# Assessment of patient and physician education on medical adherence and avoidance of hospitalisation in atrial fibrillation

Submitted to the University of Hertfordshire in partial fulfilment of the requirements of the degree of Doctorate in General Internal Medicine by Dr Divya Prakash

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# THE UNIVERSITY OF HERTFORDSHIRE

## School of Life and Medical Sciences

I, Dr Divya Prakash declares that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research. I confirm that this work was done wholly while in candidature for a research degree at the University of Hertfordshire. No part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution. Where I have consulted the published work of others, this is always clearly attributed, and where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work. I have acknowledged all main sources of help. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

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# List of Abbreviations

AF - Atrial Fibrillation

AHA- American Heart Association

ARIC - Atherosclerosis Risk in Communities

BMI- Body Mass Index

BP - Blood Pressure

BPM - Beats Per Minute

CDSS- Clinical Decision Support Systems

CHF- Chronic Heart Failure

CI - Confidence Interval

CIED - Cardiac Implantable Electronic Device

CME- Continuous Medical Education

CIED - Cardiac Implantable Electronic Device

CPD- Continuous Professional Development

CRRT - Continuous Renal Replacement Therapy

DM- Diabetes Mellitus

DSMES - Diabetes Self-Management Education and Support

EAT - Epicardial Adipose Tissue

ECG – Electrocardiogram

eGFR - Estimated Glomerular Filtration Rate

EHRA- European Heart Rhythm Association

EHRs- Electronic Health Records

ENHT - East and North Hertfordshire NHS Trust

ESC - European Society of Cardiology

EVOO - Extra Virgin Olive Oil

FRE - Flesch Reading Ease

GHDx - Global Health Data Exchange

GP - General Practitioner

HAS-BLED - Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding, Labile INR, Elderly, Drugs/Alcohol

HR - Hazard Ratio

HRQoL- Health-related Quality of Life

INR - International Normalised Ratio

LMICs- Low- and Middle-Income Countries

MACE - Major Adverse Cardiovascular Events

MET- Metabolic Equivalents

MGLS- Morisky Green Levine Medication Adherence Scale

mHealth- Mobile Health

MI- Myocardial Infarction

NGO- Non-Governmental Organisation

NHS - National Health Service

NICE - National Institute for Health and Care Excellence

NLP- Natural Language Processing

NLPCs - Natural Language Processing Chatbots

NOAC - Non-Vitamin K antagonist Oral Anticoagulants

OAC- Oral Anticoagulants

OR - Odds Ratio

ORBIT - Older Age, Reduced Haemoglobin/History of Anaemia, Bleeding History, Insufficient Kidney Function, Treatment with Antiplatelet Agents

OSA - Obstructive Sleep Apnoea

PCI - Percutaneous Coronary Intervention

PIL- Patient Information Leaflets

PPG – Photoplethysmography

PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RE-LY - Randomised Evaluation of Long-Term Anticoagulation Therapy

SVM - Support Vector Machines

TACE - Trans arterial Chemoembolisation

TTE- Transthoracic Echocardiogram

UK- United Kingdom

VHD- Valvular Heart Disease

VKA - Vitamin K Antagonist

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# ABSTRACT

Atrial fibrillation (AF) is one of the most common cardiac arrhythmias, and its global prevalence is increasing, presenting a substantial burden to healthcare systems. This thesis analyses the impact of patient education, lifestyle changes, and clinical practices on the management of AF, with the objective of finding factors that affect patient outcomes and resource utilisation. It employs a mixed-methods approach, comprising a prospective cohort service evaluation survey assessing the impact of patient education on hospitalisations and medication adherence, and a cross-sectional audit among cardiology physicians using a structured questionnaire to assess clinical practices and educational strategies.

The study underscores the significance of patient education in diminishing hospital admissions, revealing that patients who were informed about controlling irregular heartbeat events exhibited markedly reduced hospitalisation rates (11.76%), in comparison to those who were not informed (47.05%). Nonetheless, a significant percentage of cardiology physicians (42.59%) failed to provide educational leaflets to newly diagnosed AF patients, indicating a deficiency in standardised care. The study also reveals differences in patient awareness, especially with lesser-known risk factors including inadequate sleep, with only 41.17% of patients recognising it as contributing to AF.

Lifestyle alterations, such as smoking cessation and decreased alcohol intake, displayed having a small impact on patient outcomes, including admissions to hospital. Hence, the study could not establish a meaningful correlation between lifestyle changes and hospital re-admissions. Anticoagulant medication adherence was reported at 94.11%, while physician practices regarding compliance monitoring varied, with 19.05% of physicians not performing regular adherence assessments.

The study examines preferences towards anticoagulants, revealing a distinct inclination towards apixaban owing to its advantageous pharmacological characteristics, over Vitamin K Antagonists (VKAs).

The results indicate that although existing AF care regimens are beneficial, there is considerable potential for enhancement in patient education, the uniformity of clinician practices, and the incorporation of lifestyle interventions. The study advocates for the establishment of defined instructional methods, improved adherence monitoring, and personalised treatment strategies to maximise patient outcomes and healthcare resource distribution. This thesis contributes to the ongoing efforts to improve the management of AF and provides a foundation for future research in the field.

# Chapter 1

# General Introduction

According to the European Society of Cardiology (ESC), AF is defined as supraventricular tachyarrhythmia (heart rhythm that originates above the ventricles, typically in the atria or atrioventricular node) with uncoordinated atrial electrical activation and consequently ineffective atrial contraction (Van et al., 2024). Irregularly irregular R-R intervals (when atrioventricular conduction is not impaired), absence of distinct repeating P waves, and irregular atrial activations are included in the electrocardiographic characteristics of AF (Van et al., 2024).

Structural and electrical remodelling in the atria interact in a complex manner resulting in AF. In atrial ion channel function, electrical remodelling is the process by which shortened action potential durations and reduced refractoriness arise from changes in atrial ion channel activity, therefore enabling the development of re-entrant circuits, a feature of AF. Characterised by fibrosis and atrial dilatation, structural remodelling disturbs normal electrical conduction pathways, increasing arrhythmogenic activity (Shu et al., 2023).

Atrial fibrosis is predominantly caused by inflammatory cytokines (Nattel et al., 2020). Oxidative stress damages atrial tissue and aggravates remodelling. Heritable forms of AF involve genetic mutations in ion channel-related genes.

Furthermore, contributing to arrhythmic activity in atrial myocytes are changes in calcium management. Calcium signalling that is disrupted raises sensitivity to triggered events like ectopic beats, which can initiate AF (Nattel et al., 2020).

Over the past three decades, the prevalence of AF has seen a notable rise globally. More than 52 million people are living with AF as of 2021, a clear increase from past years. Population ageing, rising prevalence of risk factors like obesity and hypertension, and better diagnostic techniques, all help to explain this trend. Approximately 4.48 million new cases of AF were registered globally in 2021, marking a 124% increase since 1990.

The burden of AF varies noticeably depending on geography. High-income nations, in Europe and North America, report higher prevalence rates mostly because of efficient screening systems and broad access to healthcare facilities. These areas benefit from advanced diagnostic tools that improve AF identification even in asymptomatic individuals. On the other hand, low and middle-income nations report rather low numbers of AF cases (Cheng et al., 2024).

The ESC classifies AF into 3 types-

- Paroxysmal AF- AF which terminates spontaneously within 7 days or with the assistance of an intervention.
- Persistent AF- AF episodes which are not self-terminating. Long-standing persistent AF is defined as continuous AF of at least 12 months' duration but where rhythm control is still a treatment option in selected patients.
- Permanent AF- AF for which no further attempts at restoration of sinus rhythm are planned, after a shared decision between the patient and physician (Van et al., 2024).

Emphasising a thorough and personalised approach to patient care, the 2024 ESC guidelines for the management of AF developed the AF-CARE framework, which includes-

- [C] Comorbidity and risk factor management
- [A] Avoid stroke and thromboembolism
- [R] Reduce symptoms by rate and rhythm control
- [E] Evaluation and dynamic reassessment

Using the AF-CARE approach, lifestyle advice is important in controlling AF and thereby enhancing patient outcomes. Giving psychosocial support to meet the psychological and emotional difficulties related to AF is given great importance so that patients feel supported all during their treatment journey. Patients, their families,

and carers are all important targets for education and awareness campaigns that aim to raise understanding of the condition, get people to follow treatment plans, and get them involved in their own care. It is also important for primary care physicians and specialised AF care teams to work together to make sure that patients get the same level of care throughout their treatment. This includes early interventions and careful management that is tailored to each patient's needs (Van et al., 2024).

AF is one of the most significant risk factors for stroke (Lip and Lim, 2007). Individuals with AF have roughly a fivefold increased risk of experiencing a stroke in comparison to individuals who do not have the condition. AF is a condition which allows blood to accumulate and become stagnant in the atria (Wang et al., 2021). This stagnant blood can potentially contribute to the formation of blood clots. When these blood clots dislodge, they can travel to the brain, and have the potential to block blood flow, leading to a stroke. Appropriate usage of anticoagulant treatments can decrease the likelihood of stroke in patients with AF by as much as 70% (Wang et al., 2021).

AF also elevates the risk of myocardial infarction (MI). This condition can worsen underlying coronary artery disease, resulting in decreased blood flow to the heart muscle and potentially triggering MI. AF frequently coexists with other cardiac disorders, such as coronary artery disease and heart failure, hence augmenting the likelihood of MI (Ruddox et al., 2017).

Long-term therapy with anticoagulants is usually advised to reduce these risks, particularly for patients with other risk factors for stroke. The earliest anticoagulants established for the treatment of patients with AF were VKAs, such as warfarin, which roughly lower stroke risk by 64%. Still a major issue in AF treatment is that their use raises bleeding risks. Recently, non-vitamin K antagonist oral anticoagulants (NOACs) have been developed with benefits including the elimination of regular

coagulation monitoring and a more favourable bleeding profile. NOACs nevertheless carry a risk of bleeding, despite their advantages over VKAs. Bleeding events can range from minor complications like bruising to major complications, including potentially fatal ones like cerebral haemorrhage (López-López et al., 2017).

Effective patient education is essential for management of chronic conditions, including AF. Patients with a formal education are more likely to follow their advised treatment plans, make sensible lifestyle adjustments, and promptly spot the early stages of problems. By using this preventive strategy, hospital admissions will considerably decrease, and general health outcomes will improve. Studies show how important continuous patient education is to help patients to better control their conditions and let them to actively engage in their treatment. Important tools in this learning process are materials including educational leaflets, videos, and organised courses (Cullen et al., 2022).

Physician education is crucial in enhancing patient outcomes (Heidbuchel et al., 2018). Providing evidence-based practice training to healthcare workers guarantees that they can deliver the utmost quality of treatment (Lehane et al., 2019). Continuous medical education (CME) is crucial for ensuring that clinicians stay informed about the most current treatment protocols and optimal approaches to patient management (Reis et al., 2022). Effective communication and patient-centred treatment must first take front stage in physician education to build trust and raise patient satisfaction (Lehane et al., 2019).

Combining physician and patient education produces an overlapping impact which raises the overall quality of healthcare. Highly educated physicians are better suited to properly present complex medical information to patients, while informed patients can participate actively in their treatment plans. This cooperative approach not only enhances the patient experience but also improves clinical outcomes, hence raising

their degree of satisfaction and enhancing adherence to recommended therapies (Cullen et al., 2022).

Research has found significant inadequacies in the knowledge and understanding of AF among both patients and medical professionals. An important concern is that a significant number of patients have limited understanding of their disease, which is essential for successful self-care. Insufficient understanding frequently results in inadequate compliance with medicine and less than ideal adjustments to one's lifestyle (Cullen et al., 2022).

Healthcare professionals, such as nurses and physicians, frequently also demonstrate deficiencies in their comprehension and application of optimal strategies for managing AF, notably in areas such as anticoagulant therapies and the utilisation of risk assessment tools (Cullen et al., 2022).

There are clear deficiencies in the management in AF in various aspects, such as the execution of clinical recommendations and the application of risk assessment tools. Although the ESC and the American Heart Association (AHA) have provided comprehensive guidelines, there is a significant disparity between the recommended standards and the real-world implementation in clinical practice (Van et al., 2024; Joglar et al., 2023). Tools such as the CHA2DS2-VASc score for assessing stroke risk and the HAS-BLED and now ORBIT score for evaluating bleeding risk are not being used enough, resulting in inconsistent and occasionally insufficient patient management (Heidbuchel et al., 20 18).

These shortcomings in management and education help to explain the higher frequency of hospitalisations and unsatisfactory results in AF patients. Improving patient education, as well as professional adherence to standards will help to address these gaps. Possible interventions may involve implementing structured educational programs for patients and providing CME for healthcare professionals,

with a specific emphasis on the most up-to-date evidence-based practices and guideline revisions (Lehane et al., 2019).

Communication between primary care physicians and cardiologists is a major issue. Often, this lack of cooperation produces inconsistent messaging and inadequate patient information. Good patient education depends on constant communication among all the medical professionals engaged in patient treatment. Usually time-limited consultations constrain the information physicians may provide to patients (Amin et al, 2024). Sometimes routine consultations lack enough time for symptom management, medication adherence, and lifestyle adjustments, given the complexity of AF and the need for patients to understand their condition (Agarwal et al., 2017).

The ability of the patients with AF to understand and manage their illness depends on their health literacy. Some patients have trouble understanding medical jargon and treatment implications. Personalised instructions consider the patient demands and how they comprehend (Qvist et al., 2023).

Educational resources including leaflets, videos, and structured programs differ by healthcare context (Little et al., 2024; Kirsty M, 2020; Wang et al., 2023). Some providers may not have high-quality teaching materials or the training to use them. This may prevent patients from acquiring the information they need to manage their AF (Agarwal et al., 2017).

Patients can be difficult to involve in their care. Some patients may be uncomfortable asking questions or addressing their problems with their physician. This can cause confusion and poor treatment compliance. Promoting patient engagement and fostering a supportive environment are essential for effective education (Qvist et al., 2023)

A complete strategy including teaching patients, as well as physicians is required to solve the treatment and educational shortcomings in AF. Strict adherence to clinical

guidelines and demanding training programs will help to reduce the load of AF on the healthcare system and significantly improve patient outcomes (Hindricks et al., 2020). Furthermore, it necessitates a comprehensive approach that includes improved physician communication, providing more time for patient education, employing specialised teaching methodologies, ensuring the availability of outstanding instructional materials, and encouraging patient participation. Overcoming these issues will allow clinicians to improve the effectiveness of patient education, resulting in better AF management and patient outcomes (Silistraru, 2020).

**Aim and objectives of current study**

The aim of this thesis is to evaluate the effectiveness of patient awareness and understanding of AF, management provided by cardiology physicians in reducing hospitalisations due to AF, and to identify the challenges faced by the cardiology physicians in providing adequate support and education to these patients.

To achieve the aim of the study, following objectives have been incorporated:

1. To conduct a prospective survey to gather information on the awareness level, lifestyle habits, medication adherence and hospitalisation due to irregular heartbeat among AF patients.
2. To analyse the approach advocated by cardiology physicians in providing care to AF patients, which includes diagnostic and therapeutic interventions and patient education

# Chapter 2

# Review of Literature

## 2.1 Incidence and prevalence of atrial fibrillation

The prevalence of AF has been increasing for decades in the developed world (Krijthe et al., 2013). Based on a meta-analysis of 11 studies examining the prevalence of AF in the USA, as well as a multicentre study conducted in North America, Europe, and Asia, it was observed that individuals of white ethnicity had a greater prevalence of AF compared to their African, Asian, and Hispanic counterparts (Zulkifly et al., 2018). In this study incidence among individuals of Caucasian descent varied from 2.5 to 42%. The percentage was lower among Afro-Caribbeans, with the range being from 1.7% to 21%. Prevalence rates in East Asians were recorded in only 3 studies, with a range of 3.9% to 10.1%. Only one study has assessed the prevalence of AF in the Hispanic population, with a prevalence rate of 3.9% (Chahal et al., 2019). Moreover, based on 10 meta-analyses conducted on African Americans, it was shown that being of African American descent conferred a "protective effect" against AF (OR 0.51, 95% CI 0.44 - 0.59, P<0.001).

The number of patients diagnosed with AF in the United Kingdom (UK) has increased by 50% in ten years, from one million in 2013 to more than 1.5 million in 2023. This means that nearly one out of every 45 people are affected by this condition (Slater, 2023).

In 2020, about 50 million people around the world were suffering from AF. In the United States alone, 5.6 million people were said to have AF in 2015, and about 11% of these cases were not identified. It is expected that the number of people with AF will significantly increase. Between 2010 and 2030, the number of people with AF is expected to double, while the incidence rate of AF in the United States is expected to be 2.6 million in 2030 (Joglar et al., 2023).

Scientists from Asia became curious about the differences between the Asian population and those of Australia, Europe, and the USA, which motivated them to

probe this field of study deeper. Given the existence of 5.98% of South Asian origin residents in Leeds, England, a study was carried out on the people there from January 1, 2006, to December 31, 2016. In a retrospective study, all the Caucasian and South Asian patients having a cardiac implantable electronic device (CIED) were assessed (O'Neill et al., 2018). Later echocardiograms showed that those with South Asian backgrounds had smaller left atrial volumes than those of Caucasian backgrounds This difference might explain why South Asians have a lower likelihood of developing atrial arrythmias (O'Neill et al., 2018).

During the period from August 2004 to September 2007, a total of 458 individuals who were in good health participated in the echocardiogram component of the London Life Sciences Prospective Population (LOLIPOP) project (Chahal et al., 2019). Research revealed that Indian Asians exhibited a greater body mass index (BMI), elevated levels of fasting triglycerides, lower levels of HDL-cholesterol, a higher occurrence of hypertension, diabetes mellitus (DM), and ischemic heart disease. However, AF was less prevalent in this community. One possible explanation is that Indian Asians exhibited reduced mitral annular systolic velocity (8.9 cm/s vs 9.5 cm/s, $p<0.001$), decreased mitral annular early diastolic velocity (10.3 cm/s vs 11 cm/s, $p<0.001$), and an elevated E/Ea ratio (7.9 vs 7.0, $p<0.001$) in comparison to Caucasians (Chahal et al., 2019).

Another possible explanation is that a smaller proportion of individuals from South Asian backgrounds seek out medical services. The English NHS Bowel Cancer Screening Programme conducted a study in 2013 from May to December (Palmer et al., 2015). It was observed that South Asians exhibited a lower frequency of hospital utilisation. The cause of this was determined to be the constraints imposed by written English, dependence on younger relatives, and limited awareness. Hence, under detection of AF might also be an issue.

## 2.2 Risk factors for atrial fibrillation

AF is a complex condition influenced by several modifiable and non-modifiable risk factors interacting to disturb normal heart rhythm. The onset and course of AF are greatly affected by modifiable risk factors including hypertension, obesity, diabetes, and lifestyle choices including smoking, alcohol use, and quality of sleep. These elements work through atrial remodelling, fibrosis, and electrical conduction problems. Age, declining renal function, and non-modifiable risk factors including surgical procedures like coronary artery bypass grafting underline the multifaceted character of AF. These several risk variables, their underlying causes, and their combined influence on the worldwide AF burden are discussed in this section.

There are many modifiable risk factors which have been discovered, the most common ones are discussed below.

### 2.2.1 Hypertension

The ESC, in its 2024 guidelines has defined hypertension as a persistent elevation in systolic blood pressure (BP) of ≥140 mmHg and/or diastolic BP of ≥90 mmHg. They have, however, added a new category for 'elevated BP', described as a BP 120-139/70-89 mmHg (John William McEvoy et al., 2024).

According to a cohort study that included 14958 people of middle-age from the Atherosclerosis Risk in Communities (ARIC) study, it was seen that after a mean follow up of 17.1 years, 1520 cases of AF were identified. Out of all risk factors identified, high BP was seen in 38.7% of the entire cohort and accounted for 21.6% (95% CI:16.8-26.7) of the incident cases of AF, making it the most common risk factor (Huxley et al., 2011; Lopez, et al., 2011).

Atrial remodelling is a process in which chronic hypertension leads to the

enlargement and fibrosis of the atria (Huxley et al., 2011; Cheng et al., 2024). The structural abnormalities interfere with the usual electrical conduction pathways in the atria, leading to a favourable setting for the occurrence of AF.

Hypertension causes considerable changes in the electrical characteristics of atrial cells, which is known as electrical remodelling (Hindricks et al., 2020). This encompasses alterations in ion channel functionality, resulting in a deceleration of the transmission of electrical signals across the atria, hence augmenting the probability of the irregular electrical behaviour that is typical of AF.

Atrial fibrosis and disturbance of electrical conduction follow from inflammation and oxidative stress brought on by hypertension. This raises the probability of developing AF. Furthermore, neurohormonal activation, which is underlined as a component causing atrial remodelling and fibrosis in hypertensive individuals, particularly via the renin-angiotensin-aldosterone system (RAAS) (Gawałko and Linz, 2022).

### 2.2.2 Obesity

Through multiple mechanisms, obesity contributes to the development of AF including systemic inflammation, oxidative stress, and the accumulation of epicardial adipose tissue (EAT) (Shu et al, 2023). These factors contribute to change the structure and electrical characteristics of the atria, therefore facilitating the start and continuation of AF. Strongly linked with atrial fibrosis and issues in electrical conduction, the EAT lies between the visceral pericardium and the heart. Independent of other cardiovascular risk factors, higher EAT volume is associated with increased incidence and intensity of AF (Alijla et al., 2021).

Obstructive sleep apnoea (OSA), a condition associated with obesity, results in recurring periods of hypoxia during sleep, leading to recurrent stimulation of the sympathetic nervous system (Genuardi et al., 2019; Jaspan et al., 2024). Excessive

stimulation causes the BP and pulse rate to rise, therefore stressing the heart, particularly, the atria. This stress over time helps to cause atrial enlargement and remodelling, which are important causes of AF onset and continuation.

OSA not only causes anatomical alterations but also leads to conduction anomalies in the atria. Hypoxic episodes that occur in OSA slow down the speed at which electrical signals go through the atrial tissue and increase the variation in conduction. This disturbance offers an optimal setting for the irregular electrical signals that are typical of AF. In addition, hypoxia caused by OSA can lead to ischaemia in the atrial myocardium, further increasing the risk of AF (Shu et al., 2023).

### 2.2.3 Diabetes

DM is a group of metabolic disorders in which persistent hyperglycaemia (random plasma glucose more than 11.1 mmol/L) is caused by deficient insulin secretion, resistance to the action of insulin, or both (NICE,2024).

Diabetes and pre-diabetes have been shown to increase the incidence of AF by 28% and 20% respectively. A meta-analysis of 31 prospective studies concluded that the relative risk per 20 mg/dl (=1.11 mmol/L) increase in blood glucose was 1.11(95% CI:1.04-1.18) (Aune et al., 2018).

Another meta-analysis of 7 cohort studies and 4 case-control studies in Japan and North America indicated that patients with DM had an approximate 40% increased risk of developing AF compared to unaffected patients. (RR 1.39, 95% CI, p for heterogeneity <0.001) (Huxley et al., 2011; Filion et al., 2011).

Diabetes primarily impacts the heart by stimulating the development of atrial fibrosis. This process entails the enlargement and hardening of the walls of the atria because of the excessive accumulation of proteins in the extracellular matrix (Alijla et al., 2021). Multiple factors related to diabetes, such as persistent inflammation,

advanced glycation end products, and the initiation of the TGF-β/Smad signalling pathway, play a role in the formation of fibrosis. These factors jointly enhance the risk of AF by modifying the anatomical and functional characteristics of the atria, rendering them susceptible to irregular electrical activity.

Another important mechanism is electrical remodelling. Diabetes alters the electrical properties of atrial cells, including extended atrial conduction time and increased atrial effective refractory period (Alijla et al., 2021). The normal flow of electrical signals in the heart is disrupted by these alterations, which creates conditions that support the initiation and maintenance of AF. Additionally, diabetes may disrupt the equilibrium of the autonomic nervous system, which in turn affects the nerve activity of the sympathetic and parasympathetic systems. This increases the risk of AF.

Inflammation and oxidative stress are also major causes of AF in individuals with diabetes. Chronic hyperglycaemia in diabetes causes a pro-inflammatory response and increased oxidative stress, which promotes atrial remodelling and fibrosis. Pro-inflammatory cytokines and reactive oxygen species play essential roles in these processes, making the atria more susceptible to developing AF (Alijla et al., 2021).

### 2.2.4 Alcohol

Alcohol consumption has also been known to increase the risk of AF. In fact, acute alcohol intake causing AF has been described as the term ‘Holiday Heart Syndrome’ (Shamloo et al., 2019). By reducing the atrial action potential and effective refractory period and so encouraging re-entrant circuits in the heart, acute alcohol ingestion can act as a trigger for AF. Long-term alcohol usage causes structural changes including fibrosis and atrial enlargement that aggravates AF risk. Furthermore, alcohol can affect the autonomic nervous system, which causes vagal activation and sympathetic stimulation, both of which aggravate AF. Furthermore, aggravating

these consequences are electrolyte imbalances and oxidative damage (Jiang et al., 2022).

The National Health Service (NHS) recommends consuming not more than 14 units of alcohol in a week, with each unit equalling 10ml or 8 g of pure alcohol (NHS, 2021).

A meta-analysis of 13 prospective studies on about 645,826 participants reveals a non-linear positive correlation between alcohol consumption and the risk of AF (Zhang et al., 2022). Excessive alcohol consumption, characterised as exceeding 5 units daily, was correlated with a significantly higher risk of AF, evidenced by a pooled hazard ratio (HR) of 1.30, indicating a clear association between high alcohol intake and atrial dysfunction. Moderate alcohol intake, defined as 1.5–3 units daily, increased the risk of AF in males (HR: 1.21) but not in females, indicating gender-specific variations in alcohol metabolism and its effects on atrial function. Conversely, minimal alcohol intake, not exceeding 1.5 units daily, did not markedly increase the risk of AF, suggesting that this quantity may be a safe limit for mitigating harm (Zhang et al., 2022).

Another prospective meta-analysis of about 79,000 healthy Swedish people between 1998 to 2009 showed that considering 1 drink contains 1.5 units of alcohol (12 g of alcohol), and when compared with current drinkers of <1 drink/week (<1.5 units/week), for 2 to 6 drinks/week (3 to 9 units/week), the relative risk (RR) of AF was 1.01 (95% CI: 0.94 to 1.09). For 7 to 14 drinks/week (10.5 to 21 units/week), the RR increased to 1.07 (95% CI: 0.98 to 1.17). For 15 to 21 drinks/week (22.5 to 31.5 units/week), the RR was 1.14 (95% CI: 1.01 to 1.28). For >21 drinks per week (>31.5 units/week), the RR increased to 1.39 (95% CI: 1.22 to 1.58). Thus, even moderate alcohol consumption is a risk factor for AF (Larsson et al., 2014).

### 2.2.5 Smoking

Smoking is also considered to be an important risk factor in developing AF. According to the Rotterdam study done in the residents of Ommoord, Netherlands aged equal to or more than 55 years, the ones who were current smokers had a RR of 1.51 (95% CI:1.07 to 2.12) and the ones who used to smoke in the past had a RR of 1.49 (95% CI: 1.14 to 1.97) of getting AF. This was a result of a median follow-up of 7.2 years, identification of 371 cases of AF and multivariate adjustment of other factors like age, gender, BMI, hypertension, serum cholesterol level, DM, prevalent heart diseases and current usage of pulmonary medications (Heeringa et al., 2008). Nicotine causes fibrous tissue in the atrial area to develop, which results in abnormal electrical conduction and provides a substrate for arrhythmias, including AF. Individuals already suffering from cardiovascular problems are impacted more by this phenomenon since nicotine increases the risk of AF development.

Another crucial process is the influence of oxidative stress and carbon monoxide (CO), which is found in cigarette smoke, in the promotion of cardiac arrhythmias (D'Alessandro et al., 2011). Oxidative stress causes myocardial damage, which leads to changes in the structure of the atria and raises the chances of developing AF. Particularly in cases of ischaemia, CO reduces the capacity to transport oxygen, therefore aggravating cardiac stress and increasing the risk of arrhythmias.

Another cause of autonomic dysfunction is smoking. Nicotine triggers the sympathetic nervous system, resulting in an increase in heart rate, resulting in vulnerability to arrhythmias. A major factor increasing the incidence of AF is smoking disrupting the balance between the sympathetic and parasympathetic nerve systems (D'Alessandro et al., 2011).

### 2.2.6 Poor sleep

Poor sleep has been associated with AF. To confirm this hypothesis, polysomnography studies were done at the Pittsburgh Medical Centre sleep laboratories between March 1999 and December 2015. After adjusting for other factors, it was found that every 1-hour reduction in sleep duration increased the risk of developing AF by 1.17-fold (95%CI: 1.11 to 1.30) (Genuardi et al., 2019).

One important influence is the disturbance of the autonomic nerve system brought on by either insufficient or poor quality of sleep (Jaspan et al., 2024). Reduced activity of the parasympathetic system and increased activity of the sympathetic nervous system follow from disturbance of sleep. Increased heart rate and BP resulting from this difference are important risk factors for AF.

Endothelial cells, found along the inner lining of blood vessels, have a vital function in maintaining vascular well-being by controlling blood circulation and inhibiting the formation of blood clots.

Insufficient sleep causes endothelial dysfunction, marked by a drop in the availability of nitric oxide and an increase in oxidative stress. By encouraging atrial fibrosis and inflammation, which change the electrical conduction pathways in the heart, this dysfunction can lead to the development of AF.

Another essential step is systematic inflammation. Insufficient sleep causes the synthesis of inflammatory cytokines, notably interleukin-6 (IL-6) and tumours necrosis factor-alpha (TNF-α). Atrial remodelling and the start of AF are associated with these cytokines. Poor sleep causes persistent inflammation that produces a pro-arrhythmic milieu in the atria, increasing the heart's sensitivity to the erratic electrical impulses characterising AF (Jaspan et al., 2024).

### 2.2.7 Long working hours

The connection between AF risk and working hours was explored in a multi-cohort study published in the European Heart Journal (Kivimaki et al.,2017). The researchers examined data from the Individual-Participant-Data Meta-analysis in Working Populations (IPD-Work) Consortium, which included 85,494 people from the UK, Denmark, Sweden, and Finland. Participants did not have AF at baseline, and their working hours were measured between 1991 and 2004. The participants were monitored for an average of ten years, during which time 1,061 new AF cases were identified.

The data show that people who worked 55 or more hours per week were 40% more likely to develop AF than those who worked lesser hours (35-40 hours per week). Despite the adjustment for potential confounding factors, such as age, sex, socioeconomic status, obesity, excessive alcohol consumption, and elevated blood pressure, this association remained statistically significant (Kivimaki et al.,2017). Chronic stress is associated with prolonged working hours. This stress activates the autonomic nervous system, particularly increasing sympathetic nervous activity while decreasing parasympathetic activity. This imbalance can lead to arrhythmogenic conditions in the heart, making it more susceptible to the development of AF. Moreover, inflammation and endothelial dysfunction results in AF, which is brought about by prolonged working hours. Raised inflammatory marker levels cause systematic inflammation brought on by prolonged stress. This can drive atrial remodelling and fibrosis. These structural changes in the heart increase AF risk. Moreover linked with other lifestyle choices such physical inactivity, poor food, smoking, and excessive alcohol intake are extended working hours. These behaviours exacerbate the risk of AF by contributing to conditions like hypertension and obesity, which are established risk factors for AF (Kivimaki et al., 2017).

### 2.2.8 Rigorous exercise

Although exercise and other physical activities are known to be of benefit in cardiovascular diseases, a study has shown that vigorous endurance programs and high-performance endurance training in young individuals increase their chances of getting AF (Miguel-dos-Santos et al., 2021). In a prospective, age and sex-matched case-control analysis done in a hospital setting between January 2001 and June 2005, patients were divided into 4 groups- sedentary, light, moderate and heavy exercise activities. It was seen that while the odds ratio for the ones whose physical activity ranged from 0-2077 hours, accounting to 0 to 8.9 hours/week, between January 2001 to June 2005 was 1, it was 5.60 (95% CI: 1.59-19.75) for people who worked out for 2078-9318 hours (8.9 to 39.8 hours/week) within the same timeframe. Lastly, the odds ratio of developing AF for people having a physical activity of >9319 hours (>39.8 hours/week) was 15.11(95% CI: 3.75-60.83) within the same timeframe (Miguel-dos-Santos et al., 2021).

One important mechanism by which long-term, intense exercise alters the heart structurally is atrial remodelling, which produces fibrosis and atrial hypertrophy (Van et al., 2024).These changes can influence the normal flow of electrical signals in the atria, hence increasing their sensitivity to the irregular electrical impulses typical of AF.

The high vagal tone often found in athletes, especially when they are at rest, is another factor influencing this phenomenon. Although a higher vagal tone can have positive effects on heart health, it can also make the heart more susceptible to AF by reducing the heart rate and raising the chances of electrical re-entry circuits forming in the atria (Van et al., 2024).

In addition, intense physical activity can lead to oxidative stress and inflammation, both of which contribute to atrial remodelling and the onset of AF. Studies have

shown that those who have participated in endurance sports for an extended duration are more likely to develop AF than the general population. Nonetheless, this heightened risk is typically eclipsed by the overall beneficial effects of consistent physical exercise on cardiovascular health (Van et al., 2024).

Thus, while exercise is generally beneficial, the intensity and duration of physical activity should be balanced, particularly in individuals at risk of AF.

There are a couple of non-modifiable risk factors associated with AF.

### 2.2.9 Age

Age-associated atrial remodelling is a key factor contributing to elevated AF risk. As individuals age, the atria experience structural alterations including fibrosis, dilatation, and deterioration of atrial tissue integrity, which increases the susceptibility of the heart to arrhythmias such as AF (Chung et al., 2020). It has been shown that the risk of AF doubles with each decade. According to the Rotterdam study performed between July 1993 and December 1994 and April 1997 and December 1999, it was shown that in a population of 6,432 people, about 1.1% of the people within the age group 55-59 had developed AF (95%CI: 0.3-2.9). The percentage increased with each stratum and for people aged >85 years, the incidence rate rose to 18.2% (95% CI: 14.0-23.3) (Heeringa et al., 2016). Older adults often have heightened vagal activity, which can trigger AF, especially during periods of physical or emotional stress (Chung et al., 2020).

### 2.2.10 Chronic kidney disease

Worsening renal function often leads to electrolyte disturbances, especially hyperkalaemia and hypomagnesemia, which have been shown to predispose to AF by increasing atria excitability and promoting abnormal conduction (Rehm et al., 2021). It was seen that patients with end-stage renal disease had a higher incidence

rate of AF. According to a literature search that was done using EMBASE and Medline between 1990 and 2011, it was seen that the risk of mortality and stroke in end-stage renal disease patients with AF was 26.9 and 5.2/100 patients/ years, respectively. Interestingly, the risk of mortality and stroke in the same category of patients without AF was 13.4 and 1.9/100 patients/ years, respectively (Zimmerman et al., 2012). Systemic inflammation is a hallmark of chronic kidney disease (CKD), and it contributes to atrial fibrosis and the electrical remodelling of the heart. Cytokines like TNF-α, IL-6, and C-reactive protein (CRP) are elevated in kidney dysfunction and can lead to the activation of pathways that increases the risk of AF (McManus et al., 2012).

### 2.2.11 Genetic factor

A study by Seung Hoan Choi et al. looked at the relationship between early-onset AF and genetic variations, especially loss-of- function (LOF) mutations in the TTN gene (producing the titin protein). TTN LOF mutations were significantly linked to early-onset AF in 2,700 cases, implying a hereditary tendency (Seung Hoan Choi et al., 2018).

According to a prospective observational cohort study, LOF in TTN gene was found in 2.1% of all patients with early-onset AF. The prevalence of these variants increased to 6.5% in patients diagnosed with AF before the age of 30 years (Yoneda et al., 2021).

Furthermore, in a genetic association study involving whole-exome sequencing and a case-control approach, rare truncating variants in TTN gene (TTNtvs) were found to be carried by 4.7% of early-onset lone AF patients. Additionally, in families with multiple members affected by AF, 16.7% of the affected family members had TTNtvs (Ahlberg et al., 2018). TTNtv was found to increase susceptibility to arrhythmias in

both atrial and ventricular patient-derived induced pluripotent stem cells (iPSC)-derived cardiomyocytes, with a higher prevalence of arrhythmogenic phenotypes observed under pacing (Huang et al., 2025).

Rare missense variants in the TTN gene (TTNmvs), particularly the T32756I variant, are linked to an increased risk of AF (Pavel et al., 2024). This mutation alters cardiac contractility and ion channel activity, particularly increasing the potassium ion current, which could contribute to AF.

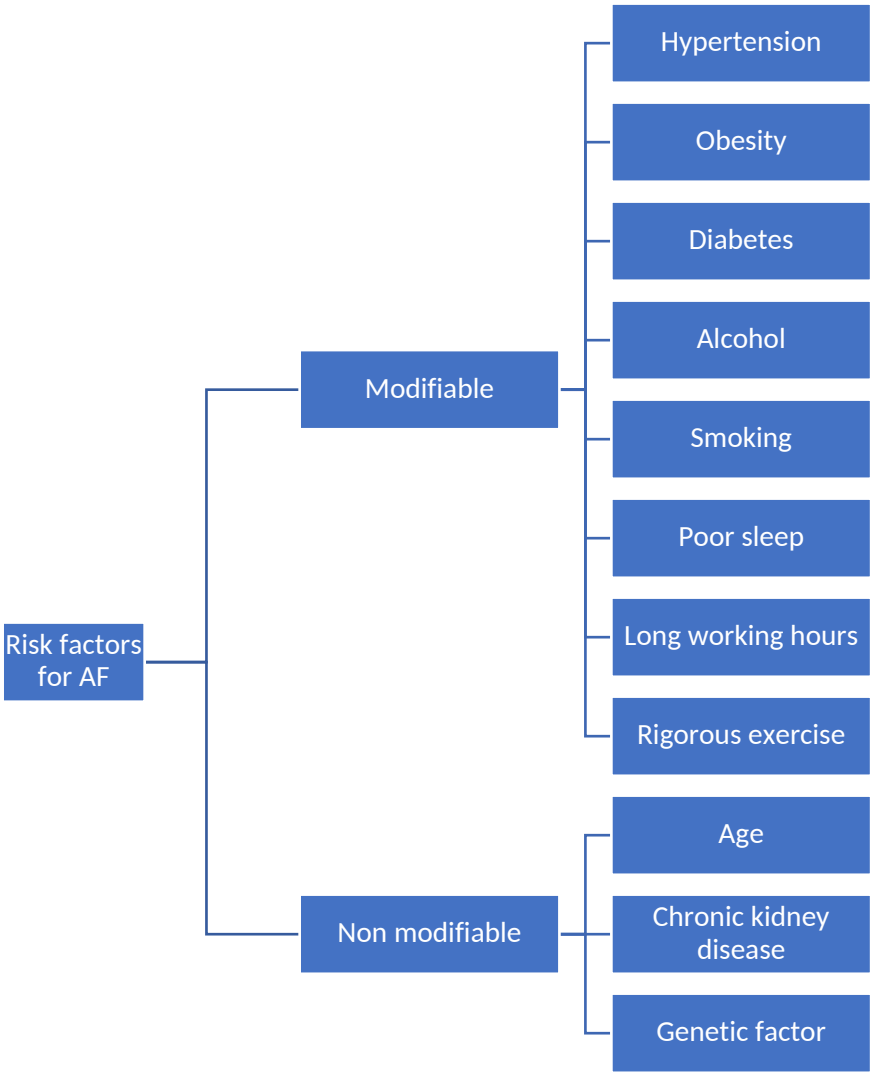


**Figure number 01: Comprehensive flowchart of modifiable and non-modifiable risk factors contributing to AF development:** The flowchart groups the risk factors for AF into both modifiable and non-modifiable categories. Conditions and behaviours that can be controlled or changed to lower AF risk are modifiable risk

factors including hypertension, obesity, diabetes, alcohol use, smoking, poor sleep, long working hours, and intense exercise. Age, chronic kidney disease and genetic factors are among non-modifiable risk factors, which are, natural or procedural elements that increase AF risk but are not under control.

## 2.3 Lifestyle modifications and their effects on atrial fibrillation

### 2.3.1 Mediterranean-style diet

It has been reported that taking a Mediterranean-style diet lowers the chances of getting AF. In a case-control study of 800 people, out of which 400 were patients with AF, it was seen that those who were in the highest quartile of the Mediterranean score had an increased chance of spontaneous conversion of AF (OR 1.9, 95% CI: 1.58-2.81) (Mattioli et al., 2013).

It helps in reducing the effects of oxidative damage and inflammation. Foods such as olive oil, fruits, and vegetables contain a significant number of antioxidants and polyphenols. These substances are effective in counteracting free radicals and minimising oxidative harm to the heart tissues. This is crucial since such damage can contribute to atrial remodelling and fibrosis, which are important factors in the progression of AF (Estruch et al., 2013).

In addition, the Mediterranean diet enhances endothelial function and decreases the probability of arterial stiffness and hypertension, both of which are substantial risk factors for AF. The diet prioritises the consumption of good fats, specifically from sources such as olive oil and nuts. This promotes improved lipid profiles and decreases the occurrence of systemic inflammation, which is a contributing factor to AF (Estruch et al., 2013).

Studies, such as the Prevention of recurrent arrhythmias with Mediterranean diet (PREDIMAR) trial, has shown that following a Mediterranean diet can effectively

decrease the likelihood of AF recurring in patients who have undergone procedures like catheter ablation (María Teresa Barrio-Lopez et al., 2023). This suggests that the diet not only prevents AF but also helps in its treatment.

### 2.3.2 Consumption of extra virgin olive oil

The protective mechanism of extra virgin olive oil (EVOO) against AF is attributed to its rich content of polyphenols and monounsaturated fatty acids, which exert anti-inflammatory and antioxidant effects (Schwingshackl and Hoffmann, 2014). These compounds reduce systemic inflammation and oxidative stress, both of which are critical factors in atrial remodelling and the development of AF. EVOO also enhances endothelial function, improving vascular health and reducing arrhythmogenic substrates. Additionally, it supports a favourable lipid profile by lowering LDL cholesterol and maintaining HDL cholesterol, which helps prevent atherosclerosis and related complications, indirectly mitigating AF risk (Schwingshackl and Hoffmann, 2014). In another study done in Spain, it was discovered that consuming EVOO reduces the probability of getting AF. This was a multi-centre trial done in 7,447 people who had not been diagnosed with AF but had a high cardiovascular risk due to other factors such as type 2 DM, cigarette smoking, hypertension and obesity. They were divided into 3 groups. One group was given a Mediterranean diet supplemented with EVOO. The second group was given Mediterranean diet and nuts, while the third group was just given advice to stop all kinds of fat. After a median follow-up of 4.7 years and been given a goal of consuming at least 50g of olive oil every day, it was seen that the AF rate for the first group was 6.8 per 1000 person years (HR 0.62, 95% CI: 0.45-0.85, p=0.003). In comparison, the other two groups had AF rates of 9.9 and 10.1 per 1000 person years respectively (HR 0.89, 95% CI: 0.65-1.20, p=0.43) (Martínez-González et al., 2014).

### 2.3.3 Reducing alcohol consumption

Drinking has been a huge cause for concern in the West. About 57% of American adults drink on a regular basis. This is due to a perception that a modest intake is cardio protective (Larsson et al., 2014). There was a multicentre, randomised controlled trial done in 6 hospitals in Australia (Voskoboinik et al., 2020). Out of the 140 patients with AF involved in the trial, 70 were in the abstinence group and had reduced their alcohol intake from 16.8 +/- 7.7 to 2.1 +/- 3.7 units /week (a reduction of 87.5%). The other 70 were assigned to the control group and were told to reduce their alcohol intake from 16.4 +/-6.9 to 13.2 +/- 6.5 units /week (a reduction of 19.5%). A standard drink was defined as 12g of alcohol. After 2 weeks it was seen that AF recurred in 51 of the 70 patients (73%) in the second group. Meanwhile, it recurred in only 37 of the 70 patients (53%) in the control group (HR 0.55, 95%CI: 0.36-0.84, p = 0.005) (Voskoboinik et al., 2020).

### 2.3.4 Quitting smoking

Not only in AF, but in all cardiovascular diseases, smoking is considered to be a major risk factor (Tomioka et al., 2014). According to a retrospective cohort study done in 2372 newly diagnosed South Korean males with AF during 2003 to 2012, it was found that smoking cessation helps in lowering the risk of cardiovascular diseases after the diagnosis of AF (Choi et al., 2020). In this study, people were divided into 4 groups- continual smokers, quitters, sustained ex-smokers and ones that never smoked. The mean age of the subjects was 62.5 years. It was seen that the ones who had quit smoking, had a reduced risk of 35% of getting a cardiovascular disease (HR 0.65, 95% CI: 0.44-0.97). The ones who had never smoked were seen to have a reduced risk of 32% of developing cardiovascular diseases (HR 0.68, 95% CI: 0.52-0.90) (Choi et al., 2020).

### 2.3.5 Moderate exercise

A randomised controlled study examined the impact of yoga on quality of life, BP, and heart rate in people with paroxysmal AF (Wahlstrom et al., 2017). During a 12-week period, 80 participants were assigned to either a yoga group or a control group. The yoga group participated in weekly sessions emphasising gentle movements, respiratory exercises, and meditation, supplemented with home practice.

The research indicated substantial enhancements in mental health-related quality of life ($p < 0.001$) and overall perceived quality of life ($p < 0.001$) within the yoga cohort, but no alterations were noted in the control group. Moreover, yoga participants experienced a decrease in heart rate ($p = 0.024$), systolic BP ($p = 0.033$), and diastolic BP ($p < 0.001$). The data indicate that yoga improves mental well-being and reduces cardiovascular risks in people with paroxysmal AF (Wahlstrom et al., 2017).

A study explored the relationship between walking and the risk of cardiac arrhythmias, particularly AF (Williams and Franklin, 2013). In a substantial cohort of 46,807 people, followed for 6.2 years, it was found that walking markedly diminished the incidence of cardiac arrhythmias, yielding an 11.8% reduction in risk each metabolic equivalent hour per day (METhr/d) walked. The reduction was especially significant in individuals under 50 years of age, with a risk decrease of 21% per METhr/d (Williams and Franklin, 2013). A study assessed the association between long-term physical activity and the risk of AF in 11,828 people over a span of 24 years (Wang et al., 2024). It was determined that sustaining moderate physical activity significantly diminished the risk of AF by 39% in comparison to light activity, whereas a reduction in activity from moderate to light elevated the AF risk by 18%. These findings underscore the protective effect of consistent moderate exercise,

such as brisk walking, in preventing AF, especially in middle-aged and older demographics (Wang et al., 2024),

### 2.4 Patient education and its impact on healthcare outcomes

Patient education is an essential component of modern medical care, supporting its ability to improve clinical outcomes, increase patient autonomy, and optimise resource allocation (Qvist et al., 2023). Patient education, founded on the principles of evidence-based practice, goes beyond providing information to actively engaging individuals in their healthcare journey. It is a process that empowers patients by increasing their knowledge, encouraging informed decision-making, and providing them with the resources they need to properly manage their conditions. The dynamic relationship between education and healthcare outcomes emphasises its significance, especially in the management of chronic diseases, where adherence to complex medication regimens and lifestyle changes are critical.

With an emphasis towards medication adherence, creative teaching strategies, and resource optimisation, this section critically explores the significance of patient education in healthcare. It also evaluates the underlying barriers stopping effective education from being implemented, as well as the difficulties healthcare professionals face in delivering it. By means of a strong evidence-based perspective, this section aims to underline the relevance of patient education in creating a complete and fair healthcare system by analysing the interaction between patient education and healthcare outcomes.

#### 2.4.1 Compliance with medications

In a randomised and controlled study done in the medical department of University Hospital Dubrava, Zagreb between April and June 2018, 125 adult patients with Type 2 DM were randomly divided into 2 groups- intervention and control group (Marušić et

al., 2018. While both groups were given some basic education about the disease, the intervention group received some extra individual pre-discharge pharmacotherapeutic education regarding discharge prescriptions. After 30 days post-discharge, the adherence among patients in the intervention group was much higher, namely- 57 out of 64 (89.9%). Meanwhile 41 out of the 61 patients (67.2%) in the control group were adherent. It was thus seen that providing some pharmacotherapeutic education at a personal level to these patients improved their adherence (Marušić et al., 2018).

The synthesis of 17 systematic reviews shows that patient-oriented methods, like personalised education and counselling, greatly improve adherence by considering each person's unique needs and situations (Wilhelmsen and Eriksson, 2019). Personalised education, modifying the knowledge based on the patient's health issues, level of literacy, and culture, has been shown to raise medication adherence rates by 15–20% in people with long-term diseases like diabetes and high BP. Moreover, individual counselling has been shown to reduce problems linked to medications, with randomised studies of heart failure patients showing that they were up to 25% less likely to need to get readmitted in the hospital (Wilhelmsen and Eriksson, 2019).

Medication adherence and general health outcomes have showed tremendous potential from community pharmacist-led programs. A systematic review examined 22 trials and found that these therapies improved many chronic diseases, including hypertension, asthma, and chronic obstructive pulmonary disease (COPD). Behavioural results were striking, with about 61.5% of adherence-related outcomes showed statistically significant increase in favour of intervention groups. Consistent observations of clinically beneficial effects including improved BP and cholesterol control underlined the value of participation of chemists in controlling diseases (Milosavljevic et al., 2018).

A systematic review and meta-analysis looked at how Diabetes Self-Management Education and Support (DSMES) smartphone applications affect medication compliance of people with Type 2 DM and their health (Enricho et al., 2021). It looked at six randomised controlled trials with a total of 696 subjects. It found that DSMES applications greatly improved clinical metrics like glycated haemoglobin (HbA1c) and BMI, as well as people's adherence to their medications (standardised mean difference of 0.393). They used features like reminders, data tracking, and connecting with healthcare providers to improve adherence to medications and improve how they manage their diabetes. However, the review stressed on the need for larger trials with long-term follow-ups to confirm that these effects last and to learn more about how this technology can be used in managing chronic diseases (Enricho et al., 2021).

### 2.4.2 Innovative approaches in patient education

A systematic mixed studies evaluation conducted by Rush et al. examined the effectiveness of nurse-led AF clinics across institutions such as the University of British Columbia and the University of Medicine and Health Sciences in St. Kitts. The review, incorporating 17 moderate to high-quality publications sourced from Medline, CINAHL, and Embase, highlighted several successful strategies employed by these clinics. Central to the clinics' success was personalised education, where nurses tailored one-to-one sessions to address individual patient needs, focusing on understanding AF, recognising symptoms, and adhering to treatment plans. Additional educational resources included leaflets and booklets, alongside frequent follow-up calls and visits to reinforce patient involvement and educational messages (Rush et al., 2019). Self-management training, empowering patients to track symptoms, manage medications, and implement lifestyle changes, was a key feature. Many clinics also integrated digital tools, such as mobile applications and

educational websites, to support ongoing learning. The study revealed multiple positive outcomes linked to nurse-led AF clinics, including cost-effectiveness, reduced wait times, and fewer emergency room visits. Patient outcomes improved with superior symptom control, higher rates of normal sinus rhythm, better treatment adherence, and enhanced quality of life. Additionally, lower mortality rates were observed in patients under nurse-led care, which also ensured better adherence to clinical guidelines and enhanced the overall quality of care (Rush et al., 2019). A non-pharmacological clinical trial was conducted as a prospective, randomised, controlled, non-blind, multi-centre study in Portugal (Silva Caetano et al., 2018). It aimed to understand the effectiveness of leaflets containing important information on type 2 DM patients on control of the disease and adherence of medications. Out of the 1170 patients, 585 were given a validated leaflet, out of which 195 were given on diabetes, 195 were given on the treatment and the remaining 195 were given on the importance of physical activity. The other 585 were not given any leaflets and just received the usual care. Interestingly, out of all the patients, 1.7% were illiterate. The groups were further divided into 2 groups- <9 years of formal education and >9 years of formal education (Aune et al., 2018). It was seen that the leaflets that were on treatment appeared to be more beneficial for people who had undergone less schooling (Silva Caetano et al., 2018).

There have been researches in marketing and psychology that have indicated that we as humans have a cognitive preference for picture-based and not text-based information, which is called the “Picture superiority effect”. In a study conducted on 96 subjects by the department of Psychology in North Carolina state university, drug sheets of four types were created- text alone, pictorials alone, fully redundant texts and pictorials and text with one half of the instructions with pictorials and the other half with no instructions. After calculating the recall means, it was seen that the

highest score was for the ones who were in the text and pictorial group-9.1. Meanwhile, the lowest score was for the ones who were in the pictorials alone group(Katz et al., 2006; Sojourner & Wogalter, 1998).

Usually, liquids are the preferred mode of oral medication by doctors for young children and infants (Chan et al., 2015). But it is very common for the wrong dosage to be given by parents or caregivers. Hence, studies were done to check whether giving the information to the parents or caregivers through the mode of pictograms is beneficial. A total of 299 subjects were taken, out of which the intervention group of 155 subjects were given the dosing instructions using text-plus-pictogram, while the control group of 144 subjects were given text-only dosing instructions. It was seen that the intervention group made fewer errors (43.9%), when compared to the control group (59%) ($p=0.01$).

In another study of 245 parents and caregivers, the intervention group of 124 subjects were given the instructions using pictograms and the control group of 121 subjects were given standard medication counselling. It was later seen that the intervention group made fewer dosing errors for both medications taken daily and as needed (5.4% and 15.6% respectively, $p=0.001$), compared to the control group (47.8% and 40% respectively, $p= 0.003$) (Chan et al., 2015). Therefore, it can be said that if patients receive the information in a pictogram-plus-text format, there are higher chances of them being compliant with their medications.

### 2.4.3 Effect of patient education on reducing resource requirements

Reduction of hospital readmissions depends mostly on patient education. Effective patient education, particularly throughout the discharge process can significantly lower readmission rates by guaranteeing that patients fully understand their post-treatment instructions. Studies show that improving patient involvement and

communication might help to significantly lower readmissions, up to 45%. Important strategies include leveraging modern communication tools like SMS for continuous patient involvement and the 'teach-back' technique, which calls for patients to review their understanding of care instructions using their own language. This method not only helps healthcare personnel to assess and enhance patient understanding, therefore reducing the need for clinic visits and hospital readmissions, it also increases their knowledge (Artera, 2021).

It is imperative to enhance the health literacy of patients to alleviate the burden on hospitals in terms of resource maintenance. The term ‘health literacy’ refers to the extent to which individuals possess the ability to acquire, comprehend, and apply fundamental health information and services to make responsible health decisions. The MedEncentive Mutual Accountability and Information Therapy (MAIT) program is an internet-based patient-doctor aligned program, that is mobile-enabled and promotes patient education. An interactive user interface plays a major role in their education. They are usually prescribed educational articles, or the articles could be self-selected as well. They also must demonstrate what they have learnt through an open-book test. After a mixed methods study done over a 5-year period, on an 1800-member employee health plan of the same program, hospitalisations and emergency rooms visits decreased by 32% (26.5/82.4) and 14% (31.3/219.9) respectively (Greene et al., 2019).

An extensive analysis done on asthmatic children in south Texas, found that educating the family about the disease paid huge dividends in the long run. The intervention focused on educating parents about asthma, starting from signs and symptoms, identifying the common triggers to actions that could be taken in case of an attack. Later, follow-up visits were also provided after 3 and 6 months to collect data regarding the number of hospital visits in that period. It was seen that the

number of visits to the hospital reduced from 0.357 to 0.033 per day (p=0.174) in that period. There was a cost difference of $11.31 per patient in hospital stays (p=0.174) and $13.76 per patient in ER visits (p=0.016). Doctor visits also had a cost difference of $13.86 per patient. In the end, it was calculated that the program cost just under $250 per household and it reduced the number of healthcare visits. It also improved the health of those children and their families (Naufal et al., 2022).

Another study done on patients from the state of Texas with type 2 DM saw a massive increase in healthcare cost savings with decreasing HbA1c levels. The Diabetes Healthcare Program (DES) was an 8-hour interactive workshop which was offered to 27 counties in south Texas. It also had four quarterly follow-up sessions at every 3 months for up to a year. The primary outcome of the study was to see a decrease in HbA1c levels, which would have led to a decrease in hospital visits. When healthcare costs were compared between a matched sample of 912 patients with decreased HbA1c levels with that of 912 patients with the same HbA1c levels, it was seen that the first group averaged a 24% reduction, which was about $2503 in healthcare costs in the first year of follow-up. In the second year of follow-up, it decreased to about 17%, which was roughly $1690. When the cost savings of the entire program was calculated, it was seen that for a reduction in HbA1c from 10 to 9%, on average the per-patient saving was $1374, for 9 to 8% it was $1303, for 8 to 7% it was $373 and $514 from 7 to 6%. In the two-to-three-year period of the study, healthcare cost savings of $5.3 to $5.6 million have been estimated (Smith et al., 2021).

A study sought to assess the potential impact of incorporating patient education into standard medical care on the clinical outcomes of patients with migraine, as well as on their consumption of healthcare resources (Rothrock et al., 2006). In this randomised controlled trial, a cohort of 100 migraine patients from a university-based

headache clinic was divided into two groups. One group underwent an intensive educational program on migraine management, while the other group received only standard medical care. The findings demonstrated that the cohort getting comprehensive instruction exhibited substantial enhancements, such as a more pronounced decrease in their Migraine Disability Assessment (MIDAS) scores, a reduced frequency of headache episodes, and a decreased reliance on analgesic or abortive treatment. Additionally, they demonstrated greater adherence to recommended preventive therapies and had a reduced number of unplanned visits or phone calls to the clinic. The results indicate that providing patient education in an efficient manner can result in improved clinical outcomes for individuals with migraines and alleviate the burden on healthcare resources (Rothrock et al., 2006).

### 2.4.4 How to deliver education to patients?

#### 2.4.4.1 Challenges faced by doctors

##### 2.4.4.1.1 Communication skills

The most important factor in providing education to patients is the communication skills of healthcare professionals. Sometimes, physicians tend to unintentionally use medical jargon while speaking to patients. Instead of the word ‘benign’, ‘not cancerous’ could be used. A statement like ‘a recurrent, persistent condition’ could be used in place of ‘chronic’. ‘Hypertension’ could be replaced with ‘high blood pressure’ (Rimmer, 2014). Avoidance of medical jargon is essential.

From a patient perspective, a trend that was found was that physicians tend to interrupt them while they are explaining their concerns (Beckman & Frankel, 1984). It was observed that the mean time for interruptions by physicians was 18 seconds. When patients were allowed to tell their complaints without getting interrupted, it was seen that most took less than a minute to complete their opening statements and no

one took more than 150 seconds. As patients do not usually start with their chief complaints, it would be beneficial for patients that they are not interrupted while speaking (Beckman & Frankel, 1984).

The communication barrier patients experience while trying to properly convey their difficulties or grasp health-related information is a big challenge. In general practice environments, where there is a greater frequency of contact with patients with poor health literacy, this issue is particularly prevalent (Murugesu et al., 2022). Many times, these patients find it difficult to follow medical advice, which results in inadequate use of healthcare resources and ineffective control of their diseases. Using the teach-back approach is highly encouraged since it helps medical practitioners to confirm that patients have understood the material provided to them. Asking patients to repeat the content in their own words allows physicians to quickly identify and correct any mistakes. Furthermore, it is advised to promote patient understanding by encouraging the use of visual aids and simpler language, particularly in situations where medical jargon may cause difficulty (Murugesu et al., 2022).

An important barrier that has been identified is a lack of balance in communication, with physicians typically dominating the discussion (Silistraru, 2020). This can lead to misconceptions or insufficient patient engagement in their own treatment. This paternalistic approach contrasts with contemporary forms of patient-centred care and shared decision-making, which emphasise the importance of dialogue and mutual understanding between the physician and the patient.

Physicians frequently encounter challenges in managing the emotional and psychological components of interpersonal communication. In the field of medicine, effective communication requires the ability to comprehend and address patients' emotional requirements, concerns, and worries, in addition to conveying knowledge.

Medical schools should prioritise the cultivation of these 'soft skills' to enhance the quality of interactions between doctors and patients.

Moreover, the presence of time constraints might result in expedited consultations, where crucial information may not be sufficiently elucidated, and patients may depart with unresolved inquiries or unclear instructions (Silistraru, 2020).

#### 2.4.4.1.2 Medication adherence by patients

Medication adherence has been a huge cause of concern for doctors. A study has shown that only about 50% of the patients follow long-term drug regimens (Butler et al., 1996). When talking about lifestyle changes, the percentage drops to less than 10. Doctors particularly find patients with addictions to smoking and alcohol the hardest to deal with. Over the years, it has caused them to become increasingly pessimistic about their efforts. Recent studies show that instead of direct persuasion, motivational interviewing could be done. This means that the motivation to change can be increased if, instead of healthcare professionals, the patients themselves compare the pros and cons of the change and then decide (Butler et al., 1996). Non-adherence of patients in the United States is responsible for around 125,000 avoidable deaths annually and adds about $290 billion to annual healthcare costs. Historically, the healthcare system has made use of extensive, uniform strategies to improve adherence, including reminding patients of the risks associated with non-adherence and scheduling follow-ups. This method frequently proves ineffective due to its inability to consider the variations in characteristics among patients. Retail and technology sectors employ data analytics to analyse customer behaviour and tailor interventions. This can provide physicians with valuable insights relevant to their practice.

A comprehensive strategy that considers the behavioural patterns, demographics, and lifestyle choices of patients is one way for physicians to enhance adherence to

their patients' medications. This '360-degree perspective' allows for the development of individualised interventions that are more effective in encouraging adherence. Utilising advanced analytics to forecast whether individuals are prone to neglecting medications or appointments enables focused assistance, hence enhancing the probability of adherence (Fox et al., 2017).

Observational research was undertaken on 84 people who had been diagnosed with non-valvular AF. The patients were monitored for 12 months after being discharged from the hospital. The study compared two groups: one receiving monthly phone calls and the other receiving phone calls every six months. The Morisky-Green test assessed therapeutic adherence. This four-item self-reported measure of non-adherence is one of the most often utilised tests and is based on the Morisky Green Levine Medication Adherence Scale (MGLS) (Beyhaghi et al., 2016). The higher the score, the more likely the responders are to stick to their treatment. The patient is deemed adherent when their score reaches a minimum of 3 points (Uchmanowicz et al., 2019).

The results indicated that increased interaction frequency correlated with elevated adherence rates. Patients with monthly encounters stopped taking anticoagulants at a rate of 14.6%, compared to 25% in the group with less regular contact. Furthermore, the adherence scores in the monthly treatment and care group remained consistent, while there was a notable decrease in adherence in the group with less regular contact.

The study determined that a personalised approach to patient care, namely through consistent and customised communication, is essential for ensuring compliance with anticoagulant treatment in patients with AF. This emphasises the necessity of continuous assistance and regular follow-ups, particularly for patients who initially demonstrate lower levels of compliance (Novikova et al., 2021).

Comprising a community-led project in Germany's Rhein-Neckar Region, the ARENA project aimed to increase public knowledge of AF and improve stroke prevention (Zylla et al., 2024). Designed as a prospective, observational study with public outreach initiatives included along with AF patients taken from a variety of healthcare settings, including hospitals and medical offices, the study was the intervention component of the trial consisted in a population-based information campaign designed to increase public knowledge and control of AF.

Given information and instruction specific to AF, the intervention group adhered more to oral anticoagulant (OAC) therapy, in comparison to the control group during the follow-up period. This implies that public health initiatives that prioritise patient education can significantly influence the degree to which patients comply with their prescribed treatments for AF (Zylla et al., 2024).

Moreover, the investigation demonstrated a substantial reduction in the incidence of rehospitalisation associated with AF in the intervention group. These findings indicate that when patients are informed and educated about their condition, they are more likely to follow their treatment plan and effectively manage their disease. As a result, they experience fewer complications that would necessitate a return to the hospital.

The study also examined the effects of these therapies on the quality of life and anxiety levels of patients with AF. Although there was no substantial disparity in the overall quality of life between the control and intervention groups, the intervention group reported a decrease in anxiety due to AF during the follow-up period. This emphasises the potential psychological advantages of focused teaching programs, which can assist in reducing the mental strain linked to managing a chronic condition such as AF (Zylla et al., 2024).

A study was conducted on patients diagnosed with type 2 DM in Ahvaz, Iran

(Davoodi et al., 2022). The results suggest that patients' ability to comply with medical recommendations is impeded by physiological and physical characteristics, including physical infirmity, comorbidities, and the ageing process. Financial constraints also have a significant impact, as a significant number of patients are unable to afford the expense of prescription medications or the recommended dietary changes. Occupational considerations, misconceptions about the disease and its treatment, and a lack of understanding additionally contribute to suboptimal adherence.

The study highlighted several systemic impediments, including inadequate dissemination and limited communication regarding diabetes treatment, insufficient resources and infrastructure, and inadequate coordination between different sectors. Many patients have reported, for example, not having access to blood glucose monitors, or the necessary tools needed to sufficiently manage their condition. Furthermore, aggravating the problem is inadequate insurance covering for necessary medications and therapies (Davoodi et al., 2022).

One of the finest strategies to increase adherence is streamlining medication schedules (Cullen et al., 2022). Reducing daily dosage frequency results in a much higher patient adherence. Furthermore, proven to be successful is behavioural theory-based therapy including rewards and reminders. These techniques operate by continuously offering cues, such as reminders to take drugs or incentives for regular adherence. Teaching individuals on improved management of their medical issues is another beneficial strategy. However, educational interventions are most effective when accompanied with behavioural support such as reinforcement and feedback.

The article by HCP Global emphasises the need for following NOAC in AF treatment. Non-adherence to NOAC treatment is a main obstacle that affects bad health

outcomes, as well as increased healthcare costs. The article presents a comprehensive list of factors that influence adherence, categorising them into three categories: patient-related, physician-related, and healthcare system-related (Abbott HCP Global, 2023). The situation of patients is further complicated by their age, lower socioeconomic status, ignorance of AF and NOACs, depression, memory loss, and bleeding anxiety. People who believe the treatment is too demanding or have a limited lifestyle sometimes neglect their drugs as advised. The common overestimation of the bleeding risk by physicians causes their reluctance to administer NOACs. In the healthcare system, non-adherence is worst when there are barriers like inadequate follow-up and integrated treatment. The study stresses the need for educating patients and changing their behaviour if they are to be guided in following their treatment plans. Some of the approaches that work are targeted teachings using a language that is easy to understand, making decisions together, and using tools like brochures, patient anticoagulation cards, and online assistance to help them stay on their programs (Cullen et al., 2022). Regular follow-ups and close patient involvement enable physicians to check adherence and address patient issues (Abbott HCP Global, 2023).

#### 2.4.4.2 Impact on patients

A study on smoking cessation was conducted in Kobe, Japan between September 2007 and August 2013 (Tomioka et al., 2014). This was done to educate patients regarding the harmful effects of smoking and how cessation of smoking would help them improve their health-related quality of life. Following this 3-month smoking cessation program, changes were seen in the median exhaled CO levels in quitters and continuous smokers. At the start, the median levels of exhaled CO in quitters and continuous smokers were 11.6 +/- 8.1 ppm and 18.2 +/- 10.3 ppm, respectively.

After 4 weeks, the median levels went down to 1.6 +/- 2.2 ppm and 7.8 +/- 8.4 ppm in quitters and continuous smokers, respectively. At the end of 12 weeks, it was seen that the levels decreased to 1.6 +/- 2.1 ppm in quitters, while it rose to 9.4 +/- 9.0 ppm in the ones who had continued smoking (Figure 2). Thus, a positive impact of patient education was witnessed (Tomioka et al., 2014).

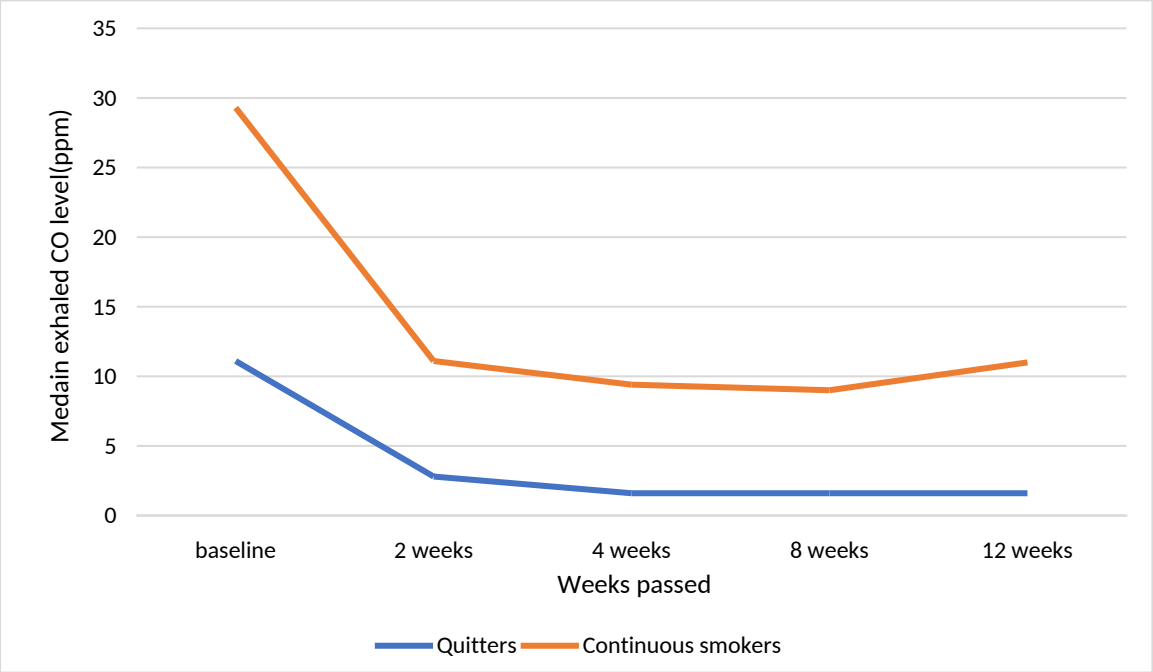


**Figure number 02: Median exhaled CO levels (ppm) over time in quitters versus continuous smokers:** This graph illustrates the change in median exhaled CO levels, measured in parts per million (ppm), for two groups: quitters (blue line) and continuous smokers (orange line) over a 12-week period.

The study titled 'Assessment of Atrial Fibrillation patients' education needs from patient and clinician perspectives' looked at knowledge gaps and educational needs of AF patients from the point of view of both patients and physicians. By use of semi-structured interviews, the study revealed the main obstacles to successful education and adherence as well as techniques to improve patient knowledge and involvement (Abbott HCP Global, 2023).

From the patient's point of view, the study exposes major knowledge gaps and misunderstandings. Often, patients did not know AF triggers, stroke risk, or the advantages of anticoagulants. Many patients mistakenly believe AF to be either directly lethal or suggestive of an approaching MI, which adds to their increased anxiety, especially upon diagnosis. Conflicting information and uncertainty about how to manage the condition in daily life exacerbated their mental distress. Patients expressed a preference for interactive educational sessions tailored to their specific needs. Although many students preferred classroom settings for the opportunity to ask questions and share experiences, the ease of online learning was also highly recognised. One recommended perfect answer was to combine both approaches. On the contrary, one of the most difficult parts of teaching AF patients turned out to be risk communication for the clinicians (Salmasi et al., 2019). Patients sometimes found it difficult to understand how stroke risk, symptom severity, and anticoagulation's advantages related to one other. Common misconceptions about anticoagulants included thinking of warfarin as a ‘rat poison’ or looking for natural alternatives. Clinicians believe that targeted education that reassures patients about the safety and efficacy of treatment can assist in clearing up these misunderstandings. They also emphasised the importance of removing mental barriers, pointing out that knowledge can significantly reduce anxiety and increase patient confidence in AF care (Salmasi et al., 2019).

The study indicates that effective AF education campaigns should encompass both the emotional and clinical dimensions of the condition. Emotional education emerged as a crucial component, informing patients that AF is not inherently fatal and that they can maintain a normal life. To increase patient involvement and reduce fear, interactive and tailored strategies, such as adapting materials to specific requirements and adding patient testimonies were suggested. To accommodate

varied learning styles and logistical constraints, physicians called for a combination of classroom and online instruction (Salmasi et al., 2019).

### 2.4.5 AF resources available to patients

There are multiple articles available to patients related to the management of AF. The AHA emphasises starting with lifestyle management, having a healthy diet that is low in salt, saturated fats and cholesterol, exercising regularly, managing weight, avoiding excessive intake of alcohol and caffeine, avoiding smoking and managing blood pressure (American Heart Association, 2019). The Arrythmia Alliance and British Heart Foundation talk about ‘pill in the pocket’, which means that patients can take an appropriate dose of an antiarrhythmic drug like flecainide, sotalol, and propafenone when they start getting symptoms of AF (British Heart Foundation, 2018).

## 2.5 The role and effectiveness of patient information leaflets in healthcare

Patient Information Leaflets (PILs) are very important in current healthcare system because they help patients understand what their physicians try to communicate. These tools are very important for giving patients freedom, teaching them more about health, and encouraging them to stick to their regimens. PILs provide patients with clear, succinct information so they may make better decisions regarding their health. They also strengthen the doctor-patient relationship. However, their degree of work depends on their development, the standardising process of the material, and their clinical practice usage. This section suggests innovative approaches to have a greater influence and discusses how PILs could assist to improve communication, adherence, and healthcare results.

'The Role of Patient Information Leaflets in the Treatment of Patients,' paper examined how PILs might be used effectively in contemporary healthcare (Mackenzie, 2018). The study included a descriptive, as well as an evaluative emphasis. Emphasising a patient-centred model over a paternalistic healthcare model, the research shows the change in decision-making between patients and physicians. In this fresh approach, PILs are considered as vital tools since they provide patients with necessary information on their diseases, treatments, and medical procedures, thereby enabling them to make well-informed decisions about their well-being.

PILs should be used as a complement to in-person meetings instead of a replacement so that patients always get human interaction and help from medical experts. Improving transparency and design is crucial. This can be accomplished by changing the text size, utilising basic language, and using images and colour-coded sections. To prevent discrepancies and ensure that patients receive accurate and consistent advice, the information must be standardised by the physicians (Mackenzie, 2018).

Engaging patients in the process of creating and evaluating PILs helps guarantee that the materials are customised to meet their specific requirements and levels of understanding. In addition, innovative methods such as involving children in the design of PILs have demonstrated potential in enhancing the appeal and comprehensibility of the materials. These strategies aim to maximise PILs as teaching tools so that patient understanding and health results will be better. Improving PIL design and execution will help them to be more effective in-patient education and eventually help to produce better healthcare results (Mackenzie, 2018).

The study titled 'The waiting room: a means for health education? The general practitioner's point of view' by Maxine Gignon is a study that describes and analyses a specific group of individuals at a certain point in time. The study investigated the effective use of waiting rooms by general practitioners (GPs) for the purpose of distributing health information to patients. The study was carried out in the Picardy region of northern France and involved 60 GPs. It employed semi-structured face-to-face interviews and analysed health information sheets that were presented in waiting rooms. The objective was to comprehend the utilisation of waiting rooms by GPs as a platform for health promotion and the specific forms of information they offer. The findings indicated that most GPs acknowledged the inherent value of the waiting room as a location with significant potential for patient education. A consensus among the physicians argued that waiting rooms should be designed to create pleasant and anxiety-free surroundings, hence potentially alleviating patient distress. They received health information from diverse sources, including institutional organisations and pharmaceutical companies. They often displayed these resources without a unified strategy. The survey indicated that the primary health topics addressed by these resources included vaccination, diet, and cardiovascular diseases. While these materials are available, certain GPs have expressed concerns that health information could increase patient distress. A limited number of them actively sought additional health education resources, whereas the majority adopted a passive stance in their distribution. The study found that although they acknowledge the need for using waiting rooms for health education, there is a deficiency in implementing a systematic approach for distributing information. The results indicate that including health information resources into a well-organised communication plan could improve their efficacy. For example, matching the content of waiting room items with the preventive measures suggested during consultations

could strengthen the impact of health messaging (Gignon et al., 2012).

Research done in 27 waiting rooms across 19 medical practices located in Brighton and Hove utilised a cross-sectional design to assess the impact of PILs and other health education materials on patient knowledge and perceptions within general practice settings (Maskell, McDonald and Paudyal, 2018). In total, 568 people were requested to complete surveys. The study combined patient opinion surveys with an evaluation of the health education materials available in diverse settings. It was found that a large majority of patients (77.9%) noticed posters, pamphlets, and other instructional materials in the waiting rooms, and 68.4% thought these resources were useful. However, mere 47.1% of individuals regarded the displays as well-designed and visually appealing. The health subjects that received the greatest coverage were vaccination, diet, and cardiovascular illnesses. An investigation including many variables revealed that patients with higher levels of knowledge exhibited a decreased likelihood of perceiving these resources as useful. Conversely, individuals who actively utilised and studied the information reported a greater degree of benefit. The study also emphasised that males exhibited a lower likelihood of perceiving the materials in comparison to females (Maskell, McDonald and Paudyal, 2018). Patients' opinions of attractiveness diminished as waiting periods increased and education levels rose.

The study's results show that patients usually notice patient information handouts and other useful learning materials in waiting rooms and find them useful. However, there is a lot of room for improvement in how they are designed and presented. The materials should be customised to make them interesting to look at and keep people's attention, especially those with more advanced educational experiences. This shows that PILs need to be standardised and well-coordinated across all healthcare sites. The goal of these methods is to help patients to learn more and feel

less anxious. To make things work better, it's best to combine PILs with direct touch from physicians. Aligning PILs' content with national standards and making them easier to read can make them effective to teach patients (Maskell, McDonald and Paudyal, 2018).

A study was done to assess the impact of PILs on doctor-patient communication, patient satisfaction, adherence, and behaviour (Sustersic et al., 2019). Two French emergency departments took part in research comparing the results of consultations with and without PILs.

The study included 324 people diagnosed with acute diseases ranging from pneumonia to ankle sprain and acute pyelonephritis. Doctors in the intervention group provided PILs during the appointment together with verbal information about the diagnosis and course of treatment. The control group lacked PILs. Patients were called seven to ten days following their session to complete surveys evaluating their experience.

The results indicated that PILs significantly enhanced doctor patient communication (DPC) scores. The intervention group did better than the control group, with a mean DPC score of 46 out of 52. Furthermore, PIL recipients were more likely to express enhanced satisfaction with healthcare workers, particularly in terms of communication and clarity (Sustersic et al., 2019). Consultation for the same disease dropped almost half in the intervention group from 32.1% in the control group to 17.9% in the group receiving PILs. In addition, doctors in the intervention group recommended more diagnostic tests relative to the control group and prescribed less medicines overall.

The study found that PILs can help make patients happier, improve interactions in EDs, and reduce the need for more visitations with doctors.

This shows how important textual tools are for allowing spoken communication in

places like emergency rooms where time is of the essence. PILs can help patients understand their illness better, which can lead to better adherence and less stress on healthcare resources (Sustersic et al., 2019).

A study published in the British Medical Journal (BMJ) examines numerous patient-centred techniques with the goal of improving patient involvement and healthcare outcomes (Coulter and Ellins, 2007). The study conducted a systematic assessment of the body of evidence on interventions designed to improve patient involvement, including printed leaflets, decision aids, and self-management programs. The main aim of the study was to assess the effectiveness of these interventions in increasing patient knowledge, health practices, and clinical outcomes.

Patient comprehension and retention of health information were improved by properly created materials, such as brochures. However, the use of leaflets in isolation was found to be less beneficial than their combination with spoken information and targeted consultations. The use of healthcare facilities is occasionally minimised, while patient experiences are improved by combining oral and written information. The study highlighted the importance of health literacy in reducing health inequities and increasing patient involvement.

It concluded that individuals with higher literacy levels were more adept at utilising health information and making informed decisions regarding their treatment.

The study also investigated additional interventions, such as decision aids and self-management education, that were thought to enhance chronic disease outcomes, such as diabetes and asthma. These interventions improved patients' sense of responsibility and self-efficacy, leading to higher adherence to treatment guidelines and better clinical outcomes (Coulter and Ellins, 2007).

Healthcare facilities provide several educational methods to try to improve patient understanding and management of AF. For AF patients especially, King's College

London provides a comprehensive leaflet. Aimed at supporting patients in their self-care and adherence to medical advice, this leaflet has important information on disease recognition, symptom management, and following the treatment course. Healthcare facilities provide several educational methods to try to improve patient understanding and management of AF (Kings College London NHS Foundation Trust, 2022).

Key elements of AF, including a thorough description of what this condition is, its symptoms, and possible complications, including stroke, are included in the leaflet. This basic understanding helps the leaflet enable patients to identify symptoms early on and appreciate the need of getting quick medical assistance. The leaflet also covers medication adherence, stressing the need for anticoagulants and other recommended drugs in lowering heart rate and risk of blood clots. Furthermore, the leaflet directs patients to refer to the leaflet provided by the British Heart Foundation (BHF) (Kings College London NHS Foundation Trust, 2022).

The 'Atrial Fibrillation: Your Quick Guide' the BHF leaflet is a complete tool for patients to better control and understand AF. Emphasising that some individuals may have no symptoms at all, which stresses the need for frequent check-ups, it starts by identifying AF and its main symptoms like palpitations, dizziness, fatigue, and dyspnoea. It highlights the health risks associated with AF, its contribution to raise stroke risk and its potential to induce heart failure should AF not be under control. To support early diagnosis and identification, it addresses diagnostic methods like ambulatory monitoring and electrocardiograms (ECGs). By consistently evaluating their pulse for irregularities, it motivates patients to be involved in their health monitoring.

Regarding treatment, the BHF lists choices for controlling AF including drugs meant for rate and rhythm control, anticoagulants to lower stroke risk, and procedural

procedures including cardioversion and catheter ablation. The leaflet especially addresses helping patients realise the importance of following their recommended treatment to prevent complications (British Heart Foundation, 2014).

### 2.6 Role of Chat GPT, YouTube and artificial intelligence in patient education

Digital platforms like YouTube and artificial intelligence (AI) tools like ChatGPT are now being used by patients to share and understand medical knowledge in new ways (Camm et al., 2018). These tools offer new ways to improve health literacy, give them more power, and make decisions together. While AI-driven models like ChatGPT offer customised, on-demand information fit to individual needs, video platforms like YouTube offer easily available visual explanations of difficult medical subjects. Their effectiveness, nevertheless, depends on the accuracy, reliability, and accessibility of the material offered. This section explores how well these tools could change patient education and emphasises their possibilities to improve healthcare delivery while tackling natural difficulties such false information, content reliability, and involvement from users.

The American Academy of Ophthalmology published a paper titled 'Patient Education in a YouTube World', which looked at the growing use of YouTube and other video platforms to educate patients (Boyd, 2016). Videos are excellent for lowering patient anxiety, increasing short-term knowledge, and promoting coping skills. The implementation of patient education videos in healthcare environments enhances the quality of information delivered during consultations, addresses misconceptions, and fosters effective communication. The paper presents practical strategies for the successful inclusion of such videos into medical care. Collaboration with IT administrators for the distribution of videos via various mediums, including tablets, servers, websites, patient portals, thumb drives, or DVDs, is crucial.

Standardisation of the documentation of video viewing in patient records can reduce malpractice risk and ensure compliance with program standards. This will guarantee that video documentation is regarded with the same consistency as other documentation forms (Boyd, 2016).

The Department of Cardiovascular Surgery at West China Hospital, Sichuan University, Chengdu, China conducted an observational retrospective study to evaluate the accuracy of YouTube videos (Luo et al., 2022). This was done to educate patients about AF. It explored YouTube extensively using certain keywords connected with AF to assess the top 50 search results for each phrase. The quality of the videos was evaluated with the Journal of the American Medical Association (JAMA), modified DISCERN score, AF-specific score (AFSA), and an essential score (Escore). Comprising 74 videos overall, they were divided into four groups according to publication background: medical facilities, news agencies/We media, government accounts, and doctors. The research indicated that 68% of the videos were classified as poor quality, 19% were classified as intermediate quality, and a mere 13% were classified as excellent. Videos created by individuals or groups with medical expertise often had higher quality ratings but had lower levels of popularity in comparison to videos produced by non-medical publishers. There was better structural integrity and data reliability of videos from medical institutions and physicians, with significantly greater JAMA and DISCERN scores.

Although the medical source videos were of better quality, they attracted less views, likes, and comments than the ones from non-medical sources. It was also found that, independent of their quality, videos with fewer than 10-minute running times usually received more views. This difference suggests that viewers could value the accessibility and interaction of videos more than the quality of the content (Luo et al., 2022).

Researchers from the Department of Cardiology at John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK conducted a study to assess the quality of patient education resources on AF ablation available on YouTube (Camm et al., 2018). The researchers conducted a methodical search on YouTube on September 11, 2016, specifically looking for videos related to 'ablation' in conjunction with 'Atrial Fibrillation', 'AFib', or 'AF'. The total videos that were assessed was 6357, out of which 111 were chosen for the study. While videos including surgical hybrid ablation or non-English content were omitted, the videos especially addressed the subject of catheter ablation for AF.

Videos were evaluated according to their adherence to a standardised set of criteria established by the Arrhythmia Alliance, which was derived from patient booklets and considered to be of the highest level. The analysis revealed that the median number of views per video was 1794.5, while the median duration was 217 seconds. Still, the videos showed poor quality since just 4 of the 21 minimum standards were fulfilled. Not one video fulfilled all the criteria. Moreover, there was no significant correlation between the quality of the instructional information provided and the number of likes or views on videos (Camm et al., 2018).

It was concluded that YouTube videos on catheter ablation for AF do not provide sufficient patient information. This lack of a relationship between the quality of the videos and the number of views or likes suggests that patients do not have the ability to evaluate these materials critically. The need for good, easily available video resources are needed to ensure that patients get accurate and comprehensive knowledge (Camm et al., 2018).

A study was conducted via a search on YouTube for videos pertaining to cervical spondylosis using specific keywords such as ‘cervical spondylosis’, ‘cervical radiculopathy’, and ‘cervical myelopathy’ on January 15, 2023 (Wang et al., 2023).

The methodology entailed examining the initial 50 videos from each search query, leading to the analysis of a total of 108 videos. The videos were evaluated using the benchmark criteria from the JAMA, the modified DISCERN (mDISCERN) tool, the Global Quality Scale (GQS), and a new Cervical-Spondylosis-Specific Scale (CSSS). The results showed that, depending on their source and the content, the videos had poor reliability and educational value. Usually, academic references provide greater consistency and better-quality videos. The study highlights the need of improved quality assurance in online health-related content, since it was identified that YouTube videos about cervical spondylosis have a great chance to spread false information (Wang et al., 2023).

Vanderbilt University Medical Centre in Nashville, Tennessee, United States conducted a study which explored the capacity of AI technologies, such as natural language processing (NLP) models like Chat-GPT, to revolutionise healthcare by improving the spread of knowledge and providing customised patient education (Goodman et al., 2023). The researchers conducted an analysis of the strengths and limitations of AI language models, with a specific emphasis on assessing the potential of Chat-GPT in delivering precise and dependable medical information. The researchers conducted a comprehensive analysis of the available literature and examined the current use of AI in the healthcare sector to evaluate the current progress and potential future developments. It was discovered that, while AI language models like Chat-GPT have enormous potential for revolutionising patient education and healthcare delivery, they now face significant challenges. These considerations include the danger of incorrect information, the importance of strong monitoring mechanisms, and the desire for regularly refreshed and precise training data. The study asserts that AI possesses immense potential to augment healthcare practices, but it necessitates cautious integration. To achieve dependable execution,

it is essential to conduct a thorough investigation, establish supervisory systems, and consistently enhance AI models to guarantee precision and dependability. By implementing appropriate precautions, AI has the potential to uncover unparalleled opportunities in the field of medical treatment and research (Goodman et al., 2023).

A multi-institutional study was done in the USA, involving the Department of Medicine at Rutgers University New Jersey Medical School, Thomas Jefferson University Hospital, and Trident Medical Centre (Lee et al., 2024). The researchers sought to assess the efficacy of ChatGPT's responses to patient education inquiries regarding AF. The researchers employed a collection of 16 common questions sourced from the AHA.

They then interacted with ChatGPT in four distinct manners: without any specific instructions, with prompts tailored for patients, with prompts tailored for physicians, and with a request for statistical data and references. Its accuracy decided how the responses were graded. They ranged from inaccurate to somewhat accurate, correct, and flawless (with references). The Flesch-Kincaid grade level approach was used to assess respondents' reading abilities. The study found that ChatGPT had an 85.9% accuracy rate, with 4.7% of its responses being faultless. Only 1.6% of the responses were inaccurate. The introduction of user-friendly prompts led to a lower average grade level, making the content more accessible to patients. Nonetheless, responses typically exceeded the recommended reading levels for patient education. Only 1.6 percent of the replies were incorrect. The implementation of user-friendly prompts resulted in a lower average grade level, making the content more accessible to patients.

ChatGPT demonstrates significant potential for patient education, especially in delivering accurate and tailored information regarding AF. The study emphasises the importance of continuous monitoring and improvement, particularly in terms of the

use of reputable sources. Despite these issues, ChatGPT's ability to alter difficulty based on user input makes it an important resource in healthcare settings for improving patient education (Lee et al., 2024).

Research was carried out at the University Hospital Marburg, Germany. The researchers assessed the viability of employing GPT-3 and GPT-4 for educating patients in the field of interventional radiology (Scheschenja et al., 2023). One hundred thirty-three questions were developed to address the different elements of 3 procedures: transarterial chemoembolisation, percutaneous transluminal angioplasty, and port installation. They covered themes like general comprehension, background information, hazards, difficulties, and post-operative care. Two radiologists utilised a 5-point Likert scale to score the accuracy of the responses given by both algorithms. The investigation revealed that both GPT-3 and GPT-4 regularly provided replies which were either 'completely correct' or 'very good,' with GPT-4 surpassing GPT-3. In comparison to GPT-3, GPT-4 had fewer ‘mostly incorrect’ replies and was more accurate ($p = 0.043$). The data produced by both models was not potentially dangerous. Both GPT-3 and GPT-4 are effective approaches for teaching patients about interventional radiology, however GPT-4 performs slightly better. The study highlighted how AI-powered language models could improve patient care, but it also emphasised the need of users identifying potential limitations and confirming AI-generated data. The data generated by both models was not potentially harmful. GPT-3 and GPT-4 serve as reliable tools for educating patients on interventional radiology, with GPT-4 demonstrating slightly superior performance. The study highlighted the potential of AI-powered language models to improve patient care while underscoring the necessity for users to acknowledge their limitations and verify the information generated by AI (Scheschenja et al., 2023).

Another study was conducted to determine the efficacy of ChatGPT 4.0 in providing appropriate responses to patient education enquiries on acute kidney injury (AKI) and continuous renal replacement therapy (CRRT) (Sheikh et al., 2024). The questions were taken from the Mayo Clinic Handbook and divided into four categories: original, paraphrased, unfinished sentences, and misspelt questions. The study sought to determine the efficacy of ChatGPT 4.0 in responding accurately to enquiries about patient education on AKI and CRRT. ChatGPT demonstrated outstanding precision across all question categories, with a 97% accuracy rate for original questions and those modified with adverbs, as well as a 98% accuracy rate for incomplete sentences or words containing spelling errors. The precision of AKI-related questions remained steady at 97% throughout all editions. The tool achieved a 96% accuracy rate in answering CRRT-related questions, both in their original form and when modified with adverbs. It also achieved a 98% accuracy rate for queries that were incomplete or had spelling problems. The statistical analysis revealed that there was no significant difference in performance across question types or between AKI and CRRT questions. ChatGPT 4.0 responded consistently and accurately to patient education questions about AKI and CRRT, regardless of linguistic differences. This illustrates its ability to function as a reliable instrument for patient education (Sheikh et al., 2024).

AI was studied at the University of Sydney, Australia to determine its role in providing care for AF patients (Trivedi et al., 2023). This study used quantitative and qualitative methods, including a six-month randomised controlled trial and post-intervention semi-structured interviews. Seven outreach sessions were done via conversational AI-powered automated phone calls, text messages, emails, and an instructive website. After the patients left the hospital, outreach began 24–48 hours later. These sessions taught, helped with behaviour, assessed AF symptoms, and encouraged

self-care. Participant interactions triggered system responses, including escalation warning indications. Participants provided comments via semi-structured interviews. The study had 82 participants, with 81 completing the investigation. Most participants were male (69%), with a mean age of 64. The average rate of outreach was 61%, and 88% of patients found the call information beneficial. It was observed that there was an improvement in post-discharge healthcare and patients' understanding of AF. It also helped them make lifestyle changes. However, limited verbal flexibility and material adaptation hindered active participation. It was also stressed that the strategy should accommodate occasional AF symptoms. The study found that conversational AI could improve AF care by filling gaps in current models. To improve patient participation and efficacy, interaction flexibility and personalisation must be optimised. Despite these challenges, the technology could improve AF care and patient education (Trivedi et al., 2023).

Research conducted at Hannover Medical School's Department of Cardiology and Angiology, examined how three natural language processing chatbots (NLPCs): Google Bard, Bing Chat, and ChatGPT Plus, reacted to questions on AF and cardiac implanted electronic devices (CIEDs) (Hillmann et al., 2023). Every NLPC was asked 50 questions, and each question was asked a total of 3 times, yielding 450 replies. Suitability, lucidity, confabulation, lack of relevant information, and clinically significant judgments were assessed. Word count and Flesch Reading Ease (FRE) scores measured readability. For AF, ChatGPT Plus had the most suitable replies (84%), followed by Bing Chat (60%), and Google Bard (52%).

Each NLP model was understandable. Google Bard achieved a score of 96%, Bing Chat scored 88%, and ChatGPT Plus received a score of 92%. Google Bard achieved the highest FRE score of 52.5, signifying the greatest readability simplicity. ChatGPT Plus achieved the lowest score of 31.6, with 52% of comments from

Google Bard, 60% from Bing Chat, and 24% from ChatGPT Plus missing important information. Meanwhile, confabulation was present in 12% of responses from Google Bard, while it was not observed in Bing Chat and ChatGPT Plus (Hillmann et al., 2023).

The highest proportion of appropriate responses for cardiac implantable electrical devices was 88%, surpassing Bing Chat at 72% and Google Bard at 16%. Responses from ChatGPT Plus were fully comprehensible, whereas Google Bard achieved 92% comprehensibility and Bing Chat reached 88%.

Google Bard did best with 56.8, while ChatGPT Plus did worst with 33.2. About 52% of ChatGPT Plus comments lacked critical substance. Also, 88% of Bing Chat and 92% of Google Bard responses lacked critical information. Many clinical judgment questions were not answered by Google Bard or Bing Chat, which often failed to recommend consulting a doctor (Hillmann et al., 2023).

It was discovered that NLPC responses are generally comprehensible but vary in appropriateness and comprehensiveness. ChatGPT Plus outperformed Google Bard and Bing Chat in terms of accuracy and completeness. However, all NLPCs overlooked crucial information and occasionally fabricated it. Thus, NLPCs should be used with caution while gathering AF and CIED medical information. Patient education must be updated on a frequent basis to be reliable (Hillmann et al., 2023).

### 2.7 Role of smartwatches in detecting atrial fibrillation

Using developments in wearable technology, AI, and patient-centred care, smartwatches have become a transforming tool in the identification and management of AF. American college of cardiology mentions that these gadgets, which have advanced sensors and algorithms, allow constant, non-invasive monitoring, therefore bridging the gap between conventional diagnostic techniques

and real-time health insights (Buda and Sengupta, 2024). Combining photoplethysmography (PPG) with single-lead ECG, smartwatches offer a two-way approach to accurately detect AF. Despite the fact that they can lower healthcare costs and assist in detecting episodes earlier, factors such as false positives, inconsistent accuracy in some groups, and the need for ongoing device maintenance still exist. This section talks about how smartwatches are becoming increasingly crucial in detecting AF, how technology is evolving, and how this affects healthcare. Smartwatches capable of processing ECGs have shown great potential in AF detection. These devices measure heart rhythms using PPG technology and alert consumers of anomalies suggestive of AF. Smartwatches are at par with medical-grade devices in some cases, according to a study showing a high degree of specificity (94%), and sensitivity (96%), in identifying (Buda and Sengupta, 2024). Two main approaches drive smartwatch technology for AF detection: PPG and single-lead ECG (Zoi Papalamprakopoulou et al., 2024). PPG is an optical non-invasive technique for measuring changes in blood volume under the skin. PPG sensor smartwatches send light into the skin and track the reflected light levels. This reflection varies with the cardiac cycle and lets the gadget either continuously or occasionally track the heart rate, giving users a quick approach to view their heart rhythm. PPG-based AF detection may exhibit reduced accuracy at very high or low heart rates and may be less effective in older people due of age-related physiological changes.

On the other hand, the single-lead ECG technique enables a more straightforward and precise assessment of the heart's electrical activity. Smartwatches can replicate a conventional lead I ECG by establishing a bipolar lead. This is achieved by using the watch's back as one electrode and placing the opposite hand's fingertip on the crown as the second electrode. This method lets the gadget capture an ECG pattern,

which physicians could review to detect AF. To increase the accuracy of AF detection, advanced smartwatches are now investigating the merging of single-lead ECG with other technologies like a 6-lead ECG system (Zoi Papalamprakopoulou et al., 2024).

Smartwatches use AI, particularly machine learning and deep learning approaches to detect AF. Raw data from PPG or ECG sensors is first pre-processed using methods including segmentation, normalisation, and noise reduction to improve data quality. The next step is feature extraction, which involves finding important characteristics such as heart rate variability and waveform morphology.

Heart beats are classified by traditional machine learning models, such as support vector machines (SVMs) and random forests, using artificial features. These models are advantageous in early smartwatch models because they can effectively process input features that are properly specified. Nevertheless, more advanced deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), are currently being used (Zoi Papalamprakopoulou et al., 2024). CNNs are highly proficient in identifying spatial patterns in ECG signals, whereas RNNs demonstrate exceptional performance in analysing sequential data, rendering them well-suited for continuous ECG monitoring.

A meta-analysis analysed data from nine prospective studies, which collectively involved 1,559 patients who were monitored for the incidence of AF over an average period of 75.6 days (Lakkireddy, 2020). The main aim of the meta-analysis was to assess the effectiveness of smartwatches utilising PPG and single-lead ECG technologies for detecting AF, in comparison to traditional methods such as standard ECGs,

The investigation demonstrated that smartwatch technology exhibits high efficiency in detecting AF, achieving sensitivity and specificity rates of 95% and 94%,

respectively. The results suggest that smartwatches are almost as dependable as conventional methods for detecting AF, therefore making them a feasible substitute for continuous and non-invasive monitoring. Furthermore, variations in the study cohorts, particularly with regards to the inclusion or exclusion of individuals with a past medical record of paroxysmal AF, may influence the applicability of the findings. The intermittent nature of Paroxysmal AF can make its identification harder, and the inclusion of such individuals may have affected the total reported detection rates. Nevertheless, the study also delineated various constraints (Lakkireddy, 2020). The presence of heterogeneity among the studies included in the analysis is a notable issue. This suggests that the design, participant traits, and methods of the studies varied, which could affect the consistency and dependability of the overall findings. The differences in algorithms across different smartwatch devices create another limitation. There is a difference in algorithms used for auto-focus detection by the manufacturers, therefore producing possible differences in performance and accuracy (Lakkireddy, 2020).

Additionally, the investigation observed the omission of specific patient demographics, including patients with implantable pacemakers. The omission of these patients is significant as it restricts the relevance of the findings to the broader community, given that these patients typically have distinct monitoring requirements and difficulties that may not be well handled by smartwatch technology (Lakkireddy, 2020).

An important advantage of smartwatches is their ease of use. Smartwatches offer a distinct advantage over traditional ECGs since they may be worn continuously by users, enabling real-time monitoring and early diagnosis of AF, even in patients who do not show any symptoms (AppleInsider 2024). Continuous monitoring is particularly advantageous for identifying paroxysmal AF episodes that might be

overlooked in a short ECG recording.

Smartwatches, including the Apple Watch and Fitbit, have obtained Food and Drug Administration (FDA) clearance for AF detection, primarily for pre-diagnostic applications (AppleInsider 2024). These devices are not designed for clinical decision-making; however, they can offer valuable data for healthcare providers to evaluate in conjunction with conventional diagnostic tools (K McCallum,2024).

The FDA has approved the Apple Watch's AF history function through the rigorous Medical Device Development Tools (MDDT) program (AppleInsider, 2024). This makes it the first digital health tool to achieve the program's non-invasive AF assessment standards. The FDA's MDDT program permits medical device developers to use approved techniques for the development and assessment of medical devices. Integrated on the Apple Watch since 2022, the AF history function got FDA approval just before Apple announced it. Since it alerts consumers of major heart diseases, frequently before any symptoms show up, this device has been recognised for its ability to save lives.

In December 2023, Apple submitted its AF history tool to the FDA, accompanied by data from a clinical study involving 280 participants (AppleInsider, 2024). This study compared the AF estimates generated by the Apple Watch to those of a validated reference device. Results demonstrated a strong concordance, as the weekly AF load predictions for most participants fell within a 5% to 10% range of the reference device’s measurements.

Despite this, the FDA acknowledged that the Apple Watch’s AF history feature met the standards of the MDDT program, affirming its capability within the specified criteria. But since it cannot identify atrial flutter or atrial tachycardia, it is only fitting to be utilised as a secondary endpoint in clinical studies (AppleInsider, 2024).

The Fitbit Heart Study at the 2021 American Heart Association Scientific Sessions evaluated a novel algorithm designed for the detection of AF, utilising Fitbit devices (J Diamond, 2021). It constituted a large-scale, nationwide, uncontrolled trial involving 455,669 adult participants across the United States. Eligible participants must have been a minimum of 22 years old, must have possessed a PPG-enabled Fitbit device that is suitable, and have no previous diagnosis of AF. The technique necessitated a minimum of 30 minutes of sporadic heart rhythm, recorded during periods of inactivity, to detect AF.

Throughout the trial, a total of 4,728 participants, which accounted for approximately 1% of the total number of participants, got a notification regarding the detection of an irregular heart rhythm. Out of them, a total of 1,671 individuals participated in a telemedicine consultation, while 1,162 individuals submitted an ECG patch for examination. AF was verified in 32.2% of these instances. The Fitbit algorithm had a sensitivity of 68% and a specificity of 98% in diagnosing AF, as revealed by the study. Although the study demonstrated potential in utilising wearable devices for detecting AF, it also emphasised several constraints, such as the incapability to identify AF during periods of physical activity and the absence of immediate warnings (J Diamond, 2021).

A prospective non-randomised study was conducted in the Cardiothoracic Unit of Bordeaux University Hospital in Pessac, France (Racine et al., 2022). The study comprised a total of 734 consecutive hospitalised patients who were 18 years of age or older. It found that the automated AF detection algorithm of the Apple Watch is generally good, although its accuracy decreases in patients with ECG irregularities. A lot of people who were brought to the hospital were looked at in the study. It found that premature complexes, sinus node failure, and atrioventricular (AV) block were some of the conditions that made false positives much more likely. Furthermore,

these settings raised the risk of false negatives, which occur when the wristwatch fails to identify existing AF. The problems in the smartwatch's readings stem from its reliance on cycle variability, which can be disrupted by these anomalies, resulting in inaccurate diagnosis (Racine et al., 2022).

In addition, the thesis conducted a comparison between the smartwatch's automated AF detection and the manual diagnostic carried out by electrophysiologists. While the wristwatch showed good sensitivity and specificity in most circumstances, it fell short compared to manual interpretation, especially in individuals with abnormal ECG readings. Although manual diagnosis is more precise, it faces difficulties, particularly when analysing low-quality ECGs or indistinct P-waves, demonstrating that neither approach is infallible (Racine et al., 2022).

The study also emphasised a notable problem with non-diagnostic ECGs. Around 19% of the smartwatch ECGs could not be categorised due to characteristics such as bradycardia or tachycardia, resulting in inconclusive recordings. The inconclusive results significantly affected the overall accuracy and precision of the smartwatch in detecting AF, making it more challenging to rely on it as a sole diagnostic tool (Racine et al., 2022).

Despite these challenges, smartwatches offer a practical solution for the continuous and personalised management of AF. The extensive adoption of smartwatches for AF detection may lower healthcare expenses by facilitating early identification of AF, thereby averting expensive complications such as stroke (Buda and Sengupta, 2024).

# Chapter 3

# Materials and Methodology

This chapter discusses the methodological approach used in this research to assess the management of AF among cardiology physicians and patients, as well as the ongoing BLEED-AF study. To meet the research goals, the method combines surveys and observational studies, therefore offering both quantitative and qualitative analysis of present practices, adherence, and educational techniques.

The first section is on the BLEED-AF study, which is a local single centre, prospective, observational study evaluating biomarkers to predict bleeding risk in patients with non-valvular AF on OAC treatment. Combining clinical data and biomarker analysis helps this effort to personalise anticoagulant therapy and improve risk classification.

The second section of the chapter discusses a prospective cohort study carried out as a service evaluation project. The main emphasis of this survey is the effect of patient education on self-management, medication adherence, and hospitalisations in AF patients. It employed structured telephone-based interviews to compile patient-reported information on knowledge, experiences, and behavioural adjustments. Using Microsoft Excel, the gathered data were methodically examined to identify trends and patterns about patient outcomes.

Comprising an online survey, the last part of the chapter details a cross-sectional audit of cardiology physicians. It assesses the clinical judgement, following of standards, and educational initiatives of physicians actively involved in the management of patients with AF. It offers insightful analysis of the obstacles and tactics healthcare workers must deal with, pointing out areas needing development in the delivery of the care of AF patients.

Overall, this chapter provides a comprehensive review of the methods applied to evaluate the clinical and biomarker-driven AF treatment approaches as well as to probe the points of view of patients and doctors. These numerous ways ensure a

powerful and thorough analysis of the study objectives, therefore fostering a greater awareness of current techniques and possible areas of development.

### 3.1 BLEED AF study

The BLEED-AF study is an ongoing single-centre, prospective, observational study designed to evaluate biomarkers that predict bleeding risk in patients with AF who are on oral anticoagulation therapy. Up to 600 people aged over 18, diagnosed with non-valvular AF, who have been on stable OAC therapy for at least four weeks are expected to take part in the study. The recruitment process started on 12th April 2021 and is ongoing, and the participants will be followed up for up to five years.
In the first three months, participants attend four in-person visits. Following that, they have a virtual follow-up every six months. Clinical data including demographic information, medication adherence, and adverse events were compiled as the participants attended the sessions. Blood samples were obtained at point of care and immediately examined for fibrinolysis and platelet reactivity. More samples are maintained so that later coagulation and inflammatory biomarkers can be investigated. Remote follow-ups mostly aim to monitor how well the patient is following their prescription schedule and look for adverse events like either minor or major bleeding and ischaemia episodes.
The primary endpoint of the study will be the number of major bleeding events. Minor bleeding events are also included as secondary outcomes. Researchers are using complex statistical models to test how useful biomarkers are for making risk assessment tools like HAS-BLED more accurate at predicting the future. The overarching goal of the study is to personalise anticoagulation therapy by integrating biomarker data, thereby reducing bleeding complications and optimising patient outcomes.

By October 2022, the BLEED AF study included 241 patients who were enrolled to investigate bleeding complications associated with AF. This represents the total starting population for this study. Out of the initial cohort, 26 patients withdrew from the study for various reasons, reducing the effective study population. These withdrawals may have occurred due to various factors such as personal choice, health complications, or logistical issues.

From the remaining patients after the withdrawals, a subset of 50 patients was selected to participate in the patient survey that I conducted. These patients were chosen to provide insights into their experiences, adherence to treatment, and understanding of AF management. Seven patients from the survey group died before they could respond to the survey.

An additional 9 patients did not respond to the survey despite being part of the selected group. Ultimately, 34 patients completed the survey, representing a response rate of 68%. These respondents represent the final sample that contributed to the survey results (Figure number 03).

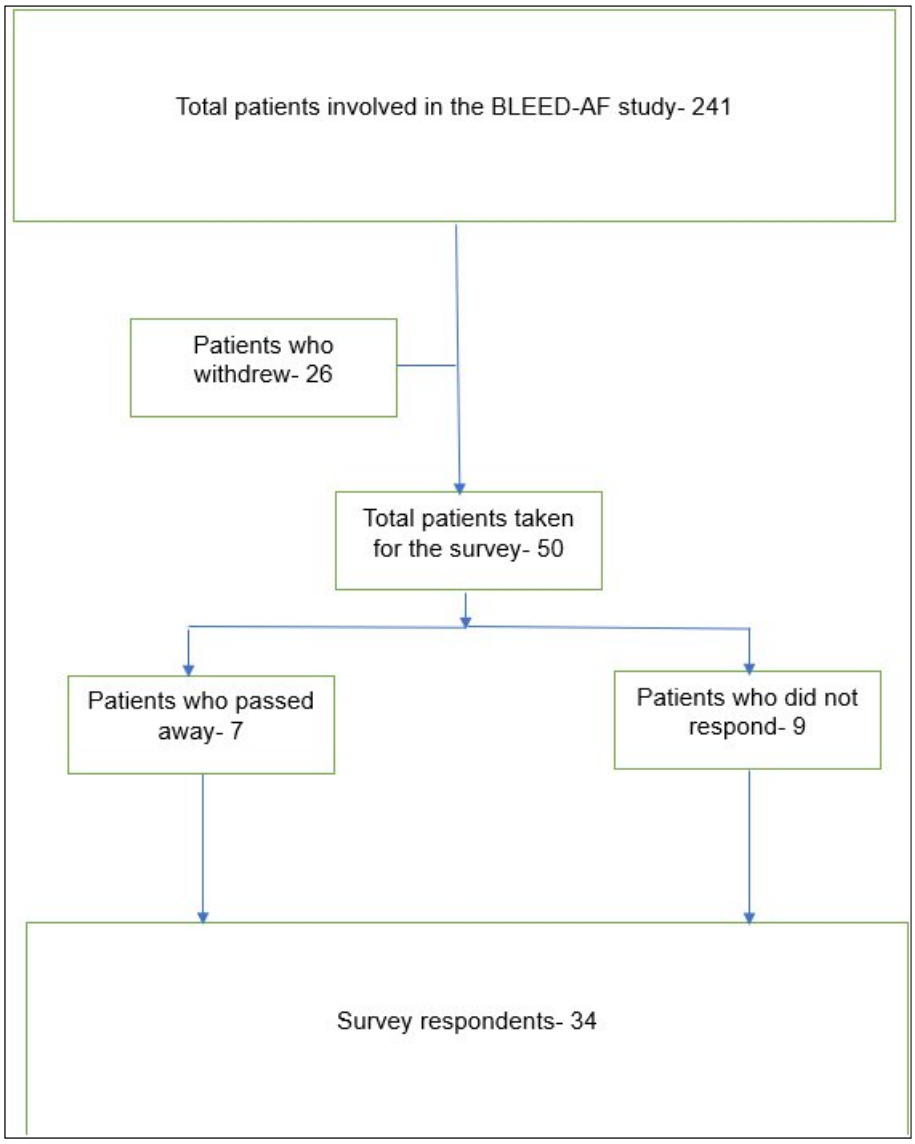


**Figure number 03: Flowchart of patient participation in the BLEED-AF study and patient survey:** This flowchart illustrates the stages of patient participation in the BLEED-AF study, from initial enrolment to survey completion

### 3.2 Survey for patients with atrial fibrillation

#### 3.2.1 Study design and setting

A prospective cohort survey, as part of a service evaluation programme carried out at the East and North Hertfordshire NHS Trust and titled, “Assessment of the impact of patient education intervention on patient self-management of AF, medication compliance and hospitalisation in a population subgroup of the BLEED-AF study” (Reference no. SE20244). Using aspects of the BLEED-AF study design, this thesis analyses the impact of patient education on self-management, medication adherence, and hospitalisations in patients with AF. Between October 2022 and October 2023, I collected comprehensive patient experiences and responses through planned telephone interviews. The study was carried out at the Lister Hospital, East and North Hertfordshire NHS Trust, in Stevenage, with a specific focus on patients who had been diagnosed with AF. The location provided an optimal setting for comprehending the intricacies of patient education and disease management in an authentic clinical context.

#### 3.2.2 Survey description

The patients were contacted via the hospital telephone at Lister hospital in Stevenage. They were told the reason for the call and verbal consent was taken. After confirming their name and date of birth, a series of both open and closed-ended questions were asked as part of a survey to assess the experience, knowledge, and management of AF among patients. Their medical history was assessed by asking about hospitalisations related to irregular heartbeat and episodes of heart attack or stroke in the last 6 months.

To gauge the patient’s ongoing treatment adherence, the survey asked about the use of blood-thinning medications, including the specific doses taken, and whether

they had experienced any bleeding problems, such as gastrointestinal bleeding, nosebleeds, or gum bleeding, within the past six months.

The survey also probed the patient's awareness of AF and its risk factors. Whether physicians explained the disease and its management upon diagnosis, was another topic of inquiry. It also gauged the patient's knowledge of important risk factors including obesity, diabetes, smoking, alcohol intake, poor sleep, and high BP. This aimed to identify weaknesses in patient knowledge of AF, which would have affected their ability to optimally manage the condition.

Lifestyle and behaviour changes were another significant focus of the survey. Patients were asked about their exercise routines, including the frequency and duration of cardiovascular activity, and whether they knew about the guidelines for exercise recommended by the NHS. With an eye towards knowing the degree of their participation in self-care activities, questions also covered any lifestyle changes or dietary adjustments taken following the AF diagnosis.

The survey asked patients with paroxysmal AF about their experience with episodes of prolonged palpitations and their reaction strategies, such as contacting ambulance services, seeing a GP, or attending A&E. It also looked at their experience with using a 'pill in the pocket' for acute symptom management.

Finally, the survey assessed the patient's self-management skills and preparedness. It asked how patients managed acute palpitations and their degree of awareness of the various possibilities. The overarching aim of the survey was to assess patient knowledge, adherence to treatment, lifestyle adaptations, and preparedness for managing their condition, providing insights into areas where educational or behavioural interventions may be required to improve outcomes.

### 3.2.3 Data management and analysis using Microsoft Excel

The survey results were methodically entered into Microsoft Excel for organisation, administration, and analysis. Excel was a useful tool for streamlining the process of data collection, enabling easy classification and storage of both quantitative and qualitative responses. It also made it easier to visualise results, allowing for a clear display of findings in graphical formats such as bar charts and pie charts to aid in the understanding of survey results. The study used Excel's capabilities to guarantee that the data analysis process was both systematic and accurate, creating a solid foundation for addressing the research objectives and identifying areas for potential improvement in patient education and care.

### 3.2.4 Ethical considerations

The study was conducted as a service evaluation to assess the effects of a patient education intervention on the self-management of AF, medication compliance, and hospitalisation in a specific population subset of the BLEED-AF study. The study obtained ethical permission from the institutional review board at Lister Hospital under reference no. SE202443, which was granted by East and North Hertfordshire NHS Trust (ENHT). An ethics approval protocol number, Minute 13/HSET ECDA/2024-10-02 was issued by the chair of the Health, Science, Engineering and Technology ECDA, University of Hertfordshire. Rigorous precautions were enforced to safeguard the privacy and confidentiality of the participants. The data underwent anonymisation, resulting in the removal of personal identifiers. The research team had exclusive access to the data. Data sharing was restricted to aggregated findings to avoid the identification of individual participants.

### 3.2.5 Sampling framework

The sampling method used in this survey is convenience sampling, which is a non-probability type of sampling. In this instance, the investigation entailed reaching out to individuals diagnosed with AF who were patients who were engaged in the BLEED-AF study under the cardiovascular outpatient clinic at Lister Hospital. Patients were initially approached by the clinical care team, and if they agreed, they were then approached by the research team. The selection of these patients was based on their accessibility through the hospital's telephone system, which facilitated a direct and quick data collection process. Initially, a sample of 50 patients was considered for this study. However, after excluding cases with missing data, the final sample size taken for the analysis is 34.

### 3.2.6 Recruitment strategy

Patients were initially approached by the clinical care team, and if they agreed, they were then approached by the research team from the hospital's cardiovascular outpatient clinic. The research team contacted eligible patients via telephone. During the initial phone conversation, the study goals and methods were clarified, and verbal agreement was achieved.

The inclusion criteria were-

1. Patients with non-valvular AF (paroxysmal, persistent or permanent)
2. Patients aged 18 and older
3. Patients who spoke English
4. Patients without cognitive impairment

The exclusion criteria were-

1. Patients aged less than 18
2. Patients who did not respond

All included patients had a verified diagnosis of non-valvular AF based on a 12-lead ECG, their medical history and associated clinical documentation as part of the recruitment and screening process. They must also have been on OAC therapy for a minimum of four weeks prior to recruitment.

### 3.2.7 Data collection

Focusing especially on education-driven management of AF, this survey included structured interviews to get both qualitative and quantitative data on patient experiences in line with the BLEED-AF study. This study included patient-reported measures of medication adherence, self-management practices, and frequency of hospital visits linked to AF. Anonymisation of data was done to protect patient confidentiality.

### 3.2.8 Exposure assessment

Patient education regarding the management of AF and medication adherence were the primary exposures of interest. Patient education was defined as the provision of information and guidance to patients regarding the management of AF, which includes the identification of symptoms and the modification of lifestyle. Details of the consumption of anticoagulants was discussed as well.

### 3.2.9 Outcome assessment

The main measures consisted of hospitalisations associated with AF in the previous six months, incidences of MI or cerebrovascular accidents, and compliance with medication. The secondary outcomes were centred on patients' understanding of risk factors for AF, their exercise patterns, and their dietary modifications.

### 3.2.10 Statistical analysis

Data are presented as numbers with percentages for binary variables. Descriptive statistics were employed to succinctly characterise both the demographic data and

the responses gathered from the questionnaire. Categorical variables were used to calculate frequencies and percentages. The qualitative data obtained from open-ended questions was carefully examined thematically to uncover recurring themes and patterns. The process of thematic analysis entailed the coding of the replies and the subsequent categorisation of these codes into overarching themes that are directly related to patient education, adherence, and hospitalisations. In this study, the issue of missing data was handled with great attention to detail to guarantee the integrity and dependability of the results. To ensure accurate and valid results, various solutions were implemented to address the issue of missing data, recognising the significance of having entire datasets. First, an initial assessment was conducted to determine the extent and patterns of missing data. This entailed detecting any systematic factors contributing to missing results, such as non-response to specific questions or dropouts during the telephone survey, as well as fatalities occurring throughout the study. Sensitivity studies were conducted by re-examining the data using alternative assumptions on the missing data. This approach served as a robustness check for the study findings, guaranteeing that they were not excessively impacted by missing data.

Categorical variables were compared with the Chi-square or Fisher's exact tests, as appropriate. A two-sided $P < 0.05$ was considered statistically significant. Statistical analysis was performed manually using the Fisher's exact test formula, with guidance and resources from online tools and references (Social Science Statistics, 2019). Fisher’s exact test was chosen over Chi-square test due to the nature of the data and the sample size involved, as the expected cell count in the contingency table was less than 5.

The study aimed to better understand patient outcomes by analysing hospital admissions, medication adherence, and bleeding problems. Evaluating patient

education and understanding of AF risk factors revealed gaps in present educational efforts, emphasising the need for more thorough patient education initiatives. The lifestyle and exercise section of the questionnaire assessed how well patients were incorporating prescribed lifestyle changes into their daily routines. The additional questions for paroxysmal AF patients provided a more in-depth look at how people with this kind of AF handle acute episodes, potentially revealing the effectiveness of current management options and the need for more assistance or education.

### 3.3 Survey for cardiology physicians treating atrial fibrillation

#### 3.3.1 Study design and setting

This study utilised a cross-sectional audit approach to evaluate the management methods for AF among cardiology physicians, who were consultants and senior speciality training registrars. The questionnaire was designed using the National Institute of Health and Care Excellence (NICE) guidelines for the management of AF. The development process involved a thorough review of the latest clinical guidelines (NICE,2021).

The questionnaire was distributed digitally through google forms, guaranteeing effortless accessibility and convenience for participants. The electronic format facilitated rapid data collecting and analysis, as responses were automatically logged in a secure database. The study ensured the preservation of confidentiality and anonymity of the participants, which aimed to promote honest and accurate reporting of their practices.

Questionnaires were disseminated by the research lead to colleagues at Lister Hospital. Invited participants were asked to circulate the questionnaire to colleagues across the UK. Cardiology physicians were identified at Lister hospital in Stevenage, Ealing Hospital in London and Freeman Hospital in Newcastle. The survey was

designed to collect data to gain information regarding their management strategies and attitudes. All the data were anonymised, and the survey was sent via secure NHS emails.

### 3.3.2 Survey description

The participants were recruited using secure NHS email invitations. In addition to providing a subject line that was clear and straightforward, the purpose of the survey was elucidated, and the respondents indicated their willingness to take part by completing the survey in its entirety. The survey was distributed over a six-week period, with a one-week window for responding.

The survey aimed to evaluate the knowledge, decision-making, and AF treatment practices of cardiology physicians. It was designed using established standards from NICE and using the most effective strategies for managing AF. It started by confirming whether physicians were involved in the treatment of patients with AF. It then focused on whether they handled AF patients in inpatient wards, outpatient clinics, or both. The study also asked about the physician's participation in managing patients with AF following percutaneous coronary intervention (PCI) and the therapeutic strategies applied, such as dual therapy, triple therapy, or treatment options depending on the risk of thrombosis against bleeding.

The survey looked at the strategies cardiology physicians used to treat new-onset AF acutely. It enquired about their main goals, rate control, rhythm control, or a choice motivated by the patient's symptoms and presentation. Reflecting on their attempts to improve patient knowledge and adherence, the poll also looked at whether doctors routinely gave leaflets to newly diagnosed AF patients.

To evaluate risk assessment strategies, they were questioned about the tools they used to determine thrombosis risk, such as the CHA2DS2-VASc score, and bleeding

risk, such as the HAS-BLED score. This section demonstrated the extent to which guideline-recommended tools were used in clinical practice.

The survey also examined anticoagulant therapy prescribing patterns. They were asked to pick between anticoagulants such apixaban, dabigatran, edoxaban, rivaroxaban, warfarin, and antiplatelets for AF therapy. Furthermore, the study sought to determine if they routinely examined patients for adherence to prescription anticoagulants, which is critical in avoiding AF-related complications.

Diagnostic and procedural practices were also addressed, with questions investigating whether physicians routinely requested transthoracic echocardiograms (TTE) for newly diagnosed AF patients as part of their diagnostic evaluations. The survey aimed to capture the comprehensiveness of physicians' diagnostic approaches and adherence to recommended practices.

### 3.3.3 Data management and analysis using Microsoft Excel

The survey results were methodically put into Microsoft Excel for organisation, administration, and analysis. Excel was a useful tool for streamlining the process of data collection, enabling easy classification and storage of all the responses. Excel also made it easier to visualise results, allowing for a clear display of findings in graphical formats such as bar charts and pie charts to aid in the understanding of survey results. The study used Excel's capabilities to guarantee that the data analysis process was both systematic and accurate, creating a solid foundation for addressing the research objectives and identifying the challenges and barriers faced by cardiology physicians to provide adequate support, guidance and education to AF patients.

### 3.3.4 Sampling framework

The physician survey conducted in this study utilised purposive sampling, which is a non-probability sampling method. The survey specifically focused on cardiology physicians who were consultants and senior specialised training registrars actively involved in the management of patients with AF. The selection of these individuals was intentional, based on their specialised skill and experience in handling AF. This ensured that the survey results would contain valuable insights and expertise related to the topic. The study employed purposive sampling to collect comprehensive data on the current clinical practices, management techniques, and educational initiatives directly from those most involved in AF care.

### 3.3.5 Participants

The inclusion criteria were –

1. Physicians who were actively engaged in the treatment of patients who were diagnosed with AF.
2. Cardiology registrars
3. Cardiology consultants

The exclusion criteria were physicians who were not actively involved in the treatment of patients with AF.

### 3.3.6 Data collection

Data were gathered implementing an internet-based survey tool to guarantee convenient accessibility and successful completion. Respondents successfully filled out the survey by accessing a link provided in the email invitation and they were automatically logged in a secure online database.

### 3.3.7 Exposure assessment

The participants' exposure was evaluated using survey questions that captured their clinical decisions, utilisation of risk assessment scores, and measures for patient education.

### 3.3.8 Outcome assessment

The primary outcomes focused on the strategies employed for managing AF, such as adherence to specific guidelines, utilisation of risk assessment tools, and administration of anticoagulant medications. Secondary outcomes encompassed the scope of patient education delivered and the strategies employed for post-PCI treatment. The outcomes were defined as the practices that were reported by physicians in the survey. These included the utilisation of risk assessment scores, preferred anticoagulants, and patient education regimens.

### 3.3.9 Statistical analysis

The main results focused on the strategies employed for managing AF, such as adherence to specific guidelines, utilisation of risk assessment tools, and administration of anticoagulant drugs. Additional outcomes addressed the scope of patient education delivered and the methodologies employed for PCI care. Outcomes were defined as the precise practices that were reported by the clinicians in the survey. These approaches encompassed the utilisation of risk assessment scores, favoured anticoagulants, and patient education.

# Chapter 4

# Results

### 4.1 Statistical trends in admissions among AF patients: exploring the impact of information provision on patient care

The study cohort consisted of 34 patients, all of whom were 65 years of age or older. Out of these 34 patients in the study cohort, the survey documented that 10 patients (29.41%) were subjected to hospitalisation due to irregular heartbeat in the preceding 6 months. Factors such as their temperature, medications and co-morbidities were not accounted for, while taking note of their hospitalisations. When enquired if they received any prior information regarding potential actions during an episode of abnormal heartbeat upon their initial diagnosis of AF, 17 patients responded negatively. This reflects merely 50% of the patients who participated in the survey. Of the 17 patients informed about potential interventions, only 2 (11.76%) were hospitalised in the past 6 months. Among the 17 patients who were not informed of potential interventions, 8 (47.05%) were hospitalised in the past 6 months.

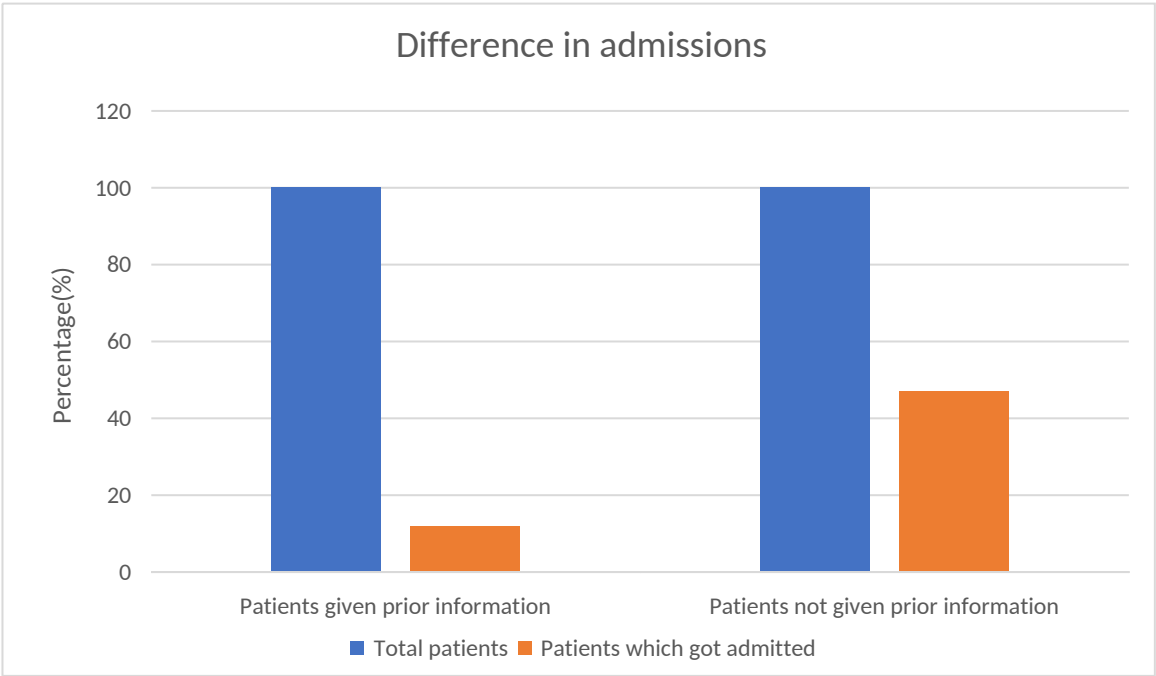


**Figure number 04: Comparison of admissions based on prior information given:** Comparison of admissions between patients who were given prior information

vs patients who were not given prior information about what is to be done in an episode of irregular heartbeat

The data suggest that equipping patients with information and expertise affects patient care. However, out of the 21 cardiology physicians surveyed, only 12 provide leaflets to patients newly diagnosed with AF, representing approximately 57.41% of the total respondents. Nine cardiology physicians (42.59%) indicated that they do not provide leaflets to newly diagnosed AF patients.

The alignment between these trends highlights the significance of organised patient education in the management of AF. Although significant advantages in decreasing hospitalisations have been noted, a substantial number of cardiology physicians do not consistently offer educational leaflets to patients with a new diagnosis. This gap highlights the necessity for standardised educational protocols and resources to guarantee that all AF patients obtain sufficient information. Enhancing this aspect of care may decrease hospital admissions and optimise the utilisation of healthcare resources.

**Table number 01: Comparison of hospitalisation between patients who were and were not provided prior information from cardiology physicians when they were first diagnosed with AF**

| Variables | Total patients | Hospitalisation | | | |
|---|---|---|---|---|---|
| | | Yes | % | No | % |
| Patients given prior information | 17 | 2 | 11.76 | 15 | 88.24 |

| | | | | | |
|---|---|---|---|---|---|
| Patients not given prior information | 17 | 8 | 47.05 | 9 | 52.95 |

**Table number 02: Association between prior information given to patients with AF and their re-admission to the hospital:** this table shows the relationship between prior information given to AF patients and their admissions to the hospital due to irregular heartbeat

| **Variables** | **Re-admission to hospital(n)** | **No re-admission to hospital(n)** | **Total(n)** |
|---|---|---|---|
| Prior information given | 2 | 15 | 17 |
| No prior information given | 8 | 9 | 17 |
| Total | 10 | 24 | 34 |

The Fisher's exact test yielded a p-value of 0.057, denoting the association between the delivery of prior information to patients with AF and their re-admission to the hospital due to irregular heartbeat. Although this value is slightly higher than the standard threshold of 0.05 for statistical significance, it is sufficiently close to indicate a significant trend. This proximity to the significance threshold suggests that with a larger sample size, the results might become statistically significant.

Despite the p-value not being less than 0.05, the observed disparity in re-admission rates is significant. This significant disparity in re-admission rates implies that

giving prior information to patients could have a substantial influence on mitigating hospital re-admissions, a crucial factor in optimising healthcare resource allocation. Ten of the 34 patients, or approximately 29.41%, were diagnosed with paroxysmal AF. Four out of the 10 paroxysmal AF patients (40%) were admitted to the hospital due to irregular heartbeats in the past 6 months. Six of the remaining 24 patients (25%), diagnosed with either permanent or persistent AF were admitted to the hospital due to irregular heartbeats in the same time period.

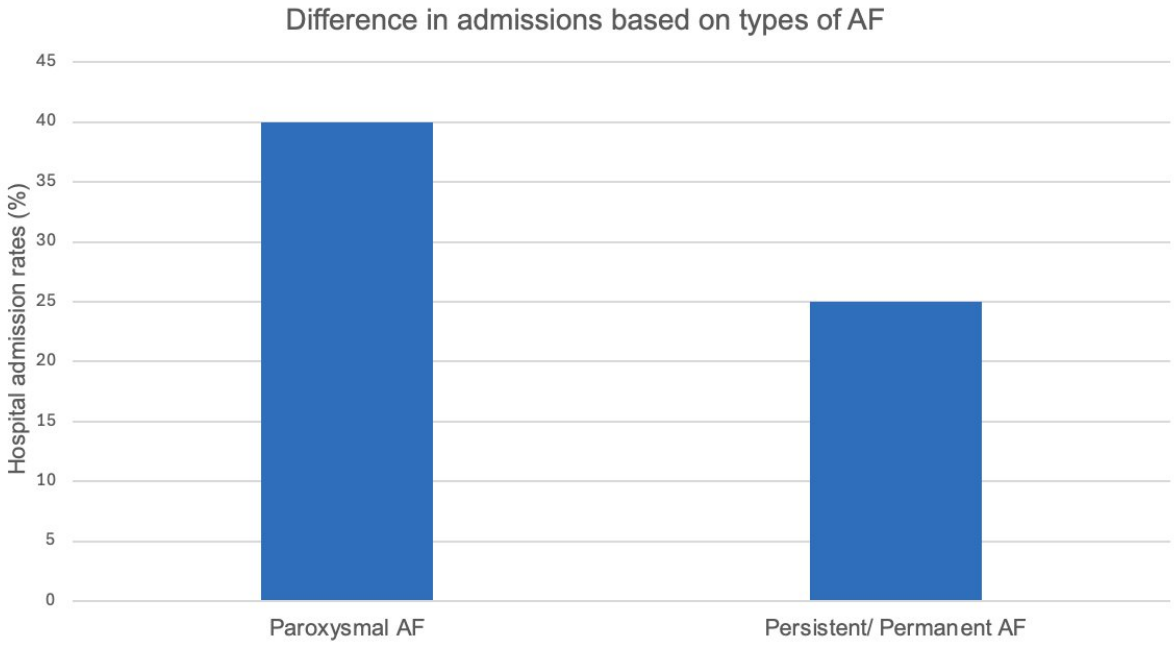


**Figure number 05: Comparison of admissions based on type of AF:**

Comparison of admissions between patients diagnosed with paroxysmal AF v/s persistent/permanent AF

The higher admission rate observed among patients with paroxysmal AF suggests that, despite the episodic nature of their arrhythmia, they may experience more acute or symptomatic episodes that necessitate hospital visits. In contrast, patients with persistent or permanent AF, where the rhythm disturbance is more continuous, may have adapted to their condition or benefit from more consistent management, leading to fewer acute admissions. These findings underscore the need for

personalised patient education and management approaches, particularly for those with paroxysmal AF, who appear to be at a higher risk of hospitalisation due to symptomatic episodes.

Enquiring about particular risk factors revealed that 26 of the 34 patients recognised alcohol as a risk factor for AF, 22 acknowledged obesity as a risk factor, 20 identified diabetes as a risk factor, and 27 were aware that alcohol consumption and cigarette smoking are risk factors for AF. Awareness of inadequate sleep as a risk factor was restricted, with merely 14 individuals recognising its association with an increased likelihood of AF.

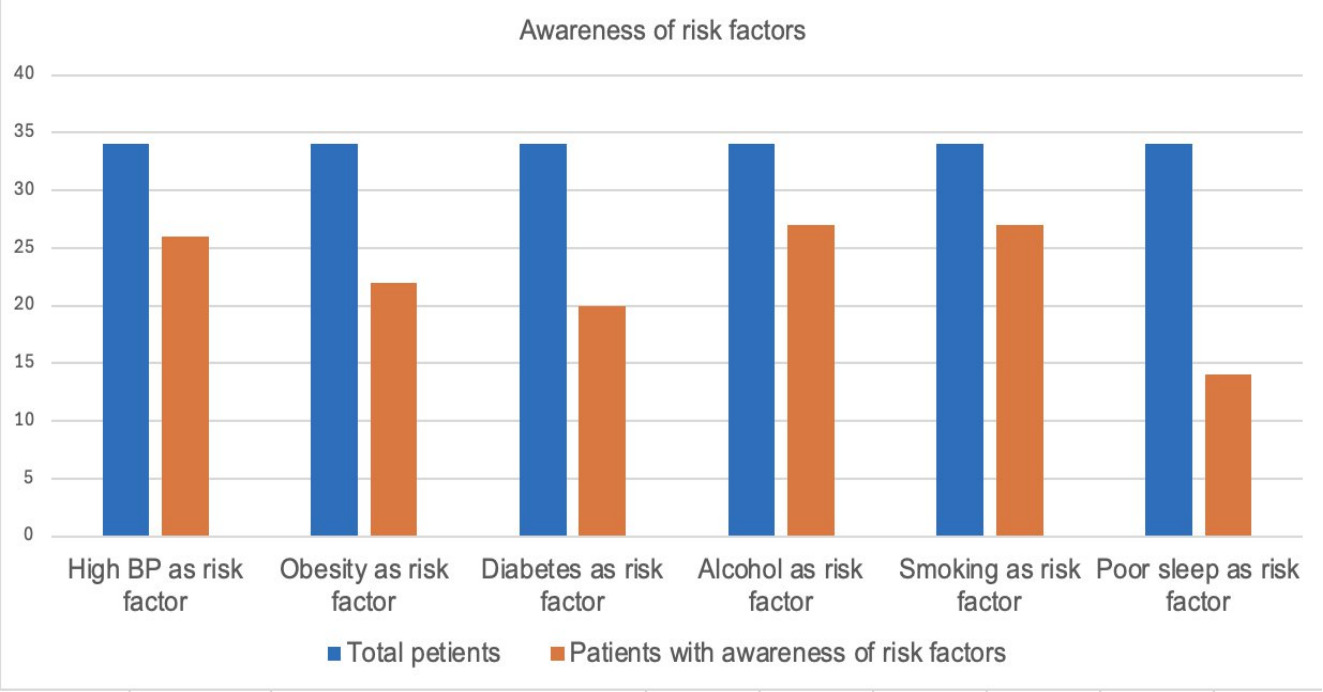


**Figure number 06: Patients with awareness of risk factors:** number of patients who knew that high BP, obesity, diabetes, alcohol consumption, smoking and poor sleep each are risk factors vs total patients enrolled in the study initially

**Table number 03: Patients who confirmed they have awareness of the following risk factors for AF**

| Variables | Total patients | Survey response | | | |
|---|---|---|---|---|---|
| | | Yes | % | No | % |
| Hypertension as risk factor | 34 | 26 | 76.47 | 8 | 23.53 |
| Obesity as risk factor | 34 | 22 | 64.70 | 12 | 35.30 |
| Diabetes as risk factor | 34 | 20 | 58.82 | 14 | 41.18 |
| Excessive alcohol as risk factor | 34 | 27 | 79.41 | 7 | 20.59 |
| Smoking as risk factor | 34 | 27 | 79.41 | 7 | 20.59 |
| Poor sleep as risk factor | 34 | 14 | 41.17 | 20 | 58.83 |

According to table number 3, there is a paradox in patient awareness. Where there is a good awareness of conventional AF risk factors including alcohol intake, smoking, and obesity among patients, the impact of inadequate sleep is not clearly appreciated, as only 41.17% of the patients confirmed of knowing poor sleep as a risk factor for developing AF. This poor understanding of poor sleep as a risk factor points to a chance for a thorough patient education including less well-known but equally important causes of AF. By enabling patients to use more all-encompassing strategies for controlling their disease, bridging this gap could help to lower the load of AF-related problems. These findings highlight the need of customising education

to solve underappreciated elements, such as sleep hygiene, along with conventional cardiovascular concerns, hence optimising AF prevention and management techniques.

### 4.2 The effects of providing prior information, and lifestyle modifications on atrial fibrillation

Among the 17 patients with restricted awareness of AF, 12 patients (70.6%) did not implement lifestyle modifications. Moreover, among 17 patients with prior knowledge of their AF, 11 patients (64.7%) did not alter their lifestyle.

**Table number 04: Association between prior information and lifestyle changes:** this table shows the relationship between prior information given to AF patients and their lifestyle changes.

| Variables | Lifestyle changes(n) | No lifestyle changes(n) | Total(n) |
|---|---|---|---|
| Prior information given | 6 | 11 | 17 |
| No prior information given | 5 | 12 | 17 |
| Total | 11 | 23 | 34 |

The Fisher's exact test yielded a p-value of 1.00, which exceeds the significance threshold of 0.05. This indicates that there is no significant association between the awareness given to patients with AF regarding their disease and change to their lifestyle.

This result implies that patient education does not necessarily translate to patient awareness or behavioural change. Although patient education is crucial for enhancing knowledge and control of AF, it might not be enough by itself to induce behavioural modification. Modifications in lifestyle could be greatly facilitated by elements such as access to resources, support networks, and tailored counselling. Moreover, the comparable rates of lifestyle modification among the patients who were and were not provided with prior information, draw attention to the intricacy of behavioural modification shaped by several social, psychological, and environmental elements outside awareness.

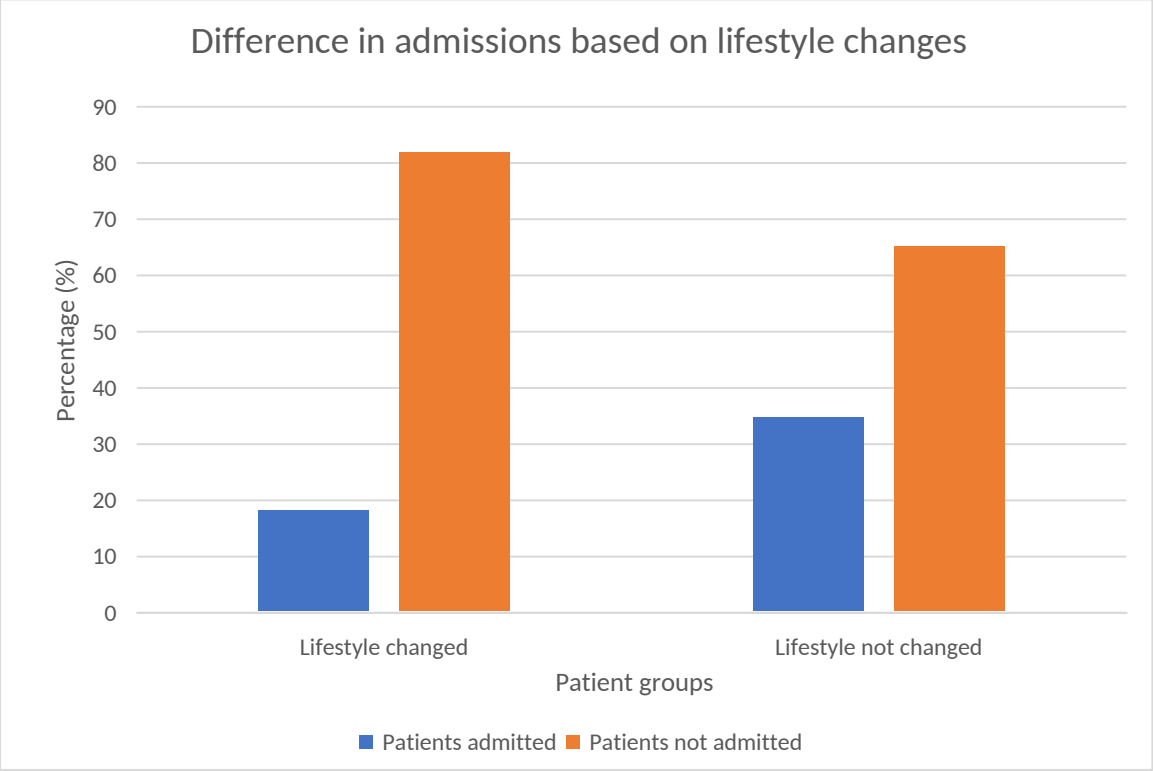


**Figure number 07: Difference in admissions to hospital based on lifestyle changes:** Comparison of admissions between patients who changed their lifestyle vs patients who did not change their lifestyle

It was observed that 11 of the 34 patients (32.35%) modified their lifestyle following an AF diagnosis, which encompassed smoking cessation, decreased consumption of alcohol, dietary modifications, and weight reduction. It is noteworthy that among these 11 patients, only 2 required re-admission to the hospital due to abnormal heartbeats, constituting approximately 18.18% of those who altered their lifestyle. Conversely, among the 23 patients who did not alter their lifestyle, 8 (34.78%) were re-admitted to the hospital due to complaints of irregular heartbeat (Figure number 7).

This indicates that lifestyle modifications may slightly affect patients with AF. These changes probably help to improve general cardiovascular health, therefore possibly lowering the frequency or intensity of irregular heartbeat episodes. Positively, the statistics emphasise the need for including lifestyle counselling as a main component of AF therapy to maximise its effects on patients and reduce healthcare costs.

**Table number 05: Comparison of hospitalisation between patients who changed their lifestyle after getting diagnosed with AF and patients who did not change their lifestyle after getting diagnosed with AF**

| Variables | Total patients | Hospitalisation | | | |
|---|---|---|---|---|---|
| | | Yes | % | No | % |
| Patients who changed their lifestyle | 11 | 2 | 18.18 | 9 | 81.82 |
| Patients who did not change their lifestyle | 23 | 8 | 34.78 | 15 | 65.22 |

**Table number 06: Association between patients who changed their lifestyle and their re-admission to the hospital:** this table shows the relationship between patients who changed their lifestyle after getting diagnosed with AF and their admissions to the hospital due to irregular heartbeat

| Variables | Re-admission to hospital(n) | No re-admission to hospital(n) | Total(n) |
|---|---|---|---|
| Patients who changed their lifestyle | 2 | 9 | 11 |
| Patients who did not change their lifestyle | 8 | 15 | 23 |
| Total | 10 | 24 | 34 |

The Fisher's exact test yielded a p-value of 0.43. This exceeds the significance threshold of 0.05, which indicates that there is no significant association between the patients who changed their lifestyle and their re-admission to the hospital. Although the present sample size might not show statistical association, the observed trend suggests that a bigger cohort might reveal a significant trend or association between changes in lifestyle and reduced hospital re-admissions.

Of the 6 patients who received prior information and made lifestyle adjustments, 1 (16.66%) was admitted to the hospital due to an irregular heartbeat. This finding highlights the substantial effect of integrating education with behavioural

modifications in decreasing hospital admissions. Patients in this group possess the knowledge necessary for proactive management of their condition, in conjunction with lifestyle modifications that may enhance overall cardiovascular health. Conversely, among the 11 patients who received prior information and failed to implement lifestyle changes, 1 (9.09%) was hospitalised. This may seem counterintuitive, yet it indicates that education alone offers a significant protective effect, potentially allowing patients to respond promptly during irregular heartbeat episodes.

Additionally, of the 5 patients who were not provided with prior information and altered their lifestyle, 2 (40%) were subsequently admitted to the hospital. This disparity underscores the significance of education in enabling patients to manage their condition effectively. However, lack of guidance in recognising and addressing acute symptoms may expose patients to complications.

Of the 12 patients who were not provided with prior information and did not alter their lifestyle, 6 (50%) were admitted to the hospital. This group constitutes the highest-risk cohort, as they possess neither the knowledge nor the behavioural tools necessary to mitigate the risks associated with AF. The findings highlight the combined detrimental impact of lack of awareness and the absence of lifestyle modifications, underscoring the essential importance of comprehensive patient care.

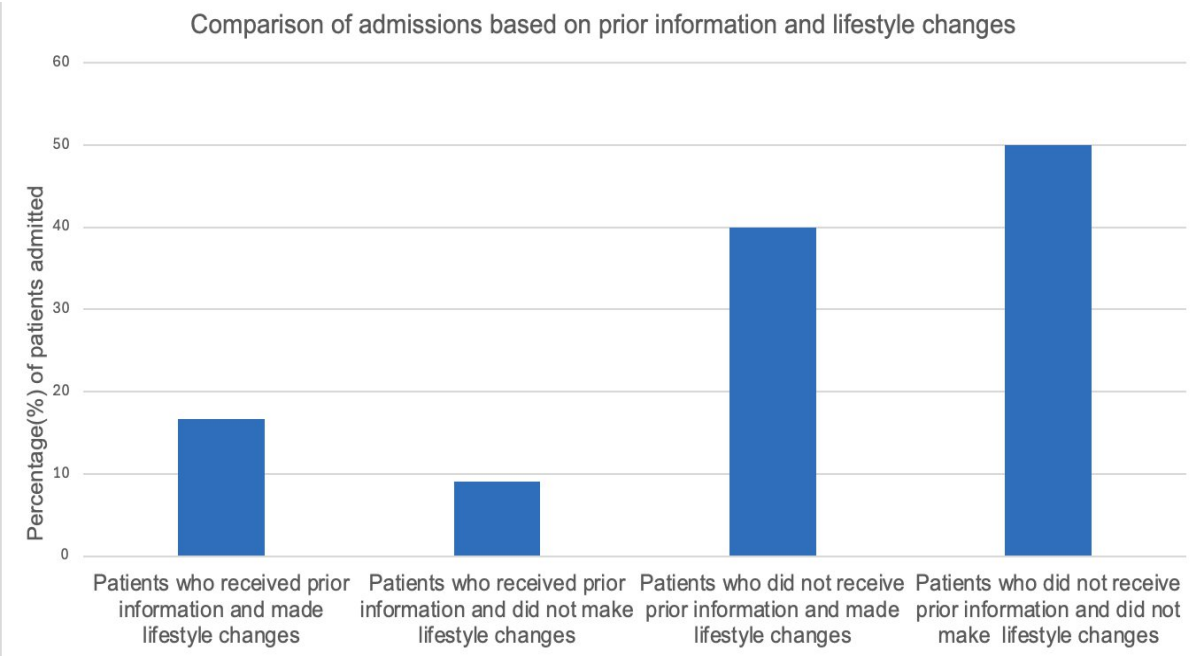


**Figure number 08: Impact of giving prior information and lifestyle changes on hospital admissions**

It was noticed that none of the patients appeared to know that the NHS recommends 150 minutes of moderate exercise or 75 minutes of vigorous exercise in a week or 30 minutes of moderate exercise for 5 days in a week (NHS,2011).

Still, 19 of them (55.88%) mentioned that they exercise on a regular basis. This implies that rather than following evidence-based recommendations suited to AF management, many patients are essentially motivated to exercise, probably influenced by general health advice or personal views.

This discrepancy represents a missed opportunity to maximise the effects of exercise on patient. Lack of knowledge about these recommendations could result in inadequate exercise habits, therefore reducing the potential benefits for the patients. This highlights the need for focused education efforts that not only underline the need for consistent physical exercise but also convey clear, practical recommendations. Including tailored exercise programs and follow-up assistance into patient care will help to close the awareness-behaviour gap and ensure that

patients benefit in a therapeutic manner from physical activity in the management of their condition. Through addressing this gap, physicians can enable patients to participate actively in their AF management, ultimately enhancing their quality of life.

### 4.3 Assessing anticoagulant compliance in atrial fibrillation: a comparison between adherence by patients and physician monitoring

It was noted that 32 of the 34 patients (94.11%) adhered to their anticoagulant treatment regimen. However, in the physician survey, only 17 (80.95%) respondents said that they undertake regular compliance assessments for their patients on anticoagulant medications (Figure number 9).

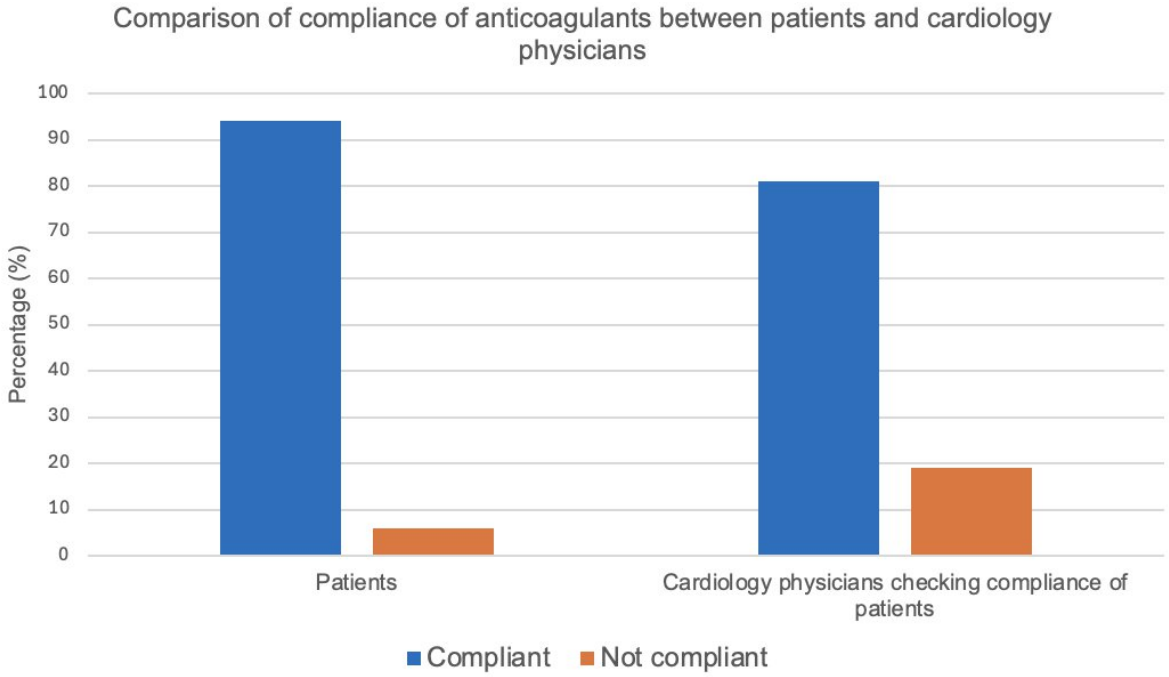


**Figure number 09: Comparison of compliance of anticoagulants between patients and cardiology physicians:** Comparison between percentage of patients compliant with their anticoagulant medication vs cardiology physicians who actively check compliance of anticoagulants among their patients

Reflecting on the efficacy of present prescribing techniques and patient education initiatives, the results show a largely positive trend in patient compliance with anticoagulant medications. The variety in physician compliance monitoring techniques, however, points up potential for development. Although most physicians actively ensure adherence, the lack of routine review of this among almost 20% of the physicians can result in lost opportunities for intervention in cases of non-compliance.

This emphasises the importance of a consistent method for compliance monitoring included into regular AF control. Frequent follow-ups combined with the use of digital adherence monitors or prescription diaries could help close gaps and guarantee continuous adherence. Furthermore, focusing on educational initiatives on physicians who do not routinely conduct compliance checks would help to improve its effects on patients by underlining the vital need of monitoring in avoiding complications. Healthcare systems could maximise the management of AF and lower the burden of anticoagulant-related complications by combining high compliance rates with regular medical oversight.

### 4.4 Analysis of the therapeutic approach by cardiology physicians in providing care to atrial fibrillation patients

In the meantime, when enquiring about the type of anticoagulant, 22 of the 32 patients (68.76%) reported that they are using apixaban. Three patients (9.37%) were administered edoxaban, three patients (9.37%) received rivaroxaban, and four patients (12.50%) were treated with warfarin. A notable preference for apixaban was observed among the cardiology physicians as well, with 16 of them (80%) selecting it as their anticoagulant of choice. Subsequently, warfarin was utilised by three

cardiology physicians (15%), whereas edoxaban was employed by one respondent (5%).

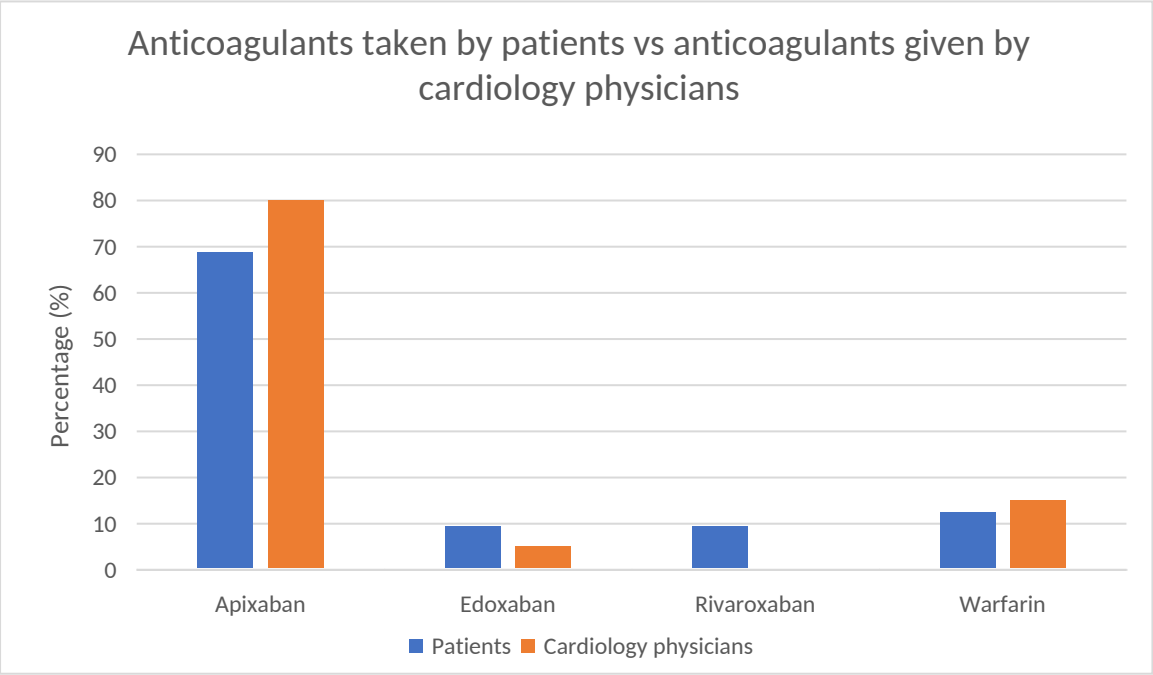


**Figure number 10: Anticoagulants taken by patients vs anticoagulants given by cardiology physicians:** Diversity in anticoagulants consumed by patients and anticoagulants given by cardiology physicians

Apixaban's favourable pharmacological profile, safety (fewer bleeding risks compared to warfarin), and efficacy in lowering stroke and systemic embolism in AF patients, reflects the preference for it (Proietti et al., 2018).

Warfarin, which previously was the standard of care, has witnessed a decrease in usage because of dietary restrictions and regular monitoring requirements that hamper patient compliance (Cohen et al., 2015).

The limited use of edoxaban among the cardiology physicians and patients points to it still being a less preferred option, probably due to limited familiarity, lack of strong guidelines supporting its use, or supposed benefits of other anticoagulants. The great congruence between physician prescription patterns and patient-reported

utilisation points to a well-integrated method of anticoagulant control in AF. However, the fact that warfarin is still being used in a subset of patients indicates that it is still a good option for some clinical situations, such as individuals who have artificial heart valves or who are contraindicated for NOACs (Banerjee et al, 2020). It was noted that barring 1 patient, everyone was on a blood thinner, which includes both anticoagulants and antiplatelets. This means that about 97.05% of the patients were on blood thinners. Eight out of the remaining 33 patients (24.24%) complained of having bleeding problems in the last 6 months.

The elevated frequency of bleeding complications in this cohort emphasises the careful balance between controlling bleeding risks and avoiding thrombotic events. Use of tools like the HAS-BLED and ORBIT score typically aim to minimise such events (NICE,2021).

When evaluating the risk of bleeding, 13 cardiology physicians (68.42%) from the survey confirmed that they utilise the HAS-BLED score, 1 participant (5.2%) employs the Caprini score, another participant (5.2%) considers clotting and bleeding time, 3 cardiology physicians (15.98%) mentioned utilising the ORBIT score, while 1 participant (5.2%) does not utilise specific scores but instead examines major contraindications, such as previous major bleeds or liver and renal failure (Figure 11). This variation in practice draws attention to the absence of universal standardisation in bleeding risk assessments. This also implies a possible gap in comparing clinical management with bleeding risk assessments. Employing blood thinning medications for AF patients should have a necessary balance. Although they greatly help to lower thromboembolic risks, they also carry a significant risk of bleeding problems.

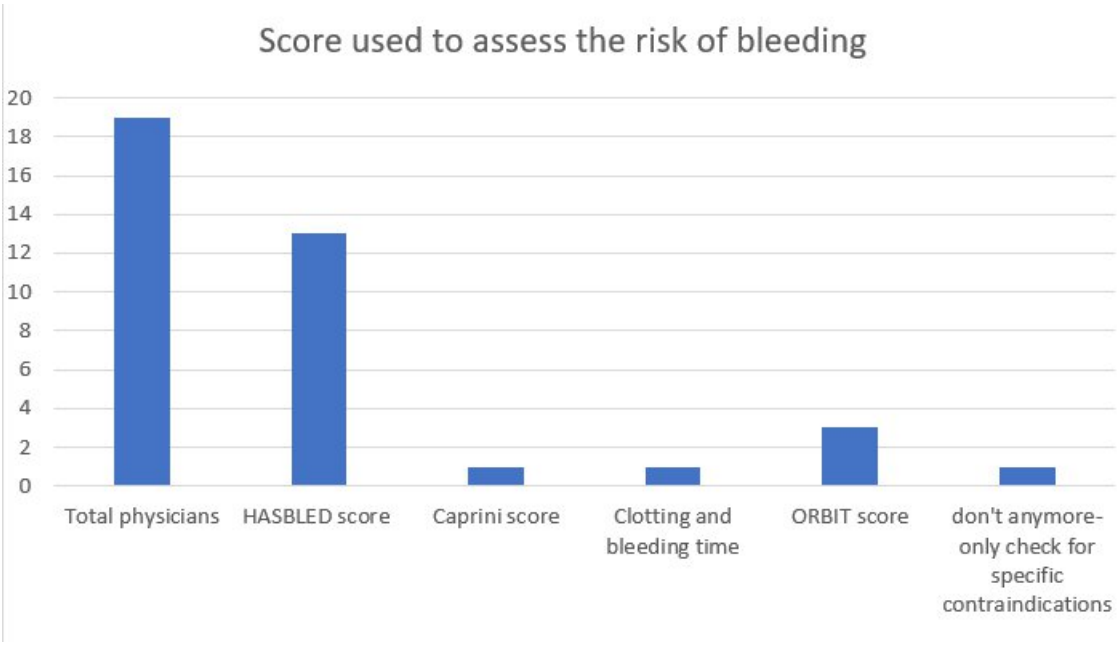


**Figure number 11: Scores used by cardiology physicians to assess the risk of bleeding vs total number of responses from cardiology physicians involved in the study initially**

Despite the risks, the fact that 97.05% of patients still use blood thinners indicates that, in most cases, the advantages of therapy exceed the complications, therefore reflecting good patient care and medication adherence.

The incidence of bleeding problems in almost one-quarter of patients emphasises the importance of rigorous risk assessment and continuous monitoring to maximise management. These findings highlight the need for customised patient evaluations since they help to balance the possible bleeding risk with the advantages of stroke avoidance. The mainstay of employing blood thinners should be patient education on recognising and responding to signs of bleeding.

It was observed that no patient had an episode of a heart attack or stroke in the past 6 months. When talking about the physician survey, the primary method for evaluating the risk of thrombosis in patients with AF is the CHA2DS2-VASc score, which was employed by 17 cardiology physicians, which accounts for 89.47% of the

physicians who responded. Additional methods of scoring used are the Caprini score and the FAST score, with each being mentioned by a single participant, which would account for 5.27% each (Figure number 12).

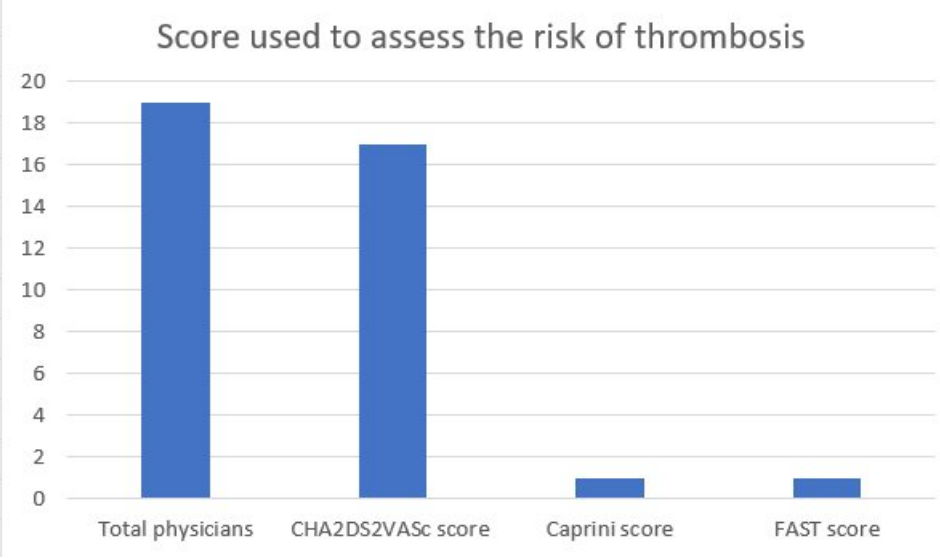


**Figure number 12: Scores used by cardiology physicians to assess the risk of thrombosis vs total number of responses from cardiology physicians involved in the study initially**

The absence of thromboembolic events among AF patients over six months highlights the effectiveness of current management strategies, particularly anticoagulation therapy and thrombosis risk assessment. The CHA2DS2-VASc score's widespread use among cardiologists demonstrates its reliability and acceptance as a standard tool for identifying patients at risk of thromboembolic events. However, the occasional use of alternative tools suggests that certain clinical situations may require tailored approaches beyond standard guidelines.
This underscores the significance of allowing for flexibility in the provision of personalised care while adhering to evidence-based practices. To enhance, it is imperative to ensure that all physicians have access to validated scoring systems, to

improve physician training on their proper use, and to investigate the integration of alternative tools when clinically applicable.

Out of the 10 patients diagnosed with paroxysmal AF, three of them (30%) reported experiencing episodes of palpitations lasting over 30 minutes. When enquired about their actions if the event exceeded one hour, one patient opined that contacting the GP would be advisable. Four individuals indicated their intention to proceed to the Accident and Emergency (A&E) department, whereas four patients referenced additional tablets they would consume should a similar incident arise. One patient preferred to call an ambulance. Five of the 10 patients (50%) were given the 'pill in the pocket' medication. This explains how patients with paroxysmal AF address symptoms related to palpitations, during episodes. This also suggests that patient education and preparation for managing acute AF symptoms are inconsistent.

The ‘pill in the pocket’ strategy shows potential as a self-management tool, with 50% of paroxysmal AF patients using it. Its limited acceptance, however, points to a chance to increase its usage where clinically relevant, therefore enabling more patients to manage episodes successfully and lower emergency visits that are not needed.

These results underscore the need to improve patient education to support consistent and informed self-management strategies. By ensuring that patients understand and have access to evidence-based management strategies, such as the ‘pill in the pocket,’ physicians can reduce reliance on emergency care for paroxysmal AF patients. This also highlights the need for tailored education that addresses gaps in symptom recognition and management strategies.

The treatment settings for AF patients by the cardiology physicians was observed to exhibit variation, with no physician exclusively treating those patients in outpatient

settings, 4 treating in inpatient settings (23.52%), while 17 (76.52%) confirmed that they treat patients in both outpatient and inpatient settings.

When it comes to the acute management of new-onset AF, the preferred approaches vary across the participants. Two physicians prioritise rate control (9.52%), while three prioritise rhythm control (14.28%). The majority, consisting of 16 (76.2%) cardiology physicians, base their approach on the patient's symptoms.

While rhythm control strives to restore and maintain sinus rhythm, rate control aims to maintain ventricular rate within an acceptable range. These decisions reflect clearly defined therapeutic goals. Evidence backs both the approaches, which are customised to patient-specific criteria like symptom load and co-morbidities (Van Gelder et al., 2005).

However, most cardiology physicians (76.2%) reported basing their approach on the patient’s clinical appearance and symptoms. This patient-centred strategy reflects a practical and adaptive approach to managing the variability in AF presentations. It allows for the flexibility to address acute distress, haemodynamic instability, or underlying triggers, while prioritising individualised care. However, the reliance on symptoms alone could introduce variability in treatment quality if not coupled with standardised protocols.

The post- PCI treatment of AF patients is addressed by 20 cardiology physicians, with one not involved in post-PCI treatment. This means that about 95.21% of them are involved in post-PCI treatment. Among those treating post-PCI patients, 2 employ dual therapy (10%), 6 use triple therapy (30%), and 12 (60%) determine the treatment strategy based on the risk of thrombosis versus bleeding. For context, dual therapy implies combining an anticoagulant with a single antiplatelet agent, while triple therapy entails an anticoagulant and two antiplatelet agents (NICE,2021).

This emphasises the critical role of cardiologists in managing the interplay between AF and coronary artery disease (CAD). Post-PCI management is complex, requiring a balance between preventing thrombotic events and minimising bleeding risks, especially when both OACs and antiplatelet agents are indicated. Although dual and triple therapy are still crucial in some high-risk cases, the focus on tailored therapies points to a change towards reducing bleeding risks while preserving good thromboprophylaxis. This emphasises the need to include risk stratification measures and collaborative decision-making into post-PCI care.

### 4.5 Analysis of the diagnostic approach by cardiology physicians in providing care to atrial fibrillation patients

Finally, out of the 21 cardiology physicians, 20 (95.23%) indicated they ask newly diagnosed AF patients for a TTE, with only one (4.77%) leaving out TTE.
This high rate of adoption underlines the need of TTE in exposing structural and functional cardiac abnormalities driving personalised treatment regimens and respects evidence-based recommendations (NICE, 2021). The consistency in TTE use improves the quality of treatment by supporting early risk stratification and thereby improving patient care. Maintaining comprehensive and efficient AF management will depend on ongoing focus on TTE as a basic diagnostic technique going ahead.

# Chapter 5

# Discussion

This study's findings offer significant insights into AF care and underscore the essential role of patient education in decreasing hospital admissions. Approximately 29% of patients in the cohort had been hospitalised in the preceding six months due to irregular heartbeat. A notable disparity was seen between individuals who received prior information on managing episodes of irregular heartbeats and those who did not. Only about 12% of patients who got this information were subsequently hospitalised, in contrast to about 47% of those who were not informed. This contrast illustrates the safeguarding influence of proactive education, which empowers patients to manage their condition efficiently, thereby decreasing unnecessary hospital visits. Moreover, patients who received previous guidance on recognising symptoms, determining when to pursue hospital care, and controlling episodes were more adept at handling their symptoms, leading to reduced hospitalisation rates. These findings underscore the necessity for clear, accessible, and actionable information to be delivered to patients to enhance self-management and reduce the burden on healthcare systems.

In the context of AF, the guidance provided by the cardiology physicians is essential for improving patient care. The correlation between the quality of physician-patient communication and patient treatment is unequivocal. Informed patients are more inclined to participate in efficient self-management, hence decreasing complications and the probability of hospital readmission. The capacity of clinicians to convey risk factors, treatment alternatives, and symptom management strategies clearly and empathetically is crucial.

The research indicates that 57% of surveyed cardiologists consistently provide informative leaflets to patients newly diagnosed with AF, whereas 43% do not. This underscores a significant discrepancy in the availability of instructional resources, despite their clear usefulness in facilitating patient self-management.

The findings also indicate that although a significant proportion of patients (79%) recognise the common risk factors linked to AF, including smoking and alcohol intake, merely 41% are cognisant of the risks posed by insufficient sleep. This indicates a deficiency in patient education concerning lifestyle factors that affect the condition. Furthermore, patients who implemented lifestyle modifications post-diagnosis had markedly decreased readmission rates (18.18%) in contrast to those who refrained from making any changes (34.78%), highlighting the critical role of lifestyle interventions in mitigating hospital readmissions.

Compliance with prescribed anticoagulant medication was high, with 94.11% of patients consistently adhering to their prescription. However, merely 80.95% of the cardiology physicians indicated that they consistently monitor adherence, underscoring a potential deficiency in systematic adherence evaluations and the necessity for more rigorous follow-up procedures.

The survey indicated the prevalent implementation of customised treatment strategies, with 50% of patients utilising a 'pill-in-the-pocket' method for the management of paroxysmal AF. This individualised care strategy aligns with best practice recommendations, providing patients with a flexible and effective method for controlling bouts of arrhythmia.

Regarding anticoagulant management, 68% of surveyed cardiology physicians utilise the HAS-BLED score to evaluate bleeding risk, whereas merely 16% employ the ORBIT score. The findings indicate a preference for established scoring systems, while the infrequent utilisation of other tools may highlight opportunities for enhancement in clinical practice. Moreover, although 80% of physicians favour apixaban as their primary anticoagulant, marginally lower percentage of patients (69%) indicated its usage, implying possible inconsistencies in treatment preferences or pharmaceutical accessibility. In the context of post-PCI anticoagulant therapy,

10% of physicians administer dual therapy, 30% employ triple therapy, and 60% customise their treatment according to individual risk evaluations, weighing the risks of thrombosis against bleeding.

The results underscore multiple opportunities for enhancement in patient education and clinical management methods for the care of AF patients. This section will discuss the ramifications of these findings in depth, focusing on the necessity of standardisation of educational interventions and enhancing clinical practices for optimal effects on patients.

### 5.1 Impact of educational interventions on medication adherence and clinical outcomes in cardiovascular patients: a comparative analysis

Structured educational programs have become an essential strategy to increase medication adherence in patients and improve their clinical outcomes (Abbott HCP Global, 2023). Customised strategies are used in these approaches to meet the specific needs of each patient, encourage self-management, and help people understand difficult treatment plans better (Rush et al., 2019). When it comes to cardiovascular diseases, these measures are becoming important because they help people have long-term adherence, avoid side effects, and avoid readmissions to the hospital. Healthcare systems can close gaps in patient knowledge, reduce socio-demographic inequalities, and follow modern recommendations, calling for a comprehensive approach to patient-centred care by including education into clinical practice (Amin et al., 2024). This section explores the great influence of organised educational programs and provides a comparison with past research to highlight their impact on management of cardiovascular conditions.

The results of this study reflect on the guidelines presented in the 2018 European Heart Rhythm Association (EHRA) practical guide on the use of NOACs in people

with AF (Steffel et al., 2018). The study underscores the vital role of education in enhancing medication adherence and decreasing hospital readmissions for patients with AF, which is in accordance with the EHRA's recommendations. Adherence to NOAC therapy is facilitated by organised education programs, including nurse-led AF clinics, which prevent hospitalisations and guarantee its therapeutic efficacy. The study emphasises the significance of comprehensive education that involves both medication adherence and lifestyle adjustments, such as enhancing sleep quality, which are frequently disregarded.

The primary focus of the service evaluation of this study is assessing the education of patients and physicians with a specific emphasis on comparing the hospitalisation of patients with prior information provided with patients with no prior information provided. The hospitalisations were only counted if they were admitted with complaints of irregular heartbeat. Education was defined as information given by healthcare professionals through individual sessions.

The results also correspond with the EHRA's recommendation for personalised treatment plans, which includes strategies such as the 'pill-in-the-pocket' approach for the management of paroxysmal AF. These strategies, in conjunction with active patient engagement, underscore the necessity of adaptable, personalised care to enhance patient outcomes and decrease hospital visits (Steffel et al., 2018).

The structured education for enhanced escalation and rhythm control in atrial fibrillation (STEEER-AF) experiment, presented at the ESC Congress 2024, sought to enhance patient-level compliance with AF management recommendations by the implementation of a focused educational program for healthcare workers (Bunting, Van Gelder and Kotecha, 2020). Conducted in six European countries, France, Germany, Italy, Poland, Spain, and the UK, the study included 1,732 patients with AF. The experiment split the involved centres in two groups. One group

maintained educational activities, while the other group underwent a 16-week specialised education program stressing on integrated care, rhythm management, and stroke prevention. The findings indicated that there was no notable enhancement in adherence to stroke prevention. However, the intervention resulted in a considerable rise in adherence to rhythm control guidelines, increasing from 21.4% to 33.9%, compared to the control group's growth from 20.5% to 22.9%. Both studies highlight the significance of educational interventions in enhancing adherence to AF management (Bunting, Van Gelder and Kotecha, 2020). Contrary to the STEEER-AF study, this study specifically focused on educating patients rather than healthcare providers. Both studies concur that education plays a crucial role in optimising AF management. These consistent results indicate that to achieve comprehensive enhancement in AF management, educational interventions should focus on both physicians and patients, addressing deficiencies in knowledge and practice across several levels of care.

The study by Amin et al. on the efficacy of clinical decision support systems (CDSS) focused on strategies to raise medication adherence among AF patients.

It looked at how medical practitioners applied CDSS, and computerised technologies designed to raise guideline adherence. CDSS reduced MI and embolic events, according to the results of the meta-analysis. The prescription rates of OACs did not, however, significantly increase or decrease serious bleeding events. These results suggest that while technology-based solutions could improve some clinical outcomes, they have minimal effect on directly influencing adherence behaviours when compared to interventions targeted on patient and physician education. Although they use different approaches, both studies agree on the need for raising treatment adherence to achieve better results in AF control. These findings imply that including education and decision-support instruments can present a whole

strategy for increasing patient adherence in AF patients. (Ahmed Mazen Amin et al., 2024).

On the other hand, Banerjee et al.'s study ranked adherence and persistence rates based on demographic and clinical criteria rather than giving instructional interventions priority. It was noticed that apixaban had the highest adherence rate at 64.7% whereas the general adherence to OACs was 55.2%. With the highest persistence rates of 78.7% in apixaban, it was indicated that patients wanted to continue using it for a long period even without instructional support.

Improved adherence was also found to be correlated with several patient attributes including older age, female gender, and higher CHA2DS2-VASc scores. Poor adherence was linked with factors such as younger age, hypertension, and socio-economic differences. Although this thesis stresses that education is a key element in improving adherence, Banerjee et al. underlines the significance of socio-demographic and clinical factors in affecting the continued use of OACs.

Both studies concur on the significance of adherence in averting complications, such as stroke, in AF patients. Additionally, the study showed that better adherence, particularly to apixaban, reduced the chances of patients stopping their prescription, leading to better long-term clinical results. (Banerjee et al., 2020).

Dagnew et al. looked at how closely Ethiopian patients with a cardiovascular disease followed their prescribed treatment. According to the results, a significant proportion of people showed low to moderate degrees of adherence. Although the study did not directly look at treatments like structured education, it did find several elements that lead to poor adherence including advanced age, alcohol use, multiple prescription use, and severe co-morbidities. The interventions in that trial mostly consisted of counselling and imparting information to family members. This suggests that these patients can also derive educational support, albeit in a less formal

environment.

The study also showed that specific patient characteristics, such as age and comorbidities, had a substantial impact on adherence levels. Nevertheless, their primary emphasis was on identifying socio-demographic determinants rather than doing specific interventions. While both studies acknowledge the influence of these factors on adherence, this thesis takes it a step further by actively evaluating educational interventions, whereas Dagnew et al. offer insights into the wider determinants of adherence without executing a systematic program (Dagnew et al., 2024).

**Table no. 07: Overview of studies on patient education, adherence and clinical outcomes in cardiovascular care:** this table offers a relative summary of the studies that concentrate on ways to enhance cardiovascular patient outcomes. It highlights each study's focus, methodology, sample size, key metrics assessed, and primary outcomes. With an eye toward maximising adherence, lowering readmissions, and improving general health in cardiovascular patients, studies include a spectrum of approaches including patient education, physical fitness, clinician education, and decision support systems.

| Study | Study focus | Methodology | Sample size | Key metrics | Key outcomes |
|---|---|---|---|---|---|
| This study | Patient education | Evaluation of impact of patient education on self- | 50 AF patients | Medication adherence, readmission rates | Improved adherence and reduced readmissions |

| | | | | | |
|---|---|---|---|---|---|
| | | management, medication adherence and hospitalisation in AF patients | | | |
| STEEER -AF study | Clinician education | 16-week education program for healthcare providers | 1732 patients | Adherence to rhythm control guidelines | Improved adherence to rhythm control guidelines |
| Amin et al. study | Clinician decision support | Utilisation of CDSS to support decision making of clinicians | Meta-analysis | MI and embolic event rates | Reduced MI and embolic events |
| Banerjee et al. study | Socio-demographic factors | Observational study on adherence based on demographics | 500 AF patients | Adherence based on demographic factors | Identified key socio-demographic factors affecting adherence |
| Dagnew et al. | Patient characteristic | Observational study | 300 patients | Medication adherence, | Identified barriers to |

| | | | | |
|---|---|---|---|---|
| study | s | assessing adherence in cardiovascular patients in Ethiopia | impact of literacy and comorbidities | adherence in low resource settings |

Another study by Villalobos-Pedroza et al. in Mexico investigated the adherence of patients to their medication following an ST-elevation myocardial infarction (STEMI). The research revealed that only 44.7% of patients followed optimal medical therapy, which encompassed medications such as beta-blockers, ACE inhibitors, statins, and antiplatelet agents. Major adverse cardiovascular events (MACEs), such as cardiovascular mortality, recurrent MI, and heart failure, were more prevalent among non-adherent patients. Nevertheless, Villalobos-Pedroza et al. did not implement a structured educational intervention to increase adherence, as they identified forgetfulness, skipping doses, and a lack of knowledge about the medication as the primary barriers to adherence.

This creates room for further investigation of how structured education can help post-STEMI patients in the manner it supported patients with AF in this study.

Though the clinical results of this trial and the Villalobos-Pedroza study were different, both results highlight the major impact that medication adherence has on patient survival and general condition (Villalobos-Pedroza et al., 2024).

Hussein et al., on the other hand, paid less emphasis on organised instructional interventions. Instead, they looked at the clinical and sociocultural elements influencing adherence among Ethiopian patients with chronic heart failure (CHF). Their study revealed that 56% of individuals showed ideal drug adherence. Determining adherence levels mostly relied on literacy, education level, access to

health insurance, and comorbidities. Patients who were insured, literate, and had less prescribed medications were more likely to follow their treatment plans. The study underlined the requirement for patient understanding and communication with healthcare practitioners, which are fundamental for improving adherence even in the absence of direct educational interventions (Hussein et al., 2024).

Non-adherence was associated to elements including polypharmacy and comorbidities, which can aggravate clinical outcomes for CHF patients. Though it did not run any educational initiatives, the study underlined the need to conquer challenges to adherence, including literacy and healthcare accessibility (Hussein et al., 2024).

**5.2 Comparative studies of anticoagulation therapies in AF**

As NOACs like apixaban, rivaroxaban, and dabigatran have become more popular, traditional VKAs like warfarin have become less prevalent. This change in anticoagulant treatment has been very important in changing how well patients do. This paradigm shift handles the problems that come with VKAs, like the need for frequent monitoring, dietary restrictions, and drug interactions. It shows a commitment to improving both clinical effectiveness and patient experience.

Independent of rhythm or rate control, studies such the AFFIRM research have demonstrated the basic importance of anticoagulation in stroke prevention for AF patients (Gillinov et al., 2016). Additional studies including the Explore the efficacy and safety of once-daily oral rivaroxaban for the prevention of cardiovascular events in patients with non-valvular AF scheduled for cardioversion (X-VeRT) and Randomised Evaluation of Long-Term Anticoagulation Therapy (RE-LY) trials have broadened the evidence base and shown the better safety profiles, convenience, and either equivalent or improved efficacy of NOACs relative to VKAs (Cohen et al., 2015; Romanelli et al., 2016).

This section emphasises on the ongoing improvement of anticoagulation therapy strategies, the integration of tailored care approaches, and the difficulties in reaching ideal management of AF by contrasting landmark studies with contemporary discoveries.

Comprising a multicentre randomised trial carried out in North America between 1995 and 1999, the Atrial Fibrillation Follow-up Investigation of Rhythm Management (AFFIRM) trial looked at how well rate control and rhythm control strategies worked for high-risk individuals with AF (Gillinov et al., 2016). Warfarin, a VKA, played a key role in the AFFIRM studies in controlling blood clots for people with AF. Regardless of whether the subjects were given rate-control or rhythm-control strategies, the study stressed how crucial it is for patients with AF to keep up with their anticoagulation therapy to lower their risk of stroke. Warfarin was the main anticoagulant employed. Patients who suffered strokes throughout the trial frequently either stopped taking warfarin or had insufficient International Normalised Ratio (INR) levels, underscoring the efficacy of warfarin in preventing strokes when appropriately administered.

Both therapeutic options equally stressed the need for continuous anticoagulation. In the group that followed a rhythm-control approach, stroke occurrences were attributed to either stopping warfarin or failing to maintain therapeutic INR levels. This highlights the importance of adherence to anticoagulants, even if sinus rhythm has been restored. The rhythm-control group exhibited elevated rates of hospitalisation and experienced negative consequences from medication administration. While warfarin was not the main cause, the total difficulty of managing it, which includes monitoring and adjusting the dosage, might have had a role in this outcome (Gillinov et al., 2016).

The findings of the study showed that those with AF should not stop using

anticoagulants because their sinus rhythm was restored. Regular anticoagulant intake is necessary to reduce the risk of thromboembolic events over a period. INR levels must be continuously monitored for stroke risk to be reduced efficiently. This draws attention to the shortcomings and the requirement of careful management in therapeutic settings (Gillinov et al., 2016).

Another multicentre randomised trial was conducted in Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, Switzerland, the United Kingdom, and the United States to compare the efficacy of rivaroxaban, a factor Xa inhibitor, with VKAs (Dawwas et al., 2022). Patients who took rivaroxaban had better outcomes than those who took VKAs. The ease of use was an important feature. Unlike VKAs, rivaroxaban does not need to be changed regularly based on INR levels or regular tracking of coagulation. It is instead presented as a fixed-dose plan. By allowing the patients to follow a simpler prescription schedule and removing the need for regular blood testing, this significantly reduces the burden.

Another notable benefit of rivaroxaban is the lack of dietary limitations (Dawwas et al., 2022). VKAs, such as warfarin, have an interaction with vitamin K. This requires careful monitoring of the diet to maintain stable levels of INR. People who consume rivaroxaban don't have to follow any dietary restrictions. The ease of handling their treatment is greatly improved by this benefit.

In addition, rivaroxaban is less likely to have drug interactions than VKAs. Thus, patients can use different medicines without having to make regular changes and be supervised, which makes their treatment plan efficient.

Patient satisfaction is significantly influenced by the efficacy and safety of rivaroxaban. Research, such as the X-VeRT study, has shown that rivaroxaban is both efficient and has a similar safety profile to VKAs (Cohen et al., 2015).

Published in the Annals of Internal Medicine, the study, "Apixaban versus rivaroxaban in patients with atrial fibrillation and valvular heart disease: a population-based study," compared the safety and efficacy of apixaban and rivaroxaban in patients diagnosed with AF and valvular heart disease (VHD) (Dawwas et al., 2022). Using practice-based claims data, the researchers replicated a target trial included 19,894 patients matched 1:1 for each anticoagulant according on propensity scores. The main measure of effectiveness was the occurrence of ischemic stroke or systemic embolism, while the main measure of safety was gastrointestinal or intracranial bleeding. Comparatively to those who received rivaroxaban (9.1 per 1000 person-years), the study found that those who received apixaban had a lower incidence risk of ischaemic stroke or systemic embolism (5.2 per 1000 person-years). Comparatively to rivaroxaban users (28.1 per 1000 person-years), apixaban users had a lower incidence of gastrointestinal or cerebral haemorrhage (14.3 per 1000 person-years). The absolute reduction in the probability of stroke or systemic embolism with apixaban was 0.0026 within six months and 0.011 within one year of treatment initiation. Similarly, the absolute reductions in the probability of bleeding events were 0.012 and 0.019 within six months and one year, respectively (Dawwas et al., 2022).

A comparative analysis was undertaken by carefully examining multiple databases to examine the effectiveness of dabigatran, a NOAC introduced in 2010, in comparison to warfarin (Romanelli et al., 2016). The report cited the significant multicentre randomised clinical trial RE-LY, carried out in 44 countries. The trial aimed to compare two specific doses of dabigatran (110 mg and 150 mg) with warfarin over a duration of more than two years. The RE-LY trial, which included 18,113 patients with non-valvular AF, determined that the 150 mg dose of dabigatran was more effective than warfarin in avoiding ischemic strokes. Additionally, it had a lower

incidence of cerebral haemorrhage (0.44; 0.34–0.59; p<0.001). Nevertheless, it exhibited an elevated incidence of gastrointestinal bleeding (1.23; 1.01–1.50; p=0.041). The 110 mg dosage of dabigatran demonstrated non-inferiority to warfarin in its ability to prevent ischemic stroke, while exhibiting comparable rates of gastrointestinal bleeding but lower rates of intracranial haemorrhage (Romanelli et al., 2016).

The Beaumont Health System in Southeast Michigan undertook a retroactive cohort study (Said et al., 2020). Data from Beaumont Health's electronic health record, particularly the Epic database, were used in the study. The information covered the period from January 1, 2010, till March 1, 2017. Prescribed one of the NOACs, apixaban, rivaroxaban, or dabigatran, the study included adult patients aged 18 to 100 who had non-valvular AF or atrial flutter. The findings indicated that individuals who concurrently consumed both NOACs and aspirin exhibited a notably elevated incidence of serious adverse cardiac events in comparison to those who exclusively used NOACs. The HR for MACE in the group exposed to aspirin was 2.11, indicating a risk that is more than double. In addition, the group of individuals using aspirin also saw a greater incidence of bleeding episodes, with a HR of 1.30. The mortality rates in the two groups were similar (Said et al., 2020).

These results highlight the increased risk of unfavourable consequences connected to the combined aspirin and NOAC use in patients with atrial flutter or AF. This suggests that this combination treatment should be used only when absolutely needed and handled carefully (Said et al., 2020).

**Table no. 08: Comparison of anticoagulant studies in AF management:** Major studies on anticoagulant treatments for AF management are compiled here in a comparative summary. Every study looks at anticoagulants, assessing their efficacy,

safety profiles, patient satisfaction, and general effect on bleeding risks and stroke prevention. Important results and key findings underline the benefits and drawbacks of several anticoagulants, including warfarin, rivaroxaban, apixaban, and dabigatran, as well as the difficulties in their use including the need of INR monitoring, dietary restrictions, and drug interactions.

| **Study** | **Location/ Duration** | **Anticoagulants compared** | **Key outcomes** | **Significant findings** |
|---|---|---|---|---|
| AFFIRM trial | North America, 1995-1999 | Warfarin | Warfarin reduced stroke when INR was controlled. Emphasised anticoagulation continuity despite rhythm control. | Strokes linked to stopping warfarin or low INR; need for continuous anticoagulation |
| Cohen et al. study | Multicentre | Rivaroxaban vs VKAs | Rivaroxaban preferred by patients, fixed dose, no INR monitoring, fewer dietary restrictions, fewer drug | Patients favoured rivaroxaban for convenience; lower management burden. |

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|---|---|---|---|---|
| | | | interactions. | |
| Apixaban versus rivaroxaban in patients with atrial fibrillation and valvular heart disease: a population-based study | USA, 2013-2020 | Apixaban vs. rivaroxaban | Apixaban reduced stroke and embolism risk, fewer GI and cerebral bleeds compared to rivaroxaban. | Apixaban is safer with reduced stroke/bleeding vs. rivaroxaban in AF and VHD. |
| RE-LY trial | 44 countries, >2 years | Dabigatran vs. warfarin | Dabigatran (150 mg) is superior to warfarin for stroke prevention | 150 mg dabigatran had less intracranial bleed risk; increased GI bleeds with both doses. |
| Said et al. study | Beaumont health system, Michigan, 2010-2017 | Apixaban, rivaroxaban, dabigatran, and aspirin | Combined use of NOACs and aspirin led to higher cardiac events and | Higher adverse cardiac events and bleeding when combined with |

bleeding risks. aspirin.

The way anticoagulants are managed in AF has changed gradually. New recommendations on choosing the most suitable anticoagulant tailored to specific patients have helped to support this evolution. The ESC designed guidelines in 2024 in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS) to offer interesting suggestions to improve anticoagulant therapy and outcomes for patients (Van et al., 2024). These recommendations especially underscore the need of customised treatment strategies and aid to rank NOACs above VKAs for most patients depending on their better safety profile and reduced bleeding risk. This aligns with the findings of studies including the RE-LY trial, which revealed how well NOACs, including dabigatran and apixaban, lower stroke and systemic embolism risk with a lower incidence of cerebral haemorrhage than warfarin (Romanelli et al., 2016). The ESC's advice of NOACs over VKAs is particularly crucial for AF patients with a higher bleeding risk when the safety of NOACs gives a clinically advantageous profile.

The inclusion of patient-centred treatment and multidisciplinary coordination in the ESC recommendations emphasises on the important role that comprehensive care performs and suggests that combining pharmacological breakthroughs with educational initiatives could greatly improve patient outcomes in AF (Van et al., 2024).

### 5.3 Updated guidelines for bleeding risk assessment in atrial fibrillation patients

NICE has recently changed its guidelines to assess the risk of bleeding. While the HAS-BLED score was used earlier, in April 2021, NICE published an updated clinical

guideline on the diagnosis and management of AF. It now recommends using the ORBIT score for predicting the risk of bleeding in patients consuming anticoagulant medications with AF.

The HAS-BLED score evaluates the 1-year risk of major bleeding in patients with AF who are on anticoagulation therapy. It considers the following factors:

- Hypertension (systolic BP > 160 mmHg)
- Abnormal renal and liver function
- Stroke history
- Prior major bleeding or predisposition
- Labile INR
- Age over 65
- Use of drugs that increase bleeding risk (e.g., antiplatelet agents, NSAIDs)
- Alcohol consumption

Each parameter carries 1 point each, and individuals with a HAS-BLED score of 3 or higher are classified as being at a heightened risk for bleeding and should get more vigilant monitoring.

The ORBIT score is a more recent tool designed to predict major bleeding in AF patients. It includes:

- Older age (≥ 75 years) (1 point)
- Reduced haemoglobin/haematocrit or history of anaemia (2 points)
- Bleeding history (2 points)
- Insufficient kidney function (eGFR < 60 mL/min/1.73 $m^2$) (1 point)
- Treatment with antiplatelet agents (1 point)

The ORBIT score is often seen as simpler and equally effective compared to HAS-BLED, with some studies suggesting it might be better at determining major bleeding events in certain populations. (NICE Publishes Updated Clinical Guideline on the Diagnosis and Management of Atrial Fibrillation | NICE, 2021, Proietti et al., 2022)

A randomised controlled trial was conducted with 7,411 patients on rivaroxaban (O'Brien et al., 2015). The trial indicated that the rate of severe bleeding was 4 cases per 1000 person-years. The study conducted a comparison between two bleeding risk scores, namely ORBIT and HAS-BLED, to determine their predictive accuracy. To evaluate the accuracy of the scores in appropriately identifying patients with and without significant bleeding episodes, the c-statistics were computed for the derivation and validation cohorts. In the derived cohort (ORBIT-AF registry), the c-statistic for the ORBIT score was 0.67; in the validation cohort, it was 0.68. However, the HAS-BLED score showed a consistent performance with c-statistics of 0.61 in the derivation and validation cohorts (O'Brien et al., 2015).
When compared to the HAS-BLED score in both cohorts, the ORBIT score demonstrated better prediction accuracy for significant bleeding events.
Although the ORBIT score has statistical benefits, the HAS-BLED score incorporates the labile INR, which is a crucial indicator of bleeding in patients on VKAs. This incorporation is essential since unstable INR is a powerful indicator of the likelihood of bleeding in patients who are using VKAs (O'Brien et al., 2015).

Particularly supporting a more flexible and patient-centred approach, the 2024 ESC recommendations give fresh focus on assessment of bleeding risk in AF treatment (Van et al., 2024). These guidelines advise bleeding risk assessment not only at the beginning of anticoagulant therapy but also on a regular basis during the patient's treatment. Healthcare providers can adjust the anticoagulant therapy depending on

changing patient circumstances by means of this stepwise approach, therefore preventing adverse events associated to anticoagulation, including major bleeding episodes.

To more precisely evaluate bleeding risk in line with this, the guidelines advise techniques including the HAS-BLED and ORBIT scores. Finding patients who might benefit from lowered dosages, temporary discontinuance, or other therapy approaches depends on these tools. Furthermore, emphasised by the ESC recommendations are the need of new risk-reducing techniques including organised patient education on lifestyle choices possibly affecting bleeding risk (Van et al., 2024). This is in line with the results of this study, which show that adherence to anticoagulants and lifestyle changes education can help to lower the clinical and financial load of AF-related problems.

### 5.4 Recommendations for dual and triple therapy in atrial fibrillation patients post-PCI

For patients with AF, the NICE guideline on AF provides recommendations for dual and triple antithrombotic therapy, therefore balancing the risks of thrombosis and bleeding (NICE, 2021).

For patients with AF who need anticoagulation for stroke prevention and have another indication for antiplatelet therapy, such as PCI, dual therapy, that is, combining an anticoagulant with a single antiplatelet agent might be considered. Starting dual therapy should be decided with careful consideration of the patient's bleeding risk, utilising scores such as the ORBIT bleeding risk score and with collaborative decision-making with the patient to balance the risks and benefits (NICE, 2021).

Usually reserved for high-risk patients, notably those having PCI with stent

placement, triple therapy, which entails an anticoagulant and two antiplatelet agents. Considering the higher bleeding risk associated with triple therapy, NICE advises employing this approach for the shortest duration. It should be personalised considering factors such the patient's co-morbidities, risk of stroke and bleeding, and the clinical setting. NICE advices to schedule regular follow-ups to review and modify the treatment if necessary.

Furthermore, as aspirin monotherapy is less effective than anticoagulation, the guideline recommends avoiding it for AF prevention from strokes. To reduce bleeding risks during dual or triple therapy, it also underlines the need for tracking and treating modifiable risk factors including hypertension, inadequate INR management, or concurrent use of other bleeding-prone medications (NICE, 2021).

Complimenting the NICE guidelines, the ESC also has recommendations for dual and triple antithrombotic therapies for patients with AF undergoing PCI (Van et al., 2024).

After an initial dosage of triple therapy, ESC advises dual therapy that is, combining a NOAC with a single antiplatelet drug such aspirin or clopidogrel. This approach preserves appropriate antithrombotic efficacy and is linked with a lower risk of bleeding. Aiming to reduce needless exposure to several antithrombotic drugs, it is especially appropriate for stable patients or those with reduced thrombotic risk.

Triple therapy, which is, combining aspirin and clopidogrel with a NOAC or VKA, could be saved for high-risk patients. Usually, these situations include patients either presenting with Acute Coronary Syndrome (ACS) or having undergone complicated coronary stenting. Triple therapy is purposefully kept short, usually lasting a few days or weeks, to reduce the increased risk of significant bleeding linked with this approach (Van et al., 2024).

Risk assessment scores, like the CHA2DS2-VASc and HAS-BLED scores underline

tailored treatment. They help physicians to customise therapy length and intensity to ensure that the best balance between bleeding risk and stroke prevention is reached.

Antiplatelet medications may be stopped early, usually after 12 months, for stable patients, leaving them on oral anticoagulation alone (Van et al., 2024). This approach continues to provide good stroke protection while lowering long-term bleeding hazards.

### 5.5 Future directions

This section addresses future directions for improving patient education management of AF by combining several innovative concepts that address global, cultural, and technological aspects while considering specialty-specific details. Comparative cross-cultural studies highlight regional differences in educational approaches. Meanwhile, using specifically adapted, culturally sensitive materials improve accessibility and influence (Protheroe, Estacio, and Saidy-Khan, 2015). Particularly tailored approaches meeting the specific needs of family-centred, acute, and chronic care could improve outcomes in many spheres of medicine (Kirsty Mackenzie, 2020).

Longitudinal studies allow evaluation of the continuous efficacy of training materials and investigation of reinforcing measures such as customised follow-ups or digital tools (Dessie et al., 2021). Driven by mHealth solutions and AI, digital health platforms offer interactive, real-time education, therefore bridging modern and traditional techniques (Coulter and Ellins, 2007). Overcoming challenges in educational practices requires system-wide improvements including training for doctors, resource allocation, and innovative distribution strategies to eliminate disparities (Protheroe, Estacio, and Saidy-Khan, 2015).

While stressing psychological and emotional aspects of education guarantees comprehensive treatment, innovative concepts including gamification, AI-driven customisation, and video-based teaching provide opportunities to actively involve patients (Reis et al., 2022; Huston, 2024). Using feedback loops and addressing health literacy helps to enhance materials for a varied patient community (Adams, 2010). Younger people with genetic predispositions or early-onset AF should especially be given special attention since they underline the importance of preventative strategies, focused monitoring, and lifestyle changes (Seung Hoan Choi et al., 2018; Peigh, Shah, and Patel, 2021).

At last, assessing the financial impact and cost-effectiveness of educational programs helps underline their importance in lowering long-term healthcare costs (Protheroe, Estacio, and Saidy-Khan, 2015; Reis et al., 2022; C. Greene, 2020). These approaches could assist to shape patient education and AF management in inclusive and dynamic shapes.

### 5.5.1 Enhancing global and cultural perspectives on patient education

Future studies could look at cross-country comparative studies to evaluate physician practices on leaflet distribution in different healthcare systems, therefore improving the knowledge of this practice in medical settings (Protheroe, Estacio and Saidy-Khan, 2015). Low- and middle-income countries (LMICs) for instance have limited access to resources like printed materials or might rely more on oral instructions because of lower literacy rates or cultural preferences. In contrast, because of resource availability and higher degrees of health literacy, high-income countries may show more inclination for delivering educational materials, in both print and digital forms (Sørensen et al., 2012).

Future research could focus on global comparative studies looking at regional

differences in leaflet distribution. This entails examining how various healthcare systems give patient education top attention and how cultural and socioeconomic factors influence these practices. They could also consider how patient education is influenced by culture. In other nations, oral traditions could be more crucial when patients depend on verbal guidance from physicians instead of written resources. Sometimes improved access to technology and higher literacy rates leads one to depend more on written or digital learning. These comparisons could also consider the research of cultural sensitivity in educational materials, including content modification to meet local customs and beliefs and the dissemination of multilingual leaflets (Protheroe, Estacio and Saidy-Khan, 2015).

### 5.5.2 Speciality-specific approaches to patient education

Various medical specialities handle patient education differently. For example, a speciality like cardiology, which treats chronic and high-risk illnesses like AF, is more likely to give a structured and detailed instructional material, including leaflets, as an integral part of patient therapy (Kirsty Mackenzie, 2020). These leaflets may emphasise the dangers associated with AF, the significance of medication compliance, and lifestyle modifications to avert consequences such as stroke.

On the other hand, acute care specialties, such as emergency medicine or surgery, might prioritise immediate, succinct spoken directives over comprehensive leaflets, due to time limitations and the nature of the service administered (Kirsty Mackenzie, 2020).

Specialities including oncology or paediatrics could approach patient education in a different manner, offering comprehensive materials addressing not just medical conditions but also psychological support, food, and physical activity.

Sometimes oncology patients need complex, multi-phase treatment plans, and

instructional books or pamphlets would help them to control the length of their therapy. Family-centred education is vital in paediatrics. Therefore, educational materials are usually meant for children and their guardians, using simplified language or visual aids to help them understand (Kirsty Mackenzie, 2020).

Analysing the distribution of teaching resources across different disciplines will enable one to determine which fields thrive in patient education and which demand more resources or methodical interventions (Little et al., 2004). Comparative studies could investigate whether specialities including diabetes management or cardiac rehabilitation, with more organised training programs, provide better patient outcomes than those with less structured education.

Through comparing investigations across different settings and disciplines, future research could offer important insights on ideal practices for patient education, particularly regarding leaflet distribution. Such studies would clarify the systematic, social, and speciality-specific factors influencing patient education, as well as possible ways to improve these approaches (Little et al., 2004).

The results of the study 'Preoperative Atrial Fibrillation is associated with long-term mortality in patients undergoing surgical aortic valve replacement' imply that preoperative AF is sometimes disregarded in conventional therapy approaches (Farag et al., 2021). This underlines the necessity for improved risk stratification and customised education. Future research should look at how risk scores such as CHA2DS2-VASc and HAS-BLED integrate into educational courses, therefore enabling clinicians and patients to make informed treatment decisions.

Preoperative AF and comorbidities such diabetes, hypertension, and reduced ventricular function highlight the need of multidisciplinary educational programs (Farag et al., 2021). Future research could concentrate on treating these comorbidities in line with a holistic AF control program.

They could look at how ongoing medical education and training courses help doctors be patient-centred and apply risk-reducing strategies into their regular work.

### 5.5.3 Evaluating long-term impact of educational materials

Future studies must first investigate the long-term consequences on patient health outcomes, particularly with relation to the role of instructional leaflets on patient management and health over time. Although the short-term benefits of distributing leaflets, including improved patient understanding and transient compliance with medical recommendations are well known, their long-term efficacy in changing patient behaviour, improving health outcomes, and lowering healthcare costs demands research.

A viable avenue for future studies is to do longitudinal studies that monitor patients over several months or years following the distribution of educational leaflets (Dessie et al., 2021). This will enable researchers to evaluate if leaflets facilitate enduring behavioural modifications, like consistent medication adherence, enhanced lifestyle choices, or improved self-management of chronic illnesses such as AF. To evaluate the relative effectiveness of each approach, studies could compare patients who received leaflets to those given other teaching tools including digital apps and verbal coaching. The results of this study could clarify the ideal timing and efficacy of instructional leaflets, as well as the possible decrease in their influence over time in the absence of expert medical reinforcement. These studies could evaluate the cost-effectiveness of utilising leaflets in patient education by comparing the initial expenses of production and distribution with the prospective savings from averting complications and minimising hospitalisations (Dessie et al., 2021).

Future research might also look at the continuous reinforcing of educational ideas across time (Adams, 2010). They might look at whether regular follow-up with

patients, by additional leaflets, phone calls, or digital alerts, sustain the benefits of early training. In the management of chronic diseases, this could be particularly important since patient involvement and adherence can decrease with time. Reinforcement strategies could consist of a sequence of leaflets covering different aspects of disease therapy, therefore improving patient's knowledge and self-efficacy in health management. (Adams, 2010).

In addition, future studies could investigate tailored approaches for teaching materials. Customised booklets which take account of medical issues, literacy rates, and cultural backgrounds could help to enhance long-term outcomes. They could contain visual assistance, personalised recommendations, and digital tools including QR codes linked to interactive materials or films. They could also compare customised materials to generic leaflets to find whether patient understanding is enhanced, and medication adherence is raised (Dessie et al., 2021).

### 5.5.4 Integrating digital platforms into patient education

The development of digital and mobile health (mHealth) platforms provides a revolutionary method for patient education, capable of reaching a wider audience, increasing participation, and enhancing long-term health outcomes (Coulter and Ellins, 2007). As healthcare progressively adopts digitalisation, future research should concentrate on the integration of mHealth technology and digital platforms with conventional educational resources such as leaflets to enhance dynamic, tailored patient experiences.

Digital health systems offer an advantage in their ability to provide interactive, real-time learning. Movies, quizzes, interactive infographics, mobile applications and web-based platforms can offer educational materials in many forms. This multifaceted approach supports fundamental ideas that might not be shared by

printed materials alone. Real-time reminders for consumption of medications, symptom tracking, lifestyle change advice, and digital instructional materials might all be included on mHealth platforms (Coulter and Ellins, 2007).

Such tools can also help with ongoing patient education. Digital platforms provide ongoing and current data as the patient's health changes, unlike printed handouts that are only sent once during appointments (Dessie et al., 2021). As their treatment plans change, people with AF may get regular updates or new information to make sure they know about lifestyle changes, medications, or warning signs to look out. In the treatment of chronic diseases, where patient adherence usually declines without continuous reinforcement, the ability to strengthen educational concepts over time may be extremely helpful.

Furthermore, mHealth systems could include features like chat services and telemedicine integration, thus enabling patients to interact directly with physicians via the mobile application. This would let patients ask questions about the educational materials they have been given, and making sure they fully understand the condition. Future studies might explore whether combining telemedicine with digital learning tools keeps patients healthier and enhances their therapeutic results by providing them with a prolonged support (Dessie et al., 2021).

### 5.5.5 Barriers in education practices

Future research and practical implementation depend critically on physician training and challenges to leaflet distribution as reducing these problems would greatly increase the efficacy and reach of patient education. Although instructional leaflets show great benefits, their regular use by healthcare workers may be hampered by numerous obstacles including inadequate time, money, or perceived efficacy (Protheroe, Estacio and Saidy-Khan, 2015). Moreover, many physicians might not

have the formal training on the optimal way to include patient education resources, such as leaflets, into their visits. Understanding and overcoming these challenges would help healthcare systems in increasing effectiveness in communicating and therefore improving outcomes related to health.

A primary obstacle to leaflet distribution is time limitation (Protheroe, Estacio and Saidy-Khan, 2015). Numerous physicians encounter considerable time constraints during consultations, especially in bustling general practices or hospital outpatient environments. In these settings, physicians may perceive a lack of time to provide care while thoroughly explaining training materials. Future research may investigate the integration of leaflets into electronic health records (EHRs) or the use of automated systems to deliver leaflets at critical junctures in a patient's care pathway, perhaps optimising this procedure and alleviating the perceived time burden. Moreover, healthcare systems can investigate methods to promote the utilisation of support staff, such as nurses and medical assistants to disseminate and elucidate these materials, hence alleviating part of the burden on physicians (Protheroe, Estacio and Saidy-Khan, 2015).

Many physicians might not entirely understand the relevance of leaflets or could be unsure about their inclusion into conversations with patients. Future studies could investigate the impact of communication training programs that give patient-centred care top priority, therefore allowing physicians to effectively use instructional materials, including leaflets during consultations (WHO, 2023). Studies could look at whether those who receive this kind of training are more likely to distribute leaflets and whether this has an impact on patient outcomes.

The efficiency of leaflets presents another potential barrier (Protheroe, Estacio and Saidy-Khan, 2015). Some physicians, especially in groups with low health literacy, could wonder whether patients understand the material given in leaflets. Studies

might look at how teaching physicians to assess their patients' health literacy and modify their instructional materials would help to remove this barrier. Training may encompass instruction on selecting or recommending materials suitable for various reading levels and on doing follow-ups with patients to ascertain their comprehension of the information presented. Future research may assess whether patients provided with customised materials have superior health outcomes relative to those receiving generic, uniform leaflets.

Moreover, resource constraints may hinder the extensive dissemination of leaflets. In certain healthcare settings, especially in LMICs, access to high-quality educational resources may be restricted, or the expenses associated with producing and disseminating leaflets might be excessive (Protheroe, Estacio and Saidy-Khan, 2015). Digital alternatives could help overcome these resource constraints by digital booklets sent through patient portals or mobile applications. Studies may also look at how low- and middle-income nations' healthcare systems might use current resources to provide patient education materials economically, involving non-governmental organisations (NGOs) or international health agencies to support these initiatives.

Ultimately, overcoming hurdles in attitude among physicians is crucial for enhancing leaflet distribution. Future research might focus on changing these perceptions by showing evidence of the clinical benefits of leaflets, such as improved medication adherence, reduced hospital readmissions, or better management of chronic diseases. Research could look at whether showing these benefits through programs for continuous professional development (CPD) or physician feedback systems encourages general use of educational resources (Protheroe, Estacio and Saidy-Khan, 2015).

### 5.5.6 Standardisation of education materials for patients

Consistency in the utilisation of leaflets is crucial to guarantee that all patients have high-quality, evidence-based educational resources as an integral component of their care. Presently, the use of leaflets differs markedly among medical institutions, sectors, and practitioners, resulting in disparities in patient education (WHO, 2023). Standardising content and distribution ensures that all patients receive precise, clear, and current information regarding their health and treatment alternatives.

Uniformity in the content of the leaflets is essential to prevent inconsistencies in the guidance provided to patients with similar illnesses, which may result from the diverse materials employed in various healthcare environments. Formulating national or worldwide norms for leaflet content, grounded in the most recent clinical studies, might avert the dissemination of obsolete or contradictory information, hence enhancing patient comprehension and health outcomes (WHO, 2023).

Standardisation depends critically on the development of regulatory systems defining the basic components of PILs (Protheroe, Estacio and Saidy-Khan, 2015). They might contain guidelines on the information's readability, so ensuring that leaflets are written at the appropriate reading level for the general community. Studies show that many modern PILs are too complicated for those with lower literacy levels to understand, thereby reducing their effectiveness. Standardising requirements for simplified language, visual aids, and culturally relevant content guarantees that leaflets will be available to a wide range of patients. Moreover, rules can call for regular review of leaflet material to match the most current therapeutic developments and clinical advice (Protheroe, Estacio and Saidy-Khan, 2015).

Alongside content standardisation, rules may also emphasise the scheduling and dissemination of leaflets. Research indicates that the efficacy of instructional materials is contingent not only upon their content but also on the timing and manner

of their delivery to patients. For example, materials sent home with patients or provided at follow-up sessions could have a bigger impact than them being handed during a stressful session. Standardising the distribution process could mean setting guidelines for the best timing for distributing them, thereby ensuring that patients get the material at a point in their treatment most likely to be useful to them (Protheroe, Estacio and Saidy-Khan, 2015).

### 5.5.7 Behavioural insights and ethical considerations in patient education

Interdisciplinary research and behavioural insights show a gradual approach to increase the effectiveness of patient education resources, including leaflets (Hallsworth, 2016). Combining concepts from behavioural science with medical practice helps healthcare professionals create strategies that not only inform patients but also inspire them to actively participate in management of their health. Coming from disciplines such as psychology, behavioural economics, and sociology, behavioural insights offer vital tools for understanding patient decision-making about health and for devising healthcare therapies that can successfully impact those decisions.

One basic behavioural concept relevant for patient education is nudge theory (Tahir, 2020). Nudge theory states that, without limiting options, little adjustments in information presentation can have a big impact on behaviour. In healthcare, for instance, settings that distribute leaflets or advise a particular course of action until the patient declines it, may nudge patients to engage with the information. Instead of highlighting the dangers of non-compliance, nudging through leaflets could imply providing information highlighting the benefits of adherence, including quality of life. This shift in presentation can increase patients' chances of adhering to recommended guidelines (Tahir, 2020).

Furthermore, the ethical concept of autonomy mandates that patients get adequate, clear, and precise information to facilitate informed decisions regarding their health (Reis et al., 2022). Informed consent is a crucial component of ethical medical practice, encompassing the instructional materials provided to patients. If leaflets are overly complex, difficult to understand, or presented in an incomprehensible manner, patients risk making decisions based on incomplete or misunderstood information. Clear and simple design of instructional leaflets combined with all necessary information helps to protect patient autonomy and improve health outcomes. Emphasising that all patients, regardless of their literacy, can understand the given materials, ethical requirements for patient education must include standards for readability and comprehensibility (Reis et al., 2022).

### 5.5.8 Innovations in patient education and feedback mechanisms

The implementation of feedback loops is a crucial future development in patient education, especially regarding the dissemination and efficacy of educational leaflets (Murphy, 2024). A feedback loop denotes a system in which patient input is gathered, analysed, and utilised to enhance and optimise the contents and techniques for disseminating information on health. Constant adaptation to the changing needs of patients and healthcare environments guarantees that training materials remain relevant, easily available, and successful.

Patient surveys and post-consultation interviews could help create feedback loops. Patients may be asked for thoughts on the clarity, usability, and efficacy of a leaflet in enabling them to better understand their disease. Surveys could be completed on digital platforms, including patient portals or mHealth apps, on the mobile phone, in person, or both. By compiling this data, physicians would be able to modify the booklets and spot prevalent issues including confusing medical jargon.

Future research could also look at whether over time these feedback systems improve patient knowledge and compliance. One smart approach is to use feedback loops via qualitative techniques, such as focus groups or patient individual interviews (Murphy, 2024). These techniques offer complete feedback, which helps to get an understanding of patients' views and use of teaching tools. Patients may be asked not just on the clarity of the leaflets but also on their effectiveness in encouraging continuous behavioural changes, including medication adherence or lifestyle alteration. These conversations can provide insights that will direct the creation of next items so guaranteeing its informative and motivating qualities.

Furthermore, feedback loops present a significant potential to engage physicians in the enhancement of educational resources (WHO, 2023).

Applied in patient education, gamification presents an innovative and rapidly acknowledged strategy to enhance patient interaction with health knowledge (Dziurzyński, 2024). Gamification is the use of game design features, including incentives, challenges, and competition into other situations to stimulate involvement and motivation. It improves the interactivity, engagement, and enjoyment of learning about health conditions, therefore increasing the probability that patients will comprehend and remember important knowledge. In healthcare, gamification has showed potential in enhancing lifestyle modifications and medication adherence among other health-related activities (Reis et al., 2022). It’s possible use in the distribution and use of instructional leaflets is a notable path for future research.

A principal advantage of integrating gamification into patient education is its capacity to enhance motivation. Conventional educational leaflets, although informative, can appear inert and lack interest, particularly for patients who are not predisposed to read extensive medical information. Point systems, badges, or progress monitoring

help patients to engage actively with the content. One interesting addition to the traditional approaches may be a mobile application rewarding users with points for reading sections of a digital brochure or for finishing tests on the offered information (Reis et al., 2022).

### 5.5.9 Potential of artificial intelligence in patient education

Including AI into patient education marks a significant progress in the effectiveness and personalisation of health information distribution (Syeda Farheen Zaidi, Shaikh and Surani, 2024). It could change the design, delivery, and personalisation of instructional leaflets to fit patient needs, therefore improving the educational process to be more dynamic and patient centric. Physicians might provide patients with a tailored and interesting educational content, that goes beyond traditional leaflets by using AI technologies such as NLP, machine learning, and predictive analytics.

One of the most potential applications of AI in patient education is its capacity to provide highly personalised content. By looking at the huge amounts of data from EHRs, AI algorithms might be able to make training materials more relevant to each patient's health state, level of health literacy, and their preferred way of learning. For instance, a patient with AF who has had trouble with medication adherence could get personalised leaflets that would explain their condition and include reminders and ways to improve compliance. This degree of personalisation ensures that patients find relevant data for their situation, thereby improving the likelihood of their interaction with and retention of the knowledge (Syeda Farheen Zaidi, Shaikh and Surani, 2024).

One major advantage of including AI is its ability to provide predictive analysis on patient behaviour and results (WHO, 2023).

The integration of AI into mHealth platforms facilitates more interactive and engaging modalities of patient education. AI-driven chatbots can function as virtual assistants, addressing patients' inquiries in real-time and directing them through the information included in instructional leaflets. These chatbots can be configured to utilise natural language processing to comprehend and address patient inquiries in a conversational style, so rendering the educational experience more accessible and less daunting (Reis et al., 2022).

### 5.5.10 Evaluating the economic impact of educational resources

Investigating the cost-effectiveness of educational interventions is essential for future research, particularly in evaluating the effectiveness of educational materials like leaflets in improving patient outcomes and reducing healthcare costs (C. Greene, 2020). Today global healthcare systems are under immense pressure to deliver high-quality management, optimising limited resources. Consequently, determining if an investment in patient education results in long-term cost reductions is essential for guiding healthcare policy and practice. Assessing the cost-effectiveness of educational interventions can furnish evidence for their broad implementation and incorporation into routine care, especially in the management of chronic conditions such as AF.

Examining the direct costs of producing and distributing instructional leaflets takes priority. The costs cover design, printing, and material distribution, as well as the time physicians commit to clearly conveying them to patients. Although initially they could seem small, these upfront costs can add up significantly across large healthcare systems. Therefore, future research should concentrate on estimating these costs and contrasting them with the expected savings brought forth by improved patient outcomes (Protheroe, Estacio and Saidy-Khan, 2015).

Besides the direct expenses, studies should also examine the indirect advantages of educational initiatives. Effective patient education enhances health literacy, hence facilitating self-management of chronic illnesses. Patients who are more prepared to manage their health are more inclined to comply with pharmaceutical protocols, adhere to food and lifestyle guidelines, and identify early indicators of difficulties. These changes in behaviour help to reduce long-term treatment costs and significantly ease the burden on physicians. For instance, reducing the frequency of preventable complications, such as stroke in AF patients could result in large savings for medical institutions. Future research should assess if the initial investment for educational resources causes significant reductions in long-term healthcare and associated costs (Reis et al., 2022).

### 5.5.11 Addressing the emotional and psychological aspects of patient education

Investigating the influence of emotional and psychological factors in health education is a crucial domain for future inquiry, especially in improving the efficacy of instructional resources like leaflets (Garner, 2010). Healthcare education has conventionally emphasised the dissemination of factual and instructional knowledge regarding medical diseases, treatments, and lifestyle modifications. This approach usually ignores the psychological and emotional aspects that greatly affect patients' perceptions. understanding, and behaviour to medical information. By means of identification and management of these psychological and emotional components, patient involvement, compliance with treatment guidelines, and general health outcomes can be improved (Garner, 2010).

A patient's emotional state mostly affects their behaviour through fear and anxiety (Huston, 2024). After being diagnosed with a chronic or life-threatening condition,

they might feel anxious or stressed about the future. They may become disengaged or fail to remember the material, if a leaflet focusses just on medical facts without considering the emotional consequences of the diagnosis. Future studies should look at including comfort, empathy, and emotional support into instructional tools to help to reduce negative emotions and improve understanding.

Moreover, psychological problems such as avoidance or denial could hinder patient interaction with teaching tools (Cherry, 2021). Certain patients, particularly when the material relates to long-term lifestyle changes or upsetting medical interventions, might avoid reading instructional leaflets or participating in their treatment because of emotional defence mechanisms. Future research may investigate techniques to mitigate these psychological hurdles, by creating leaflets that progressively address sensitive themes, beginning with basic information and advancing to specific advice. Educational materials may incorporate mindfulness techniques or stress management strategies to assist patients in managing the emotional dimensions of their condition, thereby facilitating their engagement with the content and promoting proactive measures towards improved health (Cherry, 2021).

### 5.5.12 Role of video-based patient education

The study by McIntyre et al. 'Clinician-created video education for patients with Atrial Fibrillation: a randomised clinical trial' looks at how well video-based education might fill knowledge gaps in patients with AF. Designed as a single centre randomised clinical trial in a tertiary teaching hospital in Sydney, Australia, the study sought to determine whether videos created and narrated by doctors may help patients understand AF better and increase their treatment regimen adherence (McIntyre et al., 2023). A total of 208 people were enrolled with electrocardiographically confirmed AF and a CHA2DS2-VASc score of 1 or higher, the trial guaranteed

that participants reflected a population at notable risk for thromboembolic consequences. Patients were randomised into two groups. The intervention group, which saw a series of four videos addressing AF pathophysiology, management strategies, lifestyle changes, and essential summaries, and the control group, which got normal outpatient treatment. Reiterating the learning process over a 12-week period, the intervention group was also sent weekly email links to review the video material (McIntyre et al., 2023).

At 90 days, the primary outcome evaluated using the Jessa Atrial Fibrillation Knowledge Questionnaire (JAFKQ), showed that intervention participants were notably more likely than the participants from control group, to correctly answer knowledge-based questions (odds ratio [OR], 1.23; 95% CI, 1.01-1.49). Participants who watched the videos three or more times particularly exhibited better AF understanding (OR, 1.46; 95% CI, 1.14–1.88). Secondary outcome, such patient satisfaction with care and medication adherence, the groups revealed no statistically significant variations, nevertheless. This implies that although the intervention improved knowledge, its instantaneous influence on behavioural results like adherence is yet unknown (McIntyre et al., 2023).

Building on the work of McIntyre et al., future studies could assess the combined effect on long-term outcomes including medication adherence, clinical decision-making, and quality of life of structured educational materials and digital tools such videos, mobile apps, or interactive platforms. Furthermore, optimising its efficacy is investigating the customisation of video content to meet individual patient demands, comorbidities, and cultural preferences.

### 5.6 Proposal for a new leaflet for atrial fibrillation patients

This study emphasises the need for enhanced patient education in the management of AF. A new educational leaflet has been proposed to enable patients with AF to actively participate in their care. The proposed leaflet presents numerous advantages compared to those from King's College London and the BHF (British Heart Foundation, 2014; Kings College London NHS Foundation Trust, 2022).

Firstly, the language is specifically designed for a wider audience, particularly for younger patients aged 16 and older. It utilises plain and engaging communication, contrasting with the academic language typically found in institutional handouts, to promote inclusivity and enhance understanding.

Secondly, the content incorporates findings from this study, including the notable decrease in hospitalisation rates associated with enhanced education. This evidence-based approach enhances the leaflet's relevance and credibility for patients.

It mentions the CHA2DS2-VASc scoring tool to assess the risk of stroke in AF patients and includes interactive elements such as a personal tracker, promoting patient engagement in the care. In comparison, there is limited emphasis on such features in current leaflets.

Moreover, modern devices like wearable technology and health applications are emphasised, attracting people who are technologically adept. This contemporary method corresponds with preferences of present times. Ultimately it blends comprehensive medical information with realistic guidance, so that the reader does not get overwhelmed, while offering feasible self-management strategies.

### 5.7 Strengths of the study

The study benefits from a comprehensive data-collecting strategy including viewpoints of cardiology physicians, as well as patients. This dual perspective offers a comprehensive understanding of clinical practices, patient education, and AF care. Including real-world patient outcomes including hospital admissions, medication adherence, and lifestyle modifications helps the study to clarify the pragmatic effects of education and treatment plans.

A notable strength of the study is its integration of quantitative and qualitative data. Statistical analyses, such as Fisher's exact test, are combined with qualitative insights, such as patient perceptions of risk factors, physician variability in distributing educational leaflets, and the limited uptake of strategies like the 'pill in the pocket' for paroxysmal AF management. Moreover, the study draws attention to important information gaps among patients, especially regarding less well-known risk factors and NHS exercise recommendations, highlighting the need for focused educational initiatives.

The research also focuses on practical interventions, examining the effectiveness of strategies such as the 'pill in the pocket' and anticoagulant preferences. The range of the patient cohort from paroxysmal AF to other subtypes such as, persistent and permanent AF, ensures that the results are generally relevant to diverse medical settings. Furthermore, with possible consequences for healthcare policy and practice, the outcomes offer an important foundation for creating uniform methods for patient education and compliance monitoring.

### 5.8 Limitations of the study

The study's findings are constrained by the small sample size of 34 patients and 21 cardiology physicians, which limits the generalisability of the results. It also makes it difficult to perform sub-group analysis. The small sample size in this study reflects its

nature as an early-stage, exploratory study designed to assess feasibility and generate preliminary insights. Such sample sizes are commonly employed in pilot studies to refine research questions, test methodologies, and identify key trends that can inform larger-scale investigations. Despite inherent limitations, small samples can still yield valuable data, particularly when the study context allows for meticulous data collection and focused analysis, as was the case here. Furthermore, the study was also shaped by practical constraints, including cost and resource availability, which influenced the final sample size. Nonetheless, the findings serve as an important foundation for local evaluation and provide practitioner feedback that may guide future research and service development.

Moreover, this was a single centre study in one geographical area and may not be generalised to other parts of the world or other healthcare settings. Trends observed, such as p-values nearing statistical significance, may require larger sample sizes for validation. Another limitation is the reliance on self-reported data, which is vulnerable to biases, including recall and social desirability, thus possibly influencing the accuracy of stated lifestyle modifications and awareness levels. The study's focus on preceding six months of medical history limits its ability to provide insights into the long-term effects of education and management strategies.

The heterogeneity observed in physician practices, including the use of varied risk assessment tools and patient education methods, complicates the identification of standard best practices.

Although the study mentions established metrics such as HAS-BLED and CHA2DS2-VASc, it does not investigate emerging methods for risk assessment or innovative compliance monitoring technologies.

In the patient survey, the phrasing of questions, in the form of leading questions, regarding awareness of specific AF risk factors may have influenced the responses,

potentially prompting participants to provide answers they perceived as expected. Additionally, as the medication adherence of patients was not validated through electronic health records or the MGLS, there is a possibility of social desirability bias affecting the results.

Finally, it fails to explicitly account for or analyse potential confounding variables, including socioeconomic status, access to healthcare, and support systems, which could play a substantial impact on patient outcomes.

# Chapter 6

# Conclusion

This thesis explored the various challenges and prospects in AF management through a comprehensive analysis of patient outcomes, medical practices, and the impact of education on enhancing medical care. The study integrates quantitative data with qualitative insights to elucidate the interplay between clinical and behavioural factors affecting patient health and resource usage.

A crucial discovery is the substantial influence of patient awareness on hospital admissions and the self-management of AF. Previous knowledge regarding the management of individuals with irregular heartbeats indicated a diminished probability of hospitalisation, emphasising the necessity for structured educational programs. Despite these advantages, only 57.41% of cardiology physicians, as indicated by the survey, consistently distribute leaflets to newly diagnosed patients, underscoring a notable disparity in patient education standards.

The study revealed diverse levels of comprehension concerning the risk factors for AF among patients. Although the majority recognise prevalent risk factors such as hypertension and smoking, other factors such as poor sleep remain underappreciated, with merely 41.17% of patients acknowledging their importance. This gap underscores the need for comprehensive and customised patient education programs that address both well-known and lesser-known risk factors.

Lifestyle modifications appeared as a variable factor affecting patient outcomes. Although patients who reduced alcohol intake and quit smoking demonstrated better outcomes, the absence of statistical significance underscores the challenges inherent in behavioural adjustments. The results suggest that information alone may be insufficient. Access to resources, support networks, and tailored therapy is also essential for effecting substantial lifestyle changes.

Medication adherence among patients was elevated at 94.11%, indicating the effectiveness of existing prescribing methods and patient compliance. The disparity

in physicians' approaches to compliance monitoring indicates potential for improvement. Enhanced outcomes would arise from a more consistent and technologically sophisticated approach to adherence monitoring. Moreover, while apixaban is the preferred anticoagulant locally due to its favourable risk profile, the continued use of warfarin in certain subgroups highlights the necessity for individualised treatment strategies.

The study emphasises the variability in physicians' approaches, particularly with risk evaluation for haemorrhagic and thrombotic occurrences. The frequency of the usage of CHA2DS2-VASc and HAS-BLED scores indicates compliance with evidence-based metrics. However, the rare application of alternative methods highlights the necessity for enhanced standardisation. The study indicated a restricted application of new tactics like the 'pill in the pocket', highlighting potential for improving self-management in paroxysmal AF patients.

Despite the study's contributions, its limitations, including a limited sample size, dependence on self-reported data, and a brief follow-up duration, must be recognised. These limitations highlight the necessity for further studies employing larger, varied cohorts and long-term assessments. Incorporating emerging technologies and addressing socioeconomic determinants of health will enhance the understanding of AF management.

This thesis shows that while current AF management strategies offer several benefits, significant deficiencies remain in patient education, standardisation of professional practices, and the incorporation of lifestyle interventions. By implementing targeted care, technology-based adherence monitoring, and individualised treatment, healthcare systems can enhance patient outcomes and optimise resource utilisation.

## APPENDIX 1: Survey for patients

- Have you had any admissions to hospital in the last 6 months?
- If yes, why were you admitted? Was it related to the irregular heartbeat?
- Have you had a heart attack or a stroke in the last 6 months? If so, where were you treated (which hospital)? When?
- Are you still on your blood thinning medication?
- If so, which one and what dose do you take?
- Have you had any bleeding problems in the last 6 months?
- Have you had?
    - any bleeding from the back passage?
    - Any blood in your urine?
    - Any severe nose bleeds?
    - Have you had any blood transfusions?
    - Any minor bleeding such as bleeding from the gums?
    - Do you bruise easily?
- When you were diagnosed with an irregular heartbeat called AF, did any of the doctors or nurses explain what you can do about it?
- Do you know about the risk factors for AF?
- Do you know that high blood pressure is a risk factor for AF?
- Do you know that overweight/obesity is a risk factor for AF?
- Do you know that Diabetes is a risk factor for AF?
- Do you know that consuming alcohol is a risk factor for AF?
- Do you know that smoking is a risk factor for AF?
- Do you know that poor sleep is a risk factor for AF?
- Do you exercise regularly? If so how many hours per week of cardiovascular exercise? Do you know how much is recommended (i.e. 150 min per week or 30 min at least 5 times a week)
- Have you made any changes to your lifestyle since you were diagnosed with AF? If so what have you changed?
- Have you changed your diet since your were diagnosed with AF? If so, how?
- For patients with paroxysmal AF….
    - Do you get palpitations that last more than half an hour at a time?
    - If so, what would you do if palpitations lasted more than an hour?
        - Would you call an ambulance?
        - Would you go to your GP?
        - Would you make your way to A&E?
        - Do you have any extra tablets you can take if you get palpitations?

Have you ever been given a “pill in the pocket”, in other words, an extra tablet you can take if and when you have palpitations, to help them settle?

## APPENDIX 2: Survey for cardiology physicians

# Physician survey for management of atrial fibrillation

Multidisciplinary care and recurrent arrythmia prevention in individuals with atrial fibrillation

1. Do you treat patients with atrial fibrillation (AF)?

   *Mark only one oval.*

   - ◯ Yes
   - ◯ No

2. Where do you treat them?

   *Mark only one oval.*

   - ◯ Outpatient
   - ◯ Inpatient
   - ◯ Both

3. For acute management of new onset AF, do you aim for

   *Mark only one oval.*

   - ◯ Rate control
   - ◯ Rhythm control
   - ◯ Depends on presentation and symptoms

4. Do you provide leaflets to patients diagnosed with AF for the first time?

   *Mark only one oval.*

   - ◯ Yes
   - ◯ No

5. Which score do you use to assess the risk of thrombosis?

_____

6. Which score do you use to assess the risk of bleeding?

_____

7. Which anticoagulant medication do you give?

*Mark only one oval.*

- ◯ Apixaban
- ◯ Dabigatran
- ◯ Edoxaban
- ◯ Rivaroxaban
- ◯ Warfarin
- ◯ Antiplatelets
- ◯ Others

8. Do you regularly check for compliance of anticoagulant medicines?

*Mark only one oval.*

- ◯ Yes
- ◯ No

9. Do you request Transthoracic Echocardiogram if the patient is newly diagnosed with AF?

*Mark only one oval.*

- ◯ Yes
- ◯ No

10. Do you treat patients with AF post PCI?

*Mark only one oval.*

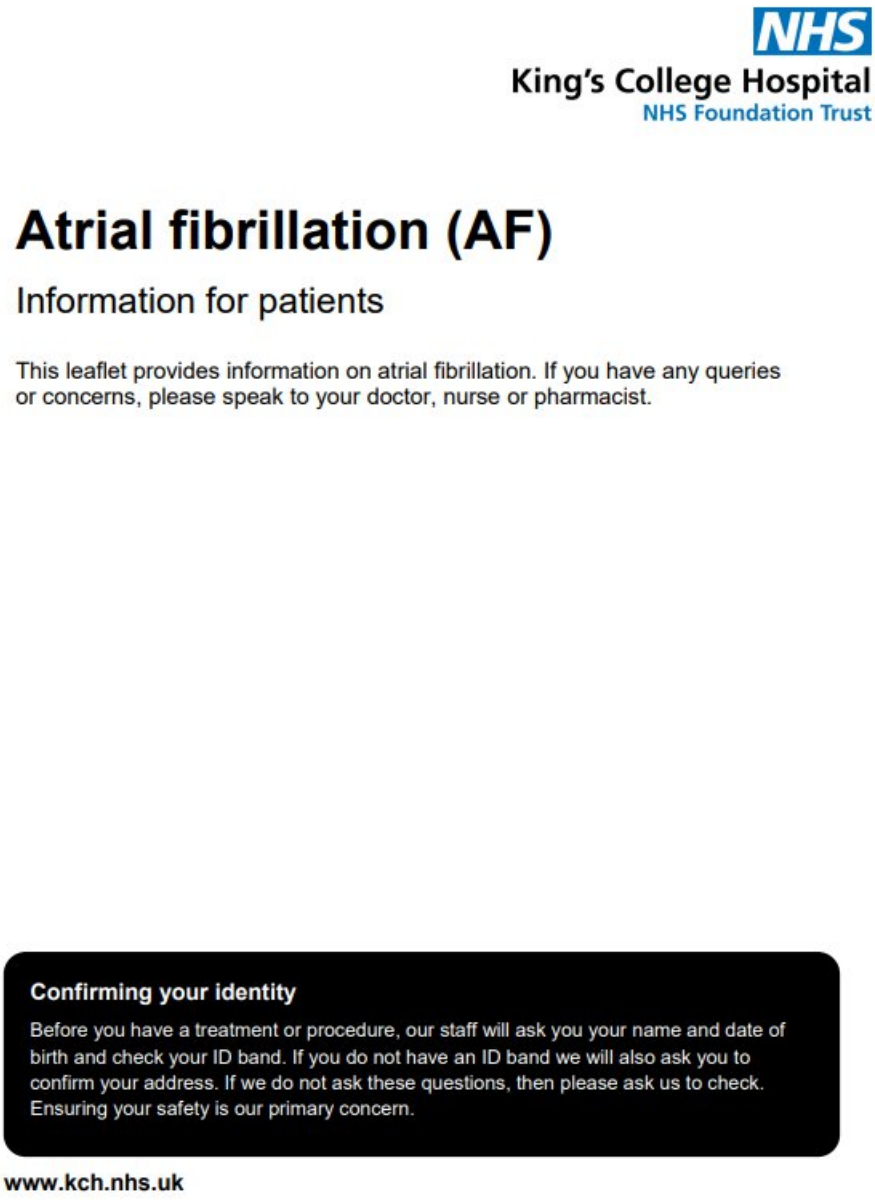
- ◯ Yes
- ◯ No

11. If yes, how do you treat them?

*Mark only one oval.*

- ◯ Dual therapy
- ◯ Triple therapy
- ◯ Depends on risk of thrombosis versus bleeding

**APPENDIX 3: Leaflet provided by King's College Hospital NHS trust to patients with atrial fibrillation**



NHS
King's College Hospital
NHS Foundation Trust

# Atrial fibrillation (AF)

## Information for patients

This leaflet provides information on atrial fibrillation. If you have any queries or concerns, please speak to your doctor, nurse or pharmacist.

**Confirming your identity**

Before you have a treatment or procedure, our staff will ask you your name and date of birth and check your ID band. If you do not have an ID band we will also ask you to confirm your address. If we do not ask these questions, then please ask us to check. Ensuring your safety is our primary concern.

**www.kch.nhs.uk**

### What is atrial fibrillation?

Atrial fibrillation (AF) is the most common heart rhythm disturbance (arrhythmia) in adults.

AF is an irregular heart rhythm that is caused by abnormal electrical impulses in the atria (upper chambers of the heart). As a result, the atria no longer beat in an organised way and pump less efficiently.

### What risks are associated with AF?

AF can cause blood to pool in the atria and increases the risk of blood clots forming. Blood clots formed in the heart may then travel to the brain and cause a stroke.

AF increases your risk of having a stroke by five times.

### How common is AF?

Over 1 million people in the UK have AF. The chance of AF increases with age and it is more common in men.

AF is more likely to occur in people with other conditions including high blood pressure, diabetes, coronary heart disease and heart failure.

### What are the symptoms of AF?

- Fast and irregular heartbeats called palpitations
- Dizziness
- Shortness of breath
- Tiredness

Some people do not have any symptoms.

### How is AF diagnosed?

AF is diagnosed on a recording of the heart's electrical activity. This is most commonly detected on an electrocardiogram (ECG) but can also be found at pacemaker check-up.

### What medications are available?

Medications are used to control heart rate and rhythm.

Anticoagulants reduce the risk of blood clots developing and causing stroke by two thirds.

### Further information

You can visit the British Heart Foundation or the AF Association website for further information:

Atrial fibrillation (AF) | British Heart Foundation (bhf.org.uk)

AF Association - United Kingdom (heartrhythmalliance.org)

## Contact details

**King's College Hospital**

Tel: 020 3299 5553

**Princess Royal University Hospital**

Tel: 01689 864263

## Sharing your information

We have teamed up with Guy's and St Thomas' Hospitals in a partnership known as King's Health Partners Academic Health Sciences Centre. We are working together to give our patients the best possible care, so you might find we invite you for appointments at Guy's or St Thomas'. To make sure everyone you meet always has the most up-to-date information about your health, we may share information about you between the hospitals.

## Care provided by students

We provide clinical training where our students get practical experience by treating patients. Please tell your doctor or nurse if you do not want students to be involved in your care. Your treatment will not be affected by your decision.

## PALS

The Patient Advice and Liaison Service (PALS) is a service that offers support, information and assistance to patients, relatives and visitors. They can also provide help and advice if you have a concern or complaint that staff have not been able to resolve for you. They can also pass on praise or thanks to our teams.

PALS at King's College Hospital, Denmark Hill, London SE5 9RS
Tel: 020 3299 3601
Email: kch-tr.palsdh@nhs.net

PALS at Princess Royal University Hospital, Farnborough Common, Orpington, Kent BR6 8ND
Tel: 01689 863252
Email: kch-tr.palspruh@nhs.net

**If you would like the information in this leaflet in a different language or format, please contact Interpreting Services on 020 3299 4826 or email kch-tr.interpreting@nhs.net.**

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Urgent and Planned Care
Corporate Comms: 3002

## APPENDIX 4: Leaflet provided by BHF to patients with atrial fibrillation

British Heart Foundation

# Atrial Fibrillation
## Your quick guide

FIGHT FOR EVERY HEARTBEAT
bhf.org.uk

British Heart Foundation

Coronary heart disease is the UK's single biggest killer.

For over 50 years we've pioneered research that's transformed the lives of people living with heart and circulatory conditions. Our work has been central to the discoveries of vital treatments that are changing the fight against heart disease.

But so many people still need our help. From babies born with life-threatening heart problems to the many Mums, Dads and Grandparents who survive a heart attack and endure the daily battles of living with heart failure.

Join our fight for every heartbeat in the UK. Every pound raised, minute of your time and donation to our shops will help make a difference to people's lives.

FIGHT FOR EVERY HEARTBEAT
bhf.org.uk



### What is atrial fibrillation?

Atrial fibrillation or AF is a common abnormal heart rhythm. Normally, the natural pacemaker in your heart sends out a regular electrical impulse that travels through your heart and makes it beat in time. But if you have AF, extra impulses fire off randomly from different points causing the top of your heart to twitch (or fibrillate). The result is often an irregular and sometimes very fast pulse.

### AF affects about a million people in the UK

Many people have AF and don't know they do.

### Why is AF such a problem?

AF increases your risk of a blood clot developing in your heart which can travel to your brain and cause a stroke.

**AF can increase your risk of stroke by five times.**

It can also affect how well your heart pumps which can increase your risk of heart failure in the future. The good news is that, with treatment, these risks can be dramatically reduced.

## Why do people get AF?

**The chances of having AF increase as you get older.**

**About 7 in every 100 people over 65 have AF.**

Having other conditions makes AF more likely. They include:

- Other diseases of the heart such as coronary heart disease and heart failure
- High blood pressure
- An overactive thyroid
- Lung cancers and chest infections like pneumonia
- Alcohol or drug misuse

## What are the signs and symptoms?

Palpitations (being aware of your heartbeat) are a common symptom of AF. People with palpitations often say it feels as if their heart is jumping all over the place.

**Your heart rhythm**
In atrial fibrillation the top chambers of your heart quiver, which means the heart rhythm is often irregular and usually faster than normal, although it can also be slower than normal too.

**Your heart rhythm**

It's also common to feel a little breathless and tired with AF, although some people don't have any symptoms at all. An irregular pulse is a sign that you might have AF, so it's important to know how to check yours (see the back of this leaflet).

**If your pulse doesn't follow a steady pattern, tell your GP.**

A cardiac event recorder can also help pick up this kind of AF but you keep this machine with you so that you can record your heart rate and rhythm when you feel symptoms.

Preventing AF from developing in the first place is very important. You can help prevent AF if you keep your blood pressure and weight under control with a healthy lifestyle.

## How is it diagnosed?

**Holter monitor**

An ECG (electrocardiogram) is a test often used to diagnose AF. But if the AF comes and goes it can be difficult to detect with an ECG and you may need to wear a holter monitor. That's a small machine which you can wear for several days to continuously record your heart rhythm.

## Can I take any medicines for AF?

Medicines are usually given to help control your heart rate and rhythm. They help to improve the symptoms of AF and reduce the risk of damage to your heart.

**People with AF are usually also prescribed a blood thinning medicine – such as warfarin – to reduce your risk of stroke.**

## Michelle's story

### Michelle was told she had atrial fibrillation in 2002.

"I had been feeling short of breath, dizzy and had even fainted. It was explained to me in full why this was happening.

I can very much feel when I'm in AF. It's like a sudden thud, almost a bolt of lightning, then the horrid feeling of your heart trying to come out of your chest.

I have been taking warfarin for over nine years to reduce my risk of stroke. I have been prescribed several other medicines over the years to try and keep things under control, but when I am in AF my heart rate can go both very fast and very slow."

"I was very scared when I was told I had slow AF and would need a pacemaker. However my consultant explained it all to me, talking me from tears to smiles."

Michelle, supporter

## Are there any other treatments for AF?

A treatment called cardioversion involves giving you a controlled electrical shock to get your heart back into a normal rhythm. It may only restore a normal rhythm for a short while, and your AF can return.

A treatment called catheter ablation is also sometimes used to try to get your heart rhythm back to normal, especially if you have very fast AF. It involves burning certain areas of tissue in your heart to block the extra electrical impulses entering your heart.

## How might it affect my day-to-day life?

People with AF don't always know when the symptoms of AF may come on. That means some people worry about going out or playing sport, but most people find that they can carry on as normal with the help of medicines. If you are taking warfarin, getting your warfarin levels checked regularly can be tiresome, but it is really important to help prevent you from having a stroke.

## How to check your pulse

You can check to see if you might have AF by feeling the pulse at your wrist.

**Checking your pulse**

1. Put one of your hands out so you're looking at your palm.

2. Use the index finger and middle finger of your other hand and place the skin of these fingertips on the inside of your wrist. You should place them at the base of your thumb near where the strap of a watch would sit.

3. Press lightly and feel the pulse. If you can't feel anything press slightly harder or move your fingers around until you feel your pulse.


4. Once you've found your pulse, continue to feel it for about 20–30 seconds. Feel the rhythm of the pulse to see if it's regular or irregular.

### A normal pulse should follow a steady beat.

If you have AF your pulse will usually feel irregular, unpredictable and possibly fast, and its strength may come and go. If your pulse feels like this, or if you're worried, see your GP.

## Use this space to make notes for discussions with your doctor.

**Join us in the fight for every heartbeat.**

**For 50 years the British Heart Foundation has been funding life-saving heart research. Our work has been central to the discoveries of vital treatments that are changing the fight against heart disease. But we need your support to continue this fight.**

**Visit bhf.org.uk to make a donation or find out more.**

**For more information**
You can order our booklet Atrial fibrillation. Other booklets and leaflets include:

**Stroke**
**Blood pressure**

You can also find out more from the AF Association **atrialfibrillation.org.uk**

**Contact**
For more information visit the British Heart Foundation website **bhf.org.uk**

**Heart Helpline 0300 330 3311**
(a similar cost to 01 and 02 numbers)
For information and support on anything heart-related.

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**APPENDIX 5: Proposed leaflet for patients with atrial fibrillation**

## ATRIAL FIBRILLATION IS TREATABLE

## What is atrial fibrillation?

Atrial fibrillation is when your heart beats in an irregular and often fast way because the upper chambers of the heart (called atria) don't work together properly. This can lead to serious problems like a stroke or heart failure if not treated.

Symptoms-

- ❖ Unusual fluttering sensations
- ❖ Feeling very tired
- ❖ Shortness of breath
- ❖ Light-headedness
- ❖ Discomfort or pain in your chest

## Take control of your heart

Learning about atrial fibrillation helps you manage your condition better and live a healthier life.

A study found that hospitalisation rates dropped from 47% in uninformed patients to 11% in informed patients.

## Important risk factors

- ❖ High blood pressure
- ❖ Obesity
- ❖ Diabetes
- ❖ Smoking
- ❖ Alcohol consumption
- ❖ Poor sleep
- ❖ Long working hours
- ❖ Rigorous exercise

## What YOU can do!

1. Follow your treatment plan
   - Set reminders to take anticoagulants regularly
   - Consult your doctor about the best medication routine
2. Embrace a heart-healthy lifestyle
   - Adopt a Mediterranean-style diet with fruits, vegetables and olive oil
   - Reduce alcohol consumption
   - Quit smoking
   - Try to be active with moderate exercises like walking or yoga
3. Schedule regular follow-ups
   - Schedule rate or rhythm control strategies with your doctor
   - Get periodic blood pressure checks

## Innovative tools

- Wearable tech: Devices like smartwatches can track your heart rhythm and alert you to changes.
- Digital apps: Use health apps to monitor your symptoms and stay organised with your medications

## Interactive section

- Track your heart health- Use the CHA2DS2-VASc scoring system with your healthcare provider to assess stroke risk.
- **What is the CHA2DS2-VASc scoring system?** - It is a tool used by healthcare providers to estimate your risk of stroke if you have atrial fibrillation. This score helps doctors determine whether you would benefit from anticoagulation therapy to prevent stroke.
- Personal tracker-
    1. Heart rate today: ____ bpm
    2. Blood pressure: ___/___ mmHg
    3. Weekly goal: _____

## Support and resources

- **Join a community:** Connect with support groups near you or online to share experiences
- **Explore resources:** Check out the free guide on atrial fibrillation on https://www.nhs.uk/conditions/atrial-fibrillation/
- **Contact support:** Call the AF hotline at 01789 867 501

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