10 re-admissions avoided. Two patients required hospital re-admission: one due to tachycardia requiring acute cardioversion and the other due to acute kidney injury requiring hospitalisation. The FFT yielded 100% positive responses among participants.

**Conclusion:** This model of care is a first real-world experience of a virtual ward for hospital patients with fast AF. It demonstrates the potential to reduce the financial and backlog pressures caused by AF admissions without compromising patient care or safety. Work is ongoing to further confirm the safety and cost-effectiveness upon further progress in a larger patient cohort. □

Oral Abstracts 2 – High-scoring Abstracts

19/The electrophysiologic substrate of Brugada syndrome patients can be revealed by electrocardiographic imaging

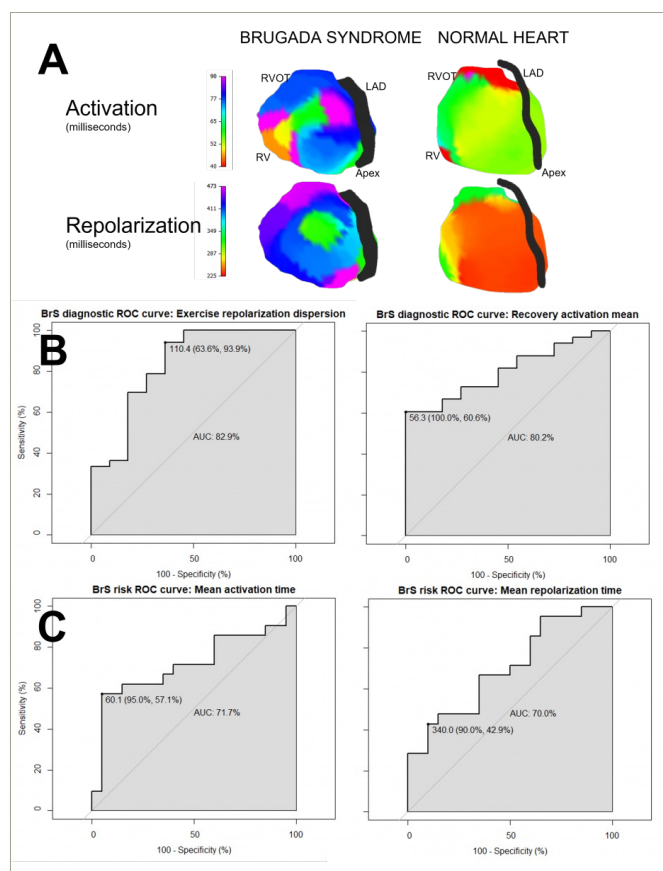
Authors: JJ Chow (Presenting Author) – Imperial College Healthcare NHS Trust, London; K Leong – Imperial College Healthcare NHS Trust, London; M Shun-Shin – Imperial College Healthcare NHS Trust, London; JOM Ormerod – Oxford University Hospitals NHS Trust, Oxford; DC Lefroy – Imperial College Healthcare NHS Trust, London; M Koa-Wing – Imperial College Healthcare NHS Trust, London; PB Lim – Imperial College Healthcare NHS Trust, London; NWF Linton – Imperial College Healthcare NHS Trust, London; FS Ng – Imperial College Healthcare NHS Trust, London; NA Qureshi – Imperial College Healthcare NHS Trust, London; ZI Whinnett – Imperial College Healthcare NHS Trust, London; NS Peters – Imperial College Healthcare NHS Trust, London; DP Francis – Imperial College Healthcare NHS Trust, London; AM Varnava – Imperial College Healthcare NHS Trust, London; P Kanagaratnam – Imperial College Healthcare NHS Trust, London

**Introduction:** Brugada syndrome (BrS) is an important cause of sudden cardiac death but diagnosis can be challenging. Body surface ECG changes in BrS are dynamic, and elicitation by sodium channel blockade carries a risk of death. The epicardial substrate of the overt Type 1 BrS ECG is known but not always spontaneously present in cardiac arrest survivors with confirmed drug-induced BrS. Traditional markers of risk in Brugada syndrome (spontaneous Type 1 ECG and syncope) are often absent in cardiac arrest survivors.

**Methods:** A total of 21 BrS cardiac arrest survivors (BrS VF), 20 BrS patients without a history of potentially lethal arrhythmia and 11 asymptomatic relatives of BrS patients proven not to have the condition by negative Ajmaline test were recruited. The 252 lead body surface ECG was combined with a 3D torso and cardiac model to reconstruct epicardial electrograms (ECG imaging; CardiInsight, Medtronic, USA) following maximal Bruce protocol exertion and into full recovery (~10 min). Local activation (LAT) and repolarization times (LRT) were measured by fully automated software and used to calculate measures of delay, dispersion and gradients for AT and RT.

**Results:** Patients with concealed BrS had longer mean whole heart AT (57.6 vs 52.5 ms;  $p=0.0022$ ), and more dispersed RTs (central 95% range 136 vs 116 ms;  $p=0.0094$ ) in recovery, as well as more dispersed RTs (central 95% range 139 vs 112 ms;  $p=0.0007$ ) and steeper RT gradients immediately after exercise (1.7 vs 1.4 ms/mm;  $p=0.029$ ). Figure 1A demonstrates visual differences in epicardial activation and repolarization maps between BrS and normal hearts. Mean AT in recovery and dispersed RT in exercise were good differentiators of concealed BrS patients from their unaffected relatives (AUC 0.83 and 0.80 respectively, specificity and sensitivity analysis by Youden’s method in Figure 1B). ECG imaging measures were then compared between the BrS VF and BrS patients. The BrS VF group had longer mean whole heart AT (56.8 vs 52.5 ms;  $p=0.004$ ) and RT (153.8 vs 133.7 ms;  $p=0.049$ ) than the BrS group. Mean AT and RT provided reasonable differentiation of BrS VF survivors (AUC 0.71, 0.70 respectively, specificity and sensitivity analysis by Youden’s method in Figure 1C). In contrast, traditional risk markers were evenly distributed between groups: 5 BrS VF survivors and 3 BrS patients had previous spontaneous Type 1 ECG. Three patients in each group had suffered syncope (prior to their sentinel event in the VF survivors).

Figure 1



**Conclusion:** Measures of epicardial electrophysiology by ECG imaging at rest and immediately following peak exercise could form a role in both diagnosis – possibly reducing the need for sodium channel blocker challenge – and risk stratification in the Brugada syndrome. Further study would be required to determine the clinical effectiveness of such a tool in a consecutive population. □

## Oral Abstracts 2 – High-scoring Abstracts

### 20/Real-world results of oesophageal protection during left atrial ablation

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**Background:** Randomised trial evidence suggests that active control of local temperature can prevent thermal injury to the oesophagus; alternative methods of protection have been proposed, including the measurement of luminal temperature, and mechanical deviation away from the source of energy. Specific devices are available for each role.

**Objective:** To use multiple sources of real-world evidence to determine the safety and clinical efficacy of oesophageal protection devices in AF ablation in clinical practice.

**Methods:** We reviewed multiple databases, including regulatory and internal company registry data. The search encompassed the United States Food and Drug Administration (FDA) Manufacturer and User Facility Device Experience (MAUDE) database, the FDA Medical and Radiation Emitting Device Recalls, the FDA Total Product Life Cycle (TPLC) database, the United Kingdom Medicines and Healthcare products Regulatory Agency (MHRA) Medical Device Alerts and the SwissMedic records of Field Safety Corrective Actions (FSCA).

**Results:** Of more than 20,000 oesophageal temperature control devices used to the end of March 2022, the purpose was recorded as

oesophageal protection during left atrial ablations in 10,300. A total of 5 events associated with the device were identified, all from the MAUDE database; all involved its use in critical care or trauma patients and were related to user error or contraindicated patient selection; none resulted in serious harm to the patient. No adverse events occurred related to its use during left atrial catheter ablations. No case of clinically significant oesophageal injury was reported in a patient who had been protected by the oesophageal temperature control device. A search for all atrio-oesophageal fistulae revealed 307 cases; a review of the narrative of each case showed that 77 had occurred in association with the use of a temperature probe and 4 in association with a dedicated deviation device. No fistula had occurred with the use of an oesophageal temperature control device.

**Conclusions:** Real-world data from multiple sources support the hypothesis that oesophageal luminal temperature control is associated with a low rate of clinically significant oesophageal injury. Other methods of protection show less evidence of efficacy. □

## Oral Abstracts 2 – High-scoring Abstracts

### 21/Silent veins during cryoballoon ablation of atrial fibrillation as a novel and independent predictor of long-term outcome: results from the Middelheim-PVI Registry 2

Authors: *Y De Greef (Presenting Author) – ZNA Heart Center, Middelheim, Antwerp; I Buysschaert – Cardiovascular Center, AZ St Jan Bruges, Bruges; F Cecchini – ZNA Heart Center, Middelheim Antwerp; D Sofianos – ZNA Heart Center, Middelheim, Antwerp; M Wolf – ZNA Heart Center, Middelheim, Antwerp; B Schwagten – ZNA Heart Center, Middelheim, Antwerp; JP Abugattas – Erasmus Hospitals, Brussel, Brussels*

**Background:** The absence of pulmonary vein potential (PVP) recordings by the Achieve catheter occurs in 15% to 40% of the veins during cryoballoon ablation (CBA) of atrial fibrillation (AF). The long-term clinical implications of this absence of PVP during CBA are yet unknown.

**Aim:** To determine whether the absence of PVP recording (silent vein) by the Achieve catheter is predictive of long-term clinical outcome.

**Methods and results:** Out of 1,000 consecutive AF patients (mean age of  $64 \pm 10$  years, 68% males) undergoing cryoballoon PVI (2017–2019) followed for 3 years, 803 had sufficient biophysical data for analysis. Primary outcome was clinical success, defined as freedom of documented AF without anti-arrhythmic drugs. At 3 years, clinical success was achieved in 65.3% of patients. Presence of PVP in all veins (no silent veins) was seen in 252 patients (31.4%), presence of 1 silent

vein in 255 (31.8%), 2 silent veins in 159 (19.8%) and 3–4 in 137 (17.1%). Independent predictors of clinical success were persistent AF type (HR 2.05, 95%CI 1.57–2.68;  $p < 0.001$ ), left atrial diameter (HR 1.05, 95%CI 1.03–1.07;  $p < 0.001$ ) and presence of silent veins (HR 1.29, 95%CI 1.16–1.45;  $p < 0.001$ ) in multivariable-adjusted analysis. The highest clinical success was achieved in patients with PVPs in all veins (77.4%), gradually decreasing with increasing number of silent veins: 66.3% for 1 silent vein, 58.5% for 2 and 48.9% for 3–4 silent veins ( $p < 0.001$ ).

**Conclusion:** Presence of a silent vein during CBA of AF, defined as the absence of PVP recordings by the Achieve catheter, is an independent predictor of AF recurrence, with increasing AF recurrence per increase in silent veins. □

## Oral Abstracts 2 – High-scoring Abstracts

### 22/Predictors and clinical value of late gadolinium enhancement on CMR in patients with premature ventricular contractions and normal echocardiogram

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**Background:** Cardiac magnetic resonance (CMR) with late gadolinium enhancement (LGE) imaging can detect subtle abnormalities including scar undetectable by echocardiography, and hence may aid diagnosis and guide clinical management in patients with premature ventricular contractions (PVCs) where decision making can be complex. However, it remains unclear which patients are most likely to benefit from further CMR assessment.

**Objective:** To determine clinical and electrocardiographic predictors of LGE on CMR in patients with PVCs and normal echocardiogram, and the subsequent impact on clinical management.

**Methods:** Consecutive patients referred for CMR for PVC assessment (1,000/24 h or 1% burden) with normal baseline echocardiograms between 2015 and 2020 were included. CMR parameters were analysed using artificial intelligence for standardization. Electrocardiograms (ECG) were analysed for PVC origin and clinical abnormalities. A total of 94 patients with PVC number of 1,000/24 h or 1% burden, and normal baseline echocardiograms were identified. Follow-up endpoints were: 1) whether CMR LGE findings resulted in a new cardiac diagnoses and/or change to clinical management; 2) death or significant arrhythmia requiring device implantation.

**Results:** A total of 94 patients (57% female, age 48 ± 16 years) were included with mean echocardiographic LV ejection fraction of 59 ±

7%, median PVC burden of 8% (interquartile range [IQR] 3–19%) and CMR LV ejection fraction of 61 ± 8%. LGE was detected in 18/94 (19%) scans. Predictors of LGE were: patients with significant previous cardiac history (previous coronary disease, myocarditis), conventional cardiovascular risk factors, family history, abnormal baseline ECG, more than 1 PVC morphology (polymorphic PVCs) and non-outflow tract/non-fascicular morphology were all more likely to have LGE on CMR (Table 1). Significant cardiac history and polymorphic PVCs were both independent predictors on multivariate analysis. At mean follow-up of 3 ± 1.6 years, 6/18 LGE vs 2/76 no LGE (33% vs 3%; p<0.001) patients had a new diagnosis resulting in initiation of medications and/or continued specialist follow-up. Two LGE patients required device implantation (permanent pacemaker [PPM] for advanced AV block with septal mid-wall LGE; ICD for arrhythmogenic right ventricular cardiomyopathy, with ring-like subepicardial LGE). In the non-LGE group, 1 had ICD for syncopal VT and new LGE detected at 3-year interval scan, and 1 died of metastatic pancreatic cancer at 4.9 years.

**Conclusion:** Older patients with normal echocardiograms but a significant cardiac history, polymorphic PVCs or non-outflow tract/fascicular origin, are likely to have focal scar on further assessment with CMR imaging. LGE detected on CMR aids diagnosis of cardiomyopathy although the long-term prognostic value remains to be determined. □

Table 1: Clinical and ECG variables in patients with or without LGE on CMR

	No LGE (n=76)	LGE (n=18)	p-value	Multivariate p value
Age	46 ± 15	58 ± 15	0.782	0.505
Male	31/76 (41%)	9/18 (50%)	0.477	0.934
Significant cardiac hx	3/71 (4%)	4/16 (25%)	0.006	<0.001
CV risk factors	16/69 (23%)	9/16 (56%)	0.009	0.620
Family history	10/68 (15%)	9/18 (50%)	0.025	0.566
ECG abnormality	12/71 (17%)	7/17 (41%)	0.029	0.342
PVC burden	12 ± 11%	14 ± 14%	0.306	0.081
Echo LVEF	60 ± 7%	54 ± 5%	0.285	0.232
>1 morphology	4/65 (6%)	8/13 (62%)	<0.001	<0.001
None OT/fascicular morphology	9/64 (14%)	11/13 (85%)	<0.001	0.093



Oral Abstracts 2 – High-scoring Abstracts

23/Redefining atrial scar: an analysis using pacing thresholds, electrogram amplitudes and local impedance. Can we improve on 0.05 and 0.5mV?

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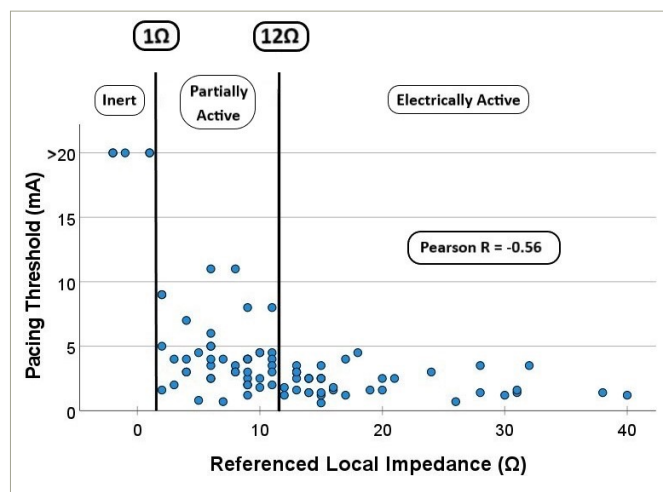
**Background:** Common cut-offs for dense scar and ‘low-voltage areas’ on atrial 3D electroanatomical mapping are 0.05 mV and 0.50 mV, respectively. These are based upon statistical assessment of left atrial voltages in healthy individuals, rather than physiological assessment and may not fully represent underlying scar compared with unipolar readings or the novel parameter local impedance (LI).

**Objectives:** Investigate the relationship of bipolar voltage, unipolar voltage and LI with pacing threshold (PT). Establish cut-offs for electrically inert (EI), partially active (PA) and electrically active (EA) atrial tissue based upon pacing capture.

**Methods:** Patients undergoing AF ablation were recruited. Ultra-high-density 3D electroanatomical maps of both atria were created in Rhythmia HDx. PTs were assessed using the IntellaNav MiFi and Stablepoint (SP) ablation catheters between the tip and first ring electrodes. With the latter, a contact force of 10 g was targeted. PTs were assessed with a 2 ms pulse duration commencing at 5 mA and moved up or down accordingly. Sites without capture had PT recorded at the maximum tested 20 mA. LI was referenced against a blood pool reading (Lir) and analysed separately for MiFi and SP catheters. EI sites were defined as no pacing capture, PA capture between 5–20 mA and EA less than 5 mA. As no previous work has defined a PT to determine underlying atrial scar, a level was sought that would reflect EA tissue with consistently low PTs and PA tissue with significant variation in PTs. 5 mA was selected after review of data on scatterplots. Receiver operator and precision recall curves were plotted to define cut-offs.

**Results:** A total of 292 PTs and LI readings (202 MiFi, 90 SP) were recorded in 40 patients (MiFi: 20, SP: 20; male: 21/40; age: 66.7 ± 8.8 years; paroxysmal AF: 10, persistent AF: 30; de novo 21, redo 19). A weak correlation exists between SR voltages and PT (Pearson’s R – bipolar: -0.25, unipolar: -0.21, both p<0.0005). Weak correlations exist between LI and PT (Pearson’s R – MiFi = -0.35, SP = -0.33, both p<0.0005), but moderate–strong correlations exist between Lir and PT (R – MiFi = -0.52, SP = -0.56, both p<0.0005 [Figure 1]). For the EI–PA cut-off, the ability to distinguish capture/no capture for bipolar voltages was fair (AUROC = 0.74, optimal cut-off 0.03 mV), but poor for unipolar (AUROC = 0.68). In contrast, Lir had excellent discriminatory ability (AUROC – MiFi = 0.87,

Figure 1: Pacing threshold vs referenced local impedance in Stablepoint patients



SP = 0.90, both optimal cut-offs 1Ω). For the PA–EA cut-off, the ability to distinguish PT above/below 5 mA for bipolar voltages was fair (AUROC = 0.69, optimal cut-off 1.86 mV), and poor for unipolar voltages (AUROC = 0.63). In contrast, Lir had good discrimination (AUROC – MiFi = 0.82, optimal cut-off 13Ω, SP = 0.89, optimal cut-off 12Ω). Using these cut-offs, there was a significant difference between PTs between EI, PA and EA, for bipolar voltage (EI: 20 mV, PA 6.0 ± 6.3 mV, EA: 2.6 ± 2.6 mV, p<0.0005) and Lir (MiFi: EI: 20 mV, PA 7.8 ± 7.5 mV, EA: 2.8 ± 2.8 mV. SP: EI 20 mV, PA: 4.0 ± 2.5 mV, EA: 2.2 ± 0.9 mV, both p<0.0005).

**Conclusions:** PTs suggest Lir is a superior marker in assessing electrical viability of atrial tissue over conventionally used voltage cut-offs. Based on pacing capture data, what has previously been labelled dense scar is not electrically inert and should be ablated if clinically indicated. Values of 0.03 mV and 1.86 mV, and for potential future Lir mapping, 1Ω and 13Ω are suggested as dense scar and low voltage area thresholds. □

## Oral Abstracts 2 – High-scoring Abstracts

### 24/The effect of His bundle pacing vs conventional biventricular pacing on repolarisation in patient's with heart failure and reduced ejection fraction and left bundle branch block?

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**Introduction:** Left bundle branch block (LBBB) is associated with an increased risk of ventricular arrhythmia. Biventricular pacing (BVP) improves symptoms, systolic left ventricular function and mortality in heart failure with LBBB, but can be pro-arrhythmic. His bundle pacing (HBP) can overcome LBBB to produce more synchronous ventricular activation than BVP, but it is not known how ventricular repolarisation heterogeneity is affected, which is important in arrhythmogenesis. We set out to measure the dispersion of repolarisation and activation recovery-interval (ARI, a surrogate for action potential duration) in narrow QRS, LBBB, BVP and HBP.

**Methods:** Patients were recruited into two groups. In the first group, patients with heart failure and LBBB scheduled to undergo clinically indicated BVP implant procedures were recruited. They underwent temporary HBP to attempt reverse LBBB during the BVP procedure. If HBP shortened activation time by  $\geq 10$  ms, patients were included (HBP cardiac resynchronisation therapy [CRT]). In the second group patients with normal, narrow QRS were recruited. Non-invasive electrocardiographic imaging was used to measure the following parameters in narrow QRS, LBBB, BVP and HBP: left ventricular activation time, left ventricular repolarisation time dispersion and left ventricular ARI dispersion.

**Results:** A total of 21 patients in whom HBP shortened LV activation

time by  $>10$  ms and an equal number of individuals with narrow intrinsic QRS were recruited. LV repolarisation dispersion was reduced by HBP-CRT (-42.0 ms, 95% confidence interval (CI) -52.3 to -31.7;  $p<0.001$ ) but not by BVP (+11.9 ms, -6.24 to 30.1;  $p=0.182$ ). The mean within-patient change in LV repolarisation dispersion from BVP to HBP-CRT was -56.5 ms (-70.5 to 42.5;  $p<0.001$ ). LV repolarisation dispersion with HBP-CRT was not different from individuals with narrow intrinsic QRS (difference: 2.75 ms, -16.2 to 21.7;  $p=0.981$ ). The magnitude of reduction in LV repolarisation dispersion with HBP-CRT from intrinsic LBBB appeared to be similar to the magnitude of LV activation time shortening (-45.9 ms, -59.3 to -32.4). However, LV activation recovery interval dispersion was also reduced by HBP-CRT (-56.5 ms, -70.5 to -42.5 ms;  $p<0.001$ ). Repolarisation mapping demonstrated normalisation of repolarisation pattern by HBP-CRT.

**Conclusions:** HBP-CRT can normalise repolarisation dispersion, producing more physiological repolarisation compared with BVP, which does not resolve the repolarisation abnormality of LBBB. HBP-CRT improves repolarisation through both activation resynchronisation and modulation of action-potential duration. If these acute results translate to longer-term outcomes, HBP-CRT may reduce the risk of ventricular arrhythmias in heart failure with LBBB to a greater extent than BVP. □

## Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

### 25/Creating patient-specific atrial fibrillation models from imaging and electroanatomic mapping data

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**Introduction:** Atrial fibrillation (AF) is the most common cardiac arrhythmia, affecting over 1.4 million people in the UK alone, and is associated with an increased risk of cardiovascular diseases, stroke and death. AF is often treated by catheter ablation therapy, which aims to isolate regions of the atrial tissue that are critical for driving the arrhythmia. However, it is challenging to identify these critical regions and target catheter ablation therapy, which is one of the reasons that AF treatment responses are suboptimal. Patient-specific simulations can be used to investigate the mechanisms underlying arrhythmias and test patient-specific therapies across cohorts of patients. This study aimed to develop and test CemrgApp for creating patient-specific left atrial models from MRI images or CT images and electroanatomic mapping data.

**Methods and results:** We developed and used tools within CemrgApp software, which is an interactive medical imaging application with image processing toolkits (cemrgapp.com), to build atrial models from

MRI or CT imaging data and electroanatomic mapping data. We used CemrgApp to post-process each surface mesh to identify the pulmonary vein structures, appendage, and mitral valve to create a labelled mesh (Figure 1). We also clipped the structures, remeshed the shell to simulation resolution, and selected landmark points. We calculated universal atrial coordinates to register atrial fibre fields from an atlas. AF simulations were then run on the models using Cardiac Arrhythmia Research Package (CARP) software, which were post-processed to generate phase singularity density maps indicating potential driver site locations over 15-second simulations. We built 44 patient-specific meshes and simulated AF across this cohort of models.

**Conclusion:** We have developed an open-source pipeline in CemrgApp for constructing personalised left atrial models. Our future work will use this pipeline to construct large cohorts of models for virtual *in silico* trials to test different ablation and antiarrhythmic drug therapies for atrial fibrillation. □

Figure 1: Overview of the functions of CemrgApp. Post-process segmentation of an atrial biophysical model. Main functions are Step 3: Identify Pulmonary veins, Step 4: Select landmarks, create labelled mesh, display Pulmonary veins and Mitral valve clippers, Step 5: Clip PVs and MV



## Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

### 26/Heart rhythm variability in patients with atrial fibrillation and atrial flutter depending on immune status, systemic inflammation and renin-angiotensin-aldosterone system activity

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**Aims:** Arterial hypertension (AH) is one of the most common causes of atrial fibrillation (AF) and atrial flutter (AFL), but still the concrete reason for their onset is not known. Indication and comparison of systemic inflammation and renin-angiotensin-aldosterone system activity and heart rhythm variability differences in these patients have become the background of our study.

**Methods and results:** The study involved 103 patients with hypertension and arrhythmias, who were divided into three main groups: Group 1 (n=35) – with paroxysmal AF; Group 2 (n=38) – with persistent form of AF; Group 3 (n=30) – with persistent form of AFL. For comparison, 2 control groups were formed: Group 4 (n=23) – patients with hypertension, but without a history of arrhythmias; Group 5 (n=21) – almost healthy people. The immune status of these patients was assessed by determining the level of monocytes (Mc), lymphocyte subpopulations and T-regulatory (T-reg) cells in the peripheral blood using flow cytometry. These 103 patients with arrhythmias were examined and divided into two groups according to highly specific C-reactive protein (CRP) and angiotensin converting enzyme (ACE) level in serum. It was noted that the number of classical CD14<sup>++</sup>CD16<sup>-</sup> and intermediate CD14<sup>++</sup>CD16<sup>+</sup> Mc was significantly higher in patients with persistent AF and AFL compared with both patients without arrhythmias and healthy people (p<0.005). The amount of non-classical CD14<sup>+</sup>CD16<sup>++</sup> Mc was significantly lower in the second group both quantitatively and in percentage (p<0.005). The count of T cells with natural killer (TNK) activity was higher in all

groups compared with the normal value, so statistical significance was observed only in comparison with the fifth group. The highest quantity of T-reg cells was found in healthy people compared with the other groups and a strong mathematical significance was obtained in all cases (p<0.005), both comparing the values in percentage and in  $\mu$ L. Assessing the activity of ACE in the vast majority of patients with arrhythmias, its increased level was observed in 82% (85/103) vs 27% (12/44) among patients in the control groups (p<0.05). Overall, 83% of patients (86/103) with AF and AFL had a significantly increased CRP rate vs 9% of patients (4/44) without arrhythmias. All patients received Holter ECG monitoring when they had sinus rhythm, and it was noted that in cases of increased CRP and ACE levels, SDNN (ms) was higher: 115 (108.4–124.2) vs 101 (97.1–108.8) (p=0.035). Also, mean heart rate was significantly higher: 82 (78.5–87.1) vs 73.1 (71.7–78.4) (p=0.048).

**Conclusions:** Compared with healthy people or patients with hypertension without arrhythmias, hypertensive patients with AF and AFL have increased activity of proinflammatory subpopulations of monocytes, higher levels of T-cells with natural killer activity and reduced T-reg cells, whose main function is to control the immune response. According to Holter ECG in patients with AF/AFL with elevated compared with normal levels of highly specific CRP and ACE, there was a statistically significant difference between mean heart rate and SDNN, indicating sympatho-adrenal system and systemic inflammation activation in these patients. □



Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

27/Artificial intelligence-enabled electrocardiogram to distinguish cavotricuspid isthmus dependence from other atrial tachycardia mechanisms

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**Background:** Accurately determining atrial arrhythmia mechanisms from a 12-lead ECG can be challenging. Given the high success rate of cavotricuspid isthmus (CTI) ablation, accurate identification of CTI-dependent typical atrial flutter (AFL) is important for treatment decisions and procedure planning. Machine learning, with convolutional neural networks (CNNs) in particular, has been used to classify arrhythmias using the 12-lead ECG with great accuracy. However, most studies use human interpretation of the ECG as the ground truth to label the arrhythmia ECGs. Therefore, these neural networks can only ever be as good as expert human interpretation. We hypothesised that a CNN can be trained to classify CTI-dependent AFL vs non-CTI-dependent atrial tachycardia (AT), when using findings from the invasive electrophysiology (EP) study as the gold standard.

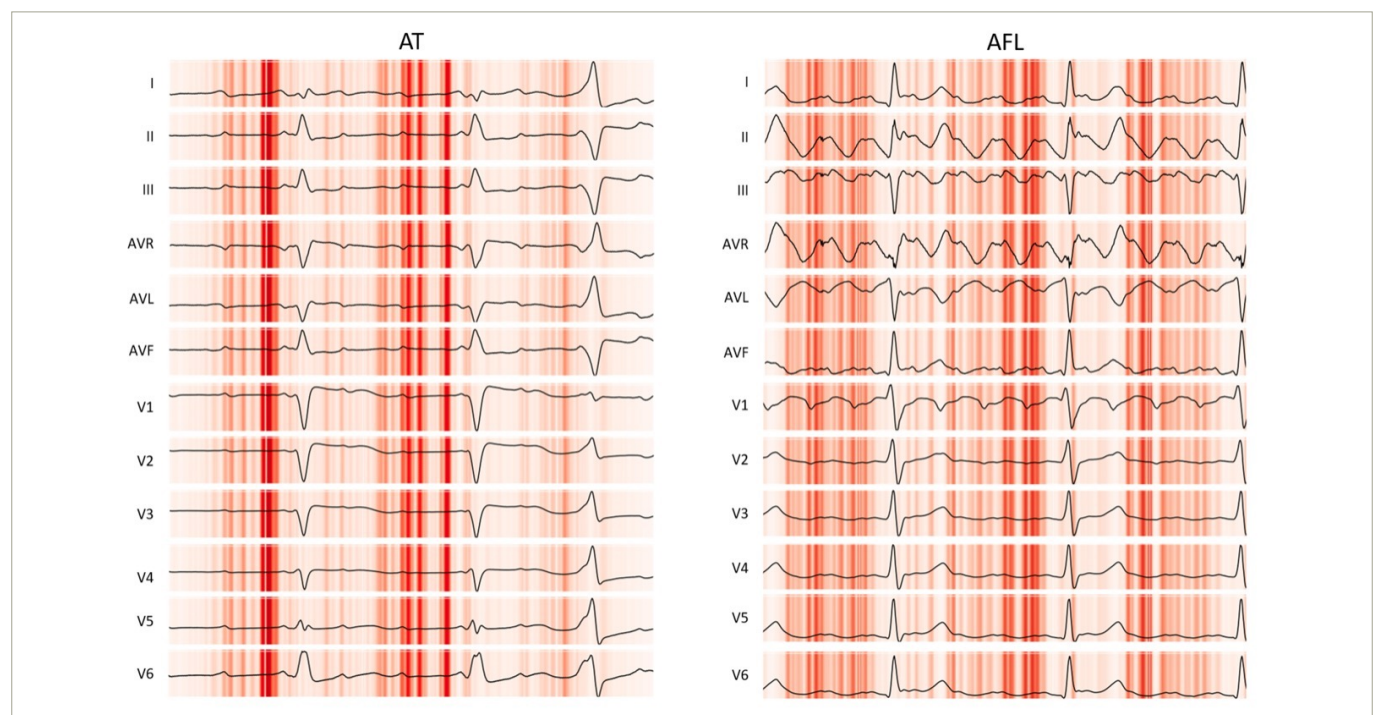
**Methods:** We trained a CNN on data from 231 patients undergoing EP studies for atrial tachyarrhythmia. A total of 13,500 5-second 12-lead ECG segments were used for training. Each case was labelled CTI-dependent AFL or non-CTI-dependent AT based on the findings of the EP study. The model performance was evaluated against a test set of 57 patients. A survey of electrophysiologists and cardiologists in Europe was undertaken on the same 57 ECGs.

**Results:** The model had an accuracy of 86% (95% CI 0.77–0.95). The F1 score was 0.87. The AT/AFL network correctly identified AT 82% and

AFL 90% of the time. A saliency map can be used to help understand why a CNN predicted a particular outcome. This is achieved by mapping the outcome back to key areas of the input that most influenced the network in producing the classification result. *Figure 1* presents the saliency mappings of an example 12-lead ECG for each class of AFL and AT. The network used the expected sections of the ECGs for diagnoses; these were the P-wave segments and not the QRS or other unexpected segments. There were 12 respondents in the clinician survey. These respondents included nine electrophysiologists. The median accuracy was 78% (range 70–86%). The electrophysiologists had a median accuracy of 79% (range 70–84%). Humans were more likely to incorrectly diagnose AFL as AT (on average incorrect diagnoses: 9 AFL, 1 AT). In comparison, the neural network most often incorrectly diagnosed AT as AFL (incorrect diagnoses: 5 AT, 3 AFL). In the two-thirds of test set cases (38/57) where both the model and electrophysiologist consensus were in agreement, the prediction accuracy was 100%.

**Conclusion:** We describe the first neural network trained to differentiate CTI-dependent AFL from other atrial tachycardias. Our model at least matched and complemented expert electrophysiologist performance. Automated artificial intelligence-enhanced ECG analysis could help guide treatment decisions and plan ablation procedures for patients with organised atrial arrhythmias. □

Figure 1





## Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

### 28/UHF-ECG detected QRS fractionation predicts arrhythmic risk in patients with hereditary arrhythmic conditions

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**Introduction:** Fragmentation of the QRS complex is a feature of arrhythmogenic conditions including primary arrhythmia syndromes, ischaemic and non-ischaemic cardiomyopathy and in the presence of myocardial scar. While gross fragmentation can be observed on 12-lead ECG, more subtle abnormalities may be missed. Ultra-high-frequency ECG (UHF-ECG) is an ECG-based technique that measures electrical activation signals in high-frequency bands that are filtered out by conventional ECG measurements. We hypothesised that UHF-ECG can unmask these subtle electrical disturbances and, by extension, could provide a mechanism to characterise arrhythmic risk.

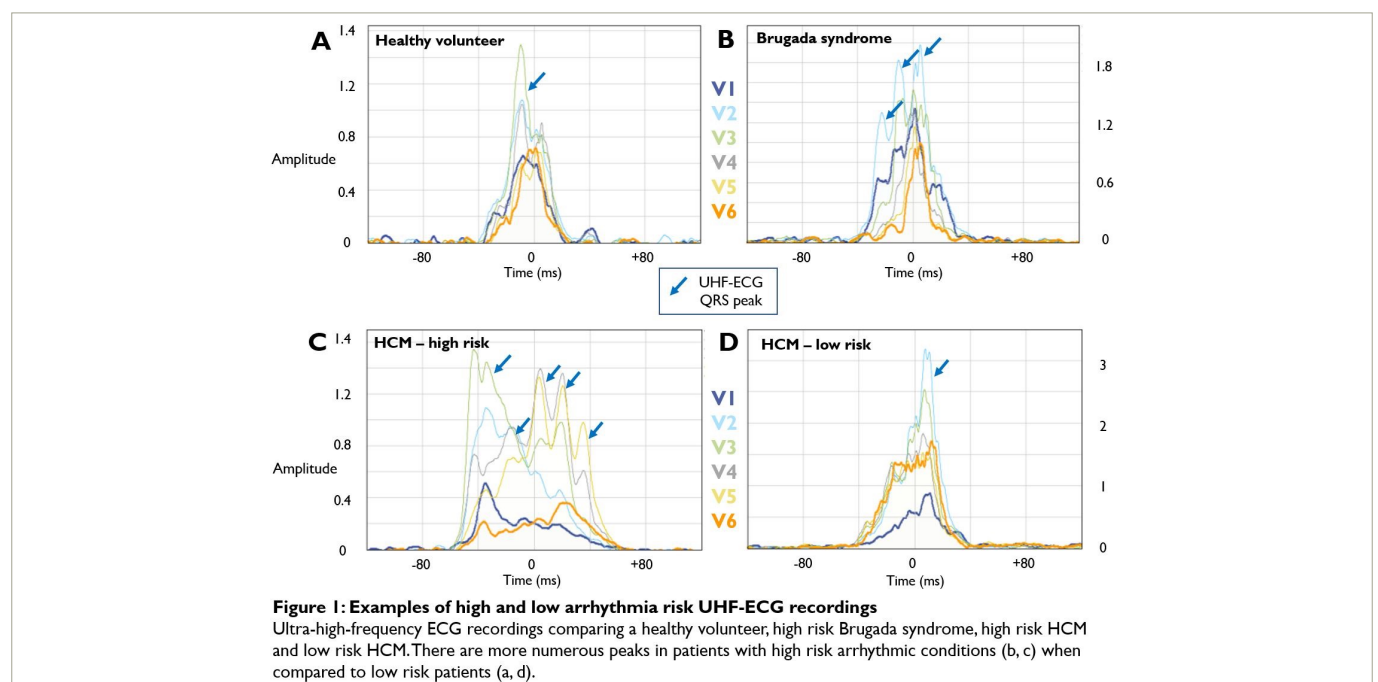
**Methods:** We prospectively recruited 60 participants to undergo UHF-ECG recordings. This consisted of 23 healthy volunteers and 37 patients with hereditary arrhythmic conditions: 25 hypertrophic cardiomyopathy (HCM), 5 Brugada syndrome, 4 arrhythmogenic cardiomyopathy, 3 idiopathic ventricular fibrillation, 2 long QT syndrome and 1 non-ischaemic dilated cardiomyopathy. Each patient with a hereditary arrhythmic condition was evaluated by two independent researchers to determine their arrhythmic risk based on the following criteria: history of cardiac arrest, sustained ventricular arrhythmia, appropriate therapy, syncope and programmed ventricular stimulation result. Healthy volunteers were assumed to have a low arrhythmic risk. Two further researchers reviewed the UHF-ECG recordings to quantify the degree

of QRS fractionation (i.e. number of discrete activation peaks) exhibited using visual assessment. UHF-QRS peaks were recorded where a discrete deflection was visualised simultaneously in two or more ECG leads. A third researcher adjudicated in instances of disagreement regarding arrhythmic risk status or fractionation peak interpretation.

**Results:** Our cohort comprised 20 patients with a high arrhythmic risk and 40 patients with a low arrhythmic risk. High arrhythmic risk subjects exhibited greater fractionation severity, as represented by more numerous UHF-ECG QRS peaks, when compared with low-risk subjects ( $\chi^2=8.95$ ,  $p=0.03$ ). When comparing high-risk and low-risk subjects within the hereditary arrhythmic condition patient group, there was more fractionation in the high-risk group. Example UHF-ECGs are shown in *Figure 1*. UHF-ECG fragmentation could be observed even when conventionally filtered 12-lead ECG QRS fragmentation could not be observed. Among patients with inherited cardiac conditions, hypertrophic cardiomyopathy patients had closest association between fractionation and risk status. Measurements of UHF-QRS peaks were highly reproducible between the independent assessors.

**Conclusion:** QRS fractionation, unmasked by UHF-ECG, may be useful for sudden cardiac death risk stratification in patients with hereditary arrhythmic conditions. □

Figure 1



Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

29/The electrophysiological substrate of HCM and propensity to ventricular fibrillation as measured by ECG imaging

Authors: JJ Chow (Presenting Author) – Imperial College Healthcare NHS Trust, London; K Leong – Imperial College Healthcare NHS Trust, London; M Shun-Shin – Imperial College Healthcare NHS Trust, London; OP Guttmann – Barts Health NHS Trust, London; SA Mohiddin – Barts Health NHS Trust, London; P Lambiasi – Barts Health NHS Trust, London; PM Elliott – Barts Health NHS Trust, London; JOM Ormerod – Oxford University Hospitals NHS Trust, Oxford; M Koa-Wing – Imperial College Healthcare NHS Trust, London; DC Lefroy – Imperial College Healthcare NHS Trust, London; P Boon Lim – Imperial College Healthcare NHS Trust, London; NWF Linton – Imperial College Healthcare NHS Trust, London; FS Ng – Imperial College Healthcare NHS Trust, London; NA Qureshi – Imperial College Healthcare NHS Trust, London; ZI Whinnett – Imperial College Healthcare NHS Trust, London; NS Peters – Imperial College Healthcare NHS Trust, London; DP Francis – Imperial College Healthcare NHS Trust, London; AM Varnava – Imperial College Healthcare NHS Trust, London; P Kanagaratnam – Imperial College Healthcare NHS Trust, London

Patients with hypertrophic cardiomyopathy (HCM) are at risk of lethal ventricular arrhythmia. The electrical substrate for this has not been well elucidated. Furthermore, despite extensive knowledge of the structural differences in HCM vs the normal heart, the effects of electrophysiology are not known.

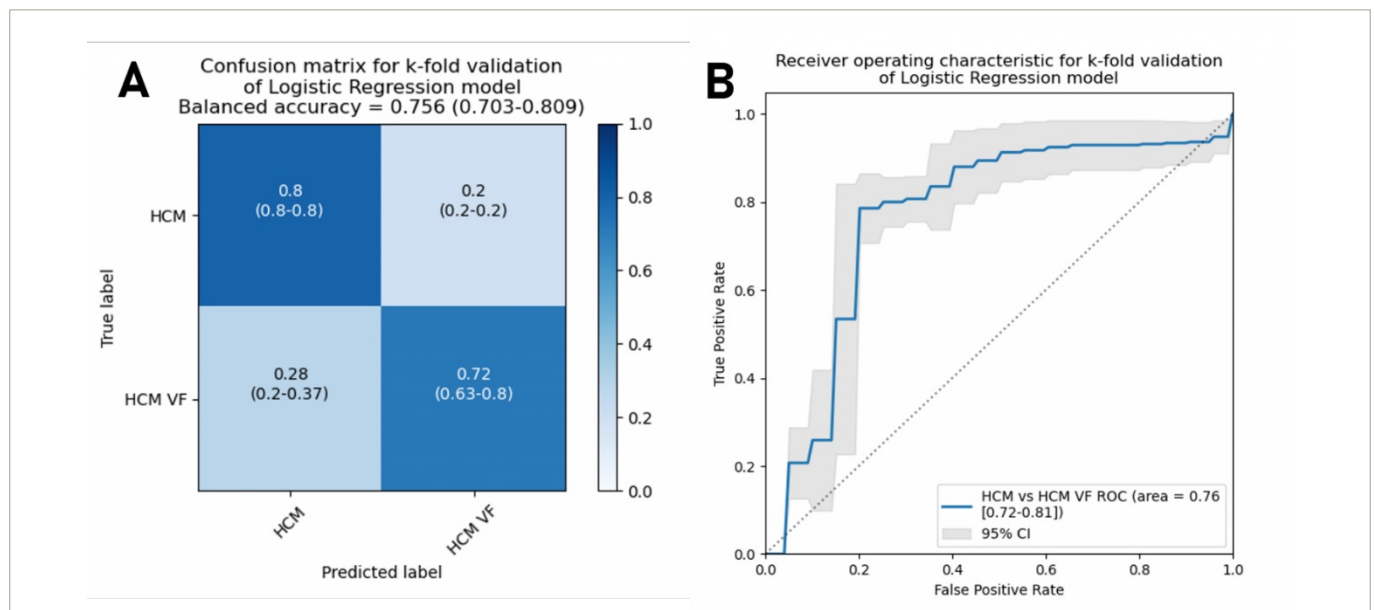
**Methods:** HCM patients surviving ventricular fibrillation or haemodynamically unstable ventricular tachycardia (HCM VF, n=17) were compared with HCM patients without a personal history of potentially lethal arrhythmia (HCM, n=20) and a pooled control group with structurally normal hearts but a range of conditions – 10 ischaemic cardiac arrest survivors with full revascularization and normalization of ventricular function, 11 patients undergoing ablation for benign VE and 11 patients proven to have normal hearts following family screening for Brugada syndrome. These 69 patients underwent exercise testing wearing a 252-electrode vest (CardioInsight ECGi, Medtronic) and a low-resolution CT. Activation time (AT) and activation recovery intervals (ARI) were compared between subjects to determine the electrical substrate in HCM.

**Results:** Most surface ECG markers were similar between the patient groups. QRS duration at both peak exercise and recovery, as well as QTc at peak exercise were not significantly different. The HCM VF group had a longer QTc in recovery than any group aside from the VE patients (p<0.01).

In contrast, following peak exercise, ECGi could demonstrate that the pooled HCM group had longer mean AT (60.1 ± 9.4 ms vs 52.2 ± 4.3 ms, p<0.001), activation dispersion (55.2 ± 16 ms vs 48.6 ± 12.1 ms, p=0.026) and mean ARI (227 ms vs 217 ms, p=0.016). These differences persisted into end recovery. HCM VF survivors could be differentiated from HCM patients without personal history of life-threatening arrhythmia. Following peak exercise, mean activation time (63.2 ± 7.2 ms vs 57.4 ± 10.3 ms, p=0.007), activation gradients (0.45 ± 0.11 ms/mm vs 0.36 ± 0.18 ms/mm, p=0.011) and ARI (234.0 ± 19.8 ms vs 221.4 ± 16.8 ms, p=0.026) were higher in HCM VF/VT. The differences in mean AT and ARI persisted into full recovery. Logistic regression was used to analyse electrical variables differentiating the HCM and HCM VF/VT groups. In k-folds validation, the model including mean AT and mean ARI produced an area under the receiver operating characteristic curve of 0.76 (95% confidence interval 0.72–0.81), with optimal sensitivity of 78.6% and specificity of 79.8% (Figure 1).

**Conclusions:** The HCM epicardial electrotype is characterized by slow, dispersed conduction and delayed, dispersed repolarization and activation-recovery intervals. ECGi is more sensitive to these differences than surface ECG. Combination of electrophysiological measures by logistic regression can improve differentiation over single variables. Future studies could test such models prospectively for risk stratification of sudden death in HCM. □

Figure 1



## Oral Abstracts 2 – Arrhythmia Mechanisms/*In Silico* Tools

### 30/Assessment of scar between atria, rhythms and atrial fibrillation types. Does ultra-high-density mapping offer new insights?

Authors: *AP Bates (Presenting Author) – Cardiology Department, University Hospital Southampton, Southampton; JR Paisey – Cardiology Department, University Hospital Southampton, Southampton; AM Yue – Cardiology Department, University Hospital Southampton, Southampton; PR Roberts – Cardiology Department, University Hospital Southampton, Southampton; W Ullah – Cardiology Department, University Hospital Southampton, Southampton*

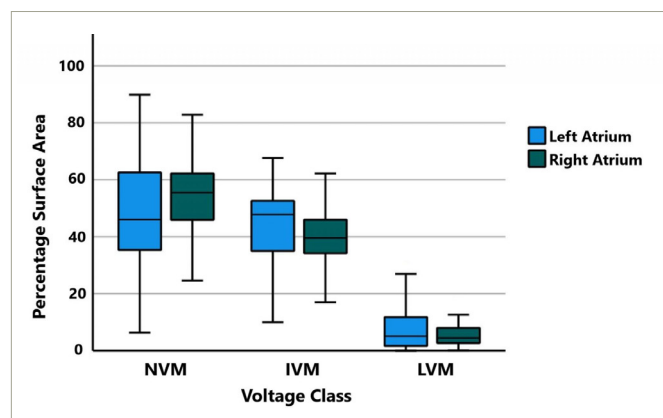
**Background:** 3D electroanatomical mapping systems demonstrate atrial scar by recording local tissue voltages as a surrogate. Increased scar has been shown with both progression of atrial fibrillation (AF, paroxysmal [PAF] to persistent [PeAF]), and between sinus rhythm (SR) and AF on low-density mapping systems. The introduction of ultra-high-density mapping allows a more detailed comparison.

**Objectives:** Assessment of atrial scar determined by voltages and surface area between atria, rhythm and AF type.

**Methods:** Patients undergoing AF ablation were recruited. Ultra-high-density 3D electroanatomical maps of left and right atria (LA, RA) were created (Orion, Rhythmia HDx). PeAF patients had maps created in AF and SR (proximal coronary sinus pacing) following DC cardioversion. PAF patients had maps created in SR only. Non-atrial mapped areas and sites of previous ablation were excluded. Electrograms (EGMs) on corresponding AF and SR maps were paired using exported co-ordinates. Percentage surface area of scar was determined and assigned as low-voltage myocardium (LVM,  $\leq 0.05$  mV), intermediate (IVM, 0.05–0.5 mV) or normal (NVM,  $>0.5$  mV).

**Results:** A total of 40 patients (PAF 10; PeAF 30; male 21/40; age  $66.7 \pm 8.8$  years; procedure length  $235 \pm 48$  min; ablation time  $31.1 \pm 15.8$  min) were recruited producing 95 maps (LA SR 38; LA AF 30; RA SR 17; RA AF 10). A total of 913,480 EGMs proceeded to analysis (mean EGMs per map: LA SR  $10,097 \pm 2,779$ ; LA AF  $10,296 \pm 2,176$ ; RA SR  $8,119 \pm 1,937$ ; RA AF  $8,290 \pm 1,802$ ). Paired SR-AF EGM voltages had a moderate–strong correlation in the LA (bipolar Pearson’s  $R = 0.50$ ; unipolar  $R = 0.40$ ; both  $p < 0.0005$ ), and moderate correlation in the RA (bipolar  $R = 0.32$ ; unipolar  $R = 0.30$ ; both  $p < 0.0005$ ). Paired voltages were significantly higher in SR in both atria (LA – bipolar mean voltage ratio SR/AF = 2.0, unipolar mean voltage SR/AF = 1.5; RA – bipolar mean voltage SR/AF = 1.5, unipolar mean voltage SR/AF = 1.2; all  $p < 0.0005$ ). There was significantly more LVM/IVM percentage surface area in AF over SR in the LA (SR to AF – LVM  $6.4 \pm 6.9$  to  $12.2 \pm 9.5$ ; IVM  $41.0 \pm 12.1$  to  $50.5 \pm 10.0$ ; NVM  $51.7 \pm 17.2$  to  $37.3 \pm 16.1$ ;  $p < 0.0005$ ), but interestingly not in the RA (SR to AF – LVM  $6.5 \pm 5.3$  to  $8.4 \pm 8.3$ ; IVM  $42.0 \pm 10.1$  to  $44.6 \pm 6.9$ ; NVM  $51.5 \pm 13.6$  to  $47.0 \pm 13.8$ ;  $p = 0.62$ ). Global tissue voltages in SR were significantly higher in

Figure 1



PAF over PeAF in both atria (LA – bipolar mean voltage PAF/PeAF = 2.1, unipolar mean voltage PAF/PeAF = 1.4; RA – bipolar SR/AF = 1.4, unipolar SR/AF = 1.3; all  $p < 0.0005$ ). There was significantly more LVM/IVM surface area demonstrated in PeAF over PAF in the LA (PAF to PeAF – LVM  $0.6 \pm 0.7$  to  $6.6 \pm 6.8$ ; IVM  $29.5 \pm 12.3$  to  $43.1 \pm 11.4$ ; NVM  $69.8 \pm 12.8$  to  $50.3 \pm 16.4$ ;  $p = 0.01$ ), but not in the RA (PAF to PeAF – LVM  $4.6 \pm 3.6$  to  $6.5 \pm 5.3$ ; IVM  $32.7 \pm 9.5$  to  $42.0 \pm 10.1$ ; NVM  $62.7 \pm 12.1$  to  $51.5 \pm 13.6$ ;  $p = 0.20$ ). Comparing atria, the LA had a significantly lower voltage in SR, but this difference was small (LA/RA = 0.89;  $p < 0.0005$ ). The percentage surface area of scar was comparable (LA to RA – LVM  $4.0 \pm 5.6$  to  $5.6 \pm 4.5$ ; IVM  $38.4 \pm 37.6$  to  $37.6 \pm 10.6$ ; NVM  $57.5 \pm 18.4$  to  $56.8 \pm 13.8$ ; *Figure 1*).

**Conclusions:** Ultra-high-density mapping confirms atrial voltages are higher in SR over AF, and PAF over PeAF. The RA is comparable to the LA for tissue voltages but does not demonstrate a change in surface area of scar between AF and SR or PAF and PeAF. This may reflect the complexity of AF wavefronts in the LA compared with the RA leading to more bipole orientation-related overestimation of scar in the fibrillating LA. □

## Oral Abstracts 3 – Devices

### 31/When to measure changes during CRT optimisation. Guidance from computer simulation studies

Authors: *L Turner (Presenting Author) – Royal Papworth Hospital, Cambridge; S Silva – Royal Papworth Hospital, Cambridge; J Hutchinson – Royal Papworth Hospital, Cambridge*

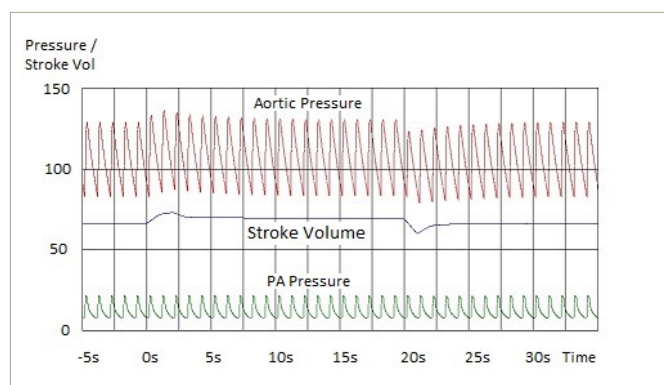
**Introduction:** Cardiac resynchronisation therapy (CRT) has become a widely used pacing technique in the treatment of heart failure. Optimisation of AV and VV delays to maximise therapeutic benefit has proven difficult and is therefore often not performed. The haemodynamics vary considerably after changes in pacing parameters and there are conflicting results as to when is the best time to measure the acute response, particularly using non-invasive blood pressure (NIBP) systems.

**Method:** A purpose-written computer simulation program was used, which was based on a set of equations with time-varying elastances to describe atrial and ventricular function, along with Windkessel (resistance and capacitance) equations to describe blood flow around the systemic and pulmonary circulations. Baroreflex and cardiopulmonary reflexes were described by time-delay equations, which affect contractility, arterial resistance and venous compliance. Simulations were calculated to describe pressure and flow after changes in contractility for varying time periods, representing the typical CRT optimisation session.

**Results:** Sudden changes in contractility, representing a step change in CRT programming, result in a relatively large increase in NIBP, which then settles to a plateau level, finally stabilising after 15–20 seconds. This stabilisation is mainly due to baroreflex-mediated changes in peripheral resistance and to a lesser extent contractility. Changes in venous compliance generally take 30–40 seconds to manifest and appear to be minor. The traces appear very similar to those reported previously in clinical studies.

**Conclusions:** The implications for optimisation are that the NIBP changes are largest over the first 5 beats, which give a good signal-to-

Figure 1: Calculated aortic and pulmonary artery pressures, as well as stroke volume, during a simulated change in programming for 20 seconds followed by reversion back to baseline



noise for detecting an effect. Pressures and flows then take 15 seconds to stabilise to a true plateau for measurements aimed at longer time periods. The relationship between the initial NIBP change and the plateau is complex and depends on factors such as the baroreflex gain, underlying level of contractility and degree of resting sympathetic tone. Averaging multiple recordings with different combinations of parameters should therefore allow at least 20 seconds in each state to ensure stable cardiac haemodynamics. □

Oral Abstracts 3 – Devices

32/Syncope in ICD recipients – data from unselected patients in a real-world setting

Authors: P Khan (Presenting Author) – King’s College Hospital NHS Trust, London; K Selvarajah – King’s College Hospital NHS Trust, London; S Gohel – King’s College Hospital NHS Trust, London; B Sidhu – King’s College Hospital NHS Trust, London; A Cannata – King’s College Hospital NHS Trust, London; D Bromage – King’s College Hospital NHS Trust, London; T McDonagh – King’s College Hospital NHS Trust, London; F Murgatroyd – King’s College Hospital NHS Trust, London; PA Scott – King’s College Hospital NHS Trust, London

**Aims:** Previous studies have evaluated the incidence and prognostic significance of syncope in ICD recipients; however, these have been almost exclusively derived from randomised controlled trials (RCTs) of primary prevention patients with severe left ventricular systolic dysfunction (LVSD). There is little evidence of the impact of syncope in implantable cardioverter defibrillator (ICD) patients in a real-world setting. This single-centre retrospective study sought to evaluate the incidence and prognostic significance of syncope in an unselected population of ICD patients including patients with secondary prevention and less severe LVSD.

**Methods:** Data were collected on consecutive patients undergoing first ICD implantation between January 2009 and December 2019. The primary endpoints were first occurrence of all-cause syncope, all-cause mortality and all-cause hospitalisation. Multivariate Cox proportional hazard models were used to identify risk factors associated with syncope and to analyse the subsequent risk of mortality and hospitalisation.

**Results:** A total of 1003 patients (58% primary prevention) were included in the final analysis. During a mean follow-up of 1,519 ± 1,055 days, 106 (10.6%) experienced syncope, 304 died (30.3%) and 477 (47.5%) were hospitalised for any cause; 106 (10.6%) patients experienced all-cause

syncope, 38 (3.7%) arrhythmic syncope and 74 (7.4%) non-arrhythmic syncope, including six patients (0.6%) with both arrhythmic and non-arrhythmic syncope. The 1-, 3- and 5-year all-cause syncope rates were 3.8%, 8.3% and 13.3%, respectively. The arrhythmias associated with arrhythmic syncope were VT (n=23, 60.5%), VF (n=11, 28.9%) and atrial arrhythmias (n=4, 10.5%). In an analysis adjusted for baseline variables, the first occurrence of syncope was associated with a significantly increased risk of mortality (HR 2.82, p<0.001) and first occurrence of hospitalisation (HR 2.46, p=0.002).

**Conclusion:** There were three main findings from this study. First, syncope, irrespective of the cause, portends a poor prognosis with significant associations with both mortality and hospitalisation. In multivariable analyses the first occurrence of all-cause syncope, arrhythmogenic syncope and non-arrhythmogenic syncope were all associated with a significant increase in mortality and hospitalisation. Second, the relationship between all-cause syncope and mortality remained significant in secondary prevention patients and in patients with less severe LVSD (LVEF >35%). Third, in multivariable analysis, strategic ICD programming, with long detection times and high detection zones, was not independently associated with an increase in first occurrence of syncope. □

Table 1

Time-dependent cox regression models evaluating the association between the first occurrence of syncope and all-cause mortality.						
	All cause syncope (n=106)		Non-arrhythmic syncope (n=74)		Arrhythmic syncope (n=38)	
	HR (95% CI)	p-value	HR (95% CI)	p-value	HR (95% CI)	p-value
All patients (n=1003)	2.82 (2.04-3.91)	<0.001	2.69 (1.86-3.90)	<0.001	2.88 (1.75-4.75)	<0.001
Indication						
Primary Indication (n=583)	2.65 (1.72-4.09)	<0.001	2.08 (1.27-3.40)	0.004	3.57 (1.92-6.67)	<0.001
Secondary Indication (n=420)	2.80 (1.62-4.83)	<0.001	4.13 (2.20-7.74)	<0.001	1.80 (0.75-4.33)	0.190
Aetiology						
IHD (n=605)	2.24 (1.42-3.54)	<0.001	2.24 (1.33-3.78)	0.003	1.74 (0.83-3.65)	0.146
NIDCM (n=231)	3.33 (1.83-6.07)	<0.001	2.94 (1.48-5.84)	0.002	4.27 (1.93-9.48)	<0.001
LVEF						
≤35% (n=695)	3.01 (2.10-4.32)	<0.001	2.47 (1.63-3.77)	<0.001	3.76 (2.20-6.43)	<0.001
>35% (n=308)	2.94 (1.20-7.22)	0.018	5.15 (1.85-14.35)	0.002	0.87 (0.11-7.18)	0.896

HR=hazard ratio; CI=confidence interval.  
 Results are adjusted for: demographics (age, sex), cardiovascular risk factors (COPD, CKD, diabetes, hypertension, PVD), baseline medication use (ACE-I/Angiotensin Receptor, amiodarone, beta-blockade, diuretic), aetiology of cardiac disease, baseline cardiac testing (LVEF, QRS width), indication (for secondary prevention presenting arrhythmia – VT or VF), device type (single/dual chamber ICD and CRTD) and programming group (PRE or POST).



Oral Abstracts 3 – Devices

33/Predicting permanent pacemaker implantation after transcatheter aortic valve implantation (TAVI) – building a risk score calculator

Authors: J Li (Presenting Author) – University of Cambridge, School of Clinical Medicine, Cambridge; J Cranley – Royal Papworth Hospital NHS Foundation Trust, Cambridge; B Clay – University of Cambridge, School of Clinical Medicine, Cambridge; A Christodoulidou – University of Cambridge, School of Clinical Medicine, Cambridge; F Ara – Royal Papworth Hospital NHS Foundation Trust, Cambridge; P Costanzo – Royal Papworth Hospital NHS Foundation Trust, Cambridge; C Costopoulos – Royal Papworth Hospital NHS Foundation Trust, Cambridge; M O’Sullivan – Royal Papworth Hospital NHS Foundation Trust, Cambridge; W Davies – Royal Papworth Hospital NHS Foundation Trust, Cambridge; C Densem – Royal Papworth Hospital NHS Foundation Trust, Cambridge; C Martin – Royal Papworth Hospital NHS Foundation Trust, Cambridge

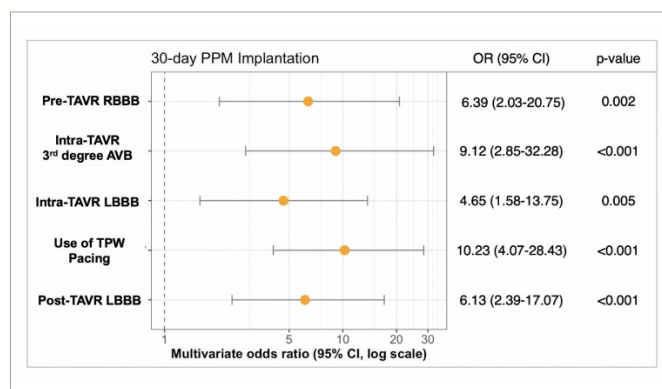
**Background:** Transcatheter aortic valve implantation (TAVI) is increasingly adopted in clinical practice for treatment of severe aortic stenosis, particularly for high-risk patients unfit for surgery. However, a major complication of TAVI is high-degree AV block necessitating permanent pacemaker (PPM) implantation.

**Objective:** The aim of our study was to evaluate standard available demographic, clinical and imaging patient parameters to develop a risk score calculator to predict PPM implantation after TAVI.

**Methods:** We evaluated patients who underwent TAVI at the Royal Papworth Hospital from August 2017 to November 2020 (n=583). Patients with pre-existing PPM or implantable cardiac defibrillators (ICDs) were excluded from the analysis. Data collected comprised demographic, clinical and imaging data, including computed tomography (CT) aortic valve calcium scores and ECG parameters (pre-, intra- and post-procedural). We then collected data on all eligible cases from December 2020 to June 2021 as a validation cohort.

**Results:** A derivation cohort with complete data (n=446) was analysed. Forty patients (8.97%) in this cohort required PPM within 30 days of TAVI. In our logistic regression model, pre-procedural existing right bundle branch block (RBBB) (OR 6.39; p=0.002), intra-TAVI left bundle branch block (LBBB) (OR 4.65; p=0.005), intra-procedural 3rd-degree AV block (OR 9.12; p<0.001), use of temporary pacing wire (TPW) pacing (OR 10.23, p<0.001) and post-TAVI LBBB (OR 6.13, p<0.001) were independent predictors of PPM and were incorporated in our multivariate logistic regression model (Figure 1). The model demonstrated excellent

Figure 1



discriminative ability (accuracy 0.925 and an AUC of 0.952) at predicting PPM implantation. A risk score calculator was built incorporating these five characteristics, with the aim of facilitating clinician decision making regarding PPM implantation for high-risk patients undergoing TAVI.

**Conclusion:** The presence of pre-TAVI RBBB, intra-procedural 3rd-degree AV block and LBBB, use of TPW pacing and post-TAVI LBBB are predictive of the need for PPM implantation within 30 days of TAVI. We aim to expand this risk score calculator to incorporate these 5 characteristics, as well as the CT aortic valve calcium score, and validate this model in a larger multicentre study. □

### Oral Abstracts 3 – Devices

#### 34/Cardiac computed tomography prior to cardiac resynchronisation therapy upgrade enhances pre-procedural planning by accurately predicting coronary sinus target vessel localisation and venous access patency

Authors: *L Whittaker (Presenting Author) – James Cook University Hospital, Middlesbrough; M Chapman – James Cook University Hospital, Middlesbrough; M Dewhurst – James Cook University Hospital, Middlesbrough; M Bates – James Cook University Hospital, Middlesbrough; A Thornley – James Cook University Hospital, Middlesbrough; A Turley – James Cook University Hospital, Middlesbrough; N Child – University Hospital of North Tees, Stockton-on-Tees*

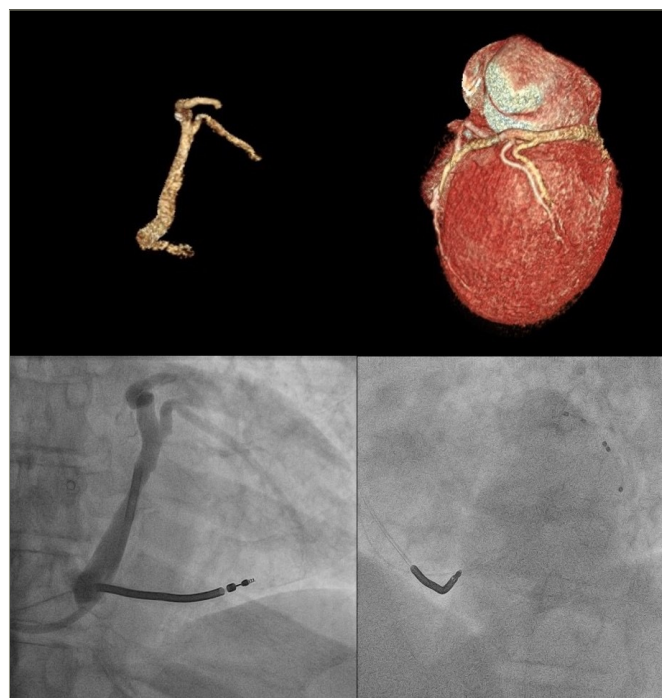
**Introduction:** With advances in cardiac resynchronisation therapy (CRT) equipment and operator experience, implant success is increasing. However, the commonest cause for procedural failure remains a lack of suitable pacing site due to an absent or insufficiently sized target vein. The role of computed tomography (CT) prior to CRT remains investigational, but improved imaging techniques allow assessment of target veins and access site patency. This may improve decision making for high-risk procedures.

**Objectives:** We sought to describe and assess the impact of CT prior to CRT upgrade/revision.

**Methods:** CT and fluoroscopic images were analysed for patients referred for CT prior to CRT upgrade/revision between 2015 and 2022 (Siemens SOMATOM Definition Flash 128-Slice Dual-Source CT Scanner and Siemens Syngo.via software) (Figure 1). Data obtained were: target vein identification on CT, target vein used at implant, subclavian vein patency, radiation dose and incidental findings.

**Results:** A total of 34 patients had CT prior to CRT upgrade/revision, mean age 73 years, 76% male. Reasons for upgrade were pacing-induced cardiomyopathy and/or deterioration of pre-existing cardiomyopathy (n=32), or LV lead displacement (n=2). Overall, 31 patients subsequently attended the lab. Subclavian vein patency was graded as patent, significantly stenosed or occluded with both CT and on-table venography (for patients attending the lab). There was 87% agreement between the two modalities. However, differentiating between stenosis and occlusion on CT is difficult. As such, these two findings were treated interchangeably for pre-procedure planning. If stenosis/occlusion are taken together the agreement between modalities is 98%. A suitable calibre posterior or lateral target vein was identified on CT in 32/34 cases (92%). Subclavian access was achieved in 27/31 patients attending the lab. In 26/27 cases (96%), CT accurately delineated cardiac vein anatomy. In 25/27 cases (92%) the target vein identified on CT was utilised. In one of the remaining cases, tight angulation prevented use of the CT-identified target; a small antero-lateral vein was used instead, though only three poles of a quadripolar lead were placed. In the second case, the target vein was occluded proximally and filled by small antegrade collaterals; an inferior bridging vein was used instead. Two patients did not proceed to upgrade partly due to poor targets on CT (small-calibre veins and/or suboptimal location); one declined given additional uncertainties of success, and the other was unsuitable for prolonged procedures due to advanced heart failure, which later required transfer for transplant assessment.

Figure 1



Mean CT radiation dose was 1426 mGy/cm. Median procedure radiation dose was 10192 mGy/cm<sup>2</sup>. Four patients had significant incidental findings: three had a left atrial thrombus, requiring changes to anticoagulation, and one patient had a lung nodule, requiring follow-up imaging.

**Conclusion:** Cardiac CT prior to CRT upgrade/revision enhanced pre-procedural decision making and supported changes in patient management in this small cohort. CT accurately identified target veins. Assessing subclavian venous patency was more difficult, though there was still high concordance between CT and on-table venography. The CT radiation dose is high relative to other cardiac CT, due to the addition of detailed subclavian imaging. Subsequent adaptation of the CT protocol has reduced radiation dose, whilst still allowing assessment of subclavian anatomy and patency. □

## Oral Abstracts 3 – Devices

### 35/Long-term follow-up and procedural safety of pacemaker implantation in nonagenarians

Authors: *A Gooma (Presenting Author) – East Sussex Healthcare NHS Trust, Eastbourne; R Dulai – East Sussex Healthcare NHS Trust, Eastbourne; C Uy – East Sussex Healthcare NHS Trust, Eastbourne; NR Patel – East Sussex Healthcare NHS Trust, Eastbourne; S Furniss – East Sussex Healthcare NHS Trust, Eastbourne; R Veasey – East Sussex Healthcare NHS Trust, Eastbourne*

**Introduction:** The life expectancy of the general population has increased over the past few decades. This has led to a more elderly population and more frail patients requiring pacemaker implantation. It may be perceived by physicians, relatives and patients that pacemaker implantation in this cohort may be too invasive or have a higher complication rate. Data and outcomes of pacemaker implantation in nonagenarians are scarce. Herein, we report the outcomes of pacemaker implantation in a large number of nonagenarians at our institution.

**Methods:** We identified patients over 90 years of age who underwent initial pacemaker implantation between September 2017 and December 2021 at East Sussex Healthcare NHS Trust. All notes were retrospectively reviewed. The primary clinical endpoint was total mortality. The secondary endpoints included procedural characteristics and safety.

**Results:** A total of 100 patients were included. The average age was  $93.50 \pm 2.43$ . 57% of patients were female. Patients were followed up for an average of  $611.58 \pm 413.60$  days. Overall, 82% of the implants were performed as an inpatient emergency; 69% of implants were due to AV nodal block, 19% due to sinus node dysfunction and 12% of implants were for rate control of atrial fibrillation. Axillary vein access was used in 62% of implants while cephalic vein and subclavian vein access were used in 35% and 3% of implants, respectively. The mortality rate during the follow-up period was 59%; 5% of patients died within 1 month of implant and 22% died within 1 year of pacemaker implantation (*Figure 1*). The complication rate was 4%. These included two pneumothoraces, one lead displacement requiring repositioning and one infected pacemaker requiring extraction.

Figure 1

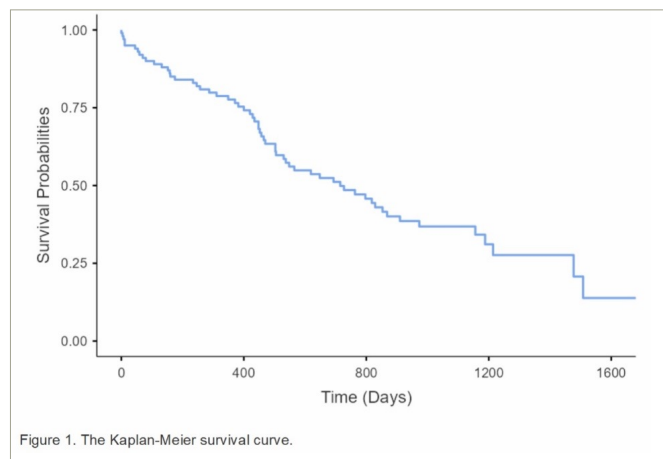


Figure 1. The Kaplan-Meier survival curve.

**Conclusion:** The major complication rate in our cohort of patients was 4%. Although not insignificant, the complication rate is comparable to previous studies and registry data with younger cohorts. However, the majority of patients died within 2 years of pacemaker implantation. This is an important consideration when discussing the merits of pacemaker implantation in this cohort of patients. □

## Oral Abstracts 3 – Devices

### 36/Optimising pacemaker therapy using multi-point pacing (the OPT-MPP Study)

Authors: *JE Lowry* – University of Leeds, Leeds; *S Straw* – University of Leeds, Leeds; *CA Cole* – University of Leeds, Leeds; *MF Paton* – University of Leeds, Leeds; *MT Kearney* – University of Leeds, Leeds; *KK Witte* – University of Leeds, Leeds; *J Gierula (Presenting Author)* – University of Leeds, Leeds

**Background:** Heart failure with reduced ejection fraction (HFrEF) is characterised by an attenuation of the positive relationship between heart rate and left ventricular (LV) contractility, known as the force-frequency relationship (FFR). Optimal therapy for around 1/3 of people with HFrEF includes a resynchronisation (CRT) cardiac implantable electronic device (CIED). We have previously demonstrated that programming the CIED to maintain the heart rate within a range for optimal cardiac contractility is associated with improved exercise capacity. Multi-point pacing (MPP) has been proposed as a method of improving CRT. Whilst MPP allows the opportunity to pace the heart over a wider area, there is no consistent improvement in terms of cardiac structure and function.

**Purpose:** To explore the effect of MPP on the FFR, exercise capacity and cardiac function.

**Methods:** A double-blind, randomised, crossover study explored the acute effects of MPP on the FFR, left ventricular function and acute exercise capacity. In random order, participants underwent an FFR

assessment, and a treadmill walk test, once with MPP activated and once with standard CRT settings. The CIED was programmed back to the pre-test standard CRT settings after each treadmill test.

**Results:** A total of 23 people were recruited. We found no differences between phases in resting LV ejection fraction. There was an acute improvement in peak cardiac contractility of borderline statistical significance ( $2.37 \pm 1.3$  vs  $2.12 \pm 1.08$ ;  $p=0.05$ ), and a reduction in LV end systolic volume index ( $65.9 \pm 30.1$  mL vs  $72.7 \pm 34.5$  mL), mean difference between the groups of 11.5 mL (95% CI 1.8–11.8;  $p=0.01$ ) and LV end diastolic volume index ( $95.3 \pm 38.1$  mL vs  $102 \pm 40.8$  mL; mean difference between the groups 6.7 mL [95% CL 0.26–13.1;  $p=0.04$ ]). These acute improvements in cardiac function and volume did not lead to an improvement in treadmill walk time in the entire cohort.

**Conclusion:** MPP acutely improves peak cardiac contractility and induces reverse remodelling. However, this did not lead to an improvement in treadmill walk time. □

**Oral Abstracts 3 – Mapping and Ablation**

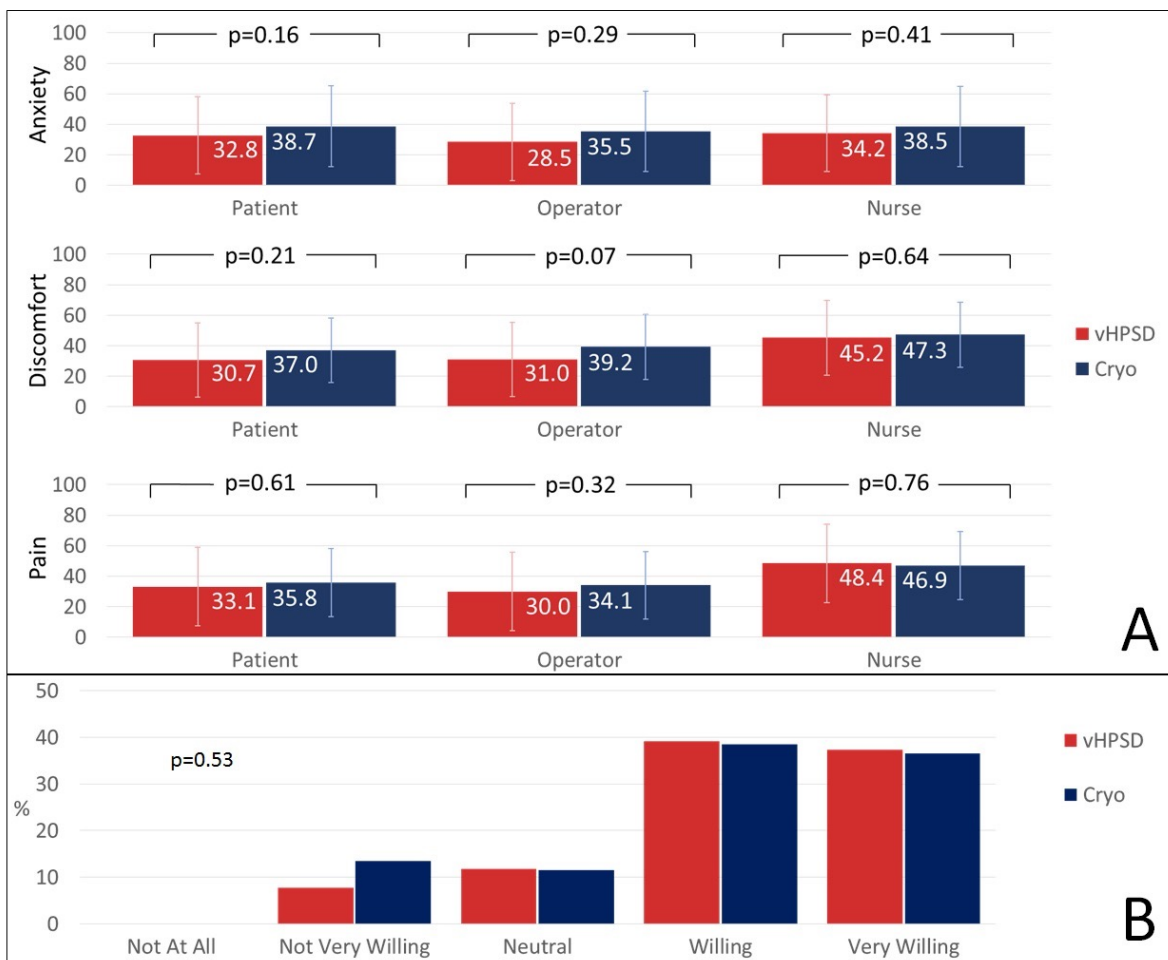
**37/Patient experience of very high-power short-duration radiofrequency ablation for atrial fibrillation under mild conscious sedation**

Authors: *GS Chu (Presenting Author) – Lancashire Cardiac Centre, Blackpool; P Calvert – Liverpool Heart and Chest Hospital, Liverpool; B Sidhu – University of Leicester, Leicester; A Mavilakandy – University of Leicester, Leicester; A Kotb – University of Leicester, Leicester; L Tovmassian – Liverpool Heart and Chest Hospital, Liverpool; N Kozuharov – Liverpool Heart and Chest Hospital, Liverpool; C Bierné – Liverpool Heart and Chest Hospital, Liverpool; N Denham – Liverpool Heart and Chest Hospital, Liverpool; C Plus – Liverpool Heart and Chest Hospital, Liverpool; J O’Brien – Liverpool Heart and Chest Hospital, Liverpool; WY Ding – Liverpool Heart and Chest Hospital, Liverpool; V Luther – Liverpool Heart and Chest Hospital, Liverpool; R Snowden – Liverpool Heart and Chest Hospital, Liverpool; GA Ng – University of Leicester, Leicester; D Gupta – Liverpool Heart and Chest Hospital, Liverpool*

**Background:** Conventional radiofrequency (RF) ablation for atrial fibrillation (AF) can cause significant patient discomfort even under mild conscious sedation (mCS), contributing to the predominant use of cryoablation (Cryo) for pulmonary vein isolation (PVI). We hypothesized that by reducing energy delivery times, a very high-power short-duration (vHPSD) RF protocol could offer a patient experience comparable to Cryo.

**Method:** Two UK tertiary cardiac centres prospectively recruited consecutive patients undergoing first-time AF ablation under mCS using intravenous paracetamol, fentanyl or morphine, and midazolam, using either vHPSD (90W lesions delivered for up to 4 seconds) or Cryo. For vHPSD, left and right wide antral circumferential ablation was performed with contact force sensing using Q Mode Plus and the

Figure 1



A: Patient-reporting of procedural anxiety, discomfort and pain during AF ablation using vHPSD or Cryo

B: Patient responses to the question: "If you knew you would have the same experience as you had this time, how willing would you be to have the same operation again? "



**Table 1: Very high-power short duration vHPSD vs cryoablation for pulmonary vein isolation under mild conscious sedation**

	vHPSD (N=51)	Cryo (N=52)	p value
<b>Patient procedure metrics</b>			
Age, years	59.6 ± 11.3	57.5 ± 10.5	0.32
Female, n (%)	14 (27%)	16 (31%)	0.71
Body mass index (kg/m <sup>2</sup> )	28.1 ± 3.8	29.6 ± 4.7	0.07
Paroxysmal AF, n (%)	38 (75%)	36 (69%)	0.55
Moderate or severe LA dilatation, n (%)	16 (31%)	13 (25%)	0.47
PVI achieved in all PVs, n (%)	48 (94%)	47 (90%)	0.72
Ablation time for PVI (min)	6.4 ± 2.9	17.9 ± 5.7	<0.001
Patients with ablation beyond PVI, n (%)	17 (33%)	1 (1.9%)	<0.001
Fluoroscopy time (min)	7.8 ± 6.7	19.8 ± 7.3	<0.001
Procedure duration (min)	121 ± 39	95 ± 20	<0.001
Same-day discharge, n (%)	31 (61%)	35 (67%)	0.49
<b>Intraprocedural medication</b>			
Fentanyl (µg)	158 ± 49	131 ± 60	0.02
Paracetamol, n (%)	41 (80.4%)	52 (100%)	<0.001
Midazolam (mg)	2.0 ± 2.2	1.9 ± 1.6	0.84

QDot Micro catheter (Biosense Webster). In the Cryo group, Arctic Front Advance Pro (Medtronic) or Polar X (Boston Scientific) catheters were used to deliver lesions for up to 4 minutes at a time. PVI was confirmed

at procedure end. All patients were asked to complete standardized questionnaires between 4–24 hours post-ablation, using Likert and visual analogue scales (VAS) to assess the anxiety, discomfort and pain that they had experienced. Operators and nursing staff also completed similar questionnaires immediately after each procedure to record their assessment of the patient’s intraprocedural status.

**Results:** A total of 103 patients were included (51 vHPSD, 52 Cryo). Their procedural metrics and intraprocedural medications are summarized in *Table 1*. Rates of successful PVI were similar, with vHPSD having lower ablation duration to achieve PVI (6.4 ± 2.9 min vs 17.9 ± 5.7 min; p<0.001) and lower fluoroscopy time (7.8 ± 6.7 min vs 19.8 ± 7.3 min; p<0.001) compared with Cryo. Overall procedure duration was greater for vHPSD (121 ± 39 min vs 95 ± 20 min; p<0.001), which was unchanged after excluding cases with non-PV ablation (110 ± 35 min vs 95 ± 20 min; p=0.024). Patient experience was comparable for vHPSD and Cryo (*Figure 1A*). Nurse VAS estimations of discomfort and pain were greater than the patients’ own scores (discomfort: p=0.02 for vHPSD, p=0.03 for Cryo; pain: p=0.007 for vHPSD, p=0.013 for Cryo). Patient willingness to have the same experience for a repeat ablation did not differ between groups (*Figure 1B*).

**Conclusion:** The patient experience of vHPSD RF ablation for AF under mCS was comparable to Cryo. vHPSD ablation was associated with reduced overall ablation times and reduced fluoroscopy exposure, and similar rates of same-day discharge. Nurses make a crucial contribution to patients’ experience through greater sensitivity to their intraprocedural needs. □

## Oral Abstracts 3 – Mapping and Ablation

### 38/Integration of structural and functional data in VT ablation

Authors: *F Bangash (Presenting Author) – Anglia Ruskin University, Chelmsford; J Collinson – Basildon and Thurrock University Hospital, Basildon; J Dzungu – Basildon and Thurrock University Hospital, Basildon; S Gedela – Basildon and Thurrock University Hospital, Basildon; M Westwood – Barts Heart Centre, London; C Manisty – Barts Heart Centre, London; D Farwell – Basildon and Thurrock University Hospital, Basildon; S Tan – Barts Heart Centre, London; H Savage – Basildon and Thurrock University Hospital, Basildon; K Vlachos – Onassis Cardiac Surgery Centre, Athens; R Schilling – Barts Heart Centre, London; R Hunter – Barts Heart Centre, London; N Srinivasan – Anglia Ruskin University, Chelmsford*

**Background:** We have previously developed the sense protocol functional substrate mapping technique for ventricular tachycardia (VT) ablation. However, functional substrate characterization can involve protracted mapping time.

**Purpose:** We incorporated the integration of magnetic resonance imaging (MRI) data using ADAS-3D software into the mapping workflow to integrate structural mapping information into the functional mapping substrate characterization in order to improve procedural efficiency.

**Method:** Cardiac MRIs were performed in 30 patients with ischaemic-related VT and VT therapy in the previous 6 months. These were processed with the ADAS-3D software to characterize the extent of ventricular scars and also ADAS corridors, which may correlate with VT channels. Focused substrate maps were then performed in patients, guided by the extent of ADAS scar and corridors, looking at the scar substrate in intrinsic rhythm and then functional channels using single extra pacing from the RV at 20 ms above ERP (SENSE2 Protocol). Specifically, healthy areas 2 cm beyond the scar border zone based on ADAS were not mapped in order to reduce substrate mapping time, and complete geometries were not created. Following delineation of functional channels, pace-mapping and entrainment mapping were used to confirm targets for ablation. The ADAS 3D MRI was integrated into the VT substrate map on Ensite-Precision with alignment to the aorta, RV and PA (Figure 1a,b). We compared our data with previous functional mapping data without the integration of MRI.

**Results:** Thirty patients (age 70 years; 20 male subjects) underwent ablation. Mean EF was 28%. The median procedure time was 161 minutes compared with 246 minutes (in our previous study  $p < 0.001$ ) (Figure 2a). The mean substrate mapping time was 32 min vs 63 min ( $p < 0.001$ ) (Figure 2b). The mean ablation time was 22 min vs 32 min ( $p = 0.11$ ). Overall, 85% of patients (17 of 20) were free from symptomatic VT/anti-tachycardia pacing or implantable cardioverter-defibrillator shocks at a median follow-up of 171 days. The mean VT burden was reduced from 22 events per patient in the 6 months pre-ablation to 1 event per patient in the median follow-up period of 171 days post-ablation ( $p = 0.02$ ). Mean shocks per-patient burden decreased from 3.5 to 0.08 in the same time period ( $p = 0.03$ ).

**Conclusion:** The SENSE2 protocol involves the integration of structural and functional data into the VT workflow for substrate characterization. It enables focused substrate maps to be performed without the need for complete geometry to be created in large ventricles. Outcomes compare favourably with our previous data but with significantly shorter procedure times. This streamlined workflow has the potential to improve care in VT ablation by shortening procedure times with similar outcomes, which may reduce risks for the patient. □

Figures 1 and 2

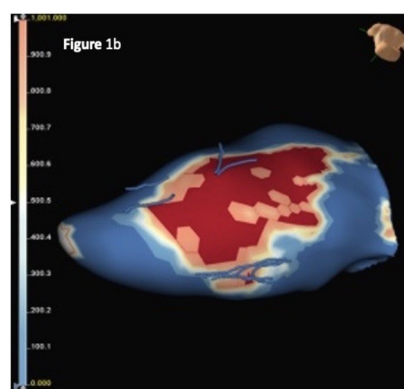
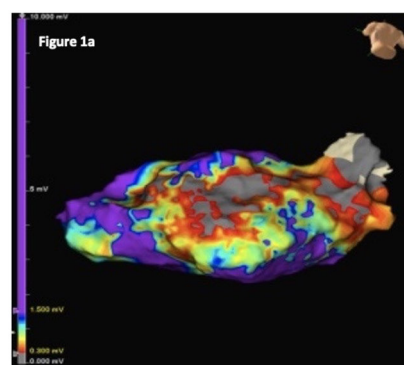


Figure 2a: Median procedure times

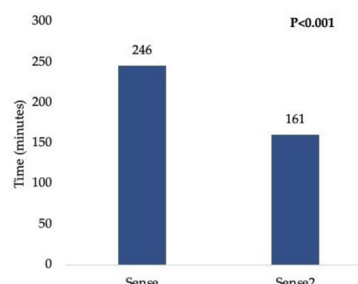
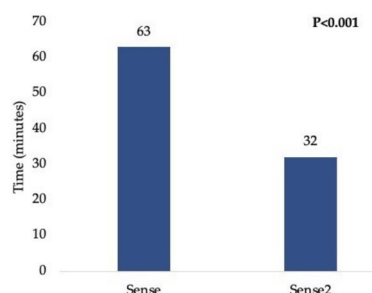


Figure 2b: Mean substrate mapping time



## Oral Abstracts 3 – Mapping and Ablation

### 39/Electroanatomical mapping improves procedural outcomes of cryoballoon pulmonary vein isolation (The Achieve Plus Study)

Authors: *Y De Greef (Presenting Author) – ZNA Heart Center, Antwerp, Grimbergen; M Tijskens – ZNA Heart Center, Antwerp; JP Abugattas de Torres – ULB Erasmus Hospital, Brussels; D Sofianos – ZNA Heart Center, Antwerp; K De Schouwer – OLV Hospital Alost, Alost; J De Cocker – ZNA Heart Center, Antwerp; I Buysschaert – Heart Centre AZ Sint Jan, Bruges; V Varnavas – University Hospital Saint-Luc UCL, Brussels; M Wolf – ZNA Heart Centre, Antwerp*

**Background:** Validation of pulmonary vein (PV) isolation (PVI) using only the Achieve catheter following cryoballoon ablation (CBA) is imperfect since pulmonary vein potentials (PVP) can be recorded in only 50–85% of the veins and residual PVP are found in up to 4.3–7.6% of the veins in remapping studies.

**Aims:** To study whether addition of electroanatomical mapping to Achieve catheter-guided CBA: (1) is superior for PVI and (2) correctly identifies low voltage areas (LVAs).

**Methods:** A total of 100 patients were randomized between Achieve catheter-guided CBA (Control group, N=50) and Achieve catheter-guided CBA with additional EnSite voltage maps performed pre- and post-CBA (Achieve Plus group, N=50). Confirmation of PVI and LVAs was done by circular mapping catheter (CMC) and EnSite mapping by a second blinded operator.

**Results:** Despite apparent PVI in all PVs after CBA, incomplete PVI was present in 0 out of 50 patients (0%) and 0 out of 204 PVs in the Achieve Plus group versus 6 patients out of 50 (12%;  $p=0.012$ ) and 6 out of 203 PVs (3%;  $p=0.013$ ) in the Control group. All 6 non-isolated PVs could be successfully isolated by additional cryo-applications. Procedure time was longer in the Achieve Plus group ( $75.76 \pm 21.65$  min vs  $66.06 \pm 16.83$  min;  $p=0.014$ ) with equal fluoroscopy times ( $14.85 \pm 6.41$  min vs  $14.33 \pm 8.55$ ;  $p=0.732$ ). All LVAs identified by Achieve/EnSite mapping in 14 patients were confirmed by CMC/EnSite voltage maps.

**Conclusion:** The addition of electroanatomical EnSite mapping to the Achieve catheter improves the PVI rate of CBA, correctly identifies LVAs and could be considered for future use. □

Oral Abstracts 3 – Mapping and Ablation

40/Electro-architectural differences between septal and non-septal post-infarct ventricular scars identified using ripple mapping

Authors: P Calvert (Presenting Author) – Liverpool Heart & Chest Hospital, Liverpool; D Khanra – Liverpool Heart & Chest Hospital, Liverpool; S Hughes – Liverpool Heart & Chest Hospital, Liverpool; J Waktare – Liverpool Heart & Chest Hospital, Liverpool; S Modi – Liverpool Heart & Chest Hospital, Liverpool; M Hall – Liverpool Heart & Chest Hospital, Liverpool; D Todd – Liverpool Heart & Chest Hospital, Liverpool; S Mahida – Liverpool Heart & Chest Hospital, Liverpool; D Gupta – Liverpool Heart & Chest Hospital, Liverpool; V Luther – Liverpool Heart & Chest Hospital, Liverpool

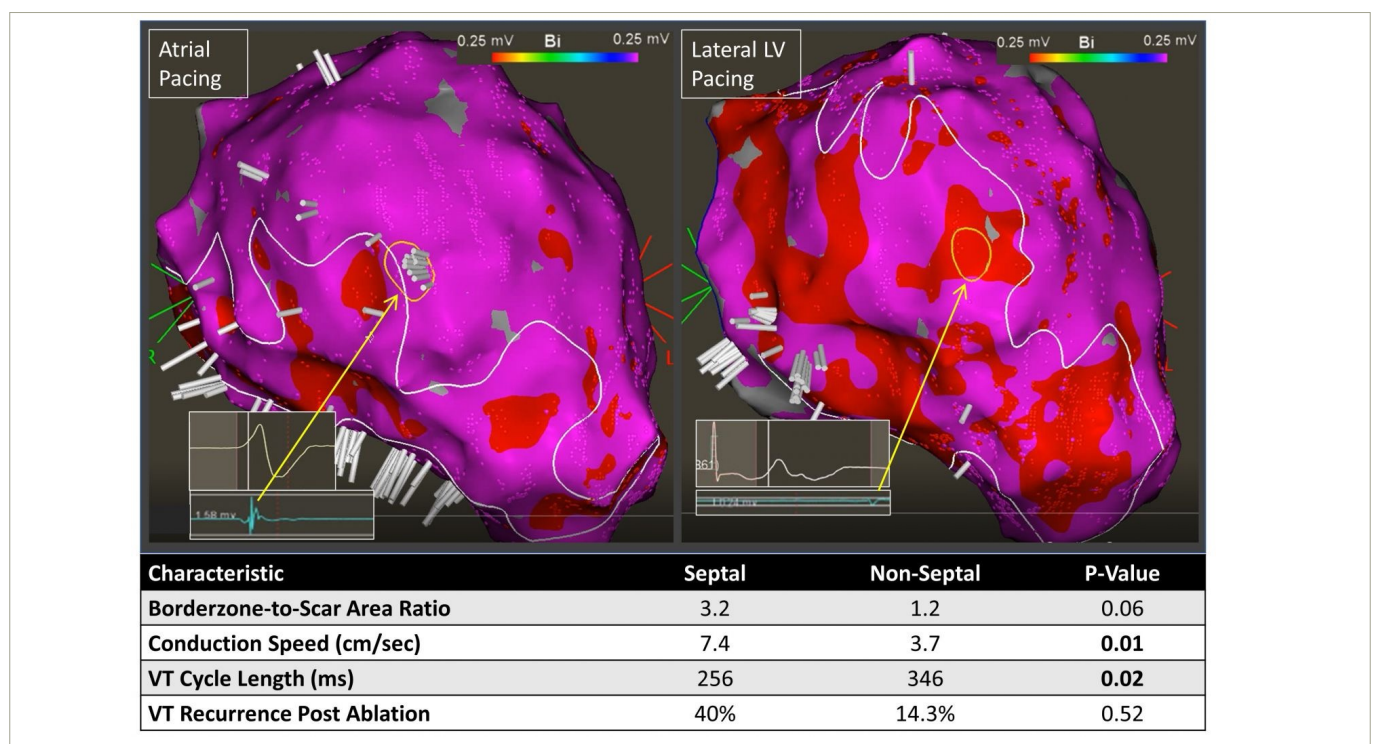
**Background:** Post-infarct septal scars are unique in their potential association with the native conduction system, but the influence of this relationship during ventricular tachycardia (VT) ablation has yet to be studied. High-density 3D mapping has offered new insights into the post-infarct ventricular electro-architecture. CARTO Ripple Maps (Biosense Webster) display myocardial activation as moving bars that can be superimposed on a 3D bipolar voltage map. We present a method using Ripple Mapping for delineating true non-conducting scar from low-voltage conducting borderzone tissue to describe observed electro-architectural differences between septal and non-septal scars.

**Methods:** Post-infarct VT ablations undertaken using Ripple Mapping in 12 consecutive patients (LVEF  $31 \pm 7\%$ ; median 5226 points) were studied. Substrate maps were collected with a Pentaray catheter with colour threshold between 3 and 5 in areas of low voltage <0.5 mV. We retrospectively analysed these cases and determined true non-conducting scar by sequentially reducing the voltage cut-off until no Ripple activation was seen within low-voltage areas. Regions with Ripple activation below the traditional 0.5 mV threshold were defined as conducting borderzone. We calculated the area of borderzone and scar in each case. We also calculated borderzone conduction speed by sampling two points of Ripple activation and utilising the time-caliper function to calculate distance over time. VT cycle lengths were also recorded. We then compared these characteristics between septal vs non-septal scars.

**Results:** Left ventricular (LV) scar was identified in all patients and was septal in 5 and non-septal in 7. Conducting borderzone tissue appeared more prevalent in septal vs non-septal scars (median borderzone-to-scar area ratio 3.2 vs 1.2;  $p=0.06$ ). Borderzone conduction speed during atrial pacing was faster in septal scars (mean 7.4 cm/s vs 3.7 cm/s;  $p=0.01$ ) and septal VTs were faster than non-septal VTs (mean cycle length 256 ms vs 346 ms;  $p=0.02$ ). At 6-month follow-up, VT recurrence was more common in septal vs non-septal scar, but not to statistical significance, possibly due to low patient numbers (40.0% vs 14.3%;  $p=0.52$ ). *Figure 1* illustrates a septal scar from a patient with prior septal infarct and rapid VTs (cycle length 230 ms). Left: The LV substrate was mapped during atrial pacing. A white design line outlines the boundary of tissue <0.5 mV. Borderzone conducting tissue using Ripple Mapping was observed down to a threshold of 0.25 mV. Septal scar collocated within the vicinity of the native conduction system and appeared patchy and heterogeneous on the bipolar voltage map. A yellow circle highlights high-voltage activation 'breakout' possibly from a limb of surviving conduction tract. Right: A remap pacing from the basal lateral LV demonstrated lower voltages along the septum (yellow circle) perhaps as the conduction system is bypassed.

**Conclusion:** Septal scars have unique electro-architectural appearances on bipolar voltage mapping, likely due to their proximity to the nearby native conduction system. Potential interaction with surviving limbs of the conduction system may explain the observed increased borderzone conduction speed and shorter VT cycle lengths. This may result in potentially more challenging ablation. □

Figure 1



## Oral Abstracts 3 – Mapping and Ablation

### 41/A local impedance-based comparison of IntellaNav MiFi and Stablepoint catheters

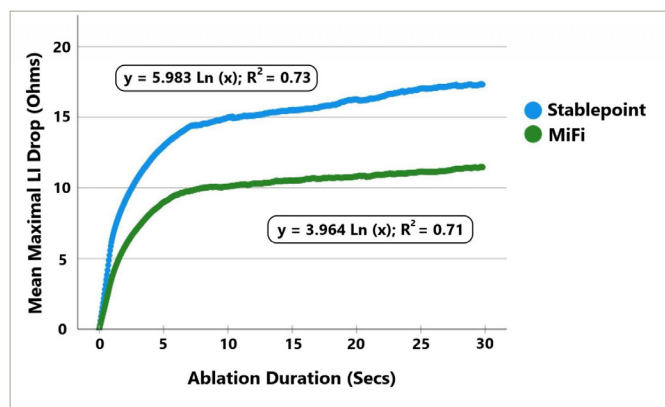
Authors: *AP Bates (Presenting Author) – Cardiology Department, University Hospital Southampton, Southampton; JR Paisey – Cardiology Department, University Hospital Southampton, Southampton; AM Yue – Cardiology Department, University Hospital Southampton, Southampton; P Banks – Cardiology Department, University Hospital Southampton, Southampton; PR Roberts – Cardiology Department, University Hospital Southampton, Southampton; W Ullah – Cardiology Department, University Hospital Southampton, Southampton*

**Background:** Local impedance (LI) drop is a novel parameter that correlates with ablation lesion size in preclinical studies. Values for LI drop that establish effective pulmonary vein isolation were established in the LOCALIZE trial using the IntellaNav MiFi catheter. However, a new contact force sensing catheter (IntellaNav Stablepoint [SP]) has recently come to market and is likely to supplant the MiFi catheter. Effective clinical values for LI drop for the SP catheter are not established. Objective: To compare the biophysical response of the MiFi and SP catheters during atrial fibrillation (AF) ablation; to establish a conversion factor for LI drop between catheters.

**Methods:** Patients undergoing AF ablation were recruited. Radiofrequency ablation occurred at sites across both left and right atria and always included pulmonary vein isolation. Ablation settings (power, duration, contact force [SP only]) were determined by the operator. LI was measured throughout each ablation and exported for further analysis. LI was sampled at 20 Hz and the filtered value generated by the Rhythmia system used for analysis. LI drop was calculated as the difference between the measured LI and that at the start of ablation. The relationship between LI drop and ablation duration for both catheters was mathematically modelled and compared. In addition, to establish a time frame whereby ablation resulted in no further biophysical changes as a surrogate for ablation completion, the beginning of the plateau of the LI drop–duration relationship was sought. This was assessed qualitatively through review of a scatterplot of ablation duration vs the mean LI drop at each 0.05 second increment.

**Results:** A total of 40 patients were recruited (MiFi 20, SP 20; male 21/40; age  $66.7 \pm 8.8$  years; paroxysmal AF 10, persistent AF 8, chronic persistent AF 22; procedure length  $235 \pm 48$  min; ablation time  $31.1 \pm 15.8$  min). Overall, 3,435 ablations (MiFi 1,730, SP 1,705) were performed generating 14,110,291 individual LI datapoints. Pre-ablation bipolar voltage and ablation duration were comparable between the catheters (MiFi vs SP:  $1.49 \pm 2.02$  mV vs  $1.12 \pm 1.48$  mV;  $21.8 \pm 11.7$  s vs  $19.7 \pm 11.2$  s). Ablation power used was either 30 W (4.5%), 40 W (48.4%) or 50 W (47.1%). There was a significant difference in the maximal LI drop with

Figure 1: The mean local impedance drop for Stablepoint and MiFi catheters. Equations are curves of best fit to the raw data and associated R2



ablation between catheters (MiFi  $13.4 \pm 7.1 \Omega$ ; SP  $18.4 \pm 8.3 \Omega$ ;  $p < 0.0005$ ). LI drop correlated strongly with ablation duration (repeated measures correlation: MiFi 0.63, SP 0.66). Both catheters showed a logarithmic relationship between LI drop (y) and ablation duration (x) (Figure 1), with a calculated conversion factor of LI drop from MiFi to SP of 1.5. Following conversion of the MiFi data, the plateau of the duration–LI drop relationship began to plateau at 10 s and 15  $\Omega$ , but notably LI drop continued to increase through to 30 s.

**Conclusions:** There was a significant difference in the LI drop between SP and MiFi catheters. This could be converted by multiplying MiFi LI values by 1.5. This information could be used to extrapolate results of the LOCALIZE study to give target values using the SP catheter of 25  $\Omega$  on the anterior/roof segments and 21  $\Omega$  for the posterior/inferior segments. Biophysical analysis suggests on average, the majority of ablation lesion development occurs in the first 10 seconds but continues through to 30 seconds. □



### Oral Abstracts 3 – Mapping and Ablation

#### 42/RETRO-map: A novel algorithm to map persistent atrial fibrillation shows a reduction in wavefront collision following circumferential pulmonary vein isolation

Authors: I Kanella (Presenting Author) – Imperial College London, London; C Coyle – Hammersmith Hospital, London; I Mann – Hammersmith Hospital, London; E Lim – Hammersmith Hospital, London; M Fudge – Hammersmith Hospital, London; N Qureshi – Hammersmith Hospital, London; M Koa-Wing – Hammersmith Hospital, London; Z Whinnett – Hammersmith Hospital, London; P Boon Lim – Hammersmith Hospital, London; F Siong Ng – Hammersmith Hospital, London; NS Peters – Hammersmith Hospital, London; DP Francis – Hammersmith Hospital, London; N Linton – Hammersmith Hospital, London; P Kanagaratnam – Hammersmith Hospital, London

**Background:** Determining the mechanisms driving atrial fibrillation (AF) during clinical procedures remains challenging. RETRO-map enables the analysis of intracardiac electrograms (EGM) to display activation maps during AF. We used RETRO-map to study the impact of circumferential pulmonary vein ablation (CPVA) on activation patterns in persistent AF.

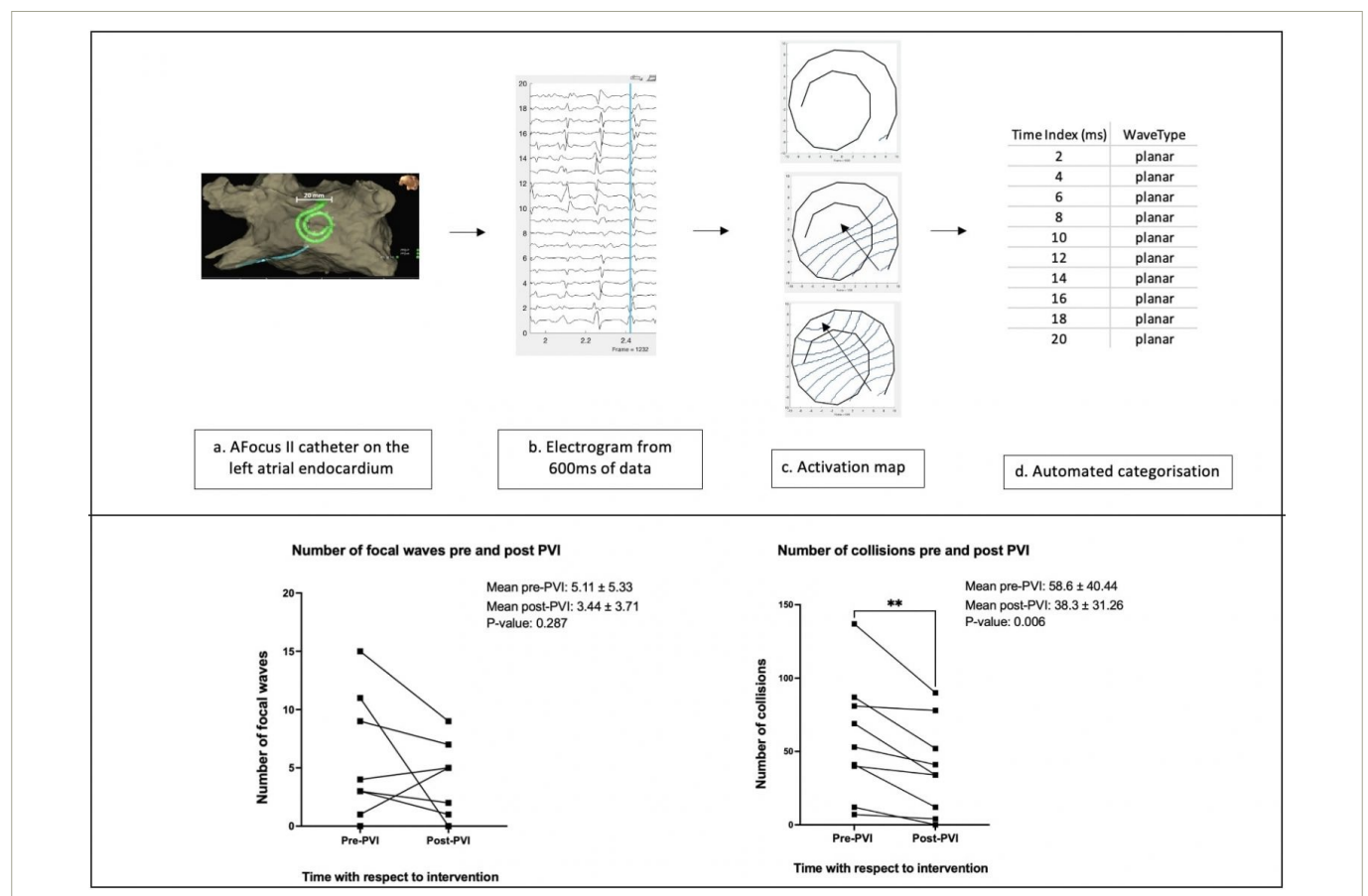
**Methods:** Patients undergoing CPVA for persistent AF using the Precision™ 3D navigation system were recruited. An AFocusII catheter was positioned on the left atrial endocardium and 30 s of AF was recorded at multiple sites prior to CPVA. Following CPVA, this was repeated at the same locations. The data were exported to a custom-written MatLab program and analysed. The RETRO-mapping algorithm produced continuous activation maps and screened 2 ms time windows for evidence of focal activation, planar waves and wavefront collisions. These automated categorisations were manually validated and compared between pre/post CPVA using a standard T-test.

**Results:** Ten patients with a mean age of  $61.3 \pm 12.1$  years (80% male) were recruited. The mean duration of persistent AF was 23 (9–51) months and the mean left atrial diameter was  $45.0 \pm 4.7$  mm. Overall, 115 data segments were recorded from 61 different locations in these

10 patients. Using 3 s of data from each segment, 53 focal waves, 652 planar waves and 168 collisions were identified and manually validated. RETRO-map was highly effective at identifying focal waves and collisions, achieving 100% correlation with manual validation within the 2 ms time windows. For planar waves, the RETRO-map planar categorisation had to occur in 12 consecutive time windows ( $\geq 24$  ms duration) to achieve an 80.3% correlation with manual validation. Comparing pre- and post-PVI recordings, the mean number of collisions significantly reduced ( $21.3 \times 10^{-6}$  collisions/mm<sup>2</sup>/s/patient pre-PVI to  $13.9 \times 10^{-6}$  collisions/mm<sup>2</sup>/s/patient post-PVI;  $p=0.006$ ). PVI decreased the number of focal activations ( $1.86 \times 10^{-6}$  focals/mm<sup>2</sup>/s/patient pre-PVI to  $1.17 \times 10^{-6}$  focals/mm<sup>2</sup>/s/patient post-PVI;  $p=0.287$ ), and it had no effect on the manually validated planar waves ( $16.0 \times 10^{-6}$  planars/mm<sup>2</sup>/s/patient pre-PVI vs  $16.1 \times 10^{-6}$  planars/mm<sup>2</sup>/s/patient post-PVI).

**Conclusion:** RETRO-mapping showed that circumferential pulmonary vein ablation caused a reduction in wavefront collision. With larger series and additional ablation sets, RETRO-mapping may be able to determine the mechanisms maintaining AF. □

Figure 1



## Moderated Posters 1

### 43/Immediate inpatient implantable loop recorder implantation for the detection of atrial fibrillation in cryptogenic stroke

Authors: *J Hunt (Presenting Author) – East Sussex Healthcare NHS Trust, Eastbourne; R Dulai – East Sussex Healthcare NHS Trust, Eastbourne; RA Veasey – East Sussex Healthcare NHS Trust, Eastbourne; C Biyanwila – East Sussex Healthcare NHS Trust, Eastbourne; B Zemanova – East Sussex Healthcare NHS Trust, Eastbourne; N Patel – East Sussex Healthcare NHS Trust, Eastbourne*

**Introduction:** Undetected atrial fibrillation (AF) is suspected as the main cause of stroke in the majority of patients presenting with cryptogenic stroke (CS). Implantable loop recorders (ILRs) are indicated for the detection of AF in these patients. This allows for continuous monitoring for up to 3 years; however, nationally there is a delay in the implantation of ILRs as these procedures are generally performed as an outpatient. Herein, we describe a novel inpatient pathway for the implantation of ILRs in CS. We describe the AF detection rate acutely in the first month and beyond. Second, we compare the safety of nurse-led vs physician-led ILR implantation in these patients.

**Methods:** This was a retrospective review of all patients who underwent inpatient ILR implantation (Medtronic Linq) between May 2020 and May 2022 at East Sussex Healthcare NHS trust. All patients underwent diagnostic testing including echocardiogram, carotid Doppler imaging and Holter monitoring before ILR implantation to rule out other causes of stroke. All patients were remotely monitored via the FOCUSONTM monitoring and triage service.

**Results:** A total of 186 patients were included in the study and were followed up for a mean period of  $363.0 \pm 222.6$  days. The average age was  $68.7 \pm 10.8$ , and 118 (63.4%) patients were male. The mean time between stroke and ILR was  $7.0 \pm 5.5$  days. The mean time between referral and ILR was  $1.0 \pm 2.0$  days. AF was detected in 25 (13.4%) patients. During the first 30 days of monitoring AF was detected in 9 (5.35%) patients.

A total of 107 (57.5%) implants were performed by a specialist nurse. There was no significant difference in the major complication rate (requiring device removal) between nurse- and physician-led implant (1 [0.95%] vs 0 [0%];  $p=0.389$ ).

**Conclusion:** Inpatient ILR for cryptogenic stroke was feasible. The rate of AF detection in the first month post CS was 5.35%; however, more AF was detected up to 1 year post implant suggesting rationale for proceeding directly to ILR implant in these patients before discharge in order to not delay treatment. A nurse-led service was also viable with no significant difference in the major complication rate compared with physician-led implants. □

Moderated Posters 1

44/First worldwide report of CT/TOE fusion tool to guide electrophysiology procedures

Authors: G Suna (Presenting Author) – Royal Papworth Hospital, Cambridge; J Weir-McCall – Royal Papworth Hospital, Cambridge; L D’Errico – Royal Papworth Hospital, Cambridge; C Densem – Royal Papworth Hospital, Cambridge; M Garbi – Royal Papworth Hospital, Cambridge; CA Martin – Royal Papworth Hospital, Cambridge

**Introduction:** Image integration has been used to good effect in electrophysiological (EP) procedures to aid in understanding the cardiac anatomy especially in complex cases. A computed tomography (CT) fusion tool has recently been developed (GE Healthcare Systems, Chicago, Illinois, USA). This new technology enables co-alignment of CT images with real-time 4D trans-oesophageal (TOE) images to allow for extended field-of-view over conventional echocardiography images for a better understanding of cardiac anatomy and tissue characterization. These features may potentially enable procedures to be performed in a more confident and safe manner. This technology has been trialed for use in structural cardiology cases, but its use in EP has not hitherto been described. We report the first worldwide use of the technology to guide transseptal puncture and locate the course of the coronary sinus (CS).

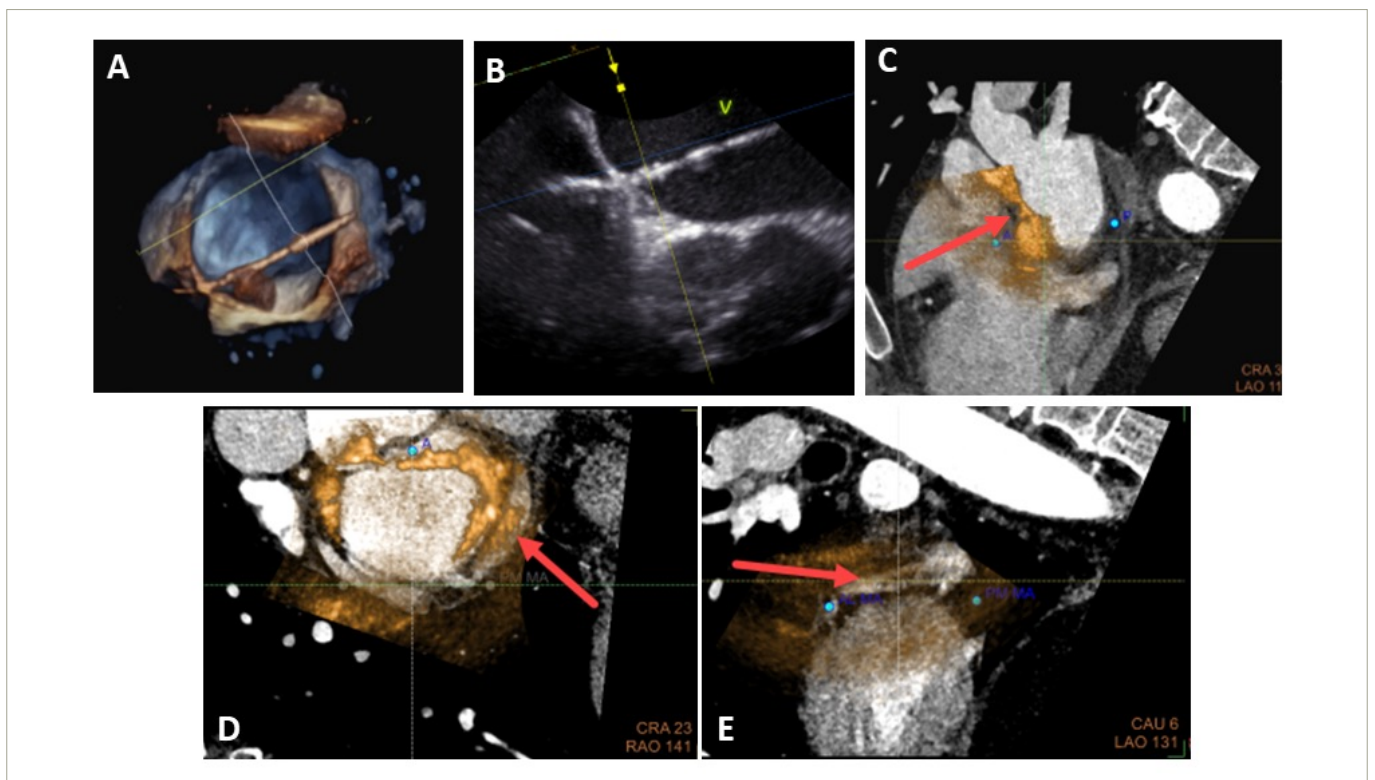
**Methods:** A 63-year-old man with ischemic heart disease and persistent atrial fibrillation (AF) and previous cryoballoon pulmonary vein isolation was listed for a redo ablation procedure including Vein of Marshall (VoM) ethanol ablation. Due to difficult transseptal puncture at his previous procedure we opted for a TOE-guided transseptal puncture with CT fusion. Cardiac CT images were acquired pre-procedure according to standard protocols. The images were pre-procedurally uploaded to the echo scanner and CT alignment was performed using anatomic markers.

The images were fused with the live 4D echo images and used to guide the procedure.

**Results:** CT images revealed the presence of two conventional left-sided and three right-sided pulmonary veins. There was no left atrial appendage thrombus. The interatrial septum was found to be thickened (“double-barrel” septum) inferiorly. CT fusion images were used to locate the thinner part of the septum and angulate the needle and sheath more posteriorly with successful transseptal puncture using a SL1 sheath and BRK1 needle at first attempt (Figure 1A–C) The origin and course of the CS were located on the aligned CT images pre-procedurally. CT fusion was used to guide CS intubation with a steerable sheath and LIMA guide catheter (Figure D,E). A guidewire was then used to locate the ostium of the VoM branching more distally from the CS, and VoM ethanol ablation was performed as previously reported.

**Conclusion:** This is the first reported application of CT/TOE fusion to guide EP procedures, demonstrating its added value for procedural support and patient safety in complex cases. CT fusion is a valuable multimodality imaging tool in preprocedural planning and procedure guiding, and has the potential to aid with difficult cardiac anatomy, for example in patients with adult congenital heart disease. We intend to build a prospective registry of such cases. □

Figure 1: A: 3D TOE image of needle in fossa ovalis; B: Same view in 2D TOE; C: Subsequently fused CT image in a different plane with arrow indicating the thinner part of the septum; D,E: Wire in CS as seen with CT fusion in different projections



## Moderated Posters 1

### 45/Drug-related atrioventricular conductive disorders – a predictive-oriented approach

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**Introduction:** Adverse drug reactions (ADRs) are responsible for 6% of annual hospitalizations and 2% of deaths, representing a significant burden on the healthcare system. Cardiovascular drugs are responsible for most ADRs, among which bradyarrhythmias are frequent outcomes. Recent studies suggest that in most cases of drug-associated atrioventricular (AV) conduction disorders, a subclinical dysfunction of the conductive tissue may be involved. Identifying risk factors and developing a predictive model for bradyarrhythmias associated with bradycardic drugs would represent a valuable tool for clinical practice.

**Material and methods:** We conducted a retrospective cohort study on 686 patients with a primary diagnosis of symptomatic bradyarrhythmia admitted to a single tertiary referral center. The patients were divided into two groups based on bradycardic treatment: under medication (n=343, divided as follows: beta-blockers 55% of cases, digoxin 21%, amiodarone 15%, propafenone, calcium channel blockers, sotalol and ivabradine – less than 10% of cases), and without any type of bradycardic medication (n=343). We analyzed demographics, clinical and paraclinical parameters related to the identified AV conduction disorder. A multivariate regression analysis was performed to explore factors associated with medication use. Statistical analysis was performed using STATA 16 SE and SPSS statistics software.

**Results:** The average age was approximately equal in the two groups (73.69 ± 8.82 vs. 74.0 ± 8.97), with a predominance of female patients (p=0.001). Patients on bradycardic medication were associated with slow atrial fibrillation (p=0.001), sick sinus syndrome (p=0.917), sinus bradycardia (p=0.009), and sinus pauses (p=0.001), while third-degree AV block was more commonly found in the second group (p=0.001). Patients in the first group had higher mean systolic blood pressure values (p=0.007), but lower mean heart rate values (p=0.001). Medication use was associated with renal dysfunction (p=0.001), syncope (p=0.011), heart failure (p=0.010), severe left ventricular dysfunction (p=0.001),

**Table 1: Predictive model for drug-related AV conduction disorders**

Item	Score
Age over 75 years	1 point
Female	1 point
Urban environment	1 point
Presence of any among diabetes mellitus, acute renal dysfunction, chronic kidney disease, moderate/severe pulmonary hypertension, arterial hypertension, mitral annular calcification, aortic stenosis	1 point
Heart rate ≥60 beats per minute	1 point
Increased values of sodium, potassium, calcium	1 point
Beta-blocker treatment	1 point
<b>TOTAL</b>	1–5 = Low risk 6–10 = Moderate risk ≥11 = High risk

pulmonary hypertension (p<0.001), atrial dilatation (p=0.001), and the need for temporary cardiac pacing (p=0.022). Bradycardic drugs were associated with higher serum levels of potassium, (p=0.017), creatinine (p=0.044), and glucose (p=0.014), while patients in the second group had higher serum levels of sodium (p=0.001). Based on the multivariate regression analysis results, we developed a predictive model (Table 1) for the association of medication and AV conduction disorders (1 point each parameter, risk categories: low, moderate and high – AUC value 0.631, p=0.001).

**Conclusions:** AV conduction disorders associated with bradycardic drugs are a public health issue. Validation of a clinical model to predict which patients are at risk of developing such disorders can improve patient management. □

## Moderated Posters 1

### 46/Transvenous lead extraction: a single-centre experience of the Tandem procedure

Authors: *MM Gallagher (Presenting Author) – St George's University Hospital, London; Z Akhtar – St George's University Hospital, London; LWM Leung – St George's University Hospital, London; M Sohal – St George's University Hospital, London*

**Background:** Transvenous lead extraction (TLE) is integral to the management of patients with cardiac implantable electronic devices (CIEDs). There are notable procedural risks; however, development of techniques has contributed to an improvement in safety. The mechanical rotational dissecting sheath is safe and efficacious whilst the Needle's Eye Snare (NES) is an additional 'bail-out' strategy. We compared the conventional TLE technique with the 'Tandem' procedure.

**Methods:** The 'Tandem' procedure consisted of extraction with the rotational powered sheath from the superior access, in combination with the NES providing countertraction on the lead via the femoral vein. Thirty-seven consecutive 'Tandem' procedures (73 targeted leads) performed between 1/12/2021–1/1/2022 in our high-volume TLE institute were matched with 37 conventional TLE procedures (72 leads) (control) using

propensity 1:1 score matching. The patients were matched for age, BMI, gender and LVEF.

**Results:** Compared with the control, the Tandem group had a significantly longer lead dwell time ( $96 \pm 67$  months vs  $147.3 \pm 74$  months;  $p < 0.05$ ), requiring a shorter procedure duration ( $136 \pm 64$  minutes vs  $94 \pm 38$  minutes;  $p < 0.02$ ), with more fluoroscopy ( $9.7 \pm 8.5$  minutes vs  $18.6 \pm 11.9$  minutes;  $p < 0.01$ ). Clinical success was similar between the control and Tandem groups (97% vs 100%;  $p = 0.4$ ) as was complete success (per lead) (95% vs 92%;  $p = 0.7$ ), with a comparable major (5% vs 0%;  $p = 0.4$ ) and minor (0% vs 3%;  $p = 0.57$ ) complication rate; there was no difference in 30-day mortality (3% vs 0%;  $p = 0.4$ ).

**Conclusion:** The 'Tandem' procedure provides an additional strategy to improve the safety and efficacy of TLE, especially in leads of a long dwell time. □



Moderated Posters 1

47/Omnipolar Electrograms are more consistent and improve substrate characterisation in Human Atrial Flutter

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**Background:** The limitations of bipolar electrograms (EGM) due to catheter orientation are well described. Omnipolar electrograms may be able to accurately identify substrate characteristics as they are not affected by directionality.

**Objectives:** To investigate the difference in voltage maps between omnipolar and bipolar electrograms in human atrial flutter.

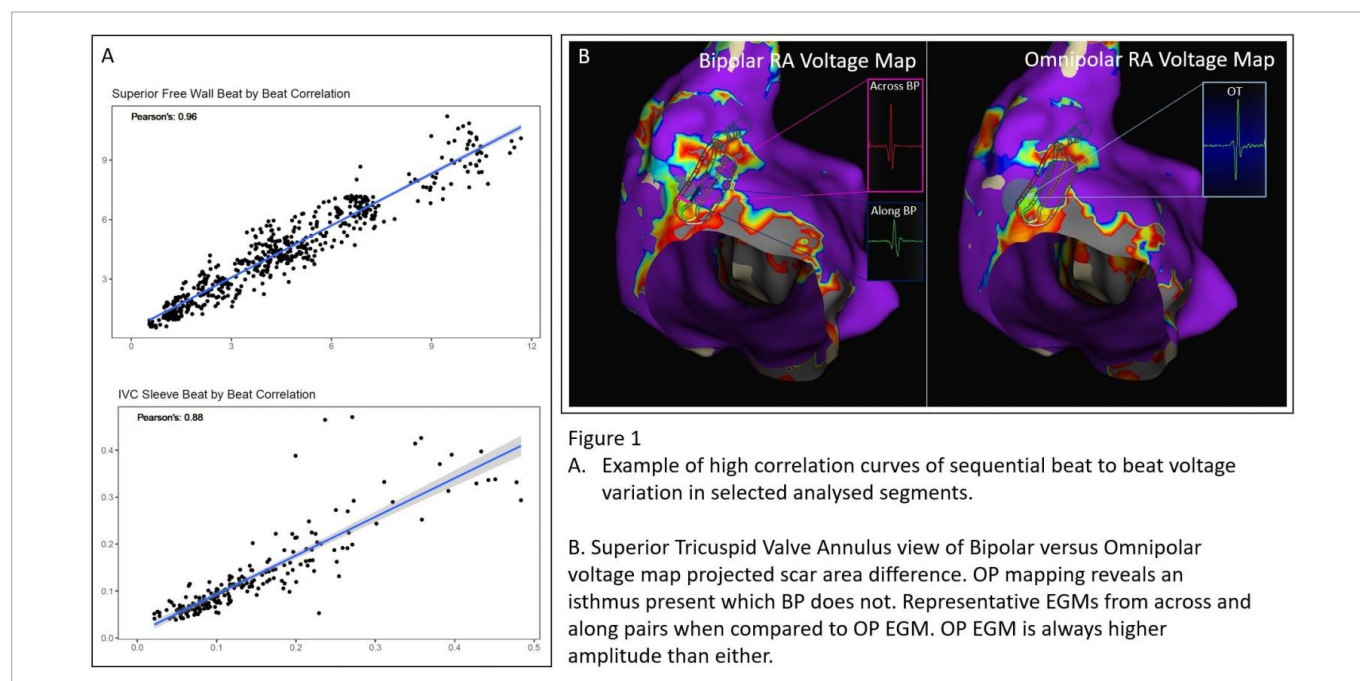
**Methods:** We recruited 15 patients with typical (clockwise or counterclockwise) persistent atrial flutter (AFL). All patients had bipolar (BP) voltage maps created during their clinical procedure. Omnipolar (OP) maps were derived from bipolar EGMs. Voltage maps were created using the traditional thresholds for scar and healthy tissue (dense scar <0.1 mV, 0.1–0.5 mV for scar border and >0.5 mV for healthy tissue).

The 10-second segments of AFL were recorded in different areas within the RA. The HD Grid was held flat against the myocardial surface model and only points within 5 mm from the geometry were used for this analysis. Each recorded segment was analysed after a steady state of at least 8 atrial beats. We created beat-to-beat correlation curves for

each segment and only highly correlating (Pearson’s  $r > 0.7$ ) segments were used for this analysis to ensure good contact and reproducibility (Figure 1A). OP and the maximum recorded BP voltage on either the vertical or horizontal direction (across or along the HD Grid electrodes) were compared in terms of beat-to-beat consistency and overall voltage recorded. Full BP and OP voltage maps were also created and then compared offline using area of scar projected on the geometry RA model (interpolation 5 mm) (Figure 1B). The exported recorded segments were analysed offline with R.

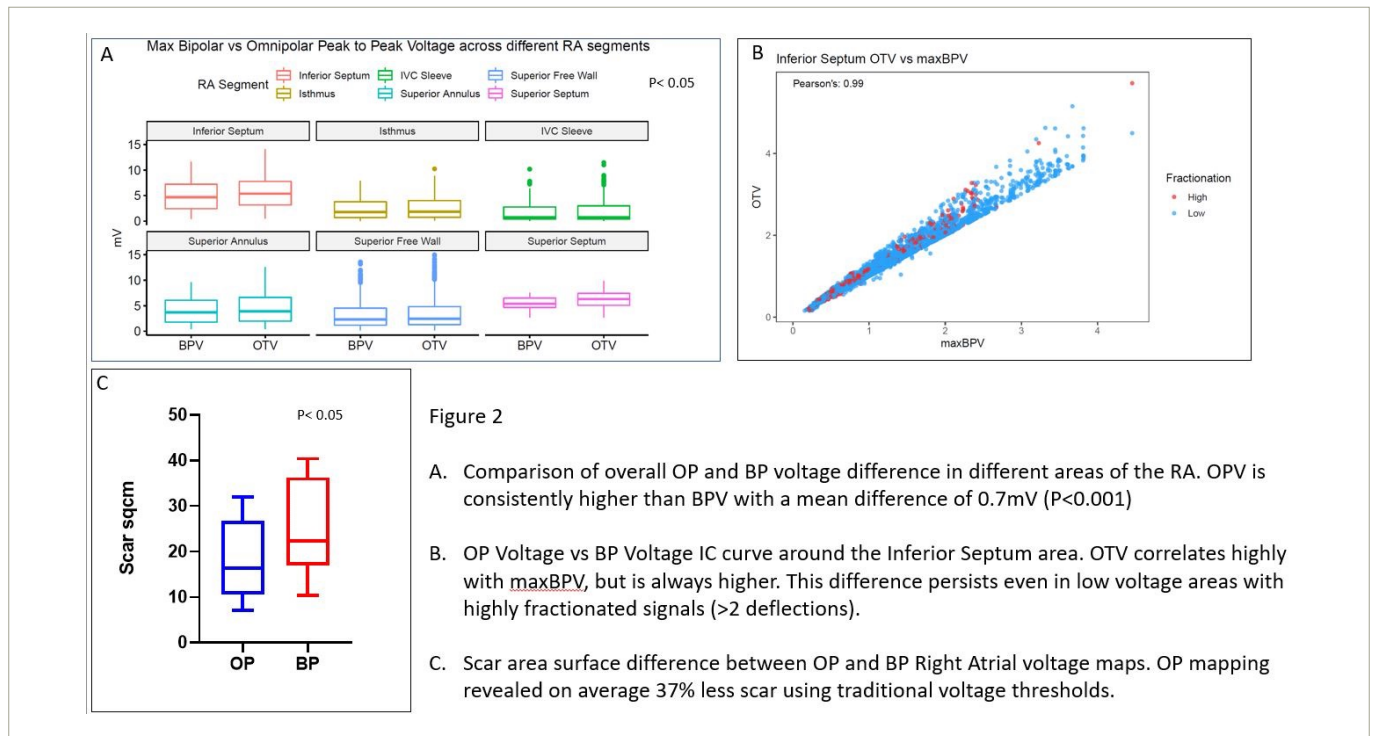
**Results:** We observed a significant difference between voltage recorded with BP and OP. In all analysed recorded segments OPV mean was 0.7 mV higher than the BPV (Figure 2A). This difference was observed along all segments of the RA and persisted in areas of low voltage at a lower magnitude. OPV highly correlated (mean Pearson’s  $r: 0.98$ ) with the maximum recorded BPV for each bipolar pair (Figure 2B) and was always higher (OPV  $2.48 \pm 2.89$  mV vs BPV  $1.78 \pm 2.25$  mV;  $p < 0.001$ ). OPV was more consistent on a beat-to-beat basis than BPV (coefficient of

Figure 1



CONTINUED

Figure 2



variation: OTV  $0.34 \pm 0.2$  vs BPV  $0.45 \pm 0.21$ ;  $p < 0.001$ ). Average OP scar area was 37% less compared with the BP scar area as projected on the surface of the RA model (interpolation 5 mm) ( $p < 0.001$ ) (Figure 2C).

**Discussion:** The ability of OP EGM to always record maximum voltage in a given location irrespective of direction increases the sensitivity of detecting healthy tissue, especially in low-voltage border zones of scar.

Beat-by-beat consistency in EGM recorded increases confidence in the fidelity of the voltage maps created. OP mapping has the potential to improve detection of scar border zones, which may serve as isthmuses for arrhythmia maintenance and therefore improve ablation accuracy and outcomes. □

Moderated Posters 1

48/Application of the MADIT ICD Benefit Score to a tertiary UK centre primary prevention population

Authors: *N Jathanna* (Presenting Author) – Nottingham University Hospitals NHS Trust, Nottingham; *R Oliver* – Nottingham University Hospitals NHS Trust, Nottingham; *S Jamil-Copley* – Nottingham University Hospitals NHS Trust, Nottingham

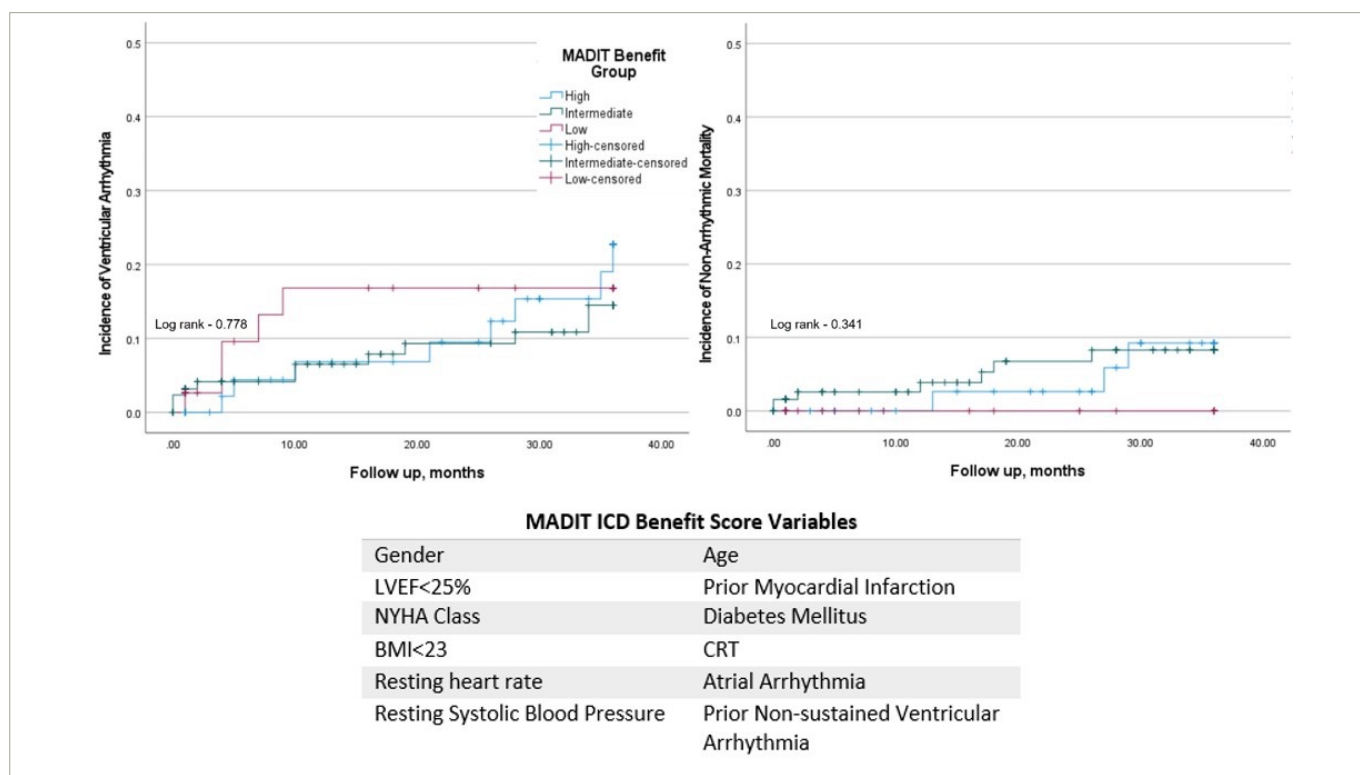
**Introduction:** Guidelines recommend the implantation of primary prevention defibrillators (pICD) in patients with a left ventricular ejection fraction (LVEF) of <35% due to the associated higher risk of ventricular arrhythmias (VA) in this cohort. However, reported incidence of VA in this cohort is only 5–10%/year with many deaths occurring prior to VA events and up to 2/3 of patients receiving no appropriate intervention over the lifetime of the device. *Post hoc* analysis of 4 prospective MADIT trials (4,531 patients, 2002–2012) developed a predictive model containing 12 unique variables to assist in patient stratification according to benefit obtained from pICD over a 3-year period. Outcomes predicted included identifying those at the greatest risk of VA or non-arrhythmic mortality without prior arrhythmia (NAM). This was validated on data from the RAID trial (2011-15). We assessed the performance of the MADIT ICD Benefit score on a ‘real-world’ cohort and correlation of the predictive value of each variable.

**Methods:** We undertook an observational study applying the MADIT ICD Benefit score to consecutive new pICD and cardiac resynchronization therapy defibrillator (CRT-D) implants of ischaemic and non-ischaemic aetiology and LVEF <35% between 2014 and 2019 at a single UK tertiary centre. The primary outcome was first VA or all-cause mortality without prior ventricular arrhythmia (NAM). VA was defined as any treated VA, any sustained VA that was monitored only or ventricular fibrillation. Follow-up data were gathered for a maximum 3-year follow-up period. Kaplan–Meier survival curves separated by MADIT Benefit group were compared for each event. Assessment of each score variable was undertaken with Cox proportional analysis.

**Results:** Out of 576 primary prevention implants, 228 had the requisite complete data for score calculation. Mean age was 66.3 ± 12.3 years, 78.1% were male, 61% received a CRT-D and 44.7% had an LVEF <25%. Aetiologies were ischaemic (52%) and dilated (48%) cardiomyopathy. There were 25 VA events and 10 NAM occurred over a median 25 months’ follow-up. At 3 years, there was no significant difference between high, intermediate or low benefit groups for incidence of VA (22.7%, 14.5% and 16.8%, respectively; p=0.778) or NAM (9.2%, 8.3% and 0%, respectively; p=0.341). Statistically significant predictive factors for VA were gender (HR 4.24, CI 1.01–17.76; p<0.05) and previous non-sustained VA (HR 4.18, CI 1.92–9.1; p<0.01). None of the model variables were linked with predictive factors of non-arrhythmic mortality.

**Conclusion:** The MADIT ICD Benefit score was unable to accurately stratify patients according to arrhythmic or mortality risk. Furthermore, only 4 variables were associated with VA and none with NAM. Our dataset had significant variation to the original training set including a higher proportion of non-ischaemic cardiomyopathy (48% vs 34%, respectively), higher CRT implants (61% vs 40%) and higher rates of atrial arrhythmia (30.3% vs 14%). Despite this, our data are representative of guideline adhered practice. The MADIT ICD Benefit Score was not applicable to our local data. This may be representative of the impact of advancing heart failure management and services on patients, a population change resulting in non-generalisability of a scoring system based on older studies. Additional heart failure medication data are being collected locally for assessment, but larger, multicentre studies would be required to confirm this hypothesis. □

Figure 1



Moderated Posters 1

49/Initial experience of a novel radiofrequency wire-based transeptal puncture system

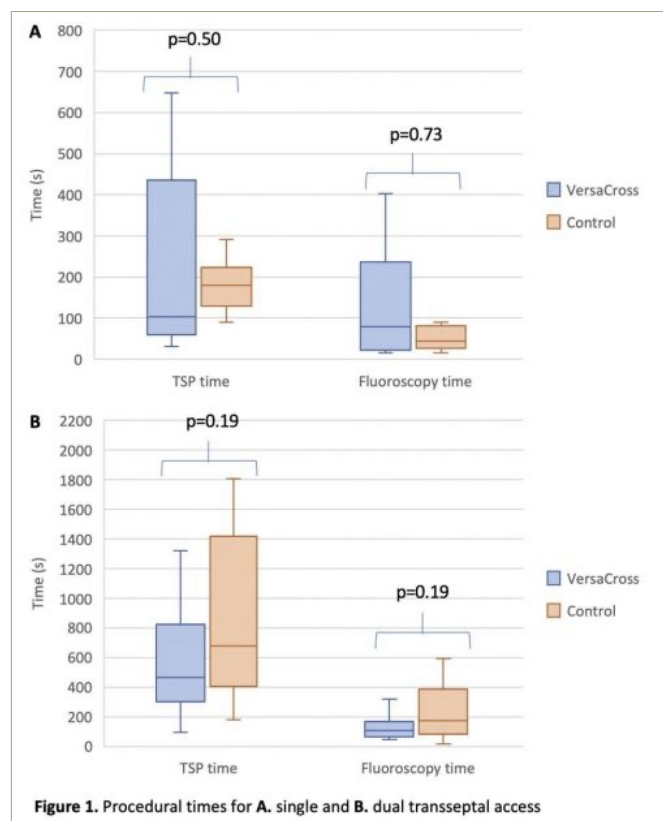
Authors: *FA Wardak (Presenting Author) – University Hospital Southampton NHS Foundation Trust, Southampton; JR Paisey – University Hospital Southampton NHS Foundation Trust, Southampton; RW Bowers – Hampshire Hospitals NHS Foundation Trust, Basingstoke; University Hospital Southampton NHS Foundation Trust, Southampton; AM Yue – University Hospital Southampton NHS Foundation Trust, Southampton; PR Roberts – University Hospital Southampton NHS Foundation Trust; School of Human Development and Health, Faculty of Medicine, University of Southampton, Southampton; W Ullah – University Hospital Southampton NHS Foundation Trust; School of Human Development and Health, Faculty of Medicine, University of Southampton, Southampton*

**Background:** Transeptal puncture is a key component of cardiac ablation and structural interventional procedures. The VersaCross RF transeptal puncture (TSP) platform (Baylis Medical) is a novel system comprising a blunt radiofrequency (RF) wire rather than a needle, passed through a malleable sheath/dilator. The wire forms a pigtail on deployment and is firm enough to exchange over. This study details the first experience of the use of this novel technology in Europe, and the first worldwide without echocardiographic guidance.

**Methods:** Consecutive patients undergoing TSP were included in the VersaCross group followed by a control group using standard equipment. All 5 operators used the VersaCross system in 2–3 cases prior to data inclusion in the study. Interventions were performed under general anaesthetic or sedation, with transoesophageal echo (TOE) used in a subset to guide the puncture. TSP and fluoroscopy times were prospectively recorded from the point when the drop down from the superior vena cava (SVC) was started until the VersaCross sheath was passed into the left atrium (LA). For double transeptal access, the latter was taken as the time the second separate transeptal puncture was completed or, based on the operator’s preference, a second sheath had been passed into the LA through the initial puncture. Also recorded were the number of drop downs from the SVC and number of RF applications or needle deployments on the septum. Immediate and post-discharge complications were recorded.

**Results:** The VersaCross (n=50) and control (n=25) groups had a mean age of  $61.9 \pm 11.1$  years vs  $64.2 \pm 11.3$  years; 54% vs 68% male; BMI of  $29.1 \pm 5.3$  vs  $29.3 \pm 5.1$ ; 34 vs 28% with prior TSP procedures; 98 vs 100% on anticoagulation; 10 vs 16% with pacemakers; and 38 vs 40% under TOE guidance ( $p > 0.05$  for all). Ablations for AF predominated in both groups (86 vs 92%), of which approximately half were cryoablations (49% vs 56%). The remaining cases were for atrial or ventricular tachycardia. For both single or dual transeptal access, there was no correlation between transeptal or fluoroscopy time and procedure number in the VersaCross group. There was no difference in transeptal or fluoroscopy time between the VersaCross and control groups ( $p > 0.05$  for all) (Figure 1). VersaCross cases needed an average of  $1.5 \pm 1$  drop downs and  $1 \pm 0.7$  RF application per TSP. For control cases this was  $1.5 \pm 0.9$  and  $1 \pm 0.6$  deployments, respectively ( $p > 0.05$  for both). In the VersaCross group, four minor complications occurred: one case of atrioventricular block lasting seconds on application of transeptal RF and three small pericardial effusions not requiring intervention. One of these was diagnosed 23 days after the procedure, and another was in a patient with

Figure 1



a temporary pacing wire placed pre-ablation. Of the three effusions, two occurred in cases performed without TOE but this was not statistically significant ( $p=0.5$ ). There was one major complication in this group of haemothorax requiring chest drain insertion. In all VersaCross cases, TSP was completed without converting to another technology, whilst two needed to be abandoned in the control group – one due to patient discomfort and another due to cardiac tamponade. There were no other complications in the control group.

**Conclusions:** The VersaCross transeptal system can be used in a variety of ablation procedures with or without echo guidance. No quantitative learning curve was evident and, compared with conventional TSP technology, no difference in TSP or fluoroscopy time. □

**Moderated Posters 1**

**50/Patients with severe systolic hypertension requiring pacemaker implantation are more likely to have preserved left ventricular systolic function: an observational study**

*Authors: DR Morgan (Presenting Author) – Lincolnshire Heart Centre, Lincoln; H Saleem – Lincolnshire Heart Centre, Lincoln; J Sharma – Lincolnshire Heart Centre, Lincoln; W Arthur – Lincoln County Hospital, Lincoln; K Lee – Lincoln County Hospital, Lincoln; K Gaughan – Lincolnshire Heart Centre, Lincoln; D Coates – Lincolnshire Heart Centre, Lincoln; J Ratcliffe – Lincolnshire Heart Centre, Lincoln; B Thornalley – Lincolnshire Heart Centre, Lincoln; E Gauci – Lincolnshire Heart Centre, Lincoln; A Majeed – Lincolnshire Heart Centre, Lincoln*

**Background:** Hypertension is associated with Mobitz II and Complete Heart Block (CHB) (JAMA Netw Open. 2019;2:e194176). Profound bradycardia such as caused by Mobitz II and CHB have also been reported to cause hypertension (Ann Pediatr Cardiol. 2020;13:248–51) albeit usually in specialist situations such as congenital CHB.

**Purpose:** We investigated the incidence of hypertension and the relationship between hypertension and left ventricular function.

**Methods:** A total of 291 patients with Mobitz II or CHB presenting to the Lincolnshire Heart Centre from Jan 2020 to Dec 2021 were assessed. All patients had routine observations prior to any procedure and echocardiogram to establish the need for conventional (single or dual chamber) pacemaker (PPM) or cardiac resynchronization device (CRT). Patients were stratified by the presence or absence of severe systolic hypertension (systolic BP >160 mmHg) at preadmission or at the time of their pacemaker implantation and LV function on echo (left ventricular ejection fraction [LVEF] of >40% and <40% in keeping with 2021 ESC guidelines.

(<https://www.escardio.org/Guidelines/Clinical-Practice-Guidelines/Cardiac-Pacing-and-Cardiac-Resynchronization-Therapy>).

**Results:** Over half of the patients presenting with Mobitz II and CHB had severe systolic hypertension (163 out of 291, 56%). A significant majority of patients had preserved or only mildly reduced LV function (260 of 291, 89%). Only 11% had evidence of reduced LVEF <40% (ref latest ESC criteria in ESC HF guidelines 2021), in whom CRT pacing would be indicated. Preserved or mildly reduced LV function (EF >40%) was associated with systolic hypertension (SBP <160) and conversely, reduced LV function (EF <40%) was associated without systolic hypertension (p<0.0148).

**Conclusions:** Patients with systolic hypertension are more likely to have preserved LV systolic function. However, in a minority of patients with impaired LV function in whom CRT pacing would be indicated, significant hypertension was less common. This may be due to the impaired LV being unable to achieve an elevated blood pressure. This observation may assist in situations where patients are taken directly from presentation to pacemaker implantation on a 24/7 basis (so-called primary pacing), where we propose that in patients with severe systolic hypertension, the likelihood of needing to perform out-of-hours (primary) CRT pacing is lower. □

**Table 1**

	LVEF ≥40%	LVEF ≤40%	Marginal Row Totals
Systolic BP ≥160	152 (145.64) [0.28]	11 (17.36) [2.33]	163
Systolic BP ≤160	108 (114.36) [0.35]	20 (13.64) [2.97]	128
Marginal Column Totals	260	31	291 (Grand Total)

Chi-square statistic is 5.9353. P value 0.014841



Moderated Posters 1

51/Assessment of optimal thresholds for ventricular scar substrate characterization

Authors: *F Bangash* (Presenting Author) – Anglia Ruskin University, Chelmsford; *J Collinson* – Basildon and Thurrock University Hospital, Basildon; *J Dungu* – Basildon and Thurrock University Hospital, Basildon; *S Gedela* – Basildon and Thurrock University Hospital, Basildon; *M Westwood* – Barts Heart Centre, London; *C Manisty* – Barts Heart Centre, London; *D Farwell* – Basildon and Thurrock University Hospital, Basildon; *S Tan* – Barts Heart Centre, London; *H Savage* – Basildon and Thurrock University Hospital, Basildon; *K Vlachos* – Onassis Cardiac Surgery Centre, Athens; *J Silberbauer* – Sussex Cardiac Centre, Brighton; *J Calvo* – Brighton and Sussex University Hospital NHS Trust, Brighton; *R Hunter* – Barts Heart Centre, London; *R Schilling* – Basildon and Thurrock University Hospital, Basildon; *N Srinivasan* – Anglia Ruskin University, Chelmsford

**Background:** Voltage thresholds for ventricular scar definition are based on historic data collected using catheters with widely spaced bipoles in the absence of contact force. Modern multipolar mapping catheters employ smaller electrodes and interelectrode spacing that theoretically allows for mapping with increased resolution and reduced far-field electrogram (EGM) component. Despite the advancement in technology, historic cut-offs of <0.5 mV for dense scar and 0.5–1.5 mV for scar borderzone continue to be used in contemporary electrophysiology.

**Purpose:** We aimed to assess the optimal voltage cut-offs for ventricular scar substrate characterization using the HD Grid multipolar mapping catheter compared with standard linear collection. Voltage cut-offs were assessed against cardiac computed tomography (CT) and magnetic resonance imaging (MRI) derived scar. We compared optimal voltage cut-offs using conventional bipolar sampling, the Best Duplicate Algorithm and with the HD wave solution plus best duplicate algorithm.

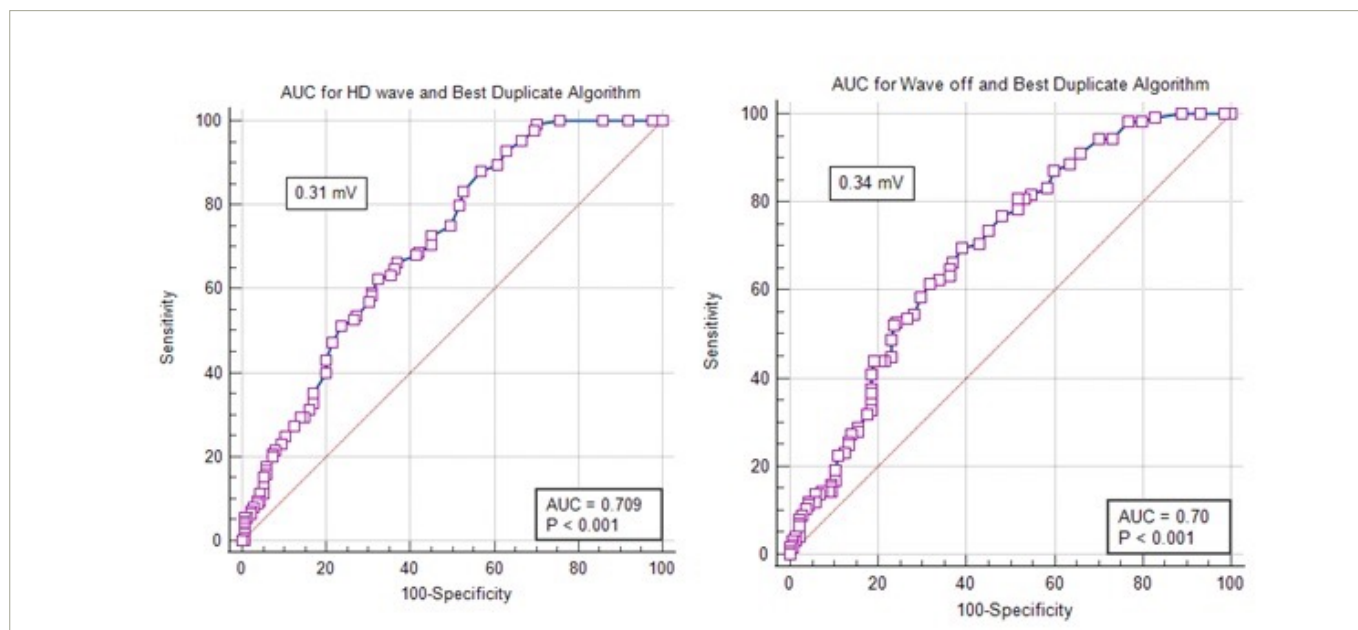
**Methods:** A multicentre study of 30 patients undergoing VT ablation was conducted. Substrate mapping was performed using the high-density HD-grid multipolar mapping catheter. Bipolar voltage maps were co-registered with cardiac MRI (CMR) or CT obtained prior to the procedure to assess the voltage characteristics of scar defined by cardiac CT/CMR. Pre-procedure contrast-enhanced imaging data were analysed using ADAS software (Galgo medical). Data points were collected in regions of scar during: (1) HD wave mapping with best duplicate algorithm on

(Waveon), (2) mapping with HD wave off and best duplicate on (Waveoff), and (3) with conventional bipolar mapping (Alloff).

**Results:** The median bipolar voltage for regions of dense CMR/CT scar using (Waveon) HD wave solution and best duplicate algorithm was 0.24 mV (IQR 0.12–0.43). The median voltage with (Waveoff) HD wave off was 0.29 mV (0.15–0.45). The median voltage with (Alloff) HD wave off and best duplicate off was 0.32 mV (0.19–0.5). ROC analysis using AUC suggested the optimal cut-off for endocardial dense scar using (Waveon) HD wave mapping and best duplicate algorithm was 0.31 mV (sensitivity 69.6%, specificity 60.74%) (Figure), (Waveoff) cut-off with the best duplicate and without the HD wave mapping was 0.34 mV (sensitivity 88.0%, specificity 42.96%), and (Alloff) without wave mapping or best duplication was 0.36 mV (sensitivity 84%, specificity 52%).

**Conclusion:** Ventricular substrate characterization with newer mapping technology using narrow electrode spacing and smaller electrode size suggests that traditional voltage cut-offs may need revision for delineation of scar characteristics. Additionally, the ability to repeat sample in a region to obtain the best signal (Best Duplicate), and the ability to obviate the effect of wavefront direction using the HD wave solution omnipolar technology, may further increase the fidelity of scar characterization. This has important implications for mapping VT and characterizing channels in order to identify VT circuits. □

Figure 1



Moderated Posters 2

**52/Acute and long-term outcome of radiofrequency ablation for outflow tract ventricular arrhythmias: impact of anatomy and high-density mapping**

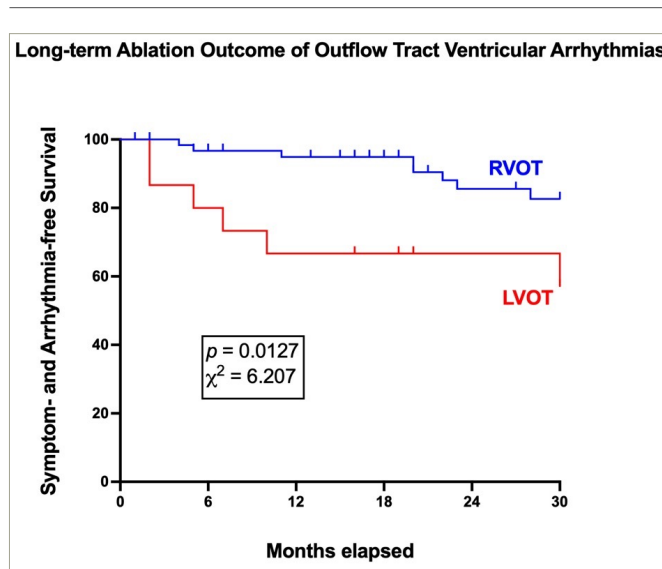
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**Introduction:** High-density (HD) mapping with multipolar catheter for ventricular arrhythmias with structural heart disease is well described. However, evidence of its efficacy in ablation of outflow tract (OT) origin premature ventricular contractions (PVC) is lacking. This study aims to: 1) compare procedural and clinical outcomes of point-by-point (PBP) mapping against HD mapping in patients undergoing OT PVC ablation; and 2) identify potential predictors for favourable outcome in patients undergoing OT PVC ablations.

**Methods:** This single-centre study enrolled consecutive patients indicated for symptomatic OT PVC ablation between April 2016 and April 2021. Patients requiring epicardial ablations were excluded. Use of HD mapping catheter was at the operator’s discretion. Pre- and post-ablation PVC burden was assessed using a 12-lead Holter monitor. Potential demographic, clinical and procedural predictors of arrhythmia-free survival were assessed. Kaplan–Meier and Cox regression analyses were performed.

**Results:** Seventy-nine patients (mean age  $49 \pm 17$  years, 39% males, left ventricular ejection fraction  $52 \pm 10\%$ ) underwent successful endocardial ablations for PVCs from right ventricular OT (RVOT, n=64) or left ventricular OT (LVOT, n=15). One patient required ablation from both RVOT and LVOT. Baseline demographics and antiarrhythmic profile did not differ between the PBP (n=56) and HD (n=23) groups. Pre-ablation PVC burden was similar between the two groups (PBP  $25 \pm 12\%$  vs HD  $27 \pm 11\%$ ; p=ns). Compared with LVOT ablations, ablation of RVOT PVCs demonstrated shorter procedure duration ( $170 \pm 67$  min vs  $212 \pm 74$  min; p=0.04) and fluoroscopy time ( $12 \pm 11$  min vs  $21 \pm 16$  min; p<0.05) but similar mapping time ( $61 \pm 29$  min vs  $70 \pm 43$  min; p=ns) and ablation time ( $443 \pm 320$  s vs  $588 \pm 615$  s; p=ns). Procedure duration, ablation time and fluoroscopy time were higher in the HD group driven by RVOT procedures. Complete PVC abolishment was achieved in 94% of cases. Intraprocedural complication rate was 3.8%, with two patients in the HD group developing heart block and one patient in PBP group developing

Figure 1



cardiac tamponade. Over a follow-up period of  $28 \pm 25$  months, the RVOT group demonstrated superior symptom- and arrhythmia-free survival compared with the LVOT group (Figure 1). Site of PVC origin was a significant predictor of symptom and arrhythmia recurrence with LVOT origin demonstrating unfavourable outcome (HR 6.9, p=0.05). Use of HD mapping catheters and presence of structural heart disease did not predict symptomatic PVC recurrence.

**Conclusion:** Catheter ablation of OT PVCs guided by HD mapping catheters was safe and noninferior to conventional PBP mapping. Long-term clinical outcome was driven by site of PVC origin. Larger, prospective data are required to assess short- and long-term benefits of HD mapping-guided ablation of OT PVCs. □

Moderated Posters 2

53/Improving understanding of lesion parametrics in high-power short-duration ablation

Authors: *G Panchal* (Presenting Author) – Glenfield hospital, Leicester; *A Mavilakandy* – Glenfield hospital, Leicester; *I Koev* – Glenfield hospital, Leicester; *A Kotb* – Glenfield hospital, Leicester; *M Ibrahim* – Glenfield hospital, Leicester; *M Lazdam* – Glenfield hospital, Leicester; *SH Chin* – Glenfield hospital, Leicester; *A Sandilands* – Glenfield hospital, Leicester; *R Somani* – Glenfield hospital, Leicester; *GA Ng* – Glenfield hospital, Leicester

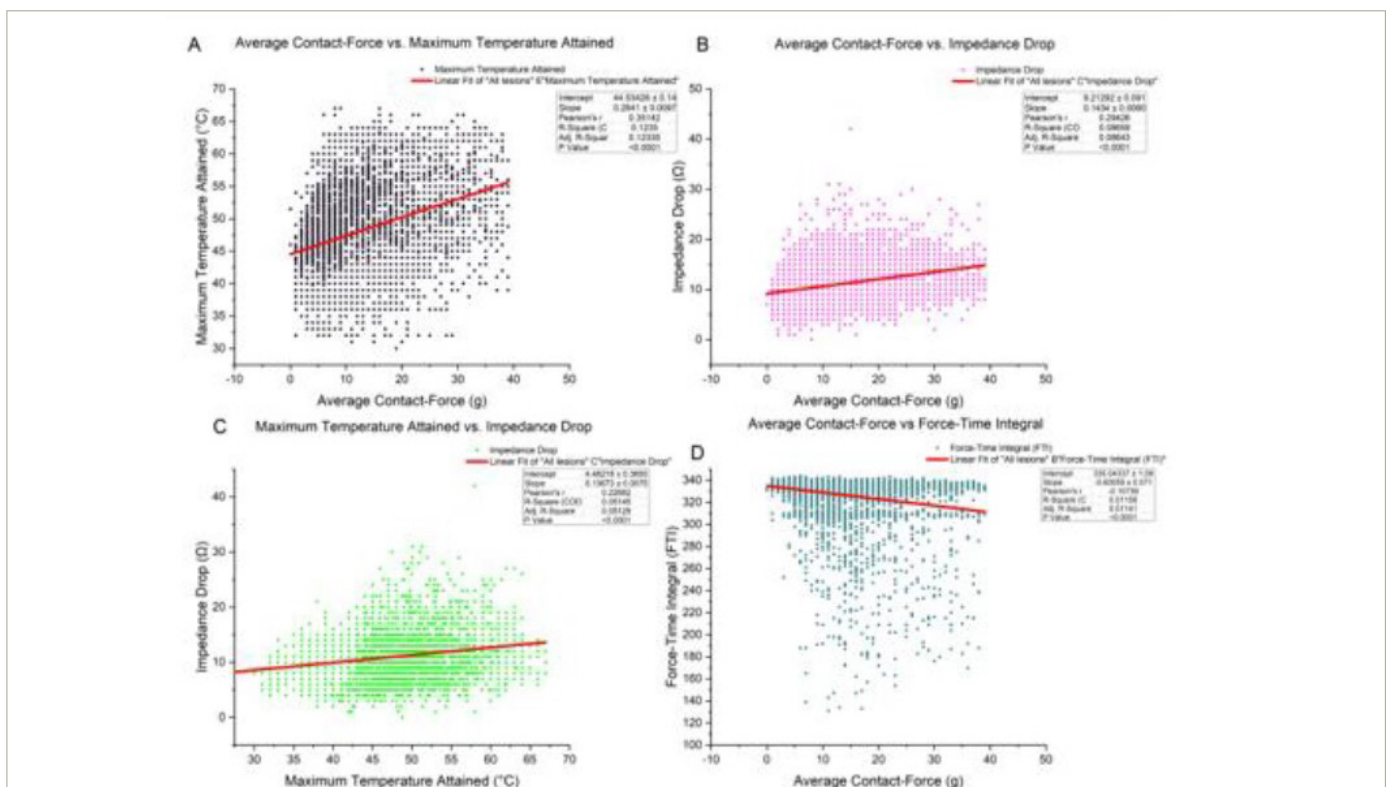
**Background:** Pulmonary vein isolation (PVI) is the gold standard management for patients with atrial fibrillation (AF) refractory to medical therapy. Contact-force (CF) sensing very-high-power short-duration (vHPSD) radiofrequency (RF) ablation (90 W/4 seconds) has emerged as a novel ablation modality. Previous RF ablation utilized Ablation Index (AI) as a surrogate marker of lesion quality to guide the operator, which is not utilized in QMODE+ (vHPSD) and thus, there is limited guidance on effective lesion formation. In this study, we investigated the correlation between certain lesion parameters to identify relationships and potential determinants for effective lesion formation. Furthermore, we studied the relationship between different anatomical locations on these parameters to gain further insight.

**Method:** A total of 60 consecutive AF patients (42 males, age 61.5 ± 9.06 years, 63% paroxysmal AF) underwent first-time PVI using QMODE+. All wide antral circumferential ablation (WACA) QMODE+ lesions (n=6040) were analysed for force-time integral (FTI), impedance drop, average CF, maximum temperature attained, and anatomical location. The anatomical regions assessed across both left and right WACA were posterior-superior (region 1-2), posterior-inferior (region 3-4), anterior-inferior (region 5-6), and anterior-superior (region 7-8), and pulmonary vein carina (region 9). All pulmonary veins (PVs) were subsequently checked with pacing manoeuvres to examine for gaps in ablation lesions and adenosine for acute pulmonary vein reconnection post-ablation.

**Results:** PVI was successful in all patients while first-pass isolation was observed in 30 patients (50%). A total of 6,040 lesions were performed, with 2,968 and 3,072 lesions in the left and right WACA, respectively. The average CF exhibited a positive correlation with maximum temperature attained and impedance drop (p<0.0001) while displaying a negative correlation with FTI (p<0.0001) (Figure 1). The PV carina (region 9) of the right WACA had the smallest impedance drop (p<0.0001) while the PV carina of the left WACA exhibited the lowest average CF and temperature attained (p<0.0001) (Figure 2). The highest number of gaps or acute reconnection (17 out of 30 patients) were seen in the region of the left pulmonary vein carina (p<0.0001).

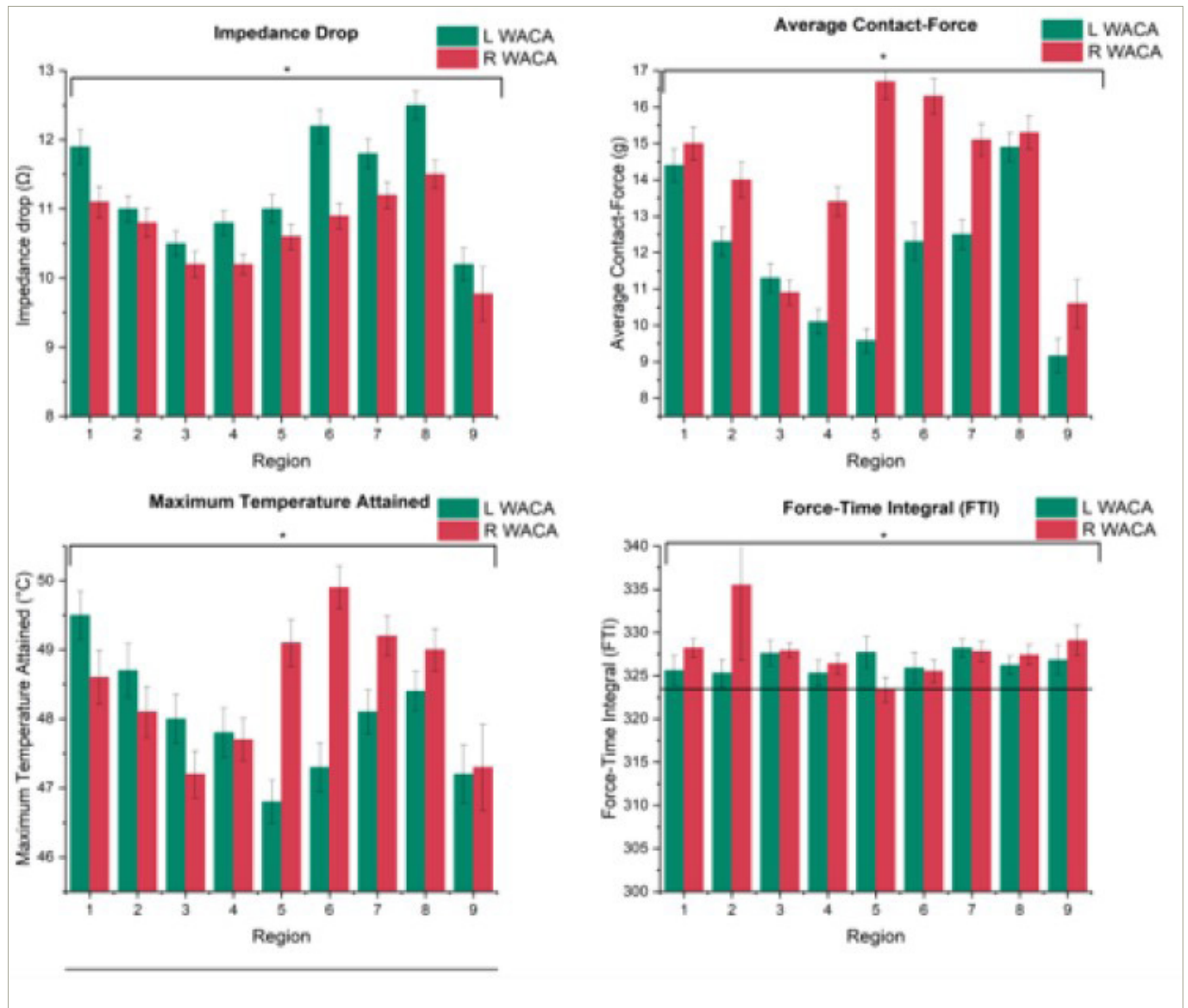
**Conclusion:** To our knowledge, this is the first study that has investigated the characteristics of vHPSD ablation lesions according to different anatomical regions in the left atrium. CF was positively correlated with maximum temperature and impedance drop but negatively correlated with FTI. This is very unique to temperature-controlled ablation to reduce complications. Furthermore, ablation at both right and left PV carina demonstrated lower impedance drop and average CF which may explain difficult catheter positioning as well as thicker tissue. This study elucidates the relationship between the anatomical region, contact force, temperature and impedance drop, and will facilitate optimization for effective vHPSD lesion formation. □

Figure 1



CONTINUED

Figure 2



Moderated Posters 2

54/Radiofrequency ablation of the diseased human left ventricle: biophysical and electrogram based analysis

Authors: AP Bates (Presenting Author) – Cardiology Department, University Hospital Southampton, Southampton; JR Paisey – Cardiology Department, University Hospital Southampton, Southampton; AM Yue – Cardiology Department, University Hospital Southampton, Southampton; P Banks – Cardiology Department, University Hospital Southampton, Southampton; PR Roberts – Cardiology Department, University Hospital Southampton, Southampton; W Ullah – Cardiology Department, University Hospital Southampton, Southampton

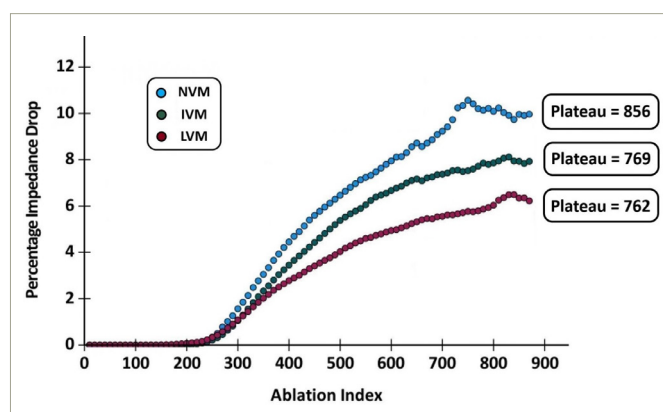
**Background:** Predictors of effective ablation lesion delivery in the human left ventricle are not established, particularly in scar. Impedance drop and electrogram (EGM) attenuation are potential surrogates to assess this.

**Objectives:** Establish the relationships between Ablation Index (AI) and Force Time Integral (FTI) with impedance drop and EGM attenuation in the human left ventricle.

**Methods:** Patients undergoing ventricular tachycardia (VT) ablation were recruited. Mapping and ablation were performed using the Pentaray catheter twinned with Carto3 and the SmartTouch Surround Flow catheter respectively. Only endocardial lesions were considered. EGMs were collected pre- and post-ablation, with impedance, AI and FTI measured during. Percentage impedance drop was used to minimise the effect of starting impedance. Based on pre-ablation bipolar voltage, myocardium was adjudged low (LVM, <0.50 mV), intermediate (IVM, 0.51–1.50 mV) and normal voltage (NVM, >1.50 mV). To establish a parameter predicting lesion completion, the point where further ablation provided little change in biophysical measurements as a surrogate for thermodynamic equilibrium was sought, this being the beginning of the plateau in the impedance drop and AI/FTI relationships. Best fit curves were applied to the datasets, formulae established and the plateau determined as an impedance drop of 0.25% over 100 gs/100 AI. To assess the predictability of AI or FTI upon percentage impedance drop, linear regression was performed from the start of ablation to the calculated plateau points, also including in the model: catheter drift, orientation and endocardial voltage category.

**Results:** A total of 402 ablations were analysed in 15 patients. Percentage impedance drop correlated with AI and FTI ( $p < 0.0005$ , Spearman's Rho 0.52 both) plateauing at 763 AI and 713 gs, an impedance drop of 7.5%. Shallower curves occurred progressively from NVM to LVM ( $p < 0.0005$ , Figure 1), alongside lower plateau points (NVM 853 AI/1007 gs at 10% drop; IVM 769 AI/761 gs at 8% drop; LVM 762 AI/540 gs at 6% drop). AI and FTI were both reasonably predictive of impedance drop (adjusted

Figure 1



R2: 0.56 and 0.46), with this relationship weakening with increased scar (adjusted R2: AI–NVM 0.59, IVM 0.52, LVM 0.49; FTI–NVM 0.53, IVM 0.45, LVM 0.35). Bipolar EGMs attenuated with ablation (median pre-ablation 0.54 mV [0.29–0.98 mV], post-ablation 0.37 mV [0.20–0.56 mV], median attenuation 29.3% [4.4%–53.3%];  $p < 0.0005$ ). Unipolar EGMs also attenuated with ablation (median pre-ablation 3.71 mV [2.36–5.40 mV], post-ablation 3.11 mV [2.09–4.65 mV], median attenuation 9.48% [3.15–23.14%]). Attenuation did not correlate with AI or FTI achieved for either bipolar or unipolar EGMs.

**Conclusions:** On biophysical analysis, an average ablation beyond AI of 763 and FTI of 713 gs offered little additional efficacy. Increasing scar blunted ablation efficacy and reduced the predictability of ablation. AI had a stronger relationship with impedance drop than FTI. EGM attenuation did not correlate with commonly used ablation parameters, suggesting it is a suboptimal surrogate for ablation lesion progression. □



## Moderated Posters 2

### 55/Invasive assessment of haemodynamic compromise and coronary blood flow during simulated VT

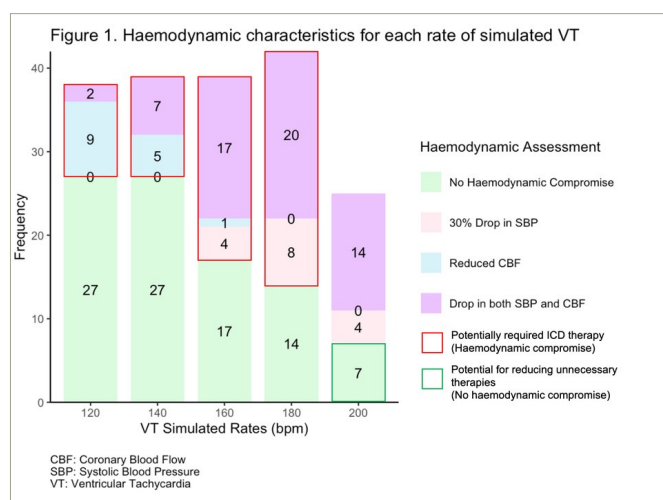
Authors: AA Miyazawa (Presenting Author) – Imperial College London, London; AD Arnold – Imperial College London, London; H Seligman – Imperial College London, London; N Ali – Imperial College London, London; S Bangi – Imperial College London, London; M Liistro – Imperial College London, London; D Keene – Imperial College London, London; MJ Shun-Shin – Imperial College London, London; R Petraco – Imperial College London, London; ZI Whinnett – Imperial College London, London

**Introduction:** Reducing unnecessary and inappropriate implantable cardioverter defibrillator (ICD) therapies reduces mortality. This was demonstrated in studies that investigated using higher rates for treatment zones and longer detection windows. ICDs currently do not utilise haemodynamic measurements to guide therapies. We have previously shown that a potentially implantable sensor can reliably identify loss of perfusion in ventricular fibrillation. It is possible that programming even longer detection windows could further reduce unnecessary shocks; however, it is not known in how many patients this may be beneficial, and the risk with adopting this approach is that appropriate shocks would be withheld for longer than necessary in the presence of reduced coronary blood flow (CBF). A disadvantage of using higher heart rate zones is that slower haemodynamically compromising VTs are left untreated. We investigated the impact of simulated VT on CBF and invasive blood pressure (BP). The aims were to determine whether detection windows could potentially be safely extended in some patients during VT and to identify what proportion of patients poorly tolerate episodes of slower VT.

**Methods:** We recruited patients undergoing a clinically indicated invasive coronary angiogram. We simulated VT by delivering right ventricular VVI pacing, via a temporary wire. Each patient underwent a randomized ventricular pacing (Vp) protocol (140, 160, 180 and 200 bpm) for a minimum of 30 seconds. During each Vp protocol, continuous 3-lead ECG, invasive beat-by-beat arterial BP and invasive CBF, using a combowire in the mid-left anterior descending artery, were recorded. Significant haemodynamic compromise was defined as a reduction in CBF and/or a sustained drop of 30% in systolic BP (SBP) compared with measurements made during baseline rhythm.

**Results:** A total of 21 patients were recruited, of whom 8 (38%) were female. The mean age was 65 years, and 5 patients (24%) had a left ventricular ejection fraction less than 35%. Data were collected during 145 simulated VT episodes (25 at 200 bpm, 42 at 180 bpm, 39 at 160 and 140 bpm, and 38 at 120 bpm). Results showed that 28% of simulated VT episodes at a rate of 200 bpm were haemodynamically tolerated. This suggests that ICD therapies could potentially be delayed for longer during these VT episodes to allow more time for VT to self-terminate. Haemodynamic compromise was observed in a proportion of slower

Figure 1



simulated VT episodes (rates that are below current guidelines for primary prevention programming). For the combined endpoint of decline in CBF and SBP, VT was not tolerated in 11 (28.9%) at 120 bpm, 12 (30.8%) at 140 bpm, 22 (56.4%) at 160 bpm and 28 (66.7%) at 180 bpm. An isolated reduction in CBF had a greater impact on haemodynamic compromise at slower rates (9 (23.7%) at 120 bpm vs 1 (2.6%) at 160 bpm), whereas faster rates were driven by sustained drops in SBP. Proportionally, more patients had haemodynamic compromise at higher heart rates compared with slower heart rates (p=0.016).

**Conclusion:** One-third of simulated VT episodes at 200 bpm were haemodynamically well tolerated. This suggests VT detection windows could potentially be safely extended, with the aim of reducing unnecessary therapies in a significant number of VT episodes. In contrast, many episodes of slower VT were poorly tolerated, implying that therapies may be beneficial. Thus, ICD programming could be further optimized with haemodynamically guided therapies compared with currently used methods, which exclusively rely on the electrogram. □

## Moderated Posters 2

### 56/Exploiting SMART Pass filter deactivation detection to minimise inappropriate subcutaneous implantable cardioverter defibrillator (S-ICD) therapies: a real-world single-centre experience and management guide

Authors: *C Monkhouse (Presenting Author) – Barts Heart Centre, London; A Wharmby – Barts Heart Centre, London; S Ahsan – Barts Heart Centre, London; M Orini – Barts Heart Centre & UCL, London; PD Lambiase – Barts Heart Centre & UCL, London*

**Introduction:** Concern persists regarding inappropriate therapy (IT) burden from the subcutaneous implantable cardioverter defibrillator (S-ICD). The SMART Pass<sup>®</sup> (SP) algorithm is a bandpass filter that aims to reduce IT. The algorithm's ability to deactivate itself in community has implications for IT that require evaluation.

**Objective:** To investigate the effect of SP deactivation, its causes and how to manage this scenario, hypothesising that SP deactivation would increase the risk of IT and re-programming, or that lead/generator repositioning could reduce the risk.

**Method:** This study was a retrospective audit of Emblem<sup>®</sup> S-ICD devices (A209 and A219) implanted from 2016 to 2020 using data from health records and remote monitoring. Cox regression models were used to study the association between SP deactivation and IT.

**Results:** A total of 348 patients with 27 ± 16.6 months' follow-up were studied. Overall, 73% of patients were implanted for primary prevention. A total of 38 patients (11.8%) patients received 83 shocks with 7.8% of patients receiving IT, totalling 44 IT, 43 of which were due to oversensing

and 1 due to aberrantly conducted atrial fibrillation. SP deactivation was significantly associated with increased risk of IT (hazard ratio 7.76, 95% CI 3.30–18.28). Deactivation was commonly due to low amplitude R-waves (94%). Effective prevention of further IT included changing the programmed sensing vector, lead repositioning, and temporary deactivation for patients with air in the sensing circuit.

**Conclusion:** SP deactivation is a significant predictor of inappropriate shocks. If the SP filter is deactivated this is likely to suggest low amplitude R waves, either periodically or continuously. To reduce the risk of IT, the cause of the automatic SP deactivation should be investigated, and sensing vector changes should be strongly considered. If the SP algorithm is unable to sustain activation, lead repositioning should be considered, akin to a transvenous right ventricular ICD lead for poor sensing. By enabling an audible or electronic communication alert for SP deactivation, the S-ICD IT rate could be significantly reduced, warranting investigation in prospective patients. □

## Moderated Posters 2

### 57/A surface evaluation of single and dual chamber ICD discriminators

Authors: *KCC Chong (Presenting Author) – Barts Trust, London; CM Monkhouse – Bart NHS Trust, London; JM Malcolmson – Barts NHS Trust, London*

**Introduction:** Ventricular tachycardia and fibrillation are both life-threatening arrhythmias. Implantable cardioverter defibrillators (ICDs) can be used to cardiovert these arrhythmias via high-voltage therapy. However, ICDs must distinguish life-threatening arrhythmias from physiological cardiac rhythms, doing so via algorithms specific to device type and manufacturer. The aim of this service evaluation was to determine rates of appropriate and inappropriate therapies (IT) delivered between single and dual chamber (SC and DC) ICDs, across a range of manufacturers with standardised settings.

**Methods:** A retrospective service evaluation was conducted at a tertiary centre. The population included all patients with SC and DC devices implanted between 1 January 2017 and 1 May 2020. Device parameters and events were assessed from remote monitoring data and electronic health records. Categorical data comparisons were made using Fisher's tests. The audit was registered with the clinical effectiveness unit (CEU).

**Results:** A total of 701 patients with SC (n=217, 31%) and DC (n=484, 69%) ICDs were included (74.1% male, mean age  $63 \pm 15.8$  years). Mean follow-up periods for SC and DC devices were both  $20 \pm 10$  months. A total of 20 (9%) SC devices delivered appropriate therapies compared with 54 (11%) DC devices. Differences in rate of IT across device type did not meet significance, occurring in 1% and 3% in SC and DC devices,

respectively (OR 0.29, 95% CI 0.07–1.20;  $p=0.08$ ). The most common cause of IT was atrial fibrillation and atrial tachycardia: 11/15 (73%) incidences in DC and 2 (100%) incidences in SC devices. Other causes of IT in DC devices were attributed to the incorrect classification of ventricular tachycardia (20%) and ventricular fibrillation. The mean follow-up across manufacturers (Boston Scientific, Medtronic, Biotronik and Abbott) was  $21 \pm 10$  months,  $23 \pm 10$  months,  $27 \pm 10$  months and  $17 \pm 10$  months, respectively. Boston Scientific accounted for the highest proportion of devices at 55%, with Abbott, Medtronic and Biotronik accounting for 25%, 16% and 4%, respectively. There were small differences in IT burden between manufacturers: Boston Scientific (3.4%), Medtronic (2.7%), Abbott (0.6%) and 0% of Biotronik devices; however, these did not meet statistical significance during pairwise comparison (all  $p>0.05$ ). A trend towards differences in IT rates between the two largest manufacturers in the cohort (Abbott and Boston Scientific OR 0.16, 95% CI 0.015–1.001;  $p=0.076$ ) may warrant further investigation during longer follow-up.

**Conclusion:** There was no difference in rate of IT between SC and DC device types, or across manufacturers. However, a trend towards differences in rate of IT between the largest manufacturers in the cohort indicates an area of potential further investigation. IT of atrial arrhythmias was the leading cause of IT. □

Moderated Posters 2

**58/Incidence and predictors of ventricular arrhythmia and mortality in a primary prevention defibrillator cohort in the era of improved heart failure and arrhythmia management**

Authors: *N Jathanna (Presenting Author) – Nottingham University Hospitals NHS Trust, Nottingham; R Oliver – Nottingham University Hospitals NHS Trust, Nottingham; S Jamil-Copley – Nottingham University Hospitals NHS Trust, Nottingham*

Primary prevention implantable cardioverter defibrillators (ICD) including those combined with cardiac resynchronisation therapy (CRT-D) are implanted primarily on the premise that reduced left ventricular ejection fraction (EF) has a higher risk of ventricular arrhythmias (VA). However, emerging data suggest that EF alone may no longer be sufficient to predict VA risk and with advances in heart failure therapies and access to specialist services, there has been a decline in the incidence of mortality in patients eligible for primary prevention devices. Multiple studies have assessed predictive risk factors but have pre-dated advances in medical and device therapies for heart failure. We assessed the incidence of VA and all-cause mortality in our locally implanted ICD/CRT-D cohort and assessed association with previously described risk factors.

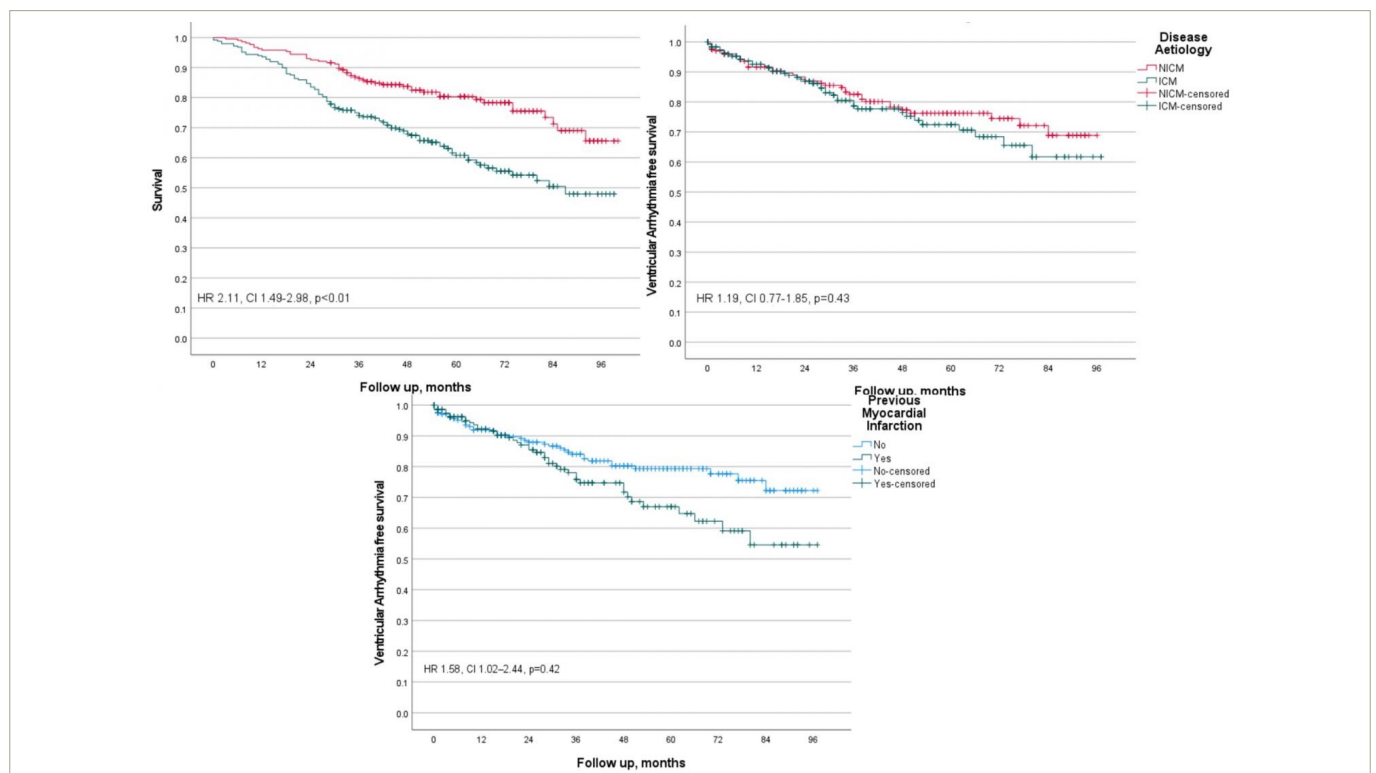
**Methods:** This was an observational study of consecutive patients with EF <35% who underwent implantation of a new primary prevention ICD/CRTD between 2014 and 2019. Baseline characteristics, clinical outcomes and previously published predictive risk factors were obtained. Primary outcome was incidence of first VA, defined as any treated VA, any sustained, monitored only VAs or ventricular fibrillation. Secondary outcome was all-cause mortality. Kaplan–Meier survival curves were generated and univariate Cox proportional analysis assessed association between risk factors and outcomes.

**Results:** A total of 466 patients were eligible for inclusion, of whom 357 (76.6%) were male. The mean age was 66.7 ± 12.1, and 53.4% had ischaemic and 45.6% had non-ischaemic cardiomyopathy. Of the devices, 286 (61.4%) were CRT-Ds. Non-sustained VA was previously documented in 52 (11.2%), diabetes mellitus in 123 (26.4%) and a history

of atrial arrhythmia in 150 (32.2%). New York Heart Association class at implantation was most frequently III (44.6%). Over a median (IQR) period of 28 (4–53) months, 81 (17.4%) had a VA event. Factors significantly associated were male gender (HR 2.84, CI 1.42–5.69; p=0.03) and previous myocardial infarction (HR 1.58, CI 1.02–2.44; p=0.42). Ischaemic aetiology (with or without infarction) was not associated with VA. During a median (IQR) follow-up of 52 (35–71) months, 171 deaths had occurred. Predictive factors were age (HR 1.05, CI 1.03–1.07; p<0.01), ischaemic aetiology (HR 2.11, CI 1.49–2.98; p<0.01) and diabetes (HR 1.85, CI 1.32–2.59; p<0.01).

**Discussion:** An annual VA event rate of ~3–7% and an all-cause mortality event rate of ~5–8% is in keeping with more recent published data. Direct comparison with some published trials is challenging due to their utilisation of an EF cut-off of 40% for ICD implantation with varying event definitions. Male gender and previous myocardial infarction were associated with VA, but aetiology was not. We could not explain the discrepancy between the positive correlation with VA for myocardial infarction but not for ischaemic aetiology. Scar burden may have an impact and we are currently collecting medication data to ascertain whether this plays a role. All-cause mortality association with age, diabetes and ischaemic cardiac disease have been previously described. Our data display similar event incidence to recently published data by Zabel et al. and van der Lingen et al. VA incidence has little association with previously published risk factors. In this new era of medical therapy, it is possible that reassessment of previous risk factors is required. □

Figure 1



## Moderated Posters 2

### 59/Virtual reality – a new addition to the anxiolytic armamentarium during implantation of cardiac devices

Authors: *C Brown (Presenting Author) – The Allan Lab, Jersey; A Gibbs – The Allan Lab, Jersey; A Mitchell – The Allan Lab, Jersey*

Pacemaker implantation can be a painful and anxiety-provoking intervention. Virtual reality (VR) offers a simple and low-cost opportunity to improve the experience of patients undergoing these procedures through immersion in a distracting and meditative virtual environment. Procedure-related complications and side effects could be avoided, and VR may result in reduced analgesic and anxiolytic medication use.

**Methods:** A total of 20 patients undergoing elective or urgent pacemaker procedures were screened for eligibility. Two patients were excluded due to either lacking capacity or having sensory impairment limiting the use of VR headsets. This demographic was open to the novel approach; only one patient declined participation. Overall, 17 patients were enrolled in the study; nine were randomised to receive the intervention, whilst eight received standard care. The intervention group received an immersive guided meditation in VR (Healthy Mind) in addition to standard care.

**Results:** In those who received the VR intervention, pain, assessed using the visual analogue scale, was lower (1.9 vs 3.1), and post-procedure anxiety, assessed using the State-Trait Anxiety Inventory, was lower (80.4 vs 81.9). Local anaesthetic use was similar in both groups (28.3 vs 28.5 mL of 1% lidocaine). Fewer patients in the VR group required anxiolytic medication with midazolam (11% vs 25%) and at lower doses (mean 1.0 vs 1.75 mg). Additionally, three patients in the VR group (33%) reported falling asleep during the procedure, compared with only one in the standard care group (13%). This pilot study was not powered to detect statistically significant differences in these parameters.

With continuous electrocardiogram, we monitored heart rate variability and a composite 'stress score' (B-Secur HeartKey); however, the prerequisite for dysrhythmias in patients undergoing pacemaker implantation precluded any meaningful interpretation. Future studies could include alternative biometrics, such as galvanic skin response, as objective markers of sympathetic stimulation. One patient removed the headset during the procedure due to discomfort related to the headset's strap, and a pneumothorax complicated the recovery of one patient in the intervention arm. The study findings are caveated by its underpowered sample size, unblinded design, heterogeneous study population and multiple possible confounding factors.

Figure 1: Patient wearing Healthy Mind VR headset during a pacemaker implantation procedure



**Conclusion:** This pilot study suggests a potential benefit from VR anxiolysis during implantation of cardiac devices, especially in the small but significant minority who experience significant pain. We showed that it is a feasible intervention in the demographic of patients requiring pacemakers. Given there is a low risk of harm with VR and, unlike drugs, exposure can be removed immediately in the event of side effects such as sickness, there seems little to lose. Further work into multimodal biometrics could help tailor the virtual perioperative experience. □



## Moderated Posters 2

### 60/The utility of transoesophageal echocardiography-derived left atrial appendage velocity in predicting postoperative atrial fibrillation in mitral valve surgery patients

Authors: *JJ Sun (Presenting Author) – Department of Cardiology, Harefield Hospital, Uxbridge, London; J Pan – Department of Cardiology, Harefield Hospital, Uxbridge, London; AJ Barron – Department of Cardiology, Harefield Hospital, Uxbridge, London*

**Background:** Postoperative atrial fibrillation (POAF) is a recognised complication of cardiac surgery associated with adverse outcomes. Preoperative left atrial dysfunction is thought to be associated with the development of POAF. In our centre, transoesophageal echocardiography (TOE) is used as part of the work-up for patients undergoing mitral valve surgery and left atrial appendage velocity is routinely assessed by performing clinicians.

**Aim:** This study aimed to investigate the utility of left atrial appendage velocity (LAAV) in predicting development of POAF after mitral valve surgery.

**Methods:** A retrospective analysis of all patients undergoing mitral valve surgery in a single specialist cardiac centre in 2019 was performed. Case records were interrogated and demographic, procedural and outcome data collected. Patients without permanent AF with a valid preoperative transoesophageal echocardiogram were included. Differences in LAAV between patients developing POAF and those who did not were compared using t test.

**Results:** Of 171 patients undergoing mitral valve surgery in our centre, 77 had valid preoperative TOE with pulsed wave Doppler assessment of the LAAV. Mean age was  $66.7 \pm 11.6$  years with F:M ratio 29:48. For those without pre-existing AF (n=50), the LAAV was significantly lower in those who developed POAF  $44.7 \pm 13$  cm/s vs  $51.6 \pm 16$  cm/s ( $p=0.05$ ). Using a cut-off value for normal LAAV of  $>40$  cm/s, those with reduced LAAV were more likely to develop POAF (56% vs 29.4%;  $p<0.05$ ). There was a trend towards increased length of stay for patients who developed POAF, though this did not reach statistical significance.

**Conclusions:** Although this study was limited by the sample size, it suggests that lower LAAV is associated with the development of POAF in patients undergoing mitral valve surgery. Routine collection of LAAV could be used as an additional tool in stratifying higher risk patients as part of the preoperative decision-making process. □

Posters 1

**61/Bariatric surgery partially reverses subclinical proarrhythmic remodelling in obese patients: a non-invasive electrocardiographic imaging study**

Authors: *KHK Patel (Presenting Author) – Imperial College London NHLI, London; N Bajaj – Imperial College London NHLI, London; BK Statton – Imperial College London, London; NS Herath – Imperial College London NHLI, London; J Stok – Maastricht University, Maastricht; X Li – Imperial College London NHLI, London; K Nyamakope – Imperial College London NHLI, London; R Davidson – Imperial College London NHLI, London; JA Coghlin – Imperial College London NHLI, London; J Cousins – Imperial College London, London; JS Ware – Imperial College London NHLI, London; S Purkayastha – Imperial College London, London; D O’Regan – Imperial College London, London; NS Peters – Imperial College London NHLI, London; PD Lambiase – University College London, London; M Cluitmans – Maastricht University, Maastricht; FS Ng – Imperial College London NHLI, London*

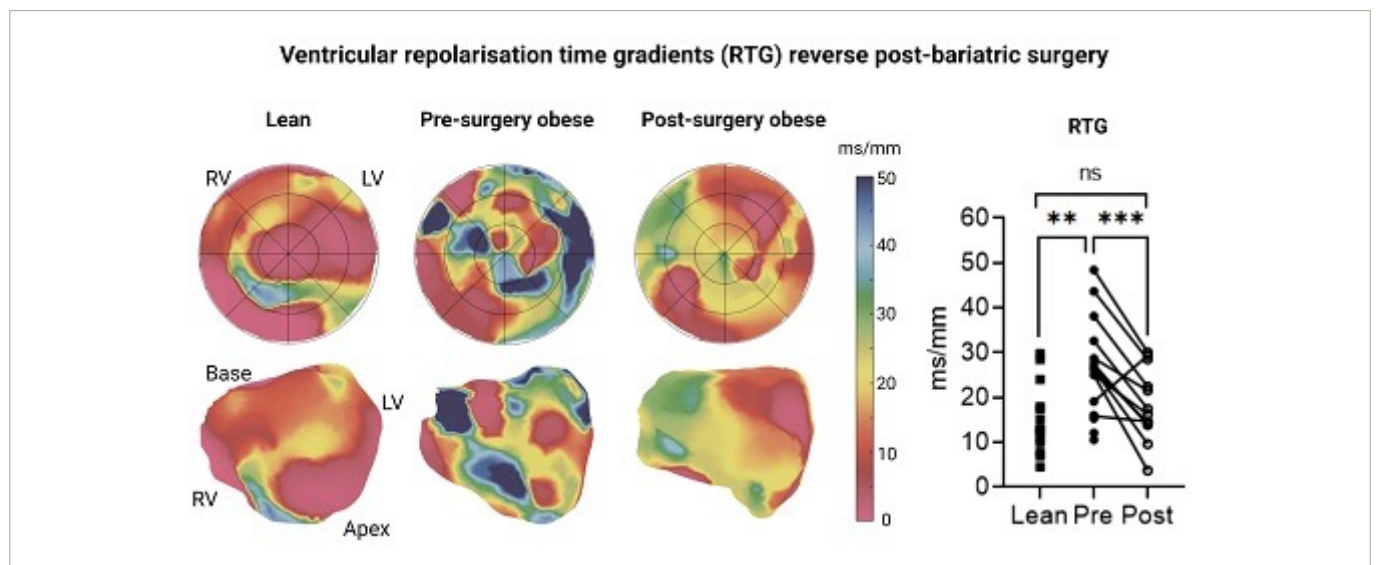
**Introduction:** Obesity confers higher risks of cardiac arrhythmias and sudden cardiac death. Given that early bariatric surgery reverses and prevents some metabolic complications of obesity, the same may also be true for the risk of cardiac arrhythmias. However, the evidence for weight loss mitigating arrhythmic risk is conflicting and inconclusive. We therefore used electrocardiographic imaging (ECGi) to provide non-invasive characterisation of the proarrhythmic substrate in obese patients before and after bariatric surgery.

**Methods:** A total of 16 obese patients ( $43 \pm 12$  years, 13 female) underwent ECGi before bariatric surgery (PreSurg), of whom 12 had ECGi post-surgery (PostSurg). In addition, 16 age- and sex-matched lean individuals ( $42 \pm 11$  years, 13 females) underwent the same protocol. All participants were in sinus rhythm, had no history of cardiac arrhythmias and were not prescribed QT-prolonging medication. ECGi comprised body surface mapping with 256 electrodes and magnetic resonance imaging. Unipolar atrial and ventricular epicardial electrograms were computed by solving the inverse problem of electrocardiography to calculate local atrial and ventricular activation (AT) and ventricular repolarisation (RT) times. Activation and repolarisation heterogeneity was quantified by their respective gradients. These were calculated as their respective maximum differences between two electrograms within a 10 mm radius divided by their anatomical distance.

**Results:** Bariatric surgery led to a significant reduction in body mass index ( $46.7 \pm 5.5$  kg/m<sup>2</sup> vs  $36.8 \pm 6.5$  kg/m<sup>2</sup>;  $p < 0.001$ ), which was greater than in lean individuals ( $22.8 \pm 2.6$  kg/m<sup>2</sup>). This was accompanied by a reduction in epicardial adipose tissue (EAT) volume ( $83 \pm 56$  cm<sup>3</sup> vs  $69 \pm 45$  cm<sup>3</sup>;  $p = 0.001$ ). Total atrial activation time was prolonged in PreSurg vs lean, and remained prolonged in PostSurg ( $62 \pm 15$  vs  $46 \pm 12$  vs  $67 \pm 15$  ms). Atrial activation gradients were also greater in PreSurg vs lean and were not improved in PostSurg ( $26 \pm 11$  vs  $14 \pm 8$  vs  $25 \pm 12$  ms). Ventricular repolarisation gradients were greater in PreSurg vs lean ( $26 \pm 11$  vs  $15 \pm 7$  ms/mm;  $p = 0.0024$ ), which was reversed in PostSurg ( $19 \pm 8$  ms/mm;  $p = 0.0009$  vs PreSurg) (Figure). EAT volumes correlated with atrial activation and ventricular repolarisation gradients ( $r = 0.36$ ,  $p = 0.044$  and  $r = 0.54$ ,  $p = 0.0014$ , respectively).

**Conclusion:** Compared with lean individuals, obesity is associated with subclinical electrophysiological remodelling, even in patients without a history of arrhythmias. This includes atrial activation prolongation and steeper ventricular repolarisation gradients. Bariatric surgery led to regression of EAT, as well as reversal of steep ventricular repolarisation gradients but did not improve atrial activation. Our data suggest that early surgical weight reduction in obese patients without cardiac arrhythmias can partly reverse the pro-arrhythmic remodelling to reduce the risks of developing arrhythmias. □

Figure 1



## Posters 1

### 62/Enhancing the identification of atrial fibrillation using prescribing records in electronic medical record research

Authors: *CV Moore (Presenting Author) – University of Dundee, Dundee; MM Oo – University of Dundee, Dundee; CX Kocherry – University of Dundee, Dundee; M Guignard-Duff – University of Dundee, Dundee; C Guo – University of Dundee, Dundee; IR Mordi – University of Dundee, Dundee; CC Lang – University of Dundee, Dundee*

**Background:** Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia that is associated with increased risk of stroke, heart failure and mortality. The increasing availability of electronic medical records (EMRs) for clinical research offers opportunities to generate timely real-world evidence to enhance patient care and facilitate research. Previous EMR-derived AF patient cohorts that had relied on International Classification of Diseases (ICD) codes have limited AF case identification. We have generated and assessed a novel method to enhance EMR-derived AF by using electronic prescribing records.

**Methods:** This was a population-based cohort study of EMR data that anonymously used a patient-specific identifier, the Community Health Index (CHI), to link the community-dispensed prescriptions maintained by the Health Informatics Centre (HIC) in Scotland. These records contain detailed prescribing information on all residents of Tayside region (population >400,000) since 1993. This dataset was linked to other clinical datasets that included echocardiography data, hospital admissions (Scottish Morbidity Record) and mortality data (General Registry Office). Electronic prescription records were filtered for patients prescribed a direct oral anticoagulant (DOAC) or warfarin. Merging with

Scottish Morbidity Records (SMR), cases were excluded if an ICD-10 code for deep vein thrombosis (DVT), pulmonary embolism (PE) or mechanical heart valve was present. Following Caldicott guardian approval, we conducted a validation and concordance exercise to assess the validity of this prescribing-enhanced EMR-derived AF.

**Results:** From electronic prescribing records, we identified 2,798 patients who were prescribed a DOAC or warfarin. After excluding based on ICD-10 code for DVT, PE or mechanical heart valve, an AF subset of 2,573 patients was established. AF cases from the SMRs using ICD-10 codes only to phenotype for AF yielded 854 patients. Combining these two methodologies yielded 2,839 unique patients after accounting for duplicates. An open-chart validation and concordance exercise of 34 patients showed a positive predictive value of 97% and a false positivity rate of 3%.

**Conclusions:** Identifying AF cases by prescribing record yielded superior sample sizes with high positive predictive value. Identification of AF through ICD codes alone may not identify a representative sample for EMR research. □

Posters 1

63/AF Association Patient Survey – remote monitoring and alert-based systems

Authors: *T Lobban* (Presenting Author) – AF Association, Stratford Upon Avon; *S Kempton* – AF Association, Stratford Upon Avon; *N Breakwell* – AF Association, Stratford Upon Avon

**Background:** The term remote monitoring means monitoring your heart and implanted device while you are at home, and ‘remote’ from the care team at your hospital. Remote monitoring of pacemakers, ICDs and ICMS, uses a special transmitter. Using an integrated aerial, the implant automatically sends medical and technical information from your heart, to your doctor, arrhythmia nurse and the cardiac physiologists who are treating you, usually via your remote monitoring device which may be connected through a mobile phone or internet link. This allows your heart rhythm specialists to monitor your condition based on accurate, up-to-date clinical information at any time – not just when you are at the hospital. (A-A Remote Monitoring Booklet, 2021).

**Purpose:** To understand the patient perspective of remote monitoring and alert-based systems, the AF Association conducted a survey, distributed to 100 people, to gather insights on the topic of remote monitoring in cardiac rhythm management.

**Method:** An online questionnaire was emailed to 100 patients on the AF Association database and the following information was collected:

- Was a patient on a waiting list for a medical device or intervention?
- Age, gender and regionality
- Impact of the COVID-19 pandemic on patient perceptions of alternative treatment options
- The decision-making process for their care
- Patient opinions about benefits of remote monitoring
- Are patients willing for manufacturers to conduct simple technical assessments of remote monitoring equipment?
- Would a patient like an additional alert-based system on the device?
- The impact of alert-based systems on outpatient appointments.

**Results:** A total of 39 people responded. All respondents had received or were on the waiting list for a medical device or intervention, with 56% taking anti-coagulation medication. Overall, 51% of patients felt more willing to consider alternative ways to receive care following the COVID-19 pandemic (41% had a neutral response and 8% were less willing), and 85% of patients agreed the remote monitoring was a useful addition to their care. The main benefits of remote monitoring were reassurance that their clinical team could monitor their progress, knowing that if there was an urgent issue their healthcare team could let them know immediately, and that the technology may keep them out of hospital. Other findings were: 87% of patients were willing to let device manufacturers conduct simple technical assessments of their remote monitoring equipment; 88% of patients would like to be in the decision-making process involved in their care, with 12% happy for a clinician to make the decisions; 81% would have an alert-based system active on the device; and 91% highlighted that they would request this technology from their doctor. When prompted that this technology could reduce the amount of outpatient appointments, 87% of patients saw this to be a benefit.

Figure 1

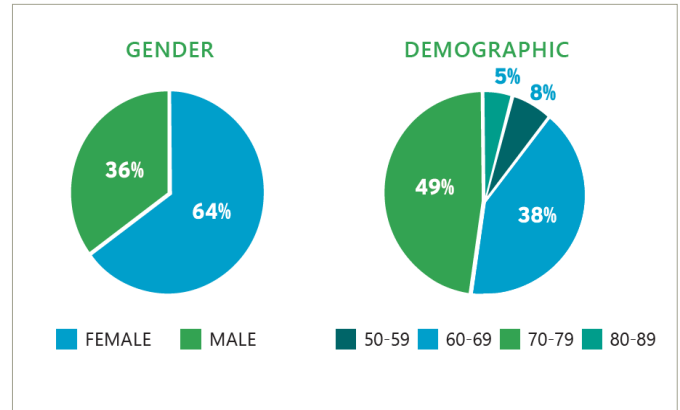


Figure 2

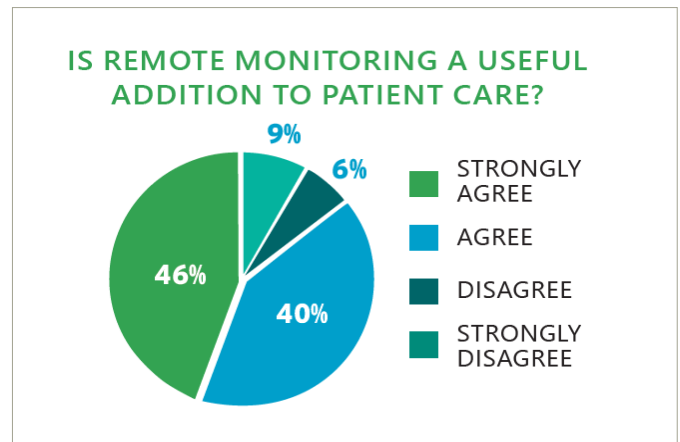
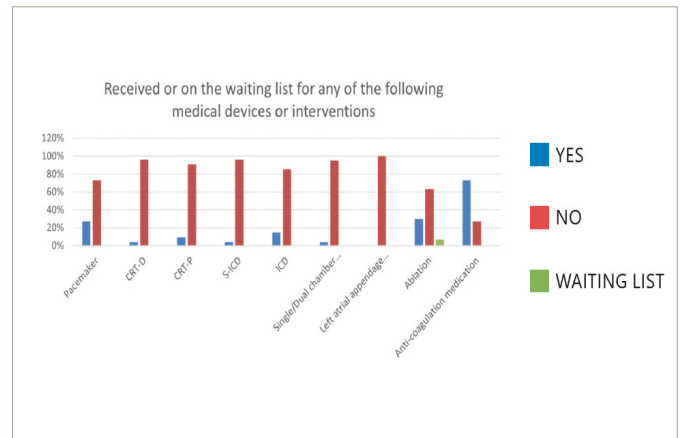


Figure 3



CONTINUED →

Figure 4

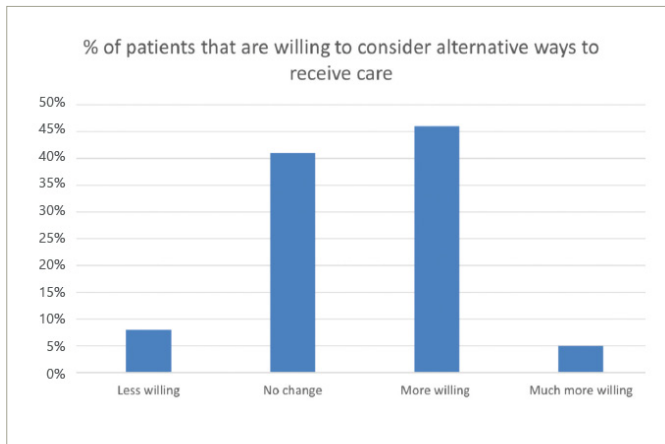
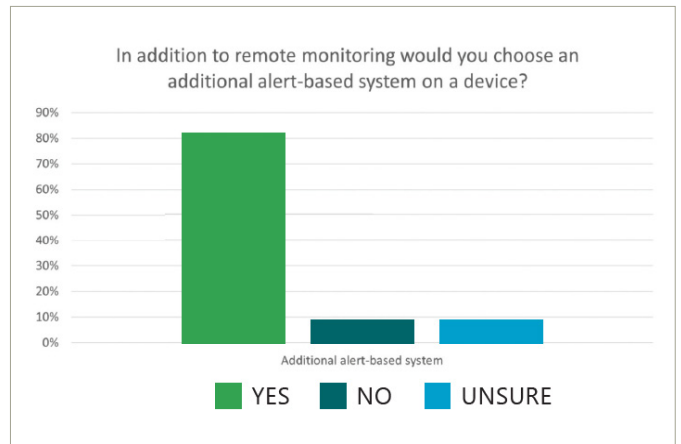


Figure 5



**Conclusions:** This survey demonstrated the positive outlook of patient opinions for the present and future, and highlighted the importance of the relationship between themselves and healthcare professionals. Remote monitoring has improved the patient experience and has the potential to grow. The findings describe how involved the patient would like to be in the decision-making process and that they are open to innovative technologies that can improve their care, such as alert-based systems.

It can be said that the COVID-19 pandemic has been a catalyst for both patients and healthcare professionals to engage more with the use of remote monitoring and overall has seen huge benefits in improving patient outcomes and quality of life. □





### Posters 1

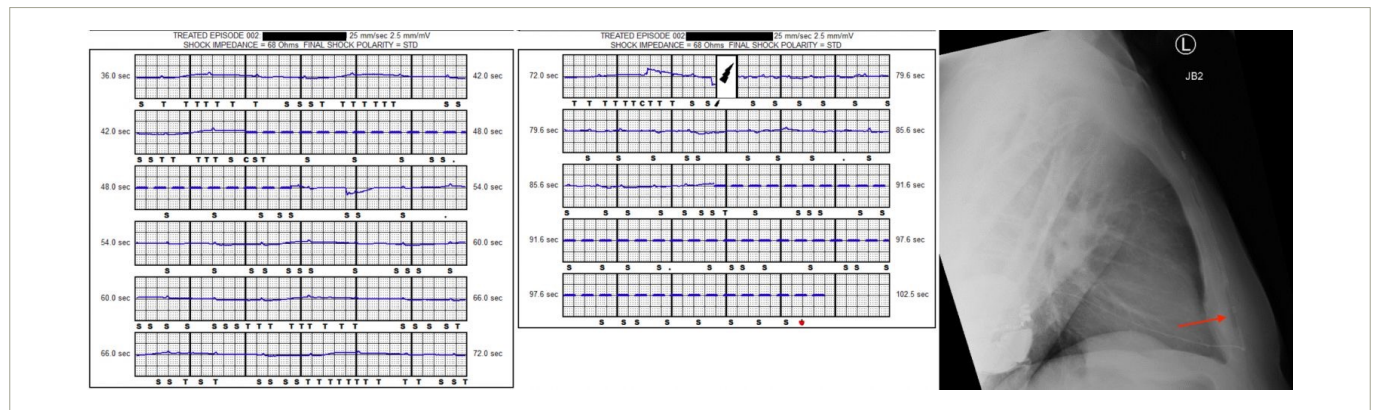
#### 64/Inappropriate shocks from an S-ICD

Authors: L Whittaker (Presenting Author) – James Cook University Hospital, Middlesbrough; M Chapman – James Cook University Hospital, Middlesbrough; A Turley – James Cook University Hospital, Middlesbrough; M Dewhurst – James Cook University Hospital, Middlesbrough

**Case:** A 62-year-old man attended electively for implantation of a subcutaneous implantable cardioverter defibrillator (S-ICD) for primary prevention due to dilated cardiomyopathy with severe left ventricular systolic dysfunction (LVSD). His past medical history included type II diabetes. Screening prior to implant demonstrated that the primary and alternative vectors were acceptable. The S-ICD was implanted under general anaesthetic using a two-incision technique. The generator was placed in an intermuscular position. Both pockets were flushed with normal saline. The sensing was programmed to the primary vector. Routine defibrillation threshold testing was performed successfully with a shock impedance of 68 Ohms. On return to the ward, the patient received two inappropriate shocks due to noise (Figure 1). Interrogation revealed a drop in R wave amplitude and intermittent noise seen in both the primary and alternate vectors. These both utilize the proximal electrode. A chest X-ray demonstrated a small amount of air overlying the

proximal electrode (Figure 1). device was briefly deactivated to allow for resorption. Unfortunately, the patient re-presented 10 weeks later with a further inappropriate shock, which again was due to noise and a transient drop in R wave amplitude. Repeat chest X-rays showed resorption of the air previously seen and that the pin remained through the header. The sensing was still programmed to the primary vector. On interrogation of the device, noise was reproducible with patient movement on the secondary vector, but not on either the primary or alternate vectors. The device was deactivated. After seeking advice from Boston, the patient attended for explant and re-implant of a new S-ICD system. Visual inspection at the time of explant confirmed that the pin was through the header and screwed in. The device was returned to Boston for further analysis. Analysis of both the generator and lead failed to identify any issue that could have caused or contributed to the inappropriate shocks. To date, the patient has not had any issues with the new device. □

Figure 1: EGM during inappropriate shock post-implant and lateral X-ray post-implant (air around proximal electrode indicated by arrow)



## Posters 1

**65/Contemporary CIED complications in a major tertiary centre: insights into rates of bleeding, infection and lead displacement**

Authors: *MNS Niespialowska-Steuden (Presenting Author) – University Hospital Southampton, Southampton; MA Abouelasaad – University Hospital Southampton, Southampton; JRP Paisey – University Hospital Southampton, Southampton; PRR Roberts – University Hospital Southampton, Southampton; WXU Ullah – University Hospital Southampton, Southampton; AMY Yue – University Hospital Southampton, Southampton*

**Introduction and methods:** Cardiac implantable electronic device (CIED) procedures are associated with complications. Our centre has incorporated multiple measures to minimize implant complications, but the rates of complications in contemporary clinical practice are not well described. We avoid heparin bridging, interrupt direct oral anticoagulants 48 hours before procedures, and maintain an international normalized ratio of  $\leq 2$  in warfarin patients unless in an emergency or with metallic valves. Infection prevention strategies include single-dose pre-procedural antibiotic, intra-pocket gentamicin, 3M™ Ioban™ skin cover, and Medtronic TYRX™ envelopes for high-risk cases. We only implant active right ventricular and atrial leads. Active fixation left ventricular (LV) leads predominate. Our retrospective analysis was performed to assess the overall complication rates and identify the risk factors for bleeding, infection and lead displacements. Clinical records of consecutive implants (including upgrades and box changes) were examined between 01/2019 and 03/2020 in a single tertiary centre. The mean follow-up was 22.1 months.

**Results:** A total of 903 patients were included (722 new implants, 122 generator changes, 17 generator changes with lead revisions, 17 Micras and 25 upgrades). The mean patient age was 74 years and 68% were male. One-third of the patients were affected by significant comorbidities, including chronic heart failure, chronic renal failure and diabetes mellitus. The global complication rate was 8.1% and included: haematoma (1.7%),

lead displacement (2.4%), pericardial effusion (1.8%), pneumothorax (0.6%), superficial skin infection (0.8%), pocket infection (0.2%), sepsis (0.2%) and significant changes in lead parameters (0.6%). No deaths were identified as being directly associated with the device procedure. The overall complication rate was higher in patients on oral anticoagulation therapy (OR 0.53, 95% CI 0.32–0.87;  $p=0.013$ ). Advanced age and reduced left ventricular function (ejection fraction  $<40\%$ ) were associated with infection (OR 0.96 [95% CI 0.92–1.0],  $p=0.024$  and OR 4.9 [95% CI 1.32–23.7],  $p=0.024$ , respectively). Pneumothorax was inversely associated with body weight (OR 0.95, 95% CI 0.88–0.99;  $p=0.017$ ). Haematoma occurred more frequently in cephalic access (vein cut down technique) (OR 6.06, 95% CI 1.84–21.4;  $p=0.003$ ). Infection occurred mainly in permanent pacemakers (OR 0.14, 95% CI 0.02–0.55;  $p=0.012$ ) and cardiac resynchronisation-pacemaker implants (OR 6.71, 95% CI 1.90–22.7;  $p=0.002$ ). Overall, 64% of LV leads had an active fixation mechanism. In contrast, the passive lead, Abbott Quartet™, was associated with overall complications (OR 6.6, 95% CI 1.60–34.6;  $p=0.013$ ).

**Conclusion:** Contemporary measures appeared to be effective in maintaining a low CIED infection rate. However, haematoma formation and LV lead displacements remained significant. Cephalic access was associated with relatively higher haematoma rates than those quoted in most published data. The Quartet™ lead was associated with a relatively high displacement rate. □

## Posters 1

**66/Efficacy and safety of a remote monitoring program for low-energy devices – 1-year follow-up**

Authors: *A Wharmby – Barts Health NHS Trust, London; C Butcher – Barts Health NHS Trust, London; A Nogueira – Barts Health NHS Trust, London; Z Carter – Barts Health NHS Trust, London; A Muthumala – Barts Health NHS Trust, London; P Moore – Barts Health NHS Trust, London*

**Background:** Remote monitoring (RM) is not routinely deployed in patients with low-energy devices, but there are limited efficacy and safety data in this population. In response to the COVID-19 pandemic, our institution enrolled all low-voltage devices onto RM to reduce clinic footfall.

**Purpose:** To assess the efficacy and safety at 1 year of RM in patients with low-voltage devices.

**Methods:** All patients implanted (Group 1) or with a scheduled follow-up (Group 2) with a pacemaker (PPM) or cardiac resynchronisation therapy pacemaker (CRTP), April to November 2020, were prospectively enrolled. Patients who were transferred to another centre were excluded. Group 1 had 1-month and 12-month virtual follow-up and Group 2 had 12-month virtual follow-up, with alerts or patient request triggering earlier review. The number, reason, outcome and time to remote or in-person clinic review were assessed. The 1-year mortality was assessed and compared with a historic cohort without RM between April and November 2018.

**Results:** A total of 263 patients were enrolled (28% males, mean age 75 (SD 14) years; 63% Group 1 and 37% Group 2). This included 201 patients with PPM and 62 with CRTP. Overall, 390 scheduled remote reviews, 180 alerts and 173 clinic reviews took place. Per patient median (IQR) scheduled remote reviews, alerts and clinic reviews were: Group 1 1 (1–2), 2 (1–2.5), 1 (1–1.5), respectively; Group 2 1 (1–2), 1 (1–2), 1 (1–2), respectively. Overall, across both groups, 82 medical reviews were requested (median 1 [1–1] per patient), with 33% resulting in a change

in clinical management, and 24 patients were referred to a specialist clinic. In Group 1, 17% had alerts before the 1-month review and 64% required early review (arrhythmia and heart failure management 50%, anticoagulation 12%, device reprogramming 12% and lead issue 22%). Between 1 and 12 months, 68% of patients had a remote or clinical review, median (IQR) 101 (31–364) days, and 51% required review outside the routine review (arrhythmia and heart failure management 27%, anticoagulation 6%, device reprogramming 32%, lead revision 1% and wound revision 2%). In Group 2, the median time to first follow-up was 141 (80–357.5) days, and 66% required clinical intervention prior to the 12-month review (arrhythmia and heart failure management 23%, anticoagulation 3%, device reprogramming 8%, lead revision 5%, generator change 21% and device upgrade 2%). Overall, 66% had a change in follow-up schedule. There was no significant difference in 12-month mortality overall when compared with a historical cohort without RM (deaths 6% (16/263) in the RM cohort and 6% (13/213) in the historical non-RM cohort (p=0.99). No device-related deaths were seen in the RM cohort.

**Conclusion:** The use of RM was both efficacious and safe in patients with low-voltage devices at 1 year. In both de novo and routine follow-up cohorts, RM identified important findings in patients requiring intervention prior to routine review. This tailored strategy was not associated with a difference in mortality when compared with a local matched historical cohort without RM. □

Posters 1

67/Unscheduled downloads from implantable cardiac device home monitoring: benefit or burden?

Authors: C Stafford (Presenting Author) – Portsmouth Hospitals University NHS Trust, Portsmouth; Dr G Morton – Portsmouth Hospitals University NHS Trust, Portsmouth; R Dixon – Portsmouth Hospitals University NHS Trust, Portsmouth

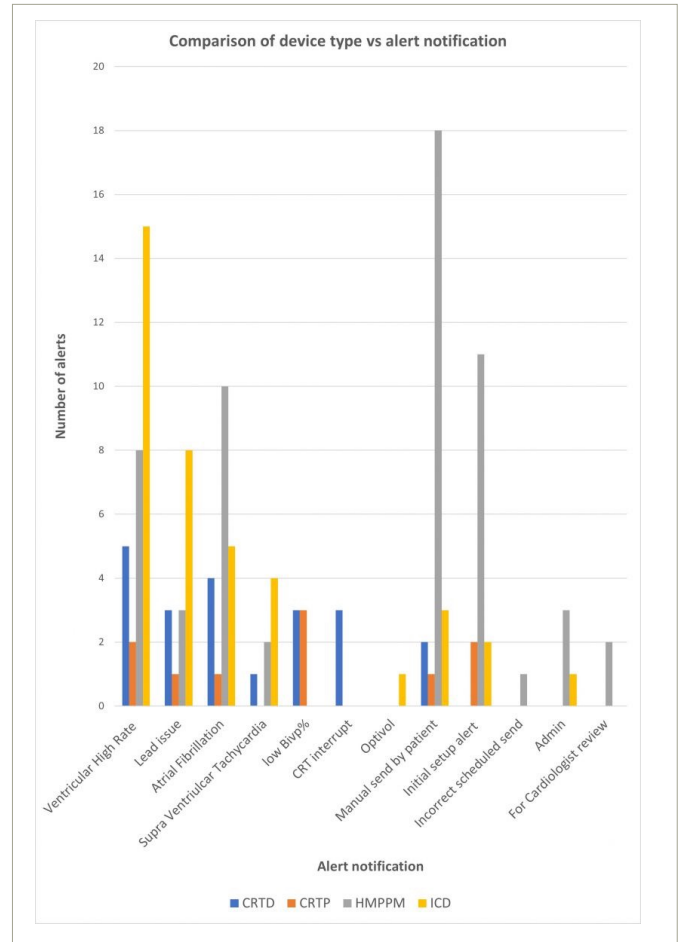
**Introduction:** Increasing numbers of patients receive implantable cardiac devices capable of home monitoring (HM). Whilst providing many advantages, HM can create an overwhelming data burden with a low signal to noise ratio. This has a significant impact on cardiac physiologists' work patterns. The aim of this work was to assess the volume and causes of unscheduled HM downloads and the frequency with which these resulted in a change in patient management. We also compared Medtronic and Biotronik downloads.

**Method:** HM alerts for all devices were set up according to default manufacturer recommendations. All unscheduled downloads between 9/8/2021 and 13/8/2021 from cardiac pacemakers (PPM), implantable cardioverter defibrillators (ICD), cardiac resynchronization therapy defibrillators and pacemakers (CRTD and CRTP) were retrospectively reviewed. Data recorded were manufacturer, device type, primary reason for alert, whether data required escalation to a physician or changed clinical management. Queen Alexandra Hospital Portsmouth is a large district general hospital with approximately 4,000 patients on HM, 70% of which are PPMs and 30% ICD/CRT devices.

**Results:** A total of 122 unscheduled HM alerts were reviewed: 56 from PPMs, 39 from ICDs, 17 from CRTDs and 10 from CRTPs. Of the Medtronic downloads, 42% were manual patient sends, predominantly from PPM devices. A high volume of ventricular high rate (VHR) episodes and potential lead issues were seen from ICDs (Figure 1). ICD devices accounted for 10% of patients with HM but 32% of downloads. ICD downloads produced 50% of the total VHR alerts and 53% of total potential lead issues. Of the unscheduled alerts received, 54% came from Biotronik devices despite Biotronik devices only accounting for 16.5% of the total HM population. Furthermore, 80% of VHR and potential lead issue alerts were from Biotronik devices. Only two (1.6%) of the unscheduled alerts were escalated to a physician. Clinical management was not changed in a single patient.

**Conclusions:** Unscheduled downloads generate a significant volume of work for pacing clinics which needs to be taken into account when planning services. Although HM will occasionally pick up clinically important events, such as arrhythmias, the signal to noise ratio appears to be very low. In this sample, minimal physician input was needed and zero changes to patient management resulted from >100 HM alerts. This suggests that the thresholds for sending alerts are set too low. Furthermore, HM alerts from Biotronik and ICD devices were disproportionately high. Newer advances with Medtronic HM monitors and the phone app will help to reduce the burden of unscheduled

Figure 1



downloads sent manually by patients. Patient education is a possible short-term interim solution. Collaborative working between centres following up cardiac devices and manufacturers to create bespoke HM templates for different patient groups, in particular ICDs, could be beneficial. Reviewing and implementing appropriate templates should be considered by all pacing clinics. Validated national standards and guidelines would facilitate effective use of HM while maintaining patient safety. □

Posters 1

68/The application of deep learning methods in S-ICD screening – a promising approach?

Authors: *Mohamed ElRefai (Presenting Author) – University Hospital Southampton NHS foundation trust, Southampton; M Abouelasaad – University Hospital Southampton NHS foundation trust, Southampton; B Wiles – University of Aberdeen NHS trust, Aberdeen; A Dunn – School of Mathematics, University of Southampton, Southampton; S Coniglio – School of Mathematics, University of Southampton, Southampton; A Zemkoho – School of Mathematics, University of Southampton, Southampton; P Roberts – University Hospital Southampton NHS foundation trust, Southampton*

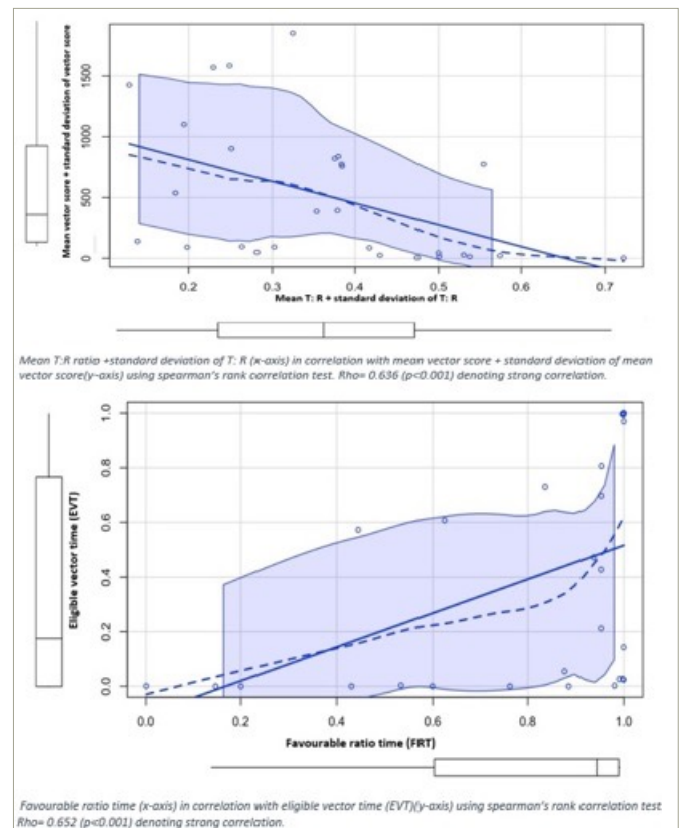
**Background:** Subcutaneous implantable cardiac defibrillators (S-ICDs) offer defibrillation protection therapy while avoiding lead-related complications associated with traditional ICDs. A major predictor of S-ICD eligibility is the T:R ratio. Despite current screening processes, T-wave oversensing remains the commonest cause of inappropriate shocks in S-ICD patients. The concept of varying S-ICD eligibility, owing to the dynamicity of electrocardiogram (ECG) signals, has been introduced before.

**Purpose:** There are practical limitations to acquiring longer durations of ECG signals for S-ICD screening. Machine learning methods are already in use for the classification of various cardiovascular diseases through ECG data analysis. This study explores the potential use of deep learning methods in S-ICD screening.

**Methods:** This was a retrospective correlation study. A deep-learning tool was used to provide descriptive analysis of the T:R ratios over 24-hour recordings of S-ICD vectors in adult ICD patients. Spearman’s rank correlation test was used to statistically compare the screening outcomes of the deep-learning tool with those of a ‘gold-standard’ S-ICD simulator for the same group of patients. Favourable ratio time (FVR) is a new concept introduced in this study representing the duration of time when the T:R ratio of a vector was deemed favourable (below the eligibility threshold) as a percentage of the whole recording. This was compared with the eligible vector time (EVT), which is the percentage of all the screening assessments with passing vector scores given by the S-ICD simulator.

**Results:** A total of 14 patients (mean age  $63.7 \pm 5.2$  years, 71.4% male) were recruited, and 28 vectors were analysed. Mean T: R was  $0.21 \pm 0.11$ , standard deviation of T: R (as a measure of dynamicity) was  $0.08 \pm 0.04$ , and FVR was  $79 \pm 30\%$ . Overall, there were statistically significant strong correlations between the outcomes of our deep-learning tool and the S-ICD simulator. Mean T:R ratio +standard deviation of T: R correlated strongly with mean vector score (measured via the S-ICD simulator) + standard deviation of mean vector score,  $Rho = 0.636$  ( $p < 0.001$ ). FVR also strongly correlated with EVT ( $Rho = 0.652$ ;  $p < 0.001$ ) (Figure 1).

Figure 1



**Conclusion:** Deep learning methods could provide a practical software solution to analyse data acquired for longer durations than current S-ICD screening practices. This could help select patients better suited for S-ICD therapy as well as guide vector selection in S-ICD eligible patients. Further work is needed before this could be translated into clinical practice. □



Posters 1

**69/Peri-procedural complications and 3-month re-intervention rates associated with cardiac device implantation: our tertiary centre experience**

Authors: *Christina Menexi (Presenting Author) – University Hospital Southampton, Southampton; M Elrefai – University Hospital Southampton, Southampton; A Chua – University Hospital Southampton, Southampton; I Handa – University Hospital Southampton, Southampton; M Abouelasaad – University Hospital Southampton, Southampton; J Paisey – University Hospital Southampton, Southampton*

**Introduction:** Cardiac implantable electronic devices (CIEDs) therapy can be associated with complications. The European Society of Cardiology guidelines on pacing recommend routine follow-up of all newly implanted devices within 72 hours of implant. The European Heart Rhythm Association expert consensus and practical guide on CIEDs recommend that a chest X-ray should be performed within 24 hours after all CIED implants to rule out pneumothorax and to document lead positions.

**Purpose:** We aimed to report first on the rate of peri-procedural complications associated with CIED implants at our centre and identify any patient- and procedural-related factors that are associated with peri-procedural complications. We also report on the 3-month re-intervention rates at our centre.

**Methods:** Consecutive CIED implants performed between January and December 2019 were retrospectively analysed. Patients' demographics, procedural reports, device checks, post-procedure chest X-rays and further intervention procedures were obtained from the hospital records. Data analyses were performed using RStudio 1.4.1106 running R 4.0.5. Categorical data are presented as n/N (%) and continuous data as mean ± SD. Fisher's exact and chi-squared tests were used to analyse categorical variables' contingency tables, while continuous non-parametric data were compared using Wilcoxon rank sum test.

**Results:** A total of 578 patients were included in our analysis (Table 1). There were 16 (2.8%) peri-procedural complications, 7 (1.2%) pneumothoraxes, 6 (1%) pericardial effusions and 3 (0.5%) lead displacements.

Table 1

	N	N = 578 <sup>†</sup>
<b>Sex</b>	578	
F	185	(32)
M	393	(68)
<b>Age in years</b>	578	74 ± 16
<b>Procedure duration in minutes</b>	557	99 ± 44
<b>Procedure urgency</b>	577	
Elective	264	(46)
Emergency	313	(54)
<b>CIED Indication</b>	578	
Atrial fibrillation with slow ventricular response	59	(10)
Complete heart block	146	(25)
High grade AV block	57	(9.9)
Heart failure meeting CRT criteria	34	(5.9)
Mobitz 2 heart block	60	(10)
Primary prevention indication for defibrillator therapy	80	(14)
Secondary prevention indication for defibrillation therapy	40	(6.9)
Sick sinus syndrome	102	(18)
<b>Left ventricular function</b>	553	
Normal function	333	(60)
Mild impairment	61	(11)
Moderate impairment	47	(8.5)
Severe impairment	112	(20)
<b>Device implanted</b>	578	
CRT-D	65	
CRT-P	61	
DDD	273	
Dual chamber ICD	32	
Single lead (ventricular) ICD	36	
Single lead (ventricular) pacemaker	111	
<b>Venous Access for the procedure</b>	564	
Axillary vein	403	(71)
Cephalic vein	79	(14)
Subclavian vein	82	(15)

Table 2

	N	Periprocedural complications n (%)	p-value <sup>‡</sup>	Lead re-intervention n (%)	p-value
<b>Total</b>	578	16(2.7%)		7(1.2%)	
<b>Sex</b>	578		0.12		>0.99
F	185	8 (4.3%)		2 (1.1%)	
M	393	8 (2%)		5 (1.3%)	
<b>Age in years</b>	578	73± 17	0.99	75±14	0.86
<b>Procedure duration in minutes</b>	557	127± 50	<b>0.02</b>	111±56	0.73
<b>Procedure urgency</b>	577		0.24		0.46
Elective	264	5(1.9%)		2 (0.8%)	
Emergency	313	11(3.5%)		5 (1.6%)	
<b>CIED indication</b>	578		0.56		0.39
Atrial fibrillation with slow ventricular response	59	0 (0)		0 (0)	
Complete heart block	146	6 (4.1%)		2 (1.4%)	
High grade AV block	57	1 (1.8%)		1 (1.8%)	
Heart failure meeting CRT criteria	34	0 (0)		1 (2.9%)	
Mobitz 2 heart block	60	1 (1.7%)		0 (0)	
Primary prevention indication for defibrillator therapy	80	4 (5%)		2 (2.5%)	
Secondary prevention indication for defibrillation therapy	40	0 (0)		1 (2.5%)	
Sick sinus syndrome	102	4 (3.9%)		0 (0)	
<b>Left ventricular function</b>	553		0.61		<b>0.014</b>
Normal	333	12 (3.6%)		0 (0)	
Mild	61	1 (1.6%)		1 (1.6%)	
Moderate	47	0 (0)		1 (2.1%)	
Severe	112	2 (1.8%)		3 (2.7%)	
<b>Device implanted</b>	578		0.63		<b>0.005</b>
CRT-D	65	4 (6.2%)		2 (3.1%)	
CRT-P	61	1 (1.6%)		0 (0)	
DDD	273	7 (2.6%)		2 (0.7%)	
Dual chamber ICD	32	0 (0)		2(6.3%)	
Single lead(ventricular) ICD	36	0 (0)		0 (0)	
Single lead (ventricular) pacemaker	111	4 (3.6%)		1 (0.9%)	
<b>Venous access</b>	564		0.59		0.58
Axillary vein	403	13(3.2%)		7 (1.7%)	
Cephalic vein	79	2 (2.5%)		0 (0)	
Subclavian vein	82	1 (1.2%)		0 (0)	

<sup>†</sup> Mean ± SD; n (%)

Axillary vein was the most common route of access (71%) followed by subclavian vein (15%) and cephalic vein (14%). All the pneumothorax cases occurred with axillary vein access; 2 out of the 3 lead displacements occurred after cephalic vein access and the other lead displacement happened after axillary access; 5 pericardial effusions followed axillary access while the remaining case followed subclavian vein access. Overall, 81.3%, 12.5% and 6.2% of the peri-procedural complications occurred after axillary, cephalic and subclavian vein access, respectively (p=0.59). The only parameter that correlated significantly with peri-procedural complications was the procedure time; the average procedure time in uncomplicated cases was 99 ± 43 minutes vs 127 ± 50 minutes in procedures associated with peri-procedural complications (p=0.02) (Table 2). The overall 3-month lead re-intervention rate was 1.2%: 4 lead revisions were required due to unsatisfactory parameters upon subsequent follow-up checks and 3 lead revisions were performed secondary to lead perforations. In 100% of the lead re-intervention cases, the primary CIED implant procedure was done via axillary vein access.

**Conclusion:** Axillary access for CIED implant was associated with higher rates of peri-procedural pneumothorax and subsequent lead re-intervention. The only statistically significant predictor of peri-procedural complications was the duration of the procedure. □

Posters 1

**70/Pilot study of non-contact mapping-guided ablation of atrial fibrillation in high complexity congenital heart disease**

Authors: *J Kakarla (Presenting Author) – Freeman Hospital, Newcastle Upon Tyne Hospitals, Newcastle Upon Tyne; E Shepherd – Freeman Hospital, Newcastle Upon Tyne Hospitals, Newcastle Upon Tyne; R Martin – Freeman Hospital, Newcastle Upon Tyne Hospitals, Newcastle Upon Tyne; N Seller – Freeman Hospital, Newcastle Upon Tyne Hospitals, Newcastle Upon Tyne*

**Introduction:** Atrial arrhythmias are a common and challenging complication of complex congenital heart disease with significant clinical implications. The limited data on ablation of atrial fibrillation (AF) within this cohort are guided by conventional mapping and pulmonary vein isolation (PVI). Rapid, charge density, non-contact mapping technology allows for specific, targeted lesion sets of great relevance to this population. We report the feasibility and initial experience of this approach within this complex cohort.

**Methods:** This pilot study recruited patients with high complexity congenital heart disease referred for ablation of persistent AF. All patients were referred with conventional indications for AF ablation following consensus in a congenital electrophysiology multidisciplinary team. Baseline demographics, anatomy, interventions, arrhythmias and previous ablations were recorded. Non-contact atrial mapping was undertaken in a single procedure with a charge density mapping system following cryo-balloon PVI. Conventional procedural metrics as well as acute success was recorded. All patients had clinical follow-up, including an electrocardiogram (ECG), at 3 and 6 months. Prolonged ECG monitoring or device interrogation was undertaken at 6 months and 1 year (if time point available).

**Results:** Four patients with persistent AF were referred and underwent ablation (*Table 1*). Mapping was undertaken via transvenous access and trans-septal or trans-baffle punctures. Limited or no pulmonary vein signals were noted in 3/4 patients; however, cryo-balloon isolation partially organised the rhythm in all cases. Non-contact mapping demonstrated variable substrate (*Table 1*) with ablation targets involving both the systemic venous and pulmonary venous atrium. Sinus rhythm was acutely restored in all patients with freedom from AF at 6 months. Recurrence of an organised arrhythmia was seen in two patients at 6 and 9 months with late recurrence of AF in a third. Two patients died from heart failure within 2 years.

**Conclusions:** Cryo-balloon PVI followed by non-contact mapping-guided ablation of persistent AF in complex congenital heart disease was feasible and achieved sinus rhythm in this pilot study. Successful ablation targets were highly variable. However, there is significant morbidity in this population related to the failing underlying circulations. These data support a larger study of this approach within this growing population. □

Table 1

Anatomy	Age	Additional arrhythmias	Previous ablation	Additional ablation targets	Follow-up (months)
Unrepaired tricuspid atresia with VSD	44	Paroxysmal atrial tachycardia (AT)	–	Lateral right atrium	6: Sinus rhythm with rare pAF (<1%) 12: Sinus rhythm Died from pulmonary hypertension
Mustard repair of transposition of the great arteries	40	Atypical atrial flutter	Atypical flutter	Posterior box isolation CTI and mitral isthmus line Septal and atrial floor line	6: Sinus rhythm Last follow-up (8): Sinus rhythm
Atriopulmonary Fontan repair of univentricular heart with right atrioventricular valve atresia	59	Paroxysmal AT	-	Roof line Anterior seatbelt line	6: Sinus rhythm with rare AT (<0.1%) Last follow-up (9): Recurrent flutter - died with heart failure despite successful ablation
Repaired Tetralogy of Fallot with biventricular impairment (NYHA III)	57	Atypical atrial flutter	Atypical right atrial flutter Right atrial MAZE	Posterior line Anterior seatbelt line	6: Sinus rhythm with paroxysmal AT (19%) 12: Sinus rhythm with paroxysmal AT (25%) Recurrent AF at 30 months

## Posters 1

### 71/Millimetre-scale batteries enable miniaturisation of cardiac implanted sensors

Author: *D Pasero (Presenting Author) – Ilika Technologies, Romsey*

**Purpose:** A new generation of miniaturised, implanted, cardiac sensing devices, possibly introduced via a catheter, is being developed by disruptive product designers. Conventional medical batteries are packaged within metallic cans for safety purposes; they are also typically primary (non-rechargeable) and must contain the whole energy required during the life of the device they power from first day of implantation. For these reasons, miniaturisation of conventional medical batteries is limited to a few 10s of cm<sup>3</sup>. New active implanted sensing devices are being designed that are less than 1 cm<sup>3</sup> in volume, including some measuring cardiac-related parameters, hence requiring a new energy source. Millimetre-scale solid-state batteries, which do not need significant packaging, have been developed to uniquely enable miniaturisation of next-generation implantable cardiac sensing devices.

**Methods:** Solid-state batteries were fabricated by physical vapour deposition and sputtering. Key developments to increase energy density used the following methods:

- Implement photolithography as a method for patterning the battery's sub-layers at the micron level, enabling miniature features
- Thin down the substrate, i.e. the mechanical support for the batteries, enabling high-energy density
- Stack and interconnect single cells on top of each other, to multiply the energy of the resulting battery for the same footprint
- Increase the cathode thickness in order to store more energy.

The rechargeable batteries have been developed on Ilika's first volume manufacturing line, which opened in Southampton, Hampshire, in 2021, the first of its kind in the UK.

**Results:** Ilika's first solid-state batteries were produced, down to a 15 mm<sup>2</sup> footprint and total thickness 1 mm. The batteries consisted of six stacked cells, interconnected in parallel, yielding a total capacity of 300 uAh and nominal voltage of 3.5 V. The arial energy density of the stacked battery was measured to be approximately 12.5 uAh/mm<sup>2</sup>. Internal resistance of the full stack was measured to be about a sixth of that of each single cell forming the stack, enabling peak power of a few mA. These batteries could be recharged in as little as 8 minutes with heating of the battery less than 2°C upon fast charging. These batteries are going through their final development stage and will go through full medical certification in 2023.

**Discussion:** A novel technique for stacking and interconnecting solid-state cells was shown to significantly increase the energy density and decrease the internal resistance of the battery stack. This development could enable further development in implanted cardiac sensors by providing an energy source of minimal size (mm-scale footprint and µm-scale thickness), appropriate energy density for increasing functionalities, and long life avoiding the risk and cost of removal. Use of rechargeable batteries for in-the-body applications have historically suffered from patient compliance with regards to regular charging. Whilst a new conversation with the patient is required, the benefit of miniaturising non-life-critical sensors that can be recharged in less than 10 minutes, is expected to outweigh the need for regular recharging. □

## Posters 1

## 72/Unsticking the spaghetti of ventricular tachycardia

Authors: *G Panchal (Presenting Author) – Glenfield hospital, Leicester; M Ibrahim – Glenfield hospital, Leicester*

**Case presentation:** The 62-year-old man had a history of anterior myocardial infarction 30 years ago, severe left ventricle (LV) systolic dysfunction due to apical scar and aneurysmal apical anterior wall in LV, with cardiac resynchronisation therapy with defibrillator in 2013 for primary prevention, atrial fibrillation and transient ischemic attack. He presented with an episode of ventricular tachycardia (VT) besides multiple anti-tachycardia pacing despite being on 2 antiarrhythmic drugs (AADs) – amiodarone and bisoprolol. He was listed for an urgent procedure as he required lidocaine infusion, which was stopped 24 hours prior to the procedure, besides other AADs. His last international normalised ratio was 3 due to warfarin. Written informed consent was obtained. Right femoral vein and arterial access was obtained using ultrasound guidance. Two 8-French sheaths were placed into the vein and a 5-French sheath was placed into the artery. A quadripolar catheter was placed into the right ventricular (RV) apex. SLO and BRK needles were used for a transseptal puncture using fluoroscopy guidance. The sheaths were then exchanged with a large curve Agilis. Heparin was given to keep the activated clotting time to >300 s throughout the procedure.

**Mapping of VT:** An HD Grid catheter was used for topographic, voltage and propagation mapping of the LV using EnSite X electro anatomical mapping system. The patient had a spontaneous induction of six different VT morphologies, four of them had a high bundle branch block configuration with superior and inferior axis, and most of them had lateral and anterior exit. Tachycardia cycle lengths varied from 380 ms

to 320 ms and all of them had stable haemodynamics, with systolic blood pressure between 80–100. We used substrate mapping with RV pacing using omnipolar mapping technique as well, and we managed to complete activation mapping of two of the six different VT episodes. The map revealed large anterior and apical scar with areas of slow conduction and mid diastolic potentials across the region. An FJ TACTICATH irrigated tip catheter was used to target the critical isthmus of tachycardia along with the late potential signals. We used 40–45 watts, 10–20 g aiming at LSI of 6. We successfully ablated and eliminated all the late potentials and conducting channels within the scar. Further programmed ventricular stimulation revealed two different VT circuits with multiple apical exits. We had noted some apical late potential within the apical aneurysm; therefore, further radiofrequency ablation targeted all these signals. At the end of the procedure, aggressive VT stimulation did not lead to any sustained arrhythmia. This was accepted as an endpoint. Protamine was given, sheaths were removed, and Z suture was applied for haemostasis and Angioseal for the right femoral artery access.

**Learning points:** Mapping multiple morphologies of VT is a challenge, but it can be due to a single re-entry utilising a single isthmus. It is very critical to target the isthmus to achieve abolition of VT. Isolation of late potentials by ablation can improve the outcome.

**Conclusion:** This is an interesting case of VT with multiple morphologies but using two discreet isthmuses. Identifying the critical isthmus and ablation of late potentials demonstrated successful control of cardiac arrhythmias. □

Posters 1

**73/Automated, high-precision echocardiographic and haemodynamic atrioventricular delay assessment for right ventricular pacing in hypertrophic obstructive cardiomyopathy**

Authors: *JS Mohal* (Presenting Author) – National Heart & Lung Institute, Imperial College London, London; *F Simader* – National Heart & Lung Institute, Imperial College London, London; *M Shun-Shin* – National Heart & Lung Institute, Imperial College London, London; *A Arnold* – National Heart & Lung Institute, Imperial College London, London; *Z Whinnett* – National Heart & Lung Institute, Imperial College London, London

**Background:** Right ventricular pacing (RVP) to reduce left ventricular outflow tract (LVOT) obstruction in hypertrophic obstructed cardiomyopathy (HOCM) remains controversial. Imprecise and variable atrioventricular delay (AVD) selection methods have contributed to the uncertainty. Using automated, high-precision AVD selection methods that target cardiac output incrementation may allow reliable identification of the optimal AVD to determine whether optimised RVP is beneficial in HOCM.

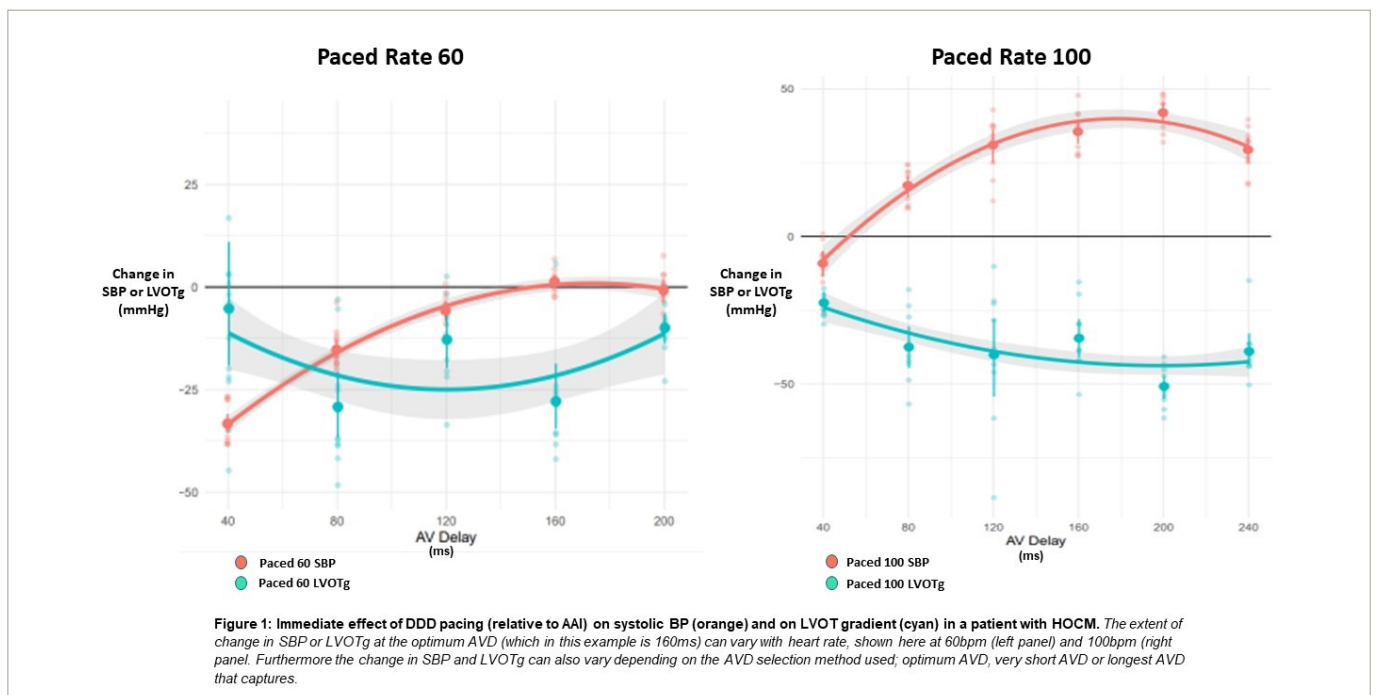
**Methods:** A total of 15 patients with HOCM and dual chamber pacing devices *in situ* were recruited. Pacing was alternated between atrial pacing (AAI) and AV sequential RVP (DDD) 10 times whilst beat-by-beat blood pressure (BP) via non-invasive finometry and LVOT continuous wave Doppler for LVOT gradient (LVOTg) via echocardiography were continuously recorded. This was repeated for a full range of AVDs at 10 bpm above sinus rate and 100 bpm. Custom software automated detection of LVOTg trace troughs and BP trace peaks to identify beat-by-beat LVOTg and systolic blood pressure (SBP), respectively. The mean difference in LVOTg and BP between pacing states (AAI and DDD) were plotted for each AVD and fitted to quadratic curves to improve precision (Figure 1). The peak of SBP curve identified the optimal AVD

for cardiac output. Averaging changes in beat-by-beat SBP and LVOTg across multiple pacing transitions accounts for physiological drift and automated analysis reduces bias.

**Results:** Mean LVOTg of recruited patients was 50 mmHg at rest. At 10 bpm above sinus rate, DDD pacing at optimal AVD significantly increased SBP (+2.72 ± 1.33 mmHg; p=0.05) and significantly reduced LVOTg (-12.4 ± 3.64 mmHg; p=0.002). At 100 bpm, greater SBP increases were seen (+10.0 ± 3.96 mmHg; p=0.02) with greater LVOTg reductions (-23.7 ± 6.95 mmHg; p=0.004). Alternative described methods for AVD selection also reduced LVOTg but with worse SBP responses. Longest fully captured AVD reduced LVOTg (-3.34 ± 2.05 mmHg) but increased SBP by a smaller amount than optimal AVD (+1.36 ± 1.1 mmHg). Very short AVD (40–80 ms) reduced LVOTg (-5.55 ± 4.3 mmHg; p=0.2) but substantially reduced SBP (-23.5 ± 3.22 mmHg; p<0.01).

**Conclusion:** High precision, automated haemodynamic measurements detected the optimum AV delay that balanced the increased LVOT size, reduced myocardial performance and altered AV filling that occur with RVP for HOCM. AVD-optimised RVP reduced LVOTg and improved cardiac output. □

Figure 1





Posters 1

**74/Safety and tolerability of inpatient and outpatient initiation of disopyramide for obstructive hypertrophic cardiomyopathy in a referral centre for septal reduction**

Authors: *YW Liao (Presenting Author) – Liverpool Heart and Chest Hospital, Liverpool; U Raza – Liverpool Heart and Chest Hospital, Liverpool; RM Cooper – Liverpool Heart and Chest Hospital, Liverpool*

**Introduction:** Left ventricular outflow tract obstruction (LVOTO) is reported in up to two-thirds of hypertrophic cardiomyopathy (HCM) patients. This can cause symptoms of dyspnoea, chest pain, pre-syncope, and syncope. Disopyramide is a negative inotrope that can reduce the pressure gradient created by LVOTO. Disopyramide has a class 1B recommendation for LVOTO in the European Society of Cardiology HCM guidelines and can be trialled in symptomatic patients before proceeding to more invasive treatment.

**Purpose:** To evaluate the safety and tolerability of disopyramide initiation in an inpatient and outpatient setting.

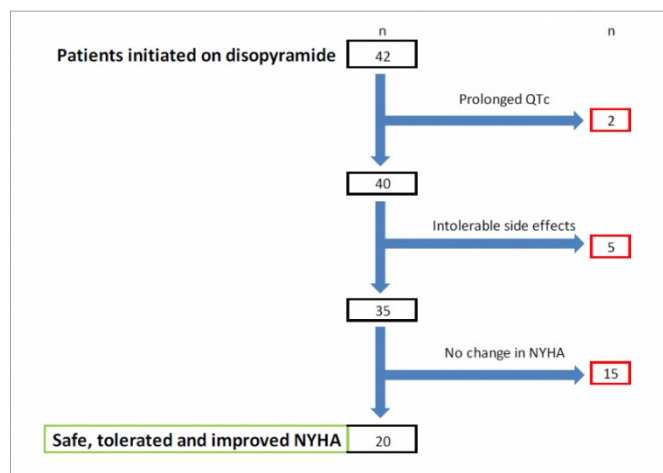
**Methods:** A total of 42 patients with obstructive HCM were started on disopyramide in our centre from 2017 to 2022. From 2017 to 2020, all disopyramide initiation required 2 days' admission with telemetry monitoring, electrocardiogram three times a day, and inpatient echocardiogram. Patients were started on 100 mg three times a day and uptitrated to 250 mg twice a day by Day 2 if there were no rhythm abnormalities or significant conduction or repolarisation changes on electrocardiogram (ECG). We started outpatient initiation from 2020 with a starting dose of 100 mg three times a day and titrating to 250 mg MR twice a day within 3 weeks. All patients had an ECG on the day of initiation, 1 week post initiation and 2 weeks post initiation.

**Results:** In our inpatient cohort (n=31), there was no significant change in heart rate (HR 73 ± 1.4 bpm to 71 ± 1.3 bpm). There was some non-significant delay in conduction when peak disopyramide dose was achieved: PR (168 ± 19 ms to 184 ± 27 ms), QRS (104 ± 21 ms to 113 ± 26 ms). Repolarisation measures were also delayed in a non-significant manner: QT (408 ± 38 ms to 439 ± 39 ms) and corrected QT (445 ± 37 ms to 475 ± 41 ms). No patient had QTc >500 ms.

Our outpatient cohort (n=11) had similar findings with HR (67 ± 1.7 bpm to 66 ± 1.5 bpm), PR (175 ± 34 ms to 193 ± 35 ms), QRS (113 ± 25 ms to 117 ± 22 ms), QT (428 ± 57 ms to 453 ± 50 ms), and corrected QT (442 ± 25 ms to 467 ± 22 ms).

A total of 11 patients had side effects following initiation and seven

Figure 1



patients (17%) had to discontinue treatment. The most common side effects reported were dry mouth (n=6), constipation (n=7), urinary symptoms (n=3), visual changes (n=4) and pre-syncope (n=1). Prolonged QTc >500msec was seen later in two patients on follow-up.

There was no sudden cardiac death or syncope in our patient cohort. For patients who continued on disopyramide (n=35), there was a decrease in the mean New York Heart Association (NYHA) functional class from 2.06 ± 0.7 to 1.35 ± 0.5 on a mean follow-up of 171 days. A total of 20 patients (57%) who continued on disopyramide improved by at least one NYHA class (Figure).

**Conclusion:** Our data suggest disopyramide is effective in improving symptoms of dyspnoea and is safe in patients with obstructive HCM. 17% of patients stopped disopyramide due to side effects and 5% stop due to QTc >500 ms. □

Posters 1

75/The development of a Comprehensive Cardiac Devices Service, NHS Forth Valley

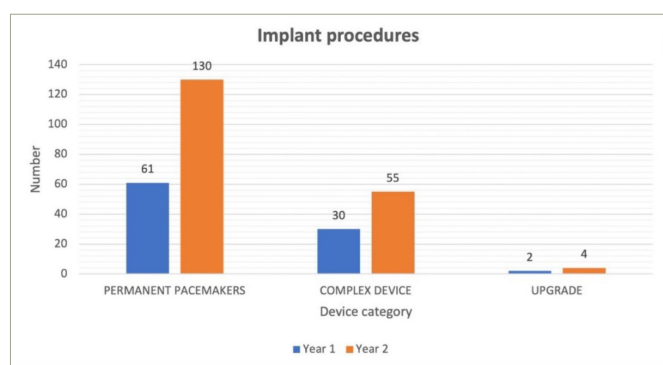
Authors: *K Hutchison (Presenting Author) – University of Glasgow, Glasgow; O Fersia – FVRH, Larbert; H Robinson – FVRH, Larbert; S Venkatasubramanian – FVRH, Larbert; G Padfield – FVRH, Larbert; J Maclachlan – FVRH, Larbert; J McDonald – FVRH, Larbert; C Mondoia – FVRH, Larbert; C Labinjoh – FVRH, Larbert*

**Introduction:** In October 2020, Forth Valley Royal Hospital’s (FVRH) pacing service underwent a full repatriation from the Royal Infirmary of Edinburgh. Interventional radiology (IR) was established as the main inpatient pacing site (2 sessions a week) with IR staff education, training and developing standard operative procedures. Theatre capacity was increased from 1 to 2 sessions per week for elective pacing and the pacing services expanded to include complex devices, subcutaneous implantable cardioverter defibrillator and His bundle pacing. This report compares data from 1 year prior to the repatriation date (Year 1) and 1 year post (Year 2), in order to assess the quality of the new service provided and impact on the local population.

**Methods:** Data were collected on all patients undergoing an implant procedure within the hospital and entered into an Excel spreadsheet. This included: date of implant, type of device implanted, if procedure occurred in IR or theatre, if patient was inpatient (I/P) or outpatient (O/P), admission and discharge date, and length of stay. Complication and re-intervention rates were collected for Year 2.

**Results/Discussion:** There were 96 patients who received an implant procedure at FVRH in Year 1 which increased to 194 patients in Year 2. From Year 1 to Year 2, the number of patients receiving implants increased in all device categories (permanent pacemakers, complex devices, generator replacements and upgrades) (Figure 1). Of the 65 O/Ps in Year 1, 71% were discharged the same day and 29% were discharged the day after. This increased in Year 2 with 75% of the 123 O/Ps being discharged the same day. I/P average length of stay decreased from 15.1 days in Year 1 to 4 days in Year 2 with most patients being discharged within 24 hours of implant. The waiting time for routine elective device implantation dropped from 3 months in Year 1 to 2 weeks in Year 2. Total complication rate from all implant procedures in Year 2 was low, at 3.6% with a re-intervention rate of 2.1% for permanent pacemakers and 4.7% for complex devices. This is less than the national 1-year re-intervention rate of 4.3% for permanent pacemakers and 6% for complex devices.<sup>1</sup>

Figure 1: Category of implant procedures in Year 1 (before repatriation) compared to Year 2 (after repatriation)



**Conclusion:** The development of a local comprehensive cardiac devices service in NHS Forth Valley had a positive effect on providing a person-centred approach that improved patients’ journeys and reduced in-hospital bed stay and need for inter-hospital transfers. The service continues to be safe and efficient with low complication rates. In Year 3, the NHS Forth Valley cardiac devices service has successfully expanded further in order to provide regional devices implantation support to patients from NHS Fife and NHS Dumfries and Galloway, underpinning the need for collaborative work between different health boards in order to provide a successful and innovative health service for the wider population. □

1. The National Institute for Cardiovascular Outcomes Research. National audit of cardiac rhythm management (NACRM), 2021 summary report. P34. [internet]. 2021 [28/03/22]. Available at: [https://www.nicor.org.uk/wp-content/uploads/2021/10/NACRM-Domain-Report\\_2021\\_FINAL.pdf](https://www.nicor.org.uk/wp-content/uploads/2021/10/NACRM-Domain-Report_2021_FINAL.pdf)

Posters 1

76/Prevalence of arrhythmia among patients attending adult congenital heart diseases clinics

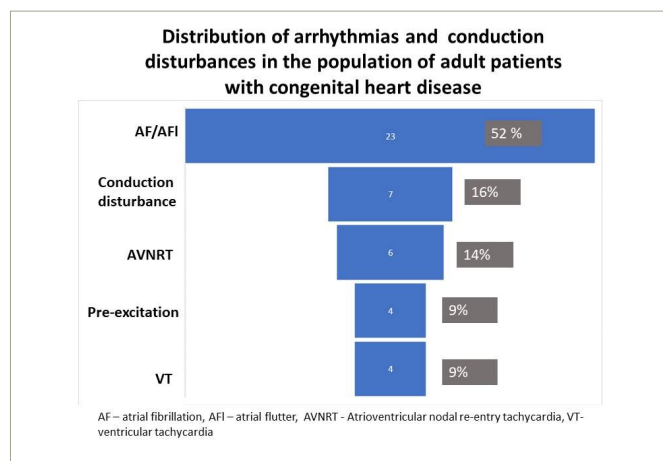
Authors: *A Ebeid (Presenting Author) – East Midlands Congenital Heart Centre, Leicester; S Alkhafaji (Presenting Author) – East Midlands Congenital Heart Centre, Leicester; S Mansoor (Presenting Author) – East Midlands Congenital Heart Centre, Leicester; M Kurian – East Midlands Congenital Heart Centre, Leicester; F Mahamoud – East Midlands Congenital Heart Centre, Leicester; R Debiec – East Midlands Congenital Heart Centre, Leicester; AP Bolger – East Midlands Congenital Heart Centre, Leicester; M Lazdam – East Midlands Congenital Heart Centre, Leicester*

**Introduction:** Arrhythmias constitute an important cause of hospitalization, morbidity and mortality among adult patients with congenital heart diseases (ACHD). These patients are more predisposed to arrhythmias due to many factors including congenital and acquired abnormalities of conduction system, abnormal loading conditions leading to structural and electrical remodelling, myocardial fibrosis due to longstanding hypoxia and presence of prosthetic materials and scars together with the anatomical barriers enabling re-entrant arrhythmias. The aim of our study was to establish the prevalence of arrhythmias and need for electrophysiology (EP) support among patients with ACHD.

**Methods:** We conducted a retrospective review of the patients who attended ACHD clinics in a single tertiary Cardiac Centre in the UK over a period of 3 months from 01/07/2021 to 01/10/2021. The clinic letters of consecutive patients who attended ACHD clinics during that period were reviewed and information recorded in a purpose-built questionnaire. The collected information included antecedent or new diagnoses of arrhythmia, type of arrhythmia, evidence of previous and new EP procedures and investigations, previous and new implantations of devices and use of anti-arrhythmic medications.

**Results:** In the period between 01/07/2022 and 01/10/2022 there were 16 separate ACHD clinic lists comprising 239 appointments. In total, 23 patients failed to attend their specified appointment. Eighteen patients had two separate appointments during the period of observation; in eight cases this was due to non-attendance to the initial appointment and in 10 cases this was due to a genuine clinical need. Altogether, 207 individual patients were reviewed in the ACHD clinic during the period of observation. Of the 207 patients, 44 (21%) had evidence of arrhythmia, conduction disturbances and previous EP procedures or devices implantations (Figure 1). The most common arrhythmias in the population of patients with ACHD were atrial fibrillation (AF) and/or atrial flutter (AFI), which affected 23 patients. In 15 patients, AF/AFI was associated with simple congenital lesions (atrial septal defect or partial anomalous pulmonary venous connection [n=11], corrected left ventricular outflow tract obstruction [n=3] and coronary artery abnormality without evidence of ischaemia [n=1]). In five patients, AF/AFI was associated with lesions of moderate complexity (corrected right ventricular outflow obstruction

Figure 1



and in three patients it was associated with complex lesions. Seven of the 207 patients had evidence of conduction abnormalities (six patients had previous pacemaker implantations due to atrioventricular block and one patient was under surveillance for asymptomatic SN disease). Of the four patients with evidence of pre-excitation, two had undergone accessory pathway ablation and two patients had been offered the procedure but refused. There were four patients with evidence of previous ventricular tachycardia; two patients had cardiac resynchronization therapy defibrillator/implantable cardioverter-defibrillator devices, one patient had undergone surgical right ventricular scar ablation, and one patient with complex univentricular physiology, refused EP study and was being managed conservatively.

**Conclusion:** The population of patients attending the ACHD clinic is characterised by high burden of arrhythmias. These patients are likely to need specialist input in the ACHD clinics as well as repeated EP procedures and device re-implantations. The provision of such services should be taken into account when planning functioning of the ACHD service. □

Posters 1

**77/Procedural safety and acute effectiveness of pulsed field ablation for treatment of atrial fibrillation – a report on the first series of cases in the UK**

Authors: LH Hong (Presenting Author) – University of Cambridge, Cambridge; J Mesquita – Royal Papworth Hospital, Cambridge; J Eldridge – Royal Papworth Hospital, Cambridge; DA Begley – Royal Papworth Hospital, Cambridge; PM Heck – Royal Papworth Hospital, Cambridge; CA Martin – Royal Papworth Hospital, Cambridge

**Introduction:** Pulsed field ablation (PFA) is a novel, non-thermal, atrial fibrillation (AF) ablation technique, in which delivery of millisecond electrical pulses generates pores in cell membranes, leading to its disruption (electroporation). PFA has demonstrated high selectivity for cardiomyocytes, thus reducing the risk of collateral extracardiac tissue damage often associated with thermal ablation methods. Both preclinical and clinical studies have indicated that PFA has promising advantages over existing techniques in terms of safety profile and enhanced lesion durability, although long and very-long term data are still lacking. We report on the procedural safety and acute effectiveness of the first PFA cases performed in the UK.

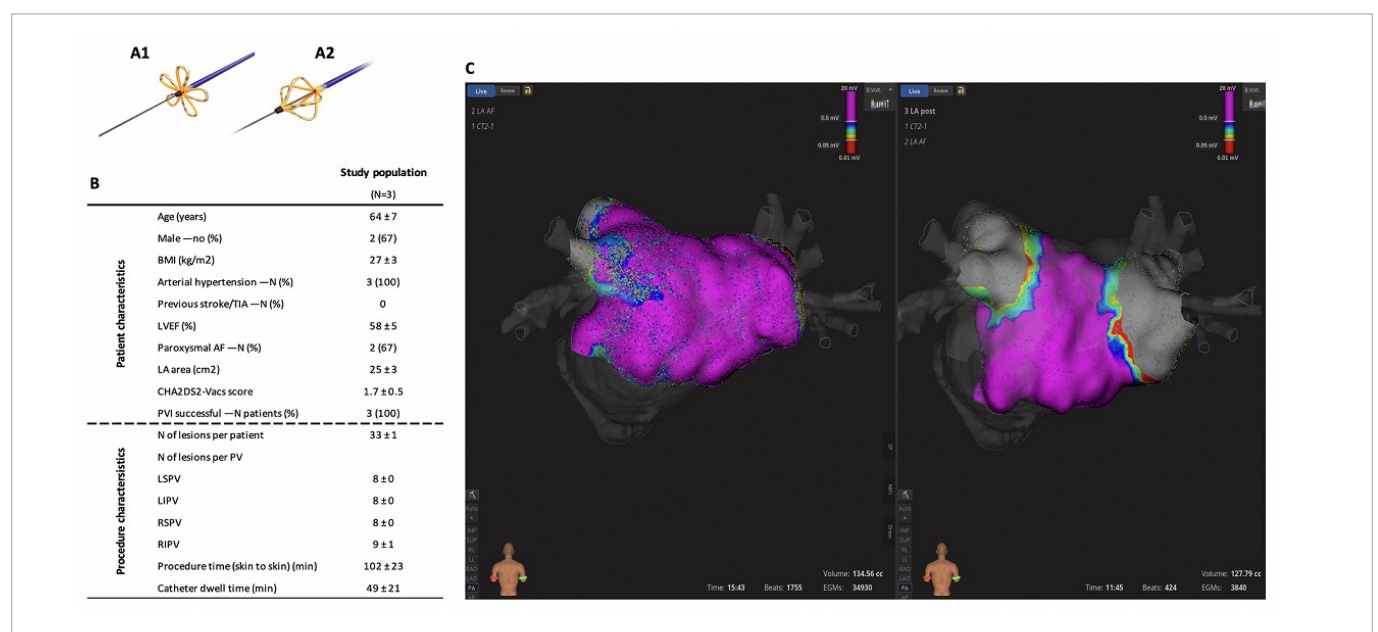
**Methods:** This was a prospective registry study including patients with AF who were eligible for ablation according to the European Society of Cardiology AF (2020) guidelines. A pre-procedural chest computed tomography scan was performed, to evaluate pulmonary vein (PV) anatomy and exclude intracardiac thrombus. All procedures were carried out under general anaesthesia, with patients omitting a single dose of their direct oral anticoagulants prior to the intervention. Heparin was administered to maintain an activated clotting time of >300 ms. The FARAPULSE® system (Boston Scientific, Massachusetts, USA) was used to perform PFA. Following a single transeptal puncture to access the left atrium, a single-shot multielectrode PFA catheter (Farawave®, Boston Scientific) was advanced over a guidewire, through a 13-Fr steerable sheath (Faradrive®, Boston Scientific). The catheter is composed of 5 splines, each containing 4 electrodes, and is rotated between applications, to ensure full circumferential PV ostial and antral coverage.

Ablation is delivered in both ‘flower’ (Figure A1) and ‘basket’ (Figure A2) configurations, with a biphasic waveform output of 2000 V. Acute isolation of the treated vein was determined by the mapping electrodes on each spline of the PFA catheter. Electroanatomical 3D maps were also created using the Rhythmia® mapping system (Boston Scientific), both before and after ablation.

**Results:** Patient and procedure characteristics are detailed in the table (Figure B). In this series of treated patients, PFA successfully isolated all PVs, without any complications during the procedure and hospital admission. Vein isolation was confirmed both with electrogram and electroanatomical voltage mapping (Figure C, pre [left] and post [right] ablation). As per protocol, each vein was isolated with 8 applications, with the exception of the right inferior pulmonary vein in the first patient, which required 11 applications due to acute angulation of the vein with respect to the transeptal puncture. The mean procedure time was 102 ± 23 minutes, which reduced significantly with each case, indicating a steep learning curve, which improved on both radiofrequency and cryoballoon ablation times.

**Conclusions:** This initial series of AF patients treated with PFA – the first performed in the UK – highlights the acute safety and effectiveness of this system. Despite missing long-term outcomes, this new technical approach shows potential in further reducing the risk of complications, while providing durable lesions and reducing procedure times. Further data will be prospectively gathered to provide statistically relevant results. □

Figure 1



Posters 1

**78/Gender-specific and cardiomyopathy-specific differences in heart rate variability under the aspect of circadian rhythm**

Authors: *S Metje (Presenting Author) – CAU, Kiel; B Baldauf – CAU, Kiel; H Bonnemeier – CAU and Helios Cuxhaven, Cuxhaven*

**Introduction:** In the past decades, a significant association between the autonomic nervous system and cardiovascular mortality, including sudden cardiac death, has been recognised. Experimental evidence of an association between the propensity for fatal arrhythmias and signs of increased sympathetic or decreased vagal activity has encouraged the development of quantitative markers of autonomic activity. Heart rate variability (HRV) is well established and has been shown to be deteriorated in individuals with known structural heart disease. The present work is a first to compare HRV in ischaemic (ICM) and dilated (DCM) cardiomyopathy with focus on circadian and gender differences using both classical time-domain parameters and non-linear time domain as well as non-linear methods of fractal geometry.

**Methods:** A database of 923 Holter electrocardiograms (ECGs) from patients with ICM or DCM was reviewed to create comparable groups in terms of New York Heart Association class III–IV, left ventricular ejection fraction (LVEF) less than 40%, medication, gender and age. In order to analyse the circadian differences between patients with DCM and ICM, a

1-hour interval was selected during the day and at night for every patient (day from 6 am to 9 pm; night 9 pm to 6 am). Time intervals for final analysis were selected after visual confirmation. Artefacts were identified as such after visual discrimination. Measurements were conducted by linear and non-linear parameters during sinus rhythm.

**Results:** Holter ECG recordings of 113 patients with structural heart disease (DCM n=38, mean age  $67 \pm 14$  years; ICM n=75, mean age  $72 \pm 11$  years) entered final analysis. Groups were comparable in baseline characteristics. Overall, 77 were male. Participants were on optimal medical treatment including medication with known antiarrhythmic effect in structural heart disease (ACE, ARB, beta blockers, no other class antiarrhythmic drugs), diuretics and MCRA; patients with ICM had additional dual antiplatelet inhibition and statins or ASA/statin therapy, with additional inconsistent ASA/statin administration in DCM patients. *Figures 1–11* show the results with significances for our observations as follows: \* ( $p < 0.05$ ), \*\* ( $p < 0.010$ ), \*\*\* ( $p < 0.001$ ) and n.s. (not significant,  $p > 0.050$ ).

Figure 1: Visual discrimination of intervals for analysis

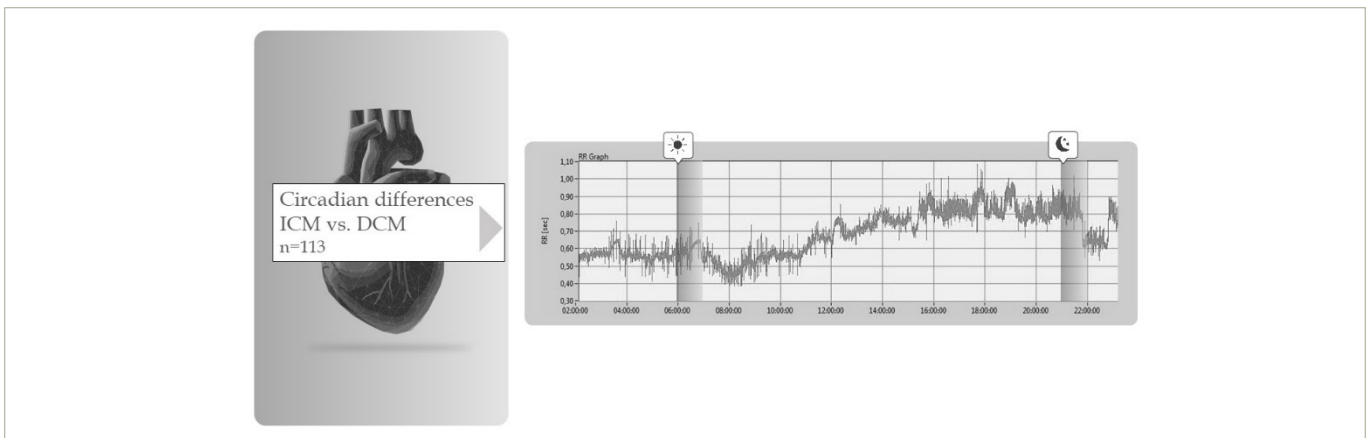


Figure 2: MeanRR

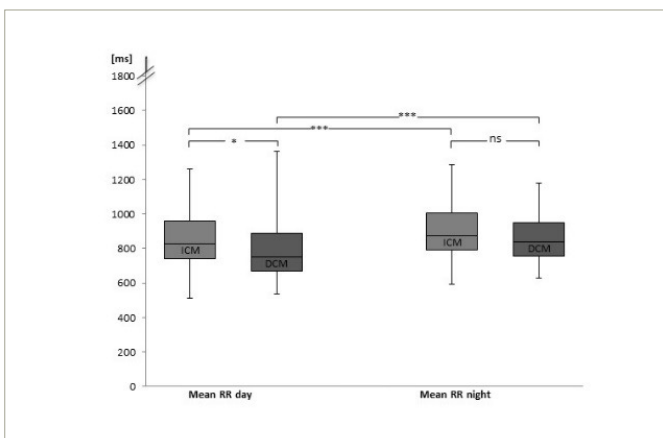
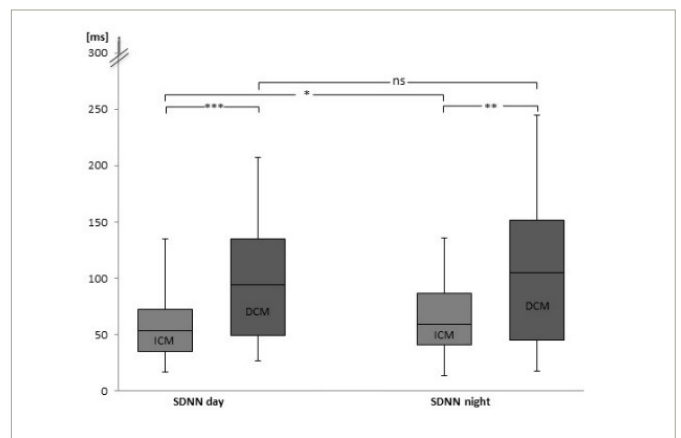


Figure 3: SDNN



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Figure 4: SDANN

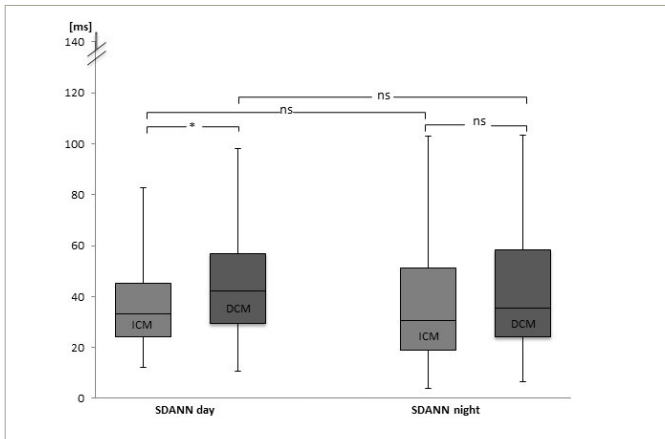


Figure 7: AppEn

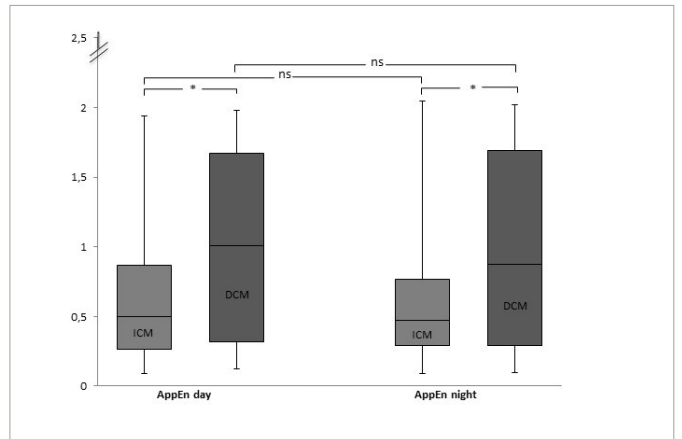


Figure 5: RMSSD

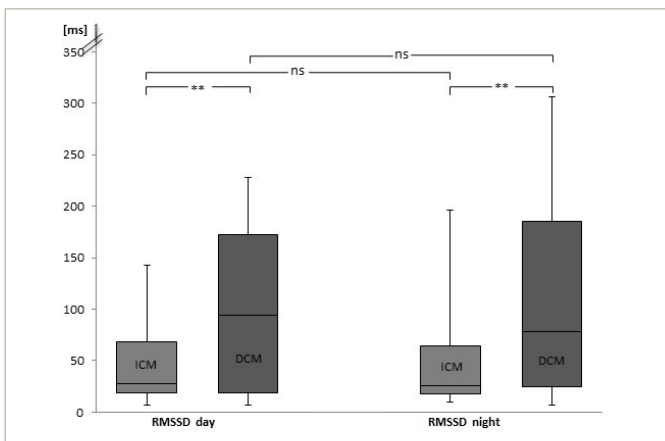


Figure 8: Power-law slope

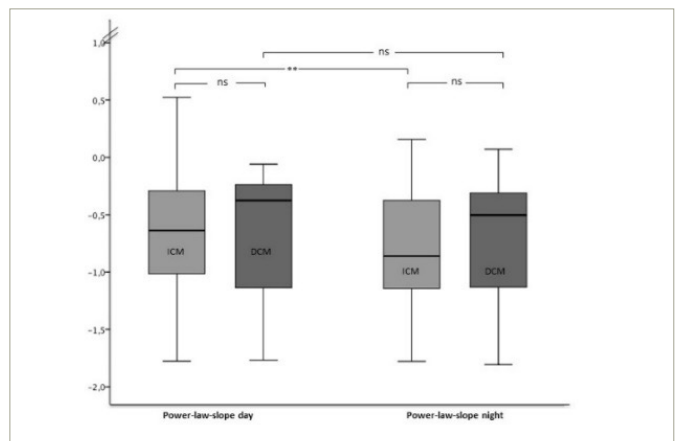


Figure 6: DFA

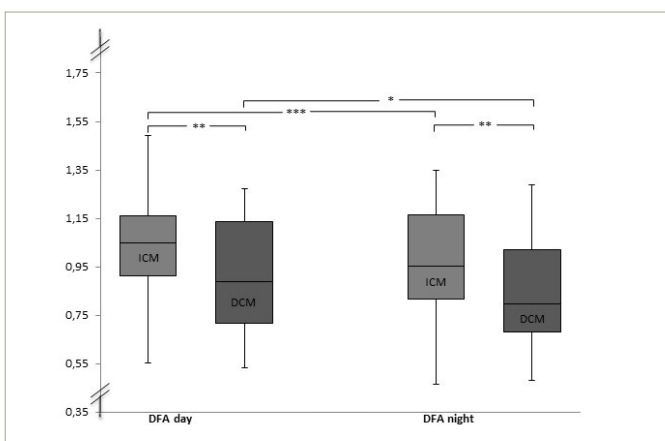
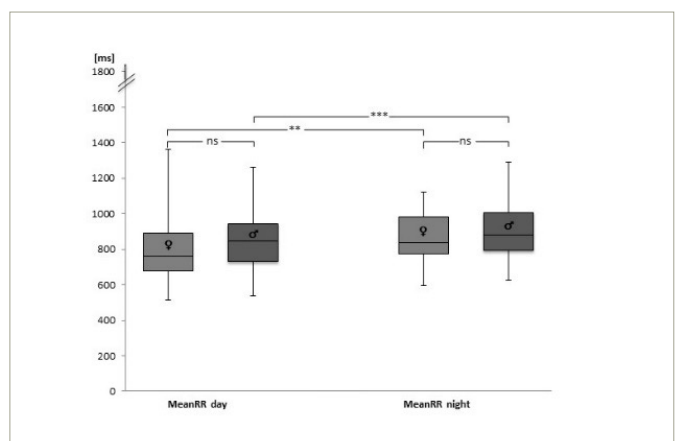
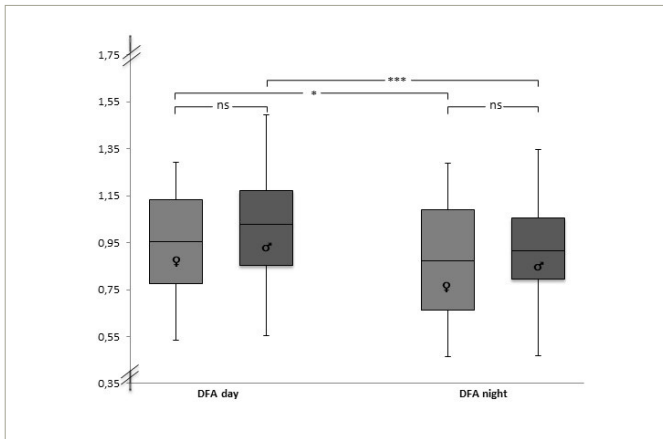


Figure 9: MeanRR gender



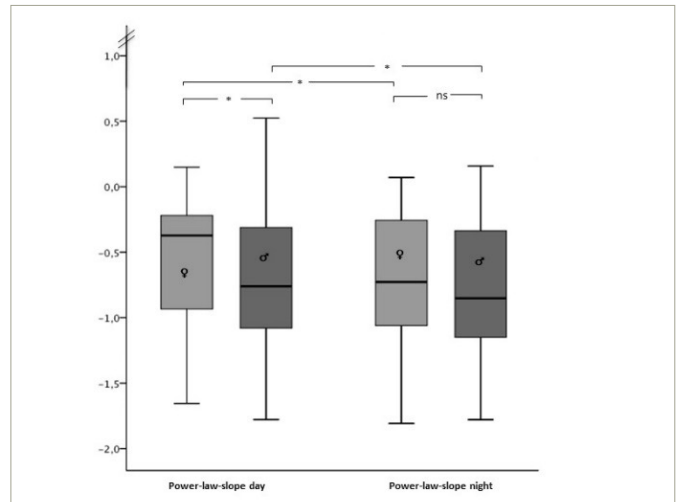
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Figure 10: DFA gender



**Conclusions:** Although the patients with DCM are clinically comparable in terms of cardiac function (mean LVEF of both groups 28%), medication and age, they appear to have higher heart rate variability compared with patients with ICM. Comparing gender differences, only a significantly steeper power law slope for men with structural heart disease was evident during the day. Whereas

Figure 11: Power-law slope gender



the observations regarding patients with DCM may come as a surprise, with only a slightly younger age as possible explanation, the observation for gender differences may be expected. □

Posters 1

**79/In-patient pacemaker implantation for sinus node dysfunction is associated with an increased mortality**

Authors: *AJ Sharp (Presenting Author) – Norfolk & Norwich University Hospital, Norwich; P Garg – Norfolk & Norwich University Hospital, Norwich; W Lim – Norfolk & Norwich University Hospital, Norwich*

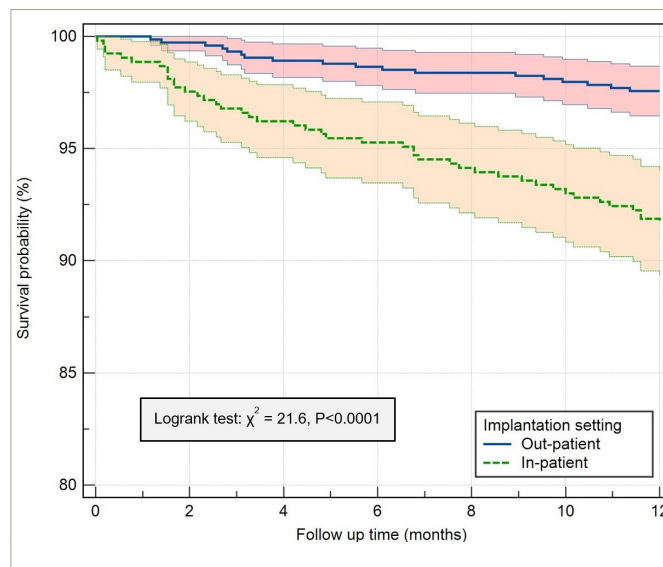
**Introduction:** Permanent pacemaker (PPM) implant is a well-established treatment to reduce morbidity in patients with symptomatic sinus node dysfunction (SND). Common symptoms of shortness of breath on exertion, fatigue, dizziness and syncope can be incredibly disabling. When we consider its increased prevalence in the elderly, where falls and deconditioning are leading drivers of mortality, the importance of timely intervention is clear. We hypothesised that early intervention before hospital admission could be beneficial in reducing overall mortality. We investigate this by comparing mortality data between patients receiving inpatient (IP) and outpatient (OP) implants.

**Methods:** This was a single-centre, observational study. We included patients who had either a single or dual chamber PPM implanted for SND between 1 January 2016 and 1 November 2020. Patients were excluded if they had any degree of atrioventricular block. Clinical information was entered at the time of implant into our institution’s electronic records database. This system is linked to the Office for National Statistics mortality records allowing us to extract all necessary data for analysis. Survival analysis was conducted using Kaplan–Meier (KM) plots and survival compared using the log-rank test. Univariate Cox proportional hazard regression analysis (CPhM) was used to assess the prognostic value of prespecified demographic, symptom, comorbidity and implant-related metrics.

**Results:** A total of 1,269 patients were included in the analysis: 740 (58%) OPs and 529 (42%) IPs. Cohorts were similar in age (OP  $76 \pm 9$  years vs IP  $77 \pm 11$  years;  $p=0.12$ ) and gender (female OP 338 [46%] vs IP 245 [46%];  $p=0.82$ ). IPs had more syncope (IP 303 [57%] vs OP 269 [36%];  $p<0.001$ ) and ischaemic heart disease (IHD; IP 125 [24%] vs OP 125 [17%];  $p<0.05$ ). Implant complication rate was non-significantly higher in OPs (OP 32 [4.3%] vs IP 15 [2.8%];  $p=0.17$ ). KM survival analysis (Figure) demonstrated worse survival in IPs, with significantly different survival curves ( $p<0.001$ ). CPhM analysis of 1-year all-cause mortality demonstrated IP implant (HR 3.25, 95% CI 1.92–5.50;  $p<0.001$ ), presence of IHD (HR 2.22, 95% CI 1.10–4.51;  $p<0.001$ ) and age (HR 1.11, 95% CI 1.07–1.15;  $p<0.001$ ) were significant predictors of mortality. Symptoms of presyncope (HR 1.13, 95% CI 0.70–1.85;  $p=1.13$ ) and syncope (HR 1.29, 95% CI 0.78–2.11;  $p=0.32$ ) were not.

**Conclusions:** Our study highlights the morbidity associated with SND,

Figure 1



with a significant proportion of patients requiring hospital admission. Importantly, we demonstrated IP implant is strongly associated with increased all-cause mortality, representing a worse prognostic marker than age or IHD. This supports our hypothesis that intervention before development of debilitating symptoms necessitating admission is beneficial in these patients. It may be considered that admission is correlated with a patient’s functional reserve (i.e. the frailer patient is likely to manifest more significant symptoms with less ability to manage within the community). As such, IP implant will inevitably be associated with higher mortality. Indeed, we do not suggest that SND is a direct cause of mortality in these patients, rather a leading driver of this deconditioning. Identification of these vulnerable patients to facilitate earlier intervention is likely to be of significant benefit. The clinical application of this is challenging. However, we suggest consideration of a patient’s frailty score may be of value and aim to investigate this with future prospective work. □

Posters 1

**80/Atrial fibrillation organisation correlates with ventricular response regularity in patients with persistent atrial fibrillation undergoing catheter ablation**

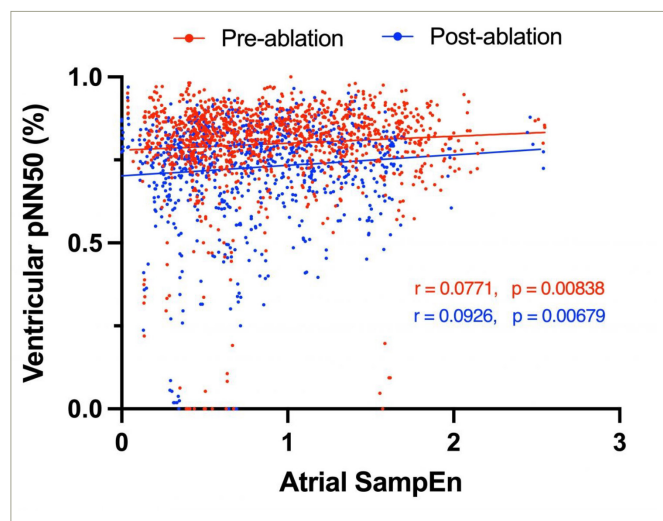
Authors: *N Ahsan (Presenting Author) – Imperial College London, London; A Sau – Imperial College London, London; R Neerahoo – Imperial College London, London; N Qureshi – Imperial College London, London; M Koa-Wing – Imperial College London, London; D Keene – Imperial College London, London; L Malcolm-Lawes – Imperial College London, London; DC Lefroy – Imperial College London, London; NWF Linton – Imperial College London, London; PB Lim – Imperial College London, London; A Varnava – Imperial College London, London; ZI Whinnett – Imperial College London, London; P Kanagaratnam – Imperial College London, London; DP Mandic – Imperial College London, London; NS Peters – Imperial College London, London; FS Ng – Imperial College London, London*

**Background:** Atrial fibrillation (AF) is characterised by an irregularly irregular ventricular rhythm. However, an understanding of the mechanisms by which the regularity of ventricular response is influenced by AF dynamics is still lacking. In AF, atrial electrical activity can have different levels of organisation on a spectrum, from organised AF sustained by focal drivers through to disorganised AF sustained by multiple wavelet re-entry. We aimed to investigate whether the ventricular response in AF was associated with the organisation of atrial electrical activity, with the hypothesis that AF organisation correlates with ventricular response regularity.

**Methods:** Data from 239 patients with persistent AF undergoing pulmonary vein isolation (PVI) were retrospectively reviewed. AF organisation and measures of ventricular variability and irregularity were evaluated in 50-second segments in each patient before and after ablation. AF organisation was assessed using Shannon entropy (ShEn) and Sample entropy (SampEn) of coronary sinus (CS) atrial electrograms. Ventricular variability and irregularity were evaluated using RR interval (RRI) metrics derived from the surface electrocardiogram (ECG). RRI variability was evaluated using the time-domain measures: normalised mean RRI difference, standard deviation of RRIs (SD RRI), normalised SD RRI, root mean square of successive RRI differences (rMSSD) and percentage of successive RR intervals that differ from each other by more than 50 ms (pNN50). RRI irregularity was measured using SampEn and normalised SampEn.

**Results:** A significant decrease in atrial ShEn and SampEn was observed following PVI across all CS channels (e.g. SampEn CS 3-4: pre-ablation  $0.907 \pm 0.512$  vs post-ablation  $0.790 \pm 0.447$ ;  $p < 0.0001$ ). Both ShEn and SampEn from CS atrial electrograms were significantly correlated with the RRI variability and irregularity measures from surface ECG (pNN50, normalised mean RRI difference, normalised SD RRI and normalised SampEn) both pre- and post-ablation (pNN50:  $r = 0.0771$ ,  $p = 0.00838$

Figure 1



[Figure 1]; normalised mean RRI difference:  $r = 0.144$ ,  $p < 0.0001$ ; normalised SD RRI:  $r = 0.175$ ,  $p < 0.0001$ ; normalised SampEn:  $r = 0.168$ ,  $p < 0.0001$ ; correlations with SampEn CS 3-4 pre-ablation shown).

**Conclusions:** The reduction in atrial ShEn and SampEn following PVI suggests that PVI is accompanied by an increase in AF organisation. The significant correlations between atrial entropy and measures of RRI variability and irregularity suggest that AF organisation impacts ventricular response regularity. Therefore, interpretation of the RRI variability and irregularity from the surface ECG may give some insight, non-invasively, into the level of AF organisation. □

Posters 1

**81/Sorry we missed you – increasing rates of CIED non-elective battery replacement in the COVID-19 era**

Authors: *JH Harfield (Presenting Author) – Peninsula Medical School, Plymouth; BS Sieniewicz – University Hospitals Plymouth NHS Foundation Trust, Plymouth*

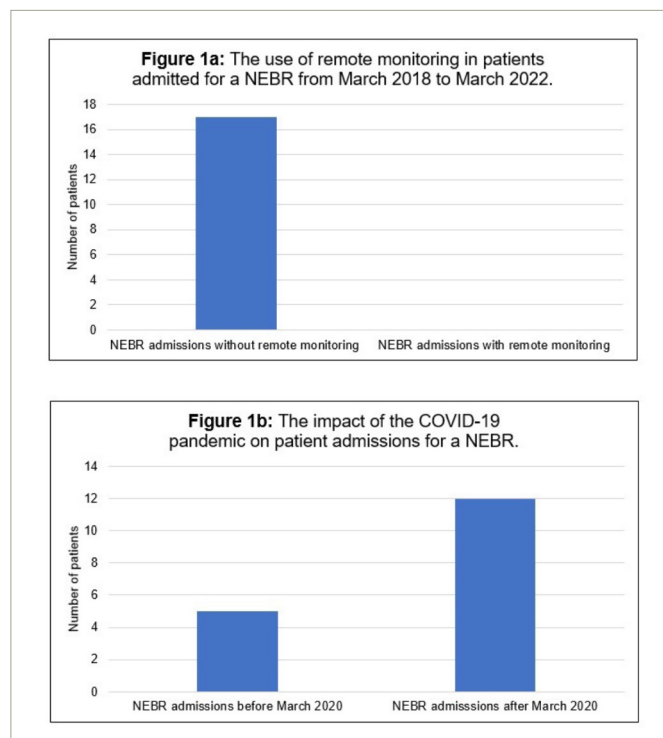
**Introduction:** Cardiac implantable electronic devices (CIEDs) are a well-established treatment of cardiac arrhythmias, comprising pacemakers, implantable cardioverter defibrillators and cardiac resynchronisation therapy. In order to ensure continued reliable delivery of CIED therapy, it is essential patients receive high-quality device monitoring.<sup>1</sup> This is mostly done with in-person reviews of symptoms, disease events and device function. However, newer CIEDs can communicate functional data remotely to provide early detection of disease events and battery depletion.<sup>2</sup> While CIED battery depletion is gradual, it is often unpredictable, and ideally batteries must be replaced before the elective replacement indicator (ERI). At this time, the CIED reprograms to conserve battery with reduced functionality and thus negatively impacts patient experience.<sup>3</sup> During the COVID-19 pandemic, capacity for in-person CIED follow-up at our centre was greatly reduced. We aimed to evaluate the impact this had on patient care by reviewing whether there was an increase in non-elective admissions for patients who had reached ERI and so needed a non-elective battery replacement (NEBR).

**Methods:** The records of patients with a CIED who underwent a battery change between March 2018 to March 2022 were retrospectively reviewed at our tertiary cardiac centre. We reviewed the electronic discharge summary of all patients with a length of stay over 24 hours to determine the reason for their admission.

**Results:** A total of 485 patients underwent a CIED battery change in this 4-year period. Of these, 42 patients were admitted for over 24 hours. Overall, 17 patients were admitted for an NEBR after it was found their CIED had reached the ERI. Notably, none of these patients had been established on remote follow-up (*Figure 1a*). The mean length of hospital stay for patients admitted for an NEBR was 3 days and 10 hours. Two patients had an extended length of stay due to a hospital-acquired infection. In the 2 years before the COVID-19 Pandemic, March 2018 – March 2020, 5 patients (2.1%) were admitted for an NEBR. In the period March 2020 – March 2022, 12 patients (4.7%) were admitted for an NEBR ( $P=0.13$ ) (*Figure 1b*).

**Conclusion:** Following the COVID-19 pandemic, twice as many patients required admission for an NEBR. No patients who required an NEBR had been established on remote follow-up. Remote monitoring can

Figure 1



be programmed to alert healthcare providers of CIED issues including battery longevity, lead integrity, arrhythmias and large changes in electrical parameters. Greater provision of remote monitoring may reduce the risk of patients requiring an NEBR. □

1. Collinson J, Wright I, Foley P, et al. Clinical standards and guidelines for the follow up of cardiac implantable electronic devices (CIEDs) for cardiac rhythm management. *British Heart Rhythm Society*; 2020.
2. Crossley GH, Boyle A, Vitense H, et al. The CONNECT (clinical evaluation of remote notification to reduce time to clinical decision) trial: The value of wireless remote monitoring with automatic clinician alerts. *J Am Coll Cardiol*. 2011;57:1181–9.
3. hillips KA, Ponamgi S, Mundell B, et al. Clinical implications of elective replacement indicator setting changes in patients with dual-chamber pacemaker devices. *J Cardiovasc Electrophysiol*. 2020;31:2704–10.



Posters 1

82/Cardiac ablation in premature ventricular contraction-induced cardiomyopathy

Authors: XL Ling (Presenting Author) – Royal Papworth Hospital NHS Foundation Trust, Cambridge; S Kassou – Royal Papworth Hospital NHS Foundation Trust, Cambridge; M Virdee – Royal Papworth Hospital NHS Foundation Trust, Cambridge; S Fynn – Royal Papworth Hospital NHS Foundation Trust, Cambridge; D Begley – Royal Papworth Hospital NHS Foundation Trust, Cambridge; C Martin – Royal Papworth Hospital NHS Foundation Trust, Cambridge; S Agarwal – Royal Papworth Hospital NHS Foundation Trust, Cambridge

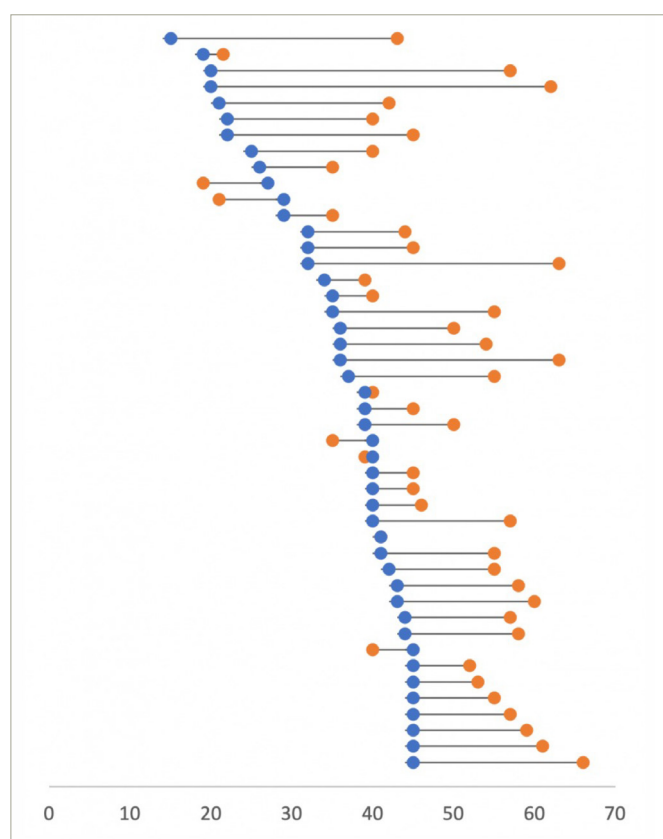
**Introduction:** Premature ventricular contraction (PVC) is commonly seen on routine electrocardiograms. Most are deemed benign and inconsequential. However, in some patients with ventricular ectopic, left ventricular (LV) impairment is observed on imaging. This study aims to investigate whether suppression of PVC with cardiac ablation is effective at improving ejection fraction (EF) of patients with PVC-induced LV impairment.

**Methods:** Retrospective data were collected from a single centre from 2015 to 2022. The study included patients with LV impairment (ejection fraction [EF] <45% on imaging) who underwent cardiac ablation for ventricular ectopic. Patients with predominantly sustained ventricular tachycardia were excluded. Patients were stratified into right ventricle (RV) vs left ventricle (LV) ablation and outflow tract vs non-outflow tract ablation. Outcomes in each group were compared. Primary outcome was improvement in EF post-ablation.

**Result:** A total of 58 patients were included (age  $61 \pm 13$  years, 36 [62%] males, body mass index  $29 \pm 6$  kg/m<sup>2</sup>). One patient had complication related to cardiac ablation (acute left main stem occlusion) and four had unsuccessful ablations. Mean pre-ablation EF was 35%. Of the 58 patients, 45 (78%) had EF 30–45% and 13 (22%) had EF <30%. Median ectopic burden pre-ablation was 28% (18–40%). Median ectopic burden post-ablation was 3% (0.6–12.5%). Overall, 50% of patients showed complete normalisation on Holter monitor (ectopic burden <1%). Overall, post-ablation EF was  $48 \pm 10\%$ . Improvement in EF was  $13.6 \pm 10\%$ . Out of 58 patients, 50 (86%) showed improvement in EF of at least >5% and 30 (52%) showed complete normalisation of EF on post-ablation imaging. Of those who showed complete normalisation on Holter monitor, all had improvement in EF of at least 5% and 72% showed complete normalisation of EF. Five patients showed worsening of LV function post-ablation, of whom two had unsuccessful ablations. Of the 58 ablations, 23 (40%) were in the RV and 34 (58%) were in the LV, and 30 (52%) were outflow tract and 27 (46%) were non-outflow tract. One patient had ectopic that could not be located. In the RV group, improvement in EF was 16.4%, and 15 (60%) showed normalisation of EF. In the LV group, improvement in EF was 13.2%, and 15 (44%) showed normalisation of EF. In the outflow tract group, mean improvement in EF was 15.7%, and 19 (63%) showed normalisation of EF. In the non-outflow tract group, mean improvement of EF was 13.1%, and 11 (40%) showed normalisation of EF.

**Conclusion:** Although relatively common and benign, PVCs can potentially lead to LV impairment. Cardiac ablation is a relatively safe

Figure 1: Improvement in ejection fraction following cardiac ablation. X-axis = EF (%). Blue = EF pre-ablation. Orange = EF post-ablation.



and effective way of treating patients with PVC-induced cardiomyopathy, with a large proportion of patients showing improvement in EF post-ablation. Ablation of outflow tract ectopic showed relatively better improvement in LV function. Further studies with stratification of patients by demographical factors, Holter monitor and imaging findings, along with investigation of long-term outcomes following cardiac ablation would add invaluable evidence to the role of cardiac ablation in PVC-induced cardiomyopathy. □

Posters 1

83/A doubly shocking case

Authors: RL Warren (Presenting Author) – Northumbria Specialist Emergency Care Hospital, Newcastle; A Hall – Northumbria Specialist Emergency Care Hospital, Newcastle; HE Thomas – Northumbria Specialist Emergency Care Hospital, Newcastle

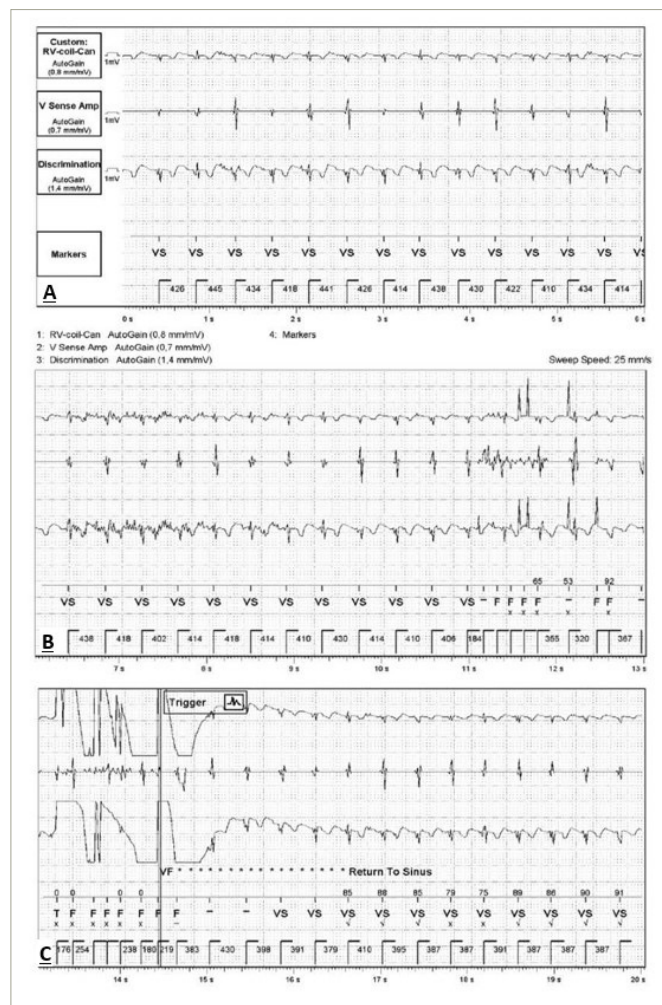
**Introduction:** Conducted energy devices (CED), commonly branded as ‘Tasers’ were authorised for use by specially trained officers in response to incidents with potential conflict in the UK in 2008. When activated, probes deliver short bursts of electric current to the target with an open circuit peak voltage of 50,000 volts. Generation of an electromagnetic field during discharge mediates loss of voluntary muscle control in the target. Exposure of an implantable cardioverter defibrillator (ICD) to this electromagnetic field may lead to oversensing, which can inhibit pacing or lead to inappropriate device therapy. This case report describes the first device interrogation and outcomes of a patient following CED application during a confrontation with Police in the UK.

**Results:** A 42-year-old man with a background of idiopathic ventricular fibrillation (VF) arrest for which an ICD was implanted 5 years previously, presented with witnessed collapse. This had occurred following two reported episodes of CED discharge delivered by police officers. On admission, observations and biochemistry were normal. The patient had no recollection of the events leading up to CED discharge, but reported a sensation of a shock from his device at the time of contact.

Interrogation of the device revealed a functioning ICD with no abnormality of sensing and pacing function. He had minimal ventricular pacing. His programmed detection criteria for VF were HR >230 min<sup>-1</sup> (260 ms) for 12 intervals with a redetection period of 6 seconds. There was an episode of VF recorded by the device with an aborted shock. The electrogram (Figure 1) demonstrated 13 intervals with a rate >230 min<sup>-1</sup> over 3.0 seconds with the appearance of oversensing electromagnetic interference. This met criteria for VF and initiated ICD charging. The delivery of electromagnetic energy (and associated ICD oversensing) from the CED lasted 3.6 seconds and then was terminated. ICD charge time was 8.3 seconds and fortunately the ICD shock was aborted due to the device appropriately recognising sinus tachycardia at a rate 146 beats min<sup>-1</sup>, 5.6 seconds after episode initiation. We did not identify any ICD- or heart rhythm-related cause for his loss of consciousness and feeling of experiencing a shock and we presume this all relates to the CED discharge he received.

**Conclusion:** This case describes ICD oversensing and aborted shock after the use of a CED with a discharge time of 3 seconds. The redetection interval of this patient was 6 seconds, which is relatively short and it is therefore possible that the patient may have received an inappropriate ICD shock if a second CED discharge was used or the CED was set to deliver a longer episode. □

Figure 1: Electrogram taken from implantable cardioverter defibrillator interrogation. A: Initial rhythm of V sensing; B: The start of the electromagnetic interference therefore the start of the “VF” detection; C: Trigger point when the device starts to charge and the cessation of the electromagnetic interference



## Posters 1

### 84/Developing a postural orthostatic tachycardia syndrome (POTS) pathway

*Authors: KS Minn (Presenting Author) – Cambridge University Hospitals NHS Foundation Trust, Cambridge; MK Zaw – Cambridge University Hospitals NHS Foundation Trust, Cambridge; NT Lin – Cambridge University Hospitals NHS Foundation Trust, Cambridge; S Kulkarni – Cambridge University Hospitals NHS Foundation Trust, Cambridge; J Graggaber – Cambridge University Hospitals NHS Foundation Trust, Cambridge; J Hampton – Cambridge University Hospitals NHS Foundation Trust, Cambridge*

**Introduction:** The Syncope Service has been running for a decade and is the only clinic to offer beat-to-beat plethysmography in Addenbrooke's Hospital. An increasing number of younger patients have been referred to the clinic with suspected postural orthostatic tachycardia syndrome (POTS) though the Syncope Service is not an ideal pathway. This project evaluated referrals to the service with an aim of commissioning a dedicated POTS pathway.

**Methodology:** The specialist Syncope Service reviewed 1,256 patients over the past 5 years (2017 – 2021). The data of 405 patients under age 50 were retrospectively analysed.

**Analysis:** *Referrals:* 43% (n=173) were referred with presyncopal symptoms or suspected POTS. The number of referrals has increased year on year. The majority of referrals came from primary care (28.6%) followed by Cardiology (19%) and the emergency department (ED; 14.3%). A total of 42 patients were found to have borderline or definite POTS. The median age was 23 years with a range of 16 to 48, and 88% were female. *Presenting symptoms:* Presenting orthostatic symptoms were lightheadedness or dizziness (88%), palpitations (71%), atypical chest discomfort (43%) and tremulousness (7%). Other symptoms comprised exercise intolerance (28%), chronic fatigue (21%), brain fogging (16%) and acrocyanosis (16%). *Investigations:* 100% of patients had a 12-lead electrocardiogram (ECG) and beat-to-beat plethysmography; 62% had an echocardiogram; 45% completed ambulatory 24-hour ECG monitoring;

12% were investigated with 24-hour ambulatory blood pressure measuring. Routine blood tests as well as cortisol, thyroid function, ferritin and plasma metanephrine were taken. *Management:* 45% of patients were managed with non-pharmacological measures alone; 31% required monotherapy, 17% used dual agents and 12% necessitated triple therapy. The choice of medication was not standardised but beta blocker, fludrocortisone and midodrine were the most used medications. *Follow-up plans:* 50% were followed up in the syncope clinic after being diagnosed with POTS.

**Implications:** The Syncope Service is commissioned as an urgent pathway to prevent admissions via ED for patients presenting with syncope of unknown aetiology. It is the only clinic that offers beat-to-beat plethysmography. Referrals of younger patients with suspected POTS have increased every year though not all patients with suspected POTS have syncope. There is a need for a specialised clinic both for patients with suspected POTS, and for patients with undiagnosed syncope to be seen urgently. Patients with suspected POTS do not need to be seen with the same degree of urgency and therefore, establishing two different pathways is recommended.

**Discussion:** POTS is becoming increasingly well known. Many patients discover this as a possible diagnosis online and there is a need to address this group of patients. The results of this project will feed into a business plan to commission a specialist POTS pathway. □

## Posters 1

**85/Impact of a telemetry monitoring sheet on detection and actioning of cardiac events at a tertiary cardiac centre – updating of British Heart Rhythm Society telemetry guidelines**

Authors: *W Ries (Presenting Author) – Bristol Heart Institute, Bristol Royal Infirmary, Bristol; F Mouy – Bristol Heart Institute, Bristol Royal Infirmary, Bristol; P Marques – Bristol Heart Institute, Bristol Royal Infirmary, Bristol; A Nisbet – Bristol Heart Institute, Bristol Royal Infirmary, Bristol; P Barman – Bristol Heart Institute, Bristol Royal Infirmary, Bristol*

**Introduction:** Ward telemetry aims to promptly identify cardiac arrest and life-threatening arrhythmia. The value of telemetry systems relies upon staff to regularly interrogate and action recordings. Several factors, such as alarm fatigue, system unfamiliarity or staffing pressures, can serve as barriers to regular interrogation and judicious discontinuation of telemetry. British Heart Rhythm Society (BHRS) and American Heart Association (AHA) guidelines advocate for formalised ward telemetry monitoring routines. These aim to improve frequency of checks and enhance telemetry initiation and discontinuation accuracy. UK centres lack comprehensive guidelines on telemetry initiation and discontinuation.

**Aims:** 1. To develop a multidisciplinary telemetry monitoring sheet (TMS) and study its impact on detection and actioning of telemetry events at a tertiary cardiac centre. 2. To develop a comprehensive guideline on the indications for telemetry initiation and discontinuation for use at UK hospitals, based on existing guidance.

**Methods:** A multidisciplinary taskforce of doctors, specialist nurses and education facilitators was created at a tertiary cardiology centre. A TMS was devised and underwent several test iterations. It consists of a single sheet of paper with stepwise instructions for documenting rate, rhythm, battery level, alarm settings, events and escalation plan. The TMS mandates four times daily interrogation of telemetry – all incorporated into the nursing and medical staff's ward routine. Baseline characteristics of telemetry practice were studied prior to introduction of the TMS on three cardiology wards between March and June 2021. Rate of event detection and escalation were then recorded at 1 week,

1 month, 3 months and 6 months after introduction of the TMS on these wards. For the second aim, existing BHRS and AHA guidelines were expanded with local guidelines and literature searches to create a resource of telemetry indications and durations – called the telemetry initiation and discontinuation sheet (TIDS). The TIDS underwent review and confirmation by multidisciplinary cardiology management and clinical governance bodies.

**Results:** Recognition and/or actioning of telemetry events increased from 41.3% (19 of 46 patients) to 82.9% (34 of 41 patients) after introduction of the TMS (week 1 100%; 1 month 100%; 3 months 100%; 6 months 78.1%, where use of the TMS had decreased on one of the wards). The percentage of patients on telemetry without an accepted indication for continuous monitoring was 24.6% (29 of 123 patients) prior to TMS introduction and 25.5% (28 of 110 patients) post TMS introduction.

**Conclusions:** The TMS significantly improved detection and actioning of telemetry events. This supports BHRS guidance to formalise telemetry interrogation into ward routines. The TMS made no significant difference to rates of correct initiation and discontinuation of telemetry, suggesting a knowledge gap on existing guidance or limited implementation of BHRS guidelines. Staff surveys revealed poor knowledge of indications for telemetry initiation and discontinuation. The creation of comprehensive telemetry indication guidelines – TIDS – has the potential to bridge this knowledge gap and become a standardised BHRS document that is easy to implement at UK centres. Studies assessing the impact of TIDS, in combination with TMS, on telemetry practice at our centre are ongoing. □

Posters 1

**86/The role of atrioventricular delay shortening and ventricular resynchronisation in achieving the haemodynamic benefit seen in biventricular pacing**

Authors: *A Naraen (Presenting Author) – St Helen’s Knowsley Teaching Hospitals Trust, Liverpool; AD Arnold – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; MJ Shun-Shin – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; N Ali – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; D Keene – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; JP Howard – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; J Chow – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; IJ Wright – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; FS Ng – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; NA Qureshi – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; M Koa-Wing – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; DC Lefroy – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; NWF Linton – Department of Bioengineering, Imperial College London, Hammersmith Hospital, London; PB Lim – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; NS Peters – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; A Muthumala – Cardiology Department, North Middlesex University Hospital NHS Trust; Cardiology Department, St Bartholomew’s Hospital, Barts Health NHS Trust, London; M Tanner – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; KA Ellenbogen – Division of Cardiac Electrophysiology, Virginia Commonwealth University, Richmond; P Kanagaratnam – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; DP Francis – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London; ZI Whinnett – National Heart and Lung Institute, Imperial College London, Hammersmith Hospital, London*

**Background:** It is assumed that resynchronisation of the ventricles in patients with heart failure and left bundle branch block (LBBB) delivers the most benefit in biventricular pacing (BVP). Because cardiac resynchronisation therapy (CRT) with BVP both shortens atrioventricular delay and reduces ventricular dyssynchrony, it is difficult to isolate their individual impact.

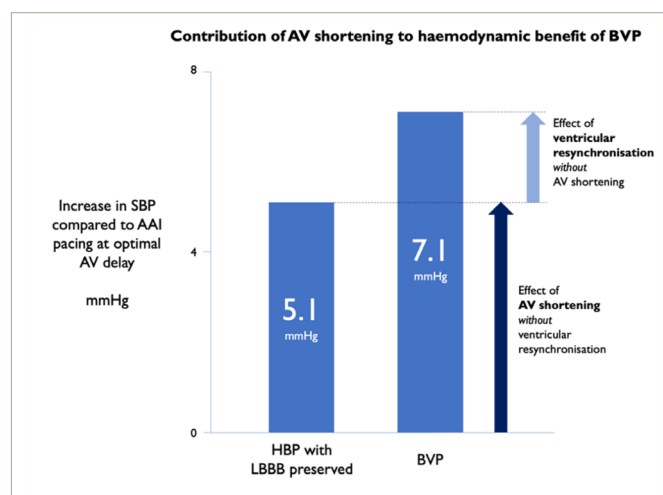
**Objectives:** In this invasive study, using His bundle pacing to shorten atrioventricular delay without correcting LBBB, we aimed to isolate the contributions of atrioventricular delay shortening versus ventricular resynchronisation.

**Methods:** Nineteen patients with LBBB referred for cardiac resynchronisation therapy were recruited. To assess the atrioventricular delay, only patients in sinus rhythm on the day of the procedure were included in the study. Using high precision, beat-by-beat assessment of acute systolic blood pressure, we performed a within-patient comparison of the haemodynamic effects of (i) BVP (which both shortens atrioventricular delay and reduces QRS duration), (ii) His bundle pacing with preservation of LBBB (which only shortens atrioventricular delay), and (iii) right ventricular apical pacing.

**Results:** BVP improved systolic blood pressure (+7.1 mmHg vs intrinsic conduction, 95% CI +3.6 to +10.7;  $p < 0.001$ ,  $n = 16$ ) (Figure 1). Atrioventricular delay optimization without correction of LBBB also improved systolic blood pressure (+5.1 mmHg, 95%CI +2.0 to +8.2;  $p = 0.0026$ ,  $n = 19$ ), which was two-thirds of the effect size of BVP. In contrast, right ventricular apical pacing did not (+1.2 mmHg, 95%CI -0.8 to +3.1;  $p = 0.206$ ,  $n = 10$ ).

**Conclusion:** This study demonstrated that the main mechanism of haemodynamic benefit in BVP appears to be shortening of atrioventricular delay, rather than resynchronisation of ventricles. This will allow

Figure 1



**Figure 1 – Contribution of AV delay shortening to haemodynamic benefit of biventricular pacing.**

The y axis is improvement in systolic blood pressure at optimal AV delay. The majority of haemodynamic benefit with biventricular pacing is also achieved by His bundle pacing with preservation of left bundle branch block, by shortening AV delay. AV – atrioventricular; LBBB – left bundle branch block.

exploration of additional pacing modalities other than conventional BVP, in delivering the most clinical benefit of CRT, even if they do not correct LBBB. □





## Posters 1

### 87/The impact of setting up an arrhythmia nurse-led, Kardia monitor loan library

Authors: *CM Shannon (Presenting Author) – Hospital, Brighton*

**Introduction:** The COVID-19 pandemic created a number of challenges in monitoring patients with arrhythmias and associated symptoms. This study looks at the impact of loaning 15 Kardia monitors from the arrhythmia nurses to patients in Sussex, over an 18-month period.

**Explanation of basic methods:** In 2020 we started to loan the monitors to patients to help aid diagnosis and review rate control. The arrhythmia nurses assessed patients on an individual basis and loaned the monitors following phone consultations and clinic reviews. The devices were either given in person or posted first class. The patient needed to have a compatible phone for the app. We sent them information on how to download and set up the app and on how to email the electrocardiograms (ECGs) back to us.

**Results:** During an 18-month period, we loaned 46 monitors to 30 men and 17 women. Patient age ranged from 17 years to 80 years, with an

average age of 65 years. The time from ECG to diagnosis was 1–4 weeks. Among the 46 patients, 26 (57%) went on to have a procedure, 2 patients had a procedure brought forward and 2 were removed from waiting lists. Overall, 54% borrowed the device between 1 and 3 months, and 75% of patients sent between 1 and 5 ECG readings to our email address. Three monitors went missing within the first 6 months; we then asked patients to complete and sign a slip agreeing to return the monitor within 3 months, listing cost.

**Conclusions/implications:** The loan library has been an efficient cost-effective way of helping patients self-manage their arrhythmia. It has improved and streamlined diagnosis, in turn saving the NHS time and money. We now receive referrals from electrophysiology consultants and have a waiting list for this service. Implications for the future are that we have applied for funding to purchase a further 25 monitors. □

Posters 1

**88/Initial experience using a diamond tip ablation catheter in conjunction with a basket high density mapping system, for the treatment of atrial flutter and ventricular tachycardia**

Authors: *J Mesquita (Presenting Author) – Royal Papworth Hospital, Cambridge; J Eldridge – Royal Papworth Hospital, Cambridge; CA Martin – Royal Papworth Hospital, Cambridge*

**Introduction:** The recently introduced DiamondTemp® (DT; Medtronic, Minneapolis, USA) has been proved non-inferior to standard irrigated force-sensing radiofrequency (RF) catheters with respect to safety, efficacy and procedural efficiency. Paired with the RealTemp® (Medtronic) technology, the diamond-embedded composite-tip is able to accurately measure tissue surface temperature in real time, and promptly adjust RF power accordingly (*Figure A*). This contributes to safer transmural lesions, by lowering the risk of charring and tissue disruption. Despite these advantages, the DT® still needs to be used in conjunction with non-native systems, which can be associated with technical challenges and limitations. To date, no data have been published on its combined use with Rhythmia® (Boston Scientific, Marlborough, USA).

**Objective:** To evaluate the safety and efficacy of the DT® catheter, in association with the Rhythmia® mapping system, during ventricular and atrial – typical atrial flutter (T-AFL) – ablation procedures.

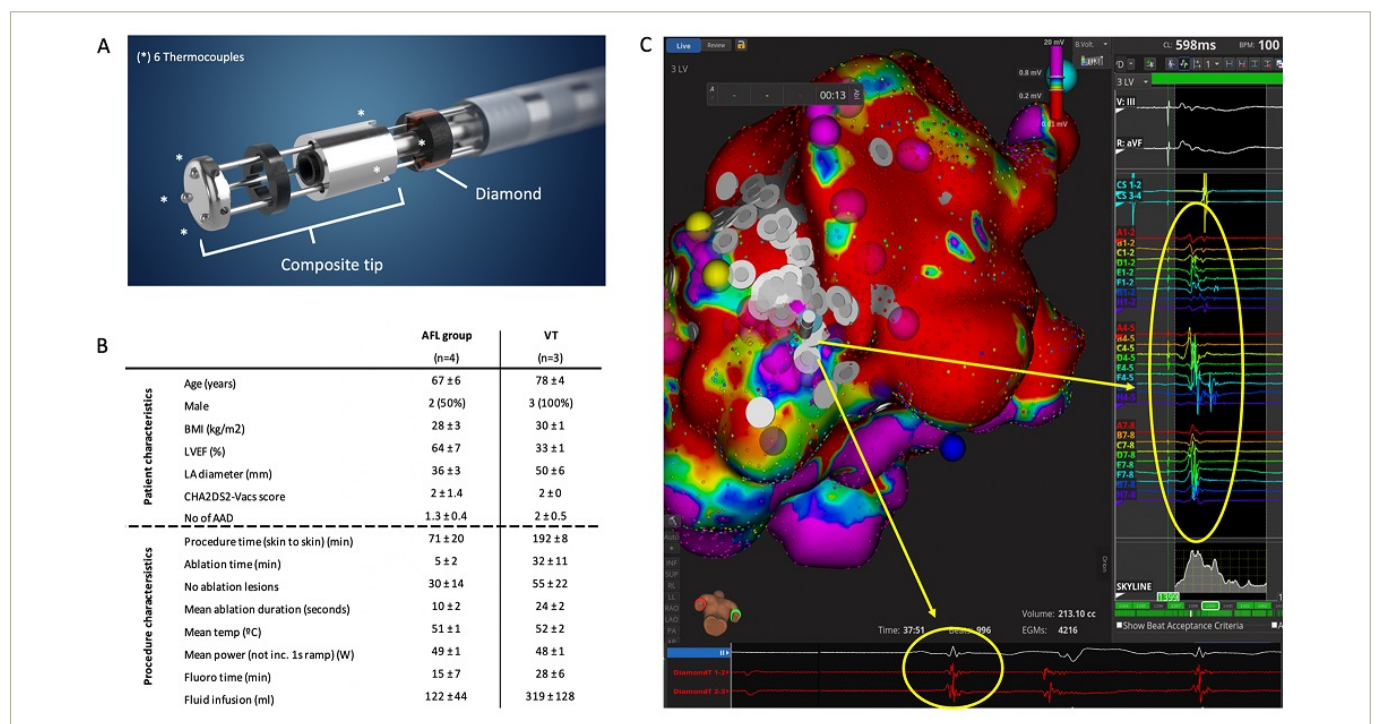
**Methods:** Prospective registry including patients referred for both T-AFL and ventricular tachycardia (VT), who underwent ablation with DT® and the Rhythmia mapping system. All the procedures were performed under general anaesthesia, with pre-ablation mapping carried out using the Orion® basket catheter (Rhythmia®). Patients with T-AFL underwent a conventional cavo-tricuspid isthmus (CTI) line, with an acute endpoint of bidirectional block. For VT patients, a substrate-based ablation strategy was pursued, targeting ablation of late potentials in the scar border zone, with an acute endpoint of lack of inducibility during programmed

stimulation. Access to the left ventricle was gained via a single transeptal puncture. For both T-AFL and VT ablation groups, lesions were achieved with interrupted point-by-point ablation. Each lesion was delivered in a temperature control mode, set to 60°C (maximum power of 50 W). Ablation was continued for 3–5 additional seconds after a 75–80% reduction in the split-tip electrogram amplitude occurred. Ablation was also stopped if impedance dropped >15 ohms. The saline irrigation rate was 2 mL/min during mapping and 8 mL/min during ablation.

**Results:** Patient and procedure characteristics are detailed in the table (*Figure B*). The DT® near-field signal was comparable to that seen on the Orion® high density basket catheter (*Figure C*). Acute procedural endpoint was achieved in all cases. There were no acute complications, and, specifically, no incidence of steam pop or char formation. Procedure and fluoroscopy times were within expected limits, compared with published datasets. Both the ablation time (5 ± 2 min for T-AFL; 32 ± 11 min for VT) and fluid infusion volume (122 ± 44 mL for T-AFL; 319 ± 128 mL for VT ablation) were reduced compared with the current body of available data, regarding conventional/standardised ablation settings.

**Conclusion:** This series of cases highlights for the first time, the feasibility of using the DT® catheter in combination with the Rhythmia® mapping system, and its effectiveness in the treatment of both atrial and ventricular arrhythmias. Acute success was achieved in all patients, with no acute complications, and lower ablation times and fluid infusion volumes than expected. Further data collection is ongoing. □

Figure 1



Posters 1

**89/Benefits of support groups for patients living with implantable cardioverter defibrillators: a mixed-methods systematic review and meta-analysis**

Authors: *KH Sanders (Presenting Author) – Cambridge University Hospitals, Cambridge; PA Chousou – Cambridge University Hospitals, Cambridge; K Carver – Cambridge University Hospitals, Cambridge; PJ Pugh – Cambridge University Hospitals, Cambridge; H Degens – Manchester Metropolitan University, Manchester; M Azzawi – Manchester Metropolitan University, Manchester*

**Background:** Patients with implantable cardioverter defibrillators (ICD) experience anxiety, depression and reduced quality of life (QoL). Patient support groups are recommended in national guidelines for follow-up of patients with ICDs; however, although ICD recipients share experiences of patients with other long-term conditions, their risk of recurrent shocks is something unique to these patients and it remains to be seen whether support groups also have a beneficial impact on well-being in ICD patients.

**Objectives:** This systematic review evaluates whether ICD support groups have a beneficial effect on mental well-being.

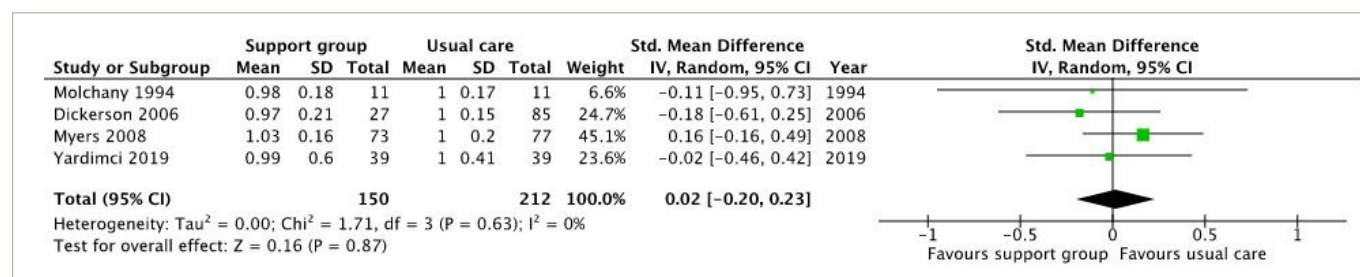
**Methods:** Literature searches were carried out in MEDLINE, Embase, CINAHL, PsycINFO and Web of Science. Eligible studies investigated patient-led support groups for ICD patients aged 18 years or older, using any quantitative or qualitative design. The Mixed-Methods Assessment Tool was used to assess quality. Quantitative results were grouped by outcomes indicative of ‘better mental health’ including measures of anxiety and QoL, and a meta-analysis was conducted. Thematic synthesis was used to generate analytic themes from the qualitative data. The data were integrated and presented using the Pillar Integration Process.

**Results:** Ten studies were included in this review. All studies bar one

were non-randomised or had a qualitative design and patients had self-selected to attend a support group. Five contributed to the quantitative data synthesis and seven to the qualitative synthesis. Meta-analysis of anxiety and QoL measures showed no significant impact of support groups on mental well-being (Figure). Qualitative data showed that patients perceived benefit from attendance through sharing experiences and acceptance of life with an ICD, which encourages them to resume normal life activities.

**Conclusion:** This first systematic review and meta-analysis showed that while there is currently no quantitative evidence that ICD support groups have a significant beneficial effect on mental well-being, qualitative data show that patient support groups are perceived as beneficial by attendees. This suggests that we need other quantitative measures to assess the benefits of support groups for mental well-being. Attendees value the opportunity to share their experiences, which helps them to accept their new life with an ICD. Further research is recommended into the optimal format of support groups, level of involvement of healthcare professionals, and whether primary and secondary prevention ICD patients have different supportive needs. □

Figure 1



Posters 1

**90/Loss of capture during pacemaker generator replacement: an unexpected surprise!**

Authors: *L Whittaker (Presenting Author) – James Cook University Hospital, Middlesbrough; C Benson – James Cook University Hospital, Middlesbrough; M Bates – James Cook University Hospital, Middlesbrough; S James – James Cook University Hospital, Middlesbrough; A Thornley – James Cook University Hospital, Middlesbrough; A Turley – James Cook University Hospital, Middlesbrough; M Chapman – James Cook University Hospital, Middlesbrough*

**Background/case:** A 27-year-old female presented electively for a dual-chamber pacemaker generator replacement as her existing generator was approaching elective replacement indicator (ERI). Her past medical history included Kearns–Sayre syndrome. Her original system was implanted in 2011 (at another centre) for acquired third-degree atrio-ventricular (AV) block (Medtronic 5076 52 cm and 45 cm leads, St Jude Identity ADx DR 5386 generator). The device was interrogated at the start of the case (*Table 1*). There had been no concerns regarding lead integrity. The battery voltage was 2.68 V (ERI 2.5 V), impedance 12.2 kΩ, magnet rate 94.8 bpm (ERI 86.3 bpm). The procedure was performed under local anaesthetic. Blunt dissection and diathermy were used. Short bursts of diathermy did not result in pacing inhibition. Further diathermy was used over the generator to incise the pocket and the device was gently manually manipulated in the pocket. At this point, loss of capture occurred for 30 seconds; the patient became syncopal and had a seizure. The device was re-interrogated, which confirmed that both leads remained in a bipolar pace/sense configuration. No noise was seen on either lead and noise reversion (to unipolar pacing) had not occurred. Further manual manipulation of the pocket, generator and leads did not result in further loss of capture. The remainder of the procedure was performed without incident and there were no lasting sequelae for the patient.

**Discussion:** Loss of capture likely resulted from a fault common to several models of St Jude (now Abbott) generators (Affinity, Entity, Integrity, Identity, Sustain, Frontier, Victory, Zephyr) whereby use of diathermy (as well as PlasmaBlade™) can cause the pacemaker to

**Table 1: Lead parameters at the start of the case**

	RA	RV
Threshold	0.5 V @ 1.0 ms	1.25 V @ 0.4 ms
Sensing	0.3–0.4 mV	NIL R WAVE @ VVI 30 bpm
Impedance	406 Ω	453 Ω

temporarily reduce pacing output. This was highlighted in a St Jude advisory in 2014. It was noted that the duration of this effect depends on several factors including battery status, proximity of diathermy to the generator and diathermy output. Any temporary change in function can last for “30 seconds or longer” after diathermy has ceased. Additionally, placement of a magnet to asynchronously pace will not terminate this phenomenon.

**Future considerations:** Given the unpredictability of this behaviour and the routine use of diathermy/PlasmaBlade™ there is significant concern for future procedures, particularly for pacing-dependent patients. This generation of St Jude devices are likely to reach ERI soon, so this issue will become more common. Consideration needs to be given to how to avoid a repeat of this case. Options include, avoiding use of diathermy/PlasmaBlade™ until the generator has been explanted, placement of a temporary pacing wire, or use of isoprenaline, which can help unmask a latent escape rhythm.<sup>1</sup> □

1. Chihrin SM, Mohamed U, Yee R, et al. Utility of isoproterenol in unmasking latent escape rhythm in pacemaker dependent patients undergoing pacemaker replacement. *Am J Cardiol.* 2008;101:631–3.



## Posters 1

**91/Innovative primary care-led community palpitation management and investigation pathway for Wakefield district**

Authors: *MM Khan (Presenting Author) – Health Care First, Methley; S Childe – Health Care First, Methley*

**Background:** Palpitations are a common reason for GP appointments in primary care and a frequent reason for cardiology referral. In Wakefield, this translated to approximately 24,000 primary care and out-of-hours consultations in 2021.

**Purpose:** The purpose of this pilot was to evaluate a pathway for palpitations diagnosis and management in primary care. The proposed pathway was designed to avoid unnecessary referrals to secondary care, to shorten the waiting time to diagnosis for patients and to cut down visits to A&E and out-of-hours service in primary care.

**Method:** The pathway piloted at Health Care First, which is a federation for 30,000 patients, was based on a community cardiology approach, where a GP with special interest in cardiology could offer the service for the wider community. The pathway began with an initial clinical evaluation comprising medical history, physical examination and a standard 12-lead electrocardiogram (ECG). After ruling out of any red flags and otherwise deemed appropriate to continue to be assessed with the proposed diagnostic method, the patients were provided with a handheld ECG device for intermittent 30-second ECG registration at home. During a 4-week investigation period, the patients would record their ECG when experiencing symptoms. The primary care team remotely monitored the traces, which were received on a cloud-based system with artificial intelligence capabilities, and if pathology was recorded, patient was contacted and informed of the management plan. If after 4 weeks no pathology was found, patients received a discharge consultation for reassurance and the final report was generated.

**Results:** During the 18-month pilot, we screened a total of 149 patients. Out of the patients screened, 16 (11%) were diagnosed with atrial fibrillation (AF) and 67 (45%) were diagnosed with benign ectopics as the cause of their palpitations. Two rare occurrences of life-threatening

**Table 1: Results by diagnosis**

Diagnosis	No. of patients	% of total
Normal sinus	56	38
Ectopics	67	45
AF	16	11
AVNRT	8	5
BCT	2	1
TOTAL	149	100

broad complex tachycardias were also detected, both of which ended up needing defib implantation. *Table 1* further presents the results by diagnosis for rest of the patients.

**Conclusions:** The results from the pilot indicated a reduction in GP/out-of-hours consultations by 50% and over 90% reduction in referral to secondary care for Holter monitoring by implementing an easy-to-use handheld ECG as part of the community-led palpitation pathway. The results further implied that a district-wide implementation could lead to at least 120 new AF diagnoses in Wakefield district per year, having a knock-on benefit of stroke reduction and cost economic impact in the society by reducing anxiety, lost employment hours and increasing productivity. Another key outcome seen is the reassurance value of conducting symptomatic palpitation monitoring to reassure patients, the majority of whom had either normal sinus rhythm or benign ventricular ectopics and had failed to be satisfied with conventional Holter monitoring in the past. □



Posters 1

**92/Incidence and predictors of permanent pacemaker implant in patients undergoing transcatheter aortic valve replacement: a single-centre retrospective study**

Author: *Mr Singleton (Presenting Author) – Royal Papworth Hospital, Cambridge*

**Background:** Permanent pacemaker implant (PPI) is a frequent complication of transcatheter aortic valve replacement (TAVR), with potential long-term implications for patient morbidity and mortality. TAVR is expected to expand towards the treatment of lower-risk patients and other aortic valve pathologies; however, the current capacity within the National Health Service (NHS) to deliver TAVR is discordant with the indicative treatable burden of severe aortic stenosis. Consequently, it is of clinical relevance to identify the predictors for new-onset conduction disturbance to minimise the incidence and associated complications of PPI post-TAVR.

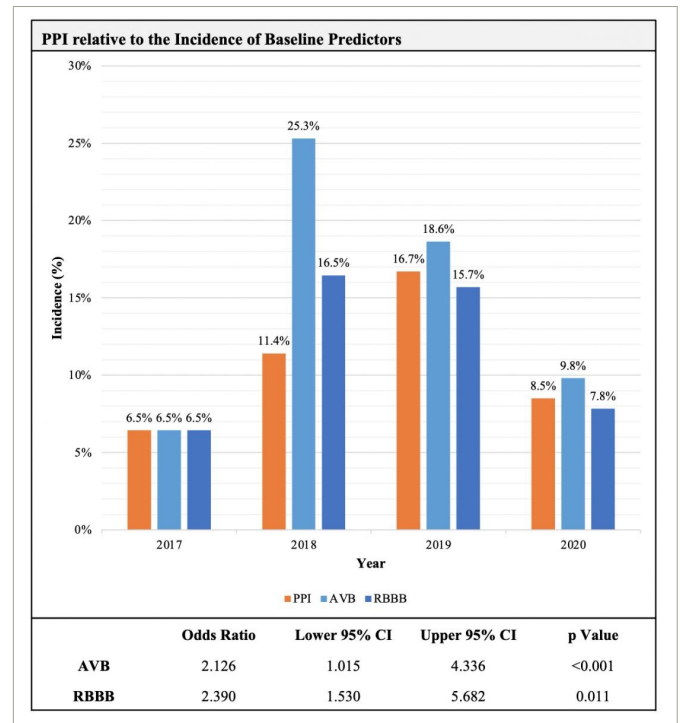
**Aims:** This study aimed to identify the burden and predictors of PPI in patients undergoing TAVR at Royal Papworth Hospital (RPH) at 12 months.

**Methods:** Baseline and procedural characteristics were collected retrospectively from 491 patients without prior aortic valve replacement or PPI undergoing TAVR between January 2016 and December 2020. The predictors of PPI were identified from a multivariate logistic regression model using statistically significant variables from initial univariate analyses.

**Results:** PPI was required in 45 patients (9.2%) and 55 patients (11.2%) at 30 days and 12 months post-TAVR, respectively. Yearly PPI incidence ranged between 6.5% and 16.7%. Overall, patients had a mean age of  $81.9 \pm 7.5$  years, and 227 (46.2%) were female. Pre-existing right bundle branch block (RBBB; no-PPI=9.2%, PPI=30.6%;  $p < 0.001$ ) conferred a 2.39 times greater risk of PPI at 12 months. Similarly, baseline first-degree atrioventricular block (FD-AVB; no-PPI=15.0%, PPI=38.8%;  $p < 0.001$ ) conferred a 2.13 times greater risk greater risk of PPI at 12 months. All-cause mortality at 12 months was 14.0% ( $n=78$ ), with no significant difference between groups ( $\chi^2(1, N = 558) = 1.84, p=0.17$ ).

**Conclusions:** The incidence of PPI post-TAVR at RPH was comparable to other UK TAVR cohorts. RBBB and FD-AVB were significant independent

Figure 1



predictors of PPI within this cohort. The results of this study could be utilised to guide TAVR pre-assessment screening tools to identify patients who are at high risk of PPI. □

Posters 1

**93/Time is brain – remote follow-up (RFU) improves new onset of atrial fibrillation (AF) diagnosis and treatment in the cardiac devices population**

Authors: *S.Silva (Presenting Author) – Royal Papworth Hospital, Cambridge; I Turner – Royal Papworth Hospital, Cambridge*

**Introduction:** With the rapid implementation of remote follow-up (RFU) during the COVID-19 period, the cardiac devices population under Royal Papworth Hospital has benefitted from this technology, with a great increase in patients followed up remotely, from 19.7% at pre-pandemic level, to 56.7% in the first year of the pandemic and 61% in the year after the pandemic, and currently accounts for 75% of patients under remote monitoring. RFU allows quicker detection and treatment of arrhythmias, as well as device issues. This project aimed to identify the benefits of RFU in detecting and treating patients with new onset of AF.

**Methods:** A sample of 360 AF letters completed was retrospectively collected for the year before (April 2019 to March 2020) and after (April 2020 – March 2021 and April 2021 – March 2022) the COVID-19 pandemic, when changes to the management of cardiac devices occurred in our service, favouring RFU. AF letters are sent to patients and General Practitioners (GPs), when an AF episode has been detected for >6 minutes as per current guidelines and patients are identified as not anticoagulated.

**Results:** Time to diagnosis was significantly shorter for patients who had RFU automatic downloads than for those on routine, manual download clinics (p<0.01 for the 2020/21 and 2021/22 year groups using the

Mann–Whitney U test). In the data from the 2021/22 group, which had the largest number of patients, the median time to diagnosis in the auto group was just 5 days (IQR 1–22 days), whilst it was 50 days (IQR 14–118 days) for patients using routine manual downloads of symptoms.

**Conclusions:** The overall reduction in number of days from the first actionable event to diagnosis appeared to be due to the fact that a higher number of patients were under RFU. In the latest period analysed, there was a small increase in time from event to diagnosis and this can be explained as the greatest increase in RFU proportion of devices enrolled during this period being pacemakers, many of which still require manual transmissions. Traditionally, a higher number of complex devices such as tachy and cardiac resynchronisation therapy devices were enrolled in RFU pre-pandemic, and these provide automatic transmissions allowing quicker diagnosis of episodes. Despite the fact that alerts for atrial arrhythmia can be triggered differently across all manufacturers and device type, as well as different RFU transmission mechanisms including automatic transmissions and manual transmissions, RFU overall appears to play a significant role in detecting these and allowing early diagnosis. Early diagnosis of AF is essential to reduce the risk of stroke. □

Table 1

Type of follow-up	Median time from AF event to diagnosis (days)	Inter-quartile range for time (days)	Number of AF patients
2019/20 Hospital Clinic	99	30-221	83
2019/20 RFU	30	5-79	8
<b>2019/20 Total (RFU + Clinic)</b>	<b>90</b>	<b>37-204</b>	<b>91</b>
2020/21 Hospital Clinic	94	23-254	39
2020/21 RFU	27	3-100	62
<b>2020/21 Total (RFU + Clinic)</b>	<b>44</b>	<b>5-159</b>	<b>101</b>
2021/22 Hospital Clinic	120	36-300	85
2021/22 RFU	11	2-60	83
<b>2021/22 Total (RFU + Clinic)</b>	<b>51</b>	<b>6-152</b>	<b>168</b>

Posters 1

94/Outsourcing management of disconnected remote monitors – collaborating with industry

Authors: *HG Granville (Presenting Author) – Barts Health NHS Trust, London; CC Clotney – Barts Health NHS Trust, London; CM Monkhouse – Barts Health NHS Trust, London; ZC Carter – Barts Health NHS Trust, London; JC Collinson (Presenting Author) – Barts Health NHS Trust, London*

**Background:** Remote monitoring (RM) for implanted cardiac devices continues to increase nationally. Ensuring patient RMs maintain connectivity is key to patient safety and service delivery. At a large tertiary centre with over 7,000 patients enrolled on RM, management of patients with disconnected remote monitors is challenging. We collaborated with industry and piloted a new disconnected patient service provided by Abbott.

**Aim:** The aim was to reduce the number of disconnected patients enrolled on Merlin.net and to identify common reasons and themes for disconnection.

**Method:** The industry team were provided with read-only login details for Merlin.net. Disconnected patient lists were reviewed on a monthly basis, with disconnected patients directly contacted by the industry team by telephone to support re-connection. A maximum of three call attempts were made. Where patients were non-contactable a voicemail was left requesting a call back. Patient education and troubleshooting was provided to contactable patients. Calls made, reasons for disconnection and comments requesting advice on how to proceed were provided to the Bart’s Heart Centre team following attempts to contact all patients. Returned lists and data received were analysed by the Bart’s team to support further patient management.

**Results:** The percentage of patients with disconnected monitors as a total of all patients enrolled reduced by 5.1% (190 to 120 patients) during the 10-week pilot study: 68 patients (36%) were reconnected following a phone call; 23 patients (12%) were contacted and required further troubleshooting; 25 patients (13%) reconnected spontaneously without the need for a call; 35 patients (18%) were non-contactable; 30 patients (16%) had findings requiring the hospital team to action; 8 patients were identified as deceased; 1 patient was an inpatient. The most common reasons for radiofrequency (RF)- and App-based transmitter disconnections are displayed in *Table 1*.

**Conclusion:** Management of patients with disconnected remote monitors creates a significant time and resource burden. Collaborating

Table 1

Reason for disconnection	Count	Comments
<b>RF transmitter</b>		
Transmitter reboot required	10	
Not plugged in	9	Patient education
New dongle required	8	
Merlin.net error	6	i.e. Not updated after box change, patient needs to be transferred, patient no longer in UK
<b>App-based transmitter</b>		
Device EOS (ILRs)	16	Merlin.net admin
App not running in background	9	Patient education
New phone	5	Patient education
Clean install required	4	
Poor signal quality	3	
Unable to receive activation code	2	Incorrect mobile number or incorrect number format on Merlin.net

with industry using a dedicated patient reconnection service has the potential to significantly reduce disconnected monitor numbers and provides a feedback mechanism to support development of RM services. Common themes for disconnection need addressing through better delivery of patient education considering transmitter type, by developing processes to ensure patient contact details and preferred contact methods are recorded, and by improving administrative processes to minimise errors in data entry at enrolment.

**Acknowledgements:** Thank you to Susana Drake and Jess Panchal at Abbott for their work and support on this project. □

Posters 1

**95/The Application of Atrial Fibrillation clinical risk scores and differences in AF risk based on ethnicity and sex within the UK Biobank Population Cohort**

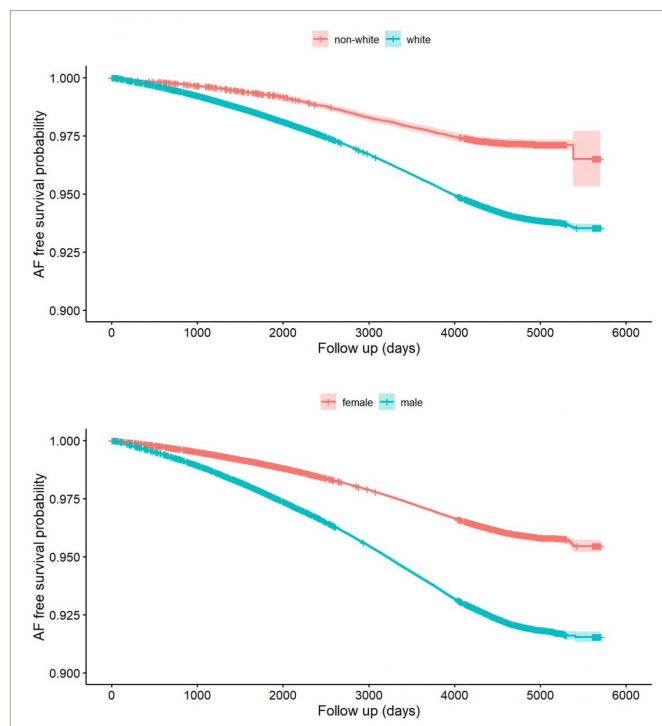
Authors: P Sivanandarajah (Presenting Author) – Chelsea and Westminster NHS Foundation Trust, Imperial College London, London; H Wu – Imperial College London, London; M Ardissino – Imperial College London, London; L Myslivecek – Imperial College London, London; S Khan – Chelsea and Westminster NHS Foundation Trust, Imperial College London, London; FS Ng – Chelsea and Westminster NHS Foundation Trust, Imperial College London, London

**Introduction:** Several clinical risk scores have been developed from specific population cohorts to predict the likelihood of atrial fibrillation (AF) occurrence for individuals. However, these risk scores often underperform when applied to an external validation cohort. These risk scores have never been compared head-to-head in a UK population. Previous observational cohort studies have also suggested that there is lower prevalence and incidence of AF in non-white ethnic groups and female individuals. Our aim was to evaluate the relative performance of 5 risk scores on the UK Biobank population in their ability to predict future AF and explore differences in AF risk based on ethnicity and sex.

**Methods:** We studied participants (n=495,972) from the UK Biobank (longitudinal cohort study). Participants were excluded if they had a previous history of AF at time of enrolment into the study or developed AF within a month of enrolment. Median age was 58 years and the median follow-up was 12.7 years. Established AF risk scores, C2HEST, CHA2DS2VASC, HATCH, Taiwan AF and CHARGE-AF were calculated based on International Classification of Disease ICD-10 diagnoses for each participant. The area under the receiver operating characteristic curve (AUROC) was calculated for each risk score to predict AF at 1 year, 2 years, 5 years, 10 years and at complete follow-up. Categorical variables were reported based on ethnicity and sex. Participants with unknown ethnicity were excluded. Survival curves for AF event-free survival were plotted to compare ethnic and sex differences.

**Results:** Table 1 shows the AUROC scores for AF prediction for all the risk scores at 1 year, 2 years, 5 years, 10 years and at complete follow-up. The risk scores with the highest AUROC scores for AF prediction were CHARGE-AF and Taiwan AF risk scores. The highest AUROC scores were found for 5-year AF risk prediction for both CHARGE-AF (AUROC 0.760) and Taiwan AF (AUROC 0.747). C2HEST, CHA2DS2VASC and HATCH consistently had AUROC scores less than 0.6 and, therefore, performed poorly at predicting AF risk. Overall, 6.2% (27,264/439,118) of white participants developed AF during their follow-up compared with 2.8% (743/26,109) of non-white participants. Furthermore, 8.4% (17,355/205,650) of male participants developed AF during their follow-up compared with 4.1% (10,652/259,577) of female participants. Survival curves of AF event-free survival between white and non-white

Figure 1: AF event-free survival curves based on ethnicity and sex



participants (p<0.001) and between male and female participants (p<0.001) using log rank statistic was statistically significant. Figure 1 shows the survival curves.

**Conclusions:** CHARGE-AF and Taiwan AF risk scores were the best performing 5-year AF risk prediction scores and most suited to the UK population compared with C2HEST, CHA2DS2VASC and HATCH. The risk of AF events was lower in non-white ethnic groups and female individuals. The reasons for the difference in AF incidence between ethnic groups and between males and females should be further explored. □

Table 1

Risk Score	AUROC at 1-year follow-up	AUROC at 2-year follow-up	AUROC at 5-year follow-up	AUROC at 10-year follow-up	AUROC at complete follow-up
C2HEST	0.546	0.551	0.550	0.544	0.541
CHA2DS2VASC	0.559	0.565	0.564	0.561	0.558
HATCH	0.573	0.575	0.578	0.570	0.566
Taiwan AF	0.740	0.742	0.747	0.742	0.736
CHARGE-AF	0.750	0.752	0.760	0.758	0.753

AUROC = area under the receiver operating characteristic curve.

## Posters 2

### 96/"Tomorrow I'm going to die": the role of patient support groups in adapting to life with an implantable cardioverter defibrillator

Authors: *KH Sanders (Presenting Author) – Cambridge University Hospitals, Cambridge; PJ Pugh – Cambridge University Hospitals, Cambridge; M Azzawi – Manchester Metropolitan University, Manchester*

**Background:** Patients with implantable cardioverter defibrillator (ICDs) are known to experience psychosocial difficulties such as anxiety and depression. The British Heart Rhythm Society encourages the use of patient support groups for patients with ICDs; however, it is not clear what patients need from a support group or what format they should take to meet these needs. A local support group was delivered in the community and then over Zoom during the COVID-19 lockdowns.

**Aim:** The goal of this study was to understand common themes and shared meanings of attending a support group for patients with ICDs.

**Methods:** Twelve ICD recipients were interviewed between December 2020 and November 2021 using a semi-structured interview guide that was based on insights from a literature review. Reflexive thematic analysis methods were utilised to code the transcripts before generating themes. The interview guide and analyses were co-produced with a patient and public involvement advisory group.

**Results:** Six participants had primary prevention indications for ICD implant, whilst the remaining six received secondary prevention. Three participants had experienced shocks from their ICD. Ten participants had attended the local support group. Analysis of the data elicited four

themes: confronting mortality, coping through sharing, coping through learning, and providing space. Participants expressed experiences consistent with the five stages of grief described by Kübler-Ross in her work with terminally ill patients. Making connections with other ICD patients, access to information and reassurance, and advice from healthcare professionals were important perceived benefits of the support group. Although Zoom was perceived as convenient, participants found it easier to share their personal stories when meeting in person. When interpreted through the theoretical lens of a task-based model for adapting to chronic illness, support groups provide patients with the opportunity to learn and utilise the coping skills required to complete these tasks.

**Conclusion/implications for practice:** Patients with ICDs are required to confront their own mortality and adapt to considerable life changes after implant. Support groups should provide a space for interpersonal communication and sharing of experiences, as well as offering healthcare professional-provided education and advice to maximise the benefit of these resources to patients and to encourage their continued adaptation to life with an ICD. □



Posters 2

97/Biotronik DX lead failure – recency bias or real issue?

Authors: *S Brown* (Presenting Author) – Musgrove Park Hospital, Taunton; *M Jones* – Musgrove Park Hospital, Taunton; *O Clayton* – Musgrove Park Hospital, Taunton; *G Furniss* – Musgrove Park Hospital, Taunton; *M Dayer* – Musgrove Park Hospital, Taunton

**Introduction:** The Biotronik DX lead is a defibrillator lead that has been in use since 2010. It offers atrial sensing from the floating dipole as it passes through the atrium. This improves tachyarrhythmia discrimination and can provide atrioventricular synchrony in patients who develop a need for pacing with a single ventricular lead in situ. Our operators noticed a series of failed DX leads at our centre and so we aimed to compare outcomes of the DX lead with a comparator group, non-DX Biotronik defibrillator leads.

**Methods:** The electronic health record was interrogated for all patients with a new Biotronik implantable cardioverter defibrillator (ICD) device, generator change or lead revision at our centre from 1 January 2012 to 31 December 2021. Lead failure was defined as need for replacement or revision.

**Results:** A total of 275 patients were identified (81.4% male, age 66 ± 12 years). Six patients were excluded (5 DX leads) due to being followed up out of area, leaving 269 patients. Overall, 99 had DX leads and 170 had non-DX leads; 81 (30.1%) had an atrial lead. Data showed that 22/269 patients (8.2%) experienced 25 lead failures over a median follow-up of 1436 days (841–2,387). Overall, 3/99 of the DX leads failed over 1,938 days (872–2462) and 22/170 of the non-DX leads over 1,262 days (848–2,275) (3.0% vs 12.9%; p=0.007). Median time to failure across both groups was 1,736 days (808–2421). None of the 99 DX leads and 4/170 non-DX leads displaced within 2 weeks of implant (0% vs 2.4%; p=0.30). One lead displaced 10 days after implant and then failed at 4.6 years and was replaced. Excluding acute lead displacement only as a cause

of failure, lead failure remained lower in the DX group: DX 3/99 vs non-DX 19/170 (3% vs 11.1%; p=0.0199) (Table 1). Four of the 25 (16%) lead failures resulted in inappropriate shocks due to late displacement (n=1) and noise (n=3). There were no adverse events due to lead repositioning. One patient had an occluded subclavian that prevented new lead insertion. Programming data were unavailable for 3 DX leads. Of the remaining 96, 29 (30.2%) had the SMART tachyarrhythmia discrimination function disabled and 68/96 (70.8%) had been re-programmed VVI due to atrial sensing issues or onset of permanent AF; 25 (26.0%) had both SMART deactivation and reprogrammed VVI and hence used none of the DX function. Vascular access was achieved using cephalic (177/269, 65.8%), axillary (35/269, 13.0%) or subclavian (57/269, 21.2%) approaches. Of the failed leads, a cephalic (13/25, 52.0%), axillary (5/25, 20%) and subclavian approach (7/25, 28%) was used. **Conclusion:** Although most patients with DX leads were reprogrammed due to problems with sensing (70.8%), DX leads failed at a lower rate than non-DX Biotronik leads (3.0% vs 12.9%; p=0.007) over similar follow-up periods. We presume that the sensing issues introduced a bias against DX leads and our findings highlight the importance of collecting objective data. Our data show that real-world ICD failure rates are higher than those quoted in the Biotronik product performance report (2022 first edition), which are between 0.48% and 2.4% for DX leads and 0.87%–5.9% for non-DX leads. The incidence of inappropriate shocks from failed leads was low (16%), and lead repositioning and replacement was safe and possible in most cases. □

Table 1

Table 1. Reasons for defibrillator failure and outcome							
Non-DX lead failures n=22 leads in 19 patients							
Lead	Reason	Time	Outcome	Lead	Reason	Time	Outcome
Protego ProMRI S 65	Rising threshold and impedance	3.8 years	New lead	Protego ProMRI S 65	Noise and high thresholds	14.6 years	New lead
Protego ProMRI S 65	Noise, fall in impedance and inappropriate shocks	4.8 years	New lead	Linix SD 65/16	Impedance >2000 ohms	9.2 years	New lead
Protego ProMRI S 65	Poor R wave sensing <3mV	4.8 years	New RV lead with CRT upgrade	Linix SD 65/16	Shock impedance >150 ohms	16.9 years	Deactivated
Protego ProMRI S 65	Noise and inappropriate shocks	5.2 years	Extraction – no new device implanted	Linix Smart ProMRI SD 65/16	Shock impedance >150 ohms	9.2 years	New lead attempted, subclavian occluded and conservatively managed. Died of VF storm after with multiple successful shocks on post-mortem ICD interrogation.
Protego ProMRI S 65	Noise and inappropriate shocks	5.5 years	New lead	Linix SD 65/16	Low impedance and battery drain	4.1 years	New lead
Protego ProMRI S 65	Noise after generator change	6.6 years	New lead	PLEXA ProMRI S 65	Failed to successfully shock out of VT despite satisfactory device and lead checks	6 months	New lead & generator
Protego ProMRI S 65	Impedance >2000 ohms	7.5 years	New lead	Plexa Pro MRI	Noise. Mechanical TVR	2.2 years	LV lead and ICD deactivation
Displaced leads				Multiple defibrillator lead failures			
Protego ProMRI S 65	Displaced on chest x-ray and unsatisfactory threshold/sensing	1 day	Reposition	Protego ProMRI S 65	Loss of capture and poor sensing. Not displaced on chest X-ray	10 days	Reposition
Protego ProMRI S 65	Displaced on chest x-ray and unsatisfactory threshold/sensing	1 day	Reposition	Protego ProMRI S 65	Poor R wave <2mV	4.6 years	CRT-upgrade and new RV lead
				PLEXA PROMRI S 65	Noise	6.2 years	New lead
				PLEXA PROMRI S 65	Noise	3.2 years	Extraction and S-ICD implant
				Linix SD 65/16	Noise	7.5 years	New lead
				PLEXA PROMRI S 65	Loss of capture and poor sensing. Not displaced on chest X-ray	9 days	Repositioned
DX lead failures n=3 leads in 3 patients							
Linix Smart ProMRI S DX 65/15	Shock impedance >150 ohms	2.4 years	New lead	Protego DF1 ProMRI S DX 65/15	Noise on RV lead	5.7 years	Clinic review (EF improved and primary prevention device)
Linix Smart ProMRI S DX 65/17	Displacement – seen on chest x-ray	2.4 years	Inappropriate shocks New lead				

RV = right ventricular, LV = left ventricular, CRT = cardiac resynchronisation therapy, S-ICD = subcutaneous implantable cardioverter defibrillator, ICD = implantable cardioverter defibrillator, VF = ventricular fibrillation, VT = ventricular tachycardia

Posters 2

**98/Cardiac implantable electronic device infections: multicentre validation of a novel risk score and its cost-utility implications for antimicrobial envelope use**

Authors: *E Maclean (Presenting Author) – St Bartholomew’s Hospital, London; K Mahtani – St. Bartholomew’s Hospital, London; S Honarbakhsh – St. Bartholomew’s Hospital, London; C Butcher – St. Bartholomew’s Hospital, London; N Ahluwalia – St. Bartholomew’s Hospital, London; ASC Dennis – St. Bartholomew’s Hospital, London; P Waddingham – St. Bartholomew’s Hospital, London; A Creta – St. Bartholomew’s Hospital, London; M Finlay – St. Bartholomew’s Hospital, London; M Elliott – St. Thomas’ Hospital, London; V Mehta – St. Thomas’ Hospital, London; N Wijesuriya – St. Thomas’ Hospital, London; O Shaikh – Royal Papworth Hospital, Cambridge; M Zaw – Royal Papworth Hospital, Cambridge; CN Ranmuthu – Royal Papworth Hospital, Cambridge; CR Ranmuthu – Royal Papworth Hospital, Cambridge; RJ Schilling – St. Bartholomew’s Hospital, London; PD Lambiase – St. Bartholomew’s Hospital, London; MJ Earley – St. Bartholomew’s Hospital, London; P Moore – St. Bartholomew’s Hospital, London; A Muthumala – St. Bartholomew’s Hospital, London; S Sporton – St. Bartholomew’s Hospital, London; RJ Hunter – St. Bartholomew’s Hospital, London; C Rinaldi – St. Thomas’ Hospital, London; JM Behar – St. Thomas’ Hospital, London; C Martin – Royal Papworth Hospital, Cambridge; C Monkhouse – St. Bartholomew’s Hospital, London; A Chow – St. Bartholomew’s Hospital, London*

**Introduction:** Antimicrobial envelopes reduce the incidence of cardiac implantable electronic device (CIED) infections; however, patient selection strategies are poorly defined and cost-utility data are limited.

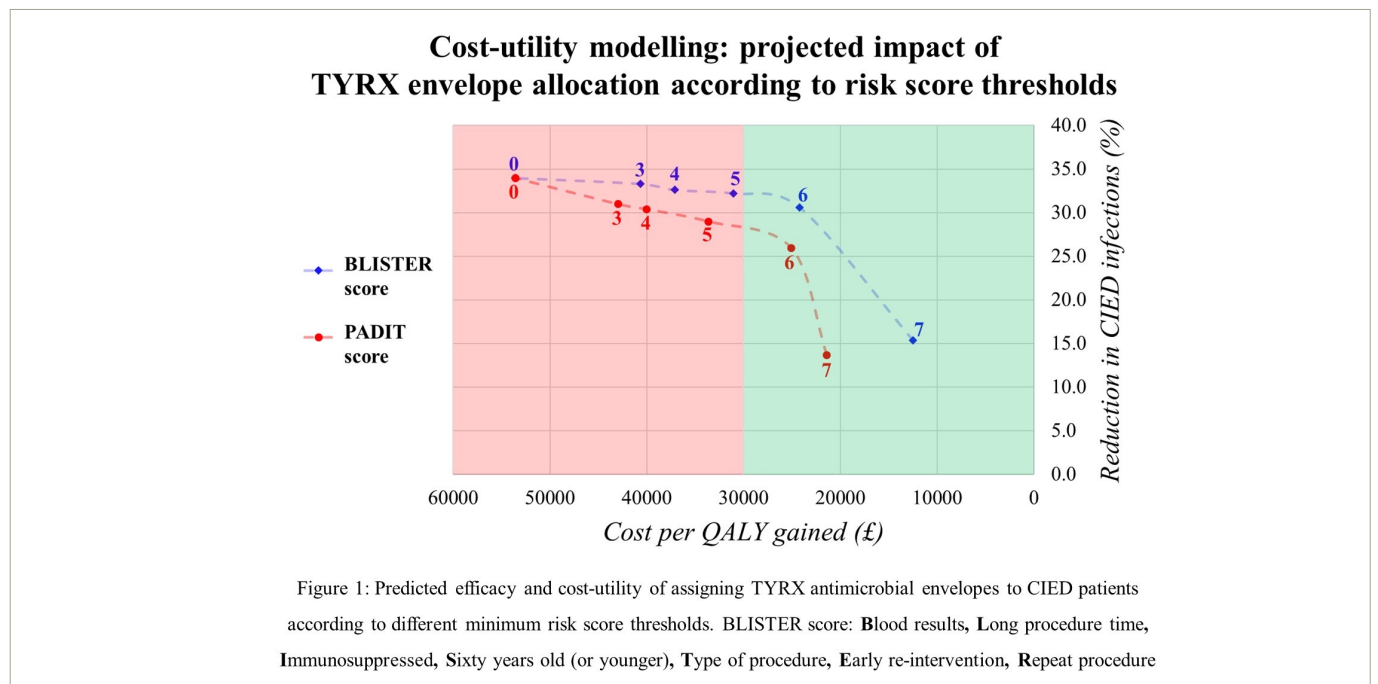
**Methods:** In a preliminary internal analysis, we examined the factors associated with infection for all transvenous CIED implants, generator changes and non-infected lead interventions at a single tertiary centre from 2016 to 2019. The primary outcome was hospitalisation for device infection within 12 months. We subsequently developed a novel risk score (BLISTER) and, in a multicentre validation cohort, compared prognostic utility versus the PADIT score. Finally, both scores were tested as gatekeepers in cost-utility modelling of the TYRX antimicrobial envelope; quality-adjusted life-year (QALY) increments were extrapolated from analysis of EQ-5D-3L data for all UK patients enrolled in the WRAP-IT trial.

**Results:** A total of 6,035 patients underwent 7,383 procedures; CIED infection occurred in 59 individuals (0.8%). In addition to the PADIT score

constituents, lead extraction (HR 3.3 [1.9–6.1];  $p < 0.0001$ ), C-reactive protein  $> 50$  mg/L (HR 3.0 [1.4–6.4];  $p = 0.005$ ), re-intervention within 2 years (HR 10.1 [5.6–17.9];  $p < 0.0001$ ), and procedure duration over 2 hours (HR 2.6 [1.6–4.1];  $p = 0.001$ ) were independent predictors of infection, and were incorporated into the novel BLISTER score. In a validation cohort comprising 2,701 additional patients from three tertiary centres, BLISTER demonstrated superior prognostic utility versus PADIT (AUC 0.83 vs 0.73;  $p = 0.01$ ). The optimum cost-utility model assigned TYRX envelopes to all patients with a BLISTER score  $\geq 6$ , and predicted a reduction in infections (0.55% versus 0.8%;  $p = 0.033$ ; number needed to treat 63) with a cost per QALY gained of £24,581.

**Conclusions:** The BLISTER score was a powerful predictor of infection in a heterogeneous CIED population and may facilitate cost-effective TYRX envelope allocation. □

Figure 2





## Posters 2

**99/The impact of COVID-19 on amiodarone use in Nottingham University Hospitals DC cardioversion service**

Authors: *F Doleman (Presenting Author) – Nottingham University Hospitals, Nottingham; J Teoh – Nottingham University Hospitals, Nottingham; B Doleman – University Hospitals of Derby & Burton, Derby; T Robinson – Nottingham University Hospitals, Nottingham*

**Background:** DC cardioversion (DCCV) is commonly used to restore sinus rhythm (SR) in patients with persistent atrial fibrillation or flutter (AF). DCCV is not always successful and often AF recurs soon after. Oral amiodarone therapy increases the efficacy of DCCV on the day and increases duration of SR after DCCV.

The NUH elective DCCV service was suspended for 6 months at the start of the COVID-19 pandemic. On its resumption, the NUH Arrhythmia team advised that all eligible patients be commenced on oral amiodarone at the time of referral for DCCV with the aims of achieving chemical cardioversion prior to DCCV, increasing on-the-day DCCV success rates, reducing the volume of repeat DCCVs and reducing the number of patients on the waiting list.

**Methods:** This was a retrospective analysis of 576 DCCV referrals and outcomes from January 2019 until August 2021; 281 prior to March 2020 and 295 after August 2020. Patient demographics, specialty of consultant in charge of patient care, body mass index, left ventricular function,

left atrium size, medications, chemical cardioversion rates and DCCV success rates were collected. Propensity score matching to assess impact of amiodarone use was performed.

**Results:** Post COVID-19 suspension, 46% of DCCV patients were on amiodarone vs 33% before ( $p=0.001$ ). Amiodarone use was higher in patients referred by an electrophysiology consultant (OR 1.42; 95% CI 1.01–1.98;  $p=0.04$ ). Propensity score matching demonstrated that patients on amiodarone were more likely to chemically cardiovert and obviate the need for DCCV (OR 1.75, 95% CI 1.06–2.89;  $p=0.03$ ). Being on amiodarone made no significant difference to on-the-day DCCV success (on amiodarone 155/170 [91%] vs off amiodarone 267/279 [95.7%];  $p=ns$ ).

**Conclusion:** Amiodarone use increased in DCCV patients post COVID-19, resulting in greater chemical cardioversion success and therefore reduced need for DCCV. Patients looked after by an electrophysiologist were more likely to receive amiodarone. Further follow-up is needed to assess maintenance of SR at first follow-up post DCCV. □

Table 1

	Amiodarone (n=190)	Control (n=190)	Standardised difference
Age	63.4 ± 10.2	64.1 ± 10.1	0.07
Female sex	44/190 (23.2%)	45/190 (23.7%)	0.01
Obese	90/190 (47.4%)	97/190 (51.1%)	0.07
Previous cardioversion	89/190 (46.8%)	92/190 (48.4%)	0.03



## Posters 2

### 100/COVID-19-associated atrial fibrillation: its incidence and potential implications, a retrospective 1-year study in a UK tertiary care hospital

Authors: *M Ahmad (Presenting Author) – University Hospital Plymouth, Plymouth; MA Noushad – University Hospital Plymouth, Plymouth*

**Introduction:** There are very few studies conducted to date linking COVID-19 with incidences of atrial fibrillation (AF) in patients. Though not so common, cardiovascular diseases and complications do occur, affecting morbidity and mortality of COVID-19 patients. The underlying mechanism of AF in COVID-19 is largely unknown. Some proposed putative mechanisms include a reduction in angiotensin-converting enzyme 2 (ACE 2) availability, sialic acid–spike protein interaction, enhanced inflammatory response and electrolytes/acid base abnormalities in the acute phase of illness.

**Methodology:** We conducted a retrospective, cross-sectional study evaluating a relationship between COVID-19 illness and new cases of AF. Cases were selected from Jan 2021 to Jan 2022 from patients who were symptomatic along with positive COVID-19 PCR test in the past 4 weeks. The inclusion criteria were met in each case (i.e. no past medical history of AF, with an electrocardiogram confirming new AF while admitted. We also tried to understand and estimate the incidences of AF with

COVID-19 clinical severity.

**Results:** Over 1 year, 500 patients who were admitted to COVID-19 isolation wards were randomly selected for this study. Of these patients, 65 were identified as having new AF while admitted due to COVID-19 illness. COVID-19 patients who required admission to the intensive care unit, just below 20% out of total studied, were found to have new episodes of AF, which was a significantly higher percentage compared with our randomized COVID-19 group who were admitted to wards.

**Conclusions:** It was found that with severe COVID-19 infection, chances of developing AF was significantly higher. It was also found that COVID-19 patients developing AF were older and had few pre-existing risk factors, such as ischaemic heart disease and hypertension. With more research studies available on this topic in future, we may have to adapt a strategy to screen patients for paroxysmal AF who have had recent severe COVID-19 illness to prevent them having a possible stroke as a complication from AF. □

Posters 2

**101/UK multicentre retrospective study of the learning curve and relative impact on success rates and procedural metrics of the Rhythmia Mapping System**

Authors: *AP Bates (Presenting Author) – Cardiology Department, University Hospital Southampton, Southampton; M Naseer – Cardiology Department, University Hospital Southampton, Southampton; M Taylor – Freeman Hospital, The Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne; N Denham – Department of Cardiology, Manchester University Foundation Trust, Manchester; A Yue – Cardiology Department, University Hospital Southampton, Southampton; M Das – Freeman Hospital, The Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne; GM Morris – Department of Cardiology, Manchester University Foundation Trust, Manchester; W Ullah – Cardiology Department, University Hospital Southampton, Southampton*

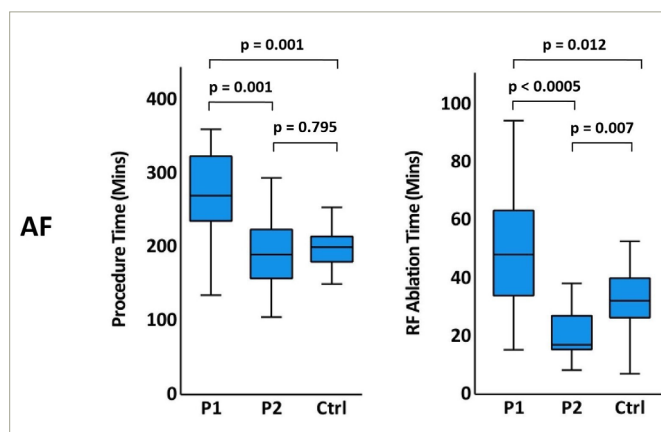
**Background:** The learning curve for the novel 3D electroanatomical system Rhythmia is unknown.

**Methods:** Retrospective data were collected from three UK centres from the introduction of Rhythmia. Procedures considered were de novo and redo atrial fibrillation (AF), cavotricuspid isthmus dependent atrial flutter and left-sided atrial tachycardias. Patients were matched with controls undergoing the same procedure using the well-established Carto3. Assessed metrics were fluoroscopy, radiofrequency ablation and procedure times, acute and long-term success, and complications.

Those procedures that showed correlation with experience using Rhythmia were divided into two groups: P1, where performance markers were improving, and P2, when a plateau had been reached. The threshold number of procedures between P1 and P2 was decided from assessment of scatterplots and comparison with the control group.

**Results:** A total of 253 study patients with 253 controls were included. Significant correlations existed between procedural efficiency metrics and centre experience for *de novo* AF ablation (procedure time Spearman’s  $\rho = -0.624$ ; ablation time  $\rho = -0.795$ ; both  $p < 0.0005$ ) and *de novo* atrial flutter (AFlut) ablation (ablation time  $\rho = -0.566$ ; fluoroscopy time  $\rho = -0.520$ ; both  $p = 0.001$ ). No such correlations existed for other assessed atrial arrhythmias. For *de novo* AF and AFlut, metrics significantly improved after 10 procedures in each centre: procedure time (AF only: P1  $272.5 \pm 65.1$  min, P2  $192.8 \pm 52.5$  min;  $p = 0.001$  [Figure 1]), ablation time (AF: P1  $51.4 \pm 22.4$  min, P2  $20.8 \pm 8.8$  min;  $p < 0.0005$  [Figure 1]; AFlut: P1  $15.4 \pm 6.9$  min, P2  $6.2 \pm 4.7$  min;  $p < 0.0005$ ) and fluoroscopy time (AFlut only: P1  $18.1 \pm 11.1$  min, P2  $10.1 \pm 9.4$  min;  $p = 0.002$ ), and became comparable to controls. Acute success and long-term success did not see significant improvement with experience, but were comparable to the control

**Figure 1: Changes in performance metrics with experience using Rhythmia in de novo AF cases**



P1 = procedures 1–10 using Rhythmia at a centre; P2 = procedures 11+ using Rhythmia at a centre; Ctrl = matched controls using Carto3.

group throughout. There was no relationship between experience and complications, which were comparable to Carto3 (3.6% in both groups).

**Conclusion:** A short learning curve was demonstrated with the use of Rhythmia HDx for standardised procedures (*de novo* AF/AFlut). Procedural performance improved and became comparable to Carto3 following 10 cases at each centre. Clinical outcomes at 6 and 12 months, and complications did not improve with experience and were no different from controls. □



Posters 2

102/Electroanatomic mapping data analysis using OpenEP

Authors: SE Williams (Presenting Author) – The University of Edinburgh, Edinburgh; P Smith – King’s College London, London; A Gharaviri – The University of Edinburgh, Edinburgh; C O’Shea – University of Birmingham, Birmingham; A Connolly – King’s College London, London; L O’Neill – King’s College London, London; I Kotadia – King’s College London, London; I Sim – King’s College London, London; N Bodagh – King’s College London, London; N Grubb – NHS Lothian, Edinburgh; J Whitaker – King’s College London, London; M Wright – Guy’s and St Thomas’ NHS Foundation Trust, London; S Niederer – King’s College London, London; M O’Neill – Guy’s and St Thomas’ NHS Foundation Trust, London; M Bishop – King’s College London, London; NWF Linton – Imperial College London, London

**Introduction:** OpenEP (<https://openep.io>) is widely used to streamline electrophysiology research, removing the need for researchers to write code to import and analyse data. OpenEP provides a common interface for the storage, representation and analysis of electroanatomic and electrophysiological data from the major system manufacturers. Significant updates to OpenEP have been added since initial release in late 2020. This abstract describes the features and tools added recently.

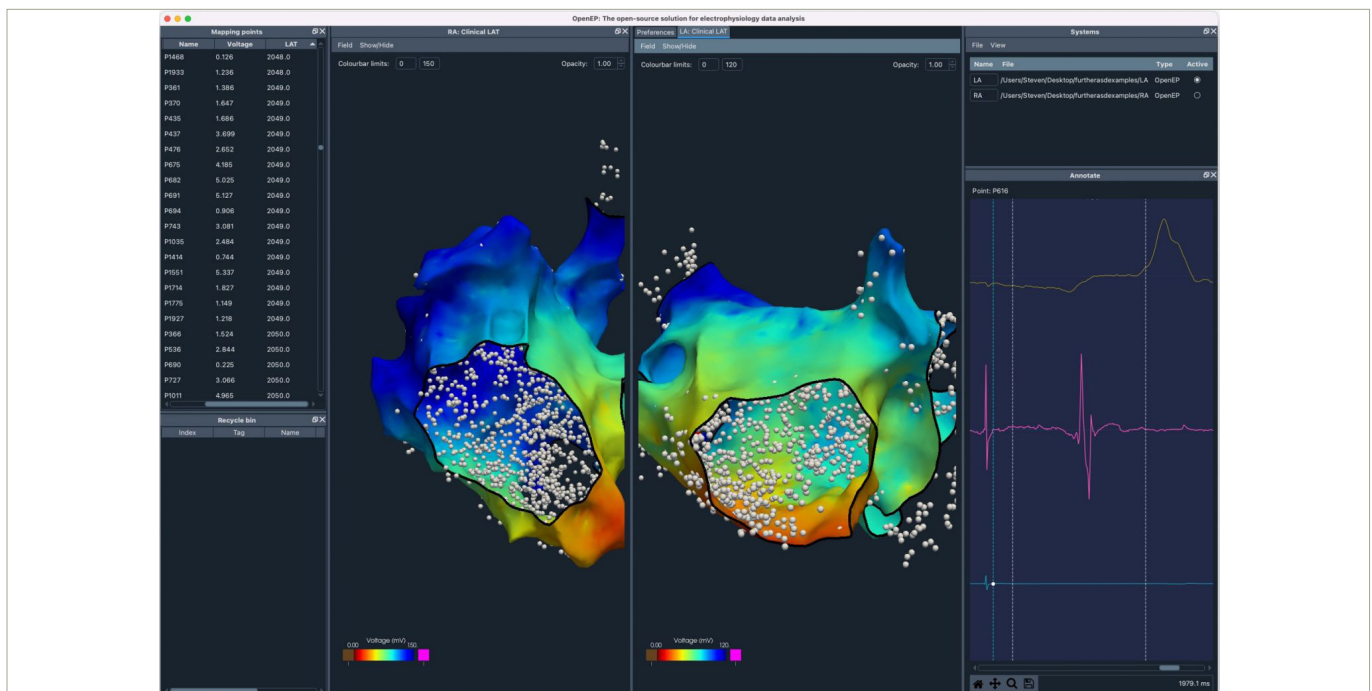
**Method:** OpenEP is a collaborative, open-source project (<https://github.com/openep>) with permissive licensing. Software development has been performed in Matlab (R2020a/R2021b), Visual Studio and Python3 with a Py-QT front-end. OpenEP consists of three components: a data-parsing system; a graphical interface; and a data-analysis system. Software and system development has been performed in each of these areas.

**Results:** *Data parsing.* At initial release, OpenEP supported reading in data from the Carto3 (Biosense Webster), Velocity (St Jude Medical) and Precision (Abbott) electroanatomic mapping systems. We continue to update and support the data parsers for Carto3, Velocity and Precision. In addition, we have added data parsers for the Kodex (EPD/Phillips) and EnSiteX (Abbott) mapping systems. It is also now possible to import simulation data from the openCARP simulation platform. Electroanatomic mapping data sets can also be export in the openCARP format for simulation experiments. *Data analysis.* Interpolation is used in electroanatomic mapping systems to create colour maps of electrical data. An extensive re-writing of code used for interpolation in OpenEP has been performed. The original *generateInterpData.m* function has

been replaced with a new extensible architecture for data interpolation based around the *openEPDataInterpolator.m* class. This new architecture has uncovered previously unrecognised variation in the interpolation schemes employed in clinical mapping systems and will permit the optimisation of interpolation methods against ‘gold standard’ simulation or histological data. A similar architecture for conduction speed and velocity measurement has also been developed. This architecture exposes established techniques including the gradient, triangulation, radial basis and cosine-fit methods for calculation of conduction velocity. Conduction velocity is a key parameter defining arrhythmia mechanisms, and this tool provides a simple method for applying previously published techniques for conduction velocity calculations to clinical data. Finally, we have refined the ablation lesion quantification tools permitting time-domain analysis of radiofrequency lesion formation. *Graphical interface.* We are developing a graphical interface, providing the ability to visualize, manipulate and analyse electrophysiological data (see figure). To facilitate this development, we are developing a Python3-based implementation of OpenEP. A beta-testing program for the graphical interface will shortly be launched. The graphical interface provides, for the first time, a standalone system for review of electroanatomic mapping data, which can be installed on desktop/laptop computers.

**Conclusion:** OpenEP is an open-source platform for analysis of electroanatomic mapping data under active development. Recent work improves data parsing and analysis functionality and facilitates usability through the development of a graphical interface. □

Figure 1



## Posters 2

**103/Using transthoracic echocardiogram (TTE) to risk-stratify patients with inherited arrhythmia syndromes (IAS)**

Author: *Al Iqbal (Presenting Author) – Royal Papworth Hospital, Cambridgeshire*

**Background:** Electromechanical window (EMW) defines the difference between the end of mechanical systole and the termination of electrical repolarisation [EMW= QAOc – QT]. A negative EMW has been established in patients with long QT syndrome (LQTS) when compared with controls, with marked EMW negativity in symptomatic LQTS. EMW negativity has been shown to be a better risk-stratification tool compared with the existing methods.

**Aims:** To validate the findings of EMW negativity in LQTS and determine whether a negative EMW exists in other inherited arrhythmia syndromes (IAS) such as Brugada syndrome (BrS) and arrhythmogenic cardiomyopathy (ACM).

**Method:** This was a retrospective study at Royal Papworth Hospital, over a 10-year period (2011–2021), investigating a convenient sample size of LQTS (n=28), BrS (n=27), ACM (n=34) and control (normal; n=64). EMW was calculated as the difference between aortic valve closure QAOc and QT-interval measured using transthoracic echocardiography.

**Results:** A negative EMW was found in LQTS ( $-40 \pm 50$ ;  $p < 0.001$ ) and ACM ( $-10 \pm 40$ ;  $p < 0.001$ ) compared with controls. However, this was not true for the BrS cohort ( $17 \pm 30$ ;  $p = 0.204$ ). EMW was more negative in the symptomatic compared with the asymptomatic LQTS cohort. Both findings validate previous literature specifically that of a negative EMW ( $-43 \pm 46$  ms;  $p < 0.0001$ ) in LQTS compared with controls. LQTS type 3 had a marked EMW negativity compared with other LQTS types. A correlation existed between EMW negativity and a prolonged QT-interval. Excellent inter-rater reliability was established via the ICC calculation; average ICC was 0.97 with a confidence interval of 0.94–0.99.

**Conclusions:** LQTS and ACM cohorts had a negative EMW compared with controls, and EMW negativity was more pronounced in symptomatic LQTS. However, this was not the case in the BrS cohort. EMW has proven to outperform the traditionally used QTc and can be used when Bazett's correction formula and wide QRS limit the use of QTc. Therefore, EMW negativity could be a useful measure of risk stratification in IAS. □

Posters 2

**104/An evaluation of the remote follow-up (RFU) service for cardiac pacing devices at Royal Papworth Hospital (RPH) and the impact of this service on patient care during the COVID-19 pandemic**

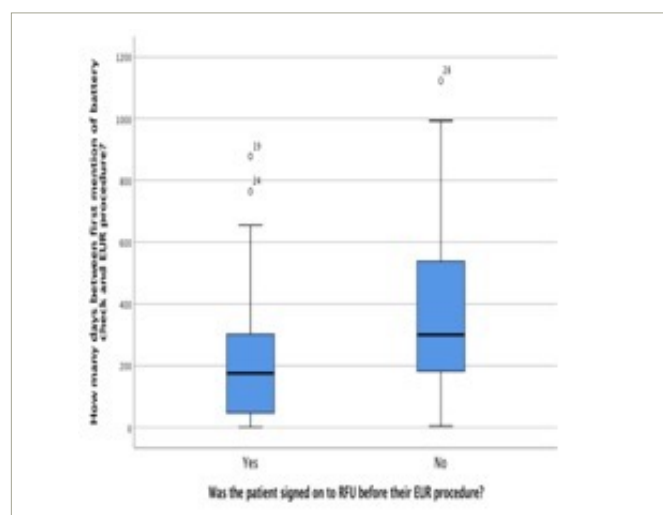
Authors: *N Case (Presenting Author) – Royal Papworth Hospital NHS Foundation Trust, Cambridge; S Silva – Royal Papworth Hospital NHS Foundation Trust, Cambridge; Dr I Turner – Royal Papworth Hospital NHS Foundation Trust, Cambridge*

**Background:** During COVID-19, Royal Papworth Hospital (RPH) expanded remote follow-up (RFU) services for cardiac pacing device patients in line with recommendations by current guidelines. RFU allows for detection of adverse clinical events such as arrhythmias, battery depletion and lead damage via monitoring of associated parameters. Whilst RFU has not been shown to increase occurrence of major adverse events, it remains underutilised with contradictory literature around costs and changing workload. This project aimed to identify how RPH RFU provision changed due to COVID-19 and the impact on patients awaiting intervention.

**Methods:** A sample of 517 RPH device patients was retrospectively collected. Proportions of these patients on RFU were analysed, establishing proportions of those who were signed-on ‘pre-COVID’ and ‘during COVID’ (i.e. before or after 1 April 2020), and how proportions differed across device types (pacemakers, implanted cardioverter defibrillators [ICDs], and cardiac resynchronisation therapy [CRT] devices). A second sample of 180 patients who underwent elective unit replacement (EUR) intervention between 1 March 2019 – 30 April 2021 was collected. Proportions of these patients on RFU was analysed, and proportions of EUR indications identified by RFU or in-house were compared. Time from indication to intervention was compared between RFU and in-house as well as overall numbers of monitoring appointments during this time.

**Results:** From the first sample, 80% of patients overall were on RFU; 53% of patients were signed-on to RFU pre-COVID and 27% during COVID. However, when analysed by device type, there were significant differences both overall ( $p=0.000$ ) and by pairwise comparison: pacemaker patients had lowest overall RFU sign-up, despite seeing the largest sign-on increase during COVID ( $p=0.000$ ), and more CRTs than ICDs were signed-on during COVID ( $p=0.001$ ). Analysis of the intervention patient sample highlighted that RFU significantly reduced the time from indication to EUR intervention (mean wait times: RFU=176 days, in-house=300 days;

Figure 1



$p=0.000$ ). However, RFU did increase the mean number of monitoring appointments compared with in-house only follow-up (RFU=4, in-house only=3;  $p=0.044$ ). Of the patients on RFU in this population, there was no difference in the number of first indications identified by RFU or in-house appointment.

**Conclusions:** Although RPH RFU services expanded during COVID-19, expansion was not equal across device types. For intervention patients, RFU significantly reduced the time from indication to EUR intervention, though monitoring workloads increased during this time. Future research may focus on alternative interventions to assess the impact of RFU in other device patient populations. □



## Posters 2

### 105/What governs immediate or delayed DC cardioversion of atrial fibrillation?

Author: *A Al-Hamdi (Presenting Author) – Alhamdi Heart Clinic, Sulaimanya*

**Introduction:** DC-cardioversion of atrial fibrillation may be immediate or delayed after shock delivery. What characterises each phenomenon is not clearly known.

**Patients and methods:** A total of 100 patients with persistent atrial fibrillation were reverted to sinus rhythm with DC cardioversion. One group showed immediate reversion and the other showed delayed reversion after shock delivery. The duration of the atrial fibrillation, the ventricular rate range before reversion, the preceding drug therapy, patient weight and left atrial (LA) size were studied in these two groups of patients to determine which factors affect reversion pattern.

**Results:** From a total of 115 patients with persistent atrial fibrillation

exposed to DC cardioversion, 100 (80%) patients who reverted to sinus rhythm were included. Of these patients, 60 reverted immediately and 40 showed delayed reversion. The average ventricular rate (VR) was faster in the immediate group at 165 versus 125 in the delayed group. The LA size was larger in the delayed group. Preceding drug effect was not significant in either group. The duration of the arrhythmia was shorter in the immediate group.

**Conclusion:** The delayed or immediate reversion of atrial fibrillation to sinus rhythm with DC shock was governed by the VR preceding the reversion, the duration of the arrhythmia and the LA size. □

## Posters 2

**106/Implantable cardioverter defibrillators: the prophylaxis of sudden cardiac death in patients with ischaemic and non-ischaemic cardiomyopathy. Contemporary clinical outcomes from a single tertiary centre**

Authors: J Mayer – Royal Stoke Hospital, Stoke on Trent; V Walker – Royal Stoke Hospital, Stoke on Trent; CS Kwok – Royal Stoke Hospital, Stoke on Trent; A Patwala – Royal Stoke Hospital, Stoke on Trent; T Phan – Royal Stoke Hospital, Stoke on Trent

**Background:** Contemporary clinical questions exist around the modern-day efficacy of implantable cardioverter defibrillators (ICDs) for the prophylaxis of sudden cardiac death. The increased use of anti-arrhythmic medications, beta-blockers and renin-angiotensin aldosterone system inhibitors have significantly improved clinical outcomes in heart failure patients and have been shown to reduce mortality and morbidity. Appropriate patient selection is very important when identifying those who may yield an overall survival benefit from an ICD. Clinical variables including age, comorbid status and the primary aetiology of the cardiomyopathy are important factors to consider during the patient selection process. Despite the potentially life-saving benefits, ICDs require subtle lifestyle changes that can potentially affect a patient's quality of life. These include potential driving implications, physical exercise restrictions, and the risk of complications and inappropriate shocks. ICD discharges that are delivered inappropriately are often painful, psychologically distressing and can cause decline in cardiac function. Complications, including chronic infection and lead failure, are rare but can occur and have potential detrimental consequences.

**Aims:** The aim of this study was to determine the clinical outcomes for patients receiving *de novo* ICDs at a single tertiary centre in the North Midlands region of the UK. Through investigating the clinical outcomes, we could assess the safety and efficacy of ICD therapy across different patient populations.

**Objectives:** 1. To calculate the incidence of mortality and defibrillator deactivation that occurs in patients following *de novo* ICD implantation; 2. to calculate the incidence of acute and chronic complications that

occurs following *de novo* ICD implantation; 3. to calculate the incidence of both appropriate and inappropriate therapy that occurs following *de novo* ICD implantation; 4. to calculate the difference in mortality and defibrillator deactivation between ischaemic and non-ischaemic cardiomyopathy patients.

**Methods:** Local electronic dating reporting systems were used to review baseline characteristics and clinical outcomes of patients who underwent ICD implantation between June 2014 and August 2015.

**Results:** A total of 200 patients were included in the study and mortality and/or deactivation of tachycardia therapies occurred in 58 (29%) patients during a mean follow-up period of 4.2 years. In all, 42 patients (21%) patients received appropriate therapy, 22 (52%) of whom received defibrillation. Ten patients (5%) in total received inappropriate therapy, 8 of whom experienced inappropriate shocks. Complications occurred in 17 patients overall (8.5%), 13 of which were acute and 4 were reported as chronic. Compared with those with non-ischaemic cardiomyopathy, patients with ischaemic cardiomyopathy were older ( $p=0.006$ ) and more commonly diabetic ( $p=0.008$ ). The clinical outcomes in terms of mortality and defibrillator deactivation were significantly different between the two populations ( $p=0.001$ ), with a higher incidence of mortality and device deactivation in those with ischaemic cardiomyopathy.

**Conclusion:** This study provides an up-to-date review of contemporary clinical outcomes in patients with an ICD, and suggests that those with ischaemic cardiomyopathy have poorer clinical outcomes than those with non-ischaemic cardiomyopathy. □



Posters 2

107/Service development of a pathway for generator changes in older adults with frailty

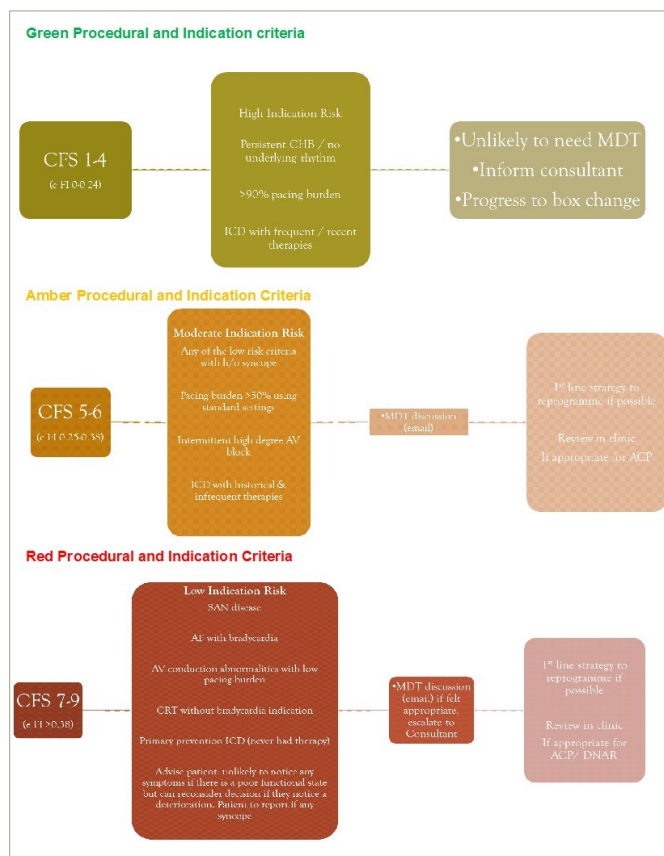
Authors: *EM Carr (Presenting Author) – Sheffield Teaching Hospitals foundation trust, Sheffield; G Kirkwood – Sheffield Teaching Hospitals Foundation Trust, Sheffield*

**Introduction:** The average age of patients presenting to healthcare services with complex arrhythmias needing intervention is increasing. With the average life span of a pacemaker generator ranging from 5 to 12 years, this often means that these already older patients have become even older with complex comorbidities and frailty by the time the device goes into elective replacement indicator (ERI). Questions subsequently arise about what happens when these generators reach ERI and need changing in these patient groups. This led us to develop an initiative using Plan-Do-Study-Act (PDSA) cycles to come up with a pathway for frail older patients who are being considered for pacemaker generator change. The focus is to provide efficient, consistent, patient-centered care and to ensure a multidisciplinary team (MDT) approach is embedded.

**Methods:** Multiple PDSA cycles were utilised at Sheffield Teaching Hospitals NHS Foundation Trust. The pathway devised was a traffic light system incorporating the Clinical Frailty Scale (CFS) as well as the indication for a pacemaker. Patient were stratified by their procedural risk (CFS) and indication risk. Patients with a low CFS and high indication were deemed green and therefore went straight to generator change. Patients with a moderate CFS and intermediate indication were deemed amber and went for MDT discussion. Patients with a high CFS and a low indication were deemed red and also went on to have an MDT discussion (see *Figure* for algorithm).

**Results:** The results, at 1 year, were that patients with moderate and high clinical frailty were all discussed at an MDT meeting, with 56% going on to have a review and further in-depth discussion around best interest decisions with the patient and their next of kin. Overall, 65% of patients had a change in management. The average CFS of patients on the pathway was 6 (amber on the pathway). This is where people need help with all outside activities and with keeping house. Inside, they often have problems with stairs and need help with bathing and might need minimal assistance (cueing, standby) with dressing. When compared with generator changes in 2018, the pathway did not increase admission rates or mortality. All-cause mortality was 9% for both datasets. Qualitative data showed that professionals and patients were supportive of the pathway. Other learning points included how to facilitate service development across multiple specialties.

Figure 1



**Conclusions:** The pathway appeared to work well and altered the outcomes for patients and facilitated discussions around future care. We can infer from the data that the pathway does not increase readmission rates or mortality. Further data are needed to conclude whether the pathway reduces readmission rates and whether further statistical significance can be given to the CFS score and the ultimate outcomes decided. □

## Posters 2

### 108/Trauma and syncope: looking beyond the injury

Author: *KS Kavi (Presenting Author) – Leeds Teaching Hospitals Trust, Leeds*

**Introduction:** This review examines the current literature and guidance relating to syncope in the trauma patient, exploring the causes of syncopal falls that may be overlooked, and discussing the optimal evaluation and safe management of syncope patients.

**Discussion:** Overall, 42% of the population will experience syncope by the age of 70 years, with 36% of syncope-related hospital attendees suffering concomitant physical injury and significant trauma through falls. The priority in the setting of trauma is to differentiate between cardiac and non-cardiac causes of syncope, where the cardiac causes carry the greatest risk of sudden death. There is no complete uniformity between the guidelines produced by the European Society of Cardiology and National Institute for Health and Care Excellence in identifying high-risk features indicative of cardiac syncope requiring specialist assessment in under 24 hours. Adherence to thorough history-taking, examination, orthostatic blood pressure recordings and an electrocardiogram (ECG) can diagnose the cause in up to 50% of syncope cases. Recurrent falls, polypharmacy, and head injury without concomitant hand or forearm injury should increase suspicion of syncope, whilst abnormal ECG findings are 95–98% sensitive in the detection of serious adverse outcomes. Examining the relationship

between syncope and advanced trauma life support (TM) principles reveals that appropriate replacement of circulatory volume, application of compression stockings and abdominal binders, and administration of analgesia aid in reducing syncopal events. Spinal immobilisation boards and a vertical head tilt of 10° reduces the risk of syncope and watershed strokes. However, consideration on an individual basis should be given to patients with head injury and suspected intracranial hypertension. Target systolic blood pressures of 120–140 mmHg are not always feasible in major trauma. A permissive or ‘damage control’ systolic blood pressure target of 80–90 mmHg in trauma without brain injury and mean arterial pressure of over 80 mmHg in trauma with brain injury could be adopted to reduce further syncopal episodes in the acute setting. Standardised routine syncope blood testing in trauma patients produce low yield results, and diagnostic work-up should be determined on an individual clinical basis.

**Conclusion:** In the absence of a gold-standard clinical test to identify the cause of a syncopal episode, standardised syncope guidelines should be incorporated into trauma protocols to determine high-risk aetiologies, improving diagnostic accuracy, reducing unnecessary investigations, and developing an effective and safer management plan. □

## Posters 2

### 109/Structural and functional characteristics of the heart after CRT in patients with heart failure

*Authors: BA Akhyt (Presenting Author) – Institute of Cardiology and Internal Medicine, Almaty; RT Kuanyshbekova – Institute of Cardiology and Internal Medicine, Almaty; AT Mussagaliyeva – Institute of Cardiology and Internal Medicine, Almaty; KN Madaliyev – Institute of Cardiology and Internal Medicine, Almaty; KM Koshumbayeva – Institute of Cardiology and Internal Medicine, Almaty; KA Atageldiyeva – Department of Medicine, Nazarbayev University School of Medicine, Nur-Sultan*

**Aim:** The aim of the study was to evaluate the clinical and hemodynamic effects of resynchronization therapy in patients with congestive heart failure.

**Materials and methods:** Seventy-six consecutive patients underwent echocardiography, New York Heart Association (NYHA) classification, 6-minute walk test and clinical assessment scale modified by Mareev, before and after cardiac resynchronization therapy. All had complete left bundle branch block, with a QRS complex duration  $\geq 130$  ms and left ventricular ejection fraction  $\leq 35\%$ . Also, all patients had received optimal medical therapy for at least 3 months before inclusion to the study.

**Results:** We observed significant increase in left ventricular ejection

fraction ( $35.4 \pm 3.7\%$ ;  $p < 0.001$  compared with baseline) and decrease in end-systolic volume of the left ventricle ( $20.2 \pm 3.0\%$ ;  $p < 0.001$  compared with baseline). Improvement in functional class of congestive heart failure by NYHA classification by  $>1$  was observed in 68.4% of individuals, 26.3% demonstrated no change and 5.3% of patients had worsening of CHF symptoms.

**Conclusions:** The response of patients with congestive heart failure to cardiac resynchronization therapy was heterogeneous. The relationship between left ventricular reverse remodeling and the functional class of the congestive heart failure was not significant. □

Posters 2

**110/Sotalol and mexiletine in combination are effective in suppressing ventricular arrhythmias in high-risk patients with ARVC: a single-centre experience**

Authors: *MA Rauf (Presenting Author) – University Hospitals Birmingham NHS Foundation Trust, Birmingham; A Aljehani – University Hospitals Birmingham NHS Foundation Trust, Birmingham; B Ensam – University Hospitals Birmingham NHS Foundation Trust, Birmingham; L Fabritz – University Hospitals Birmingham NHS Foundation Trust, Birmingham; R Steeds – University Hospitals Birmingham NHS Foundation Trust, Birmingham; J De Bono – University Hospitals Birmingham NHS Foundation Trust, Birmingham; M Kalla – University Hospitals Birmingham NHS Foundation Trust, Birmingham*

**Background:** Arrhythmogenic right ventricular cardiomyopathy (ARVC) is a rare, inherited non-ischaemic cardiomyopathy, which is linked to a high incidence of recurrent ventricular arrhythmias (VA) and sudden death, especially in young and athletic people. The purpose of this study was to describe the experience with mexiletine and sotalol combination for the treatment of VA.

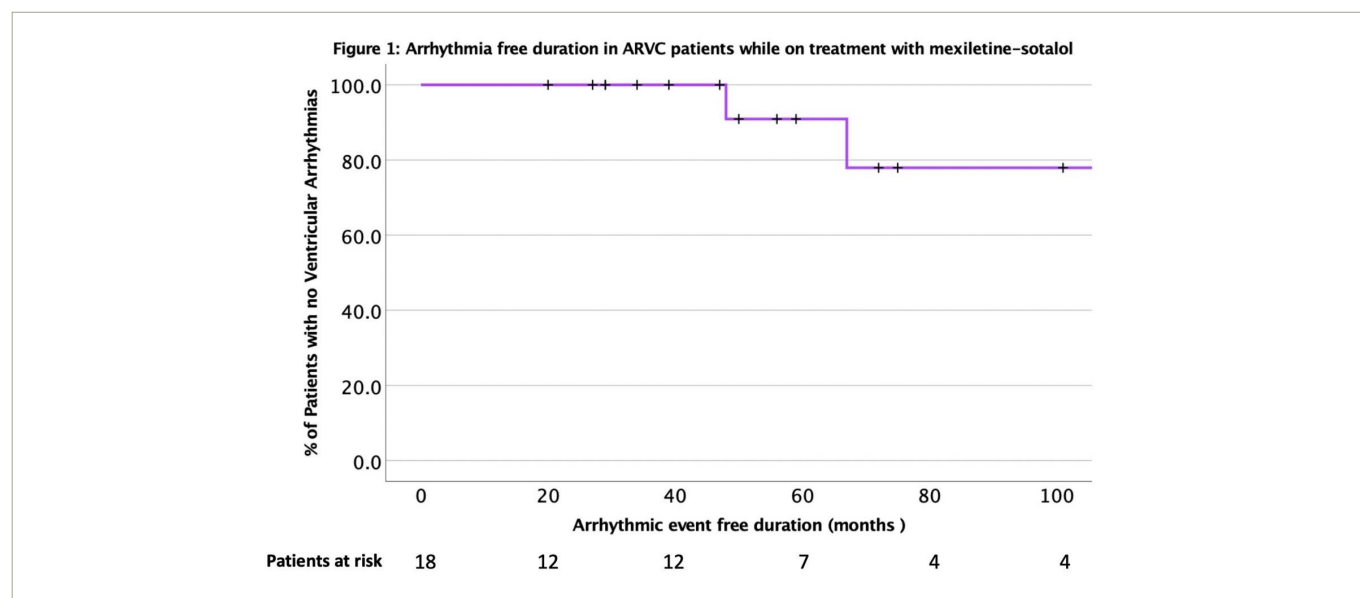
**Methods:** This was a single-centre, observational cohort of patients with ARVC seen at the Inherited Cardiac Condition Services at University Hospitals Birmingham (UHB) between 2010 and 2022. ARVC patients being treated with mexiletine and sotalol were identified by digital health records. Electrocardiographic, imaging, device and genetic testing data were analysed in this cohort. The type of VA and the treatment with antiarrhythmic therapy in relation to defibrillator implantation and ablation were examined.

**Results:** A total of 18 patients (mean age  $45 \pm 12$  years, 72% male) were on treatment with mexiletine and sotalol combination out of a cohort of 165 patients with definite, borderline and possible ARVC. All 18 met diagnostic 2010 Task Force Criteria for ARVC. A total of 13 patients had documented sustained ventricular tachycardia, while four patients had high burden ventricular ectopy and one patient had a ventricular fibrillation arrest. An implantable cardioverter defibrillator

was implanted in 13 patients, and 5 patients underwent catheter ablation (3 patients had endocardial while 2 patients had combined endocardial-epicardial ablations) for VA. Epsilon waves were identified on 12-lead electrocardiogram (ECG) in 6 patients (33%) while late potentials were found in signal averaged ECG (SAECG) in 11 patients (61%). Left ventricular (LV) ejection fraction was  $55 \pm 12\%$ , while right ventricular (RV) fractional area change (FAC) was  $29 \pm 9\%$ . Late gadolinium enhancement (LGE) of the ventricular myocardium was identified in 11 patients (10 had RV LGE and 5 had LV LGE). Plakophilin-2 (PKP2) was the most identified genetic mutation (11 patients, 56%). Participation in sports was reported by 11 patients (61%). The mean dose of mexiletine was 558 mg per day (range 300–900 mg/day) while the mean dose of sotalol was 149 mg/day (range 80–360 mg/day). Arrhythmic event-free duration on the mexiletine-sotalol combination in these patients was found to be  $61 \pm 32$  months during follow-up (Figure 1).

**Conclusion:** VA is an important cause of morbidity and mortality in patients with ARVC. Mexiletine-sotalol combination is a useful adjunct to ablation and defibrillator implantation in these patients and provides effective arrhythmia-free periods in these high-risk patients. Larger datasets are required to compare the efficacy of the mexiletine-sotalol combination with other antiarrhythmic drugs in patients with ARVC. □

Figure 1



Posters 2

111/Ventricular tachycardia burden between surgical and control group

Authors: *R Mravljak* (Presenting Author) – Barts Heart Centre, London; *J Elliott* – Barts Heart Centre, London; *C Monkhouse* – Barts Heart Centre, London; *P Waddingham* – Barts Heart Centre, London; *J Bennett* – Barts Heart Centre, London; *S Honarbakhsh* – Barts Heart Centre, London; *G Thornton* – Barts Heart Centre, London; *P Lambiase* – Barts Heart Centre, London; *T Treibel* – Barts Heart Centre, London

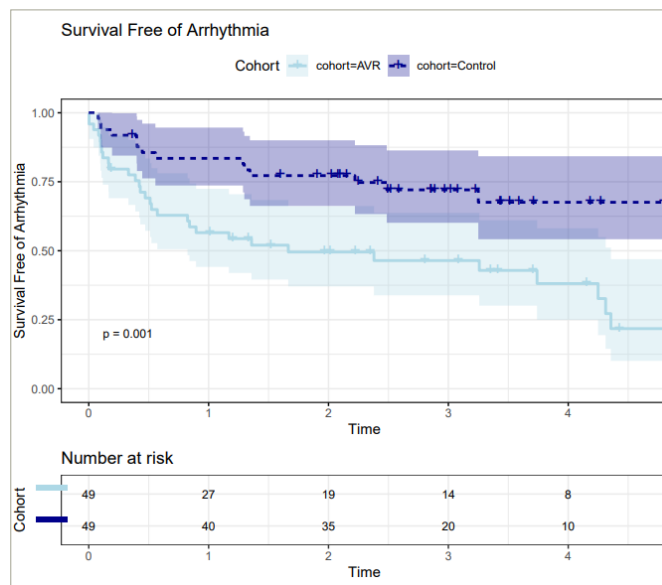
**Introduction:** Aortic valve replacement (AVR) improves outcome in patients with severe aortic stenosis (AS). Nevertheless, late mortality remains high (15–35% at 3.5 years in some series) following AVR and is associated with myocardial scarring. Whether excessive mortality is due to heart failure or arrhythmia is unknown, and the burden of ventricular arrhythmia after surgical AVR remains poorly characterised.

**Objectives:** To determine the incidence of ventricular arrhythmia, post-AVR for severe AS in patients with implantable electronic devices (IEDs) compared with a control group of patients with IEDs but no history of aortic valve disease.

**Methods:** A total of 134 consecutive patients undergoing surgical aortic valve replacement (SAVR) for severe AS between January 2016 and May 2018 who had a pacemaker or defibrillator implanted post-AVR were retrospectively reviewed. Exclusions (n=85) were non-aortic moderate-to-severe valve disease (n=21), history of cardiomyopathy (n=44) and follow-up at a different centre (n=20). The primary outcomes were incidence and burden of ventricular arrhythmia. Device and demographic data were reviewed via patients' electronic records.

**Results:** A total of 98 patients were included (49 AS and 49 control). The mean age of AS patients was 67 ± 13 years. Common comorbidities were arterial hypertension (n=41; 84%), diabetes mellitus (n=9; 18%) and chronic kidney disease (n=2; 4%) with only a minority of patients having significant left ventricular impairment (n=3, 6%). Compared with the AS cohort, the control cohort was older (74 ± 13 years vs 67 ± 13 years), had less hypertension (n=24; 49% vs 84%), had more diabetes mellitus (n=14; 29% vs 18%) and chronic kidney disease (n=6; 12% vs 4%). All patients in this cohort had preserved left ventricular ejection fraction. Bradycardia indications for implantation in the AVR cohort were atrioventricular block (77%) and sinus node disease (23%). In contrast, indication for ppm implantation in the control group were atrioventricular block (94%) and documented bradycardia in the context of atrial fibrillation (6%). Exclusion criteria for the control group were history of valve disease, cardiomyopathy, ≥ mildly impaired left ventricular ejection fraction and previous open-heart surgery. At a median follow-up of 38 and 39 months for the control and SAVR groups, respectively, we documented ventricular arrhythmias in 31 SAVR patients (63%) and in 19 control patients (39%; p=0.0257). In the SAVR group, 24 patients (49%) had documented nonsustained ventricular tachycardia (NSVT) and 7 patients

Figure 1



(14%) had documented sustained VT episodes, whereas in the control group, 14 patients (29%) had NSVT and 5 patients (10%) had sustained VT. Time from device implantation to first arrhythmia recording was 156 (IQR 35–402) and 163 (IQR 71–474) days in the SAVR and control groups, respectively. Ventricular arrhythmia was an isolated event (1–2 episodes) in 45% of the SAVR group who had arrhythmia and 58% in the control group. Mortality rate for AVR was 14% (n=7) and 2% (n=1) for the control group. One AVR death was documented as an arrhythmic cause; the remaining reported causes were unavailable. A control group patient died due to organ failure.

**Conclusion:** Ventricular tachycardia (VT/NSVT) was more common in patients after SAVR for severe AS than an unselected IED cohort, though the overall burden was low and primarily isolated asymptomatic episodes. Further prospective studies are required to understand the mode of death after AVR and whether NSVT is a relevant marker of prognosis. □

## Posters 2

### 112/Consult requests by emergency department (ED) or medical teams due to atrial fibrillation (AF) made to the cardiology ANP service: a review of the reliance on and compounding factors that reduce the accuracy of automated ECG software reports

Authors: *P Stoneman (Presenting Author) – Beaumont Hospital, Dublin; F Colbert – Beaumont Hospital, Dublin; J Adams – Beaumont Hospital, Dublin; R Sheahan – Beaumont Hospital, Dublin*

**Aim:** Within the 6-month prospective timeframe: 1. to determine the extent to which clinicians referring to the cardiology advanced nurse practitioner (ANP) service have relied on automated electrocardiogram (ECG) machine software reports to confirm or rule out the diagnosis of atrial fibrillation; 2. to determine the false-positive or false-negative rates of AF made by the automated ECG software; 3. to identify factors that increase the likelihood of false-positive or false-negative rates of AF.

**Design:** This was a 6-month prospective review of formal cardiology consults provided to clinicians (emergency department [ED] and medical teams) for what they believed to be confirmed cases of AF. All patients have been referred or had self-presented to the ED. All ECGs were reviewed by a Registered cardiology ANP (RANP). Potential, contributory factors that may have compounded the software interpretation were considered by the RANP, including motion artefact, premature atrial/ventricular contractions (APCs/PVCs), visually low amplitude P waves and irregular QRS.

**Results:** A total of 21 consult requests, which were made to the Cardiology ANP service by clinicians in the ED or on-call medical teams as a result of what was believed to be a confirmed case of atrial fibrillation, were included. Overall, 19 automated ECG reports were deemed by the RANP to be false positives, which inaccurately reported AF. In 2 cases, the RANP was asked to provide consults for other reasons and identified false-negative reports where atrial flutter was not accurately reported.

Motion artefact was the biggest compounding factor affecting the accuracy of automated ECG reports seen in 62% (13/21) of false-positive reports followed by low amplitude P waves (48%, 10/21), irregular QRS (43%, 9/21) and presence of APC/PVCs in 38% (8/21) of reports. Interestingly, the 2 false-negative reports had no compounding factors to explain the inaccuracy.

**Conclusions/recommendations:** Significantly larger studies are aligned with ours and support the fact that clinicians are over-reliant on automated ECG reports, and that regardless of ECG machine manufacturer or cost, false-positive automated ECG software reports are worryingly high in general and seem inevitable when there are compounding factors, for example when: 1. there is motion artefact on the isoelectric line; 2. there is premature atrial or ventricular ectopy; 3. the QRS is irregular; 4. there are visually low amplitude P waves. These findings should serve as a warning to those involved in the management of AF, particularly when the cornerstone of AF management from the outset is predicated on accurate ECG diagnosis. The reality is that inexperienced clinical staff are more likely, in the absence of strict senior oversight and clinical governance with regards to manual ECG review, to over-rely on automated ECG machine software reports that have consistently proven to have high false-positive rates. This over-reliance has the potential, in the worst-case scenario, to put patients at risk of unnecessary lifelong anticoagulation and resulting serious bleed events. □



Posters 2

113/Left atrial appendage occlusion for atrial fibrillation and bleeding diathesis

Authors: *BS Kailey (Presenting Author) – Imperial College London, London; M Koa-Wing – Imperial College Healthcare NHS Trust, London; N Sutaria – Imperial College Healthcare NHS Trust, London; T Mott – Abbott Healthcare, London; A Sohaib – Barts Healthcare NHS Trust, London; N Qureshi – Imperial College Healthcare NHS Trust, London; C Wadsworth – Imperial College Healthcare NHS Trust, London; S Jamil – Imperial College Healthcare NHS Trust, London; L D’Anna – Imperial College Healthcare NHS Trust, London; C Shi – Imperial College Healthcare NHS Trust, London; P Padam – Imperial College Healthcare NHS Trust, London; J Howard – Imperial College Healthcare NHS Trust, London; S Levy – Imperial College Healthcare NHS Trust, London; B Porter – Imperial College Healthcare NHS Trust, London; Z Whinnett – Imperial College Healthcare NHS Trust, London; N Linton – Imperial College Healthcare NHS Trust, London; B Lim – Imperial College Healthcare NHS Trust, London; N Peters – Imperial College Healthcare NHS Trust, London; FS Ng – Imperial College Healthcare NHS Trust, London; D Keene – Imperial College Healthcare NHS Trust, London; L Malcolme-Lawes – Imperial College Healthcare NHS Trust, London; D Lefroy – Imperial College Healthcare NHS Trust, London; G Cole – Imperial College Healthcare NHS Trust, London; P Asaria – Imperial College Healthcare NHS Trust, London; B Ariff – Imperial College Healthcare NHS Trust, London; D Gopalan – Imperial College Healthcare NHS Trust, London; A Varnava – Imperial College Healthcare NHS Trust, London; P Pabari – Imperial College Healthcare NHS Trust, London; B Rana – Imperial College Healthcare NHS Trust, London; P Kanagaratnam – Imperial College Healthcare NHS Trust, London*

**Introduction:** Patients with atrial fibrillation (AF) and likelihood of bleeding can undergo left atrial appendage occlusion (LAAO) as an alternative method of stroke prophylaxis. A short course of anti-thrombotic drugs is used post-procedure to offset the risk of device-related thrombus, but evidence for this practice is limited.

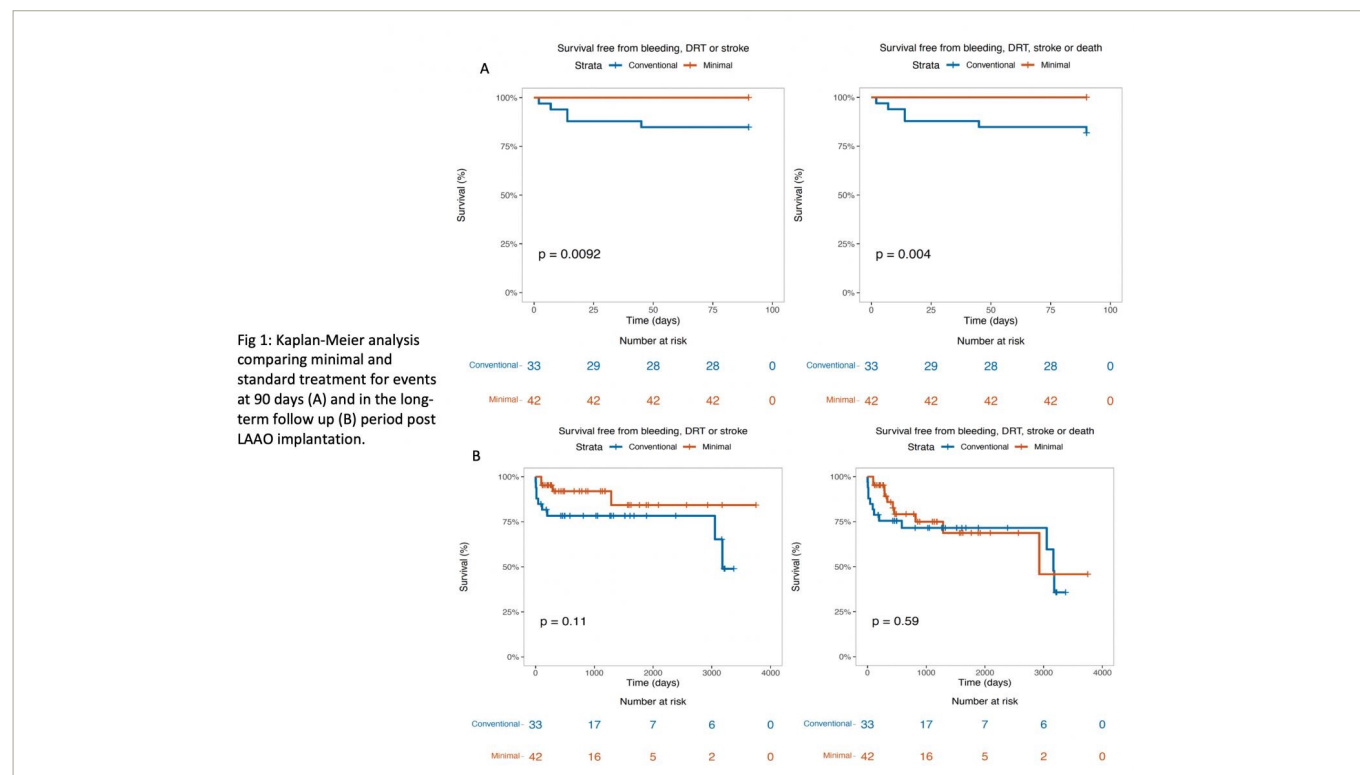
**Methods:** Patients with AF and high risk for both stroke and bleeding were advised about their management strategy by a multidisciplinary physician panel. This included the perioperative drug therapy for those patients advised to undergo LAAO. Those deemed to be at unduly high risk of bleeding from anti-thrombotic drugs were assigned to minimal treatment with no anti-thrombotic drugs or aspirin alone. The remaining patients received standard care with a 6–12-week course of dual antiplatelets or anticoagulation following device implant. We compared mortality, device-related thrombus, ischaemic stroke and bleeding events during the 90 days post-implant and long term. Event-free survival was assessed using Kaplan–Meier survival analysis, with log rank testing for

statistical significance.

**Results:** A total of 75 patients underwent LAAO (Amulet™, Abbott Medical) of whom 63 (84%) had a prior serious bleeding event. The 42 patients on minimal treatment were older ( $74.3 \pm 7.7$  vs  $71.2 \pm 7.2$ ) and had higher HASBLED score ( $3.6 \pm 0.9$  vs  $3.3 \pm 1.2$ ) than the 33 patients receiving standard care. There were no device-related thrombi or strokes in either group in the 90 days post-procedure, but patients having standard treatment had more bleeding events (5/33 vs 0/42;  $p=0.01$ ) with associated deaths (3/33 vs 0/42;  $p=0.05$ ). During median long-term follow-up of 2.2 years, all patients were transitioned onto no antithrombotic drugs (43 patients [61%]) or a single antiplatelet (29 patients [39%]). There was no evidence of early minimal treatment adversely affecting long-term outcomes.

**Conclusions:** Short-term anti-thrombotic drugs are not needed after LAAO implant in patients with high bleeding risk and this is the first clinical study to show that they may be harmful. □

Figure 1



Posters 2

**114/Adverse LA remodelling is needed to decrease success rates in obese patients with AF: a single-centre retrospective study on RECURRENCE of Atrial Fibrillation following first time ablation (RECUR-AF)**

Authors: *KZ Win (Presenting Author) – Queen Elizabeth Hospital Birmingham/University of Birmingham, Birmingham; MA Rauf – Queen Elizabeth Hospital Birmingham, Birmingham; I Shakeel – University of Birmingham, Birmingham; J De Bono – Queen Elizabeth Hospital Birmingham, Birmingham; M Lencioni – Queen Elizabeth Hospital Birmingham, Birmingham; H Marshall – Queen Elizabeth Hospital Birmingham, Birmingham; JN Townend – Queen Elizabeth Hospital Birmingham, Birmingham; R Steeds – Queen Elizabeth Hospital Birmingham, Birmingham; M Kalla – Queen Elizabeth Hospital Birmingham, Birmingham*

**Introduction:** The outcome of atrial fibrillation (AF) ablation is suboptimal in overweight patients. This study reports the relationship of overweight patients and AF ablation outcome from a high-volume UK centre (>250 per year).

**Methods:** The study population consisted of 283 patients (mean age 62 ± 11 years, 61% male) who underwent their first-time AF ablation at Queen Elizabeth Hospital (QEH) Birmingham in 2018–2019. Recurrence of AF (AF >30 s, symptomatic recurrence) at 1 year (365 days) after 90-day blanking period was reviewed. Recurrence and no recurrence groups were compared according to body mass index (BMI), indexed left atrial (LA) volume and ablation methods.

**Results:** Mean BMI was 29.3 ± 5 kg/m<sup>2</sup> and 111 (39%) patients were obese (BMI >30) at ablation despite risk factor (RF) modification advice at clinic. A total of 35 patients (12%) with morbid obesity (BMI >35 kg/m<sup>2</sup>) had higher prevalence of diabetes (1.7% in BMI <25 vs 22.9% in BMI >35; p=0.002), hypertension (18.3% in BMI <25 vs 57.1% in BMI >35; p<0.001) and sleep apnoea (nil in BMI <25 vs 20% in BMI >35; p<0.001). Overall, 25 patients (10%) had impaired left ventricular function (<50%) on echocardiography, and 109 patients (45%) had dilated indexed LA volume (>34 mL/m<sup>2</sup>) with mean 34.2 ± 12.5 mL/m<sup>2</sup>. In total, 15 patients (5%) had at least moderately severe valvular heart diseases. Single-procedure success rate in the cohort was 76% (74% pulmonary vein isolation only). The only predictor of outcome in our cohort between the recurrence vs no recurrence groups was indexed LA volume (37.1 ± 14.4 vs 33.3 ± 11.7 mL/m<sup>2</sup>; p=0.04). Higher BMI patients (BMI >30 and BMI >35) tended to have worse outcomes; however, results were not statistically

**Table 1: Recurrence of AF in patients who underwent first-time AF ablation in QEH in 2018–2019**

	Recurrence at 1 year	No recurrence at 1 year	p value
n=283	68 (24%)	215 (76%)	
Age (years)	64.6 ± 9.7	62.2 ± 11.4	0.11
Male	44 (64.7%)	131 (60.9%)	0.57
BMI (kg/m <sup>2</sup> )	29.7 ± 5	29.1 ± 5.1	0.45
BMI >30	27 (39.7%)	84 (39.1%)	0.92
BMI >35	11 (16.2%)	21 (9.8%)	0.14
Indexed LA volume (mL/m <sup>2</sup> )	37.1 ± 14.4	33.3 ± 11.7	0.04
PVI only	42 (61.8%)	158 (73.5%)	0.06

significant (no recurrence 39.1% vs recurrence 39.7% in BMI >30 group, p=0.92; and no recurrence 9.8% vs recurrence 16.2% in BMI >35 group, p=0.14) (Table 1).

**Conclusion:** The success rate of first-time AF ablation at QEH was better than the published research data despite nearly 40% of our cohort consisting of obese patients with dilated LA. Obesity alone may not be a sufficient marker of poor outcome with ablation, but if associated with adverse LA remodelling, outcomes are poorer. Further mechanistic research is needed to optimise patient selection prior to catheter ablation. □

Posters 2

115/Conduction system pacing and AV node ablation – Glenfield stepwise approach for perfection

Authors: *M Ibrahim – Glenfield, Leicester; I Koev (Presenting Author) – Glenfield, Leicester*

**Introduction:** Pacemaker implantation and atrioventricular node (AVN) ablation is the last option for rate control of atrial fibrillation (AF) in patients unresponsive or intolerant to intensive rate and rhythm control and not eligible for rhythm control by pulmonary vein isolation (Class IIa indication in the European Society of Cardiology guidelines). Conduction system pacing is slowly evolving as an alternative to cardiac resynchronization therapy (CRT) pacing in these patients, providing a better physiological pacing and better haemodynamic response.

We present the case of a 69-year-old female patient with a history of persistent AF. She underwent two ablations, which were not sufficient to control her AF. In addition, she underwent four direct current cardioversions (DCCVs) in the last year. Rhythm control was not achieved with medications and the patient suffered from severe intolerance to beta-blockers and sotalol. As the patient’s desire was to end these ‘regular’ visits to A&E for DCCVs and to stop medical treatment too, we offered to proceed with native conduction system pacing and AVN ablation.

**Methods:** The following stepwise approach was taken.

**I. Pacing**

1. Narrow complex in sinus rhythm. Measurements of HV, QRS and H-end QRS intervals.
2. Looking for selective His pacing (distal His) leading to equivalent P-V, QRS and P-end QRS intervals.
3. Screwing in of the His pacing lead at the abovementioned position. If pacemaker parameters are good and there is no change in the His capture, proceed to AV node ablation.
4. If the threshold at this position is high or if there is no good native conduction system capture with narrow QRS at distal His, proceed to LBBA pacing.

5. Move the lead approximately 1 cm lower on the septum in apical direction.
6. Starting septal RV pacing with ‘W shape QRS’ in V1.
7. Start screwing the lead with special focus on PVCs and impedance.
  - a) Once we see any RBB looking PVC, we stop.
  - b) Also after 10 turns, we stop and pace.
  - c) Continue until we see a tall R in V1 – this means we captured the LBB.
8. Aim for LBB potential on intracardiac EGM – sharp positive deflection before the QRS – ‘bull’s eye’.
9. Important measurements during LBB mapping and pacing:
  - a) PS to QRS <40 ms
  - b) PS to peak QRS in V5 <80 ms
  - c) PS to end QRS <130 ms.
10. Contrast injection to assess the depth of the lead into the septum.
11. If pacemaker parameters are good and there is no change in the LBB capture, proceed to AV node ablation.

**II. Ablation**

1. Do not dislocate the pacemaker leads!
2. LV pacing at VVI 40 bpm.
3. Target the proximal His bundle – proximal ablation side allows narrow complex escape rhythm too and is far from His/LBBA pacing lead.
4. Ablate for 30 seconds while achieving CHB in the process.

**Results and conclusion:** In this patient, we achieved a LBBAP with final ECG intervals similar to the baseline ECG before the procedure. This allowed better physiological pacing compared with dual-chamber pacing and CRT with a better haemodynamic response. □

Figure 1



Posters 2

**116/Substrate-based modification in ventricular tachycardia: ablation of the local abnormal ventricular activity only should we focus on LAVA? Learning from a case series**

Authors: *S Borov (Presenting Author) – CAU and Landshut Achdorf Hospital, Landshut; B Baldauf – CAU, Kiel; EW Lau – RVH, Belfast; M Giaccardi – Santa Maria Annunziata Hospital, Florence; H Bonnemeier – CAU and Helios Cuxhaven, Cuxhaven*

**Introduction:** Local abnormal ventricular activities (LAVAs) are key targets for substrate-based ablation of ventricular tachycardia (VT). LAVAs are traditionally mapped with the ablation catheter. The distal electrode of the ablation catheter has to be large for effective lesion formation (whether by radiofrequency energy or cryothermia), but this is not conducive to high-definition mapping of low-amplitude highly fractionated electrograms, which are the hallmarks of LAVAs. High-density mapping catheters (e.g. the Advisor HD grid catheter from Abbott, the Pentaray from Biosense-Webster) might reveal LAVAs that would have been missed by the ablation catheter. These additional targets for ablation might improve the clinical efficacy of the procedure.

**Methods:** VT ablation was performed in sinus rhythm with a substrate-based approach whenever possible in order to avoid haemodynamic instability in patients with structural heart disease at the authors' institute. The endocardial surface of the relevant ventricular chamber (mainly the left ventricle) was first mapped with the Advisor HD grid catheter. All the LAVAs identified by the multi-poles of the catheter (Figure 1) were tagged in the conventional substrate map based on the maximum local electrogram amplitude (Figure 2a). All the LAVAs identified, which might be in or around 'scarred' areas or in apparently 'healthy' areas, were ablated with TactiCath (Abbott). No other ablation strategies (e.g. scar homogenisation, core isolation, dechannelling) were pursued. The clinical outcomes of a cohort of patients who received only LAVA-guided ablation were analysed.

**Results:** Between March 2019 and March 2021, 22 patients (20 male; mean age 68 years [32–85]) received only LAVA-guided ablation but no VT ablation in the preceding 12 months were included in the study out of 59 patients who underwent VT ablation. A trans-septal approach was used in 20 of the 22 patients (91%). A median of 3 (2–7) LAVA zones were identified in each patient. Out of the 72 LAVA zones identified, 71 (98.6%) were ablated. A single LAVA zone (1.4%) was not ablated due to proximity to the atrioventricular node. There were no procedural deaths or related complications such as induction of haemodynamically unstable VTs requiring defibrillation. After a median 216 (156–941) days' follow-up, 4 patients (18%) experienced recurrent VT, and 2 of them (9%) underwent repeat LAVA-guided ablation. The other 2 patients were satisfactorily controlled by their implantable cardioverter defibrillators. Three patients (14%) died due to end-stage heart failure and non-arrhythmic causes.

**Conclusion:** This retrospective study demonstrated the safety and efficacy of high-density mapped LAVA-guided VT ablation. LAVAs were identified within apparently 'healthy' areas of the endocardium,

Figure 1: LAVAs identified only by the HD grid catheter but missed by the ablation catheter

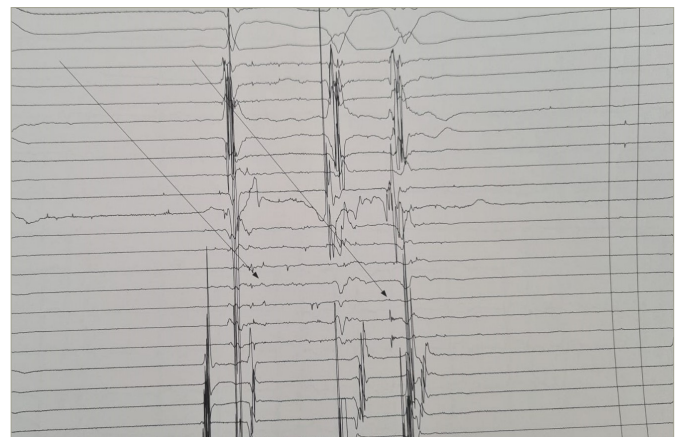
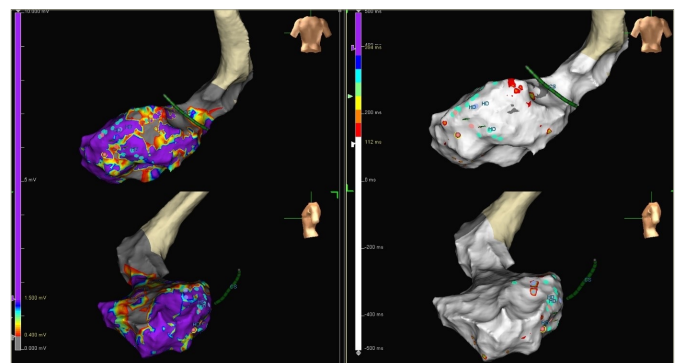


Figure 2: Mapping and ablation of LAVAs identified by high-density mapping



A: Voltage map of the LV endocardial surface with 0.40 mV set as the cut-off for dense scars. LAVAs (tagged with blue dots) were identified not only in or along scarred areas, but also within apparently healthy areas; B: All the LAVAs were targeted for ablation.

supporting the notion that arrhythmia substrates reside where healthy and diseased myocardial fibres intermingle. The high-density mapped LAVA-guided VT ablation strategy described may have general clinical utility and deserves to be investigated in a large-scale prospective randomised clinical trial. □



Posters 2

**117/Single-centre retrospective evaluation of procedure time, fluoroscopy time and complication rates of conduction system pacing compared with traditional methods**

Authors: *P Veacock (Presenting Author) – Great Western Hospital, Swindon; MA Swift – Great Western Hospital, Swindon; P Foley – Great Western Hospital, Swindon; B Chandrasekaran – Great Western Hospital, Swindon; N Hadgraft – Manchester Metropolitan University, Manchester*

**Introduction:** Physiological pacing is a new and innovative technique of activating the heart’s native conduction system via a pacing lead situated at the His bundle or left bundle branch first reported by Deshmukh et al. (2000). The technique was developed as an alternative to right ventricular pacing, which is known to cause ventricular dyssynchrony (Figure 1).

**Aim: 1.** To assess the procedure time, fluoroscopy time and complication rates of physiological pacing procedures and compare the data with traditional established methods (dual chamber pacing [DDD], cardiac resynchronization therapy [CRT], implantable cardioverter-defibrillator [ICD]); 2. to determine whether there is any relationship between device type, procedure time, fluoroscopy time and complication rates.

**Method:** Patients were categorised into device group: DDD pacemaker (n=458), conduction system pacing (n=174), CRT (n=148), ICD (n=153). Fluoroscopy time, procedure time and documented complications were extracted from the central database for each device group.

**Results:** Upon analysis of the statistical outputs, the procedure time (minutes) for physiological pacing (CSP) and CRT procedures were significantly longer (p=0.05). The fluoroscopy time (minutes) for physiological pacing and CRT procedures were significantly longer than those of DDD and ICD procedures (p<0.001). There was no significant difference in fluoroscopy time between DDD and ICD procedures. However, physiological pacing procedures were found to have significantly lower fluoroscopy times than CRT procedures (p=0.002). There was no significant effect of time for any of the device groups. The DDD group displayed the highest complication rate of 4% over the 4 years with a total of 20 complications and one procedure-related death. CRT and ICD groups displayed a complication rate of 1.4% and 1.3%, with a total of 3 and 2 reported complications, respectively. Physiological pacing procedures displayed the lowest complication rate of 0.5%, with only 1 complication over the 4-year period

**Discussion:** The extended procedure and fluoroscopy time of physiological and CRT procedures are supported by Keene et al. (2019) and can be attributed to the smaller target area of the His bundle/left bundle branch and technically demanding navigation of the coronary venous system, respectively. Additionally, the techniques displayed have been well established from the initial set up of the service in 2017, and the operating procedures have been optimised; therefore, there was no significant effect on time. The complication rates can be attributed

Figure 1

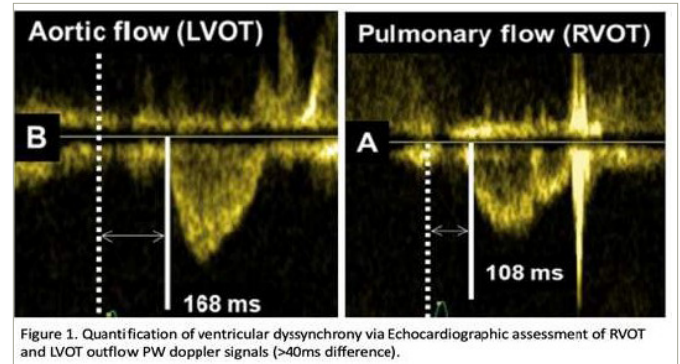
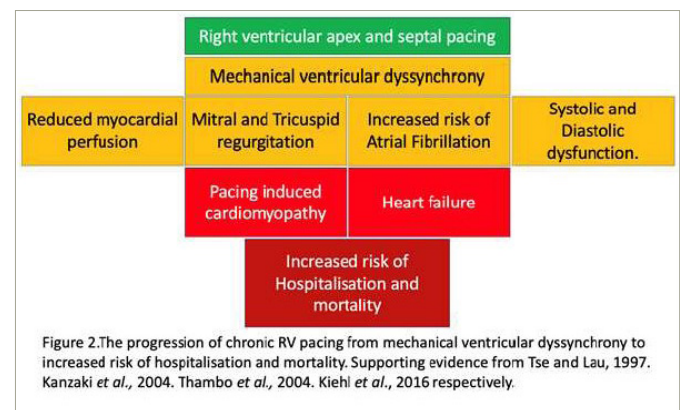


Figure 2



to the experience of the operator, the comorbidities of the patients and the urgency of the procedure. Physiological pacing, CRT and ICD procedures are exclusively performed by experienced operators with a high annual procedure volume (>50 per annum) supported by two experienced specialist cardiac physiologists, whereas DDD devices are occasionally implanted by specialist registrars learning the procedure under supervision with lower annual procedure volumes (<50 per annum) supported by non-pacing-accredited cardiac physiologists (Kirkfeldt et al., 2014). □

CONTINUED

Figure 3

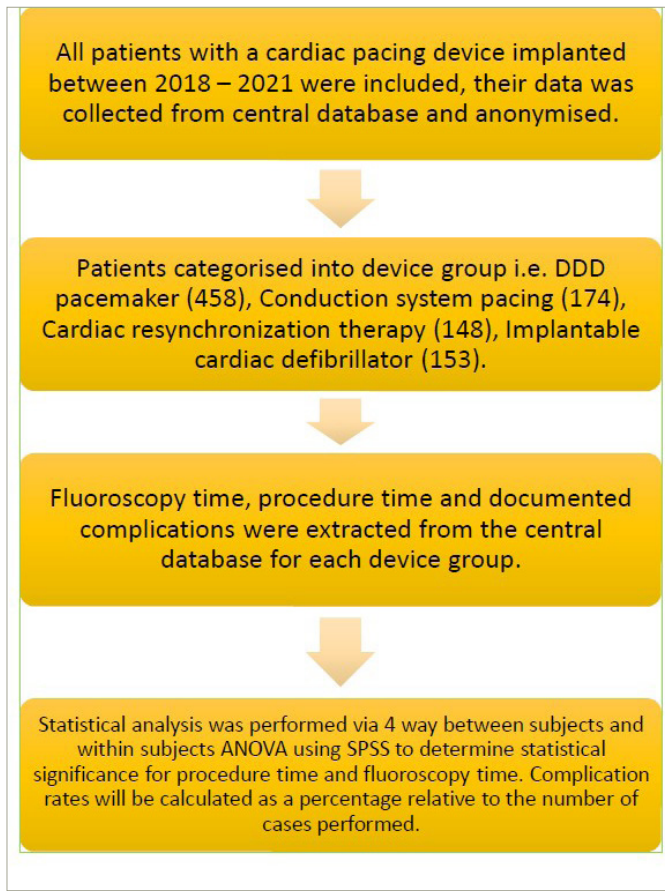


Figure 4

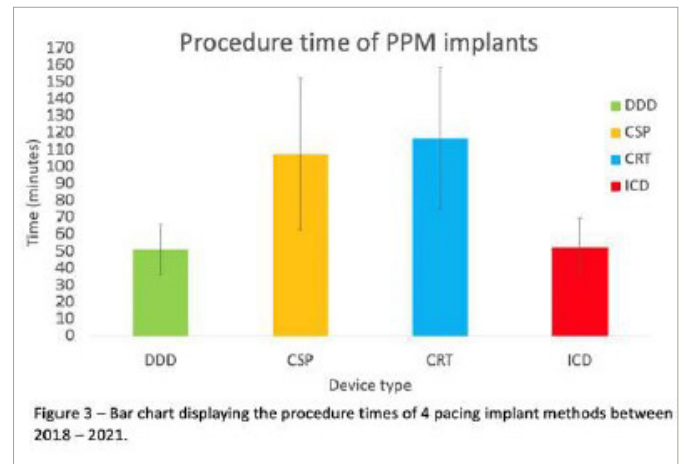


Figure 3 – Bar chart displaying the procedure times of 4 pacing implant methods between 2018 – 2021.

Figure 5

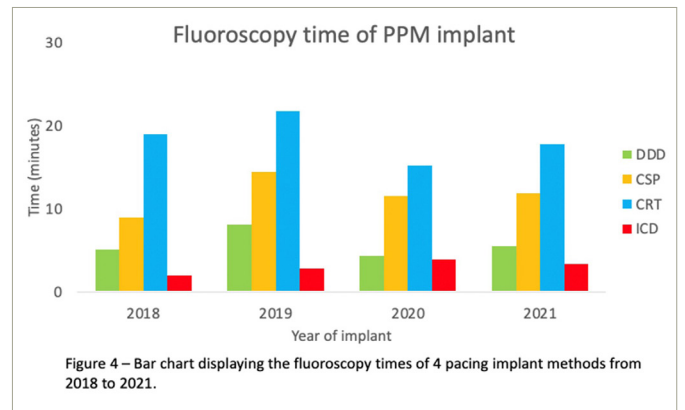


Figure 4 – Bar chart displaying the fluoroscopy times of 4 pacing implant methods from 2018 to 2021.



Posters 2

118/Things that go 'brady' in the night

Authors: *S Manjooan (Presenting Author) – Mid and South Essex, Chelmsford; A Jha (Presenting Author) – Mid and South Essex NHS Trust, Chelmsford; O Dhillon – Mid and South Essex NHS Trust, Chelmsford*

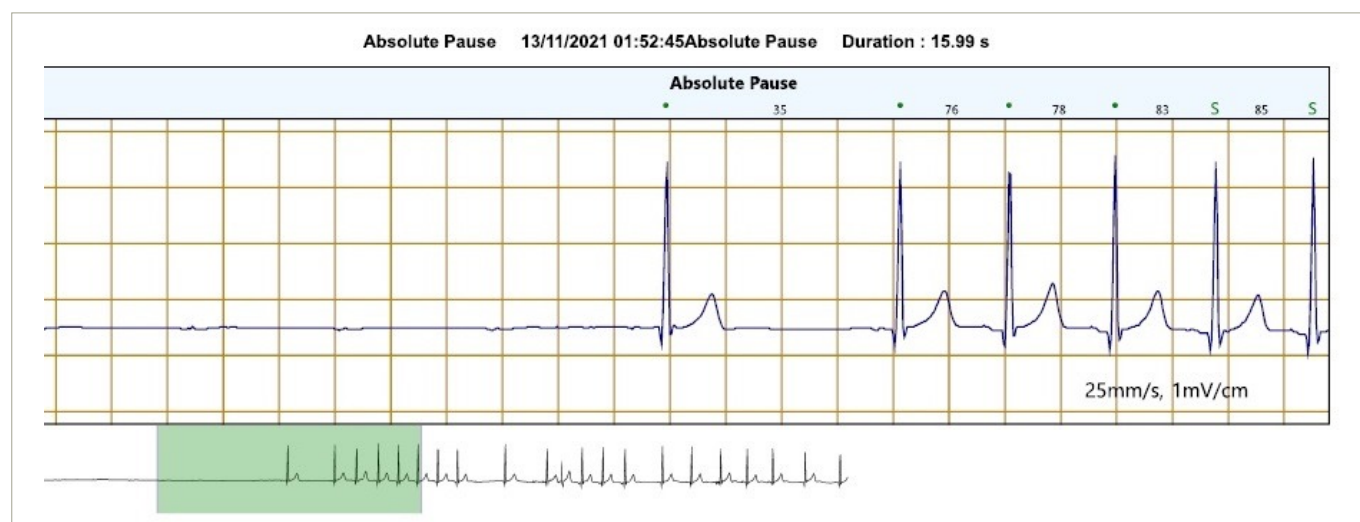
A 28-year-old man who worked as a scaffolder had been waking up in the middle of night gasping for air and with a sensation of choking. His 7-day Holter revealed a 16-second pause (p wave asystole) associated with his symptoms (*Figure*). He had been experiencing such nocturnal symptoms sporadically for several years, having first been investigated with a 24-hour tape when he was 20 years old, which demonstrated nocturnal pauses up to 3.55 seconds and nocturnal second-degree atrioventricular block (2:1) lasting up to 13 seconds. An echocardiogram revealed no abnormality, and he had no other medical history though at the time he was a regular user of cannabis. He was lost to follow-up for several years until he was referred back to cardiology services following another presentation with palpitations waking him up at night. His body mass index was 26 and his Epworth score was 15, so he was referred for sleep studies for sleep apnoea work-up. His sleep study came back as negative for obstructive sleep apnoea (OSA). A repeat echocardiogram was also normal. He also had a cardiac magnetic resonance imaging scan, which showed mild left ventricular impairment and no evidence of scar tissue. Computed tomography coronary angiogram was negative for coronary artery disease. Other than his nocturnal symptoms he had no daytime bradyarrhythmias and no history of syncope, presyncope, chest pain or shortness of breath. Biochemical work-up and Lyme serology were negative. His case was taken to electrophysiology multidisciplinary team following the 16-second pause to discuss his young age, occupation and benefits of implanting a permanent pacemaker. Ultimately, it was decided he would not be a candidate for a permanent pacemaker, and a watch-and-wait strategy was adopted.

**Discussion:** The autonomic nervous system is the key regulator of our rhythm during sleep. The sleep stages are divided into rapid eye movement

(REM) and non-REM stages, each stage with a unique autonomic profile. REM sleep is characterised by increases in sympathetic activity, whereas in non-REM sleep there is an increase in parasympathetic tone and decrease in sympathetic influx. Commonly, bradyarrhythmia during sleep may also be a manifestation of sleep apnoea syndromes (SAS) including OSA. Cannabis use has been linked to symptomatic bradycardia; a case series of symptomatic bradycardia in young cannabis users showed that cessation of cannabis use helped resolve bradycardia. Cannabinoids are thought to act centrally by enhancing parasympathetic response and damping the sympathetic drive. The syndrome of REM sleep-related bradycardia is another explanation for nocturnal bradycardia. First described in 1984, this rare clinical entity was characterised by transient sinus arrest or complete heart block with ventricular arrest during the REM phase, independently of apnoea. A case report by Duba et al. described a patient with symptomatic REM sleep bradycardia who underwent electrophysiology study (EPS), which showed sinus nodal disease, and subsequently received a dual chamber pacemaker. European guidelines suggest that EPS may be considered in patients with syncope in whom bradycardia is suspected, but it is not routinely recommended for bradyarrhythmias.

**Conclusion:** The case highlights the difficulty in deciding optimum management for nocturnal bradyarrhythmias, particularly those that are symptomatic and do not fit what is considered as 'benign' physiological response to sleep and not related to sleep apnoea. The role of invasive EPS and permanent pacemaker implantation is uncertain and not included in guidelines. Hence, nocturnal bradyarrhythmias with negative sleep study for SAS is an area of electrophysiology that still warrants more research. □

Figure 1



Posters 2

**119/The long-term effect of thoracoscopic ablation on atrial fibrillation burden using continuous monitoring**

Authors: *R Dulai (Presenting Author) – East Sussex Healthcare NHS Trust, Eastbourne; C Sugihara – Maidstone and Tunbridge Wells NHS Trust, Maidstone; M Lewis – Royal Sussex County Hospital, Brighton; J Hyde – Royal Sussex County Hospital, Brighton; R Veasey – East Sussex Healthcare NHS Trust, Eastbourne; S Furniss – East Sussex Healthcare NHS Trust, Eastbourne; N Sulke – East Sussex Healthcare NHS Trust, Eastbourne*

**Introduction:** There are limited long-term data using continuous monitoring to assess outcomes of thoracoscopic ablation in patients with paroxysmal atrial fibrillation (AF). This study evaluated the long-term outcomes of thoracoscopic AF ablation in patients with implantable cardiac devices, allowing long-term beat-to-beat monitoring.

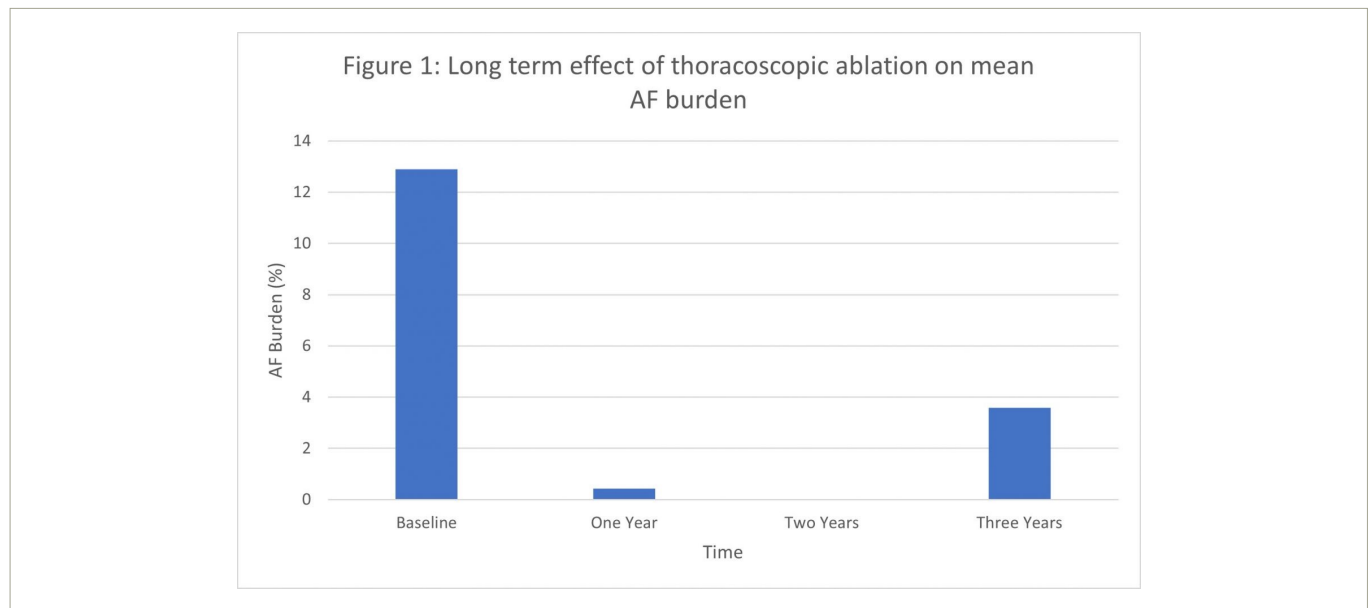
**Methods:** A total of 19 patients with paroxysmal AF (PAF) undergoing thoracoscopic ablation were evaluated. All patients had either an implantable loop recorder or pacemaker inserted, enabling continuous monitoring. AF burden was measured yearly for 3 years post-procedure. Mean and median AF burden at yearly intervals were compared across time intervals using the repeated measures ANOVA test and Friedman test.

**Results:** The mean age of patients was  $60.0 \pm 8.0$  years and 11 (58%)

were male. The mean AF burden at baseline was  $12.9\% \pm 31.8\%$ . This was reduced to  $0.426\% \pm 1.08\%$  at 1 year,  $0\% \pm 0.0\%$  at 2 years and  $3.58\% \pm 15.6\%$  at 3 years ( $p=0.068$ ) (Figure 1). The median AF burden at baseline was 0.45% (interquartile range [IQR] 0.00%–0.07%), which significantly reduced to 0.00% at 1 year, 2 years and 3 years (IQR 0.00%–0.00%;  $p=0.01$ ) post-ablation. During the study period, one patient underwent further cavotricuspid isthmus ablation and one patient underwent endocardial atrial tachycardia ablation using 3D electroanatomical mapping.

**Conclusion:** Thoracoscopic ablation resulted in excellent short-term and long-term arrhythmia outcomes with a significant reduction in median AF burden to 0% and a strong trend to reduction in mean AF burden seen up to 3 years post-ablation. □

Figure 1



Posters 2

120/Stridor and dyspnoea after atrial fibrillation catheter ablation: a case report

Authors: MM Gallagher (Presenting Author) – St George’s University Hospitals NHS Foundation Trust, London; Z Akhtar – St George’s University Hospitals NHS Foundation Trust, London; LWM Leung – St George’s University Hospitals NHS Foundation Trust, London; K Waleed – St George’s University Hospitals NHS Foundation Trust, London

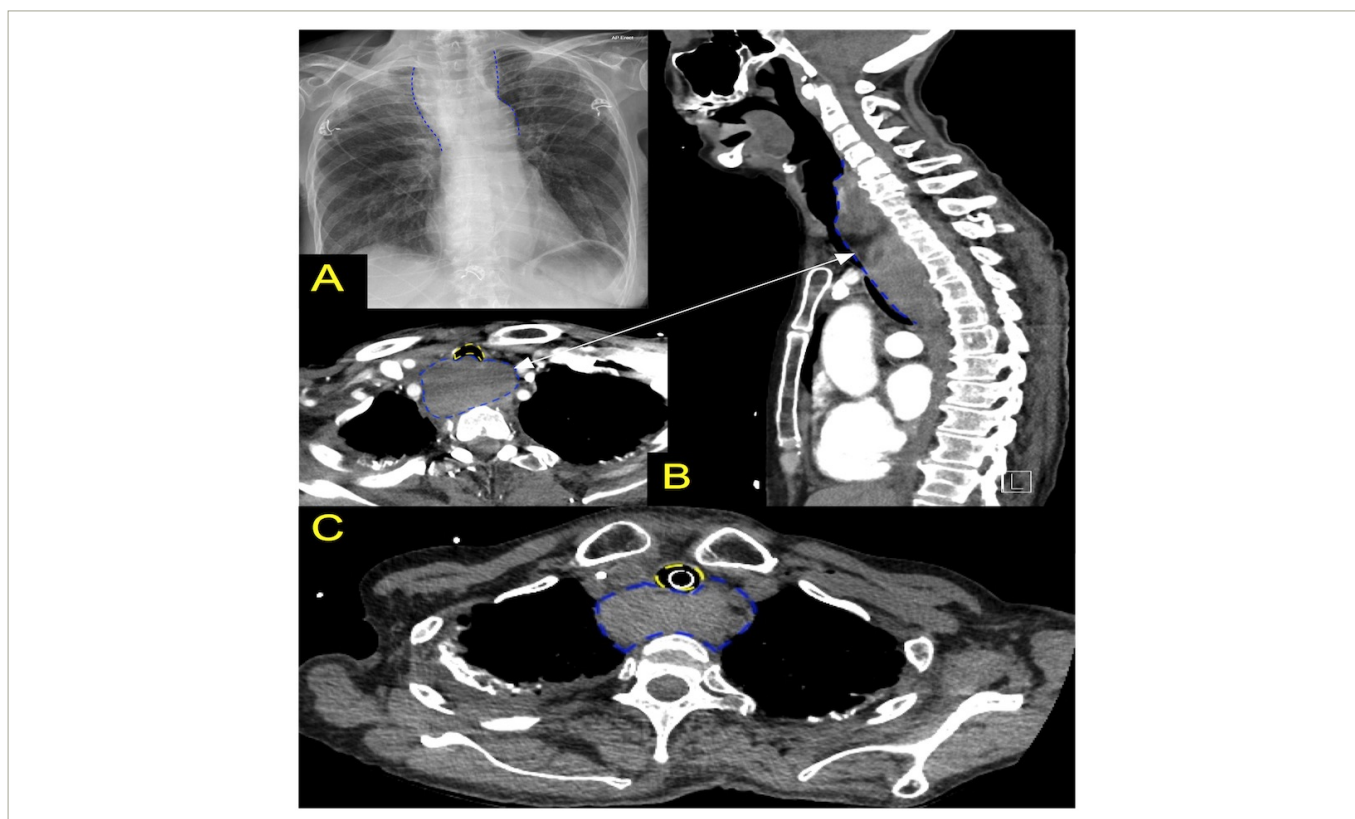
**Introduction:** Catheter ablation for atrial fibrillation (AF) is safer than pharmacological alternatives but requires constant vigilance to maintain this safety. We present a case report of a patient who developed stridor and progressive dyspnoea in the hours after ablation for AF.

**Case report:** A 74-year-old female with impaired ventricular function (ejection fraction 35%) underwent redo ablation AF under general anaesthesia without interruption of anticoagulation. Transeptal puncture was performed without difficulty. Pulmonary veins were isolated at baseline; radiofrequency energy was applied at the left atrial roof and posterior wall, and cavotricuspid isthmus by QDOT® catheter (Biosense Webster) using standard protocols without immediate complication. Approximately 10 hours post-ablation, the patient reported a foreign-body sensation in the throat, then progressive shortness of breath with stridor. Chest X-ray performed 16 hours post-ablation demonstrated widening of the upper mediastinum (Figure 1A); computed tomography (CT) at 24 hours post-ablation confirmed a superior mediastinal haematoma, with a maximum size of 6 × 3.5 cm extending to 12 cm into the neck and compressing surrounding structures including displacement of the trachea with the luminal diameter squeezed to 5–6 mm (Figure 1B). The patient was transferred to the intensive care unit (ICU) where her airway was secured with an 8-mm (internal diameter) endotracheal tube for positive pressure ventilation. Due to the patient’s

stable haemodynamics, a multidisciplinary team (electrophysiologist, intensivists, respiratory physician, thoracic surgeon and cardiac surgeon) decided to avoid surgical intervention. Repeat CT scan on ICU Day 3 showed the haematoma had decreased to 5.7 cm transversely, with reduced compression to the trachea (Figure 1C). The patient was extubated and transferred to the cardiology ward. On Day 8, oesophagogastrosocopy showed no oesophageal injury. Anticoagulation was resumed and the patient was discharged from hospital.

**Conclusions/implications:** To our knowledge, this is the first report of superior mediastinal haematoma following ablation. The mechanism is difficult to explain. Possibilities include blunt trauma to the tissues around the oesophagus during placement of the transoesophageal echocardiography probe, perforation of the superior vena cava by the transeptal needle or sheath during preparation for trans-septal puncture, or perforation of the left atrial roof during ablation; whichever of these initiated the bleeding, anticoagulant therapy was a factor in its development. However, this case offers lessons that the sensation of a foreign body in the throat beginning soon after ablation should arouse suspicion, while the occurrence of stridor demands urgent imaging of the superior part of the thorax and the lower neck. The response to ventilation suggests that a conservative approach rather than early surgical intervention should be considered as first line in such cases. □

Figure 1: A: The chest X-ray shows marked widening of the upper mediastinum (blue dash line). B: Computed tomography (CT) shows a mediastinal haematoma extending into the neck (blue dash line). The trachea and oesophagus were compressed and displaced (yellow dash line). C: On Day 3, CT demonstrated a reduced haematoma with normal expansion of the trachea, which contains an endotracheal tube



## Posters 2

**121/Temporal trends of catheter ablation for patients with atrial fibrillation: earlier is better**

Authors: *Y De Greef (Presenting Author) – ZNA Heart Center, Middelheim, Antwerp; M Wolf – ZNA Heart Center, Middelheim, Antwerp; B Schwagten – ZNA Heart Center, Middelheim, Antwerp; I Buyschaert – Cardiovascular Centre AZ St. Jan Bruges, Bruges*

**Background:** Diagnosis-to-ablation time (DAT) of less than 1 year improves outcome and encourages earlier referral. The linear relation between DAT and outcome suggests that DATs of <1 year could further improve outcome.

**Aims:** 1. To determine whether a linear relation persists and/or whether a threshold can be defined within a DAT of <1 year. 2. To assess temporal trends in efficacy, safety and patient profile over time.

**Methods and results:** Two cohorts of 1,000 patients with atrial fibrillation (AF) (69% males, age  $62 \pm 10$  years) undergoing pulmonary vein isolation (PVI) (2006–2014 and 2017–2019) were followed for 3 years. Primary outcome was clinical success, defined as freedom of documented AF without anti-arrhythmic drugs (AADs) respecting a 1-month blanking period. At 3 years, clinical success was achieved in 61.7% of patients, improving from 55.2% to 68.2% ( $p < 0.001$ ) over time. Complication rate decreased from 99 to 77 ( $p < 0.001$ ). DAT ( $48 \pm 47$  versus  $35 \pm 60$ ;  $p = 0.001$ ) and number of previous AADs ( $2.1 \pm 0.8$  to  $1.4 \pm 0.8$ ;  $p < 0.001$ ) decreased, while % female patients (28.3% to 33.5%;  $p = 0.013$ ), age ( $60 \pm 10$  years to  $64 \pm 10$  years;  $p < 0.001$ ), % paroxysmal AF (58.5 to 63.8;  $p = 0.015$ ),

underlying structural heart disease (19.8% to 28%;  $p < 0.001$ ) and CHA<sub>2</sub>DS<sub>2</sub>-VASc ( $1 \pm 1$  to  $2 \pm 1.5$ ;  $p < 0.001$ ) increased over time. DAT analysis was done in 1,892 patients divided into 3 groups according to the DAT: DAT  $\leq 6$  months ( $n = 503$ ), DAT 6–12 months ( $n = 242$ ) and DAT  $> 12$  months ( $n = 1147$ ). Independent predictors of clinical success were age (HR 1.01, 95% CI 1.01–1.02;  $p = 0.003$ ), AF type (HR 0.54, 95% CI 0.46–0.63;  $p < 0.0001$ ), left atrial size (HR 1.05, 95% CI 1.03–1.06;  $p < 0.0001$ ), DAT (HR 1.00, 95% CI 1.00–1.00;  $p = 0.001$ ) and ablation technique ( $p = 0.01$ ) in multivariable-adjusted analysis. The highest clinical success was achieved when PVI was performed  $\leq 6$  months, and gradually declined with increasing DAT: 72.8% for DAT  $\leq 6$  months, 64.9% for DAT 6–12 months and 56.2% for DAT  $> 1$  year ( $p < 0.001$ ). Within 6 months, no difference in outcome was seen: 73.2%, 72.1% and 73.4% for DAT 0–2 months, 2–4 months and 4–6 months, respectively.

**Conclusion:** Despite ablation in higher-risk patients, long-term efficacy increased over time with an improved safety profile. Our data advocate for early PVI following diagnosis of AF, with a DAT threshold of 6 months. □

Posters 2

122/Implementing a service to identify and manage patients with low biventricular pacing

Authors: *BJ Jones (Presenting Author) – Barts Health NHS Trust, London; JR Ramplin – Barts Health NHS Trust, London; ZC Carter – Barts Health NHS Trust, London; NM Mark – Barts Health NHS Trust, London; PL Lloyd – Barts Health NHS Trust, London; BP Patel – Barts Health NHS Trust, London; SC Cowap – Barts Health NHS Trust, London; HG Granville – Barts Health NHS Trust, London; AM Muthumala – Barts Health NHS Trust, London*

**Introduction:** Cardiac resynchronisation therapy (CRT) has proven to improve left ventricular function, symptoms and quality of life in patients with symptomatic heart failure. Its effectiveness is largely dependent on the percentage of biventricular pacing (BiVp%). This can be reduced by a number of factors such as atrial and ventricular dysrhythmias and device programming. Barts Health NHS Trust has set up a service where patients with low BiVp% can be discussed with a cardiac scientist and a consultant cardiologist.

**Methods:** Any patient with a BiVp% of  $\leq 97$  can be referred by cardiac physiologists from the device clinic. A *pro forma* was completed to include the patient’s past medical history, cause of the drop in BiVp%, patient symptoms, CRT device details and current medications (Figure 1). Any outstanding patients were discussed at a weekly meeting with an

outcome documented and actioned.

**Results:** Between June 2020 and July 2021, a total of 121 patients (76% male; age at referral  $75 \pm 10.6$  years) were referred. Overall, 95 patients had a CRT-D (79%) and ischaemic heart disease was the most common underlying aetiology (63 patients, 53%). The mean BiVp% was  $81 \pm 10.7\%$ , with the most common cause of reduced BiVp% being premature ventricular complexes (88 patients, 72%). A total of 50 patients (43%) were New York Heart Association class II at the time of referral, with shortness of breath being the most common symptom (62 patients, 52%).

**Conclusion:** It is feasible to set-up an MDT-style service where patients with identified low biventricular pacing can be discussed and a clear outcome actioned to support cardiac scientists with the managements of this patient group. □

Figure 1

Low BiVp% Cardiac Scientist review				
Name:	DOB:	MRN(Barts): NHS no:	Cons:	Completed by:
BiVp% (range)				
Cause of low BiVp% (i.e. VEs, breakthrough AF)				
Symptoms (i.e. palpitations, SOB, swelling, presyncope, NYHA class) – any change with BiVp% drop?				
Device History: - CRTD/CRTP - Manufacturer and Model - Home monitoring available? - Implant date(s) - Previous CRT optimisation (include 12 lead ECG) – change in QRS duration? - LV lead position				
PMH: - Aetiology/implant indication (i.e. pace and ablate, LBBB) - Underlying rhythm - Any other relevant medical history (previous ablations?)				
Echo (Date, EF%) – any change with CRT implant?				
Medication list with dosages (Date)				
Local HF Follow up, where?				
Initial impression/action taken :				
Date and outcome of discussion:				

Figure 1 – ‘Low BiV’ pro forma. Pro forma completed by cardiac scientists prior to MDT.

Posters 2

**123/Therapeutic options for syncope: a meta-analysis of blinded and unblinded randomised controlled trials**

Authors: *N Kaza (Presenting Author) – Imperial College London, London; M Sorbini – Imperial College London, London; M Dani – Imperial College London, London; P Taraborelli – Imperial College London, London; PB Lim – Imperial College London, London; D Francis – Imperial College London, London; MJ Shun-Shin – Imperial College London, London; D Keene – Imperial College London, London*

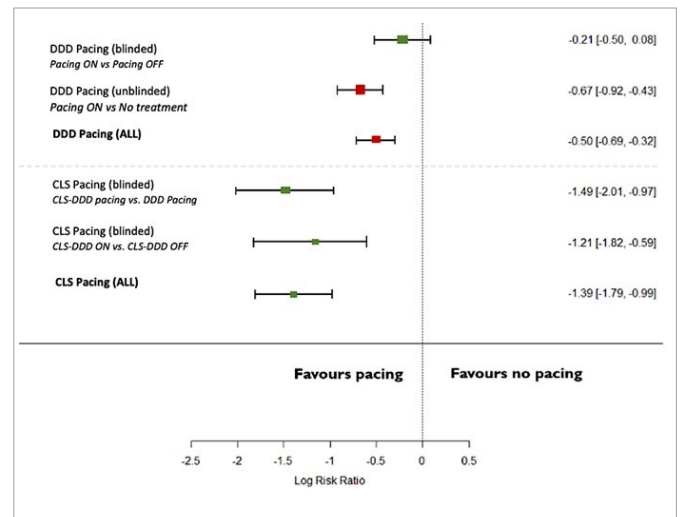
**Background:** About 25% of the population suffers from syncope, and 8% of the population experience recurrent episodes, which can cause physical injury and psychological morbidity.

**Methods:** We performed a meta-analysis of randomised trials of pacing, pharmacological and physical interventions for syncope. We assessed the effect of these therapeutic interventions on clinical syncope recurrence. We stratified the trials by whether the patient was blinded to the allocation arm.

**Results:** There were 49 eligible randomised clinical trials: 22 of pacing, 19 of pharmacological interventions and 8 of physical interventions. Blinded trials were neutral for conventional pacing (relative risk [RR] of recurrent syncope 0.81, 95% CI 0.60–1.1;  $p=0.45$ ) but favourable for closed-loop-stimulation (CLS) pacing (RR of recurrent syncope 0.21, 95% CI 0.12–0.34;  $p<0.001$ ). Assessing non-placebo-controlled trials instead, virtually every category of therapy reported significant benefit. Three categories of therapy have been trialled with and without placebo control: the unblinded studies showed significantly different results from their blinded counterparts (dual chamber pacing  $p=0.017$ , beta blockers  $p=0.024$ , midodrine  $p=0.006$ ).

**Conclusion:** The placebo effect of device implantation is more powerful than previously assumed. Unblinded randomised trials of conventional dual chamber pacing appeared to show remarkable efficacy. However, with placebo control, this efficacy is revealed to have been the placebo effect. Under blinded conditions, CLS pacing reduces risk of syncope

Figure 1



recurrence by ~75%, whereas conventional pacing does not. Selective serotonin reuptake inhibitors and midodrine also show significant efficacy under blinded conditions. Without blinding, trials consistently show artefactually larger benefits. Therefore, all future trials of treatment for syncope should blind patients to the allocation arm. □



Posters 2

124/Evaluation of a novel, digitised pre-procedural assessment pathway

Authors: *OR Riad (Presenting Author) – Royal Brompton Hospital, Guy’s and St Thomas’ NHS foundation trust, London; BM Moloce – Royal Brompton Hospital, Guy’s and St Thomas’ NHS Foundation Trust, London; AI Igra – Royal Brompton Hospital, Guy’s and St Thomas’ NHS Foundation Trust, London; JMB Behar – Guy’s and St Thomas’ NHS Foundation Trust, Department of Imaging Sciences and Biomedical Engineering, King’s College London, London*

**Aims:** The pre-procedural assessment for elective procedures requires an important shared decision-making process and consent, which is a conversation about the procedure, benefits, risks and alternatives. The guidance from the General Medical Council highlights important steps clinicians should take to ensure patients have a comprehensive understanding of their forthcoming procedure. Handwritten consent forms are often associated with errors of omission, have a lack of standardisation and are often illegible. The safety concerns of face-to-face consultations during the COVID-19 pandemic have increased the need for simplistic, pragmatic and patient-centred solutions to conduct the pre-procedural assessment. We describe our experience in the design and implementation of a novel, digitised pre-procedural assessment pathway.

**Methods and results:** This was a non-randomised, single-centre study recruiting all patients scheduled for an elective procedure in the department of electrophysiology, who agreed to participate in this

survey. All patients were asked questions on their understanding of the procedure, the benefits and risks prior to (n=48) and after (n=134) implementation of a digital pathway. The digital pathway included use of a pre-assessment appointment via video, use of animation-guided consent videos and an electronic consent form (Figure 1A). Patients in the digital group had better understanding of procedural details (54% pre vs 95.5% post), benefits (58% vs 95.5%), risks (50% vs 95.5%) and alternatives (38% vs 86%) (Figure 1B). Two subgroup analyses evaluating the procedural videos (n=65) and the electronic consent (n=18) showed that 88% of patients reported that the video helped their understanding, and 78% preferred the electronic consent to the standard handwritten consent, respectively.

**Conclusion:** The digital pre-procedural assessment pathway with the aid of procedural videos and electronic consent have increased patient understanding and facilitated their informed decision in our cohort. □

Figure 1

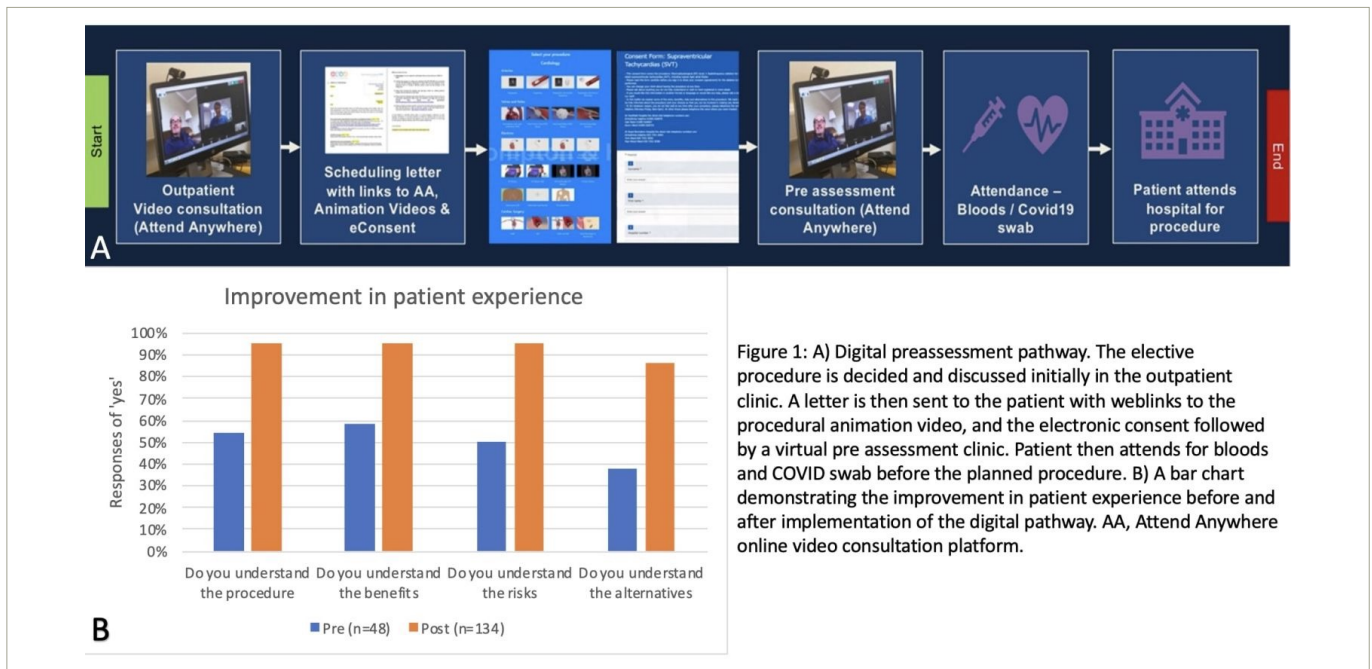


Figure 1: A) Digital preassessment pathway. The elective procedure is decided and discussed initially in the outpatient clinic. A letter is then sent to the patient with weblinks to the procedural animation video, and the electronic consent followed by a virtual pre assessment clinic. Patient then attends for bloods and COVID swab before the planned procedure. B) A bar chart demonstrating the improvement in patient experience before and after implementation of the digital pathway. AA, Attend Anywhere online video consultation platform.

## Posters 2

### 125/Complex device nurse-led VT clinic – a single-centre experience (OxVT)

Authors: *R Imms (Presenting Author) – Oxford University Hospitals (OUH), Oxford; MJ Davies – OUH, Oxford; R Sumner – OUH, Oxford; J Cole – OUH, Oxford; K Rajappan – OUH, Oxford; MR Ginks – OUH, Oxford; J Ormerod – OUH, Oxford; J Gamble – OUH, Oxford; N Herring – OUH, Oxford; TR Betts – OUH, Oxford; Y Bashir – OUH, Oxford*

**Introduction:** Patients with established implantable defibrillation devices (ICDs) are traditionally reviewed in routine ICD or complex device clinic as part of their ongoing surveillance. Advances in remote monitoring have led to a high frequency of automated alerts to life-threatening arrhythmias such as ventricular tachycardia (VT). This has driven demands in patient care to identify patients who may benefit from more intense investigations, clinical and psychological management to mitigate their perceived future morbidity and mortality.

**Methods:** We have developed a clinical service that can rapidly assess and manage patients from symptomatic and progressive asymptomatic tachyarrhythmia therapies in a dedicated outpatient clinic. This is led by a highly specialised complex device nurse and enthusiastic clinical team.

**Results:** From establishing our weekly OxVT clinic in August 2021, we have seen 65 new patients who fulfil our strict inclusion criteria. Unsurprisingly, 47 patients (71%) have underlying ischaemic heart disease as the primary aetiology of their ventricular arrhythmia. The remaining are non-

ischaemic aetiology including idiopathic dilated cardiomyopathy (n=8), arrhythmogenic cardiomyopathy (n=3), sarcoid (n=1), adult congenital heart disease (n=3), hypertrophic cardiomyopathy (n=2), cardiac amyloid (n=1) or calcium release deficiency syndrome (n=1).

These patients present along a spectrum of device-related therapy, from appropriate shocks to frequent episodes of asymptomatic anti-tachycardia pacing. They all undergo a series of holistic assessment resulting in a personalised management and follow-up plan. These range from individual psychological support, device optimisation/upgrades, optimal medical management to invasive catheter ablations. Patients are provided with a dedicated first point of contact and regular follow-up until confident to discharged back into routine ICD follow-up.

**Conclusion:** These complex patients require a personalised approach to bridge the gap to routine device monitoring. This can be achieved effectively with a highly specialised complex device nurse working alongside a multidisciplinary team. □

## Posters 2

**126/The PADIT score and antibiotic decision making for patients undergoing cardiac implantable electronic device (CIEDs) procedures – time for a rethink?**

Authors: *PL Galaway (Presenting Author) – James Cook University Hospital, Middlesbrough; AJ Turley – James Cook University Hospital, Middlesbrough; JE Peal – Newcastle University Teaching Hospitals, Newcastle; S Mani – County Durham and Darlington NHS Foundation Trust, Darlington; S Watson – South Tyneside & Sunderland NHS Foundation Trust, Sunderland; SR Ali – Northumbria Healthcare Trust, Cramlington; F Ahmed – North Tees and Hartlepool NHS Foundation Trust, Stockton-on-Tees; D Chan – Queen Elizabeth Hospital, Gateshead*

**Introduction:** Infection of cardiac implantable electronic devices (CIEDs) poses considerable risk to patients in terms of morbidity and mortality. The recently published, independently validated Prevention of Arrhythmia Device Infection Trial (PADIT) score predicts infection risk at the time of the device procedure based on non-modifiable risk factors (higher score correlates to greater risk). The risk profile of patients receiving CIED across the North of England Cardiovascular Network (NECVN) is currently unknown. Calculation of the PADIT score potentially allows for tailored, patient-specific consent and modification of antibiotic strategy. In this prospective study, we calculated the PADIT score across implanting centres in the NECVN over a 6-week period and documented peri-procedural antibiotic use.

**Methods:** Prospective anonymised patient data were collected from across 7 centres in the NECVN and inputted into a shared spreadsheet. We recorded basic baseline demographics, the individual components of the PADIT score and antibiotic strategies, pre-, peri- and postoperatively. Basic statistics were used to evaluate the data.

**Results:** A total of 271 patients (172 male, 99 female) were involved in this study, with a mean age of 77 years (standard error [SE] 0.8) at non-surgical sites and 71 years (SE 1.2) at surgical sites. The PADIT scores

were positively skewed. Subgroup analysis demonstrated significantly higher scores ( $p < 0.05$ , Kruskal–Wallis test) at the surgical sites (mean 3.3 [SE 0.2], median 3 [range 0–13] compared with mean 1.1 [SE 0.13], median 1 [range 0–8]) due to greater device complexity case mix (implantable defibrillator or cardiac resynchronisation compared with permanent pacemaker). All patients received pre-operative cefuroxime (93/271, 34%) or teicoplanin (178/271, 66%). In addition, 30 patients received gentamicin pre-procedurally (17%) and 110 patients were given gentamicin peri-procedurally by injection into the pocket (65/271, 24%) or gentamicin-impregnated collagen (45/271, 17%). Eight patients received an antibiotic mesh (Tyrx).

**Conclusion:** The PADIT score is a useful tool to challenge operators' perceived risks around device procedures. The risk profile across the NECVN is not uniform. The PADIT score offers the opportunity for a more informed patient-tailored decision-making process around CIED procedures. Our data demonstrate a lack of regional consensus for antibiotic choice in patients undergoing CIED insertion. □

DH Birnie, Wang J, Alings M, et al. Risk factors for infections involving cardiac implanted electronic devices. *J Am Coll Cardiol.* 2019;74:2845–54.



Posters 2

127/Atrial tachycardia masquerading as inappropriate sinus tachycardia

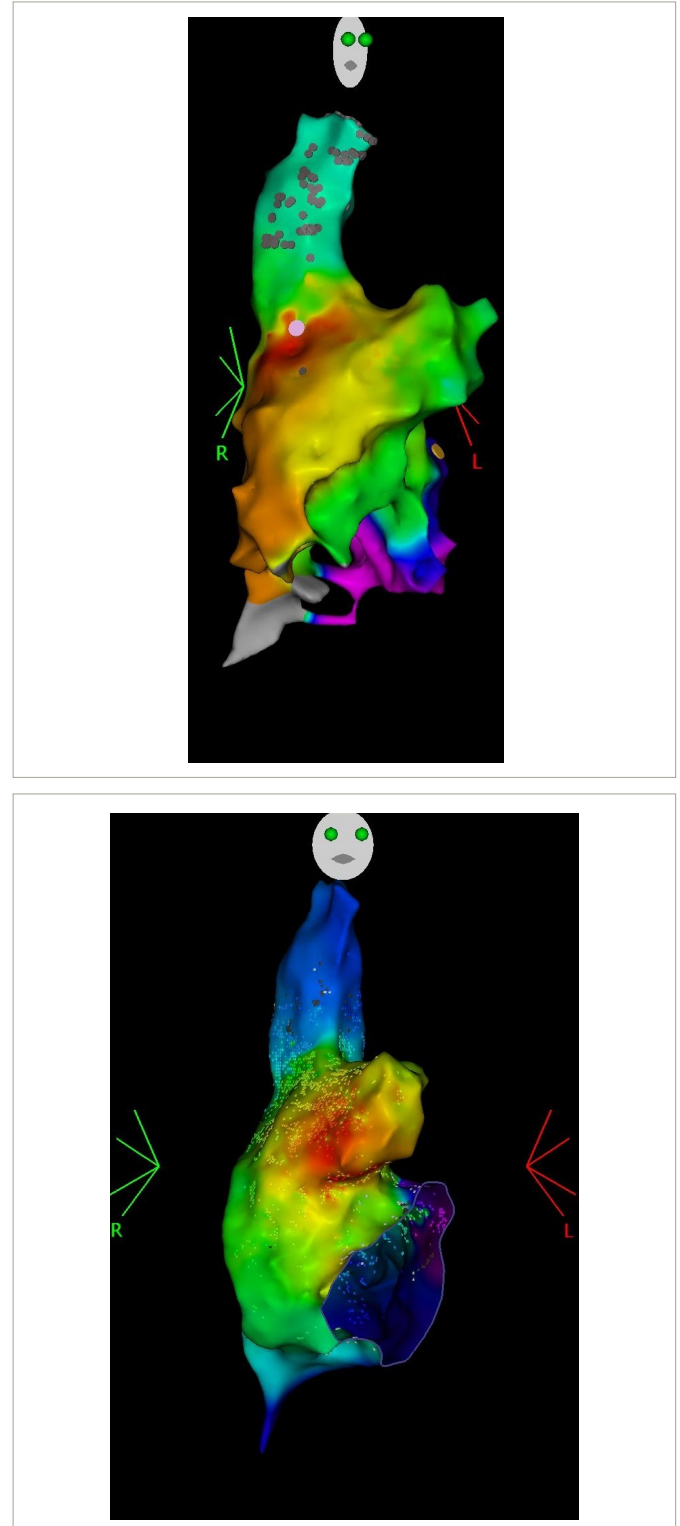
Authors: I Koev (Presenting Author) – Glenfield, Leicester; P Stafford – Glenfield, Leicester; M Lazdam – Glenfield, Leicester

**Introduction:** A number of patients present with recurrent palpitations and documented tachycardia where the P wave morphology on electrocardiogram (ECG) is similar to sinus P wave, making it difficult to distinguish between sinus or atrial tachycardia.

**Case presentation:** We present the case of a 22-year-old patient with incidental finding of incessant tachycardia and mild left ventricular systolic dysfunction, ejection fraction at 46% and no scar on cardiac magnetic resonance. ECG showed narrow complex tachycardia at 109 bpm with P wave axis similar to sinus rhythm but notched prolonged negative P wave in V1. She did not respond to trials with either bisoprolol or ivabradine. The differential diagnosis was inappropriate sinus tachycardia or atrial tachycardia (AT). However, in the absence of diurnal variation on Holter and the presence of systolic dysfunction, this was most likely AT and tachycardiomyopathy. She was listed for an electrophysiological study (EPS) and catheter ablation using 3D electroanatomical mapping (EAM) under general anaesthesia. ECG in pre-assessment showed a rate of 95 bpm and negative P waves in V1-3. On the day of the procedure, she was in narrow complex tachycardia with concentric coronary sinus activation (tachycardia cycle length [TCL] 530 ms). Ventricular entrainment showed VAAV response consistent with AT. During re-induction of AT, atrial flutter was induced. 3D EAM using Pentaray© and Carto 3 Coherent map confirmed cavotricuspid isthmus (CTI)-dependent flutter. Ablation using STSF DF catheter along CTI successfully resulted in bidirectional block. 3D EAM of sinus node was carried out. AT was re-induced and the 2 different TCLs (530 ms and 510 ms) mapped using Parallel mapping confirmed focal AT from the same focus in the anterolateral to basal right atrial appendage. Unipolar signals confirmed Qs morphology and catheter ablation was carried out. Another tachycardia was induced and mapped to the same focus, hence further ablation was carried out. Repeated EPS during the waiting period at baseline, on isoprenaline infusion and washout did not induce any tachycardia. Remapping on isoprenaline confirmed sinus tachycardia and CTI block.

**Discussion and conclusion:** Focal AT can result from automatic or triggered activity or micro-re-entry. Sometimes, it can be challenging to distinguish focal AT from inappropriate sinus tachycardia when P wave axis appears similar when the focus is close to the sinus node. However, the presence of negative P waves in the precordial leads would be more in keeping with an AT. The presence of systolic dysfunction in conjunction with the tachycardia was also more suggestive of AT and tachycardiomyopathy. Focal AT and sinus tachycardia are sometimes difficult to differentiate on Holter or ECG because of the similar morphology of the P-wave when focal AT originates from an area in proximity to the sinus node. EPS and EAM are critical in these cases as they can provide a more accurate diagnosis and can help locate the area of origin of the arrhythmia. □

Figure 1



## Posters 2

### 128/Service evaluation of the effectiveness and potential benefits of a mobile Kardia clinic for an NHS cardiology department

Author: *MCD Dale (Presenting Author) – Buckinghamshire Healthcare NHS Trust, High Wycombe*

For years we have used ambulatory Holter monitoring to try and detect symptomatic arrhythmias in patients. However, many of these tests are ineffective when patient symptoms are less frequent than daily or even weekly. We have looked at a subgroup of patients suffering from infrequent palpitations and offered them a Kardia device for a 25-day monitoring period.

The Kardia mobile device was identified by the NHS Innovation Accelerator in 2015 as a monitor available for detecting atrial fibrillation in the community. However, the scope of this monitor is much greater than atrial fibrillation screening. We have found it can detect not only atrial fibrillation, but any symptomatic arrhythmia including atrial or ventricular ectopy, supraventricular and ventricular tachycardias.

The clinic was set up at Wycombe Hospital with referrals restricted to Consultant Cardiologists and Cardiac Specialist Nurses who felt their patients met the inclusion criteria. The patient selection involved those

with infrequent palpitations who were smart-phone literate. Patients were asked to send tracings of a single-channel ECG using a Kardia device during their episodes of palpitations. Their tracing could then be sent from their smartphone to a secure NHS email address for review by a Cardiac Physiologist. Results from the Kardia clinic would be reported to the referrer and patients had appropriate follow-up.

We have now been able to prove there is a diagnostic place for outpatient mobile monitoring with the success of our Kardia clinic that has been running since December 2017; a one-sample proportion test proved there was >50% likelihood of a symptom–rhythm correlation ( $p=0.000$ , 76% of patients) and >50% likelihood of diagnosing an arrhythmia or sinus tachycardia ( $p=0.006$ , 62% of patients). These results are of great value to the future management of infrequent palpitations on an outpatient basis for the specialty of cardiology. □

Posters 2

**129/Taurolidine containing antimicrobial wash to prevent cardiac implantable electronic device infection**

Authors: J Henke (Presenting Author) – CAU, Kiel; B Baldauf – CAU, Kiel; EW Lau – RVH, Belfast; H Pavacci – Lakumed, Landshut; J Dietl – Lakumed, Landshut; A Perani – Lakumed, Landshut; J Mehilli – Lakumed, Landshut; B Zrenner – TUM, Landshut; M Giaccardi – Santa Maria Annunziata Hospital, Florence; H Bonnemeier – CAU and Helios Cuxhaven, Cuxhaven; R Vonthein – IMBS, Luebeck; S Borov – CAU and Lakumed, Landshut

**Background:** Cardiac implantable electronic device (CIED) infection has risen faster than the volume of procedures. Many measures against CIED infection have been tried, but only peri-operative antibiotics and an antibiotic-eluting envelope have proved effective. Taurolidine is a long-established antimicrobial agent with a wide range of chemical activities and biological effects. The effectiveness of a taurolidine-containing solution in preventing CIED infection was assessed in this observational study.

**Methods:** All the hardware (leads, suture sleeves, pulse generator) was washed and the device pocket irrigated with an adjunct antimicrobial solution, which could be 3% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), taurolidine in a galenic formulation or TauroPace™ (TP, Tauropharm, Bavaria, Germany), during any invasive procedure (e.g. generator replacement) involving a CIED system at the authors' institute. Before 01/01/2020, the choice of antimicrobial solution was at the operator's discretion. Afterwards, only TP was used. All CIED procedures performed at the author's institute between 01/01/2017 and 28/02/2022 were included for analysis. Patients who received the galenic taurolidine formulation were excluded from analysis. The primary endpoint was CIED infection according to the Novel 2019 international diagnostic criteria. The secondary endpoint was any serious adverse events (SAE, e.g. pneumothorax) possibly related to the use of the antimicrobial solution, the CIED or the procedure, and all-cause mortality. The follow-up duration was standardised to 3 months as only acute and sub-acute infection post-CIED procedure was of interest. The procedures and not the patients were the data units. Patients who underwent more than one procedure were deemed to have been censored for the initial treatment group and re-classified as new data units (with or without cross-over to the other treatment group) at the time of the second procedure.

Figure 1: Enrolment and follow-up

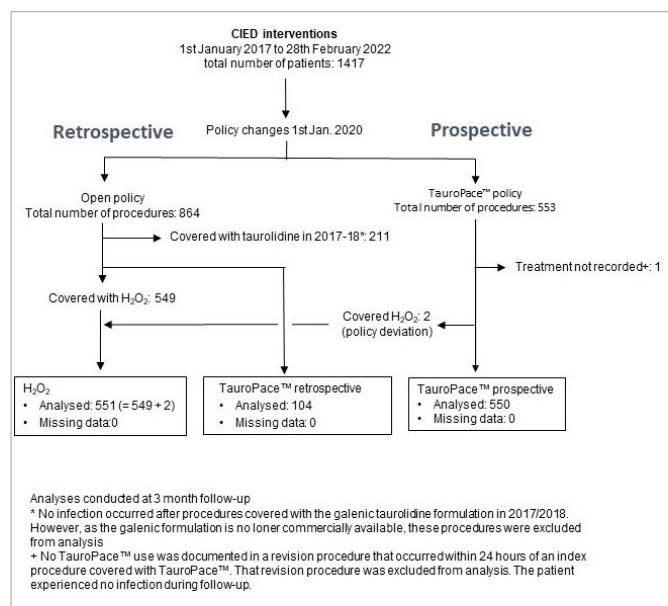


Figure 2: Cumulative incidence curves for major CIED infection (bottom) and death (top) by cohort (blue: H2O2, red: TauroPace) as solid lines with pointwise confidence intervals (broken lines)

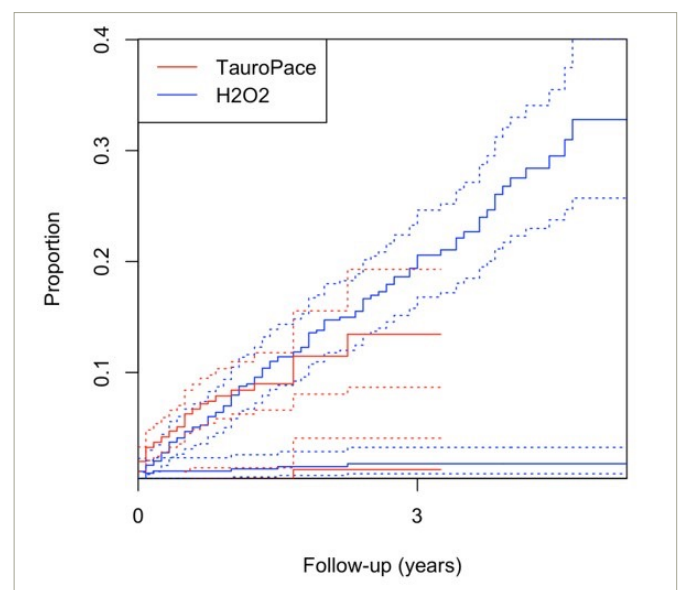
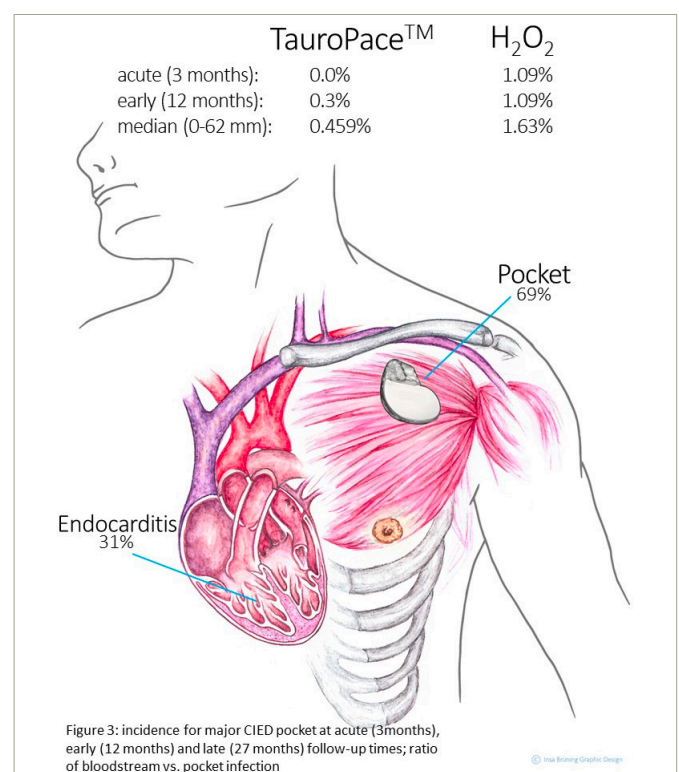


Figure 3



CONTINUED





**Results:** Between January 2017 and February 2022, 654 procedures were conducted with adjunct TP in 631 distinct patients, and 551 procedures with adjunct H<sub>2</sub>O<sub>2</sub> in 532 distinct patients (*Figure 1*). The TP group had significantly more host risk factors for infection (e.g. inexperienced operator) than the H<sub>2</sub>O<sub>2</sub> group (p=0.0017), but similar device- and procedure-specific risk factors (p=0.22). Within 3 months post-index procedure, CIED infection occurred in 0/654 (0.0%) in the TP group and 6/551 (1.09%) in the H<sub>2</sub>O<sub>2</sub> group (95% CI 0.5% to 2.36%; p=0.0075) (*Figure 2, Figure 3*). Death occurred in 23/654 (3.5%) of the TP group and 14/551 (2.5%) in the H<sub>2</sub>O<sub>2</sub> group (95% CI -2.98% to 1.05%; p=0.32). Non-infection-

related SAEs were rarer in the TP group than in the H<sub>2</sub>O<sub>2</sub> group (95% CI -4.79% to 0.26%; p=0.0802) (3.8% vs 6.0%). The hazard ratio for major pocket infection was 0.41 (0.11 to 1.56) without adjustment and 0.35 (0.09 to 1.37) when adjusted for number of patient risk factors in a Cox regression using all follow-up (median 15 months).

**Conclusions:** The use of TP as an antimicrobial solution during CIED procedures may have been a cause of a lower rate of acute and delayed CIED infection compared with 3% H<sub>2</sub>O<sub>2</sub> in an observational study. The clinical utility of TP in reducing CIED infection will need to be assessed in a randomised clinical trial. □

Posters 2

**130/Arrhythmia Alliance<sup>1</sup> and Mended Hearts<sup>2</sup> Survey – Patient understanding and awareness of CIED infection**

Authors: *T Lobban – Arrhythmia Alliance, Stratford-upon-Avon; A Bauer – The Mended Hearts, Inc, Albany, Georgia*

**Background:** Survey undertaken to assess the level of patients and carer understanding of CIED device infection. Cardiac implantable electronic devices (CIEDs) continuously monitor heart rhythm. The device can slow or increase the heart rhythm and can shock it back into normal rhythm when a potentially fatal arrhythmia is detected. CIEDs are life-saving medical devices. By 2030 it is predicted that 2.3 billion devices will have been implanted globally. There are relatively few risks associated with the implant of the device, the most common are infection, bleeding and bruising. Infection is the most serious risk, yet the majority of survey respondents were unaware of the signs and symptoms of CIED infection and the potentially fatal consequences.

**Purpose:** Arrhythmia Alliance<sup>1</sup> (A-A) in collaboration with Mended Hearts,<sup>2</sup> conducted a survey to gather insights from patients on their knowledge of awareness, signs, symptoms, treatment and implications of device infection through their own experience or somebody they care for. The results will be used to support the findings of research undertaken by Duke University Medical School into CIED infection and adherence by healthcare professionals (HCPs) to international CIED infection guidelines.

**Method:** An online questionnaire was designed and distributed across the A-A, AF Assoc, Mended Hearts and STARS (Syncope Trust) databases, social media and online forums.

**Results:** 265 patients responded to the online questionnaire, 94% of respondents had a CIED or were a caregiver to someone with a CIED. Findings from the questionnaire are summarised in the diagrams.

**Conclusions:** This survey highlights a lack of patient knowledge about risk of CIED infection. There were limited discussions with doctors, and patients were unaware of infection signs or symptoms and unaware of potential relapse. It is therefore evident that HCPs need to engage with patients and caregivers regarding the risk of infection and the signs and symptoms of infection. Patients need to better understand signs and symptoms of infection and when to seek medical attention. HCPs, patients and caregivers need to know where to find further information and support from professional patient organizations such as Arrhythmia Alliance. □

Arrhythmia Alliance Devices for an Arrhythmia Patient Booklet, 2021

Figure 1

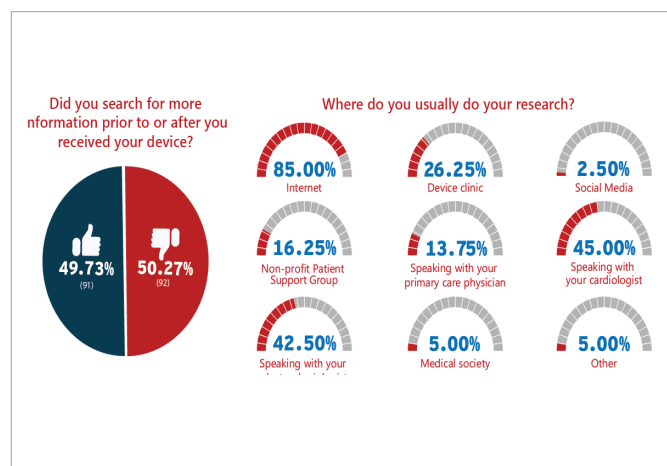


Figure 2

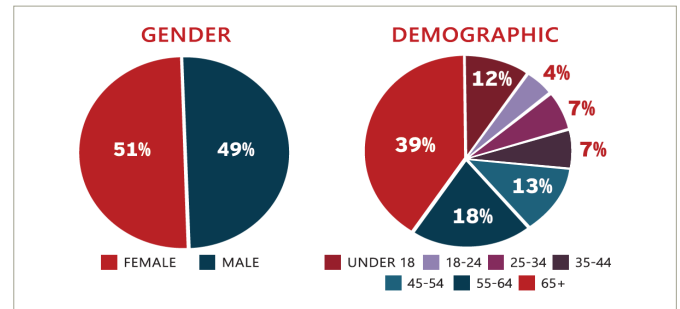


Figure 3

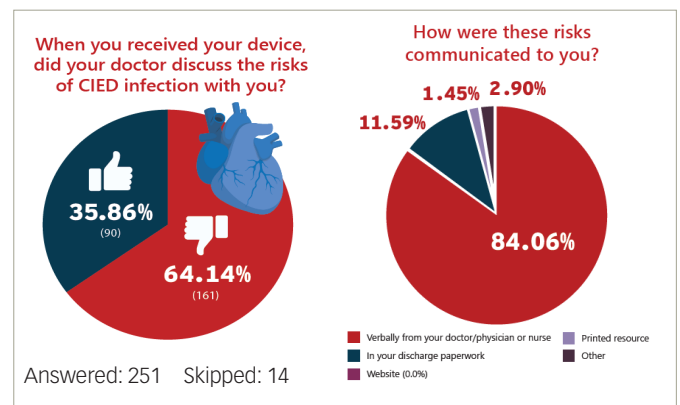


Figure 4

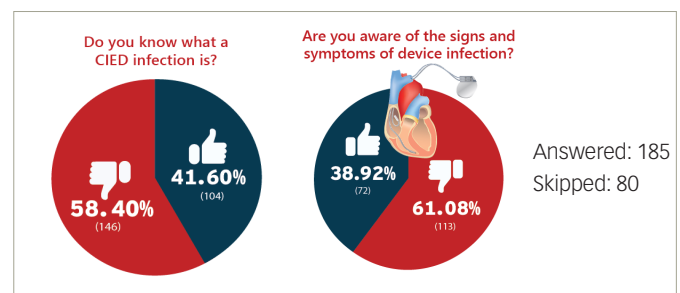
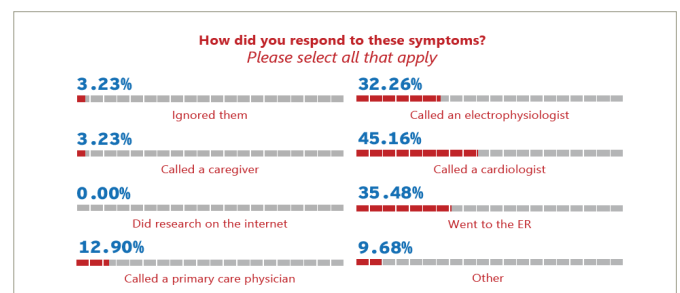


Figure 5



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Figure 6

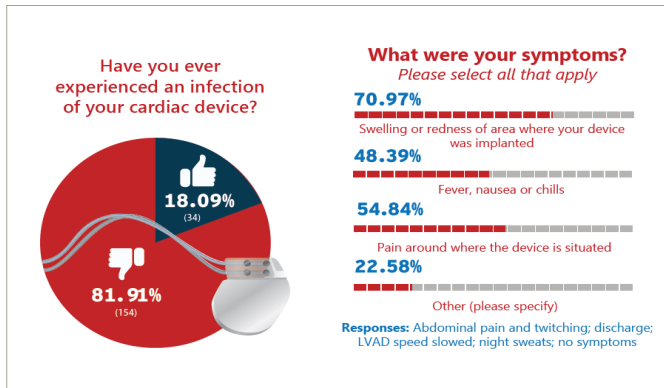
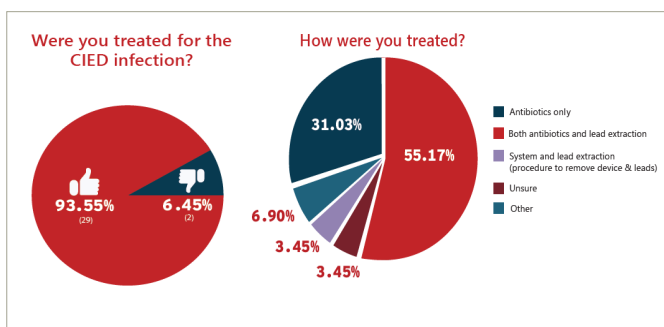


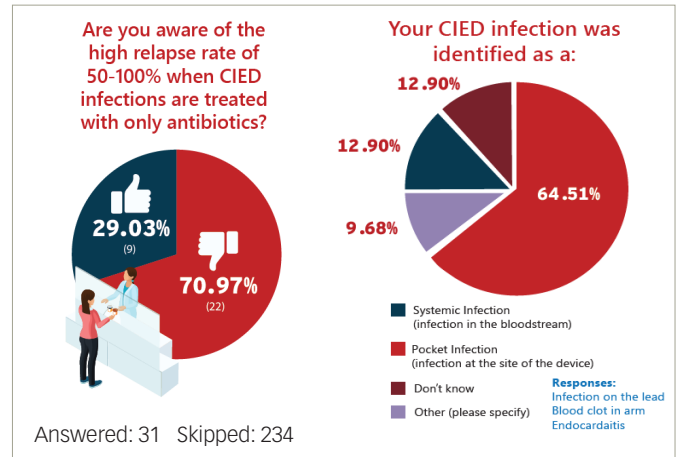
Figure 7



**Back-up notes: Results:** A total of 265 people responded to the online questionnaire; 94% of respondents had a CIED or were a caregiver to someone with a CIED; 39% of patients experienced a CIED infection when they were over 65 years old, with all other age categories each making up a minority of the results; 59% of respondents were unaware what a CIED infection was, with only 41% knowing.

The majority (64% of respondents) also highlighted that their doctor did not discuss the risks of CIED infection with them. Those that did discuss the risks were told verbally by their doctor/physician (84%), and 12% reported that they were informed through their discharge paperwork. Furthermore, 61%

Figure 8



noted that they would not be able to identify signs or symptoms of CIED infection, with 82% indicating that they had never experienced an infection.

For those that did have symptoms, 70% experienced swelling or redness of the area where the device was implanted, 48% said they had a fever, nausea, or chills, 54% had pain around the device area and 23% selected other. When diagnosed, 64% were identified as a pocket infection, 13% as a systemic infection, and 23% selected other or that they did not know.

When patients were asked how they responded to these symptoms, 43% contacted their cardiologist, 32% contacted an electrophysiologist and 13% made contact with a primary care physician; only 3% ignored them.

In terms of treatment options, 94% said they were treated for the infection, with 55% treated with both antibiotics and lead extraction, and 31% treated with antibiotics alone.

Half of patients (50%) said they searched for information prior to when they received their device; 85% used the internet, 45% spoke with their cardiologist and 42% spoke with their electrophysiologist.

Overall, 71% of patients were not aware of the high relapse rate of 50–100% when CIED infections are treated with only antibiotics; however, it is feared that this is higher, as 234 skipped this question. □

Paediatric

**131/Late presentation of Wolff–Parkinson–White syndrome in children with previously normal electrocardiogram (ECG) – a case series**

Authors: *M Ravichandran (Presenting Author) – Department of Paediatric Cardiology, University Hospital of Wales, Cardiff; A Wong – Department of Paediatric Cardiology, University Hospital of Wales, Cardiff; O Uzun – Department of Paediatric Cardiology, University Hospital of Wales, Cardiff*

**Introduction:** Wolff–Parkinson–White (WPW) syndrome is an important cause of arrhythmias in children. Despite having significant evidence and guidelines on diagnosis and management of this condition, it still proves enigmatic. We discuss here three cases with late manifestations of WPW syndrome that were not evident on previous electrocardiograms (ECGs), Holter and exercise tests.

**Case 1:** A 14-year-old girl with previous patent ductus arteriosus (PDA) Amplatzer device closure had presented with recurrent episodes of dizziness, light headedness and easy fatigue during exercise. She was previously well with normal ECG and exercise test. Repeat ECG this time, however, showed bradycardia (heart rate 56 bpm) with short PR interval of 80 ms, overt pre-excitation and wide QRS (146 ms). Echocardiogram showed reduced left ventricular function with fractional shortening (FS) 21%. Incremental atrial and ventricular pacing mapped an accessory pathway at the 7 o’clock position at tricuspid annulus, which was then successfully ablated. Post-procedure ECG showed sinus rhythm and the echocardiogram showed improved ventricular function (FS 35%).

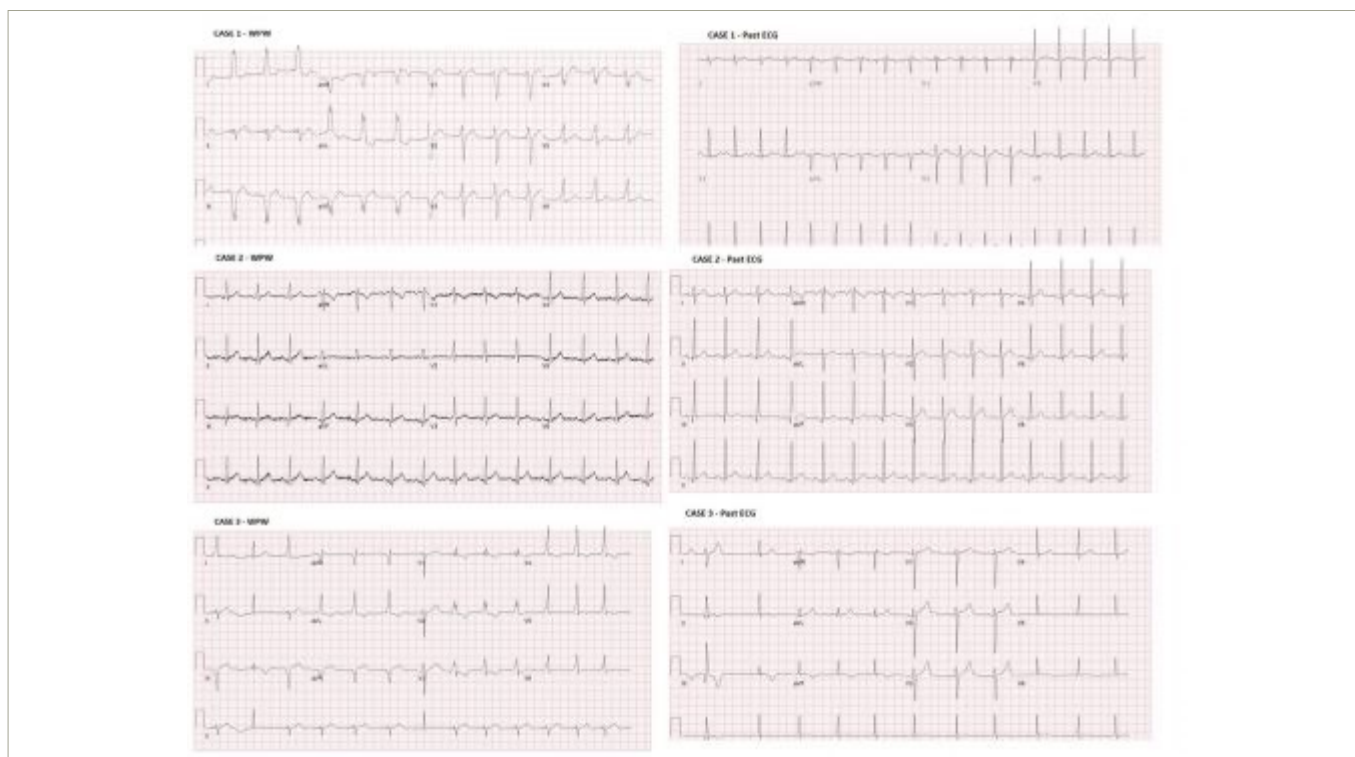
**Case 2:** A 23-year-old woman who was under regular cardiac surveillance since the age of 2 in view of strong family history of hypertrophic cardiomyopathy presented with palpitations. All through her surveillance, her ECG, echocardiogram, 24-hour Holter (twice) and cardiac magnetic resonance imaging (at age 21 years) were normal. However, a repeat ECG at the emergency department showed a narrow complex tachycardia associated with ectopics and suspected pre-excitation at age 23. Electrophysiology (EP) study demonstrated a bidirectional accessory pathway conduction at the 6 o’clock position on

the atrioventricular groove with a life-threatening behaviour following isoprenaline (antegrade effective refractory period [ERP] <220 ms; retrograde ERP 240 ms). A successful ablation was performed. Post-procedural ECG showed normal sinus rhythm with no pre-excitation.

**Case 3:** A 13-year-old girl with a past history of spontaneously closed muscular ventricular septal defect (VSD) at 2 years of age presented with recurrent episodes of shortness of breath and chest tightness. Her previous ECG during VSD surveillance was normal, as was her echocardiogram. Repeat ECG during initial presentations of chest tightness showed occasional ectopics, but otherwise normal findings. Hence, a Holter was arranged. However, she presented 1 week later with worsening symptoms and ECG managed to capture delta waves with short PR interval (98 ms) and widened QRS (140 ms). Interestingly, her repeat ECG 24 hours later was normal again. She was thus started on flecainide and is currently awaiting EP study.

**Conclusion:** We have here three girls who were under intensive cardiac surveillance for various reasons and have had documented normal ECG findings with no evidence of delta wave previously. All three presented again in teenage or young adult age with varying symptoms and were found to have WPW syndrome. This highlights the importance of concealed and late-presenting WPW and the challenges in its diagnosis on not only spot ECGs, but also Holter and exercise tests. Further re-evaluation of existing diagnostic guidelines for excluding WPW may be necessary to identify these patients, including the use of wearable ECG devices and regular follow-up despite normal ECG. □

Figure 1



## Index of Presenting Authors



### A

Ahmad, M 113  
 Ahsan, N 93  
 Akhyt, BA 122  
 Al-Hamdi, A 118  
 Ali, N 9  
 Armstrong, S 20

### B

Bangash, F 47, 61  
 Bates, AP 31, 38, 50, 64, 114  
 Bin Waleed, K 24  
 Borov, S 129  
 Brown, C 69  
 Brown, S 25, 110

### C

Calvert, P 49  
 Carr, FM 120  
 Carter, Z 19  
 Case, N 117  
 Chong, KCC 67  
 Chow, JJ 27, 37  
 Chu, GS 45

### D

Dale, MCD 141  
 De Greef, Y 29, 48, 134  
 Doleman, F 112  
 Dulai, R 132

### E

Ebeid, A 87  
 ElRefai, M 79

### F

Fenwick, A 14

### G

Galaway, PL 139  
 Gallagher, MM 55, 133  
 Gomaa, A 43  
 Granville, HG 107  
 Green, PG 11  
 Griffiths, JR 62

### H

Harfield, JH 94  
 Henke, J 142  
 Hong, LH 88  
 Hunt, J 52  
 Hutchison, K 86

### I

Ibrahim, M 128  
 Ilchyshyna, OY 34  
 Imms, R 138  
 Iqbal, AI 116

### J

Jathanna, N 58, 68  
 Jones, AR 12  
 Jones, BJ 15, 135

### K

Kailey, BS 126  
 Kakarla, J 81  
 Kanella, I 51  
 Kavi, KS 121  
 Kaza, N 136  
 Khan, MM 104  
 Khan, P 16, 40  
 Koev, I 140  
 Kotb, A 26

### L

Leung, L 28  
 Liao, YW 85  
 Li, J 41  
 Ling, XL 95  
 Lobban, T 22, 73, 144  
 Lowry, JE 44

### M

Maclean, E 111  
 Manjooran, S 131  
 Marcu, DTM 54  
 Mayer, J 119  
 Menexi, C 80  
 Metje, S 89  
 Minn, KS 97  
 Miyazawa, AA 65  
 Mohal, JS 84  
 Monkhouse, C 66  
 Moore, CV 72  
 Morgan, DR 60  
 Mravljak, R 124

### N

Naraen, A 99  
 Ng, WC 30  
 Niespialowska-Steuden, MNS 76

### P

Panagopoulos, D 56  
 Panchal, G 63, 83  
 Pasero, D 82  
 Patel, KHK 71

### R

Raffaele, GR 33  
 Rauf, MA 123  
 Ravichandran, M 146  
 Riad, OR 137  
 Ries, W 98

### S

Saleh, K 36  
 Samways, JW 32  
 Sanders, KH 102, 109  
 Sau, A 23, 35  
 Scrocco, C 10  
 Shannon, CM 100  
 Sharp, AJ 92  
 Silva, S 106  
 Singleton, Mr 105  
 Sivanandarajah, P 108  
 Stafford, C 78  
 Stoneman, P 125  
 Suna, G 53  
 Sun, JJ 70

### T

Turner, I 39

### U

Uy, CP 21

### V

Veacock, P 130  
 Vyas, V 13

### W

Walker, D 17  
 Wardak, FA 59  
 Warren, RL 96  
 Wharmby, A 77  
 Wharmby, ALW 18  
 Whittaker, L 42, 75, 103  
 Williams, SE 115  
 Win, KZ 127