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Integrated care for atrial fibrillation management: The role of the pharmacist

Running head: The pharmacist's role in atrial fibrillation management

Leona A Ritchie*[1,2] (MPharm), Peter E Penson[1,2,3] (PhD), Asangaedem Akpan[4,5] (MPhil), Gregory Y H Lip[1,2,6,7] (MD), Deirdre A Lane[1,2,6,7] (PhD)

[1]Liverpool Centre for Cardiovascular Science, University of Liverpool, Liverpool, L7 8TX, United Kingdom

[2]Department of Cardiovascular and Metabolic Medicine, Institute of Life Course and Medical Sciences, University of Liverpool, Liverpool, L7 8TX, United Kingdom

[3]Clinical Pharmacy and Therapeutics Research Group, School of Pharmacy and Biomolecular Sciences, Liverpool John Moores University, Liverpool, L3 3AF, United Kingdom

[4]Musculoskeletal and Ageing Science, Institute of Life Course & Medical Sciences, University of Liverpool, L7 8TX, United Kingdom

[5]Liverpool University Hospitals NHS Foundation Trust, Liverpool, L9 7AL, United Kingdom

[6]Liverpool Heart & Chest Hospital, Liverpool, L14 3PE, United Kingdom

[7]Aalborg Thrombosis Research Unit, Department of Clinical Medicine, Aalborg University, Aalborg, DK-9220, Denmark

*__Correspondence to:__ Leona A Ritchie, Liverpool Centre for Cardiovascular Science, William Henry Duncan Building, University of Liverpool, Liverpool, L7 8TX, United Kingdom.
Email: leona.ritchie@liverpool.ac.uk Tel: 0151 706 4070 Fax: Not available
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Abstract

Within Europe and the Asia-Pacific, the Atrial Fibrillation Better Care (ABC) pathway is the gold standard integrated care strategy for atrial fibrillation management. Atrial fibrillation diagnosis should be Confirmed and Characterized (CC) before implementation of ABC pathway components: (1) 'A'- Anticoagulation/Avoid stroke; (2) 'B'- Better symptom management and (3) 'C'- Cardiovascular and other co-morbidity optimization. Pharmacists have the potential to expedite integrated care for atrial fibrillation across the healthcare continuum -hospital, community pharmacy and general practice. This review summarizes the available evidence base for pharmacist-led implementation of the 'CC to ABC' model.

Clinical significance

- Pharmacists are a potentially untapped resource in relation to Atrial Fibrillation Better Care pathway delivery across the healthcare continuum of hospital, community pharmacy and general practice
- Most research has focused on pharmacist interventions to implement pathway components in isolation, particularly 'A - Anticoagulation'
- The pharmacy service framework needs re-structuring to support translation of pharmacist interventions into everyday clinical practice, and with scope for these to include prescribing

Introduction

Integrated care for atrial fibrillation has been advocated for over a decade, with different models proposed. The Atrial Fibrillation Better Care (ABC) pathway was first proposed in 2017 as a framework for integrated care to align generalist and specialist atrial fibrillation management across primary and secondary care settings.[1] The pathway is comprised of three components: (1) 'A'- Anticoagulation/Avoid stroke; (2) 'B'- Better symptom management and (3) 'C'- Cardiovascular and other co-morbidity optimization.[1] Currently, the ABC pathway is recommended as the 'gold-standard' atrial fibrillation management strategy in the latest European Society of Cardiology and Asia-Pacific guidelines.[2, 3] The European guidelines also highlight two steps that precede ABC pathway implementation, providing a complete model for integrated atrial fibrillation care, 'CC to ABC'.[2] This consists of 'C'- Confirming the atrial fibrillation diagnosis with a 12-lead electrocardiogram (ECG) or single-lead ECG tracing of ≥30 seconds, followed by 'C'- Characterization of atrial fibrillation including stroke risk, symptom severity, severity of atrial fibrillation burden and substrate severity.[2]

With definitive guidance on what integrated care model to follow, the next consideration is whether pharmacists could help operationalise it. As medicines experts, pharmacists screen and optimize medication prescriptions to ensure safety and effectiveness. In addition, pharmacist prescribers can initiate and modify medications, and monitor for their effect. With this skillset, pharmacists have the potential to implement integrated atrial fibrillation care across the healthcare continuum of hospital, community pharmacy and general practice (**Figure 1**). This narrative review summarizes the findings from research studies of pharmacist interventions that can be mapped to the 'CC to ABC' model. The aim is to determine what role pharmacists could adopt in the delivery of integrated atrial fibrillation care.

'CC' Confirm and Characterize atrial fibrillation : pharmacist interventions for atrial fibrillation screening and characterization

Thirteen studies have tested the feasibility of pharmacist-led atrial fibrillation screening programmes (**Table 1**).[4-16] Three of these also attempted to characterize atrial fibrillation by assessing symptoms[12] or using the CHA_2DS_2-VASc score to quantify stroke risk.[8, 11] None of these studies have characterized atrial fibrillation by severity of atrial fibrillation burden or substrate severity.

Eleven studies[4-6, 8, 9, 11-16] relied on a single-lead electrocardiogram (ECG) recording for the detection of atrial fibrillation using the AliveCor KardiaMobile device (n=9),[4-9, 11, 15, 16] MyDiagnostick (n=1)[13] and HeartCheck, CardioComm (n=1).[14] In one study, the AliveCor Kardia mobile single-lead ECG was only performed if abnormalities were first detected by a blood pressure (BP) monitor (Microlife AFIB).[15] One study did not specify the device used to generate the single-lead ECG,[12] and another study used the Microlife AFIB in isolation to detect atrial fibrillation.[10] Manual pulse palpation was performed in five studies,[5, 6, 9, 12, 16] and in one study[12] this was combined with a symptom and risk factor assessment.

Study settings varied but were predominantly conducted in community pharmacies (n=7).[4, 7, 10, 12, 14-16] The incidence of new atrial fibrillation was reported in eight studies[4, 5, 7, 9, 12, 14-16] and ranged from 0.7%[5] to 6.3%.[9] Other studies only reported cases of possible atrial fibrillation,[6, 8, 10, 11] and no results were available for one study.[13]

In seven studies[5-7, 9, 14-16] a cardiologist was an integral part of the screening programme and had responsibility for interpreting single-lead ECG recordings before follow-up was arranged with the participant's physician,[5-7, 9, 15, 16] or jointly by their physician and local atrial fibrillation clinic.[14] Five studies[4, 8, 10, 11, 13] relied initially on algorithm interpretation of the Microlife AFIB BP monitor,[10] AliveCor KardiaMobile[4, 8, 11] or MyDiagnostick single-lead ECG recording[13] to detect abnormalities and determine the need for referral.

Only two studies[5, 6] reported the inter-rater agreement between the pharmacist, cardiologist and the AliveCor KardiaMobile algorithm interpretation of single-lead ECG recordings. In one study, the interrater agreement (Cohen's kappa [κ]) was 0.56 between the pharmacist and mobile algorithm, and 0.70 between the cardiologist and mobile algorithm.[6] In the other study, inter-rater agreement was reported as Cohen's κ 0.69 (95% confidence interval [CI] 0.56-0.82) between the pharmacist and cardiologist, and 0.72 (95% CI 0.60-0.85) between the mobile algorithm and cardiologist.[5]

Two studies evaluated cost-effectiveness using a National Institute for Health and Care Excellence costing report for atrial fibrillation,[5] or treatment/outcome data from a UK cohort of 5,555 patients with incidentally detected asymptomatic atrial fibrillation.[16] Incremental savings of approximately £120 million using the AliveCor KardiaMobile device and £50 million using pulse palpation were predicted on the basis that screening was applied to all patients in England and Wales ≥65 years old, with 50% uptake of screening and newly detected atrial fibrillation.[5] In

the other study, an incremental cost-effectiveness ratio, based on 55% of warfarin prescription adherence, was reported as $AUD 30,481 (€15,993; $USD 20,695) for preventing one stroke.[16]

'A' Anticoagulation/Avoid stroke: pharmacist interventions for anticoagulant management

Thirty studies investigated the effect of pharmacist-led interventions to optimize anticoagulation for stroke prevention in atrial fibrillation [17-47] (**Table 2**). Half of the studies (n=15) were conducted in hospitals,[17, 18, 20, 21, 26, 28-31, 35-37, 40, 42, 44] and the remainder in outpatient clinics (n=6),[22-24, 33, 45, 46] general practice (n=2),[25, 43] non-profit integrated healthcare delivery systems (n=2),[19, 39] Veterans Health Administration site(s) (n=2)[34, 41] and an Academic Healthcare System (n=1).[27] The study setting was not specified in two studies.[32, 38] Studies included patients on warfarin (n=9),[18-20, 23, 30, 36, 37, 39, 44] non-vitamin K antagonist oral anticoagulants (NOACs) (n=8)[17, 27, 31-35, 41] or both (n=1).[46] Nine studies referred broadly to anticoagulants,[22, 24, 25, 28, 29, 38, 40, 43, 45] and three evaluated antithrombotics.[21, 26, 42] Seven studies reported the quality of warfarin therapy, measured by time in therapeutic range (TTR),[18, 20, 30, 36, 37, 39, 44] seven reported on health outcomes (thromboembolism, bleeding, mortality),[19, 27, 29, 33, 35, 39, 44] 15 reported on oral anticoagulant (OAC) prescribing,[21-26, 31, 34, 38, 40, 42, 43, 45, 46 28] one on patient knowledge[32], one on patient cognition,[17] two on patient satisfaction[17, 28], and three on medication adherence.[32, 33, 41] Five of these studies reported on two outcomes, including TTR and health outcomes,[39, 44] medication adherence and health outcomes,[33] patient satisfaction and OAC prescribing,[28] patient satisfaction and cognition,[17] and patient knowledge and medication adherence.[32]

Quality of warfarin therapy (TTR)

Physician-pharmacist collaborations were the most common intervention types in studies reporting on quality of warfarin therapy, using TTR.[18, 30, 44] Most studies reported differences in TTR between the pharmacist intervention and control group, with three reporting significantly higher TTR in the intervention group compared to controls.[20, 30, 39] Two studies found no significant difference in TTR between groups (**Table 2**).[18, 36] One study found a significantly higher proportion of participants with TTR ≥60% in the physician-pharmacist atrial fibrillation warfarin clinic compared to those who attended a general clinic (73.7% vs. 47.1%, p=0.002).[44] Another study implemented a 12-week pharmacist management programme for atrial fibrillation patients with a TTR <50%. Participants were categorised by warfarin adherence (low: two or more missed doses; medium: one missed dose; high: no missed doses).[37] There was a significant difference in basal, 12-week and one year mean TTR within low-, medium- and high- adherence groups (**Table 2**).

Health outcomes

Seven studies reported on health outcomes[19, 27, 29, 33, 35, 39, 44] (**Table 2**). Only one study that used a before-and-after design was powered to performed adjusted analyses,[39] and found a pharmacist-led anticoagulant management services focused on TTR improvement was associated with lower odds of a composite endpoint of clinically-relevant bleeding, thromboembolism and all-cause mortality (adjusted odds ratio [OR] 0.69, 95% CI 0.54-0.87).[39] A cohort study of 460 participants (intervention n=90, control n=370) carried out at an Academic Healthcare System found no association between pharmacist-led management of patients taking NOACs and the same composite endpoint (**Table 2**), although the

study was limited by low statistical power.[27] One cohort study of pharmacist-led rivaroxaban management for atrial fibrillation patients found no association with heart failure, left atrial dilation or thrombosis, but a significantly lower incidence of bleeding events when compared to patients under the care of cardiologists or primary care providers (gastrointestinal: 6.1% vs. 12.4%, p=0.038; skin ecchymosis 0.6% vs. 4.5%, p=0.018).[35] Other studies reported no association between pharmacist-led interventions and health outcomes.[44, 19, 33]

OAC prescribing

Most studies explored the impact of pharmacist interventions on the appropriateness of OAC prescribing,[24, 28, 31, 34, 46] or OAC prescribing rates (**Table 2**).[21-23, 26, 40, 42, 45] Inappropriate OAC use was reported to be less likely in atrial fibrillation patients who received multidisciplinary follow-up (cardiologist, nurse, pharmacist) compared to cardiologist only follow-up (8% vs. 22%).[46] Other interventions including pharmacist delivered patient education to promote shared decision making,[28] and a pharmacist anticoagulant management programme for patients newly initiated on NOACs[34] were also associated with improved appropriateness of OAC therapy (**Table 2**). One small cohort study (n=87) found pharmacist-led clinics targeting patients with suboptimal vitamin K antagonist (VKA) therapy (TTR <65%) promoted review of anticoagulant therapy, with 65 participants (74.7%) switched from VKA to NOAC.[24] In five studies,[22, 25, 38, 43, 45] pharmacists were responsible for independently reviewing medical records to identify patients with atrial fibrillation not prescribed anticoagulation. Only three studies explored whether this translated into increased OAC prescribing.[22, 25, 45] One randomised controlled trial (RCT) of 1,727 participants found no significant difference in the proportion of OAC prescriptions between intervention and usual care groups (**Table 2**).[45] In a before-and-after study, higher

OAC prescribing rates were reported in two clinical commissioning groups[22] and in another cohort study, the proportion of atrial fibrillation patients prescribed OAC increased significantly from 62% to 80% (**Table 2**).[25] Other studies also demonstrated positive effects of other distinct pharmacist-led interventions on increasing OAC prescribing (**Table 2**).[21, 23, 26, 40, 42]

Medication adherence, knowledge and patient satisfaction

Pharmacist-delivered patient education was a core component of three studies[32, 33, 41] that reported on patient knowledge[32] and medication adherence (**Table 2**).[32, 33, 41] In a before-and-after study of 68 participants taking dabigatran, there was no significant difference in the proportion of participants with a medication possession ratio (number of dispensed doses in a specified time period divided by the total number of days in that time period) ≥80% (**Table 2**).[33] A larger mixed-method study (n=4,863) also found no significant association between pharmacist education and dabigatran adherence (adjusted relative risk [aRR] 0.94, 95% CI 0.83-1.06).[41] In contrast, another educational intervention significantly increased medication adherence from baseline to 4-months and marginally improved patient knowledge about AF and NOAC.[32] Two studies assessed the effect of pharmacist interventions on patient satisfaction[28 17] and reported significant improvements (**Table 2**).[28 17]

'B' Better symptom management: pharmacist interventions for symptom management

Two studies tested pharmacist interventions for symptom management in atrial fibrillation,[48, 49] focusing on prescription of sotalol[48] or the care setting for administration[49] (**Table 3**). In one small cohort study (n=360), pharmacists identified most (89%) sotalol prescriptions were

inappropriate based on patients' renal function and recommended changes to physicians, but only 38% of recommendations were implemented.[48] In another study, pharmacists led an anti-arrhythmic outpatient clinic for sotalol loading (oversight from electrophysiologist) to determine feasibility compared to inpatient sotalol loading.[49] Out-patient sotalol loading was found to be a safe alternative.[49]

'ABC': multi-faceted pharmacist interventions covering two or more components of the Atrial Fibrillation Better Care pathway

Three before-and-after studies explored pharmacist implementation of multi-faceted interventions aligned with ≥2 components of the ABC pathway (**Table 4**).[50-52] One before- and- after study (n=300) examined an AF-specific medication assessment tool (MAT-AF), focused on appropriate OAC dosing by renal function, and necessary monitoring of rate or rhythm controlling agents.[51] Use of the medication tool was associated with significantly higher odds of OAC and rate control prescriptions (OR 4.07, 95% CI 2.12-7.82 and OR 3.92, 95% CI 1.06-14.54, respectively).[51] In another study, pharmacists used Active Patient Link (APL-AF) software to identify AF patients potentially eligible for OAC therapy and invited them to attend a general practitioner (GP)-pharmacist clinic.[50] The clinic initiated OAC therapy where appropriate, and optimized antihypertensive/lipid-lowering therapy. The intervention was associated with a significant increase in OAC prescription (77% to 83%) and the proportion of patients with a serum cholesterol <5mmol/L, although this did not translate into a significant increase in statin use. Data on dosage changes to statin therapy are not reported.[50] There was no significant difference in the proportion of patients with uncontrolled blood pressure ≥140/90mmHg.[50] Delivery of a protocol for atrial fibrillation care post-hospital discharge that comprised rate control, stroke

prevention and risk factor assessment and modification was associated with significantly higher odds of discharge from the hospital emergency department (OR 4.2, 95% CI 1.9-9.8), but no significant reduction in hospital length of stay for subsequent admissions.[52]

Pharmacist-led educational interventions

Three studies (one before-and-after[53] and two cohort studies[54, 55]) tested pharmacist-delivered education (**Table 4**). Studies reported on different outcomes and the results were variable.[53-55] One reported no difference in the number of emergency department visits or hospital admissions after matching participants to historic controls,[54] and another reported lower hospital admission rates when national admission rates were used as a comparator.[55] A 70 minute pharmacist-led educational session increased the proportion of participants who identified atrial fibrillation as a modifiable stroke risk factor (none identified it pre-education, six identified it post-education).[53]

Discussion

Research efforts have predominantly focused on pharmacist interventions for anticoagulant management in atrial fibrillation, reporting on appropriateness (guideline-adherent) or prescription rates. Thirteen studies have demonstrated the feasibility of pharmacist-led AF screening in primary care, most commonly using the AliveCor Kardia Mobile single-lead ECG. There is a paucity of research on pharmacist-led characterization or symptom management of atrial fibrillation, or delivery of multifaceted interventions to provide holistic care for AF patients

based on the ABC pathway. Extensive heterogeneity among included studies in relation to their design, populations, interventions, outcome measures and statistical analyses limits the conclusions that can be drawn from the available evidence.

Pharmacist-led atrial fibrillation screening programmes appear to have demonstrated feasibility across a variety of clinical and non-clinical settings,[4-12, 14-16] To be valuable, any screening programme must be precise, and there must be a robust infrastructure to support effective and safe referral and follow-up in the event of positive screening.[56] There is a paucity of cost-effectiveness data to accompany the studies, and use of a cross-sectional design limited study follow-up, for example, not all studies quantified the number of new atrial fibrillation cases. To support implementation of atrial fibrillation screening programmes, studies need to demonstrate that the associated expenditure translates into a reduced burden on health and social care services. Large scale RCTs are underway to address this,[57-59] but do not mention the involvement of pharmacists in screening programme delivery. Pharmacists embedded within primary care services (general practice or community pharmacy) could run opportunistic or systematic atrial fibrillation screening programmes.

Arguably, the interventions most suitably aligned to a pharmacist's skillset are those that focus on medication initiation, optimization and education. Pharmacist-led anticoagulant management services comprised of education,[18, 20, 27, 28, 33, 36, 37, 44] adverse event monitoring[19, 27, 29, 33, 35, 37, 39, 41, 44] and dose-adjustment[18, 20, 37, 44] were the most common interventions tested, as well as pharmacist identification of people with an atrial

fibrillation diagnosis recorded with no evidence of anticoagulant prescription.[22, 25, 38, 43, 45] Overall, pharmacist interventions increased OAC prescription rates in eligible patients, and improved the appropriateness of prescribing.

Studies that report on health outcomes require cautious interpretation because of low statistical power due to low event rates, with only one study adequately powered and adjusting for confounders.[39] Further refinement of pharmacist interventions to improve the quality of warfarin therapy is required; only three out of seven studies reported improvements in TTR above the recommended target >70%.[20, 30, 39, 60] The paucity of studies testing pharmacist interventions for atrial fibrillation symptom management may reflect the perceived competency of pharmacists in making prescribing interventions for rate and rhythm control therapies. A review of studies investigating pharmacist confidence and competency in prescribing concluded that whilst most pharmacists felt competent to prescribe, they lacked confidence.[61] Prescribing is a growing scope of practice for pharmacists, and in the UK reforms have been made to education and training so that individuals qualify as prescribers at the point of first registration as a pharmacist.[62] Interventional studies should adapt and move away from traditional physician-led prescribing models.

Pharmacist delivery of multifaceted interventions for atrial fibrillation that targeted two or more ABC pathway components relied on collaboration with GPs, cardiologists and electrophysiologists. This is similar to the core integrated atrial fibrillation care team outlined in the European Society of Cardiology guidelines.[60] Two multi-faceted interventional studies considered atrial fibrillation symptom management with

rate or rhythm-controlling therapies, but none reported patient-centred outcomes such as improved symptom management and quality of life. A patient-centred approach ought to be adopted in future interventional studies that aim to improve symptom management in atrial fibrillation.

Conclusions

In summary, pharmacists can help to operationalise different components of the 'CC to ABC' model for integrated atrial fibrillation care. Most of the available data considers individual ABC pathway components in isolation, particularly 'A – Anticoagulation/Avoid stroke'. As the scope of pharmacist practice continues to evolve and includes prescribing, it seems feasible for pharmacists to deliver all components of the ABC pathway across the healthcare continuum. Hospital pharmacists could perform targeted medication reviews for atrial fibrillation patients, optimizing therapies with cardiology input as needed and providing education. In primary care, pharmacists could lead screening programmes, check medication adherence, provide new medicine reviews, monitor for adverse effects, monitor blood pressure, blood glucose and cholesterol and reinforce key educational messages. Pharmacists are a potentially untapped resource in relation to integrated atrial fibrillation care, but the pharmacy service framework would need some re-structuring to support translation of these pharmacist interventions into everyday clinical practice.

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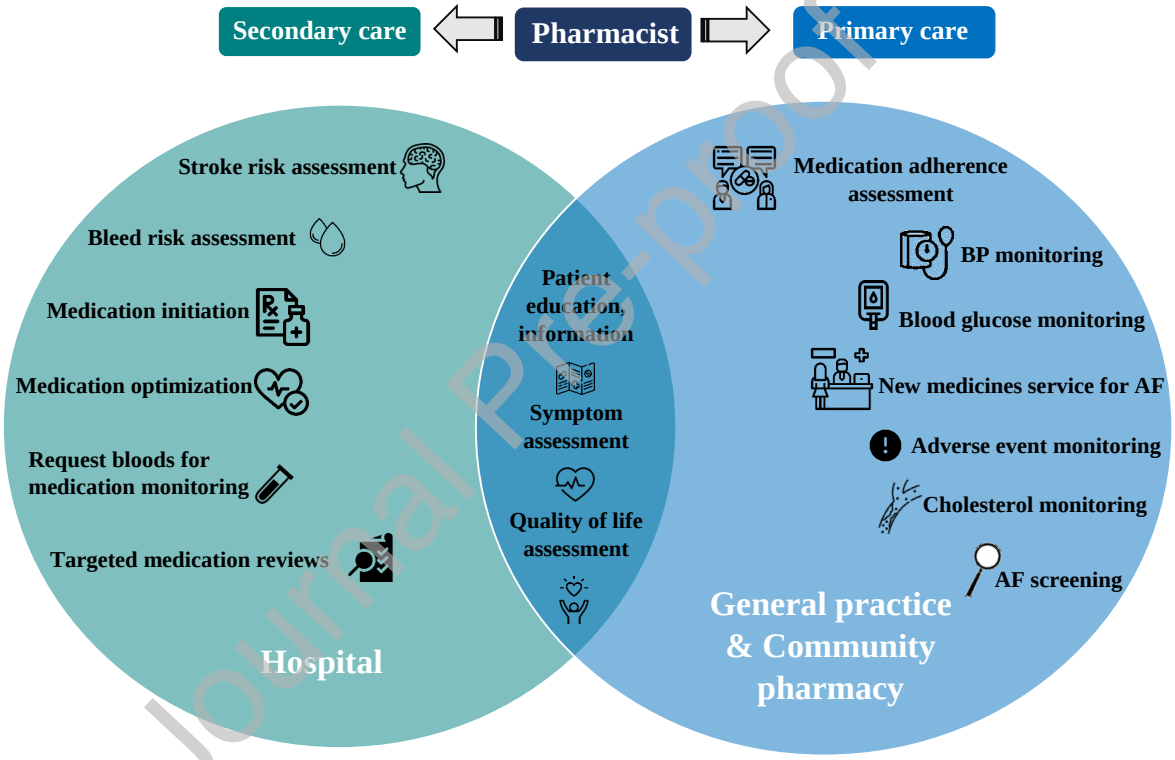
Figure 1. Roles pharmacists could adopt in the delivery of integrated atrial fibrillation care across the healthcare continuum – hospital, general practice and community pharmacy.



BP, blood pressure

Image source: Flaticon.com

Table 1. Characteristics of cross-sectional studies of pharmacist-led screening for atrial fibrillation.

Author (study name), year, country	Study setting (n)	[a]Sample size [b]Age (median [IQR], mean ± SD) [c]Proportion of females, n (%)	Description of screening intervention
Screening device: AliveCor KardiaMobile single-lead ECG			
Khanbhai (CAPTURE-AF), 2020, UK[4]	Community pharmacies (28)	[a]1737 [b]† (n=851 were >75 years) [c]846 (48.7%)	Pharmacist screening (ECG, atrial fibrillation screening tool), specialist team referral if possible atrial fibrillation
Savickas (PDAF), 2020, UK[5]	General practice (4)	[a]604 [b]73 [69-78] [c]346 (57.3%)	Pharmacist screening (pulse palpation, ECG), ECG over-read by cardiologist within 72 hours, irregularities reported to GP
Savickas, 2019, UK[6]	Care homes (4)	[a]53 [b]90 ± † [c]40 (76%)	Pharmacist screening (pulse palpation, ECG), ECG over-read by cardiologist within 72 hours, irregularities reported to GP
Zaprutko, 2020, Poland[7]	Community pharmacies (10)	[a]525 [b]73.72 ± 6.49 [c]358 (68.19%)	Pharmacist or student (with pharmacist supervision) screening (ECG only), ECG over-read by cardiologist within 48 hours, participants contacted if atrial fibrillation detected, advised to self-refer to GP
Anderson, 2020, USA[8]	Health fairs (13)	[a]697 [b]56 ± 15 [c]494 (71%)	Student pharmacist screening with pharmacist supervision (ECG, CHA_2DS_2-VASc), advised to seek follow-up with doctor if irregularities
Cunha, 2019, Portugal[9]	Community pharmacy (1), nursing home (1), hospital outpatient cardiology clinic (1)	[a]223 [b]66 ± 15 [c]131 (64%)	Pharmacist screening (brief medical history, pulse palpation, ECG), ECG over-read by cardiologist, if irregularities, advised to seek follow-up with doctor (community pharmacy), directly referred to physician (nursing home), or 12-lead ECG immediately reviewed by cardiologist (hospital outpatient cardiology clinic)
Hazelrigg, 2019, UK[11]	Public awareness campaign	[a]1144 [b]54.99 ± † [c]505 (44.1%)	Pharmacist and nurse screening (ECG, CHA_2DS_2-VASc), participant education, 12-lead ECG if irregularities with referral to GP
Twigg, 2016, UK[15]	Community pharmacies (6)	[c]594 [d]68.3 ± 8.9 [e]†	Pharmacist or pharmacy staff initial screening (brief medical history, alcohol consumption questionnaire [Audit-C], atrial fibrillation detecting BP monitor) and if possible atrial fibrillation, ECG obtained and over-read by cardiologist if atrial fibrillation detected again
Lowres (SEARCH-AF), 2015, Australia[16]	Community pharmacies (10)	[c]1000 [d]76 ± 7 [e]560 (56%)	Pharmacist screening (brief medical history, pulse palpation, ECG) and ECG over-read by cardiologist
Screening device: Microlife AFIB (Atrial fibrillation **-detecting BP monitor)**			

Bacchini, 2019, Italy[10]	Community pharmacies (74)	[a]3071 [b]73.7 ± 9.2 (screening positive), 66.4 ± 9.9 (screening negative) [c]1855 (60.4%)	Pharmacist screening and brief medical history, advised to seek follow-up with doctor or attend hospital if irregularities
Screening device: †			
Lobban, 2018, UK, Portugal, Spain, Canada, New Zealand, France, Hungary, Prague, Switzerland, Australia[12]	Community pharmacies (†)	[a]2573 [b]64.71 ± 12.95 [c]1773 (68.9%)	Pharmacist screening (pulse palpation, single-lead ECG where possible, symptom and risk factor assessment), referral to doctor if irregularities
Screening device: MyDiagnostick single-lead ECG			
Modesti (Elba-FA), 2017, Italy[13]	General practice (10), community pharmacies (10)	[a]1000 (target) [b]† [c]†	Pharmacist screening (brief medical history, ECG)
Screening device: HeartCheck CardioComm single-lead ECG			
Sandhu (PIAFF-Pharmacy), 2016, Canada [14]	Community pharmacies (30)	[a]1145 [b]77.2 ± 6.8 (unrecognised or undertreated atrial fibrillation), 74.6 ± 6.8 (no atrial fibrillation) [c]677 (59.1%)	Volunteer or research staff screening (brief medical history, ECG over-read by cardiologist, two automated BP readings [PharmaSmart], Canadian Diabetes Risk Assessment Questionnaire), participant education and opportunity to speak to pharmacist

BP, blood pressure; CAPTURE-AF, Community pharmacy led atrial fibrillation detection and referral service; CHA_2DS_2-VASc score, score of 1 point each for congestive heart failure, hypertension, female, age 65-74 years, diabetes mellitus, vascular disease and 2 points for previous stroke/transient ischaemic attack/thromboembolism and age ≥75 years; ECG, electrocardiogram; Elba-AF, screening of undiagnosed atrial fibrillation on the Isle of Elba; GP, General Practitioner; PDAF, Pharmacists detecting atrial fibrillation; PIAFF-Pharmacy, Program for the identification of "actionable" atrial fibrillation in the pharmacy setting; SEARCH-AF, Stroke prevention through community screening for atrial fibrillation using iPhone ECG in pharmacies

†not reported

Table 2. Characteristics of studies of pharmacist interventions for anticoagulation in atrial fibrillation.

Author (study name)[x], year, country	Study setting (n), study design	Intervention/control [a]Sample size [b]Age (median [IQR], or mean ± SD) [c]Proportion of females, n (%)	Description of intervention and control (where applicable)	Main outcomes of intervention
Quality of warfarin therapy (TTR)				
Wang, 2021, China[44]	Hospital (1), cohort study	[a]57/208 [b]67.1 ± 10.9/70.4 ± 9.5 [c]31 (54.4%)/116 (55.8%)	Physician-pharmacist atrial fibrillation warfarin clinic, joint determination of INR target, drug dosage, treatment course, date of next visit. Pharmacist delivered patient education, assessment of TTR and INR at follow-up, dose adjustments as needed vs. general clinic (control)	Significantly higher proportion of participants achieved a TTR ≥60% (intervention 73.7% vs. usual care 47.1%, p=0.002).
Marcatto[π], 2021, Brazil[37]	Hospital (1), cohort study	[a]262 [b]† [c]†	Pharmacist-led warfarin management for atrial fibrillation patients with TTR <50%, 12-week programme (education, dispensing, INR monitoring, dose adjustment, adherence/adverse event assessment). Pharmacist visits once weekly for 4 weeks, then according to INR monitoring. After week 12, medical team provide care without pharmacist presence	Significant difference in basal, 12-week and one year mean TTR within low-, medium- and high- warfarin adherence groups (low: 15.8% ± 17.4 vs. 35.9% ± 19.9 vs. 46.7% ± 20.8, p <0.001; medium: 11.7% ± 15.9 vs. 49.0% ± 23.5 vs. 51.7 ± 20.9, p <0.001; high: 13.7% ± 15.8 vs. 61.4% ± 21.5 vs. 60.8% ± 22.6, p<0.001).
Liang, 2019, China[36]	Hospital (1), randomised controlled trial	[a]77/75 [b]60.1 ± 16.3/62.5 ± 14.5 [c]36 (46.8%)/31 (41.3%)	Pharmacist-led warfarin education and follow-up service (two phone calls day 30 and 90 post-discharge) vs. usual care (control)	No significant difference in TTR (intervention 35.9% vs. usual care 29.5%, p=0.203)
Phelps, 2018, USA[39]	Non-profit integrated healthcare delivery system (1), before- and-after study	[a]4764/3641 [b]74.6 ± 10.1/73.9 ± 10.6 [c]2626 (55.1%)/1948 (53.5%)	Pharmacist-led AMS with efforts to improve warfarin therapy for atrial fibrillation patients, specifically TTR vs. pharmacist-led AMS before efforts were made to improve warfarin therapy (control)	Significantly higher TTR after efforts were made as part of the pharmacist-led AMS (70.5% vs. 63.4%, p <0.001)
Kose, 2018, Japan[30]	Hospital (1), cohort study	[a]16/23 [b]71.8 ± 2.2/ 72.3 ± 1.8 [c]7 (43.8%)/4 (17.4%)	Pharmacist and physician vs. physician only (control) guidance on warfarin treatment for atrial fibrillation patients with chronic kidney	TTR (defined as PT-INR 1.6-2.6) significantly higher in pharmacist and physician group vs. physician only group (76.8% ± 15.6 vs. 55.9% ± 25.1, p= 0.005)

			disease	
An, 2017, Japan[20]	Hospital (1), cohort study	[c]25/32 [d]70 [64-76.5]/72 [66.3-76.8] [e]13 (52%)/9 (28.1%)	Pharmacist (confirmation of drug-drug interactions, monitoring bleeding/PT-INR, dose adjustment recommendations, patient education - lifestyle precautions, warfarin-food interactions) and physician (oral instructions with lifestyle guidance generally omitted) management of atrial fibrillation patients with HF vs. physician only management (control)	TTR (defined as PT-INR 1.6-2.6) significantly higher in pharmacist and physician group vs. physician only group (73.8% [61.4-93.4] vs. 59.8% [44.2- 77.4], p=0.017)
Aidit, 2017, Malaysia[18]	Hospital (1), before- and-after study	[a]106/126 [b]66.11 ± 10.81 (all participants) [c]80 (53%) (all participants)	Pharmacist and physician-led WMTAC for atrial fibrillation patients. Pharmacists responsible for patient education/counselling and implementation of a treatment protocol, recommendations made for dose adjustments/continuation of warfarin therapy vs. physician-led WMTAC with referral to pharmacist only when necessary (control)	No significant difference in TTR between pharmacist and physician-led WMTAC vs. physician-led WMTAC (63.97% ± 19.41 vs, 59.25% ± 20.74, p=0.120)
Health outcomes				
Wang, 2021, China[44]	Hospital (1), cohort study	[a]57/208 [b]67.1 ± 10.9/70.4 ± 9.5 [c]31 (54.4%)/116 (55.8%)	See Wang 2021, *Quality of warfarin therapy (TTR)*	No significant difference in thromboembolic (intervention 5.3% vs. control 5.3%, *p*=1.000) or bleeding events (intervention 3.5% vs. control 4.3%, *p*=1.000)
Li, 2020, China[35]	Hospital (1), cohort study	[a]179/202 [b]76.3 ± 7.8/75.2 ± 7.1 [c]69 (38.5%)/80 (39.6%)	Remote pharmacist-led management of atrial fibrillation patients taking rivaroxaban. Education, drug administration and observation of drug interactions, weekly adverse event monitoring vs. usual care by cardiologists or primary care providers (control)	No significant difference in thrombosis, heart failure, left atrial dilation. Significant reduction in incidence of gastrointestinal bleeding (intervention 6.1% vs. control 12.4%, p=0.038), skin ecchymosis (intervention 0.6% vs. control 4.5%, p=0.018)
Jones, 2020, USA[27]	Academic Healthcare System (1), cohort study	[a]90/370 [b]68.9 ± 11/67.1 ± 12 [c]34 (37.8%)/141 (38.1%)	Pharmacist-led AMS for atrial fibrillation patients on NOACs. Initial patient education, phone calls (discuss stroke or bleeding concerns, adherence and provide reminders about required blood tests) or chart reviews vs. other providers - neurologists, cardiologists and primary care providers (control)	No significant difference in the composite endpoint of thromboembolism, bleeding, and all-cause mortality between intervention vs. control (HR 1.25, 95% CI 0.70–2.24)
Kirwan[∞],	Hospital	[a]177	Implementation of a pathway (SAFE)	65/73 (89%) participants reached 90 days follow-up, one

2020, Canada[29]	emergency departments (2), cohort study	[b]70 [61-78] [c]92 (52%)	developed by pharmacists and physicians for patients with new atrial fibrillationdiagnoses (step 1: assessment of contraindications to OAC; step 2: stroke risk assessment with CHADS65; step 3: OAC dosing if indicated). Pathway triggered referral to atrial fibrillation clinic, letter for family physician and follow-up call from pharmacist	report of gastrointestinal bleeding in participant taking OAC, and one report of stroke in participant who refused OAC
Phelps, 2018, USA[39]	Non-profit integrated healthcare delivery system (1), before- and-after study	[a]4764/3641 [b]74.6 ± 10.1/73.9 ± 10.6 [c]2626 (55.1%)/1948 (53.5%)	See Phelps 2018, *Quality of warfarin therapy (TTR)*	Significantly lower odds of the composite endpoint of clinically-relevant bleeding, thromboembolism and all-cause mortality associated with pharmacist-led anticoagulant management (adjusted OR 0.69, 95% CI 0.54-0.87)
An, 2017, USA[19]	Non-profit, integrated healthcare delivery organisation (1), comprised of hospitals (14), outpatient facilities (>200), and a centralised laboratory (1), cohort study	[a]32074 [b]72.2 ± 10.7 [c]13645 (42.5%)	Pharmacist-led anticoagulation clinic for atrial fibrillation patients on warfarin (approximately weekly for first three months of treatment and every three weeks after six months). Pharmacists responsible for monitoring, dose adjustment and reversal, triage of related adverse events, drug interaction interventions, telephone counselling	No significant difference in stroke or systemic embolism event rates between patients with TTR <65% who received frequent pharmacist interventions (≥24 times per year) and patients with TTR <65% who received less frequent interventions (1.88 vs. 1.54 per 100 person-years, respectively, p=0.780)
Lee, 2013, USA[33]	Outpatient clinic (1), before- and-after study	[a]20/48[*] [b]78 [72–83]/72 [67–81] [c]0 (0%)/1 (2%)	Pharmacist anticoagulation clinic for dabigatran (patient education on adherence, tolerance issues, storage and refill at initial consultation). Follow-up at two weeks, one month and three months vs. usual care (control)	No significant difference in frequency of minor (p=0.148) or major bleeding events (p=0.516) between pharmacist anticoagulation clinic for dabigatran and usual care
OAC prescribing				
Sandhu[~] (PIAAF Rx), study ongoing, Canada[62]	Community pharmacy (†), randomised controlled trial	[a]370 (estimate) [b]† [c]†	Community pharmacist initiates/adjusts OAC therapy in atrial fibrillation patients vs. enhanced usual care -community pharmacist refers atrial fibrillation patients to physician for OAC therapy (control)	Proportion of participants receiving optimal OAC therapy (pending, study ongoing)

Brouillette[∞], 2021, Canada[46]	Multidisciplinary heart failure clinic (1), general outpatient clinic (1), cohort study	[a]307 [b]† [c]†	MDT follow-up of cardiologists, nurses and pharmacists for atrial fibrillation patients vs. cardiologist-only follow-up (control)	Inappropriate anticoagulant use less likely with MDT follow-up (8% vs. 22%). Prescription of VKA in NOAC-eligible patients and incorrect NOAC dosing were the most common reasons for inappropriate use
Khalil, 2021, Australia[28]	Hospital (1), before- and-after study	[a]65/61 [b]72.78 ± † (males), 75.03 ± † (females)/75.30 ± † (males), 74.60 ± † (females) [c]29 (44.6%)/30 (49.1%)	One-to-one education with pharmacist during admission new atrial fibrillation patients, provision of atrial fibrillation brochure to promote shared decision making about OAC therapy vs. usual care provided pre-intervention (control)	Significant improvement in the appropriateness of OAC therapy (intervention 92% vs. control 36%, p <0.001)
Schwab, 2021, USA[40]	Hospital (1), cohort study	[a]146/99 [b]73.6 ± 14.7/75.2 ± 12.6 [c]77 (52.7%)/51 (51.5%)	Emergency physicians, pharmacists and electrophysiologists collaborating in shared decision-making model; emergency physician identifies atrial fibrillation patients using ECG, referral to electrophysiologist when atrial fibrillation confirmed, pharmacist determines appropriate OAC, provides medication, arranges post-discharge clinic with electrophysiologist/ cardiologist vs. usual care (control)	Significant increase in proportion of atrial fibrillation patients discharged on OAC (87.8% intervention vs. 62.3% control, P ≤0.001)
Wang[§], 2019, USA[45]	AMS clinics (14), randomised controlled trial	[a]1727[§] [b]† [c]†	Pharmacist assessment of appropriateness of initiating OAC in atrial fibrillation patients identified with CHA_2DS_2-VASc score ≥2 and no OAC prescription within 12 months, escalation to primary care provider as needed vs. usual care (control)	432/1727 (25%) participants potentially eligible for OAC. After pharmacist screening, 75/432 (17%) escalated to the primary care provider. No significant increase in proportion of OAC prescriptions (intervention 4.1% vs. control 4.0%, p=0.860)
Mensah[∞], 2019, USA[38]	†, cohort study	[a]489 [b]† [c]†	Pharmacist review of patient records to confirm documentation supporting absence of OAC in patients with atrial fibrillation /atrial flutter. Pharmacist contact with physician to request review to initiate OAC or document reason for no treatment	349/489 (71.4%) patients had warfarin initiated or clear documentation to explain reason for the absence of OAC therapy after pharmacist review
Leef, 2019, USA[34]	Veterans Health Administration (1), cohort study	[a]5060 [b]69 ± 10 [c]96 (1.9%)	AMS for new atrial fibrillation patients started on NOACs, generally led by pharmacists	Improvement in correct NOAC dosing when compared to other fee-for-service non-integrated systems. 4735/5060 (93.6%) new atrial fibrillation patients prescribed rivaroxaban or dabigatran at the correct dose, 86/5060

				(1.7%) overdosed and 239/5060 (4.7%) under-dosed
Durand[∞], 2018, UK[25]	General practices (20), before- and-after study	[a]501 [b]† [c]†	Pharmacist identification of atrial fibrillation patients not on OAC or on antiplatelet monotherapy using patient records and APL-AF software, review of medical records to confirm atrial fibrillation diagnosis, blood results and patient characteristics with initiation of OAC therapy (warfarin or NOACs) when indicated vs. usual care provided pre-intervention (control)	Significant increase in proportion of atrial fibrillation patients prescribed OAC from 62% to 80%, p <0.001
Brown[∞], 2017, UK[22]	Outpatient clinics (†), before- and-after study	[a]† [b]† [c]†	Pharmacist-led virtual clinics with GPs to identify atrial fibrillation patients with a CHA_2DS_2VASc score ≥2 not anticoagulated vs. usual care provided pre-intervention (control)	Increased prescription of anticoagulation for atrial fibrillation patients in two CCGs from 73% (pre-intervention) to 83% (post-intervention), and from 72% to 78%
Virdee, 2017, UK[43]	General Practices (15), cross-sectional study	[a]497 [b]75.5 ± 11.9 [c]206 (41.4%)	Pharmacist treatment recommendations made to GP for atrial fibrillation patients with CHA_2DS_2-VASc score ≥1/≥2 (male/female) and no anticoagulant prescription	202/497 participants (40.6%) suitable for anticoagulation, 103/202 (51%) commenced on anticoagulant (76/202 refused, 16/202 failed to attend, 7 commenced treatment in secondary care), 85/103 (83%) switched from antiplatelet to anticoagulant
Dowling, 2016, UK[24]	Outpatient clinic (1), cohort study	[a]87 [b]76.9 ± † [c]46 (52.9%)	Pharmacist-led anticoagulant review clinic (weekly, four-hour clinic for six months) targeted at atrial fibrillation patients on VKA with TTR <65%	65/87 (74.7%) switched from VKA to NOAC, 63/87 continued on NOAC at two-week follow-up, 1/87 had VKA discontinued (haemorrhagic risk outweighed benefit), 21/87 (24.1%) remained on VKA
Larock, 2014, Belgium[31]	Hospital (1), cross-sectional study	[a]69 [b]74 [45-89] [c]26 (38%)	Pharmacist assessment of dabigatran and rivaroxaban prescribing using Medication Appropriateness Index tool adapted for NOAC prescribing with recommendations made to physicians	34/69 (49%) inappropriate criteria for treatment, 48 pharmacist interventions, 94% accepted by physicians
Jackson, 2011, Australia[26]	Hospital (1), before- and-after study	[a]134/394 [b]79 ± †/75 ± † [c]84 (63%)/180 (45%)	Pharmacist stroke risk assessment in atrial fibrillation patients, antithrombotic therapy recommendations to physicians vs. usual care provided pre-intervention (control)	Significant increase in warfarin use from 43% to 58% p=0.050, significant decrease in aspirin use from 48% to 39%, p=0.040 from admission to discharge in intervention group, no significant change in antithrombotic use from admission to discharge in usual care
Touchette, 2007, USA[42]	Hospital (1), before- and-after study	[a]154/98 [b]79.7 ± 10.2/77.8 ± 10.1 [c]76 (49.4%)/57 (58.2%)	Pharmacist review of antithrombotic prescribing in atrial fibrillation patients, assessment of bleeding risk factors, interacting medicines, direct patient	No significant difference in antithrombotic use (70.8% intervention vs. 67.3% control, p=0.580), significant difference in proportion of patients with antithrombotic discharge plan (88.3% intervention vs. 73.5% control, P

			interview, treatment recommendations made to physicians vs. usual care provided pre-intervention (control)	<0.01), significantly higher odds of planned or actual warfarin use with intervention (aOR 2.46, 95% CI 1.63-3.74)
Bajorek, 2005, Australia[21]	Hospital (1), cohort study	[a]218 [b]85.2 ± 6.2 [c]133 (61%)	Pharmacist identification of atrial fibrillation patients, consultation with patients, caregivers and MDT to obtain information for application of evidence-based algorithm to determine appropriate antithrombotic, discussion with clinical team at ward rounds/case conferences before final treatment decisions made	78/218 (35.8%) had changes made to antithrombotic prescribed pre-intervention (at admission); 60/78 (76.9%) treatment upgrade (no therapy/antiplatelet to anticoagulant), significant overall increase in antithrombotic use pre-intervention vs. post-intervention (at discharge), 59.6% vs 81.2%, p <0.001
Burkiewicz, 2004, USA[23]	Outpatient clinics (2), cohort	[a]131/47 [b]71.7 ± 11.3/74.7 ± 11.5 [c]66 (50.4%)/24 (51.1%)	Ambulatory care clinic (delivered by cardiologists and primary care physicians) for atrial fibrillation patients with access to a pharmacist-staffed AMS vs. ambulatory care clinic without access (control)	Significant difference in warfarin use between clinic with access to pharmacist-staffed AMS vs. clinic without access (77.9% vs. 61.7%, p=0.030), access to pharmacist-staffed AMS was an independent predictor of warfarin use (adjusted OR 2.19, 95% CI 1.05-4.56)
Medication adherence, knowledge and patient satisfaction				
Khalil, 2021, Australia[28]	Hospital (1), before- and-after study	[a]65/61 [b]72.78 ± † (males), 75.03 ± † (females)/75.30 ± † (males), 74.60 ± † (females) [c]29 (44.6%)/30 (49.1%)	See Khalil 2021, *OAC prescribing*	Significant improvement in patient satisfaction measured using a standard satisfaction survey based on a Likert scale (intervention 68% vs. control 25%, p <0.001)
Sun, 2021, China[17]	Hospital (1), randomised controlled trial	[a]100/99 [b]75.9 ± 9.0/75.8 ± 9.1 [c]45 (45%)/46 (46.5%)	Pharmacist implementation of evidence-based pharmaceutical care model. Pharmacists consider patients' preferences, search and evaluate literature, provide objective suggestions to hospitalised atrial fibrillation patients taking rivaroxaban vs. implementation of a general pharmaceutical care model (control)	Satisfaction (14.6 ± 0.9 vs.13.8 ± 1.0, p <0.01) and cognition scores (22.6 ±2.2 vs 20.8 ± 3.0, p <0.01) measured using a questionnaire designed by the researchers significantly higher in patients in intervention group
Leblanc[∞], 2017, Canada[32]	†, cohort study	[a]338 [b]† [c]†	Pharmacist delivered education and counselling to atrial fibrillation patients taking NOACs	Increased patient knowledge (assessed using five questions) of atrial fibrillation and NOAC use from 3.7/5 (baseline) to 4.3/5 (4 month follow-up), increased

				medication adherence from 93% (baseline) to 98% (4 month follow-up), P <0.001
Shore, 2015, USA[41]	Veterans Health Administration sites (67), mixed-method study	[a]4863 [b]†** [c]†**	Pharmacist review of dabigatran prescriptions for atrial fibrillation patients, patient education, adverse event and adherence monitoring	Pharmacist patient education had no effect on dabigatran adherence (adjusted RR 0.94, 95% CI 0.83-1.06), significant association between pharmacist-led monitoring on dabigatran adherence (adjusted RR 1.25, 95% CI 1.11–1.41)
Lee, 2013, USA[33]	Outpatient clinic (1), before- and-after study	[a]20/48* [b]78 [72–83]/72 [67–81] [c]0 (0%)/1 (2%)	See Lee 2013, *Health otucomes*	No effect on mean medication possession ratio (intervention 93.1% vs. control 88.3%), no effect on the proportion of participants achieving a medication possession ratio ≥80% (intervention 25% vs. usual care 10%, p=0.160)

AMS, anticoagulant management service; APL-AF, Active Patient Link – Atrial Fibrillation; CCG, clinical commissioning group; CHADS65 score, Canadian algorithm which recommends anticoagulation for most people aged 65 years old and for younger patients with congestive heart failure, hypertension, age, diabetes, stroke/transient ischemic attack score of 1; CHA_2DS_2-VASc score, score of 1 point each for congestive heart failure, hypertension, female, age 65-74 years, diabetes mellitus, vascular disease and 2 points for previous stroke/transient ischaemic attack/thromboembolism and age ≥75 years; CI, confidence interval; ECG, electrocardiogram; GP, general practitioner; HF, heart failure; HR, hazard ratio; MDT, multidisciplinary team; NOAC, non-vitamin K antagonist oral anticoagulant; OAC, oral anticoagulant; OR, odds ratio; PIAAF-RX, The Improving Stroke Prevention in Atrial Fibrillation Through Pharmacist Prescribing study; PT-INR, prothrombin time – international normalised ratio; RR, relative risk; TTR, time in therapeutic range; VKA, vitamin K antagonist; WMTAC, warfarin medication therapy adherence clinic

Table 3. Characteristics of cohort studies implementing pharmacist-led symptom management interventions for atrial fibrillation.

Author (study name), year, country	**Study setting (n)**	**Intervention/control** **[a]Sample size** **[b]Age (median [IQR], or mean ± SD)** **[c]Proportion of females, n (%)**	**Description of intervention and control (where applicable)**	**Main outcomes of intervention**
Labreck[∞], 2021, USA[49]	Antiarrhythmic clinic (1)	[a]12/9 [b]† [c]3 (25%)/4 (44.5%)	Pharmacy-led outpatient clinic using the AliveCor Kardia Mobile ECG to deliver sotalol loading (electrophysiologist oversight) vs. inpatient sotalol loading (control)	Inpatients administered 120mg twice daily, 88.3% outpatients received this dose (three received different doses at electrophysiologist discretion (n=2), or because of prolonged baseline QT interval (n=1)
Finks, 2011, USA[48]	Hospital (1)	[a]36 [b]75 ± 8.9 dose appropriate or accepted dose adjustment, 78 ± 7.6 partial dose adjustment or no adjustment [c]†	Pharmacist assessment of sotalol prescribing for atrial fibrillation patients according to renal function, physician prescribing recommendations made when appropriate	Pharmacist recommendation of drug discontinuation/ dose amendment in 32/36, accepted for 12/32 (appropriate therapy) but not for 20/32 (inappropriate therapy), no effect on all-cause hospital re-admission rates at six months for patients on appropriate therapy (31% vs. 55%, p=0.095)

ECG, electrocardiogram

[∞]available as abstract only
†not reported

Table 4. Characteristics of studies of pharmacist-led educational or multi-faceted interventions covering two or more components of the ABC pathway for atrial fibrillation.

Author (study name), year, country	Study setting, (n), study design	Intervention/control [a]Sample size [b]Age (median [IQR], or mean ± SD) [c]Proportion of females, n (%)	Description of intervention and control (where applicable)	Main outcomes of intervention
Multi-faceted interventions covering two or more components of the ABC pathway				
Chahal, 2019, UK[50]	General practices (43), before- and- after study	[a]310972 (2016/17)/320422 (2017/18) [b]† [c]†	Pharmacist identification of atrial fibrillation patients potentially eligible for anticoagulation using patient records and APL-AF software, patient invitation to GP-pharmacist consultation with anticoagulant initiation, optimization of BP/lipid therapy where appropriate, discussion of complex patients at weekly MDT (cardiologist, haematologist, GP with specialist interest in cardiology, GP co-ordinator and pharmacist) vs. usual care provided pre-intervention between April 2016/17 (control)	Significant increase in proportion of atrial fibrillation patients prescribed anticoagulation from 2016/17 to 2017/18 (77% to 83%, p <0.0001), non-significant increase in use of statins (66.8% to 68.1%), but significant increase in serum cholesterol reported as <5mmol/L (64.2% to 68%, p=0.012), no significant difference in proportion of patients with blood pressure ≥140/90mmHg (2.9% to 3.2%)
Gauci, 2019, Malta[51]	Hospital (1), before- and- after study	[a]150/150 [b]82.7 ± 6.4/81.7 ± 7.6 [c]106 (70.7%)/96 (64%)	Pharmacist implementation of MAT-AF to assess appropriateness of antithrombotic, rate and rhythm therapy for atrial fibrillation patients vs. usual care provided pre-intervention (control)	Significantly higher odds of prescription of oral anticoagulants (OR 4.07, 95% CI 2.12-7.82, p <0.001), rate-control (OR 3.92, 95% CI 1.06-14.54, P=0.041), digoxin monitoring (OR 10.40, 95% CI 3.59-30.10, P <0.001), referral of patients on anti-arrhythmic drugs not in sinus rhythm to cardiology (OR 8.00, 95% CI 1.13-56.79, P=0.038)
Gehi, 2018, USA[52]	Hospital (1), before- and- after study	[a]98/100 [b]68.5 ± 14.2 (all participants) [c]†	Pharmacist-led atrial fibrillation clinic (cardiologist/electrophysiologist supervision) for patient follow up post-ED discharge after an atrial fibrillation-related admission, pharmacist delivery of protocol for atrial fibrillation care including rate-control and stroke prevention, risk factor assessment and modification, education, coordination of care	Significantly higher odds of discharge from ED (OR 4.20, 95% CI 1.90-9.80) but had no significant difference on hospital length of stay in the event of repeat ED presentations (pre-intervention 3.0 ± 4.6 days vs. post-intervention 2.5 ± 4.4

			across teams in primary care and ED vs. usual care provided pre-intervention (control)	days, p=0.560)
Educational-based interventions				
Dorian, 2020, Canada[54]	Hospital emergency departments (3), cohort study	[a]212 [b]65 ± † [c]95 (45%)	Implementation of nurse practitioner and pharmacist-centred follow-up programme (AF-QCP) for atrial fibrillation patients discharged from hospital. Tailored patient education, support for self-management, atrial fibrillation care plan for primary care providers, support from cardiologists and internists vs. usual care provided pre-intervention (control)	No difference in repeat ED visits or hospital admissions over 12 months between patients on AF-QCP follow-up programme compared to historic controls
Marvanova, 2019, USA[53]	Faith-based institutions (4), before-and- after study	[a]97 [b]75.0 ± 13.7 [c]69 (71.1%)	Pharmacist-led education (70 minute event; baseline assessment of stroke knowledge, study questionnaire, BP and HR readings, presentation, question-and-answer session, post-education questionnaire) for community-dwelling adults	Participants self-reporting atrial fibrillation (n=6) identified atrial fibrillation management as a modifiable stroke-risk factor after pharmacist-led education (none identified it before educational session)
Tran, 2013, USA[55]	Hospital (1), cohort study	[a]71 [b]71.7 ± 9.54 clinic patient non-hospitalised with atrial fibrillation , 72 ± 11.8 clinic patient hospitalised with atrial fibrillation [c]22 (31.1%)	MDT atrial fibrillation clinic led by pharmacists and electrophysiologists to evaluate and implement individualised treatment plans and provide patient education, medication management and follow-up	17/71 (23.9%) clinic patients hospitalised and 2/17 (11.7%) had an ischaemic stroke, reduction in hospital admission rate within one year when compared to reported national admission rates occurring within six months (23.9% vs. 65.8%), study ischaemic stroke rate (2.82%) lower than rates reported in the literature (23.50%)

ABC, Atrial Fibrillation Better Care pathway; AF-QCP, Atrial Fibrillation Quality Care Programme; APL-AF, Active Patient Link – Atrial Fibrillation; BP, blood pressure; CI, confidence interval; ED, emergency department; GP, General Practitioner; HR, heart rate; MAT-AF, medication assessment tool for AF; MDT, multidisciplinary team; OR, odds ratio

†not reported

Graphical Abstract

Integrated atrial fibrillation care:	Pharmacist intervention aimed to:	Evidence:	Studies (n):
C - Confirm atrial fibrillation	Screen for atrial fibrillation	🟡	12
A – Anticoagulation/Avoid stroke	Improve TTR	🟢	5
		🔴	2
	Improve health outcomes	🟢	2
		🔴	4
		⚫	1
	Improve OAC prescribing	🟢	1
		⚫	4
	Increase OAC prescription	🟢	8
		🔴	1
		⚫	3
	Increase adherence	🟢	1
		🔴	2
	Improve satisfaction	🟢	2
	Improve knowledge	⚫	1
B - Better symptom control	Increase prescription of rate control	🟢	1
	Improve sotalol prescribing	⚫	1
	Deliver outpatient sotalol loading	🟡	1
C – Cardiovascular comorbidities	Improve blood pressure control	🔴	1
	Reduce serum cholesterol	🟢	1

🔴 No association
🟡 Supporting feasibility evidence
🟢 Evidence of positive association
⚫ No statistical analysis presented

Summary of pharmacist-led interventional studies for atrial fibrillation, mapped to relevant components of an integrated care model - the Atrial Fibrillation Better Care (ABC) Pathway.

ABC, Atrial Fibrillation Better Care; CV, cardiovascular; OAC, oral anticoagulant; TTR, time in therapeutic range

Image source: Flaticon.com