ABSTRACT  
Atrial fibrillation (AF) and heart failure (HF) are complex clinical entities that occur concomitantly in a significant population of patients, and their prevalence is rising in epidemic proportions. Traditionally, both rate and rhythm control strategies have been regarded as equivalent in the management of dysrhythmia in this AF-HF cohort with escalation of treatment largely guided by symptoms. Both disorders are involved in an elaborate pathophysiological interplay with shared cardiovascular risk factors that contribute to the development and sustenance of both AF and HF. Recent studies and continued development of evidence to support catheter ablation for AF has brought into question the traditional belief in equivalence between rate and rhythm control. Indeed, recent trials, in particular the CASTLE-AF (Catheter Ablation versus Standard Conventional Therapy in Patients with Left Ventricular Dysfunction and Atrial Fibrillation) study, suggest that catheter ablation for AF improves survival and rates of hospitalisation in patients with concomitant HF and AF, threatening a paradigm shift in the management of this patient cohort. The evident mortality benefit from clinical trials suggests that catheter ablation for AF should be considered as a therapeutic intervention in all suitable patients with the AF-HF syndrome as these patients may derive the greatest benefit from restoration of sinus rhythm. Further research is needed to refine the evidence base, especially to determine which subgroup of HF patients benefit most from catheter ablation and what is the optimal timing.

Epidemiology of AF and HF

Already the most common sustained dysrhythmia in adults, the prevalence of AF is rising at an alarming rate. Recent estimates suggest that the prevalence of AF is expected to triple in the next three decades. In the US, the national cost associated with the burden of AF was estimated at around $26 billion in 2008, while estimates suggest that as much as 0.9%–1.6% of the UK National Health Service expenditure is directly attributed to AF. The AF pandemic is paralleled by a high global prevalence of HF, estimated at over 26 million patients worldwide with a global healthcare cost estimated at over $100 billion.

Both AF and HF are complex clinical syndromes with significant interplay. Indeed, AF and HF coexist in a significant subset of patients, representing 1% to 2% of the adult population. Up to half of all HF patients have AF, with the prevalence ranging from 5% in people with New York Heart Association (NYHA) Class I HF to 50% in NYHA Class IV disease.

This AF-HF cohort has particularly poor clinical outcomes with AF associated with increased throm-
boembolic risk, HF hospitalization and death.\[1\] Indeed, the development of AF in HF doubles mortality while the development of HF in patients with pre-existing AF is associated with a threefold rise in mortality.\[1\] Though the relationship between AF and HF has been identified since at least 1937 and both conditions lead to pathophysiological derangements that drive the development of the other, the exact mechanisms underpinning this relationship are not completely understood.\[12\] Both conditions do share a similar risk factor profile including age, hypertension, obesity, diabetes mellitus, ischaemia, and structural and valvular heart disease.\[1,2,13\]

PATHOPHYSIOLOGY

The pathophysiological mechanisms underpinning the AF-HF relationship are summarized in Figure 1.\[1,12,14\] Briefly, HF is associated with sustained rise in left atrial pressure and distension, which in turn promote fibrotic change and cardiac scarring.\[15\] As a consequence, conduction abnormalities arise, such as anisotropy and reduced atrial conduction velocity.\[14,16\] Together, the conduction abnormalities, neurohumoral aberrations, and structural remodelling observed in HF drive a pro-arrhythmogenic substrate that favours the initiation and maintenance of AF.

In contrast, the pathophysiological changes encountered in AF, such as irregular ventricular filling and rapid ventricular rates accompanied with neurohumoral activation due to haemodynamic changes, loss of the “atrial kick” and tachycardia-induced cardiomyopathy (TIC) lead to a low cardiac output state, reduced blood pressure, exercise tolerance and pulmonary venous congestion that can drive HF decompensation.\[3,14\]

Data suggest that TIC occurs in 9% to 34% of patients with AF.\[17-19\] Successfully identifying and treating TIC early, ideally before permanent structural alterations such as left ventricle (LV) scarring, is key to improving outcomes in this cohort. LV scarring has been found to be independently associated with AF and is a predictor for future cardio and cerebrovascular morbidity.\[20,21\] Restoring sinus rhythm (SR) in patients with HF and AF may be beneficial through alleviation of the underlying pathophysiology (such as inflammation) that contributes to HF and improving diastolic filling of the LV through sequential activation of the atria and ventricles.\[12\]

Additionally, AF and HF both share some pathophysiological changes that can exacerbate the AF-HF syndrome. For example, both clinical entities are associated with a chronic inflammatory state that promotes both structural and electrical remodelling.\[22\] Chronic inflammation is also a feature of syndromes that predispose to both HF and AF including hypertension, diabetes mellitus, coronary artery disease, smoking, obesity, and obstructive sleep apnoea.\[9,22\]

While most studies investigating the AF-HF cohort have focussed on heart failure with reduced ejection fraction (HFrEF), even heart failure with preserved ejection fraction (HFpEF) represents a substantial subset of patients with HF.\[23,24\] The mechanism(s) driving both AF and HF in both HFpEF and HFrEF remain the same.\[23\] While there is a higher risk of AF in patients with lower ejection

Figure 1  Risk factors and pathophysiological mechanisms contributing to comorbid AF and HF. AF: atrial fibrillation; HF: heart failure.
fraction, the broad risk of cardiovascular and thromboembolic complications remains similar regardless of the type of HF.\[24\]

**RATE VERSUS PHARMACOLOGICAL RHYTHM CONTROL IN AF-HF**

The treatment of AF is built on four pillars: rate and/or rhythm control, anticoagulation to manage thromboembolic risk and risk factor management.\[3\] Traditionally, a number of patient-specific factors determine the choice of rate or rhythm control approach. These factors include age, comorbidities and other concomitant medications, the type and duration of AF and the symptom profile of the patient. Symptomatic AF can be pragmatically defined in a AF-HF context as worsening of symptoms, reduction in exercise capacity or worsening LV function in AF compared to SR.\[14,23\]

Interestingly, while beta-blockers are a major component of the pharmacological management of HF, data to support their use in AF-HF are somewhat more controversial.\[25\]

In the Beta-Blocker Heart Failure Collaborative Group study, the use of beta-blockers in HF and SR was associated with a reduction in hospital admissions and mortality. This observation did not however extend to the AF-HF cohort.\[25–27\] In contrast, in propensity matched analysis of the AF-CHF (Rhythm Control versus Rate Control for Atrial Fibrillation and Heart Failure) trial found evidence for improved survival for AF-HF patients receiving beta-blockers though there was no reduction in hospitalizations.\[27\]

The AF-CHF study remains the largest randomized trial to compare mortality between rate and rhythm control strategies in AF patients (n = 1,376) with symptomatic congestive HF [left ventricular ejection fraction (LVEF) < 35%].\[28\] Patients randomized to either the rhythm control (n = 682) with antiarrhythmic drugs such as amiodarone, sotalol, and dofetilide; and direct current cardioversion or to the rate control arm (n = 694). Rate control was established with beta-blockers and/or cardiac glycosides. At a mean follow-up of 37 months, the cardiovascular mortality rate was similar in both treatment arms (27% for rhythm control vs. 25% for rate control, P = 0.60). Additionally, there was no difference in the composite endpoint of stroke, HF progression and cardiovascular death between the two cohorts.\[28\]

Though the maintenance of SR was high was in the rhythm control group (> 70%), patients in the rhythm control group had greater rates of hospitalization (46% vs. 39%, P = 0.001).\[28\] The findings of this study echo those of DIAMOND-CHF (Danish Investigators of Arrhythmia and Mortality on Dofetilide in Congestive Heart Failure) where 1,518 patients were randomised to either treatment with dofetilide (n = 762) or placebo (n = 758).\[29\] While a greater proportion of patients were in SR in the treatment arm compared to the placebo arm (65% vs. 30%), no overall differences in mortality were observed between the two arms.

Given the favourable intuitive impact of SR maintenance on the pathophysiological substrate driving AF and HF, the findings of these studies seem counterintuitive. It has been hypothesised that the benefits of rhythm control may be negated by adverse effects associated with antiarrhythmic treatment.\[12,14\] In the AF-CHF study, more patients in the rhythm control arm received treatment with amiodarone compared to the rate control arm (82% vs. 7%).\[28\] In addition, a significant proportion of hospitalizations in the first year was higher due to need for repeated direct current cardioversion in the rhythm control group compared to the rate control arm (59% vs. 9%, P = 0.001) and there was significant crossover between the two trial arms with 21% of the participants crossing over to the rate control group. In the AF-CHF trial, a large proportion of patients (~35%) remained in SR in the rate control group after a median follow-up of 47 months. Amiodarone is associated with significant adverse effects, high discontinuation rates and greater rates of non-cardiovascular morbidity and mortality.\[12,30,31\] Indeed, in the AFFIRM (Atrial Fibrillation Follow-up Investigation of Rhythm Management) Study, antiarrhythmic pharmacotherapy was associated with a higher mortality rate [hazard ratio (HR) = 1.50] while SR maintenance was associated with lower mortality rate (HR = 0.53).\[32\] This has led to growing interest for a strategy that combines the hemodynamic benefits of establishing SR in the AF-HF cohort without the undesirable impact of long-term pharmacotherapy.
Since Hsu, et al. [33] first described the favourable impact of curative catheter ablation for AF on clinical outcomes in 2004, there has been burgeoning interest in the role catheter ablation can play in the management of AF-HF. Recent trial evidence has further emphasised the role that catheter ablation can play in the management of this cohort. [34] Initial evidence largely from observational retrospective

### Table 1  Summary of clinical trials for catheter ablation for AF in HF.

| Study               | Year | Sample size | Follow-up, months | Primary study outcome                                                                 | Comparator arm            | Interpretation                                                                                     |
|---------------------|------|-------------|-------------------|----------------------------------------------------------------------------------------|---------------------------|---------------------------------------------------------------------------------------------------|
| MacDonald, et al.   | 2011 | 41          | 6                 | (1) Improvement in LVEF                                                                | Rate control              | No improvement in LVEF at 6 months by CMR in the catheter ablation group as the primary endpoint. There was a higher-than-expected procedural complication rate |
|                     |      |             |                   | (2) Catheter ablation did not have a statistically significant improvement in LVEF at 6 months |                           |                                                                                                   |
|                     |      |             |                   | (3) Catheter ablation: 4.5% ± 11.1%                                                   |                           |                                                                                                   |
|                     |      |             |                   | (4) Medical therapy: 2.8% ± 6.7%, \( P = 0.60 \)                                     |                           |                                                                                                   |
| Jones, et al.       | 2013 | 52          | 12                | (1) Peak oxygen consumption at 12 months                                              | Rate control              | Improved QOL and exercise capacity and reduced B-type natriuretic peptide in the catheter ablation group |
|                     |      |             |                   | (2) Catheter ablation had a slight improvement over medical therapy +3.07 mL/kg per min change, 95% CI: 0.56–5.39, \( P = 0.018 \) |                           |                                                                                                   |
| Hunter, et al.      | 2014 | 50          | 6                 | (1) Change in LVEF at 6 months                                                        | Rate control              | Improved EF and functional capacity in catheter ablation group                                        |
|                     |      |             |                   | (2) Catheter ablation had a statistically significant increase over rate control at 6 months |                           |                                                                                                   |
|                     |      |             |                   | (3) Catheter ablation: 40% ± 12%                                                      |                           |                                                                                                   |
|                     |      |             |                   | (4) Medical therapy: 31% ± 13%, \( P = 0.015 \)                                       |                           |                                                                                                   |
| Di Biase, et al.    | 2016 | 203         | 24                | (1) Recurrence of AF at 24 months                                                     | Amiodarone                | Reduced AF burden, improved QOL, functional capacity, and mortality benefit                           |
|                     |      |             |                   | (2) Catheter ablation had a significant improvement over amiodarone for maintenance of SR at follow-up |                           |                                                                                                   |
|                     |      |             |                   | (3) Catheter ablation: 70% SR, 95% CI: 60%–78%                                         |                           |                                                                                                   |
|                     |      |             |                   | (4) Medical therapy: 34%, 95% CI: 25%–44%, \( P < 0.001 \)                           |                           |                                                                                                   |
| Prabhu, et al.      | 2017 | 66          | 6                 | (1) LVEF change at 6 months via CMR                                                   | Rate control              | EF and functional status improvement in the catheter ablation group                                   |
|                     |      |             |                   | (2) Catheter ablation had a significant improvement in LVEF at 6 months compared with rate control |                           |                                                                                                   |
|                     |      |             |                   | (3) Catheter ablation: 18% ± 13%                                                      |                           |                                                                                                   |
|                     |      |             |                   | (4) Medical therapy: 4.4% ± 13%, \( P < 0.0001 \)                                    |                           |                                                                                                   |
| Marrouche, et al.   | 2018 | 303         | 60                | (1) Composite all-cause mortality or HF hospitalisation                               | Rate or rhythm control   | Mortality benefit, improved exercise capacity, reduced AF burden in the catheter ablation group    |
|                     |      |             |                   | (2) Catheter ablation had a significant reduction in the composite endpoint compared with rate or rhythm control |                           |                                                                                                   |
|                     |      |             |                   | (3) Catheter ablation: 13.4% all-cause mortality                                      |                           |                                                                                                   |
|                     |      |             |                   | (4) Medical therapy: 25% all-cause mortality, \( HR = 0.53, 95\% CI: 0.32–0.86, \( P = 0.01 \) |                           |                                                                                                   |
cohnets suggested an improvement in LVEF, quality of life (QOL) and exercise capacity over traditional pharmacotherapy-based approaches.\textsuperscript{16,34}

These studies laid the foundation for later randomised studies in cohorts with coexistent AF and HFrEF to examine the role of catheter ablation. The ARC-HF (A Randomized Trial to Assess Catheter Ablation Versus Rate Control in the Management of Persistent Atrial Fibrillation in Heart Failure) study was amongst the earliest trials to demonstrate that, relative to rate control, catheter ablation for AF in an AF-HF cohort (n = 51) improved QOL, exercise capacity and led to a reduction in B-natriuretic peptide levels during the follow-up of 12 months.\textsuperscript{35} The CAMTAF (A Randomized Controlled Trial of Catheter Ablation Versus Medical Treatment of Atrial Fibrillation in Heart Failure) study reported a similar improvement in both LVEF and functional capacity with catheter ablation in a HF cohort with persistent AF.\textsuperscript{36}

In contrast, a small study by MacDonald and colleagues demonstrated that in a cohort of 41 patients with persistent AF, severe left ventricular systolic function (LVSF) impairment and NYHA Class II-IV HF, catheter ablation was not associated with a significant change in LVEF, QOL or functional capacity compared to medical optimisation.\textsuperscript{37} However, it should be noted that this study was limited by its small study population, high rates of procedural complications (approximately 15\%) and high AF recurrence in 50\% of patients undergoing catheter ablation within the study cohort at 6 months.

Published in 2017, the CAMERA-MRI (Catheter Ablation Versus Medical Rate Control in Atrial Fibrillation and Systolic Dysfunction) trial was a randomised multicentre study which prospectively evaluated a cohort of 68 patients with persistent AF and HF (LVEF < 45\% attributed to idiopathic cardiomyopathy).\textsuperscript{38} Patients underwent an initial cardiac magnetic resonance imaging (MRI) scan with late gadolinium enhancement prior to randomization in a 1:1 manner to either optimal medical management or catheter ablation for AF through either pulmonary vein isolation and adjunctive posterior wall isolation. The study outcomes were assessed through serial Holter measurements as well as loop recorder implantations. Subjects underwent repeat cardiac MRI scans at 6 months which demonstrated a statistically significant improvement in LVEF (11\%, P = 0.007) as well as normalisation of the LVSF in the ablation cohort compared to subjects receiving medical management (73\% vs. 29\%, P = 0.009).\textsuperscript{38} Interesting, patients with no LV scarring on cardiac magnetic resonance imaging (CMR) had a greater improvement in LV function as compared to subjects with established LV scarring, suggesting that CMR may help identify patients most likely to benefit from ablation.\textsuperscript{39}

The AATAC (Ablation Versus Amiodarone for Treatment of Persistent Atrial Fibrillation in Patients with Congestive Heart Failure and an Implantable Device) study was an open label, multicentre randomised study that enrolled a cohort (n = 203) with persistent AF and dual chamber implantable cardioverter defibrillator (ICD) or cardiac resynchronization therapy defibrillator (CRT-D) devices in-situ, with established HF (LVEF < 40\% and NYHA Class II or III disease).\textsuperscript{31} Patients underwent randomised in a roughly 1:1 manner to either catheter ablation or medical management through rhythm control with amiodarone. The study noted a meaningful improvement in LVEF (P = 0.02), QOL (P = 0.04) and exercise capacity (6-minute walking distance, \(P = 0.03\)) within the catheter ablation cohort relative to medical management. Though the study was underpowered to assess for differences in mortality, an absolute reduction in the all-cause mortality rate (8\% vs. 18\%, \(P = 0.037\)), and hospitalization events (31\% vs. 57\%, \(P < 0.001\)) was noted in the ablation cohort compared to medical management.\textsuperscript{31}

An important limitation of these earlier studies examining the role of catheter ablation in the AF-HF cohort has been relatively small cohorts examined.\textsuperscript{12,34} In addition, some early prospective studies had been powered to examine effects in LVEF rather than hard outcomes including cardiovascular death and hospitalizations.\textsuperscript{38} This discrepancy in clinical evidence was addressed by the CASTLE-AF (Catheter Ablation Versus Standard Conventional Therapy in Patients with Left Ventricular Dysfunction and Atrial Fibrillation) trial.\textsuperscript{40} This randomised controlled trial involved 33 centres and randomised patients with persistent or paroxysmal AF and HF (defined as LVEF < 35\% with NYHA Class II-IV disease) to either catheter ablation (n = 179) or medical management (n = 184). All patients in the study
had an implantable cardioverter-defibrillator or cardiac resynchronization therapy-defibrillator with home monitoring capabilities. Within the medical management cohort, patients were established or either a pharmacological rate or rhythm control regime (30% of patients had amiodarone as pharmacological rhythm control). Catheter ablation was found to reduce AF burden compared to the medical management arm (63% vs. 22%). During a median follow-up of 38 months, the primary endpoint of all-cause mortality or HF hospitalization was substantially lower in the catheter ablation arm compared to the medically managed arm (28.5% vs. 44.6%, *P* = 0.007). The absolute mortality rate was also reduced in the catheter ablation arm (13.4% vs. 25.0%, *P* = 0.01). The observed favourable evidence for catheter ablation in the CASTLE-AF study was due to a reduction in both HF hospitalizations (20.7% vs. 35.9%, HR = 0.56, 95% CI: 0.37–0.83) and improved cardiovascular mortality (11.2% vs. 22.3%, HR = 0.49, 95% CI: 0.29–0.84).[40] Finally, there was also an improvement in LVEF at 60 months in ablation arm compared to pharmacological management (8.0% vs. 0.2%, *P* = 0.005).

The CASTLE-AF study had a number of strengths. It was adequately powered to assess hard outcomes including its primary endpoints of death and HF hospitalization in a reasonable sample size across multiple centres. There was limited crossover between trial arms and good adherence to medical treatment which was largely guideline-directed. Additionally, the inclusion criteria specifically targeted patients with CRT-D or ICD implanted, conferring major benefits. Firstly, this allowed for sustained monitoring for AF burden and, secondly, this study population typically represents a patient cohort with advanced HF. A lengthy follow-up duration also allowed effective ascertainment of statistically and clinically significant differences in outcome between the two trial arms.

Interestingly, the AF-CHF trial had a similar follow-up duration to CASTLE-AF but with additional benefit of a four times greater study population.[28,40] Despite this design advantage, no improvement in survival was observed in the pharmacological rhythm control over rate control in HF.[28] Taken together, it is apparent that catheter ablation appears to be more effective in achieving and sustaining rhythm control through reduction in AF burden, possibly conferring a more sustained physiological benefit. Furthermore, catheter ablation may be better tolerated by patients with a more favourable adverse risk profile compared with medical therapy including amiodarone, which has clinically important interactions and high discontinuation rates due to side effects.

It is of particular interest that, in the CASTLE-AF study, within the catheter ablation arm complete cure through elimination of AF was not achieved in all subjects. Indeed, the key improvement was in time spent in AF which was significantly reduced in patients undergoing ablation compared to the control cohort undergoing medical treatment (25% vs. 60%).[40] An AF burden below 50%, after 6 months of catheter ablation, was associated with a significant decrease in primary composite outcome and all-cause mortality.[44]

Not only does this highlight the inherent strength of the study in accurately assessing AF burden through continuous monitoring but also suggests that the observed benefits with catheter ablation in the AF-HF cohort may be due to greater time spent in SR relative to AF, rather than achieving a complete cure. These benefits are likely to result from alleviating the underlying pathophysiological mechanisms ultimately leading to improved cardiac output.[12,14] Indeed, other trials that observed favourable outcomes with catheter ablation also observed similar rates of AF burden in the catheter ablation arm of their studies.

Despite its strengths, the CASTLE-AF trial has some limitations including a relatively small study population, the lack of blinding when allocating treatment arms and the use of large volume centres for AF ablation with experienced operators which may have lowered the overall complications observed. Interestingly, a recently published sub-analysis of the CABANA (Catheter Ablation Versus Antiarrhythmic Drug Therapy for Atrial Fibrillation) trial analyzed the 778 patients with AF and clinically stable HF at trial entry.[42] The patients randomised to ablation (*n* = 378) had greater survival (HR = 0.57, 95% CI: 0.33–0.96) over a median follow-up of 49 months compared to subjects receiving drug therapy (*n* = 400). Clinically meaningful improvements in freedom from AF recurrence...
and QOL in the catheter ablation group.\cite{42}

Most recently, the EAST-AFNET 4 trial (Early Treatment of Atrial Fibrillation for Stroke Prevention Trial) has offered further insights into the role that catheter ablation can play in management of the patient where AF coexists with other cardiovascular conditions.\cite{43} This large trial enrolled 2,789 patients that were randomised in a 1:1 manner to either rhythm control or standard care. Only patients with an AF diagnosis within one-year with specific associated adverse events or risk factors qualified for the trial. In addition to either AF, patient had to meet to: (1) > 75 years old with previous transient ischemic attack or stroke; or (2) meet two of the criteria: age > 65 years, female sex, stable HF (LVEF < 50\% or NYHA Class II), hypertension, diabetes mellitus, severe coronary artery disease (previous percutaneous coronary intervention or coronary artery bypass grafting), chronic kidney disease (MDRD stage III or IV), left ventricular hypertrophy (diastolic septal wall width > 15 mm).\cite{43}

Rhythm control was achieved early in natural history of AF through pharmacotherapy, cardioversion or catheter ablation. Of interest, the initial treatment choice in the rhythm control cohort included flecainide (36\%), amiodarone (20\%) and AF ablation (8\%). The trial was stopped early due to efficacy with a mean follow-up of five years. The primary outcome measure (cardiovascular death, stroke and hospitalization due to HF or acute coronary syndrome) occurred less frequently with early rhythm control compared with usual therapy (249 vs. 316 patients, HR = 0.79, P = 0.005). Early rhythm control conferred an absolute risk reduction of 1.1\% per year compared to usual care. These benefits persisted across subgroups within the rhythm control arm. However, there was no difference noted in days spent in hospital due to HF hospitalization.

The EAST-AFNET 4 study demonstrated that at five years, amongst a cohort with newly diagnosed AF with concomitant cardiovascular conditions, a strategy favouring rhythm control improved outcome. The EAST-AFNET 4 trial used a large sample size across 135 sites and a larger population underwent early AF ablation relative to other comparable studies. In addition, the rhythm control cohort included dronedarone, a newer agent not considered in some earlier trials. The safety of catheter ablation was excellent and comparable to safety reported in the CABANA trial.\cite{44} A particular strength of the study are the similar baseline characteristics between study population apart from slightly greater use of rate-control medications including digoxin and beta-blockers in the standard care cohort (6\% vs. 3\% and 86\% vs. 76\%, respectively).\cite{43} The use of anticoagulation, antihypertensives and HF medications was similar across cohorts.\cite{45}

While some experts recommend early consideration of AF ablation in patients with AF and concomitant cardiovascular comorbidities based on the findings of the EAST-AFNET 4 trial, the heterogeneity of the approach taken by the individual centres to the rhythm control of early AF makes generalising the findings to the care of the individual patient challenging.\cite{45,46} Furthermore, in addition to a relatively high rate of patients who were lost to follow-up in both trial arms (9.0\% for rhythm control, 6.6\% for standard care), only around 20\% of the rhythm control cohort underwent AF ablation over a five-year period.\cite{45} While AF ablation availability is improving, whether this approach could reasonably be offered to all early onset AF patients may limited by resource availability. Also, of note was the lower-than-expected overall mortality as well as other adverse clinical outcomes observed in both arms of the trial in the context of effective risk factor control. This highlights the role of an integrated approach to AF management where risk factors are aggressively managed.\cite{46}

A number of meta-analyses have analysed data from trials evaluating AF ablation in HF.\cite{34,47,48} In one such recently published analysis of six trials, catheter ablation improved LV function, QOL as well as exercise capacity.\cite{34} These benefits were thought to arise from reduction in AF burden with broadly similar complications rates in HF compared to subjects with normal LV function.

**FUTURE DIRECTIONS**

The above promising findings to support the role of catheter ablation for AF in patients with concomitant HF suggest that clinicians should be consider earlier referral for ablation in this patient population.\cite{43,49} However, several questions remain unanswered. Firstly, as success rate for catheter abla-
tion for AF improves, the degree of benefit patients can expect with an ablation strategy in AF-HF needs further evaluation. Secondly, as the CASTLE-AF trial demonstrated, although patients were in SR for longer within the catheter ablation cohort compared to the medical management arm of the trial, not all patients had complete remission from AF. Whether a threshold for time spent in SR exists where beneficial reverse remodelling and treatment effects become apparent remains to be elucidated. Increasing proliferation of cardiac MRI imaging offers a platform for combining advances in cardiac imaging and electrophysiology to gain an enhanced understanding of treatment effects. Last but not least, the favourable outcomes observed in earlier trials focussed largely on HFrEF and whether these can be replicated in other HF states, in particular HfPEF, will likely be the focus of future clinical studies. Of interest, a recent study by Sugumar, et al. in small cohort of patients with HfPEF undergoing catheter ablation for AF reported improvements in haemodynamic parameters, B-type natriuretic peptide and symptoms associated with HfPEF through restoration of SR. Correlating these findings with hard clinical outcomes in large multicentre studies will likely be the focus of future studies.

Furthermore, whether the improvement in mortality and morbidity observed with catheter ablation and greater time spent in SR in AF-HF transcends the class of HF and the degree of LV impairment remains to be established. This has important implications for patient selection: who benefits most and when is the best time to intervene?

CONCLUSION

In the era of catheter ablation, management of patients in whom AF and HF coexist appears to be undergoing a paradigm shift. As data emerges to support decision making in managing dysrhythmias in patients with HF, given the demonstrable benefit of catheter ablation in the CASTLE-AF trial combined with the favourable impact of treating early AF in the EAST-AFNET 4 study, clinicians should consider early referral for AF ablation through joint decision-making bringing together multidisciplinary expertise including electrophysiologists, HF specialists, other healthcare professionals and, most importantly, the patient. As highlighted by the integrated Atrial fibrillation Better Care (ABC) approach to the management of AF: avoid stroke, better symptom control through rate or rhythm control, and cardiovascular risk factors and comorbid conditions management. In recent guidance from the European Society of Cardiology, a holistic approach is needed to the management of the patient with AF. Indeed, in addition to the restoration of SR and control of AF, clinicians should also focus on managing concomitant cardiovascular risk factors, for these many represent low-hanging fruit in managing the patient with coexisting AF and HF.

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