Variation in the use of electrical cardioversion and catheter ablation for atrial fibrillation/flutter according to sex and ethnicity in Aotearoa New Zealand

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ABSTRACT

AIM: The aim of this article was to examine clinical and demographic factors associated with receipt of rhythm control procedures (electrical cardioversion [ECV] or ablation) in patients with atrial fibrillation or flutter (AF/AFL) in Auckland, Aotearoa New Zealand.

METHOD: We conducted a retrospective cross-sectional study of patients with AF/AFL, collecting data up to 31 August 2021. Descriptive statistics were used to characterise procedural use, and associations between patient factors and rhythm control procedures were assessed using multivariable logistic regression.

RESULTS: We identified 1,908 patients with AF/AFL (46.8% female), of whom 292 (15.3%) underwent rhythm control procedures (ablation in 109, ECV only 183). In adjusted analysis, increasing age (adjusted odds ratio [aOR] per year 0.96 [95% confidence interval (CI) 0.95–0.97]) and female sex (aOR 0.46 [95% CI 0.34–0.63]) were associated with lower odds of receiving rhythm control procedures. Compared with European patients (New Zealand/other European), Māori (aOR 0.52 [95% CI 0.36–0.77]), Pacific peoples (aOR 0.41 [95% CI 0.28–0.60]) and other ethnicities (aOR 0.47 95% CI 0.28–0.79]) were less likely to undergo rhythm control procedures. The most common indication for rhythm control procedures was symptomatic relief (76.7%) followed by heart failure optimisation (13.7%).

CONCLUSION: Rhythm control procedures are selectively applied and vary by demographic and clinical factors. Female sex and ethnicity-based differences highlight the need to understand decision-making and access to rhythm control pathways.

Atrial fibrillation or flutter (AF/AFL) are the most common sustained cardiac arrhythmia and a major contributor to stroke, heart failure and health system burden in Aotearoa New Zealand.[1,2] Management strategies for AF/AFL include rate control, rhythm control and stroke-prevention strategies. Australasian guidelines recommend rhythm control in younger, more physically active and highly symptomatic patients; those with paroxysmal or early persistent AF/AFL; those with left ventricular dysfunction and no severe left atrial enlargement; and those in whom adequate control of the ventricular rate is difficult to achieve.[3]

Rhythm control strategies include pharmacological methods (e.g., flecainide, amiodarone, sotalol), electrical cardioversion (ECV) and ablation; the latter may be surgical, but it is more often performed by percutaneous catheter techniques. Studies have shown significant reductions in cardiovascular outcomes and mortality in patients with AF/AFL who receive rhythm control strategies.[4,5] New Zealand data have also demonstrated that rhythm control interventions delivered in routine hospital care can be undertaken safely and are associated with favourable clinical outcomes, reinforcing their relevance in local practice.[6]

Previous studies have demonstrated variation in rhythm control strategies according to sex and ethnicity, with females, African Americans and Hispanics less likely to undergo rhythm control procedures (i.e., ECV or ablation).[7,8] However, contemporary national evidence describing patterns of rhythm control use across demographic groups, including ethnicity, remains limited. This is particularly relevant in Aotearoa New Zealand, where AF/AFL prevalence, comorbidity burden and access to specialist care differ across population sub-groups.[9] Local outcome data supporting rhythm control strengthen the importance of understanding which patients receive these interventions in clinical practice.

We therefore examined clinical and demographic factors associated with rhythm control procedures in patients with AF/AFL managed across Auckland.

Methods

We performed a cross-sectional analysis of patients with AF/AFL identified from electronic health records up to 31 August 2021. All available historical data were used to ascertain prior diagnoses and procedures, rather than defining a fixed observation period. AF/AFL pattern was defined based on clinical classification and was not necessarily contemporaneous with rhythm control procedures. The outcome was a documented history of ECV or catheter ablation up to 31 August 2021. AF/AFL duration was defined as the time from first documented AF/AFL diagnosis to this date and was included as a continuous variable (years) in the regression model.

Data sources

Patients were identified using administrative coding from the Ministry of Health – Manatū Hauora National Minimum Dataset who presented to one of Auckland's three public hospitals (Health New Zealand – Te Whatu Ora Te Toka Tumai Auckland, Health New Zealand – Te Whatu Ora Counties Manukau and Health New Zealand – Te Whatu Ora Waitematā). Additional patients with AF/AFL were identified from the fifth Auckland Regional Community Stroke Study (ARCOS V).

Eligibility

Electronic clinical records, including electrocardiograms, echocardiography reports and clinician documentation, were reviewed to confirm AF/AFL. Both incident and prevalent AF/AFL cases were included. Patients with moderate-to-severe mitral stenosis, mechanical heart valves or transient AF/AFL occurring during a cardiac procedure and resolving before discharge were excluded.

Covariates

Data collected included demographics and comorbidities (left ventricular failure, diabetes, hypertension, prior ischaemic stroke [IS] or transient ischaemic attack [TIA], vascular disease, AF/AFL pattern [i.e., paroxysmal vs non-paroxysmal] and body mass index [BMI kg/m^2]). Ethnicity was based on self-identification and classified using the Aotearoa New Zealand standard prioritised ethnicity approach, whereby individuals reporting multiple ethnicities were assigned to a single group in the following order: Māori, Pacific peoples (e.g., Samoan, Cook Island Māori), European (including New Zealand European and other European) and Other.[10]

Outcome

The outcome of interest was receipt of rhythm control procedures, defined as completed ECV or catheter ablation, with procedures identified up to 31 August 2021.

We also performed a predefined sub-group analysis comparing patients treated with ECV vs ablation. Demographic and clinical characteristics, AF/AFL pattern, comorbidities, BMI and documented indication for rhythm control were recorded and compared descriptively between groups.

This study was approved by the Health and Disability Ethics Committee (HDEC) (ref: 2023 AM 9094) and the Auckland University of Technology Ethics Committee AUTEC (24/4) and granted an exemption from obtaining informed consent.

Statistical analysis

Continuous variables were non-parametrically distributed and are presented as median (interquartile range [IQR]); between-group differences were assessed using the Wilcoxon Rank-Sum Test. Categorical variables are presented as counts and percentages, with differences assessed using the Chi-squared test for association. Crude and multivariable logistic regression was used to estimate associations with rhythm control procedures, expressed as adjusted odds ratios (aORs) with 95% confidence intervals (CIs). Ethnicity was modelled as a categorical variable, with European ethnicity as the reference category. Model diagnostics focussed on assessment of model specification, including linearity of continuous predictors in the odds on logarithmic scale and evaluation of multicollinearity.

For sensitivity analyses, the regression model was repeated, restricting the cohort to patients with paroxysmal AF/AFL. This study has been reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for observational studies.[11] All analyses were performed using Stata version 17BE (StataCorp, College Station, Texas, United States of America).

Results

Baseline characteristics

Among 1,908 patients with AF/AFL, 892 (46.8%) were female. Females were older than males (median age 71.7 vs 67.8 years). Rhythm control procedures were performed in 292

(15.3%). Patients in the rhythm control group were younger than those in the non–rhythm control group (median age 64.7 vs 71.6 years) and were less likely to be female. European patients were more commonly represented in the rhythm control group than in the non–rhythm control group (49.3 vs 37.5%), whereas Pacific peoples (22.3 vs 29.8%) and patients from other ethnic groups (7.2 vs 11.8%) were less commonly represented (p<0.001). Patients with paroxysmal AF/AFL were also more likely to undergo rhythm control. Table 1 summarises baseline differences.

Comorbidity burden differed between patients selected for rhythm control and non–rhythm control groups. Patients selected for rhythm control procedures were less likely to have hypertension, diabetes, prior IS or TIA, and vascular disease. Three hundred and forty-four had left ventricular systolic dysfunction (defined as ejection fraction ≤40%) and were more likely to undergo rhythm control procedures than those without systolic dysfunction. Median BMI did not differ between groups. Total AF/AFL duration was greater in patients receiving rhythm control compared with those who did not (p=0.0001).

Factors associated with use of rhythm control procedures

In multivariable logistic regression analysis, increasing age was independently associated with a lower aOR of receiving rhythm control procedures (aOR 0.96 per year [95% CI 0.95–0.97], p<0.001). Female sex was associated with substantially lower odds of receiving rhythm control

Table 1: Baseline clinical and demographic characteristics of patients with atrial fibrillation or flutter (AF/AFL), stratified by rate versus procedural rhythm control strategy.

Variable	All n=1908	No rhythm control procedure n=1616	Rhythm control procedure n=292	p-values
Median age (IQR) years	70.3 (61.2–79.2)	71.6 (62.2–80.3)	64.7 (56.6–73.2)	<0.0001
Female n (%)	892 (46.8)	806 (49.9)	86 (29.5)	<0.001
Ethnicity n (%)				
European	747 (39.2)	606 (37.5)	144 (49.3)	
Māori	403 (21.1)	339 (21.0)	62 (21.2)	<0.001
Pacific peoples	547 (28.7)	482 (29.8)	65 (22.3)	
Others	211 (11.1)	190 (11.8)	21 (7.2)	
Median BMI (IQR) kg/m²	31.2 (26.1–37.2)	31.1 (26.0–37.0)	32.2 (26.8–37.6)	0.0667
Paroxysmal AF/AFL n (%)	869 (45.6)	701 (43.4)	168 (57.5)	<0.001
Median AF/AFL duration (years)	5 (2–8)	4 (2–8)	6 (3–10)	0.0001
Comorbidities n (%)				
Left ventricular failure	344 (18.0)	278 (17.2)	66 (22.6)	0.027
Hypertension	1215 (63.7)	1068 (66.1)	147 (50.3)	<0.001
Diabetes	556 (29.1)	497 (30.8)	59 (20.2)	<0.001
Prior IS or TIA	338 (17.7)	309 (19.1)	29 (10.0)	<0.001
Vascular disease	565 (29.6)	503 (31.1)	62 (21.3)	0.001

Vascular disease = coronary artery disease/peripheral vascular disease. IS = ischaemic stroke. TIA = transient ischaemic attack. IQR = interquartile range. BMI = body mass index.

procedures compared with males (aOR 0.46 [95% CI 0.34–0.63], p<0.001).

BMI demonstrated evidence of non-linearity and was therefore modelled as a binary variable, with obesity defined as ≥30kg/m². After adjustment for age, female sex, obesity, AF/AFL phenotype and clinical covariates, ethnicity remained independently associated with rhythm control strategy. Compared with European patients, Māori (aOR 0.52 [95% CI 0.36–0.77]), Pacific peoples (aOR 0.41 [95% CI 0.28–0.60]) and patients of other ethnicities (aOR 0.47 [95% CI 0.28–0.79]) were significantly less likely to undergo rhythm control procedures.

Several comorbid conditions were associated with lower odds of rhythm control, including diabetes, prior IS or TIA, and vascular disease. Left ventricular failure was associated with higher odds of rhythm control in unadjusted analysis, but this association was attenuated after adjustment, consistent with confounding.

Paroxysmal AF/AFL was strongly associated with rhythm control use (aOR 1.48 [95% CI 1.10–1.97], p=0.009). Obesity was not independently associated with rhythm control.

In sensitivity analyses restricted to patients with paroxysmal AF/AFL, obesity (aOR 1.69 [95% CI 1.09–2.61]) and heart failure (aOR 3.22 [95% CI 1.91–5.41]) were independently associated with a higher likelihood of rhythm control. AF/AFL duration was not significantly associated in this sub-group.

Rhythm control strategies

Of 292 patients who underwent rhythm control procedures, 183 received ECV only, 67 received ablation only and 42 underwent ECV followed by ablation. Comparing ECV vs ablation±ECV, there were no statistically significant differences in age, sex, ethnicity, BMI or comorbidities. Symptom relief was the predominant indication for pursuing

Table 2: Clinical and demographic factors associated with rhythm control procedures in patients with atrial fibrillation or flutter (AF/AFL).

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Age per year	0.96 (0.95–0.97)	0.96 (0.95–0.97)	<0.001
Female	0.42 (0.32–0.55)	0.46 (0.34–0.63)	<0.001
Ethnicity			
European	Ref	Ref	
Māori	0.76 (0.55–1.06)	0.52 (0.36–0.77)	0.001
Pacific peoples	0.56 (0.41–0.78)	0.41 (0.28–0.60)	<0.001
Others	0.46 (0.29–0.75)	0.47 (0.28–0.79)	0.005
Obesity	1.01 (1.0–1.02)	1.29 (0.94–1.77)	0.122
Comorbidities			
Left ventricular failure	1.41 (1.04–1.9)	1.41 (1.0–2.0)	0.051
Hypertension	0.52 (0.41–0.67)	0.76 (0.57–1.018)	0.056
Diabetes	0.57 (0.42–0.77)	0.70 (0.50–0.98)	0.039
Previous IS or TIA	0.47 (0.31–0.70)	0.60 (0.39–0.92)	0.019
Vascular disease	0.60 (0.44–0.81)	0.68 (0.49–0.94)	0.019
Paroxysmal AF/AFL	1.77 (1.38–2.28)	1.48 (1.10–1.97)	0.009
AF/AFL duration per year	1.05 (1.02–1.07)	1.05 (1.02–1.08)	0.001

Adjusted odds ratios are from a multivariable logistic regression model including all variables shown.
OR = odds ratio. CI = confidence interval. Vascular disease = coronary artery disease/peripheral vascular disease. IS = ischaemic stroke. TIA = transient ischaemic attack. IQR = interquartile range. BMI = body mass index.

rhythm control (76.7%), followed by heart failure optimisation as part of guideline-directed medical care (13.7%), and did not differ between groups. Patients undergoing ablation were significantly more likely to have paroxysmal AF/AFL compared with those receiving ECV (68.8% vs 50.8%, p=0.003). Data are summarised in Table 3.

Discussion

In this Aotearoa New Zealand–based cohort, rhythm control procedures for AF/AFL were used in a minority of patients and varied substantially according to age, sex, AF/AFL phenotype, comorbidity burden and ethnicity. Symptom relief was the most commonly documented indication for pursuing rhythm control.

Ethnicity remained independently associated with receipt of rhythm control procedures after adjustment for measured clinical factors. Māori, Pacific peoples and patients of other ethnicities were less likely to undergo ECV or ablation compared with European patients. While this study cannot determine whether these differences reflect inequitable care, they were not fully explained by measured clinical characteristics. Potential contributors include unmeasured comorbidity, referral pathways and patient preferences. Given evidence that appropriately selected patients can derive benefit from rhythm control strategies, variation in procedure use between population groups may have important

Table 3: Baseline clinical characteristics of patients undergoing electrical cardioversion (ECV) or ablation.

Variable	ECV n=183	Ablation±ECV n=109	p-value
Median age (IQR) years	64.8 (57.0–73.3)	62.3 (56.1–73.2)	0.3791
Female n (%)	56 (30.6)	30 (34.9)	0.577
Ethnicity n (%)			
European	87 (47.5)	57 (52.3)	
Māori	37 (20.2)	25 (22.9)	0.596
Pacific peoples	45 (24.6)	20 (18.4)	
Others	14 (7.7)	7 (6.4)	
Paroxysmal AF/AFL n (%)	93 (50.8)	75 (68.8)	0.003
Median BMI (IQR) kg/m²	32.5 (27.8–37.8)	31.2 (26.3–37.2)	0.2386
Comorbidities n (%)			
Left ventricular failure	40 (21.9)	26 (23.9)	0.693
Hypertension	97 (53.0)	50 (45.9)	0.238
Diabetes	38 (20.8)	21 (19.3)	0.758
Previous IS or TIA	19 (10.4)	10 (9.2)	0.738
Vascular disease	38 (20.8)	24 (22.0)	0.80
Rhythm control indication n (%)			
Heart failure optimisation	22 (12.0)	18 (16.5)	
Patient/clinician preference	18 (9.8)	3 (2.8)	0.093
Symptomatic relief	138 (75.4)	86 (78.9)	
Unclear	5 (2.7)	2 (1.8)	

IQR = interquartile range. AF/AFL = atrial fibrillation or flutter. Vascular disease = coronary artery disease/peripheral vascular disease. IS = ischaemic stroke. TIA = transient ischaemic attack. IQR = interquartile range. BMI = body mass index.

clinical implications.[4,5]

AF/AFL phenotype was not temporally linked to rhythm control procedures in this cross-sectional analysis. Patients classified as having paroxysmal AF/AFL may therefore have had prior sustained episodes requiring ECV, which may partly explain the presence of ECV in this group. Patients undergoing rhythm control had longer AF/AFL duration, likely reflecting greater cumulative opportunity to receive intervention. It may also reflect evolving clinical indications over time, including persistent or symptomatic disease, although these factors were not directly measured. This supports the inclusion of AF/AFL duration in the multivariable model to account for differential exposure time.

Among patients selected for rhythm control, there were no significant differences in age, sex, ethnicity or comorbidity burden between those undergoing ECV alone and those receiving ablation. These findings suggest that once patients are referred for rhythm control, procedural decision-making appears to be driven primarily by clinical factors rather than demographic characteristics. In contrast, AF/AFL pattern remained an important determinant, with patients undergoing ablation more likely to have paroxysmal AF/AFL, consistent with current guideline recommendations and the higher likelihood of maintaining sinus rhythm in this group.

Previous studies suggest that females with AF report greater symptom burden, functional impairment and lower quality of life than males.[12] Other studies have also reported higher rates of AF recurrence following ablation/ECV among females compared with males.[12] In our study, females had lower odds of receiving rhythm control procedures after adjustment for age and comorbidities. Similar sex-based differences in rhythm control use have been reported internationally and may reflect differences in referral patterns, clinician perceptions of procedural benefit, symptom reporting or patient preference.[12] Together, these findings indicate that sex-based variation in rhythm control strategies remains evident in contemporary practice.

Associations with age and AF/AFL subtype were consistent with current guideline recommendations.[3] Rhythm control procedures were more frequently used in younger patients and those with paroxysmal AF/AFL, reflecting both a higher likelihood of maintaining sinus rhythm and a more favourable balance between anticipated benefit and procedural risk. Lower use among patients with established vascular comorbidity likely reflects reduced expected efficacy and clinician preference for rate control strategies.

The strengths of this study include the use of a large, ethnically diverse cohort with detailed individual-level clinical data. AF/AFL and comorbidities were defined using clinician-documented diagnoses and detailed record review rather than administrative codes alone, reducing the risk of misclassification. This enabled more accurate characterisation of AF/AFL phenotype and its association with rhythm control use in routine clinical practice.

This study has several limitations. The observational, cross-sectional design is subject to residual confounding and does not permit causal inference. In addition, AF/AFL pattern and rhythm control procedures were not temporally linked, which may limit the interpretation of the relationship between AF/AFL phenotype and treatment selection. Important clinical factors influencing rhythm control decisions, including symptom burden, response to antiarrhythmic therapy, left atrial size and patient preference, were not captured. Further, obstructive sleep apnoea, an important risk factor for AF/AFL and its progression, was not captured in this dataset.[13] Its omission may contribute to residual confounding, particularly as it is associated with AF/AFL severity and may influence selection for rhythm control interventions.

Procedures performed in the private sector were not systematically recorded; although a small number were identified from clinical documentation, this information was incomplete and inconsistently captured. As a result, procedural rates may be under-estimated, and associations, particularly by ethnicity, may be biased if access to private care differs between groups.

Finally, AF/AFL were analysed together due to coding limitations. Given differing management pathways, particularly greater use of ablation in AFL, this may have influenced observed associations, including sex differences.

In conclusion, rhythm control procedures for AF/AFL in Aotearoa New Zealand are selectively applied and vary substantially by demographic and clinical characteristics. Persistent sex and ethnicity-based differences highlight the need for prospective studies to better understand how clinical decision-making, access to care and patient preferences shape the use of rhythm control strategies.

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