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Atrial Fibrillation Episodes of Illness in a Primary Care Setting

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ABSTRACT

Atrial fibrillation is the most common type of irregular heartbeat. It is associated with substantial health risks, limited treatment success, and high relapse rates, and this chronic condition is difficult to diagnose due to transient symptoms or absence of such. Atrial fibrillation has important public health implications as it adversely affects one to two persons per hundred in psychological, social, and economic terms.

The objective of this research was to quantitatively describe the patient's journey towards the diagnosis of atrial fibrillation within an episode of illness framework. Electronic medical records were accessed through the DELPHI database. The patient's lived experience was analyzed with descriptive statistics in terms of the number of physician visits, episode length, medications prescribed, diagnostic investigations ordered, and referrals made. The observed findings were compared to a control group of patients with other chronic conditions. The differences between the two groups were statistically significant, with an overall large effect size.

The emerging knowledge of a patient's journey may identify patients' unmet needs and inform future public policy development in the diagnosis and management of atrial fibrillation.

KEYWORDS: Atrial Fibrillation, Episode of Illness, Primary Care, Electronic Medical Records

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
AF	Atrial Fibrillation
APA	the American Psychological Association
BPMs	Blood Pressure Monitors
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CT Scan	Computerized Tomography Scan
CVD	Cardiovascular Disease
CPCSSN	the Canadian Primary Care Sentinel Surveillance Network
the DELPHI Project	the Deliver Primary Healthcare Information Project
ECG	Electrocardiogram
ED	Emergency Department
EMRs	Electronic Medical Records
ICPC	International Classification of Primary Care
MACE	Major Adverse Cardiac Event
MI	Myocardial Infarction
NOS	Not Otherwise Specified
PHC	Primary Health Care
PCC	Patient-Centered Care
RFE	Reason for Encounter
SD	Standard Deviation

CHAPTER ONE – INTRODUCTION

1.1 Thesis Overview

The overall objective of this thesis was to quantitatively describe the lived experience of patients diagnosed in primary care with the most common sustained cardiac arrhythmia called Atrial Fibrillation (AF).

It is important to capture the disease experience from the patients' in addition to health care providers' perspective for several reasons. First, AF is accompanied by substantial health risks and patients deal with uncertainty around the diagnosis of AF. . This ongoing uncertainty can significantly affect patients' quality of life[1]. Furthermore, despite the patient's high compliance with the treatment protocol, the achieved success is limited and relapse rates are high. Second, AF has public health implications because it affects one to two persons per hundred not only physically but also in psychological, social and economic terms. Third, due to ambiguous and transient symptomatology or absence of such, AF is difficult to diagnose, thus leading to a protracted assessment period. This adds to emotional distress and significantly disrupts daily living of AF patients and their families as well as delays the start of evidence-based disease management.

Health service researchers have devised a concept called the episode of care that is suitable for studying the experience of people with a health condition. While there exist different definitions, the one operationally used in this thesis is the time-period from the first ICPC-coded outpatient encounter as a starting point to the date of diagnosis as an end-point. This definition was applied using a sophisticated ICPC-coded portion of the DELPHI database (Deliver Primary Healthcare Information). As a result, we identified69 primary care patients that were seen by 23 physicians in 10 practices over a ten-year period (2006-2015). The ten-year prevalence of AF in the DELPHI database (including the ICPC-coded portion) is 3.1% in the patient population of 48,387 individuals (Appendix K). Approximately 10% of the DELPHI patient population was coded using ICPC and the ten-year prevalence of AF among the ICPC-coded population of 4,838 persons is 1.98%, i. e.., with 69 identified cases. In other words, 23 family

doctors in 10 practices diagnosed AF in 69 out of 4,838 ICPC-coded patients over a span of 10 years.

The following variables pertaining to the length of time between the first outpatient medical encounter and the final diagnosis within an episode of illness were studied: 1) the number of physician visits; 2) the episode length; 3) the number and type of medications prescribed; 4) the number and type of diagnostic investigations ordered; and 5) the number and type of referrals made.

The thesis is organized as follows. Chapter 2 contains a review of the literature on AF as well as the concepts of an outpatient medical encounter and an episode of care. It is followed by the description of the Methods used in Chapter 3. Chapter 4 contains the results of the analyses whereas Chapter 5 is devoted to Discussion and Conclusion.

CHAPTER TWO – LITERATURE REVIEW

This chapter will present the review of the published literature on the epidemiology of AF, the concepts of outpatient medical encounters, episodes of illness, symptomatology and methods for detecting AF as well as touch upon early drug therapies prior to the confirmatory diagnosis of AF.

2.1 Overview of AF

Being the most common sustained cardiac arrhythmia, AF affects 1-2% of the general population.[2, 3] Aging is associated with an increased risk of developing AF, potentially through age-related isolation and loss of atrial myocardium.[4] Thus, at the age of 40-50, the prevalence of AF is less than 0.5% whereas between 65 and 69 years of age, it is 2%[5] and at 80 years, it increases up to 8-15%.[3, 2, 6, 7, 8] Within the next 50 years, as the population ages, the prevalence of AF is expected to double.[4] Men are usually more affected than women. AF, especially of an early onset, has a genetic predisposition.[9]

The classical risk factors for developing AF include cardiac and non-cardiac conditions such as ischaemic cardiomyopathy, valvular disease, hypertension, thyroid disease and diabetes[10]. Parental AF as a risk factor for AF in offspring[9] is also present. The findings of the study conducted by Fox et al.[9] demonstrated that a familial component predicted an increased risk of offspring AF, after having adjusted for other standard AF risks with genetic components (i.e., diabetes, hypertension, and myocardial infarction).

In some patients, AF (also known as lone AF) has an idiopathic aetiology, with no underlying pathology. In recent years, however, clinicians and researchers started talking about "not-so-lone atrial fibrillation"[11] and evaluated "new risk factors"[11] as playing a role in the genesis of AF. Among the "new risk factors"[11] (as juxtaposed to the classical risk factors) are overweight and obesity, sleep apnea, sedentary life style, its counterpart – excessive sports practice, inflammation, latent hypertension, abuse of alcohol and other substances.

AF is an independent risk factor for stroke: in its presence, the risk of stroke is 5 times higher and increases with age.[5] Ischaemic strokes in combination with AF lead twice as often to fatalities, and survivors are more disabled by their stroke and more likely to experience a recurrence than patients with other stroke causes.[4, 12]

AF is associated with increased rates of heart failure and hospitalizations.[4] Cognitive dysfunction,[13] impaired quality of life[14] and reduced exercise capacity[15] are other negative consequences that AF patients experience on a daily basis. Approximately 67% of all emergency department visits with a primary diagnosis of AF get hospitalized to acute inpatient units.[16, 17]

A retrospective cohort study of emergency department patients with a primary diagnosis of AF[18] over an eight-year period (2002-2010) in the province of Ontario found that the frequency of AF as well as proxy measures for its severity (CHADS2 score and triage category) increased. There was a relative increase of 29% in the number of AF-related emergency department (ED) visits in 8 years. This increase included approximately 20% of patients who were readmitted to ED for AF[18]. Over time, however, the admission rates decreased, accounting for 0.5% of all ED visits. The authors attributed the observed increase partly (about 15 % of the increase) to aging of the population[18]. Another possible explanation suggested by Tu et al.[19] - as they analyzed mortality data from Statistic Canada's Canadian Mortality Database for the period of 1994-2004 – is longer survival of patients with congestive heart failure, myocardial infarction, and stroke. AF is also associated with a number of medical conditions that are risk markers rather than solely causative agents.[4] Among the comorbidities are both various cardiomyopathies[20, 21, 22] and other medical conditions. Based on their prevalence in the general population, it is worth mentioning the following disorders : diabetes mellitus[4] (20% of AF population); chronic obstructive pulmonary disease (COPD) (10-15% of AF population)[4]; obesity (25% of AF population)[21]; hypertension, sleep apnea and chronic renal disease (10-15% of AF patients).[4] Although relatively uncommon in the AF population,[20, 21] thyroid dysfunction alone can cause AF and AF-related complications.

Management of AF patients is dependent on the type of AF which, in turn, is based on clinical presentation and duration of the arrhythmia.[4] Specifically, anti-thrombotic treatment protocol is dependent on the definition of the valvular (rheumatic) versus non-valvular (hypertensive) origin of AF[23]. There are five main types of AF: paroxysmal, persistent, long-standing persistent, permanent and silent AF (Figure 1).[4]

A patient presenting with AF for the first time is deemed to have first diagnosed AF. Paroxysmal *AF* terminates by itself usually within 48 hours of onset. Although AF paroxysms can last up to 7 days, the 48-hour time window is clinically relevant for the management of AF.

After 48 hours, sinus rhythm is not likely to spontaneously return and anticoagulation therapy must be implemented. First of all, to improve cardiac performance and to alleviate symptoms[24], there may be a need for pharmacological (for recent-onset AF) or electrical cardioversion (for prolonged AF). Unfortunately, cardioversion is an inherent risk factor for thromboembolism[25]. The risk associated with cardioversion can be minimized from 5-7%[26] to less than 1%[27] with prophylactic anticoagulation therapy. Anticoagulation is highly recommended before and after cardioversion. The traditional anticoagulant has been warfarin[24]. Recently, after having demonstrated their non-inferiority to warfarin in clinical trials[28], the direct oral anticoagulants have also been approved[24].

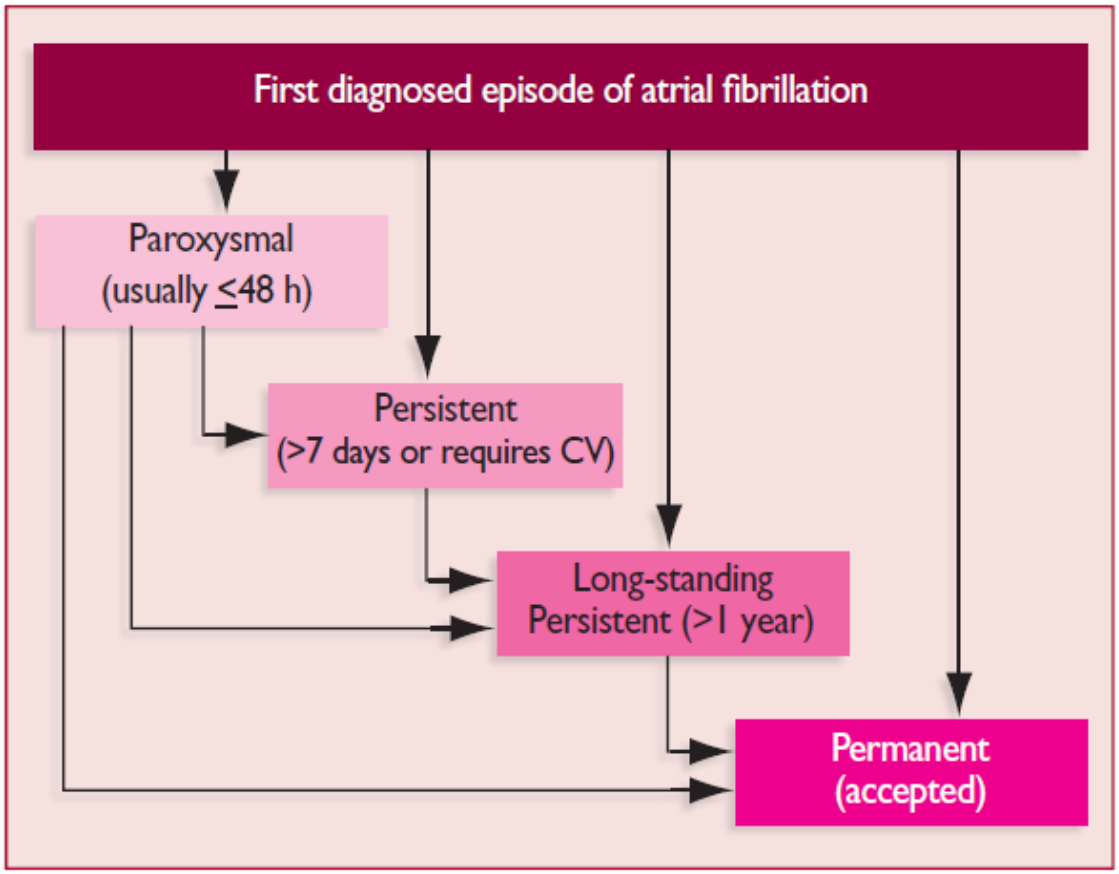
When an AF episode lasts longer than 7 days or cardioversion is used to terminate it, the diagnosis is persistent AF.

Whether rhythm control management is desired or not, there distinguish two more types of AF: long-standing persistent AF and permanent AF. Long-standing persistent AF lasts longer than one year and a rhythm control protocol is adopted. With permanent AF, its existence is recognized by the patient and the physician and there is no pursuit of rhythm control interventions.

Finally, silent AF is asymptomatic in nature and is often diagnosed by an opportunistic electrocardiogram (ECG). Silent AF can be of any temporal form of AF.

Because the objective of this thesis was to quantitatively describe a patient's journey to the diagnosis of AF and based on the available data, the emphasis was on first diagnosed episodes of AF, without further distinguishing its subtypes.

Figure 1: Types of Atrial Fibrillation[1]



[1] Source: Camm AJ, Kirchhof P, Lip GYH, et al. Guidelines for the management of atrial fibrillation. *Eur Heart J*. 2010;31(19):2369-2429. doi:10.1093/eurheartj/ehq278

An irregular pulse can be indicative of the underlying AF in individuals presenting with chest pain, palpitations, breathlessness and dizziness.[29, 30, 31, 32] At the same time, AF can present with a variety of non-specific symptoms that may differ not only between patients but in the same individuals over time.[15] At the opposite end of the spectrum are asymptomatic cases and this proportion can be as high as 15% -30% of the AF population[15, 33, 34, 35]. Indeed, many patients in a primary care setting remain asymptomatic at the time of their first encounter with their family physicians.[36]

It is key to identify, assess and diagnose patients with AF, especially the asymptomatic cohort, so that they can receive prompt treatment.[36] The recommended strategy for early detection and management of AF is to perform opportunistic (≥65 years), routine (known risk factors or cardiovascular disease) or triggered (suspicious symptoms or palpitations) screening in general practice [29,37]. Once patients are diagnosed with an underlying cardiovascular disease, hypertension and diabetes, it is prudent to assess them for the presence of AF. For pragmatic purposes, screening in primary care is easy to conduct since such patients regularly see their family physicians for routine check-ups.[36] In order not to miss an opportunity of diagnosing the pre-existing AF and giving timely antithrombotic treatment to patients at risk,[36] it is good practice to check blood pressure and pulse. Antiarrhythmic therapy is also appropriate for specific case scenarios: for symptomatic, young, active patients, and in recent-onset AF)[38].

General management of AF includes the following five strategies:[4] 1) anti-thrombotic treatment; 2) relief of symptoms; 3) ventricular rate control; 4) management of cardiovascular comorbidities; and 5) maintenance of sinus rhythm. However, the recent research[39] has demonstrated no clinical value of rhythm disturbance correction. Strict rate control therapy has not been proven advantageous, either.[4] Unfortunately, 'upstream' drug therapies and life style modification strategies (exercise, diet, fish oil) aiming at delaying or preventing myocardial remodeling, have also achieved modest success.[40] A modest treatment effect and high rates of reoccurence[41] are accompanied by other negative consequences such as psychological, social, economic and employment-related.

2.2 The Concept of an Outpatient Medical Encounter

An encounter (visit) in a primary care setting starts with a patient presenting with one or more reasons for the encounter, either in the form of a symptom or complaint, a diagnosis or a request for an intervention, such as filling prescriptions, advice or a referral to a specialist.[42] The family physician establishes the most likely diagnosis and performs one or more interventions. Sometimes, on the basis of a most probable diagnosis, the doctor monitors the patient by so-called "watchful waiting"[43, 44] This widely accepted representation of the doctor–patient encounter is considered to be an international standard approach. [45, 44]

From the health care system standpoint and for billing purposes, a patient-doctor encounter constitutes a face-to-face documented visit during which the provider (doctor) exercises an independent judgment while providing services to the client (patient). The encounter criteria are extended to such services as X-rays, prescription refills, vaccinations and laboratory tests. In order to be classified as an encounter, services rendered must be billed.

In this research, an outpatient medical encounter is defined as an in-office physical contact during which the family physician provides any medical service to the patient. Each date of service in a primary care setting constitutes a separate encounter, i.e., one "billable" medical encounter per patient per day. Although there exist different provider types, in the DELPHI database the provider is a general practitioner who is primarily responsible for assessing the patient and documenting the services rendered in the patient's electronic medical record (EMR). The patient (user, client) is defined as an individual who had at least one encounter. Each patient is counted only once regardless of the number of services received.

2.3 The Concept of an Episode of Illness

The literature recognizes different types of episode concepts[46, 47] . There exist four distinct perspectives on the definition of a health care episode [48]: 1) an episode of

illness or indisposition (from the patient's perspective); 2) an episode of disease (from the care provider's standpoint); 3) an episode of care (from the payer's or the health care system perspective) and 4) a health maintenance episode (from the societal perspective).

Each episode, regardless of its type, has a defined starting and end-point and the end-point is the same for all types – disease resolution or patient's death. It is accepted in the literature, however, that some diseases (for instance, chronic conditions) may be open-ended, with no discrete starting and end-points.[46] In such a case, based on its technologic feasibility, the treatment is shifted from "cure" or "resolution" to "maintenance" or "palliation".

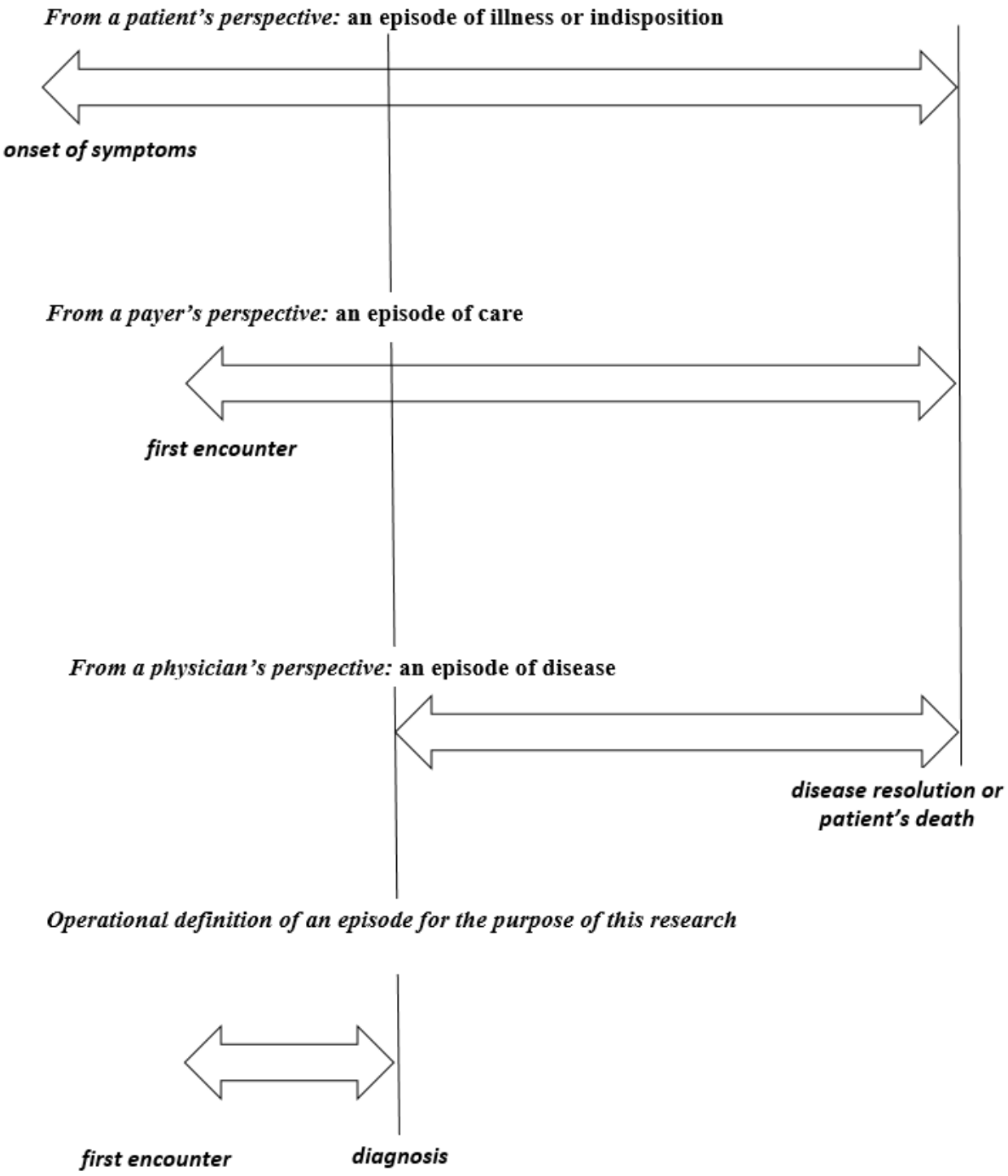
From a patient's perspective, an episode of illness or indisposition entails a continuous time-period that the patient is suffering from a medical condition. The patient may experiences a continuous spell of symptoms that are perceived as ill-health[46]. Symptoms are experienced and reported by the patient (subjective) whereas signs are observed by the health care provider (objective).

From a care provider's perspective, an episode of disease constitutes a time-period that starts at the disease diagnosis and ends at its resolution or until the patient's death[49].

From a payer-centric standpoint, an episode of care is a set of associated healthcare services to the diagnosis and treatment of a complaint. The broad definition of an episode of care refers to a health problem from its first to the last encounter with a family physician[49].

Health maintenance episodes describe encounters with the health care system that do not involve an illness or a disease[46]: health promotion, cosmetic procedures, employment-related physical examinations, etc.

Figure 2: Types of Heath Care Episodes



The episode of care concept is easily defined for acute-onset events such as hip fracture, but more challenging to use to capture the patient's experience of AF, particularly in the stressful time before the definitive diagnosis. This is because the specific encounter that eventually led to the diagnosis may have been for one or more of the many non-specific symptoms of AF.

To capture the patient's experience towards the diagnosis of AF, an episode of illness is operationally defined as a time-period from the first ICPC-coded encounter as a starting point to the date of diagnosis as an end-point. Episode-framed patient data allow a more thorough evaluation of the degree to which family practitioners are involved in a vast majority of patient's health care needs[49]. The notion of an episode of illness also enables to capture the patient's lived experience.

Relevance of a medical encounter to the diagnosis of AF will be determined based on reasons for encounter as reported by patients. Although symptomatology is a major reason for patients with AF to see their family physicians,[15] other reasons for encounter may be in place: for instance, medication renewal, regular check up, blood tests, preventive immunization, etc. From the established diagnosis of AF, we will attempt to retrospectively cluster different encounters into an episode of illness.

All the encounters within the patient's electronic medical record are considered for inclusion into an episode of illness and apparently unrelated ones ("sprained ankle", "frozen shoulder", etc.) are excluded from the subsequent analyses.

An episode is a meaningful unit of analysis for evaluating primary services utilization in treating a particular health problem. Episode-of-care analyses have been conducted in a wide range of studies[50] assessing the efficiency and quality of care; evaluating charges in different clinical settings; exploring physician referral patterns and patient resource utilization. Studies of the effect of cost-sharing on patient behavior[50] also used the concept of an episode of care as a unit of analysis.

The framework of an episode of care has the potential of better reflecting general practice care, overall[46], and a patient's journey, in particular. It allows us to maintain the continuity of care dimension[51] which is not the case with, for instance, a commonly used visit-per-visit framework of analysis. Family physicians provide not only personal,

but also factual continuity of care. As far as the personal component is concerned, the patient presents to the doctor with any health-related problem at any stage of development[49]. The factual continuity of care, on the other hand, is much broader in its scope: the physician keeps the medical health records of the patients up to date in a structured manner, over a period of time, while accounting for professional field and societal changes[49].

2.4 Symptomatology in Atrial Fibrillation and Associated Challenges

For any disease, symptom report is key as it drives medical care, serves as motivation for treatment adherence and serves both as a clinically relevant outcome for patient care and a benchmark in clinical decision-making.[52] Accurate symptom reporting could improve symptom palliation and differential diagnosis.

Despite the fact that AF was first recognized as early as in 1906,[53] its symptomatology has not been thoroughly evaluated.[52] Signs and symptoms - generic and disease-specific ones - have a great variability in AF[35]. Some patients have no symptoms, and the condition is discovered incidentally. In others, the generic symptoms can be clinically presented by weakness, fatigue, dizziness and exercise intolerance. The disease-specific symptoms include heart palpitations, chest pain, pressure or discomfort and shortness of breath. Until now, there has not been developed a "gold standard" in terms of standardized assessment of AF-related symptoms. This lack of standardization can have a detrimental effect on management of AF as decision-making in AF is primarily symptom-driven.[54] Additional challenges arise due to high variability of symptoms not only among patients but also in individual patients at different points in time[15].

In the Euro Heart Survey of Atrial Fibrillation,[55] 69% of patients presented with AF-specific symptoms. Fifty-four percent of currently asymptomatic patients had experienced AF symptoms in the past .[20] Holter 24-hour monitoring demonstrated that patients with symptomatic paroxysmal AF were 10-fold more likely to have an

asymptomatic versus a symptomatic recurrence.[52] Overall, many patients' experience consists of both symptomatic and asymptomatic episodes of AF.[56, 57, 58, 59]

Although patient symptoms are extremely important in detecting and treating AF,[52] they have no diagnostic capacity for "silent" AF. The proportion of asymptomatic AF patients is approximately between 15% and 30%.[15, 33, 34, 35] A few studies showed that 65% of documented AF episodes are not associated with any symptoms in nature.[60]

Notwithstanding "silent" AF, there are other reasons that make patient symptoms an unreliable diagnostic tool. In a study of 518 consecutive 24-hour electrocardiographic recordings,[61] less than 10% of patients reported palpitations accurately. The researchers of this study also found little correlation between the type of arrhythmia and the specific nature of the patient's symptoms.[61] It is widely recognized in the literature that a cardiac pathology and symptoms do not correspond on a one-to-one, fixed basis.[62]

Patients with a history of AF often report symptoms attributable to AF when in normal sinus rhythm.[52] In other words, there are many patients with palpitations that do not have arrhythmias.[62] The transtelephonic monitoring study by Bhandari et al.[63] demonstrated that 69% of symptomatic patients were recorded to have arrhythmia. Thirty-one percent of those patients who complained of AF symptoms had normal sinus rhythm.[63] In a later study, Gerstenfeld et al.[64] confirmed that AF-specific symptoms could equally occur in normal sinus rhythm versus AF. Furthermore, a patient with AF is treated to achieve ideal rate control that minimizes arrhythmic symptoms.

Alongside physiologic variables, such psychological variables as anxiety, stress and depression come into play. Symptom-wise, there is a lot of overlap between psychological distress and AF. Furthermore, a panic attack can not only mimic AF symptoms but also aggravate them. Unfortunately, no systematic evaluation of both physiologic and psychological variables that might affect patient-reported AF symptoms has been conducted to date.[52]

Other cardiovascular comorbidities, such as heart failure and valve disease, in combination with AF produce similar symptoms.[15] It is difficult to dissect AF-related

symptoms from the symptoms caused by co-morbidities: heart failure may be secondary to AF and vice versa

In cardiology, the term "palpitations" is sometimes referred to as a "bland label" that requires further operationalization.[65] Palpitation is defined as a sudden awareness of one's heartbeat. It can be described as skipping, racing, stopping, pounding, or fluttering.[62] By its nature, the term is vague and ambiguous[65] and neither physicians nor patients explicate the precise meaning in which they use the term. As a result, an electronic medical record database is filled with "symptoms within symptoms" or "information within the information"[62] that needs to be accounted for in the research process. At the stage of analysis, per se, there is an important requirement to precisely define a set of potential predictive variables.

The majority of symptomatology studies were conducted on hospital-based cohorts or on subjects referred for AF assessment.[15] Consequently, the study results can have limited generalizability: hospital-based cohorts may be different from population- and community-based cohorts.[36] In hospital-based studies, the risk of selection bias is high. This is particularly true since many patients either present to hospital due to an associated comorbidity or do not go to hospital at all.

There are major gaps in knowledge about whether there is a clinically relevant, mechanistic link between symptoms and the final diagnosis of AF in primary care.[66, 50] Little is known about the patient's experience of AF in relation to functional status and magnitude of symptoms in general practice. Symptoms may be non-specific for AF (for instance, anxiety and fatigue).[15] It is often the case when the patient has other cardiovascular comorbidities. Risk factors for AF and comorbidities can initiate similar symptoms. Research is complicated by the fact that AF is often accompanied by valve disease and heart failure – the two conditions with similar symptomatology.[15]

Heart failure is common in AF patients as both diseases have major risk factors in common, such as diabetes mellitus, myocardial infarction, valve disease and hypertension.[67] Furthermore, each condition can predispose to the other one: AF predisposes to heart failure and vice versa. The 'safe' conclusion would be that

symptoms attributable to AF are multifactorial due to their direct and indirect effects of the underlying arrhythmia.[15]

Physicians already predict the presence of AF from different sources – albeit non-quantitatively and informally.[68] Their decision-making is based on diagnostic investigations, physical examination findings and on patient's symptoms and observed signs. Identifying symptom patterns can be important in predicting the diagnosis of AF for the selected patient populations and in defining clinical states for individual patients.[68]

Using the database of the Transition Project, Lamberts et al.[66] calculated posterior probabilities (in the form of an odds ratio) of the final diagnosis in general practice. The International Classification in Primary Care (ICPC) was used to code both the reason for encounter and the diagnosis. As a result of the Transition Project, a database with a total of 201,127 patient-years for the period of 1985-2002 was created.[66]

The question of interest was whether there was a clinically relevant relationship between two simultaneously occurring events – a symptom and a diagnosis – in general practice. Out of a few conditions, the highest odds ratios of 32.5 were reported for AF. These results are promising as the high value of posterior probability is indicative of the clinical relevance of physician observations.

The posterior probability approach enabled the authors to determine the clinical relevance of general practitioners' observations and only 'certain' or verified diagnoses were used in the calculation.[66] Symptoms as predictive variables for the diagnosis provide evidence-based support for clinical work. With calculated posterior probabilities for primary care,[66] it is possible to determine whether a specific symptom plays an important role in diagnosis while another symptom contributes little or nothing to it.

2.5 Symptomatology

Based on the literature review, the following symptoms related to AF were distinguished: 1) palpitations; 2) chest pain or discomfort; 3) shortness of breath; 4) reduced exercise capacity, and 5) dizziness.

Palpitations, or increased awareness of heartbeat irregularity: More than 50% of patients with AF report having palpitations or are aware of their heartbeat irregularity. Even though the correlation of palpitations with arrhythmia was the strongest of all other AF-related symptoms (palpitations occurred more frequently during AF (67%) versus sinus rhythm (24%))[52], the value of 67% is far from definitive for the diagnosis establishment.

Interestingly, but not surprisingly, the perception of arrhythmia (not its presence) and neuropsychiatric variables are strongly correlated. It is conceivable that a patient experiencing anxiety or a negative emotion is more likely to report arrhythmia when in normal sinus rhythm.[52] Psychological distress potentially augments a patient's perception of ill-health and disease symptomatology.[52]

Chest pain or discomfort: Chest discomfort, pressure and pain often occur during AF episodes even in the absence of structural heart diseases[69] such as critical valve disease or coronary disease.[70]

Dyspnea or shortness of breath: Dyspnea is an indirect consequence of AF[15] and can be accompanied by any type of intracardiac pressures – low, normal and elevated.[70] It is commonly accepted that elevated intracardiac pressures can initiate ventricular arrhythmias[71]. In vivo humans and in isolated hearts, acute ventricular dilatation has potentially arrhythmogenic effects[71]

Exercise intolerance or reduced exercise capacity: As measured by New York Heart Association,[72] over 50% of AF patients experience reduced exercise capacity. Reduction in exercise performance may be due to dyspnea or may be non-specific.[73] The New York Heart Association classifies cardiac patients based on the clinical severity and prognosis of their conditions and distinguishes four classes of functional capacity. Functional capacity is an estimate of how much physical activity the patient's heart will tolerate and is based entirely on subjective symptoms[72] The status of cardiac functional capacity informs subsequent management of the patient's activities . Similarly to dyspnea, patients may have reduced exercise capacity due to arrhythmia with low or even normal intracardiac pressures.[74] Dizziness, syncope and presyncope are rarely reported by patients with AF.[15]

2.6 The Concept of Symptom Clusters

Symptom clusters have long been used for diagnostic purposes in general medicine. Even though a medical diagnosis is ultimately dependent on diagnostic tests, symptoms still play a fundamental role in disease detection.[75] By understanding symptom clusters, clinicians can develop more accurate and comprehensive diagnostic tools.[75]

A symptom cluster consists of two or more concurrent symptoms that are related to each other and may or may not share common etiology. This definition requires further clarification:[75]

1) In terms of the number of symptoms within a cluster, the presence of at least two symptoms serves as an antecedent for a symptom cluster.

2) The meaning of symptom is extended to include both signs (objective, observed by the clinician) and symptoms (subjective, self-reported by the patient).

3) A symptom cluster consists of a stable group of symptoms, i.e., symptom patterns that are replicated across time and subjects. In case of AF, stability of symptoms cannot be easily achieved due to high inter- and intra-individual variability,[15] yet needs to be assumed for diagnostic purposes.[75]

4) Each symptom cluster is relatively independent of other clusters.

5) The relationships among symptoms within a cluster should be stronger than the ones across clusters. Otherwise, the symptom cluster could not identify specific underlying dimensions of symptoms.

6) Etiology in the context of general medicine refers primarily to the underlying biological mechanism of a symptom.

2.7 Atrial Fibrillation-Specific Symptom Clusters

As a new area of cardiovascular research,[76,77] symptom clustering is a group of two or more related symptoms due to shared underlying mechanism, common effect on outcomes and covariance.[78, 75] Several researchers not only identified symptom clusters

but also described an association between cardiovascular symptom clusters and outcomes of interest.[76, 79, 8081]

Gaps in knowledge in regards to AF symptom clustering make it difficult for physicians to develop appropriately individualized, patient-centred treatment plans.[78] Therefore, additional information gained from cluster analysis can be used to tailor management approaches to the needs of an individual patient.

Cardiovascular symptom clustering has already been explored in a number of studies[77, 78, 76]. Some researchers went beyond the strictly descriptive aspect of cluster identification and analyzed symptom clusters for their association with outcomes of interest. Thus, Song et al. explored possible associations between symptom clusters and event-free survival in 421 patients with heart failure.[79]

The study by Hwang et al.[80] attempted to answer the question of whether atypical symptom clustering predicts a higher mortality in 391 patients with first-time acute myocardial infarction. Finally, a few years later the same researcher explored the relationship between cluster dyads of risk factors and symptoms and major adverse cardiac events (MACE) in 522 patients with acute myocardial infarction.[81] The outcome of interest was the incidence of 12-month MACE after the myocardial infarction[81]. Based on the association between the risk factors and symptom clusters, Hwang and Kim identified six cluster dyads and confirmed them to be a significant predictor of 12-moth MACEs. The incidence of adverse cardiac events was three times higher in the hypertension/diabetes/atypical symptoms dyad than in the dyslipidemia/smoking/typical symptoms dyad. In their analyses, the researchers accounted for age, gender, and a type of MI diagnosis. The study results suggest that, in order to prevent MACEs via risk stratification, clinicians need to take into consideration both symptoms and risk factors at clinical presentation[81].

In application to AF, Streur and her colleagues[78] identified AF-specific symptom clusters in 1501 adults, characterized individuals within each cluster and assessed cluster association with an end-point of healthcare utilization. Patients' utilization of heath care services was defined as the number of emergency department (ED) visits, AF-related hospitalizations and cardioversions patients had within the past

12 months.[78] The researchers identified two clusters that met the definition of a symptom cluster (two or more simultaneously occurring symptoms) and labelled them as 1) the Weary cluster (shortness of breath at rest, fatigue at rest, dizziness, and chest pain) and 2) the Exertional cluster (dyspnea with activity and exercise intolerance). The most common symptoms were exercise intolerance (42%), dyspnea with activity (40%) and palpitations (33%).

Another study used participants from the SAFETY trial[77, 82] and identified AF-specific symptom clusters that differed from those in the study by Streur et al.[78] In the order of their frequency, the clusters from the SAFETY trial were labelled as: 1) the heart cluster (palpitations/fluttering and chest pain/discomfort): it was the most common symptom cluster occurring in 26% of participants; 2) the tired cluster (dyspnea/breathlessness, syncope/dizziness, weakness, fatigue/lethargy): all the symptoms were present in 14% of the subjects; 3) the vagal cluster (diaphoresis and nausea) occurred only in 3 patients. Over 50% of the participants with the tired cluster also reported experiencing the heart cluster.

In spite of the differences in the number and composition of the clusters, the palpitations cluster[78] or the heart cluster[77, 82] was still the most common in both studies. The tired cluster and the weary cluster demonstrated the most similarity as they differed by only one symptom: chest pain was used in the weary cluster whereas in the tired cluster, weakness as a symptom was embedded. The observed differences in the clusters may be attributable to inclusion criteria, measurement error as well as recruitment strategies employed in both studies.[78] These identified clusters have yet to be replicated. Although AF-specific symptom research is an emerging field,[77, 76] some studies have already identified symptom clusters among AF patients[76] and their relationship with health outcomes.[79, 80, 81]

2.8 Clinical Assessment of Atrial Fibrillation

To determine efficacious management of AF, it is essential to understand the underlying development of AF-related symptoms, i. e., how AF-related symptoms

change over time.[15] Symptom fluctuation poses the biggest challenge when symptom patterns vary not only in different AF subsets but also in an individual patient.[54, 52, 83]

Given the considerable variability of symptoms and their severity as well as treatment dependence on individual circumstances,[36] a patient with suspected AF needs to undergo a thorough clinical assessment. Clinicians have to manage patients presenting with a variety of symptom severity, yet with "substantively similar physiology".[70] The hardest aspect of diagnosing AF is that the correlation between symptomatology and objective findings varies a lot for any given patient.[70] As a result, it is challenging for clinicians to distinguish a set of typical cases to expect in terms of clinical manifestation in patients with AF.

At the stage of clinical assessment of AF, one aims at establishing the type of AF, its etiology and time of onset. [36] It is important to explore major comorbidities and potential complications which would, in turn, affect the suitability of future treatment plans.

The existing research provides very limited, if any, information on mapping the patient journey after the first visit to the general practitioner. Little is known about the sequence of decisions made "to identify, assess, manage and monitor patients with AF".[29] Knowing common patient care pathways is crucial, particularly because they are evidence-based and as such provide a "guide to the guideline" by informing clinician's decision-making. Unfortunately, multiple versions of guidelines for AF – both in North America and Europe – hardly reflect on real-life context within the primary care framework. While the clinical literature is rich and extensive, the individual variability mentioned in most guidelines underscores the need for a better understanding of the patient experience.

2.9 Methods for Detecting Atrial Fibrillation

The major methods currently used to identify pulse irregularity caused by AF can be classified in the following groups: 1) pulse palpation;[37, 84, 85, 86, 87, 88] 2) blood pressure monitors (BPMs);[84, 89, 90, 91, 92, 93] 3) and ECG[37, 94, 95, 96, 97, 98, 84, 99, 87, 100].

In accordance with current guidelines,[101, 102] pulse palpation should be used as the first step in screening for AF. Two randomized controlled trials in a primary care setting evaluated pulse palpation in combination with confirmatory 12-lead ECG and found it to be a cost-effective and efficacious method of AF screening.[37, 86]

Nevertheless, pulse palpation is thought to be the least diagnostically accurate which is reflected by its lower specificity.[103] This tendency can be explained by inter-observer reliability when health care professionals are required to classify the pulse as being normal or irregular.[103]

The range of sensitivity in most studies on pulse palpation was high: between 91% and 100% whereas the specificity ranged from 70% to 77%. The pooled results of positive and negative likelihood ratios[5] demonstrated that pulse palpation could moderately help in ruling in AF. However, in all the studies, the patient population was older than 65 years and the pulse was taken by a nurse, not a general practitioner. Therefore, it is difficult to generalize these findings to younger patients, with their pulse rate taken by a physician.

Blood pressure monitors overcome the limitation of inter-rater reliability that can be misleading in the pulse palpation method. Any electronic device, including BPMs, uses rigid software algorithms with predetermined cut-off points. The BPM determines the severity of irregular pulse and classifies patients as meeting or non-meeting the inclusion criteria for AF. As a result, other non-AF-related causes of pulse irregularities are excluded by the software algorithms.[103]

When compared to pulse palpation, BPMs are much more accurate in detecting patients with suspected AF. In a primary care setting, the use of BPMs is commonly advocated among patients being monitored for hypertension.[104] Apart from being "simple, quick and accurate", BPMs are also cost-effective and do not require any additional training. Since blood pressure monitoring is already integrated into cardiovascular screening protocols in primary care,[103] BPMs can be a pragmatic substitute for pulse palpation.

The diagnosis of AF requires rhythm recording demonstrating irregular rhythm in the absence of organized atrial activity. The 10-second 12-lead standard ECG cannot register the typical episode of AF that lasts ⩾ 30 seconds. Ironically, for most trials that formed the evidence for guidelines, ECG-diagnosed AF was an inclusion criterion. However, following the 2007 consensus document on catheter and surgical ablation of AF that was adopted by the Heart Rhythm Society, the European Cardiac Arrhythmia Society and the European Heart Rhythm Association[105], AF is defined as an arrhythmia lasting ⩾ 30 seconds[106]. Furthermore, the thirty-second gold standard definition of AF may lead to various predictive implications when detected on a 24-hour Holter monitor versus an implanted device[106].

For chronic forms of AF, ECG is a cost-effective and effective method of prompt recording of irregular heart rate.[107] Substantive evidence also confirmed the effectiveness of ECG recording for silent, undetected AF. This type of AF is common, particularly for older patients and patients with heart failure.[108] The adverse health outcomes of undiagnosed AF include stroke and rate-related cardiomyopathy, and patients with significant comorbidities and increased mortality more often have AF.[109, 110, 111] As a risk factor, AF is associated with mortality in patients with evidence of organic heart disease or systemic disorders. ECG monitoring 72 hours post-stroke[112, 113] or for longer periods[114, 115] enhances the diagnosis of silent AF. In older patient populations (over 75 years of age), short-term ECG on a daily basis increases detection of AF.[116] It is unclear, however, whether early diagnosis changes management strategies for AF patients and more research is warranted in this direction.

2.10 Drug Therapies After the Diagnosis of Atrial Fibrillation

Once the clinical significance of arrhythmia is determined, pharmacological treatment of rate versus rhythm control is based on symptoms Acute cardioversion is safe if the onset of AF is known to have been within 48 hours. Otherwise, one-month anticoagulation therapy followed by cardioversion or trans-esophageal echocardiogram (TEE) is required. The decision of initiating anticoagulation is dependent on the CHADS score and whether cardioversion is to be attempted. A patient presented to the

emergency department due to AF could be cardioverted electrically or with medications if the onset of AF is known to have been less than 48 hours. In cases of new onset AF, heart rate and rhythm can be controlled with anti-arrhythmic drugs as the first course of action.[117] Anti-arrhythmic drugs are prescribed for most patients with no need of immediate cardioversion.[117] Digoxin slows down ventricular heart rate but due to its slow onset, it is less effective in patients with high levels of adrenalin.[118, 119]

In an emergency department setting, beta-blockers and calcium-channel blockers can be administered intravenously[120] as – irrespective of the patient's sympathetic tone – they initiate a much faster response. These drugs are also synergetic with digoxin.[121] However, they are very short-acting and must be followed by oral administration if they work and are tolerated. In a clinic, oral forms of calcium-channel blockers and beta-blockers are prescribed for newly diagnosed patients.

When adequately high doses are used at the onset of AF, anti-arrhythmic drugs are generally effective in converting AF to normal sinus rhythm.[122] However, the majority of these patients come back to sinus rhythm spontaneously within a 24-hour period of AF onset.[123]

Anticoagulant therapy is prescribed when the onset of AF cannot be accurately determined in an emergency-department patient with the CHADS score of 0 .[117] According to the Canadian Cardiovascular Society's (CCS) Atrial Fibrillation Guidelines (2010, 2012, 22014, and 2016)[124], anticoagulant therapy is prescribed regardless in patients with the CHADS score of more than 0 or age 65 or over even when the time of onset is known. Early anticoagulant therapy is key as patients with suspected AF are prone to blood clotting which can potentially lead to stroke.[125, 126] The risk of clot formation among older AF patient populations (80-89 years of age) that do not receive anticoagulants can be particularly high and reach the value of 23.5%.[127] To prevent stroke for the current and future episodes and regardless of the time of onset, the patient receives anticoagulant therapy.

The choice of a specific anticoagulant drug is dependent on the type of AF, presence of comorbidities, patient's adherence to the treatment plan as well as potential

drug interactions.[125] Medication compliance is of particular importance as a missed dose increases the risk of thrombosis.[128]

2.11 Indications for Referral of Patients with Suspected Atrial Fibrillation

Referral pathways in AF are dependent on the type of AF and clinical manifestation of the disease (Table 1). For a small group of haemodynamically compromised patients at the onset of AF for less than 48 hours, the decision on immediate hospitalization is driven by the patient's clinical presentation.These patients are referred for cardioversion within a 48-hour time-frame. The time window is key as the patients may be cardioverted without the subsequent need of anticoagulation.

The referral pathway is tailored to individual needs of a patient and referral to a specialist is usually required. Due to high inter- and intra-individual diversity in clinical manifestation, it is difficult to define a typical case scenario for every type of AF. For instance, a patient with persistent AF is usually referred for elective cardioversion and for specialist advice to establish pharmacotherapy.[29] Pharmacotherapy is also integrated in patient care for those diagnosed with permanent AF. However, not all AF patients are in need for pharmacotherapy and not everybody requiring pharmacotherapy will benefit from specialist advice.[29]

Davis et al.[29] distinguished the following most common reasons for referrals: 1) failed medical treatment; 2) specific electrophysiological problems such as focal or slow, symptomatic AF or Wolff-Parkinson-White syndrome; and 3) lone AF.

Due to its ambiguous and transient symptomatology or absence of such, the disease of AF is difficult to diagnose. In addition, there is a broad heterogeneity in precipitants of AF and diagnostic approaches. As a result, patients experience protracted assessment time. This adds to emotional distress and significantly disrupts their daily living as well as delays the start of evidence-based disease management.

Table 1: Indications for Referral of Patients with Suspected Atrial Fibrillation:[2]

Type of Referral	Indications for Referral
Immediate / emergency referral	• haemodynamic compromise at the onset of atrial fibrillation • atrial fibrillation for < 48 hours
Early referral	• onset of atrial fibrillation within 48 hours • patients with symptomatic atrial fibrillation
Elective referral	• paroxysmal atrial fibrillation • persistent atrial fibrillation for possible cardioversion • persistent or permanent atrial fibrillation for advice on pharmacotherapy • failure of medical treatment • Wolff-Parkinson-White syndrome • lone atrial fibrillation • focal or slow symptomatic atrial fibrillation, which may benefit from pacing

[2] Davis M, Rodgers S, Rudolf M, Hughes M, Lip GYH. Patient care pathway, implementation and audit criteria for patients with atrial fibrillation. *Heart*. 2007;93(1):48-52. doi:10.1136/hrt.2006.099937

2.12 Patient-Centered Care and Lived Experience of Atrial Fibrillation

There is a growing tendency to give equal considerations both to clinical practice perspective and to patients' experiences, feelings, fears and expectations.[129, 130, 131] At the core of the rhetoric around healthcare reforms is the philosophy and practice of patient-centered care. Governmental agencies in Great Britain (National Health Service 2005),[132] in the USA (US Department of Health and Human Services 2008)[133] and in Australia (Australian Commission on Safety and Quality in Healthcare 2012)[134] along with the World Health Organization[135] and multiple health policy and patient-advocating organizations around the world[136, 137, 138] recognize the importance of prioritizing individual patient's needs in medical care delivery.

The first mention of patient-centered care was by Enid Balint in 1969[139] who juxtaposed "illness-oriented medicine" to a different way of medical thinking also known as "patient-centered medicine". In addition to establishing a medical diagnosis, the doctor needs to consider the patient in one's wholeness in order to be able to form "an overall diagnosis"[139]. In Balint's words, this two-fold task makes the doctor a general practitioner for some patients and "a minor psychotherapist" to others. It was when "the problem of the split doctor" was brought up for discussion. The question was whether such split was aimed at as it might have changed the whole medical approach of the general practitioners. Furthermore, doing "psychotherapy" with some patients would lead to the evolvement of new skills – both as psychotherapists and as detective inspectors. Enid Balint was the first researcher to challenge the traditional, taken-for-granted emphasis on the doctor's perspective rather than on what the patient "tries to get from the doctor"[139].

The full publication of the patient-centred clinical method appropriate for family medicine was by Levenstein et al.[140] in 1986. In operational terms, a rigorous patient-centred method that is applicable to any family medicine situation, answers the question, "What is the minimum that can be expected of any family physician at any patient visit?"[140] The authors' firm belief[140] is that it is essential for family medicine to develop such a method.

Interestingly, in family medicine, a clear-cut diagnosis marks a failure, indicating missed opportunities for disease prevention. When the patient presents cues of unwellness

and the physician observes signs of the abnormality, the principle of an objective standard does not work. It is important to assess the patient in relation to one's own norms rather than by an objective standard[140].

For the patient-centredness to be effectively integrated into the disease management which is "the quintessence of family medicine"[141], the doctor needs to understand both the patient and the disease. Levenstein et al. stress that this two-fold purpose can only be achieved by including the process of differential diagnosis. At the same time, the physician needs to know individual life circumstances of the patient, his or her expectations, feelings and fears. Patient-physician interactions are best described in terms of the patient's and physician's agendas[140]. As the patient-centered method relates to the patient's agenda, the physician sees the illness through the patient's eyes by trying to enter the patient's world. Simultaneously, the doctor applies his disease-centered agenda by bringing the patient's problems into his clinical world of pathologies and diagnoses.

According to Levenstein et al[140], there is no risk of invading a patient's privacy in this method if the doctor does not play the role of a detective inspector. Instead of probing, the physician poses open-ended questions for the patient to express one's own feelings, expectations and fears. Through such an expression, the doctor gets the context of the illness that may be crucial to understanding of the whole illness.

The concept of patient-centered care was further developed by the Picker Institute in 1988[142] and the existing scientific paradigm has already accumulated sufficient evidence of benefits of patient-centered care.[129] It can improve patient-important outcomes,[143, 144, 145, 146, 147] on the one hand, and reduce the workload and healthcare expenditures,[148149] on the other hand, by avoiding services that patients may neither want nor need. From a legal standpoint, fewer malpractice lawsuits will occur[150, 151] as person-centered care increases patient satisfaction.[152] Lastly, patient-centered care has ethical value of its own as it treats patients as persons with significance.[153]

While there is no singular, universally accepted definition of person-centered practice, various health care groups tend to focus on its different aspects. This happens at all the levels – from an individual encounter level, through various management stages to policy activities.[130] Being reflective of their professional interests and roles,[130] different

stakeholders interpret patient-centered care in their specific ways. In order to operationalize this concept at the patient care level, it is key to explore the lived experience of patients. Without mapping the patients' journey through their interactions with the health care system and across its organizational sectors, it is impossible to meaningfully apply the concept of patient-centered care to individual patients.

Capturing patients' experiences from the symptom onset to the definitive diagnosis of AF is needed not only for the sake of early management from the doctor's perspective, but also for fear and uncertainty reduction, from the patient's perspective. Each patient journey can be slightly or totally different from what physicians anticipate it to be. A standard case scenario would be the one of an emergency admission, with the arrhythmia documented on ECG and a clinical diagnosis obtained.

A more typical experience, however, is characterized by delays in obtaining a confirmed diagnosis.[154] The delays are attributable to transient episodes of AF that are difficult to "catch" on physical examination or to confirm by ECG. Shortness of breath, palpitations and loss of energy are generic symptoms with no objective explanation[154] that are often interpreted by primary care physicians as insignificant and caused by stress.[155] Symptom vagueness and arrhythmic elusiveness significantly defy diagnosis, making some patients go to great lengths in validating their disease experience.[154] As a result, patients perceive themselves to be a "bother" that is either dismissed or not believed.[156]

CHAPTER THREE – METHODS

3.1 Objectives

The objectives of this research were: 1) to characterize an AF episode of illness in terms of the number of physician visits, episode length, medications prescribed, diagnostic investigations ordered, and referrals made in a sample of Canadian family practice patients; and 2) to compare the findings with the control group of patients living with other chronic conditions by defining a magnitude of effect.

Objective One: to characterize an AF episode of illness in a sample of Canadian family practice patients.

Question 1:

What is the mean and median number of physician visits in an AF episode of illness?

Question 2:

What is the mean and median length (in months) of an AF episode of illness?

Question 3:

a) How many medications are prescribed during an AF episode of illness?
b) What medications are prescribed during an AF episode of illness?

Question 4:

a) How many diagnostic investigations are ordered during an AF episode of illness?
b) What diagnostic investigations are ordered during an AF episode of illness?

Question 5:

a) How many referrals are made during an AF episode of illness?
b) What referrals are made during an AF episode of illness?

Objective Two: to explore the differences between the study group and the control group in terms of the number of physician visits, episode length, medications prescribed, diagnostic investigations ordered, and referrals made as well as to measure an effect size.

3.2 The Deliver Primary Health Care Information (DELPHI) Database as Source of Data

De-identified, high-quality data for a 10-year period (2005 – 2015) from 23 general practices in 10 primary care urban and rural practices from southwestern Ontario were extracted from the DELPHI (Deliver Primary Healthcare Information) database and further analyzed for the two objectives specified above.

The DELPHI Project is an ongoing project with the starting date of 2003. The overarching goals of the project were:[157] 1) to facilitate information-sharing in interdisciplinary primary healthcare by developing an EMR system; and 2) to define, evaluate and improve the quality of primary health care.

Three types of structured data – symptoms, diseases and interventions - are coded in the DELPHI database which is similar to an analogous albeit larger database in the United Kingdom called the General Practice Research Database[158]. Twenty-three general practitioners in ten primary care urban and rural practices from southwestern Ontario were recruited into the DELPHI project. The constructed DELPHI database covers a wide geographic area of Ontario, stretching to Windsor in the south, to Kincardine in the north, to Brantford in the east and encompasses the London area. According to the DELPHI developers, [157] sex and age distribution of the participating physicians represents Ontario physicians as a whole, although the DELPHI sample of the participating physicians is less urban. Age and sex distribution of the patients also largely resembles the Canadian general population.

Data extraction from each practice occurs quarterly. The extracted data include the billing code, family history, problem lists, interventions, medications, referrals, allergies, laboratory tests, immunizations, investigations and physical examinations for each patient.

On a random sample of patients with International Classification of Primary Care (ICPC)-coded data (please see Section 3.3, below), the following additional data components are extracted[157]: 1) up to five reasons for encounter (RFE) per visit coded within the vocabulary available in ICPC (codes 1-20 for each chapter); 2) up to five diagnoses per visit, and 3) non-chronic disease tracking within the framework of episodes of care.

Each subsequent data extract is longer in its time-period than the previous extract because the longer period includes the time of both the previous and the new extract. In other words, the DELPHI database is re-created with successive cumulative extracts of electronic medical records each quarter of the year. For instance, at Extract 1 (at the very first data extraction since the launch of the DELPHI database), three months of data were extracted; at Extract 2, six months of data were collected (three previous months + three new months) and at Extract 3, nine months of electronic medical records were extracted (six previous months + three new months) and so on. The pooled database that is being refreshed on an ongoing basis, is referred to as the DELPHI database.

A unique number is assigned to each patient record. The patient's name, address and telephone number are not retrieved from the general practitioner's office[157]. The only personal identifiers collected are partial date of birth, partial postal code and sex/gender[157]. Repeated data extraction is performed in such a manner that patients' identification is not required. Consequently, it is impossible to identify either a participating physician, or a patient. Moreover, access to the database is restricted to personnel involved in DELPHI research projects and only after they have signed confidentiality agreements.

3.3 The International Classification of Primary Care (ICPC)

The International Classification of Primary Care (ICPC) is a classification system that was developed to categorize medical concepts into classes on the basis of their relevance for primary care[159, 45] The basic structure of an encounter within an episode of illness distinguishes reasons for encounter, symptoms, complaints, diagnoses and diagnostic and therapeutic interventions[160].

ICPC conversion structure with the International Classification of Diseases (ICD-10) allows high specificity that is necessary in patient care[161]. For the use of expert systems and for retrieval purposes, ICPC structures computer-based patient records into the episode-oriented database. And a large nomenclature such as ICD-10 ensures the highest possible level of specificity of the individual diagnostic labels. Consequently, on the level of individual patients' problem list, the complete conversion of ICPC and ICD-10 ensures an optimal description of a patient's clinical problems[161].

The twenty-two chapters of ICD-10 include blocks corresponding to different body systems: for instance, Chapter X corresponds to the diseases of the respiratory system whereas Chapter XV encompasses pregnancy, childbirth and the puerperium and so on.

With its three core modes – a reason for encounter classification, a diagnostic classification and a process classification, - the ICPC is used as an instrument for identification and analysis of primary care elements. In application to this research, the ICPC allows to move to an episode-oriented epidemiology[159], when transitions (changes) between encounters in an episode of care can be explored.

To include the ICPC aspect in the DELPHI project, the selected electronic health record (EHR) company modified the existing EHR. As a result of the ICPC-related modifications, the participating physicians needed to enter additional information that was outside of their routine recording in the EHR. That was why the DELPHI personnel first familiarized the health care providers with the core EHR functions[162]: the participating sites received training in the entry of clinical data, billing and scheduling. Furthermore, prior to the ICPC inclusion, the EHR was implemented for at least one year[162].

Once the participants became proficient in their daily use of EHR, they were introduced to the research specific data modifications[162]. The DELPHI personnel provided specific examples to the participating sites to reinforce the importance of entering as much as possible in the corresponding fields in the database. For instance, the results of the physical examination performed in the office are to be entered into the "physical signs" module rather than as narrative text in the notes field.

To assess the degree to which all the EHR components were used for entering appropriate data, audits were run. The identified weaknesses informed further, more specific training that was offered either by the DELPHI staff or by the EHR company. For the purpose of collecting reliable research data, only the health care providers (and not the administrative staff)[162] were asked to identify the relevant ICPC codes.

To further ensure data reliability, a three-phase ICPC training process was implemented[162].

At the first phase, the trainer reviewed ICPC-related theory with up to six participants and provided multiple examples over a period of 1.5 hours. For future reference, the participants received a laminated colour-coded list of ICPC code names, a thirty-page ICPC manual, and a bound list of ICPC codes with descriptive details.

At Phase Two, fifteen previously developed clinical vignettes were distributed to the participating sites with a request to identify ICPC codes that are relevant – in regards to diagnosis and reason for encounter - to each case. Base on the results, inter-rater reliability was assessed. Another set of fifteen vignettes was distributed among the participants, after they got some experience in coding their actual encounters. Similarly, these codes were used for the comparison of inter-rater (among the participants) as well as intra-rater reliability (when compared to the initial results)[162].

At the final 1.5-hour stage of training, the instructor demonstrated the correct use of ICPC-related software that captures reason for encounter and diagnosis fields. Another goal of the final stage of training was to ensure that the participants gained an understanding of the episode of care structure within the EHR framework.

Approximately 10% of the DELPHI patient population was coded using ICPC. A 'ramp-up' method for coding ICPC data was implemented in order to simplify the process for the physicians who were building up their confidence in using a new coding system. A few patients from the physician's list were randomly selected every day and then coded using ICPC. For obtaining a longitudinal record, once a patient was selected, each subsequent physician visit was ICPC-coded.

3.4 Episodes of Atrial Fibrillation Illness Defined Using ICPC-Coded Data

An episode of AF illness is defined as an inclusive number of days between the first ICPC-coded encounter and the date of AF diagnosis. An episode length was calculated by taking the difference in number of days between the starting point and the end-point of an episode of illness, with the addition of one day to include the first and the last day.

To identify patients with the diagnosis of AF, the International Classification of Primary Care (ICPC, 2nd edition) code K78 ("atrial fibrillation/flutter") was used. Since this research was conducted within the framework of an episode of illness, there was a need for accurate registration of physician visits in general practice. The focus was on the reasons for encounter, the diagnoses and the interventions. These three components form the core of an episode of illness and the ICPC provides detailed coding for them in EMR data[161].

3.5 Look-Back Period and Left-Censored Data

The choice of the type of a look-back period considerably impacts the number of identified incident cases and depends on the research question and available data. As far as the duration of a disease-free period is concerned, Czwikla et al.[163] recommend using - if data permit - a fixed-window look-back period of two years and more. A sufficiently long disease-free period prior to diagnosis would allow one to distinguish incident cases from recurrent and prevalent ones[164] and prevent incidence overestimation.[165] Of note, Schubert et al.[165] stress that three years of looking back can still lead to incidence overestimation.

Informed by the current research,[166] the decision was made to use an all-available rather than a fixed-window look-back period. A fixed-window look-back period has limitations of its own and needs to be at least 1 year in length when used.[167] Since there is a defined study entry date (first diagnosis of AF), the use of all historically available baseline information for each subject helps get an analytical sample of incident cases. All the patients had available data for at least 6 months prior to diagnosis (the look-back period) and differed in lead-up time before that period.

It is often impossible to distinguish an absence of the condition from missing data.[166] Commonly and operationally, missing data indicate that the condition is not present.[168] However, if the diagnosis of AF has been established before the patients' enrollment into the DELPHI database, it means that the data are left-censored. In this instance, misclassification of incident cases[163] and, thus, introduction of bias occurs. It is particularly relevant to administrative data. We considered the possibility of left censoring in the DELPHI database because the goal of DELPHI data collection was individual patient care, not research.[157] Only the cases with the documented diagnosis of AF were included as it is considered to be a resilient case definition for incidence estimation.[165]

3.6 Definition of Independent Variables

3.6.1 Study Group

For the purpose of this research, the full sample of 69 patients with ICPC-coded first-time diagnosis of AF (K78) comprises the study group.

3.6.2 Control Group

For Objective Two, an independent-samples t-test was performed to compare the mean scores on the following dependent continuous variables – the number of physician visits, the episode length, the number of medications prescribed, the number of diagnostic investigations ordered, and the number of referrals made for two distinct groups of patients – an AF group (the group of our primary interest) and a comparison group.

There are several steps involved in defining a comparison group which have been informed by the review of literature on multimorbidity. Primarily, our decision has been informed by Fortin, Almirall & Nicholson[169]. The comparison group is composed of nine smaller groups of patients who are first ever diagnosed with one of the nine most prevalent chronic conditions/categories of conditions in Canada. Each of the nine mutually exclusive groups has more than 100 patients. These chronic conditions/categories of conditions[169] include hypertension; depression or anxiety;

chronic musculoskeletal conditions causing pain or limitation; arthritis and/or rheumatoid arthritis; osteoporosis; asthma, chronic obstructive pulmonary disease (COPD), or chronic bronchitis; cardiovascular disease (angina, myocardial infarction, atrial fibrillation, poor circulation in the lower limbs); heart failure (including valve problems or replacement); and stroke and transient ischemic attack. For the purpose of comparison, a group of patients from firstly diagnosed AF are excluded.

The pre-defined criteria that initially informed the selection of chronic conditions and that are presented in the above mentioned article are coherent with our overarching goal of exploring an AF patient journey in the primary care setting. They are:[169] 1) relevance to a primary care setting; 2) impact on patients; 3) high prevalence in primary care; and 4) high prevalence of occurrence in the existing body of literature. Grouping related conditions under one category to be more flexible and inclusive of them is another reason why we have adopted this approach for creating our comparison group. It also allows comparability among studies that use the same criteria of creating comparison groups or rely on the same measuring tool of comorbidity.

The first visit day and the day of diagnosis are used to calculate an episode length and, subsequently, the number of physician visits, medications prescribed, diagnostic investigations ordered, and referrals made within an episode of illness.

The 90-day lag period after the date of diagnosis is used for the number of referrals and diagnostic investigations.

3.7 Definition of Dependent Variables

Five dependent variables were created: the number of physician visits, the episode length, the medications, the diagnostic investigations, and the referrals. The number of physician visits variable was coded using ICPC diagnostic codes within the pre-defined framework of an episode of illness. Except for the ICPC component of the electronic medical records, longitudinal records of patients' medications, diagnostic investigations and referrals were used to construct medications, diagnostic investigations, and referrals

variables. To meet the first objective of the research, the descriptive statistics for the five dependent variables are provided.

3.7.1 Number of Physician Visits

The number of physician visits is a count variable that is defined as the number of in-office physician visits within the framework of an AF episode of illness. In the study group, there were no patients with a one-visit episode of illness. The minimum number of physician visits was 2 visits per an episode of illness and three of the patients were fortunate to be diagnosed within a two-visit time period.

3.7.2 Episode Length

The episode length is a count variable that is defined as an inclusive number of days between the first ICPC-coded physician visit and the physician visit during which the diagnosis of AF was confirmed.

There was not a single one-day episode length. This variable was calculated by getting the time difference between the date of diagnosis and the date of the first ICPC-coded physician visit within the framework of an episode of illness for each of the 69 participating patients. Consequently, 69 episodes of illness were defined in 69 patients, with each of them having their varying episode length.

3.7.3 Medication

The medication variable is defined as the number and type of AF-specific medications prescribed during the episode of illness. For Objective One (to characterize an AF episode of illness for in a Canadian primary care setting), medication is defined as a count variable. The choice of the two drug groups is based on the conducted review of current treatment strategies of AF[117]. If promptly administered and at an adequately high dosage, antiarrhythmic drugs are effectively used to convert AF to normal sinus

rhythm[170]. To prevent blood clot formation in the atria, anticoagulant therapy is essential[126].

This variable captured the AF-specific medication prescriptions that were recorded in the electronic medical records (EMRs) during physician visits within an episode of illness.

To confirm relevance of identified medications to an AF episode of illness, each drug title was queried on HealthyOntario.com. It is a Canadian government-sponsored health information site that promotes greater individual responsibility for well-being by addressing everyday health concerns in layman's terms[171]. As far as medication is concerned, HealthyOntario.com is a helpful resource of ensuring medication review and safety in order to decrease rates of "near misses"[172]. A "near miss" is an event in medicine that had the potential of resulting in harm to the patient but did not occur because of the timely intervention by the patient, the physician or the family member, or due to good fortune. "Near misses" are also known as "good catches" or "close calls".

3.7.4 Diagnostic Investigation

The diagnostic investigation variable is defined as the number and type of diagnostic investigations performed within an episode of illness. To meet Objective One (to characterize an AF episode of illness in Canadian family practice), this variable is labelled as a count variable.

By its major types, the diagnostic investigation variable has the following categories that are initiated in a primary care setting[29]: clinical assessment, basic blood tests (including thyroid function tests), chest X-rays and an electrocardiogram (ECG). We expect to see ECG as a diagnostic test for many patients diagnosed with AF as, according to current guidelines for the diagnosis of AF, confirmation of the arrhythmia through ECG, telemetry, or portable heart rhythm recorder is essential[29]. However, the best practice guidelines may not necessarily be followed as was revealed by a study describing the management of prevalent cases of atrial fibrillation in two UK practices. The authors reported a suboptimal use of standard diagnostic investigations, with only

18% of the patients receiving an ECG close to the date of their first diagnosis[173]. More specialized diagnostic investigations such as electrophysiological studies may require a referral to a secondary care clinical setting. Some general practitioners, however, have open-access echocardiography in their offices, which should significantly expedite assessment of patients for functional and structural heart disease[29].

3.7.5 Rationale for Lag Period in Definition of Diagnostic Investigation

In the sample of 69 patients, there were instances when it was impossible to link a diagnostic investigation to the physician visit during which it was ordered. Missed appointment dates is another challenge that makes it impossible to associate a specific diagnostic investigation with a specific physician visit. Moreover, the date of record creating could denote several options – the date of the investigation being ordered, the date of the appointment being booked, or the date of inputting diagnostic results into the EMRs. Although the date of record creating did not have any missed value, it still lacked interpretative power. In order to resolve this issue, a lag period of 90 days was incorporated into the variable definition.

3.7.6 Referral

The referral variable is defined as the number and type of referrals made during the episode of illness. To meet Objective One, the referral variable is defined as a count variable.

A referral was included in the episode of illness if the date of the referral was recorded between the starting and end-points of the episode of illness plus a 90-day lag period. Both AF-related and non-specific referrals were included into the episode of illness.

In order to define AF-specific referrals, additional components of the EMR were explored to determine the type of information recorded in the EMR and the mode of its categorization. A referral record was a separate dataset in the EMR extract and provided

the following information: a type, purpose, an appointment date of referral (with the name of the referred physician), a date of record creation, and an encounter number to bind the referral with the schedule of physician visits.

The referral dataset included all the referrals recorded for the patient, regardless of the underlying reasons for the referrals. Both AF-specific and non-specific referrals recorded within the episode of illness were included in the subsequent analyses.

3.7.7 Rationale for Lag Period in Definition of Referral

The same rationale for a 90-day lag period applies in definition of both the referral and diagnostic investigation variables.

3.8 Data Analysis Objective One: Characteristics of an Atrial Fibrillation Episode of Illness

IBM SPSS Statistics 25 software was used for statistical analyses conducted on the entire sample of 69 patients with firstly diagnosed AF. Correspondently, 69 complete episodes of AF illness were identified for subsequent analysis.

To minimize measurement biases in statistical analyses, each variable in the data file was checked for errors. To do so, the frequencies for all the variables were inspected. It allowed to ensure that there were no values falling outside the range of possible values for each specified variable.

3.9 Data Analysis Objective Two: Comparison of Study Group and Control Group.

3.9.1 An Independent-Samples T-Test

As we would like to compare the mean scores of the five continuous dependent variables in the study group with the mean values from the control group, an independent-samples t-test is an appropriate statistic.

3.9.2 Underlying Assumptions for an Independent-Samples T-Test[174]

Level of Measurement: It is assumed that each dependent variable uses a continuous scale instead of discrete categories. At the initial stage of the research planning, a decision was made to give a preferential choice to continuous dependent variables. It gave us a wider range of techniques to choose from for data analysis.

Random Sampling: The scores are assumed to be obtained from a random population sample.

Independence of Observations: The observations are assumed to be statistically independent of one another, i. e., not influenced by any other measurement or observation.

Normal Distribution: The populations from which the samples are taken are assumed to be normally distributed. This is often not the case in real-life research as scores on dependent variables can be not normally distributed. However, with a relatively large sample size (more than 30), approximately normal distributions are sufficient. Moreover, most statistical techniques are robust to this assumption.

Homogeneity of Variance: Samples are assumed to be obtained from populations of equal variances. In other words, the variability of scores in each group is expected to be similar.

3.9.3 Effect Size Statistics

Following the guidelines of the fifth edition of the American Psychological Association (APA), effects sizes are reported for Objective Two: "it is almost always necessary to include some index of effect size or strength of relationship in your results section, for the reader to fully understand the importance of your findings"[175]. Similarly, Snyder and Lawson[176] emphasize that it is impossible to predict an effect size based entirely on statistically significant results. In unison with them, Thompson[177] and Volker[178] believe the effect size to be critical information that cannot be assessed by considering only a *P*-value.

Being a function of both an effect and sample size, a small *P*-value can relate to any magnitude of effect[179]. With a large sample size, the likelihood of getting a statistically significant difference is increased. However, a small *P*-value might not mean a large effect size. Conversely, a modest study can generate a large effect, regardless of its statistically insignificant findings that are the direct consequence of the small sample size[176, 179].

In the absence of previously reported effect sizes for the dependent variables of interest in the literature (the number of physician visits, the episode length, the medication prescribed, the diagnostic investigation ordered, and the referral made), a decision was made to report several common effect size statistics and to compare the results between them: Cohen's *d*, eta-squared, Glass' *delta*, and Hedge's *g*. All the measures of effect size are used to interpret the strength of association between the group variable as an independent variable and each of the five dependent variables. Moreover, reporting multiple effect sizes to address the same question improves the communication of the results[180].

3.9.4 Missing Data

There were no missing data for any of the variables included in the analysis.

3.9.5 Outlying Points

Since many statistical techniques are sensitive to outliers,[181] it is essential to check for cases with values significantly below or above the majority of other cases. This was done by inspecting the residuals in the Residuals Statistics table.

Another statistic used for assessing the presence of outliers was the 5% trimmed mean, when the software removed the top and bottom 5 per cent of the cases and calculated a new mean value.[181]

CHAPTER FOUR – RESULTS

4.1 Sample Description

The sample consists of 69 complete AF episodes of illness extracted from the ICPC-coded part of the DELPHI database over a four-year period, between October 2005 and September 2009. A summary of patient- and episode-level characteristics is presented in Table 2. This table also contains information on the top five most common chronic conditions.

From the output generated by IBM SPSS, by biological sex, there are 35 females (50.7%) and 34 males (49.3%), giving a total of 69 patients. By age, the patients range between 50 and 95 years old at the time of their diagnosis, with a mean of 75.83 and a standard deviation of 10.68. Only 5% of the patients are younger than 55 years of age and another 5% are above the age of 90. 25% of them are not older than 71 years of age at the time of diagnosis. Another 25% of the patients are older than 83 years of age.

Out of the ten practices participating in the DELPHI project and contributing their patient-level data to the DELPHI database, only seven practices had ICPC-coded data on first-time-diagnosed AF patients. 28 patients (40.6%) were seen in one rural primary care practice whereas 41 patients (59.4%) visited six urban practices, thus demonstrating a higher clustering of cases in the urban setting.

Three practices (one rural and two urban) accounted for 88.4% of all the cases. Of the 88.4%, slightly more cases (by 7.2%) were diagnosed in the two urban practices than in the one rural practice. There were 33 urban cases (47.8%) compared to 28 cases (40.6%) in the rural setting.

When further analyzed by the doctor's code, 40.6% of the 69-patient sample (28 cases) were diagnosed by two doctors in the single rural practice that is presented in the sample. Surprisingly, one doctor in this particular practice diagnosed AF in 20 patients, thus accounting for 29.0% of all the cases in the sample.

The larger of the two urban practices added another 25 cases (36.2%) to the sample. There were five diagnosticians in total in that practice, with three of them having identified one new case each (4.2%) and one of them having established the diagnosis of AF in two patients (2.9%). Similarly, there was a doctor in the practice

who identified 20 incident cases, thus contributing another 29.0% of patients to the final sample.

The much smaller urban practice – in terms of its contribution of cases – had only one doctor who identified 8 new cases of AF (11.6% of the sample).

Only 27.5 % (19 cases) do not have any comorbidities, i.e., they have a single diagnosis of AF; the mean number of diagnoses is 6.74, with a standard deviation of 7.41.

As the literature considers the reason for encounter to be a practical source of patient information[161], we have decided to include it for a more detailed description of the sample. Furthermore, ICPC contains over 200 complaints and symptoms serving the categorization of both clinical findings and reasons for encounter[161].

The reasons for encounter are registered in the ICPC-coded portion of the DELPHI database in the form of ICPC codes. The five most prevalent reasons for encounter are 1) blood test; 2) weakness/tiredness general; 3) medication/prescription/renewal/injection; 4) hypertension uncomplicated; and 5) medical examination.

There are two broad classes of reasons for encounter: 1) procedural or diagnostic and 2) therapeutic interventions. It is important to distinguish between the two of them as a specific type plays a crucial role in explaining the differences in the intervention distribution within an episode framework[49]. It is also the case that these two classes may be mixed. They are not mutually exclusive in that patients may come requesting a procedure or in need of a diagnosis, but also undergo an intervention.

Procedural reasons for encounter include, for instance, patient's requests for interventions, a referral to a specialty outpatient clinic/tertiary care hospital, an X-ray of different body parts (as the most common type of diagnostic investigation), a medication prescription or renewal, etc. Given the proportion of the patients studied who had multiple chronic conditions, the most common procedural reason for encounter was medication renewal.

Out of the total 361reasons for encounter in the sample, 298 (82.5%) were procedural in nature. This finding has important implications for clinical care, as patients are no longer seen as passive recipients of medical services but rather active

participants in diagnosis and treatment. They are able to identify their own needs and request the services that they believe to be beneficial to their health and well-being. In other words, patients shape the content of primary care[45]. As a result, primary care physicians – those in general practice, pediatrics, family and internal medicine[182] – although performing a gatekeeper function, are inclined to satisfy their patients' requests[183]. The high number of procedural reasons for encounter at the first date of AF diagnosis is highly suggestive of this tendency. Less than 20 per cent of the reasons for encounter are initiated due to patients' symptoms and complaints at the date of AF diagnosis. This means that for the overwhelming majority of AF patients in the sample, the disease of AF does not have clinical manifestation that could be self-reported in the form of symptoms.

Comorbidity is defined as "a distinct additional clinical entity"[184].In terms of the presence of comorbidities, approximately 20 per cent of the patients did not have any other comorbidities: AF was a first chronic condition they have ever been diagnosed with. Forty per cent of the patients, however, had been diagnosed with 2 to 3 chronic conditions. A relatively large number of patients (16%) were diagnosed with five or more chronic conditions.

The five most prevalent comorbidities account for 72.4% of all the comorbidities recorded in the sample. The five less common chronic conditions represent 16.8% of the total number of comorbidities. As expected, the top two of these – cardiovascular disease and hypertension – are cardiac related. The other three from the top five chronic conditions - arthritis, chronic musculoskeletal and diabetes - are likely to be age-related as the mean age at diagnosis is 75.8 years of age. The five less prevalent chronic conditions accounted only for 16.8% of the total number of chronic conditions.

Table 2: Description of Sample

Characteristics	Central Tendency and Dispersion/Type	Frequency (%)
Patient-Level Characteristics		
Age at Diagnosis (years)	Mean	75.8 years
	Std. Deviation	10.7 years
	Percentile 5	55 years
	Percentile 25	71 years
	Percentile 50	77 years
	Minimum	50 years
	Maximum	95 years
	Range	45 years
	50-60 years	9 (13.0%)
	61-70 years	8 (11.6%)
	71-80 years	27 (39.2%)
	81-90 years	23 (33.3%)
	91-95 years	2 (2.9%)
Sex	Male	34 (49.3%)
	Female	35 (50.7%)
Episode-Level Characteristics		
Practice Type	Urban	41 (59.4%)
	Rural	28 (40.6%)
Number of Practices	Urban	6
	Rural	1

Table 2: Description of Sample Continued

Characteristics	Central Tendency and Dispersion/Type	Frequency (%)[3]
Episode-Level Characteristics		
Number of Cases by Doctor's Code	Practice 004-1[4]	8 (11.6%)
	Practice 004-2	20 (29.0%)
	Practice 009-1	1 (1.4%)
	Practice 009-2	2 (2.9%)
	Practice 009-3	1 (1.4%)
	Practice 009-4	1 (1.4%)
	Practice 009-5	1 (1.4%)
	Practice 010-1	8 (11.6%)
Distribution of Reasons for Encounter at First Date of Diagnosis	0 reason for encounter	34 (9.4%)
	1 reason for encounter	75 (20.8%)
	2 reasons for encounter	35 (9.7%)
	4-6 reasons for encounter	89 (24.6%)
	8-10 reasons for encounter	73 (20.2%)
	13-18 reasons for encounter	55 (15.2%)
	Total # of reasons for encounter	361
	Mean	5.91
	Std. Deviation	5.43
	Minimum	0
	Maximum	18
	Range	18
	Percentile 25	1
	Percentile 50	4
	Percentile 75	9
Description of Top 6 Reasons for Encounter at First Date of Diagnosis	Medication/prescription/renewal/injection	28 (7.7%)
	Blood test	13 (3.6%)
	Weakness/tiredness general	11 (3.0%)
	Hypertension uncomplicated	10 (2.8%)
	Medical examination/health evaluation	9 (2.5%)
	Preventive immunization/medication	9 (2.5%)

[3] The percentage of "description" is the number of episodes of illness with a reason for encounter from the total episode of illness sample. It may not add up to 100% as some episodes of illness have a few reasons for encounter whereas others have none.

[4] The first three digits indicate the practice number and the last digit refers to a doctor in that practice.

Table 2: Description of Sample Continued

Characteristics	Central Tendency and Dispersion/Type	Frequency (%)[5]
Episode-Level Characteristics		
Reasons for Encounter at First Date of Diagnosis	Symptom-free (procedural)	298 (82.5%)
	Symptoms & complaints	63 (17.5%)
	Total # of reasons for encounter	361
Chronic Conditions	Mean	4.34
	Std. Deviation	2.59
	Minimum	1
	Maximum	11
	Range	10
	Percentile 25	2
	Percentile 50	3
	Percentile 75	6
Distribution of Chronic Conditions	1 chronic condition	15 (7.2%)
	2 chronic conditions	40 (19.3%)
	3 chronic conditions	51 (24.6%)
	4 chronic conditions	24 (11.6%)
	5 chronic conditions or more	77 (37.3%)
	Total # of chronic conditions	207
	1 chronic condition	15 (21.7%)
	2 chronic conditions	20 (29.0%)
	3 chronic conditions	17 (24.6%)
	4 chronic conditions	6 (8.7%)
	5 chronic conditions or more	11 (16.0%)
	Total # patients	69
Description of Top 5 Chronic Conditions	CVD	83 (40.1%)
	Hypertension	29 (14.0%)
	Arthritis	15 (7.2%)
	Chronic Musculoskeletal	13 (6.3%)
	Diabetes	10 (4.8%)

[5] The percentage of "description" is the number of episodes of illness with a chronic condition from the total episode of illness sample. It may not add up to 100% as some episodes of illness have a few chronic conditions whereas others have none.

Table 2: Description of Sample Continued

Characteristics	Central Tendency and Dispersion/Type	Frequency (%)
Episode-Level Characteristics		
5 Less Prevalent Chronic Conditions	Asthma/COPD[6]/Bronchitis	9 (4.3%)
	Heart Failure	9 (4.3%)
	Depression/Anxiety	7 (3.4%)
	Hyperlipidemia[7]	5 (2.4%)
	Cancer	5 (2.4%)

[6] COPD chronic obstructive pulmonary disease

[7] Hyperlipidemia – a high concentration of lipids or fats in the blood

4.2 Objective One: Characteristics of an Atrial Fibrillation Episode of Illness

To complete Objective One of the thesis, Table 3 summarizes important findings that characterize an AF episode of illness in general practice. There was not a single one-visit AF episode of illness in the sample of 69 patients, i.e., none of the patients were diagnosed with this chronic condition by the end of their first doctor's appointment that was also a first ever ICPC-coded visit in the DELPHI database. It took approximately 10 per cent of the patients up to 5 physician visits before AF diagnosis. In the middle of the spectrum were another 35 per cent of the patients who paid between 11 and 20 visits to their family doctors before receiving their diagnosis. A striking and somewhat unexpected finding is that 37.7% of the patients had 26 visits or more after which an established diagnosis of AF was shared with them.

As far as the episode length is concerned, none of the patients were diagnosed with AF within an eight-month period and only 1 of 69 patients knew by the end of the ninth month that he or she had this condition. Over 40 per cent of the patients got diagnosed a year and a half later. Another 38 per cent of the patients received a diagnosis of AF after 20 to 49 months. About 8% of the patients (6 out of 69 patients) (8.5%) got diagnosed with AF after 50 months or more.

A substantial number of medications (with the mean of 21.1 and the standard deviation of 12.8) was prescribed within all the episodes of illness. There was not a single episode of illness in which no medication was prescribed. A small portion of patients (7.2%) was prescribed a moderate number of medications (compared to the rest of the sample), i. e., 1-5 medications. There was another 10 per cent of the patients who got prescribed 21 medications and more. Diuretics (6.6%), anticoagulant medication (6.2%), and beta-blockers (4.4%) were most commonly prescribed. The minimum number of medications was 1 and the maximum number was 46, giving a wide range of 45 medications.

Different diagnostic investigations were ordered for about 52 per cent of the patients. Consequently, approximately another half of the patients (47.8%) did not undergo any diagnostic investigations. It is important to note that ECG as a cardiac-specific diagnostic tool comprises only 14.9% of the total number of investigations.

Twenty five ECGs were done for 16 patients. It is also worth mentioning that 11 out of 25 ECGs were performed on two patients (7 and 4 ECGs, respectively) and the majority of the "ECG patients" attended a single rural practice. So in the sub-sample of 36 patients undergoing any type of diagnostic investigations, only 16 patients were prescribed ECG as a cardiac-specific investigation. In other words, 44.4% (16/36) of those experiencing diagnostic investigations of any sort, had ECGs performed throughout their journey to the diagnosis of AF.

For our patient sample, the most commonly utilized type of investigation was an X-ray of different body parts. Out of the patients that were sent for further diagnostic investigations (i.e., half of the sample), 50 per cent had fewer than four investigations and 25 percent had more than eight diagnostic investigations.

For the total sample of 69 patients, there were 106 referrals, i.e., less than 2 referrals per each patient (106 referrals/69 patients = 1.5). Almost half of the patients (46.4%) were not referred to any secondary/tertiary care service. So if we take only the patients who did get referred to medical services outside their family physicians' offices (37 patients), we will get the proportion of 2.9 referrals for each referred patient: 106 referrals / 37 referred patients = 2.9 referrals for each referred patients.

By looking closely at the referral types, one can see that cardiology referrals make only a small proportion of 5.7% of the total number of referrals. By going even further into the data, one can find that the six referrals to the cardiologist were made for 5 patients attending the single participating rural practice that contributes 28 patients or 40.6% of the total sample size. There was no cardiac-specific referral made in any of the six participating urban practices.

30 per cent of the patients had one referral within their episodes of illness. 10 per cent had two referrals and another 10 per cent of the patients were referred three times within the framework of an AF episode of illness. A very small proportion of patients (4.3%) had a large number of referrals (over 13 referrals).

As far as the description of the referrals is concerned, cardiology referrals are at the bottom of the list for the top six referrals and comprise only 5.7% of the total number

of referrals. Internal medicine as the most common referral type (19.8% of the total number of referrals) followed by referrals for orthopedic (11.3%) and vascular surgery (10.4%). Among less common types of referrals that still make to the top-six list are dermatology and neurology, with 10.4% and 4.7% of the total number of referrals, respectively.

Table 3: Episode of Illness Characteristics

Characteristics	Central Tendency & Dispersion / Type	Frequency (%)
Number of Physician Visits	2 visits	6 (0.4%)
	3 visits	4 (0.3%)
	4 visits	19 (1.3%)
	6 visits	14 (0.9%)
	7-15 visits	316 (21.2%)
	17-30 visits or more	440 (29.5%)
	31 visits or more	688 (46.1%)
	Total # of visits	1487
	Mean	32.2
	Median	30
	Std. Deviation	19
	Minimum	2
	Maximum	75
	Range	73
	0-5 visits	7 (10.2%)
	6-10 visits	11 (15.9%)
	11-15 visits	14 (20.3%)
	16-20 visits	11 (15.9%)
	21 visits or more	26 (37.7%)
	Total # of patients	69
	Mean	20.8
	Median	16
	Std. Deviation	15.7
	Minimum	3
	Maximum	52
	Range	49

Table 3: Episode of Illness Characteristics Continued

Characteristics	Central Tendency & Dispersion / Type	Frequency (%)
Episode Length (months)	1-8 months	0 (0%)
	9 months	1 (1.4%)
	10-19 months	29 (41.9%)
	20-29 months	13 (18.7%)
	30-39 months	14 (20.1%)
	40-49 months	6 (8.5%)
	50 or more months	6 (8.5%)
	Total # of patients	69
	Mean	25.9
	Median	22
	Std. Deviation	13.7
	Minimum	9
	Maximum	56
	Range	47
Distribution of Medications	1 medication	1 (0.1%)
	2 medications	2 (0.1%)
	3 medications	10 (0.5%)
	4 medications	9 (0.5%)
	5-10 medications	378 (20.4%)
	11-15 medications	427 (23.1%)
	16-20 medications	324 (17.6%)
	21-46 medications	694 (37.7%)
	Total # of medications	1845
	Mean	21.1
	Median	17
	Std. Deviation	12.8
	Minimum	1
	Maximum	46
	Range	45
	1-5 medications	6 (7.2%)
	6-10 medications	30 (43.5%)
	11-15 medications	17 (24.6%)
	16-20 medications	9 (13.0%)
	21 medications and more	7 (10.1%)
	Total # of patients	69

Table 3: Episode of Illness Characteristics Continued

Characteristics	Central Tendency & Dispersion/ Type	Frequency (%)[8]
Description of Medications	Diuretics	123 (6.6%)
	Anticoagulants	116 (6.2%)
	Beta-blockers	80 (4.4%)
	Statins	69 (3.7%)
	Non-opioid pain relievers	69 (3.7%)
	Anti-inflammatory	54 (3.0%)
	Antiarrhythmic	45 (2.4%)
	Hypertension	37 (2.1%)
	Opioid pain relievers	28 (1.8%)
	Vitamins	26 (1.7%)
	Antidepressants	25 (1.4%)
	Diabetes medication	24 (1.3%)
	Medication for angina	24 (1.3%)
	Thyroid replacement hormo	24 (1.3%)
	Gastrointestinal	18 (1.0%)
	Corticosteroids	16 (0.9%)
Distribution of Investigations	0 investigation	33 (19.6%)
	1 investigation	10 (6.0%)
	2 investigations	8 (4.8%)
	3 investigations	24 (14.3%)
	4 investigations or more	93 (55.4%)
	Total # of investigations	168
	Mean	4.0
	Median	3.99
	Std. Deviation	0.00
	Minimum	0
	Maximum	12
	Range	0
	0 investigation	33 (47.8%)
	1 investigation	10 (14.5%)
	2 investigations	4 (5.8%)
	3-6 investigations	16 (23.2%)
	7 investigations or more	6 (8.7%)
	Total # of patients	69

[8] The percentage of "description" is the number of episodes of illness with a medication from the total episode of illness sample. It may not add up to 100% as some episodes of illness have a few medications whereas others have none.

Table 3: Episode of Illness Characteristics Continued

Characteristics	Central Tendency & Dispersion / Type	Frequency (%)[9]
Distribution of Investigations	Percentile 25	1.0
	Percentile 50	4.0
	Percentile 75	8.0
Description of Top 6 Investigations	XR (different body parts)	43 (25.8%)
	ECG	25 (14.9%)
	US (different body parts)	22 (13.2%)
	XR (chest)	19 (11.3%)
	CT[10] (different body parts)	8 (4.8%)
	Nuclear Medicine	4 (2.4%)
Distribution of Referrals	1 referral	2.0 (1.9%)
	2 referrals	14 (13.2%)
	3 referrals	9.0 (8.5%)
	4 referrals	12.0 (11.3%)
	6 referrals or more	69.0 (65.1%)
	Total # of referrals	106
	0 referral	32 (46.4%)
	1 referral	21 (30.4%)
	2 referrals	6 (8.7%)
	3-6 referrals	7 (10.1%)
	13 referrals or more	3 (4.3%)
	Total # of patients	69
Description of Top 6 Referrals	Internal Medicine	21 (19.8%)
	Orthopedic Surgery	12 (11.3%)
	Vascular Surgery	11 (10.4%)
	Dermatology	11 (10.4%)
	Cardiology	6 (5.7%)
	Neurology	5 (4.7%)

[9] The percentage of "description" is the number of episodes of illness with a referral from the total episode of illness sample. It may not add up to 100% as some episodes of illness have a few referrals whereas others have none.
[10] CT computerized tomography (CT-scan)

4.3 Objective Two: Comparison of Study Group and Control Group. An Independent-Samples T-Test

A series of independent-samples t-tests were conducted to compare the mean values for the number of physician visits, the episode length, the number of medications, diagnostic investigations and referrals between the AF and comparison groups.

We first ran a Levene's test for equality of variances to assess whether the population variances for the groups were equal[185]. This test result also determined that the t–value under no assumption of equal variances was the correct one to use for further interpretation of the five dependent variables of interest.

The review conducted by Glass, Peckham, and Sanders in 1972[186] defined an F-statistic to be robust against heterogeneous variances when groups are equal in size. Stevens[185] goes further by stating that the robustness of the F-statistic is preserved with approximately equal group sizes, i. e., the ratio of the largest sample to the smallest is not more than 1.5. This rule of thumb demonstrates robustness again unequal population variances only for two out of five dependent variables – for the number of physician visits (1487/1287 = 1.2) and for the number of medications (1845/1327 = 1.4). For the remaining three variables – the episode length, the number of diagnostic investigations and referrals – the ratio values are much higher, thus demonstrating sharply unequal sample sizes: 3.7 (1327/361), 7.9 (1327/168), and 12.5 (1327/106), respectively.

Since the level of significance for Levene's test is $P < .05$, the observed variances for the two groups are different. Therefore, the assumption of homogeneity of variance is violated. It indicates that the two samples for the AF and the comparison groups are not taken from populations of equal variances. As a result, the *P*-value from the first, "equal variances assumed" row is not trustworthy: the two groups are substantially unequal in size and the population variances are different.

IBM SPSS accounts for the homogeneity of variance violation by giving slightly different results in the second row under "equal variances not assumed". In fact, when performing a standard independent-samples t-test, this software automatically runs a Welch t-test statistic under the "equal variances not assumed" or second row.

The Welch t-test, also known as the Unequal Variance t-test or Separate Variances t-test is used here as an alternative statistic. Since the Welch t-test is robust to unequal variances and unequal sample sizes simultaneously, its use is relevant in our case. The null hypothesis it tests is that two means are equal even when the variances are statistically significantly different from each other as well as when sample sizes are unequal.

To ensure a higher level of robustness to unequal variances and unequal sample sizes, the Brown-Forsythe test was also performed. It is arguably even more robust than the Welch t-test[187]. The results of the Welch t-test and the Brown-Forsythe test are presented in the table below: the independent-samples t-test under the 'equal variances not assumed' option is in fact the Welch t-test itself. For the five dependent variables of interest, the Welch t-test and the Brown-Forsythe test yielded exactly the same results within each dependent – group variable pair.

The results of independent-samples t-tests are presented below.

Since for all the dependent variables, the value of significance (Sig.) in Levene's test for the Equality of Variances is below the required cut-off of .05, we interpret an alternative t-value generated by the software which is, in fact, the result of the Welch t-test. As previously mentioned, the Welch test compensates for unequal variances and, for result interpretation, the t-value under the 'equal variances not assumed' option is reported. This applies to the t-test results for all the dependent variables.

Number of Physician Visits: An independent samples t-test was conducted to compare the number of physician visits for the AF and the comparison groups. There is a highly statistically significant difference (t (2562.46) = 32.68, *P* (two-tailed) < .001) in the number of physician visits between the two groups, with the mean value for the AF group (M = 33.17, SD = 19.04) being over twice that of the comparison group (M = 13.58, SD = 12.19). Patients with undiagnosed AF visit their primary care physicians, on average, 33 times before they obtain a firstly established diagnosis of AF. It usually takes patients with other prevalent chronic conditions 2.5 times fewer visits (about 13 in total) to visit their family doctor's offices before their chronic condition is first diagnosed.

The Number of Medications: In accordance with the results of the independent-samples t-test, the difference in the mean number of medications for the AF and the comparison groups is highly statistically significant: t (3131.41) = 19.11, P < .001. The mean number of different medication names for both groups indicate that AF patients tend to have slightly over 50% more medications prescribed (M = 21.13, SD = 12.83), when compared to patients with other chronic conditions (M = 13.27, SD = 10.31).

The Episode Length (Days to Diagnosis): The performed independent-samples t-test indicates that – in terms of the time-to-diagnosis (number of days) - patients who are first diagnosed with AF, wait, on average, for 2.8 years (when the number of days is converted to the number of years: 1019.27 days are equal to 2.8 years). Their counterparts from the control group, on the other hand, have their new diagnosis of a chronic condition established in slightly less than a year and a half (560.17 days). The t-test findings of t (521.761) = 20.23 are highly statistically significant as the *P*-value is less than .001. In a summary, there is a highly statistically significant difference in the time-to-diagnosis for the AF group (M = 1019.27, SD = 391.78) and for the comparison group (M = 560.17, SD = 345.16); t (521.761) = 20.23, *P* (two-tailed) < .001.

The Number of Investigations: Generally, patients with AF have more diagnostic investigations ordered by their physicians compared to the numbers from the comparison group. The mean value of 4.88 (standard deviation of 3.99) for the AF group are 50% higher than the mean value of 3.28 (standard deviation of 3.72) for the comparison group. As is the case with other, previously described dependent variables, this t-test also yields a highly statistically significant result (t (205.319) = 4.92) as the two-tailed *P*-value of the test is much lower than the required cut-off of .05 (*P* < .001).

The Number of Referrals: An independent samples t-test was performed to compare the number of referrals made for the AF and the comparison groups. There is a highly statistically significant difference (t (1326.000) = 4.90, *P* (two-tailed) < .001) in the number of referrals made between the two groups, with the mean value of 1.0000 and the standard deviation of 0.7713 for the AF group being, however, very close in its numeric value to the mean of 0.7769 and the standard deviation of 1.65819 for the comparison group.

Table 4: Group Statistics for Independent-Samples T-Test

Characteristic	Group	N	Mean	Std. Deviation	Std. Error Mean
Physician Visits	AF	1487	33.1742	19.04291	. 49383
	Comparison	1287	13.5835	12.18994	.33979
Medications	AF	1845	21.1301	12.82827	.29865
	Comparison	1327	13.2683	10.30817	.28297
Episode Length (Days to Diagnosis)	AF	361	1019.27	391.782	20.620
	Comparison	1327	560.17	345.160	9.475
Diagnostic Investigations	AF	168	4.8750	3.99429	.30817
	Comparison	1327	3.2781	3.71723	.10204
Referrals	AF	106	1.2347	.7713	.00103
	Comparison	1327	.7769	1.65819	0.04552

Table 5: Independent-Samples T-Test

Characteristic	Assumption	Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Sd. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Physician Visits	Equal variances assumed	369.067	.000	31.709	2772	.000	19.59065	.61782	18.37921	20.80208
	Equal variances not assumed			32.682	2562.461	.000	19.59065	.59944	18.41522	20.76608
Medications	Equal variances assumed	122.153	.000	18.448	3170	.000	7.86181	.42616	7.02624	8.69738
	Equal variances not assumed			19.109	3131.407	.000	7.86181	.41142	7.05512	8.66849
Episode Length (Days to Diagnosis)	Equal variances assumed	26.217	.000	21.748	1686	.000	459.100	21.110	417.695	500.505
	Equal variances not assumed			20.231	521.761	.000	459.100	22.693	414.519	503.680

Table 5: Independent-Samples T-Test Continued

Characteristic	Assumption	Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Sd. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Diagnostic Investigations + 90-Day Lag Period after Diagnosis	Equal variances assumed	10.282	.001	5.201	1493	.000	1.59693	30702	.99468	2.19917
	Equal variances not assumed			32.682	2562.461	.000	1.59693	32462	.95691	2.23695
Referrals + 90-Day Lag Period after Diagnosis	Equal variances assumed	51.156	.000	1.385	1431	.166	.22306	.16111	-.09298	.53910
	Equal variances not assumed			4.900	1326.000	.000	.22306	.04552	.13376	.31236

Table 6: Comparison of Standard One-Way ANOVA and Independent-Samples T-Test (under 'Equal Variances Assumed') Results

Type of Test	F/t-Statistic					Sig.				
	Physician Visits	Medications	Episode Length (Days to Diagnosis)	Diagnostic Investigations	Referrals	Physician Visits	Medications	Episode Length (Days to Diagnosis)	Diagnostic Investigations	Referrals
Standard One-Way ANOVA Test	1005.477	340.336	472.963	27.054	1.917	.000	.000	.000	.000	.166
Independent-Samples T-Test (under 'equal variances assumed')	31.709	18.448	21.748	5.201	1.385	.000	.000	.000	.000	.166

Note:

√ANOVA F-value = t-value for independent-samples t-test (under 'equal variances assumed')

Table 7: Comparison of Robust Tests of Equality of Means and Independent-Samples T-Test (under 'Equal Variances Not Assumed') Results

Type of Test	F/t-Statistic					Sig.				
	Physician Visits	Medications	Episode Length (Days to Diagnosis)	Diagnostic Investigations	Referrals	Physician Visits	Medications	Episode Length (Days to Diagnosis)	Diagnostic Investigations	Referrals
Welch T-Test	1068.091	365.147	409.293	24.200	24.01	.000	.000	.000	.000	.000
Brown-Forsythe Test	1068.091	365.147	409.293	24.200	24.01	.000	.000	.000	.000	.000
Independent-Samples T-Test (under 'equal variances not assumed')	32.682	19.109	20.231	4.919	4.900	.000	.000	.000	.000	.000

Note:

√Welch t-test asymptotically F-distributed value = √Brown-Forsythe test asymptotically F-distributed value = t-value for independent-samples t-test (under 'equal variances not assumed')

4.4 Objective Two: Magnitude of Effect. Effect Size Analysis.

Based on the findings across the four different effect size measures, the highest level of consistency in the reported effect magnitude is demonstrated by the statistics that rely on standard deviation units to present the difference between the two groups, i. e., Cohen's *d*, Hedge's *g*, and Glass' *delta*. Not a single statistic of the three above indicates a small size of effect for any of the five dependent variables.

The results of the *eta* squared, on the contrary, are indicative of a borderline small/medium effect size (10%) for the number of medications prescribed and a very small magnitude of effect for the diagnostic investigations ordered (only 2%). When the *eta* squared findings for these two variables are compared to other effect size statistics, the magnitude of the differences in the means is substantially higher, presenting a three-level paradigm of effects. Specifically, the range of effect includes: 1) the medium effect in Cohen's *d* statistic for the diagnostic investigation variable; 2) the medium magnitude of effect in Glass' *delta* and Hedge's *g* statistics for the medication and diagnostic investigation variables, and 3) the borderline medium/large effect for the medication variable in Cohen's *d* statistic.

The results of effect size statistics are presented in Table 7. They are interpreted entirely from a quantitative perspective, without any account of their practical relevance and clinical significance in the context of an AF patient's journey.

The Number of Physician Visits: The value of 0.27 or 27% of variance in *eta* squared statistic is indicative of the large size of an effect by the group assignment. In other words, 27 per cent of the total variation in the number of physician visits depends on which group the patient is assigned to. Apart from the statistically significant difference between the two groups, the measured effect index of 0.27 gives practical importance to the finding.

The value of Cohen's $d = 1.23$ indicates that the difference between the mean number of physician visits in the AF group and the comparison group is larger than one standard deviation, to be more precise, larger than 1.23 SD (large effect). Similarly, in Hedge's *g* and in Glass' *delta* statistics, the magnitude of difference is larger than one

standard deviation: 1.21 SD in Hedge's *g*, 1.03 SD in Glass' $delta_1$, and 1.61 SD in Glass' $delta_2$. Overall, for the number of physician visits as a dependent variable, the effect size indices are consistent in the magnitude of effect being reported as large across all of them.

The Number of Medications: For the medication variable, some degree of inconsistency across the four effect size indices is observed. The *eta* squared value of 0.10 measures the 10 per cent proportion of variance in the number of medications that is explained by the group assignment. Purely in quantitative terms, it is a borderline small/medium size of an effect. At the opposite end of the spectrum is the value of 0.68 in Cohen's d statistic that implies a borderline medium/large effect size. In the middle are the values of Hedge's *g* (0.66) and Glass' *delta* statistics (0.61 and 0.76 for Glass' $delta_1$ and Glass' $delta_2$, respectively), with the reported medium magnitude of effect for both indices.

The Episode Length (Days to Diagnosis): For the episode length variable, the mean values for the two groups differ by 1.24 (Cohen's *d* statistic), 1.29 (Hedge's *g* statistic), and by 1.17 and 1.33 (Glass' $delta_1$ and Glass' $delta_2$, respectively) standard deviations. The *eta* square value of 0.22 (or 22%) is also highly suggestive of a large effect size: the 22% proportion of variance in the episode length is due to the group variable. The magnitude of effect is consistent throughout the four effect size indices. Such results suggest that the length of an episode of illness varies substantially for a patient depending on one's group allocation.

The Number of Investigations: When applying the SD-based effect size measures, i.e., Cohen's *d*, Hedge's *g*, and Glass' *delta*, the effect size for the investigation variable can be interpreted as medium. Only the *eta* square value of 0.02 (or 2%) indicates a small association of variance in the number of investigations with the group allocation.

The Number of Referrals: As already mentioned, patients with chronic conditions and co-morbidities are not often referred to specialty outpatient facilities for diagnosis. Being referred to as "complex care physicians", primary care physicians are heavily relied on in terms of management of patients with high-cost chronic conditions.[182] As a

result, the allocation of a patient to an AF or a comparison group does not make much of a variation as far as the diagnostic referrals are concerned. This status quo is reflected in the low values of the effect size statistics (the *eta* square value of 0.001 or 0.1%; the Cohen's *d* value of 0.35; the Hedge's *g* value of 0.28, and the Glass' *delta* values of 0.59 and 0.13, respectively), thus indicating a very small effect size. Despite its high statistical significance of the independent samples t-test, the difference between the two groups in the number of referrals is although not trivial, but still very small.

By their original definition, our dependent variables have meaningful metrics that are expressed by the number of physician visits, medications, referrals, diagnostic investigations and days-to-diagnosis. These metrics are practically significant and directly interpretable[188] which is a great asset. However, IMB SPSS – like any other statistical software – standardizes effect sizes. As a result, the original meaningful scale of metrics is lost but standardized effect sizes (in this case, the proportion of variance in percentage for the *eta* square statistic and standard deviation units for Cohen's *d*, Hedge's *g* and Glass' *delta*) are directly comparable across studies with different-scale outcomes[188].

The goal is - despite the statistically significant differences between the AF and the comparison groups in relation to the set of the dependent variables - to quantify the magnitude of those differences. In this sense, as rightfully stressed by Kline,[188] the size of an effect is a statistic "with a purpose of quantifying a phenomenon of interest". The rejection of a null hypothesis, by itself, does not guarantee substantive significance. Kline[180]insists that clearly explicating the importance of the research findings in terms of their clinical relevance and practical value for the patients is required.

The decision to use multiple effect size indices is a direct consequence of the dilemma on how "to improve the communication of the results"[188]. The literature allows reporting of multiple effect sizes that directly address the same research question to test for the consistency of the effect size results. The choice of the effect size statistics is also informed by the literature and is based on their commonality and relevance to the field of research. *D* and *r* statistics have been chosen, with the *d* statistics describing mean

contrasts in units of standard deviation and *r* statistic being a proportion of variance explained effect size.[188]

Table 8: Summary of Effect Size Calculations

Dependent Variable	Independent (Group) Variable	Sample Size (N)	Mean	SD	Sig. (2-tailed)	Eta squared (η^2)	Cohen's *d*	Hedge's *g*	Glass' delta$_1$ (Δ_1)	Glass' delta$_2$ (Δ_2)
Physician Visit	AF Group	1487	33.1742	19.04291	<0.001	0.27 large	1.225344 (1.23) large	1.207246 (1.21) large	1.0287661 (1.03) large	1.6071203 (1.61) large
	Comparison Group	1287	13.5835	12.18994						
Medication	AF Group	1845	21.1301	12.82827	<0.001	0.10 small/medium	0.675607 (0.68) medium/ large	0.664028 (0.66) medium	0.6128496 (0.61) medium	0.7626766 (0.76) medium
	Comparison Group	1327	13.2683	10.30817						
Episode Length (Days to Diagnosis)	AF Group	361	1019.27	391.782	<0.001	0.22 large	1.243474 (1.24) large	1.290954 (1.29) large	1.1718251 (1.17) large	1.3301078 (1.33) large
	Comparison Group	1327	560.17	345.160						
Diagnostic Investigation + 90-day Lag Period after Diagnosis	AF Group	168	4.8750	3.99429	<0.001	0.02 very small	0.413893 (0.41) medium	0.425927 (0.43) medium	0.3997957 (0.40) medium	0.4295941 (0.43) medium
	Comparison Group	1327	3.2781	3.71723						

Table 8: Summary of Effect Size Calculations Continued

Dependent Variable	Independent (Group) Variable	Sample Size (N)	Mean	SD	Sig. (2-tailed)	Eta squared (η^2)	Cohen's *d*	Hedge's *g*	Glass' delta$_1$ (Δ_1)	Glass' delta$_2$ (Δ_2)
Referrals + 90-day Lag Period after Diagnosis	AF Group	106	1.0000	.00000	<0.001	0.001 (almost no effect)	0.354018 (0.35) small	0.284381 (0.28) small	0.5935433 (0.59) medium	0.1345443 (0.13) small
	Comparison Group	1327	.7769	1.65819						

CHAPTER FIVE – DISCUSSION AND CONCLUSION

5.1 Strengths of Research

To the best of our knowledge, this has been one of the first studies to describe an episode of AF illness in terms of the number of physician visits, the episode length, the diagnostic investigations ordered, the medications prescribed, and the referrals made in a primary care setting. The literature review did not identify any studies that are related to the diagnosis of AF in the conceptual framework of an episode of care. Not only were there no AF studies that would operationalize the episode of care as an appropriate unit of assessment[161], but also no current research explored time-to-diagnosis characteristics in AF on a visit-per-visit basis. Using high-quality electronic medical records as a data source for describing an AF episode of illness is another innovation. Given the rising popularity of electronic health records systems and a profound shift of medical record keeping from paper-based physicians' notes to computerized modules, the methodology employed in this research is transferable for use in other types of medical practice and medical conditions.

The current research also contributes to quantitative research conducted from the perspective of a patient rather than a health care provider. Choosing patient-important outcomes helps to meaningfully map the patient's journey to the diagnosis of AF in quantitative terms. Previous research on other chronic conditions explored conditions of interest within an episode of care. The focus of this study, however, is on an episode of illness that should be clearly distinguished from both an episode of disease and an episode of care.

In order to capture the patient's experience in navigating the Canadian health care system with the ultimate goal of diagnosis establishment, this research has a look-back period of up to 4 years and specifies a distinct end-point. Such an approach of including complete episodes of illness allows to explore patterns of health care utilization in AF diagnosis. The research results can be of interest to different stakeholders ‐ patients, physicians, policy makers and governmental agencies – as they identified the gaps in the diagnosis of a chronic condition that can be addressed in future research.

In the modern context, general practice is a complex care entity that is heavily relied on for diagnosis and management of high-cost chronic conditions. That is why recognizing patients' challenges, identifying gaps on an upstream, system level and facilitating positive downstream changes as well as stimulating a shift in professional culture are key.

5.2 Limitations of Research

A major limitation of this research is the source of data itself. Electronic medical records (EMRs) were developed to collect data for the purpose of individual patient care, not for the purpose of research. As a result, the same type of information can be stored in multiple places in the database. A number of terms can be used to denote the same condition or phenomenon. In such a case, the researcher develops a list of related terms and verifies it for completeness by examining each description to ensure that no related terms are omitted. At the same time, clinically irrelevant – yet valuable for research – information may not be found in EMRs. In an attempt to locate, extract and analyze data, researchers have to explore all possible locations in an electronic medical record which might not be feasible.

The dependent variables that were used imply some degree of uncertainty in data interpretation. For instance, a patient may or may not express all the reasons for encounter in the form of symptoms, complaints and requests for medical procedures. This is particularly true now when patients are asked to restrict their encounter with a physician to one major concern. The physician, on the other hand, is an initial recipient of the patient's information who exercises judgments on what to record in the database, based entirely on situated and fragmented pieces of information[189]. This may or may not lead to depiction of complete patient information. The question remains open how concordant the patient self-report and the medical record are.

Another important limitation of this research that is beyond control is a lack of definitive, proven information on the variables of interest: the number of physician visits, the medications prescribed, the diagnostic investigations ordered and the referrals

made. Hoping to meet current clinical guidelines, family doctors record is what recommended or prescribed to patients. The actual result of a physician-patient encounter remains unknown. It does not necessarily translate into the patient's compliance to the treatment protocol. Other external factors such as long wait lists for a specialty outpatient service (in case of referrals) may cause patient non-compliance. A patient is prescribed a medication but whether the prescription is filled is not known. Similarly, a diagnostic investigation is ordered for a patient but there are no readily available means of confirming that the investigation was conducted.

The logical consequence of the two previous points – the "uncertain" and "unknown" nature of medical data - is its incompleteness. The researcher cannot be sure if the data are missing as such (in terms of medications, referrals and investigations) due to the physician's failure to record them or whether there have been truly no referrals made, no diagnostic investigations ordered, and no medications prescribed.

Finally, we cannot establish a distinct start point of an episode of illness due to transiency of symptoms in AF. That is why the decision has been made (and justified in more detail in the Methods chapter) to use all of the available look-back period when determining the boundaries of an episode of AF illness. This may overestimate the duration of AF if the presenting symptom was not AF-related and AF first occurred at a later date.

5.3 Objective One: Characteristics of an Atrial Fibrillation Episode of Illness

5.3.1 Number of Physician Visits

As already mentioned, no literature on characterizing an episode of AF illness in the context of the dependent variables used in this thesis has been identified. With AF being a chronic condition, we decided to compare our findings with the reported results of the studies on other chronic conditions in family practice. Since the comparison group consists of patients with the nine most common chronic conditions, the search was extended to include any relevant information on those nine conditions.

As is evident from the published research on the 14 highest-cost chronic conditions in the USA[182], a majority of patients seek care for their chronic conditions from a generalist (69%) rather than a specialist physician (24%).

It is increasingly recognized that primary care medicine is distinctly different with regard to pathologies, patients, and clinical presentations general practitioners deal with in comparison with their specialty outpatient colleagues. The populations in general practice are relatively unselected[190]. Rigid diagnostic labelling is less important than deciding on an appropriate course of action. For instance, the use of a specific diagnosis can be simply a justification of antibiotic treatment instead of its reason[191]. The so-called diagnostic uncertainty is not the new Achilles' heel of general practice, as metaphorically labelled by Howie in 1972[191], but rather an inherent, salient feature of a primary care setting[192]. Often, family physicians frame their diagnostic decisions in dichotomous terms: referral versus non-referral, diagnostic investigation versus no diagnostic investigation, and treatment versus non-treatment.

The current research yields some insights with reference to the number of in-office physician visits between the AF and comparison groups. Patients awaiting the diagnosis of AF have, on average, 2.5 times more visits than patients with other undiagnosed chronic conditions. In the context of family practice, it is still unclear why this happens.

There are a number of possible explanations for the observed difference in the number of physician visits between the two groups. A plausible explanation would be the asymptomatic and transient nature of symptoms in AF. It takes time for the disease to declare itself in the form of signs and symptoms. Or, on the contrary, the diagnosis of AF is established incidentally with no related reason for encounter recorded in the EMRs when the patient is completely asymptomatic. Another possible explanation is the presence of multi-morbidity that clouds the clinical picture.[192] When comparing the two groups in the current work in terms of other chronic conditions , we can explain the substantive difference in the number of physician visits due to the older age of the AF group with a larger number of associated chronic conditions. These differences are presented by both statistically significant t-test results and by a large effect size.

5.3.2 Episode Length

The dependent variable of the episode length is directly connected to the number of physician visits. It is also associated with the visit continuity on patients' experience with care[193]. It would be valuable to understand whether visit continuity is beneficial to AF patients.

Little do we know about the realized and potential wait time to diagnosis. In a situation when the patient does not present with any observable signs and reports no symptoms, there is technically no wait time to diagnosis. The biggest obstacle in "recognizing the zebras among the horses" is inability to rigidly define a starting point of an AF episode of illness that would be measurable and expressed in standardized terms. Even developing typical scenarios or patterns of diagnostic steps is problematic. As McWhinney has pointed out, in the situated, community-based context, the focus of a primary care physician is on patient management and not so much on diagnosis establishment[190].

The key defining feature of general practice is its holistic approach towards disease and illness[194]. The patient's journey to diagnosis is intertwined with the context of an individual's life experience and circumstances, including a myriad of diverse, hardly quantitatively measurable factors such as social, environmental, occupational, developmental, etc. Manipulations and tools of any sort (physical examination, diagnostic testing, referrals) are only assistive devices for a family doctor to define a "whole person diagnosis" of patient problems[195] from a biopsychosocial perspective.

The question is, however, whether early diagnosis and intervention may favourably impact the prognosis[38]. AF is recognized as a progressive disease that generally evolves from paroxysmal through persistent to "permanent" forms[38]. Theoretically, earlier diagnosis and timely intervention might limit or prevent the disease progression. Furthermore, a personalized approach to the disease management entails a treatment plan that is tailored to an individual's risk factors, pathophysiology, and genetic predisposition[196]. Nattel et al.[38] believe that earlier diagnosis and treatment

of AF can also prevent serious long-term complications such as blood clot formation, stroke, heart attack, heart failure, and sudden cardiac arrest.

Clinical efficacy of early therapy warrants confirmation. If it can be shown that more proactive diagnosis and treatment prevent progression and complications of AF, intensive ECG monitoring could be established as a clinically relevant screening tool.

5.3.3 Medication

Based on our findings, medications are prescribed for the AF group of patients, with a mean of 21.1 and standard deviation of 12.8. When compared to the control group, AF patients tend to get by 50% more medications than the individuals living with other chronic conditions (mean of 13.27 and standard deviation of 10.31).

Our findings are consistent with some previous studies. Of particular interest are the results of the 2008 Commonwealth Fund International Health Policy Survey conducted among eight industrialized nations: the United Kingdom, Canada, the United States, Australia, New Zealand, Germany, France, and the Netherlands[172]. This survey builds on an annual series that informs government health policies in the surveyed countries. This international study focused on experiences of chronically ill patients with complex health care needs. Among the major inclusion criteria were presence of chronic disease(s) and frequent contact with the health care delivery system, including hospitalizations and major surgeries within the last two years. The AF patients took six or more prescription medications regularly whereas 30-50% per cent of the international cohort of the participants reported taking four or more medications.

These findings are expected as they reflect the high dependency of chronic patients on medication for disease management. In spite of the complicated medication regimens, approximately 40% of the respondents were concerned by a lack of medical supervision when neither primary care physicians, nor pharmacists reviewed their medication lists[172].

5.3.4 Investigation

The most common type of diagnostic investigations was an X-ray of different body parts. ECG comprised a relatively small proportion (less than 15%) of the total number of investigations. Among other utilized diagnostic investigations were ultrasound and computerized tomography scans of different body parts.

These findings resonate with characteristics of a family practice model that are commonly described in the literature. For instance, primary care physicians are estimated to diagnose a conventional disease in approximately 50% of patients presenting to their offices[197]. In another study, after a 6-month follow-up period, only 50% of the patients with chest pain were told the cause of their disease[198]. The numbers were even lower in another study in which only 20% of ambulatory male patients with abdominal pain were ascribed a definitive diagnosis[199].

Apparently, within the framework of family practice that "includes primary, comprehensive, continuing, community-based, patient-centred, and preventive care", diagnostic investigations are useful in a small proportion of 5% of cases[200].

As becomes clear from the above mentioned examples, although a part of family practice, radiological and laboratory investigations have a limited role, leading to the diagnosis establishment in 2-3 cases of every hundred of patients.

The general tendency that can be easily observed by a patient visiting one's physician's office or even an emergency department in hospital is a selective use of diagnostic testing for the sake of avoiding diagnostic inefficiency, i. e., unnecessary, excessive testing, and over-diagnosis. In fact, over-diagnosis can have very similar untoward consequences as under-diagnosis does. A striking example comes from the study on diagnosing organic heart disease in children: false positive cases demonstrate as much deterioration in social and physical function as children who do have the disease[201].

5.4 Objective Two: Effect Size in Study Group and Comparison Group

In terms of the effect size, it is important to consider not only the magnitude for each variable of interest but also the clinical relevance and practical value. Per se, a "small" or "medium" clinically relevant effect size is more important than a "large" effect of less practical value. It is more so a context-dependent judgment call.

We are aware of criticisms of so-called "T-shirt effect sizes"[202] when standardized magnitudes of effect are arbitrarily labelled as "small", medium", and "large" and applied with little considerations of a particular context. Not withstanding the context-dependent aspect of the effect magnitude, we purposively interpret effects with the rigor of significance testing. It is an experimental, purely quantitative type of research, and contextual analysis is outside its realm of expertise. Cohen[203] suggested threshold values of effect magnitude in behavioral research as a general rule of thumb rather than a ready-to-use recipe. These values are arbitrary and should not be interpreted rigidly[204]. No existing related literature on the effects of our variables of interest in a primary care setting has been identified. Therefore, we cannot interpret our effects in explicit or direct comparison against the published effects, as recommended by Thompson[204].

5.5 Generalizability of Results

5.5.1 Representativeness of DELPHI Population in Comparison to General Practice Population

In spite of a relatively small sample of AF cases, the DELPHI database is largely representative of Ontario general practice patients and therefore, the results being generalizable to a Canadian primary care setting. Below is the comparison of prevalence of such patient-important outcomes as AF and stroke between the DELPHI database and the current literature. The DELPHI descriptive statistics presented in Appendix K is consistent with the age and sex distribution of AF patients and prevalence of AF by age group in the general population.

As a recognized independent risk factor for stroke, AF accounts for at least a 5-time increase in its incidence.[205, 2,206, 207] Overall, the literature suggested 2-3% per year of an absolute risk of stroke in the adult population versus 10-12% risk in patients with a

previous cerebrovascular accident.[208] Thus, 679 out of 48096 patients with stroke were identified in the DELPHI database that corresponds to 1.4%. Among 1500 patients with AF in the DELPHI database (Appendix K), 140 of them (9.3%) had a stroke: 62 females and 78 males.

The ten-year prevalence of AF in the DELPHI database is 3.1% that rose steadily with age up to the 80-89 age group (Appendix K). The majority of large studies conducted in North America and Europe reported a prevalence of 0.4% to 3.9%. Notably, such variation in the disease prevalence can be explained by a number of factors: 1) hospital-based studies[209,210] showed higher rates of AF than community-based ones; 2) studies conducted in different ethnic populations such as African Americans[2, 211] and Indo-Asians[212] and in different geographical areas[213, 209, 210] yielded a variety of prevalence estimates; [213, 209, 210] 3) differences in age stratification as well as inclusion of limited age ranges[214] can explain considerable variance of AF prevalence.

To demonstrate DELPHI feasibility in answering a specific research question and its representativeness of general practice, the DELPHI prevalence values for AF were compared to the ones from large studies across the world that were similar to the DELPHI database in crucial parameters.

The eight-year overall prevalence of AF in the adult population, based on the Clalit Heath Services computerized database of 2 420 000 adults (Israel), was 3%. It was a methodologically sound study that was conducted in the population older than 20 years of age and included both community and hospital diagnoses of AF.

Another large, population-based study that was conducted in Sweden with similar patient populations reported a prevalence of 3.2%. The data were extracted from primary healthcare, specialized outpatient, hospital drug registries in a Swedish region with 1.56 million residents[215].

A study conducted by German researchers aimed at quantifying age- and gender-specific prevalence of AF in Germany.[216] A database covering a large patient population of all ages (8.298 million members of two German statutory health insurance funds) was analyzed and the reported prevalence was 2.132%.

5.5.2 Compatibility of the DELPHI Database with Other Electronic Medical Record Databases

The DELPHI database is designed in the same structure as the nation-wide electronic medical record surveillance database called "CPCSSN" (the Canadian Primary Care Sentinel Surveillance Network). Therefore, the DELPHI database is fully compatible with CPCSSN. The DELPHI database can be used as a pilot test platform of data search fields as well as diagnostic and treatment algorithms for a variety of diseases. Following initial statistical analyses of DELPHI findings, researchers can shift towards examining region-determined commonalities and differences across primary care experience of Canadians for a specific disease.

In its coding major types of structured data - symptoms, diseases, and interventions – the DELPHI database is similar to larger UK-located databases, specifically, to the General Practice Research Database in the United Kingdom[158].

Although available now in 19 languages, the core of a computer-based patient record classified with ICPC is language independent. This allows comparisons of data from different countries[161]. Furthermore, it develops family medicine to a profession with a well-defined and empirically based framework of reference[161, 159].

Another operational characteristic of the DELPHI database is its inherent capacity to monitor preventive care and chronic diseases that is similar to the US databases[217, 218]. The feature that is unique to the DELPHI database is that it makes it possible to pose health service-related questions and answer them. The examples of such would be the scope of interdisciplinary care, wait times and workload[157].

In order to create a researchable database, regular data quality assessment and collaboration with information technology specialists are warranted[157]. After the DELPHI database was populated with extracted data, a data quality assessment system was initiated. This ensures that the data are complete and standardized across the participating sites, i. e., suitable for research purposes[157].

Given data access by researchers, EMR data have several important advantages for research[157]. First, longitudinal data enable researchers not only to explore a natural course

of various diseases that are treated in general practice but also to follow patterns of care delivery over time. Second, the DELPHI database is particularly useful in monitoring preventive care and chronic disease management. This aspect of usefulness was also touched upon in several US studies[217, 218]. Third, data can be collected, extracted and stored relatively quickly. Overall, EMRs are a reliable source of information on various aspects of primary health care.

5.5.3 Comparison of ICPC-Coded DELPHI Population and 2016 Canadian Census Population

The comparison of ICPC-coded DELPHI population is made to the 2016 Canadian Census population. It was a seventh quinquennial census conducted by Statistics Canada on May 10, 216. The 2016 Canadian Census presents the most recent detailed enumeration of the Canadian residents. It counted a population of 35,151,728 which was a 5-per cent increase from the 2011 population of 33,476,688.

When compared to the 2016 Canadian Census population, the DELPHI ICPC-coded population is generally older and has a slightly higher proportion (by 5%) of female patients. In Appendix L, the median age of 54 years in the ICPC-coded DELPHI population is higher than the median age of 40 years reported by the 2016 Canadian Census[219]. The proportion of female population in the ICPC-coded DELPHI project is by 5% higher (56%) in comparison to the 51% from the 2016 Census.

The fact that more older females comprise the DELPHI population brings into consideration the umbrella term of "the complex older patient" in general practice[220]. This concept includes a number of social, psychological and medical problems[221]. In broad strokes, complex patients, i. e., individuals with a few comorbidities and functional disabilities, prefer to live in the community as long as possible rather than being placed into residential facilities. This tendency is, in turn, reflected in higher numbers of patients with several concurrent problems whom physicians see in their practices[221].

As well documented in previous research[220], older individuals and females are more likely to be included into clinical samples as they tend to visit their physicians more often than the general population. However, this discrepancy in age and sex distribution does not indicate that the DELPHI population is different from the Canadian population, overall. The reason is that the ICPC-coded DELPHI population represents a random sample of patients who seek medical care from their family physicians.

5.6 Policy Implications

It is increasingly recognized that heath care delivery systems all over the world are facing the challenge of aging, chronically ill patients with complex care needs. The growing burden of care is falling on primary care physicians. However, the degree to which general practitioners are relied on in providing patient-centered care, might be neither realistic, nor fully appreciated[222]. The increasing societal demands and public expectations of the quality of medical service can make it impossible for physicians to meet all expectations. It is within the realm of family practice to screen patients and identify their needs, to offer preventive services and provide education, to work with communities and to stimulate behavioral changes[182]. This list is far from exhaustive. The topic being debated within the last few years is whether there is time for managing patients with chronic diseases in primary care. Ostbye et al.[223] calculated that in order to be compliant with current clinical guidelines of managing hypertension and diabetes, a physician would need about 10 hours per day to care for each patient with multi-morbidities.

This study is a first step towards identifying common areas of overlap in terms of factors, barriers and facilitators of the AF patient's journey towards diagnosis in the primary care setting. Developing a detailed, multi-level knowledge transfer plan based on consultation, involvement and partnership with key stakeholders - patients, caregivers, healthcare providers and multi-disciplined researchers – can facilitate positive changes in the current clinical guidelines for diagnosing and managing AF.

5.7 Future Research

Patients' experiences of arrhythmia diagnosis extend across multiple health care sectors. For the majority of them, however, the initial diagnosis and management of AF will be conducted in primary care,[29] with the family doctor's office being a starting point of a patient's journey. In Canada, primary care physicians serve as gatekeepers for further referrals and diagnostic investigations. The primary care setting continues to be a coordinating site of patient care. That is why the focus of this research is on mapping patients' experiences using electronic medical records (EMRs) that are accessed through the DELPHI database. The data collected from the physicians' offices was used to describe a patient's journey in quantitative terms.

It is quite an endeavor to tell a story behind the numbers when patients' experiences are explored solely quantitatively, with the use of a database. With qualitative research, on the contrary, a patient's journey can be captured and mapped through focus groups, surveys and in-depth narrative interviews. Although it is outside the scope of this thesis, further qualitative and mixed-methods research is warranted. It can provide knowledge of the context by documenting various aspects of a patient's life between interactions with the health care system. Ideally, we would like to know more about the life of AF patients between doctor visits. The contextual approach might facilitate more meaningful interpretation of patient history records, physician notes and questionnaire scores.

For future research, an overarching goal could be to appreciate patients' stories behind the numbers, hear their voices and acknowledge patients' right to fully participate in the planning and delivery of patient-centered care. To do so, it is important to understand what it is like for common Canadians to live with a potentially serious condition and seek medical care from their physicians. By assessing similarities and differences across a diversity of patients' experiences, the researcher can potentially inform patient-centered care, advocate for quality control initiatives and account for context-level quality of life determinants.

Another important aspect to consider for future research is the socio-economic impact of atrial fibrillation on individuals and their families. What we need to further know

is an associated public health implication and its various aspects. To name a few, it would be valuable to explore opportunity costs for patients and care givers, quality of life variables (both physical and psychological), health care system utilization such as doctors' referrals to tertiary care facilities, atrial fibrillation hospitalizations, emergency department visits, etc.

An interesting opportunity within the qualitative realm could be participatory action research. Patients with the experience of living with AF engage in the research process and provide some insights by thinking critically, yet in a distance from their own stories of a patient's journey to diagnosis. This type of inquiry empowers participants to co-manage the research cycle – from its conceptualization to the completion and knowledge translation phases. The patient-led research could potentially identify unmet needs and concerns as well as define patient-important outcomes rather than have them imposed on the participants by the researcher(s).

5.8 Conclusion

Being the most common sustained cardiac arrhythmia, AF can carry substantial health risk and thus has important public health implications. This was the first study to explore AF episodes of illness in terms of the episode length, the number of physician visits, the medications prescribed, the referrals made, and the diagnostic investigations ordered in general practice.

All the findings were statistically significant, with reported large effect sizes. Recognizing the limitations of establishing a precise starting point in the episode of AF and whether initial symptoms were AF-related, it was on average, between 1.5 and 3 years and after multiple visits that the majority of patients received a first-time diagnosis of AF. Patients tend to take multiple medications on a regular basis not only for the suspected AF but also for other pre-existing comorbidities.

Further qualitative and mixed methods research can provide an in-depth situated knowledge of the patient's journey by documenting various aspects of their lives between physician visits. The contextual approach could allow meaningful interpretation of patient history records, physician notes and questionnaires scores.

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APPENDIX A: List of Atrial Fibrillation-Related ICPC Diagnostic Codes

ICPC Code	ICPC Code Description
K78	Atrial fibrillation/flutter
K04	Palpitations/awareness of heart
K05	Irregular heartbeat other
R02	Shortness of breath/dyspnea
A11	Chest pain NOS (not otherwise specified)
K28	Limited function/disability
A04	Weakness/tiredness general
P01	Feeling anxious/nervous/tense
N17	Vertigo/dizziness
K77	Heart failure
K83	Heart valve disease NOS (not otherwise specified)
K84	Heart disease other
K29	Cardiovascular symptoms/complications other
K99	Cardiovascular disease other

APPENDIX B: List of Chronic ICPC Diagnostic Codes

ICPC Code	ICPC Code Description
A21	Risk factor for malignancy
A23	Risk factor NOS
A90	Congenital anomaly nos/multiple
A93	Premature newborn
A95	Perinatal mortality
A96	Death
B71	Lymphadenitis chronic/non-specific
B72	Hodgkin's disease/lymphoma
B73	Leukaemia
B74	Malignant neoplasm blood other
B78	Hereditary haemolytic anaemia
B79	Congenital anomaly blood/lymph other
B90	HIV infection/AIDS
D90	Hiatus Hernia
D92	Diverticular disease
D93	Irritable bowel syndrome
D94	Chronic Enteritis/ulcerative colitis
F74	Neoplasm of eye/adnexa
F81	Congenital anomaly eye other
F83	Retinopathy
F84	Macular degeneration
F93	Glaucoma
F94	Blindness
F95	Strabismus
H80	Congenital anomaly of ear
H83	Otosclerosis
H84	Presbyacusis
H86	Deafness
K22	Risk factor for cardiovascular disease
K73	Congenital anomaly cardiovascular
K74	Ischaemic heart disease with angina
K76	Ischaemic heart disease without angina
K78	Atrial fibrillation/flutter
K82	Pulmonary heart disease
K86	Hypertension uncomplicated
K87	hypertension complicated
K90	Stroke/cerebrovascular accident
K91	Cerebrovascular disease
K92	Atherosclerosis/peripheral vascular disease
K95	Varicose veins of leg
K96	Haemorrhoids
N70	Poliomyelitis

N74	Malignant neoplasm nervous system
N75	Benign neoplasm nervous system
N76	Neoplasm nervous system unspecified
N85	Congenital anomaly neurological
N86	Multiple sclerosis
N87	Parkinsonism
N88	Epilepsy
N89	Migraine
N94	Peripheral neuritis/neoropathy
N99	Neurological disease other
R79	Chronic bronchitis
R89	Congenital anomaly respiratory
R95	Chronic obstructive pulmonary disease
R96	Asthma
R97	Allergic rhinitis
S91	Psoriasis
S97	Chronic ulcer skin
T78	Thyroglossal duct/cyst
T80	Congenital anomaly endocrine/metabolic
T81	Goitre
T85	Hyperthyroidism/thyrotoxicosis
T86	Hypothyroidism/myxoedema
T89	Diabetes insulin dependent
T90	Diabetes non-insulin dependent
T92	Gout
T93	Lipid disorder
U85	Congenital anomaly urinary tract
W13	Sterilization female
W15	Infertility/subfertility female
W76	Congenital anomaly complicating pregnancy
W85	Gestational diabetes
X11	Menopausal symptom/complaint
X88	Fibrocystic disease breast
Y13	Sterilization male
Y72	Genital herpes male
Y85	Benign prostatic hypertrophy

APPENDIX C: List of Musculoskeletal ICPC Diagnostic Codes

ICPC Code	Description
L01	Neck symptom/complaint
L04	Chest symptom complaint
L05	Flank/axilla symptom/complaint
L07	Jaw symptom/complaint
L08	Shoulder symptom/complaint
L09	Arm symptom/complaint
L10	Elbow symptom/complaint
L11	Wrist symptom/complaint
L12	Hand/finger symptom/complaint
L13	Hip symptom/complaint
L14	Leg/thigh symptom/complaint
L15	Knee symptom/complaint
L16	Ankle symptom/complaint
L17	Foot/toe symptom/complaint
L18	Muscle pain
L19	Muscle symptom/complaint NOS
L20	Joint symptom/complaint NOS
L28	Limited function/disability (L)
L29	Musculoskeletal symptom/complaint other
L70	Infection of musculoskeletal system
L71	Malignant neoplasm musculoskeletal
L72	Fracture: radius/ulna
L73	Fracture: tibia/fibula
L74	Fracture: hand/foot bone
L75	Fracture: femur
L76	Fracture: other
L77	Sprain/strain of ankle
L78	Sprain/strain of knee
L79	Sprain/strain of joint NOS
L80	Dislocation/subluxation
L81	Injury musculoskeletal NOS
L82	Congenital anomaly musculoskeletal
L83	Neck syndrome
L85	Acquired deformity of spine
L87	Bursitis/tendinitis/synovitis NOS
L88	Rheumatoid/seropositive arthritis
L89	Osteoarthrosis of hip
L90	Osteoarthrosis of knee
L91	Osteoarthrosis other
L92	Shoulder syndrome
L93	Tennis elbow
L94	Osteochondrosis

L95	Osteoporosis
L96	Acute internal damage knee
L97	Neoplasm musculoskeletal benign/unspecified
L98	Acquired deformity of limb
L99	Musculoskeletal disease other

APPENDIX D: List of Psychosocial ICPC Diagnostic Codes

ICPC Code	Code Description
Psychological	
P01	Feeling anxious/nervous/tense
P02	Acute stress reaction
P03	Feeling depressed
P04	Feeling/behaving irritable/angry
P05	Senility, feeling/behaving old
P06	Sleep disturbance
P07	Sexual desire reduced
P08	Sexual fulfillment reduced
P09	Sexual preference concern
P10	Stammering/stuttering/tic
P11	Eating problem in child
P12	Bedwetting/enuresis
P13	Encopresis/bowel training problem
P15	Chronic alcohol abuse
P16	Acute alcohol abuse
P17	Tobacco abuse
P18	Medication abuse
P19	Drug abuse
P20	Memory disturbance
P22	Child behaviour symptom/complaint
P23	Adolescent behaviour symptom/complaint
P24	Specific learning problem
P25	Phase of life problem adult
P28	Limited function/disability
P29	Psychological symptom/complaint other
P70	Dementia
P71	Organic psychosis other
P72	Schizophrenia
P73	Affective psychosis
P74	Anxiety disorder/anxiety state
P75	Somatization disorder
P76	Depressive disorder
P77	Suicide/suicide attempt
P78	Neuraesthenia/surmenage
P79	Phobia/compulsive disorder
P80	Personality disorder
P81	Hyperkinetic disorder
P82	Post-traumatic stress disorder
P85	Mental retardation
P86	Anorexia nervosa/bulimia
P98	Psychosis NOS/other
P99	Psychological disorders other

Fear

A25	Fear of death/dying
A26	Fear of cancer NOS
A27	Fear of other disease NOS
B25	Fear of AIDS/HIV
B26	Fear of cancer blood/lymph
B27	Fear of blood/lymph disease other
D26	Fear of cancer of digestive system
D27	Fear of digestive disease other
F27	Fear of eye disease
H27	Fear of ear disease
K24	Fear of heart disease
K25	Fear of hypertension
K27	Fear of cardiovascular disease
L26	Fear of cancer musculoskeletal
L27	Fear of musculoskeletal disease other
N26	Fear of cancer of neurological system
N27	Fear of neurological disease other
P27	Fear of mental disorder
R26	Fear of cancer of respiratory system
R27	Fear of respiratory disease other
S26	Fear of cancer of skin
S27	Fear of skin disease other
T26	Fear of cancer of endocrine system
T27	Fear of endocrine/metabolic disease other
U26	Fear of cancer of urinary system
U27	Fear of urinary disease other
W02	Fear of pregnancy
W21	Concern about boday image related to pregnancy
W27	Fear of complications of pregnancy
X22	Concern about breast appearance female
X23	Fear of sexually transmitted disease female
X24	Fear of sexual dysfunction female
X25	Fear of genital cancer female
X26	Fear of breast cancer female
X27	Fear genital/breast disease female other
Y24	Fear of sexual dysfunction male
Y25	Fear of sexually transmitted disease male
Y26	Fear of genital cancer male
Y27	Fear of genital disease male other
Z27	Fear of social problem

Social

Z01	Poverty/financial problem
Z02	Food/water problem
Z03	Housing/neighbourhood problem

Z04	Social cultural problem
Z05	Work problem
Z06	Unemployment problem
Z07	Education problem
Z08	Social welfare problem
Z09	Legal problem
Z10	Health care system problem
Z11	Compliance/being ill problem
Z12	Relationship problem with partner
Z13	Partner`s behaviour problem
Z14	Partner illness problem
Z15	Loss/death of partner problem
Z16	Relationship problem with child
Z18	Illness problem with child
Z19	Loss/death of child problem
Z20	Relationship problem parent/family
Z21	Behaviour problem parent/family
Z22	Illness problem parent/family
Z23	Loss/death of parent/family member problem
Z24	Relationship problem friend
Z25	Assault/harmful event problem
Z28	Limited function/disability (Z)
Z29	Social problem NOS

APPENDIX E: Measures of Effect Size

#	Measure of Effect Size	Formula	Operational Definition	Interpretation	Applicability
1.	*Eta* squared	$\eta^2 = \frac{t^2}{t^2+(N1+N2-2)}$ **Where**: • η^2 = eta squared • t = *t*-value • N_1= sample size of group 1 • N_2= sample size of group 2	*Eta* squared measures the proportion of variance in the dependent variable that is explained by the independent (group) variable	An *eta* squared value indicates the proportion of the total variation in a dependent variable *Y* that is attributed to an independent (group) variable *X*. Eta squared threshold values: 0 – no association 0.26 – large effect size 0.13 – medium effect 0.02 – small effect 1 – perfect association Can be expressed as a percentage	tends to be biased in overestimating the size of effect in the population
, 2.	Cohen's *d*	**Cohen's *d*** = $(M_2 - M_1) / SD_{pooled}$ $SD_{pooled} = \sqrt{\frac{(SD_1^2 + SD_2^2)}{2}}$ **Where**: • M_1 = mean value for group 1 • M_2 = mean value for group 2	Cohen's *d* presents the difference between the groups in terms of standard deviation units.	*Cohen's threshold values of effect magnitude:* 0.20 – small, but not trivial 0.50 – medium around or above 0.80 – large If two groups' means do not differ by 0.2 standard deviations or more, the difference is trivial, despite its statistical significance.	appropriate if two groups have similar standard deviations and are of the same size; most commonly reported in medical research

		• SD_{pooled} = pooled standard deviation • SD_1 = standard deviation for group 1 • SD_2 = standard deviation for group 2		If the value of Cohen's *d* is larger than 1, the difference between the two means is larger than one standard deviation (large effect).	
3.	Glass' *delta*	$\Delta = M1 - M2 / SD\ control$ **Where**: • Δ = Glass' delta • M_1 = mean value for group 1 • M_2 = mean value for group 2 • *SD control* = standard deviation of the control group However, Kline[180] recommends reporting Glass' delta twice - Δ_1 and Δ_2, using the standard deviation of each group.	Glass' *delta* uses the standard deviation of the comparison group. Using the standard deviation of the comparison group in the denominator is justified when the standard deviation of the control group is believed to be a better estimate of the standard deviation in the population to which the study results are inferred than the standard deviation of the experimental group is. The logic is that the standard deviation of the control group is not contaminated by the treatment effects and, therefore, reflects more accurately the population standard deviation[224]. The difference between the groups is presented in terms of standard deviation units	If two groups' means do not differ by 0.2 standard deviations or more, the difference is trivial, despite of its statistical significance. If the value of Cohen's d is larger than 1, the difference between the two means is larger than one standard deviation	an alternative measure for groups with substantially different standard deviations, i. e.., with unequal variance; also with unequal comparison group

4.	Hedge's *g*	$g = \frac{\lvert \bar{x}_1 - \bar{x}_2 \rvert}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}}$ **Where**: • g = Hedge's g • x_1 = mean value for group 1 • x_2 = mean value for group 2 • n_1 = sample size of group 1 • n_2 = sample size of group 2 • s_1 = standard deviation of group 1 • s_2 = standard deviation of group 2	Hedge's *g* provides a measure of effect size that is weighted according to the relative size of each sample. It presents the difference between the groups in terms of standard deviation units.	If two groups' means do not differ by 0.2 standard deviations or more, the difference is trivial, despite of its statistical significance. If the value of Hedge's *g* is larger than 1, the difference between the two means is larger than one standard deviation.	used for unequal or small sample sizes

APPENDIX F: Manual Calculation of Effect Size: Eta Squared

The formula for eta squared is as follows:[174]

Eta squared = $\frac{t^2}{t^2+(N1+N2-2)}$

Replacing with the appropriate values for each of the five dependent variables:

1) Eta squared (the number of physician visits as a dependent variable) =
$=\frac{32.682^2}{32.682^2+(1487+1287-2)} = \frac{1068.113124}{1068.113124+2772} = \frac{1068.113124}{3840.113124} = 0.2781462654$

Eta squared = 0.28

2) Eta squared (the number of different medication names as a dependent variable) =
$=\frac{19.109^2}{19.109^2+(1845+1327-2)} = \frac{365.153881}{3535.153881} = 0.1032922168$

Eta squared = 0.10

3) Eta squared (the episode length as a dependent variable) =
$=\frac{20.231^2}{20.231^2+(361+1327-2)} = \frac{409.293361}{2095.293361} = 0.1953394062$

Eta squared = 0.20

4) Eta squared (the number of diagnostic investigations as a dependent variable) =
$=\frac{4.919^2}{4.919^2+(168+1327-2)} = \frac{24.196561}{1517.196561} = 0.0159482045$

Eta squared = 0.02

Ever,

5) Eta squared (the number of referrals as a dependent variable) =
$=\frac{4.900^2}{4.900^2+(106+1327-2)} = \frac{24.01}{1455.01} = 0.0165016048$

Eta squared = 0.02

APPENDIX G: Semi-Manual Calculation of Effect Size: Eta Squared

IBM SPSS does not provide effect size statistics for t-tests in the output[174]. However, it is possible to get an eta value through crosstabs in descriptive statistics. Below are the IBM SPSS outputs with eta values for the five dependent variables.

1) Eta (the number of physician visits as a dependent variable) = 0.516

Directional Measures

			Value
Nominal by Interval	Eta	visit_sum Dependent	.516
		group Dependent	.694

2) Eta (the number of different medication names as a dependent variable) = 0.311

Directional Measures

			Value
Nominal by Interval	Eta	total number of different medication names Dependent	.311
		group Dependent	.598

3) Eta (the episode length as a dependent variable) = 0.468

Directional Measures

			Value
Nominal by Interval	Eta	daystodiagnosis Dependent	.468
		group Dependent	.941

4) Eta (the number of diagnostic investigations as a dependent variable) = 0.133

Directional Measures

			Value
Nominal by Interval	Eta	investigations + 90 day lag after diagnosis Dependent	.133
		Group Dependent	.319

5) Eta (the number of referrals as a dependent variable) = 0.037

Directional Measures

			Value
Nominal by Interval	Eta	referrals + 90 day lag after diagnosis Dependent	.037
		group Dependent	.446

From the eta values above, we can manually calculate eta squared values for each of the five dependent variables:

1) Eta squared (the number of physician visits as a dependent variable) = 0.516^2 = 0.266256 = 0.27
2) Eta squared (the number of different medication names as a dependent variable) = 0.311^2 = 0.096721 = 0.10
3) Eta squared (the episode length as a dependent variable) = 0.468^2 = 0.219024 = 0.22
4) Eta squared (the number of diagnostic investigations as a dependent variable) = 0.133^2 = 0.017689 = 0.02
5) Eta squared (the number of referrals as a dependent variable) = 0.037^2= 0.001369 = 0.001

APPENDIX H: Summary Table of Eta Squared Values

#	Dependent variable	SPSS Calculated Eta Value	Manually Calculated Eta Value	Magnitude of Effect
1.	The number of physician visits	0.266256 (0.27)	0.2781462654 (0.28)	large
2.	The number of different medication names	0.096721 (0.10)	0.1032922168 (0.10)	small
3.	The episode length	0.219024 (0.22)	0.1953394062 (0.20)	medium
4.	The number of diagnostic investigations	0.017689 (0.02)	0.0159482045 (0.02)	small
5.	The number of referrals	0.001369 (0.001)	0.0165016048 (0.02)	almost no effect

NOTES:

[1]Eta squared ranges from 0 to 1[174], 0 meaning "no association" and 1 representing "perfect association".

[2]Eta squared measures the proportion of variation in a dependent variable that is related to the membership of different groups defined by an independent variable (or a group variable).

[3]Eta squared assesses how much variation in the dependent variable is explained by variation of the independent variable.

[4] The variance can be expressed as percentage by multiplying an eta squared value by 100.

[5]Interpretation scheme:

0 – no association

0.02 – small effect size

0.13 – medium effect size

0.26 – large effect size

1 – perfect association

APPENDIX I: Calculation of Cohen's *d*

Using the information provided in the IBM SPSS output for the independent-samples t-test, i. e., mean and standard deviation values for both groups, and with the help of an online calculator from https://www.socscistatistics.com/effectsize/Default3.aspx, we calculated Cohen's *d* for the five dependent variables.

The formula for Cohen's *d* is as follows:

Cohen's *d* = $(M_2 - M_1) / SD_{pooled}$

$$SD_{pooled} = \sqrt{\frac{(SD_1^2 + SD_2^2)}{2}}$$

Where:

- M_1 = mean value for group 1
- M_2 = mean value for group 2
- SP_{pooled} = pooled standard deviation
- SD_1 = standard deviation for group 1
- SD_1 = standard deviation for group 2

1) Cohen's *d* (the number of physician visits as a dependent variable) = (13.5835 - 33.1742)/15.987918 = 1.225344.

2) Cohen's *d* (the number of different medication names as a dependent variable) = (13.2683 - 21.1301)/11.636642 = 0.675607.

3) Cohen's *d* (the episode length as a dependent variable) = (560.17 – 1019.27)/369.207639 = 1.243474.

4) Cohen's *d* (the number of diagnostic investigations as a dependent variable) = (3.2781 - 4.875)/3.858248 = 0.413893.

5) Cohen's *d* (the number of referrals as a dependent variable) = (0.7769 - 1.2347)/1.293155 = 0.354018.

NOTES:

[1]Cohen's *d* presents the difference between the groups in terms of standard deviation units.

[2]A negative sign before the value is uninformative of the effect size. The negative sign indicates that there is a mean increase from one group to the other.

APPENDIX J: Calculation of Hedge's *g*

Using the information provided in the IBM SPSS output for the independent-samples t-test, i. e., mean and standard deviation values for both groups, and with the help of an online calculator from https://www.socscistatistics.com/effectsize/Default3.aspx, we calculated Hedge's *g* for the five dependent variables:

The formula for Hedge's *g* is as follows:

$$g = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}}$$

Where:

- *g* = Hedge's *g*
- x_1 = mean value for group 1
- x_2 = mean value for group 2
- n_1 = sample size of group 1
- n_2 = sample size of group 2
- s_1 = standard deviation of group 1
- s_2 = standard deviation of group 2

1) Hedge's *g* (the number of physician visits as a dependent variable) = (13.5835 - 33.1742)/16.227598 = 1.207246.
2) Hedge's *g* (the number of different medication names as a dependent variable) = (13.2683 - 21.1301)/11.839563 = 0.664028.
3) Hedge's *g* (the episode length as a dependent variable) = (560.17 – 1019.27)/355.628446 = 1.290954.
4) Hedge's *g* (the number of diagnostic investigations as a dependent variable) = (3.2781 - 4.875)/3.749238 = 0.425927.
5) Hedge's *g* (the number of referrals as a dependent variable) = (0.7769 - 1.2347)/1.609812 = 0.284381.

NOTES:

[1]Hedge's *g* provides a measure of effect size that is weighted according to the relative size of each sample.

[2]Hedge's *g* presents the difference between the groups in terms of standard deviation units.

[3]Hedge's *g* used for unequal or small sample sizes.

[4]Hedge's *g* results are deemed most valid as the AF and comparison groups have different sample sizes.

APPENDIX K: Representativeness of DELPHI Population

Prevalence of Atrial Fibrillation by Age Group

Age (years)	Number of Patients	Number of patients with atrial fibrillation	Percentage of patients with atrial fibrillation
0-9	3510	*	*
10-19	3878	8	0.2%
20-29	5669	33	0.6%
30-39	5468	33	0.6%
40-49	5477	55	1.0%
50-59	7608	129	1.7%
60-69	7190	250	3.5%
70-79	5062	402	7.9%
80-89	2970	425	14.3%
90-99	1171	157	13.4%
100+	93	6	6.5%
Total	48096	1500	3.1%

APPENDIX K: Representativeness of DELPHI Population Continued

Age and sex distribution of patients with atrial fibrillation

Gender	Number of Patients	Mean Age	Standard Deviation	Range	95% C.I.
Male	800	73.2	14.9	10-107	72.2 -74.2
Female	700	72.1	17.8	2-104	70.8-73.4
Total	1500	72.6	16.4	2-107	71.8-73.4

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	800	53.3	53.3	53.3
Female	700	46.7	46.7	100.0
Total	1500	100.0	100.0	

Mode of Patient Identification	Number of Patients	Percentage of Patients (%)	95% C.I.
Continuous Patient Profile	424	28.3	26.0-30.6
ICD9 code 427x	696	46.4	43.9-49.0
Both CPP and ICD9	380	25.3	23.1-27.6
Total	1500	100	

APPENDIX L: Age and Sex Distribution in the ICPC-Coded DELPHI Population (N=3,525) and the 2016 Canadian Census Population (N= 35,151,728)

	Median Age (years)	Median age Males (years)	Median age Females (years)	% Males	% Females
Census Population	40	39	41	49%	51%
ICPC Population	54	53	56	44%	56%

NOTES:

N=3,525 - the sample of ICPC-coded patients coded from the Deliver Primary Health Care Information (DELPHI) Project.

N=35,151,728 - the 2016 Canadian Census data from Statistics Canada[219].

CURRICULUM VITAE

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EDUCATION:

09/01/2005 – 06/22/2011 Russian State Medical University Named after N.I.Pirogov, Moscow, Russia - 6-year full-time program with specialty in Medical Science
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09/2015 – 08/2016–The University of Western Ontario, Schulich Interfaculty Program in Public Health
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09/2016 – in progress – The University of Western Ontario, a master's program in Epidemiology and Biostatistics (part-time)

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EMPLOYMENT HISTORY:

07/2014 – 06/2015: Registered Massage Therapist in Goreway Physiotherapy and Rehabilitation, Mississauga, ON

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07/2011 - 09/2012: Registered Massage Therapist at Active Rehabilitation Works, Toronto, ON providing quality therapeutic massage and educating post-MVA patients on their overall wellness. Instructed patients in proper self-care and remedial exercises and helped to take steps to improve, maintain and augment their musculoskeletal health.

07/1998 - 08/2005: an escort in Chernobyl Children's Life Line - Oldham Link (Greater Manchester, UK).

PROFESSIONAL ACTIVITIES:

09/2010 - present: College of Massage Therapists of Ontario (CMTO), Member in good standing - licensed and registered with CMTO; have a professional liability insurance for $3, 000, 000 per occurrence.

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