SUPPORT-AF II: Supporting Use of Anticoagulants Through Provider Profiling of Oral Anticoagulant Therapy for Atrial Fibrillation

A Cluster-Randomized Study of Electronic Profiling and Messaging Combined With Academic Detailing for Providers Making Decisions About Anticoagulation in Patients With Atrial Fibrillation

BACKGROUND: Previous provider-directed electronic messaging interventions have not by themselves improved anticoagulation use in patients with atrial fibrillation. Direct engagement with providers using academic detailing coupled with electronic messaging may overcome the limitations of the prior interventions.

METHODS AND RESULTS: We randomized outpatient providers affiliated with our health system in a 2.5:1 ratio to our electronic profiling/messaging combined with academic detailing intervention. In the intervention, we emailed providers monthly reports of their anticoagulation percentage relative to peers for atrial fibrillation patients with elevated stroke risk (CHA2DS2-VASc ≥2). We also sent electronic medical record-based messages shortly before an appointment with an anticoagulation-eligible but untreated atrial fibrillation patient. Providers had the option to send responses with explanations for prescribing decisions. We also offered to meet with intervention providers using an academic detailing approach developed based on knowledge gaps discussed in provider focus groups. To assess feasibility, we tracked provider review of our messages. To assess effectiveness, we measured the change in anticoagulation for patients of intervention providers relative to controls. We identified 85 intervention and 34 control providers taking care of 3591 and 1908 patients, respectively; 33 intervention providers participated in academic detailing. More than 80% of intervention providers read our emails, and 98% of the time a provider reviewed our in-basket messages. Replies to messages identified patient refusal as the most common reason for patients not being on anticoagulation (11.2%). For the group of patients not on anticoagulation at baseline assigned to an intervention versus control provider, the adjusted percent increase in the use of anticoagulation over 6 months was 5.2% versus 7.4%, respectively (P=0.21).

CONCLUSIONS: Our electronic messaging and academic detailing intervention was feasible but did not increase anticoagulation use. Patient-directed interventions or provider interventions targeting patients declining anticoagulation may be necessary to raise the rate of anticoagulation.

CLINICAL TRIAL REGISTRATION: URL: http://www.clinicaltrials.gov. Unique identifier: NCT03583008.
Atrial fibrillation (AF) currently affects >5 million Americans, with 12 million projected by 2050.1,2 The disease accounts for 15% of all ischemic strokes and results in permanent disability in 60% of patients and death in up to 20%.3,4 The main approach to prevention of stroke is anticoagulation therapy. However, only about half of eligible patients receive anticoagulation, constituting a large treatment gap and significant public health concern.5

Knowing when to prescribe anticoagulation and when to discontinue it remains a struggle for health care providers who treat patients with AF. Professional society guidelines6,7 advise providers about anticoagulation, recommending its initiation for those patients with a stroke risk CHA2DS2-VASc score of ≥2, irrespective of bleeding risk. Complications from anticoagulation, particularly in older, frail patients and perceived excessive bleeding risk are the primary reasons for not prescribing anticoagulation, but data show that physicians often over-estimate risks of bleeding and falling and underestimate risks of stroke.5 These concerns, as well as uncertainty about the stroke risk associated with brief duration AF episodes or AF occurring in the context of a concomitant surgery or medical illness, may contribute to the anticoagulation treatment gap observed in many observational studies of AF.

Traditional educational methods, such as continuing medical education and dissemination of treatment guidelines, have not proven effective in reducing the anticoagulation treatment gap.8 Studies have shown that giving providers detailed information about their practice patterns, that is—profiling, may be a more effective way to change prescribing behaviors and improve adherence to guidelines.8 We previously assessed the feasibility and effectiveness of a multi-component, profiling intervention to improve anticoagulation guideline adherence, including sending ambulatory care providers electronic medical record (EMR)-based messages to notify them of an upcoming appointment with an eligible patient with AF not on anticoagulation.9 Whereas we found that that intervention was feasible, we did not see an improvement in anticoagulation prescription, suggesting that profiling with messaging alone was insufficient to affect change in prescribing practices. Academic detailing, the process by which a clinical educator trained in the techniques of social marketing meets with a provider one-on-one to discuss medical evidence and recommend specific changes to improve patient care and outcomes, is an alternative method of delivering education to providers. Academic detailing has been shown to be more successful than traditional didactic methods in multiple randomized controlled trials.8,10,11

We hypothesized that adding academic detailing to our prior intervention would increase overall rates of anticoagulation use for untreated AF among providers within our health system. To develop educational content for the academic detailing intervention, we first conducted focus groups with cardiology and primary care providers to find knowledge gaps about anticoagulation use. Then, we conducted a cluster-randomized trial examining the feasibility and effectiveness of an electronic profiling and alert program combined with academic detailing for supporting providers making decisions about anticoagulation with their patients with AF.

**WHAT IS KNOWN**

- Only half of patients with atrial fibrillation eligible for anticoagulation are receiving anticoagulation.
- Previous provider-directed electronic messaging interventions to fill the gap in use of anticoagulation have not by themselves improved anticoagulation use.

**WHAT THE STUDY ADDS**

- Academic detailing coupled with electronic messaging is a novel intervention not previously tested to address the treatment gap for anticoagulation in patients with atrial fibrillation.
- The combined intervention was able to raise provider comfort in prescribing anticoagulation in a clinical vignette describing a patient who had fallen 3 times in the past 6 months.
- The finding from this study that patient refusal was the most common reason for a patient not being on anticoagulation suggests potential areas for future research including a provider directed intervention targeting patients that have refused anticoagulation or an intervention directly engaging these patients.

**METHODS**

The data that support the findings of this study are available from the corresponding author on reasonable request.

**Setting**

The UMass-Memorial Medical Center is the largest not-for-profit health care system in Central Massachusetts with 1600 physicians, 13500 employees, and a large ambulatory service footprint with an effective catchment area of nearly 1 million individuals. The UMass-Memorial Medical Center used the Epic Systems EMR12 during the period under study. The EMR captures visit dates and list of problems associated with International Classification of Diseases based diagnostic codes. Providers documented and prescribed medication including anticoagulation through the same EMR.

**Inclusion Criteria for Providers**

Using the repository of patients associated with our EMR, we identified providers taking care of at least 5 patients with AF.
with a CHA\textsubscript{2}DS\textsubscript{2}-VASc score $\geq 2$ and not currently on anticoagulation using the EMR repository. We selected this criterion based on the belief that these providers would provide the greatest potential for improving the population-level anticoagulation percentage should our intervention be effective. We included all qualifying providers after allowing them an opportunity to opt-out based on an email sent to them as permitted by our Institutional Review Board.

**Inclusion Criteria for Patients**

We identified patients with AF and then restricted our sample to those with a CHA\textsubscript{2}DS\textsubscript{2}-VASc score of $\geq 2$ based on age and *International Classification of Diseases* codes available in our EMR after a protocol we previously validated (Appendix A in the Data Supplement for diagnostic codes). In the United States, healthcare providers use *International Classification of Diseases* diagnosis codes to bill insurance companies and patients directly for services rendered including anticoagulation management. Similarly, pharmacies bill insurance companies for anticoagulant medications dispensed to patients.

To be included in our study, patients with AF had to have at least one ambulatory visit in the prior 12 months with either a cardiology or primary care provider (PCP) from participating providers as described further below. To validate the above identification process, we randomly selected and reviewed 100 charts of the 5475 patients identified electronically at baseline. This process confirmed that only 2% of the time (ie, 98% specificity) electronic capture misspecified a patient’s AF diagnosis (*International Classification of Diseases* code is on the patient’s record, but chart review of provider progress notes did not confirm the diagnosis). It also confirmed that in no case (100% specificity) did our electronic algorithm misidentify a patient as having a CHA\textsubscript{2}DS\textsubscript{2}-VASc score of 2+ (ie, when it was really $<2$). The final part of the chart review assessed the accuracy of the patient anticoagulation status and found a sensitivity of 99% and specificity of 90%. Chart review included a review of medication records, International Normalized Ratio labs, and provider progress notes. To establish the generalizability of our hundred patient validation sample, we compared patients in the validation set with the remaining patients on CHA\textsubscript{2}DS\textsubscript{2}-VASc score, anticoagulation status, and other key variables identified through electronic capture.

**Patient Assignment to Provider**

We assigned patients with AF to a cardiology provider (either nurse practitioner or physician) if the patient had such a visit in the past 12 months. This followed our prior protocol which assumed that the patient’s PCP would likely defer decision-making regarding anticoagulation to a cardiology provider if the latter had seen the patient in the past 12 months. For all other patients with AF a PCP, we assigned the patient to the PCP. For patients seeing cardiology providers outside of our medical group, we also assigned the patient to his/her PCP given our inability to electronically message and profile outside providers.

Similar to our prior protocol, we permitted reassignment of patients to alternate providers for the purpose of targeting the most current provider. This included scenarios in which a patient initially assigned to his or her PCP visits a cardiology provider. We also permitted providers to report errors in assignment of a patient. If confirmed after our own review, we reassigned these patients to the correct provider in subsequent emails sent to providers. We continued to follow all providers randomized regardless of whether they contributed patients to the baseline cohort after reassignment. This included sending them in basket messages if a patient not eligible at baseline became eligible during the course of the intervention. It also included requesting them to participate in academic detailing and responding to all surveys.

**Determining Anticoagulation Status**

We determined each patient’s anticoagulation status at baseline and then again at the end of follow-up based on medication records available in the EMR. We considered a patient as receiving anticoagulation if the EMR indicated that he or she had an active prescription, irrespective of dose, for any vitamin K antagonist, enoxaparin, dalteparin, dabigatran, rivaroxaban, apixaban, or edoxaban. We did not exclude medication regimens with lower total daily doses more consistent with prophylaxis for venous thromboembolism so as to avoid flagging a provider for patient actually on anticoagulation even if dose appeared to be too low. The chart reviews we conducted allowed us to weigh the significance of this decision. We also examined lab values from the past 365 days to ascertain if a patient had evidence of warfarin use; specifically, we labeled a patient as a warfarin user if they had an value of $\geq 1.5$. As mentioned earlier, we validated anticoagulation status at baseline and found that electronic capture was very accurate.

**Randomization**

As our intervention was provider-directed, we used a cluster randomized design. More specifically, our study statistician generated the random allocation sequence using Statistical Analysis Software (SAS) in a 2:5 to 1 intervention: control allocation, stratified by provider type (cardiology or PCP). We randomized more patients to intervention because we believed that many providers would not end up meeting with us, and we wanted to ensure sufficient participation in the one-on-one, academic detailing part of our intervention. In the analysis section, we discuss the statistical power implications of this decision.

**Intervention Protocol**

**Electronic Profiling—Dashboard and Email With Screenshot of Dashboard**

We designed a dashboard and graphical report that tracked providers’ prescription of anticoagulation over time using the secure Amazon Web Services cloud-based computing platform. More specifically, we created these reports based on data in the EMR to profile anticoagulation prescription percentages for each provider included in our intervention group. We then designed our dashboard to include both aggregate panel level and patient-level information. We plotted a bar graph with the percentage of patients in the provider’s panel currently receiving anticoagulation (Figure 1A). We also superimposed 2 lines representing benchmarks on the bar graph to enhance impact and help providers assess their prescription rate. The first line showed the percentage of anticoagulation prescribed
Figure 1. A. Example of anticoagulation (AC) prescription rate reports sent to intervention providers caring for AC-eligible atrial fibrillation (AF) patients with CHA2DS2-VASc ≥2. Bar graph with provider AC rate (red if lower compared with peer rate, yellow if between peer rate and goal rate, green if above goal rate). B. Example of lower half of report with individual patient CHA2DS2-VASc score, 5-year stroke risk, and upcoming appointment information.

Electronic Messaging
We sent standardized EMR-based messages, called in-basket messages in Epic Systems, from a user account created for our study team to individual providers 1 week and then again 1 day before a scheduled appointment with an anticoagulation-eligible patient with AF. We linked the EMR message to the AF patient’s medical record. This facilitated review of patient charts by providers as well as providing a format for providers to communicate back with our team (Appendix B in the Data Supplement).

Focus Groups
We conducted focus groups with cardiology and PCPs to collect qualitative data on knowledge gaps and barriers to anticoagulation prescribing. We emailed invitations to 74 providers in our healthcare system. Based on responses from providers and their availability, we scheduled 4 focus group sessions with 25 attendees overall (18 physicians and 7 nurse practitioners). Providers were given a $50 gift card incentive for their participation. Each focus group session was ≈2 hours long and consisted of discussions about factors that make prescribing anticoagulation difficult in patients with AF; factors that contribute to the providers’ decision to prescribe anticoagulation, and the need for evidence-based information on these factors.
factors and resources for anticoagulation prescription. We recorded audio, transcribed, and coded these discussions for major themes on factors related to provider anticoagulation prescription. Themes that emerged from the coded analysis included history or risk of bleeding, history or risk of falls, patient noncompliance, patient refusal, alcohol use, secondary AF, the need for provider education on risk calculators and direct oral anticoagulants (DOACs), and lack of guidelines and resources. We used this data to inform the development of material for academic detailing.

**Academic Detailing**

We invited each intervention provider to participate in our adapted form of academic detailing. Specifically, we designed a PowerPoint presentation with 11 themes related to anticoagulation and its management for patients with AF. Unlike a typical PowerPoint, however, we allowed providers to choose which theme to discuss and engineered the last slide in a topic to return to the first slide where the provider could select the next topic to review. Topics ranged from reviewing and interpreting anticoagulation dashboards, to use of DOACs, to anticoagulation in the elderly. We allotted between 30 and 60 minutes for the initial session and 15 to 30 minutes for a follow-up session. We offered providers the opportunity to meet in person or remotely through a web-conferencing software. In addition to materials shared during the academic detailing session, we sent providers additional materials on request including a PDF of the presentation (see Appendix C in the Data Supplement). We also asked providers to commit to integrate/try to integrate some aspect of the presented evidence into their practice and report their findings from this effort. Between initial and follow-up sessions, we sent brief emails reminding providers of the topics covered and the item(s) that they committed to integrate.

**Timeline of Intervention and Follow-Up**

From July to November 2018, we continued our intervention including monthly emails and in-basket messages. We identified February 1, 2019 as the end point of our follow-up, which provided intervention providers at least 2 months to intervene with each of the patients for whom we sent an in-basket message. Figure 2 provides a timeline of the milestones of our intervention.

**Control Group**

Control providers did not receive any of the components of the intervention, and we did not attempt to mask their assignment to control or notify them of their assignment. As in the intervention group, we analyzed control participants using an intention-to-treat analysis. As such, if a patient assigned to a control provider at baseline saw an intervention provider during the course of the study, changing their assigned provider to this intervention provider, we still analyzed the patient with controls for the main analysis. This scenario would occur most commonly if a patient initially assigned to a control provider (either cardiologist or PCP) visited an intervention cardiologist over the course of the study. We discuss the ramifications of this decision in the analysis section.

**Outcomes**

**Feasibility**

We tabulated how often providers in the intervention groups read our emails with the report of their anticoagulation percentage using Microsoft Outlook-based read receipts. We also tracked how many providers reviewed (opened) the in-basket messages we sent them and what they did with the message. Specifically, if there was no reply but the provider marked the message as done, pending, or read, we considered the message reviewed. Only if the provider receiving the message did not take any action and the message status remained marked new (ie, unopened), did we consider the message not reviewed.

**Effectiveness**

**Change in Anticoagulation Status**

For determination of change in anticoagulation status (follow-up compared with baseline), we performed a separate chart review for any case in which our electronic data capture suggested a switch in anticoagulation status, correcting any instances of misspecification.
of a switch in anticoagulation status. We then calculated the change in percentage of eligible patients prescribed anticoagulation in the intervention and control groups over 6 months.

**Survey Outcomes**

We also measured some provider-level outcomes based on baseline and follow-up surveys administered to providers (see Figure 2 for timeline). We previously published details regarding administration and outcomes of the baseline survey.\(^1\) Briefly, 70 of 112 (63%) providers randomized to the intervention completed the baseline survey, including an expanded set of questions regarding provider use of and confidence in stroke and bleeding risk calculators and knowledge of warfarin in addition to DOACs. To decrease respondent burden for the follow-up survey, we selected 5 items from the baseline survey to administer at follow-up. The 5 selected items reflected those items which suggested the largest gap in terms of adherence with current evidence. Two of these items included frequency of using bleeding risk calculator and self-reported knowledge of DOACs (ie, change from baseline to follow-up). The remaining 3 items included provider reported comfort resuming anticoagulation in 3 challenging patient scenarios—2 weeks after gastrointestinal bleed, 4 weeks after subarachnoid bleed, and in a patient with 3 mechanical falls without injury in the past 6 months (Appendix D in the Data Supplement for survey items).

**Analysis**

**Feasibility**

We calculated simple percentages of providers who read our emails and the frequencies of actions providers took with inbox messages. We also asked providers participating in the academic detailing to rate the helpfulness of individual parts of the detailing session.

**Effectiveness—Change in Anticoagulation Status**

**Main-Full and Partial Dose**

For this analysis, we analyzed intervention and control patients in an intent to treat fashion including those providers who were assigned to intervention or control but after reassignment of patients contributed no patients as described above in the patient assignment section. For those patients whose provider did not participate in academic detailing, we considered their exposure to our intervention as a partial dose, given they received only electronic messaging. By comparison, we considered patients of providers who participated in academic detailing as having received a full dose of the intervention.

To assess the impact of the intervention in this cohort, we modeled a patient’s follow-up (post-intervention) anticoagulation status as a function of their baseline (preintervention) anticoagulation status, the allocation of the provider to whom they were assigned at baseline (intervention versus control), and CHA2DS2-VASc score. We did not separately include the patient’s sex given sex, age, and stroke risk comorbidities (prior stroke, congestive heart failure, hypertension, diabetes mellitus, and vascular disease) as each variable is already part of the CHA2DS2-VASc score. In addition, we did not adjust for number of patients attended by individual patients or the time since study start. To account for within-provider clustering, we used the generalized linear mixed models (ie, generalized linear mixed model with a logit link with patient anticoagulation status as binary and a random effect for provider).\(^1\) Before beginning the intervention, we determined that we would have at least 80% statistical power to detect a difference in change in anticoagulation percentage for intervention versus controls of 2.7% to 5.7% over the range of 0.1% to 5% for change in anticoagulation percentage in the control population. We considered a P value of <0.05 to be statistically significant.

**Subset Analyses of Above Cohort**

1. Given that not every patient came in for a visit over the 6 months of our study, we repeated the above analysis on the subset of patients who saw their assigned provider.
2. Given that some patients allocated to one group saw a provider of another group over the course of the study, we reran our analysis using a per-protocol analysis, restricting the sample to those patients who only saw providers in the group to which they were originally assigned.
3. Effect of the intervention in cardiology providers.
4. Effect of the intervention in PCPs.

**Main-Full Dose Only Analysis**

We reran our generalized linear mixed model limiting the inclusion of patients for the intervention group to those whose provider participated in academic detailing.

Analysis of patients on antiplatelet therapy: We educated providers who participated in academic detailing about current guidelines\(^6\) recommending against prescribing aspirin for prophylaxis against stroke. To assess the effectiveness of this teaching, we repeated the above analyses for patients prescribed aspirin or another antiplatelet agent.

**Effectiveness—Provider Survey**

We compared intervention and control providers for increase in report of use of bleeding risk calculators, knowledge of DOACs, and comfort with prescribing anticoagulation in challenging patient scenarios. More specifically, we conducted \(\chi^2\) testing on the difference in proportions between groups with significance testing based on a P value of 0.05.

We performed all analyses in SAS 9.4.\(^17\)

**Institutional Review Board**

The Institutional Review Board at the University of Massachusetts Medical School approved our study. We registered the study as a clinical trial on clinicaltrials.gov.

**RESULTS**

**Descriptive Statistics**

We identified 236 potentially eligible providers, of whom 115 were ineligible due to having fewer than 5 patients with AF not on anticoagulation and of whom 2 opted out, leaving a study sample of 119 providers. Of those 119 providers, 85 fell into the intervention group, and 34 were part of the control group (2.5:1 allocation). Later, 5 providers from the
intervention cohort and 1 provider from the control cohort dropped out because they retired or left the institution. None of these providers received emails or in-basket messages. Another intervention provider dropped out after having received initial emails. Three additional intervention providers did not receive in-basket messages because they did not have a visit with an eligible patient during the course of the study. Five additional providers randomized did not contribute any patients to the baseline cohort. This occurred after these providers reported not being the provider of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients).

The intervention and control provider groups had similar proportions of cardiology practitioners (30% for each). However, the intervention group had slightly lower proportion of internal medicine practitioners (55.7% versus 60.6%) and slightly higher proportion of family medicine practitioners (13.9% versus 9.1%)

### Table 1. Comparison of Key Characteristics Recorded at Beginning of Intervention for Patients

| Characteristics                          | Intervention | Controls |
|-----------------------------------------|--------------|----------|
| Age, y                                   |              |          |
| 75+                                     | 2011 (56.2)  | 1100 (58.0) |
| 65–74                                    | 1165 (32.6)  | 563 (29.7) |
| <65                                     | 402 (11.2)   | 234 (12.3) |
| Sex                                      |              |          |
| Female                                  | 1638 (45.8)  | 820 (43.2) |
| Male                                    | 1940 (54.2)  | 1077 (56.8) |
| Median area level annual income          |              |          |
| ≤400% poverty level                     | 2328 (65.1)  | 1210 (63.8) |
| >400%                                   | 1229 (34.3)  | 674 (35.5) |
| Missing                                 | 21 (0.6)     | 13 (0.7) |
| Race                                     |              |          |
| Nonwhite                                 | 257 (7.2)    | 103 (5.4) |
| White                                    | 3313 (92.6)  | 1789 (94.3) |
| Missing                                 | 8 (0.2)      | 5 (0.3) |
| Hispanic ethnicity                       |              |          |
| Hispanic                                | 110 (3.1)    | 32 (1.7) |
| Non-Hispanic                            | 2977 (83.2)  | 1618 (85.3) |
| Missing                                 | 491 (13.7)   | 247 (13.0) |
| Language preference                      |              |          |
| English                                 | 2904 (81.1)  | 1600 (84.3) |
| Non-English                             | 199 (5.6)    | 65 (3.4) |
| Missing                                 | 475 (13.3)   | 232 (12.2) |
| Insurance                                |              |          |
| Commercial                              | 376 (10.5)   | 204 (10.8) |
| Medicare                                | 2788 (77.9)  | 1507 (79.4) |
| Medicaid                                | 7 (0.2)      | 6 (0.3) |
| Other/MA state health insurance exchange| 254 (7.1)    | 113 (6.0) |
| Uninsured/self-pay                      | 8 (0.2)      | 0 (0.0) |
| Missing                                 | 145 (4.1)    | 67 (3.5) |

#### Individual CHA$_{2}$DS$_{2}$-VASc comorbidities

| Comorbidity               | Intervention | Controls |
|---------------------------|--------------|----------|
| CHF                       | 995 (27.8)   | 694 (36.6) |
| Hypertension              | 3036 (84.9)  | 1591 (83.9) |
| Diabetes mellitus         | 1108 (31.0)  | 574 (30.3) |
| Stroke/TIA                | 415 (11.6)   | 236 (12.4) |
| Vascular disease          | 426 (12.0)   | 224 (11.8) |
| CHA$_{2}$DS$_{2}$-VASc score |            |          |
| 2                         | 691 (19.3)   | 378 (19.9) |
| 3                         | 1003 (28.0)  | 514 (27.1) |
| 4                         | 974 (27.2)   | 489 (25.8) |
| 5                         | 536 (15.0)   | 322 (17.0) |
| 6                         | 261 (7.3)    | 122 (6.4) |
| 7                         | 86 (2.4)     | 53 (2.8) |

(Continued)
compared with controls. In addition, fewer intervention providers were male (58.2% versus 66.7%). Intervention providers had a longer average number of years elapsed since medical school graduation compared with controls (25.5 versus 24.0 years).

Next, we identified 3578 patients with AF under the care of intervention providers and 1897 patients with AF under the care of control providers. There was balance among those patient groups in age, sex, and CHA2DS2-VASc score. By contrast, there were more patients of nonwhite race, Hispanic ethnicity, and non-English language preference in the intervention group. Of the 3578 patients assigned to an intervention provider at baseline, 1848 (51.6%) had a visit during the study period with the intervention provider assigned to them at baseline. At the same time, 370 (10.3%) patients from this group had an appointment during the follow-up with a control provider. Of the 1897 patients of control providers, 1023 (53.9%) saw their assigned provider over the study follow-up; at the same time, 512 (27.0%) of these patients saw an intervention provider. Most patients received care from a cardiology provider who invariably contributed >50 patients each to our population (ie, patients in our sample received care from providers taking care of a lot of similar patients; Table 1 and Figure 3). Patients randomly selected for chart review from the baseline cohort for the purpose of verifying accuracy of electronic capture of AF CHA2DS2-VASc score, and anticoagulation status mostly resembled the

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**Figure 3.** CONSORT diagram for cluster randomized SUPPORT-AF Trial.

AC indicates anticoagulation. *Patients of these providers retained for the main analysis in intent to treat fashion.
remaining patients not selected. Both chart review and remaining patients were male 55% of the time and had a median CHA2DS2-VASc score of 4. In the chart review patients, the percentage on anticoagulation was 72% compared with 73% for the remaining patients. Whereas chart review patients had a cardiology provider 71% of the time, the remaining patients were assigned to a cardiology provider 75% of the time.

Feasibility

Most patients in the intervention group were assigned to a provider who read at least one of our emails. More specifically, 621 (17.4%) were assigned to a provider that read none of our emails, 953 (26.6%) were assigned to providers who read one email, and 2004 (56.0%) were assigned to providers who read >1 of our emails.

Intervention providers reviewed our EMR, in basket messages, 98% of the time. We sent a total of 957 in basket messages to 76 providers for upcoming appointments with 489 unique patients over the course of the intervention. Of 957 messages, we received 152 replies (15.9%) sent by 13 different cardiology providers and 31 PCPs. Providers reviewed another 790 (82.5%) without replying. In only 15 cases (1.6%), providers did not review our EMR message. Of the 152 replies, nearly all (94.1%) included reasons for not anticoagulating these patients. In their responses, providers cited patient refusal as the most common reason for a patient not being on anticoagulation (11.2%) followed by the provider’s report that his/her patient had developed AF after transient illness or as an isolated event (10.5%; Table 2).

In general, providers completing academic detailing rated academic detailing as helpful. More specifically, for the following items they found the intervention component somewhat or very helpful (% of providers): Web-based remote conferencing platform (77%), slide presentation (97%), review of individual patients with AF not on anticoagulation during initial session (80%), follow-up material sent after initial session (83%), overall helpfulness of initial session (96.7%), and overall helpfulness of follow-up session (83%).

Effectiveness: Change in Anticoagulation Status

At baseline, 70.8% of patients receiving care from intervention providers were on anticoagulation versus 74.0% of patients of control providers. At follow-up, 72.1% of patients of intervention providers and 75.5% of patients of control providers were on anticoagulation. This translated to a net switch percent-

### Table 2.

| Explanation* | Frequency (% out of 155) |
|--------------|-------------------------|
| Patient never had AF | 4 (2.6) |
| CHA2DS2-VASc not ≥2  | 4 (2.6) |
| Temporarily off AC for a procedure | 2 (1.3) |
| Patient already on AC; possible mistake in algorithm or med list not up to date | 9 (5.8) |
| Atrial flutter status post ablation | 1 (0.6) |
| Hospice | 2 (1.3) |
| Watchman/closure of appendage | 4 (2.6) |
| Active bleeding | 6 (3.9) |
| Cost | 2 (1.3) |
| Other intracranial hemorrhage | 3 (1.9) |
| Resolved gastrointestinal bleed | 5 (3.2) |
| Resolved other site bleed | 9 (5.8) |
| Patient not a good candidate such as from perceived or calculated bleed risk | 11 (7.1) |
| Fall risk | 11 (7.1) |
| Transient condition/isolated event | 16 (10.3) |
| Patient no longer in AF | 4 (2.6) |
| Patient post ablation | 2 (1.3) |
| On aspirin/Plavix | 9 (5.8) |
| Patient has cardiologist/cardiologist recommended against AC | 14 (9.0) |
| Patient refused | 17 (11.0) |
| Other | 11 (7.1) |

AC indicates anticoagulation; AF, atrial fibrillation; and EMR, electronic medical record.

*We categorized each reply to an in-basket message using a hierarchy that our clinician authors (Drs Kapoor and McManus) established. The hierarchy ranked explanations highest for those that were most compelling, logical, and evidence-based such as CHA2DS2-VASc not ≥2 compared with those where continued efforts to educate patient and provider could result in a decision to start anticoagulation. This hierarchy included providers who believed the patient never truly had AF given that diagnosis could have been misspecified by a different provider. In cases in which providers offered >1 explanation, we chose the one highest on the hierarchy.

age of 1.3% for the intervention group versus 1.5% for control group (Table 3). Based on the generalized linear mixed regression, the adjusted change in difference was not significant for the intervention group. More specifically, for the group of patients not on anticoagulation at baseline assigned to an intervention versus control provider, the adjusted percent increase from baseline in the use of anticoagulation was 5.2% versus 7.4% (P=0.21). For the group of patients on anticoagulation at baseline, there was no difference in the adjusted percent decrease from baseline in the use of anticoagulation. The intracluster correlation was 0.053. There was also no significant effect of our intervention for patients in any of the subset analyses or for patients in the full dose only cohort. It is worth noting that patients having a visit over the duration of the
study (whether with treatment or control provider)—that is, subset analysis number 1—had greater increases in anticoagulation use compared to the general cohort (Table 4).

**Effectiveness: Provider Survey**

Intervention providers who completed academic detailing were more likely than controls to go from not being comfortable to being comfortable prescribing anticoagulation in a patient with 3 falls in the past 6 months (40% versus 11%, \( P = 0.02 \)). There was also a trend toward these providers going from not being comfortable to being comfortable prescribing anticoagulation after gastrointestinal and subarachnoid bleeds (27% versus 11% for each with \( P = 0.17 \)). There was no difference for the other comparisons (Table 5).

**DISCUSSION**

We demonstrated that it is feasible to generate and distribute reports of anticoagulation prescription percentages and in-basket messages to bring attention to the underutilization of anticoagulation among patients with AF within a health system. We also found that it is possible to recruit nearly half of requested providers from a health system to participate in academic detailing. These providers rated the different parts of academic detailing across the board as helpful. Providers frequently responded to electronic messages about their untreated patients with AF, citing patient refusal to take anticoagulation and AF occurring after transient illness or as an isolated event as the most common reasons for not prescribing anticoagulation. Despite its feasibility and provider-perceived helpfulness, our intervention did not increase the rate of anticoagulation prescription among providers randomized to receive the interven-

| Analysis Population | No. of Providers | No. of Patients | Percentage on AC at Baseline | Positive Switches | Negative Switches | Net Switches | Net Switch Percentage | Percentage on AC at Follow-Up |
|---------------------|------------------|----------------|-----------------------------|-------------------|-----------------|--------------|----------------------|-----------------------------|
| Full and partial dose* |                  |                |                             |                   |                 |              |                      |                             |
| Intervention        | 79†              | 3578           | 70.8%                       | 53                | 7               | 46           | 1.3%                 | 72.1%                       |
| Controls            | 33‡              | 1897           | 74.0%                       | 35                | 6               | 29           | 1.5%                 | 75.5%                       |
| **Subset analysis number 1¶** | | | | | | | | |
| Intervention        | 76               | 1848           | 73.3%                       | 36                | 4               | 32           | 1.7%                 | 75.0%                       |
| Controls            | 31               | 1023           | 76.1%                       | 25                | 2               | 23           | 2.2%                 | 78.4%                       |
| **Subset analysis number 2¶** | | | | | | | | |
| Intervention        | 78               | 2067           | 73.8%                       | 36                | 4               | 32           | 1.5%                 | 75.4%                       |
| Controls            | 32               | 809            | 74.7%                       | 12                | 1               | 11           | 1.4%                 | 76.0%                       |
| **Subset analyses number 3—cardiology providers only** | | | | | | | | |
| Intervention        | 25               | 2623           | 73.6%                       | 36                | 6               | 30           | 1.1%                 | 74.8%                       |
| Controls            | 10               | 1464           | 76.0%                       | 24                | 5               | 19           | 1.3%                 | 77.3%                       |
| **Subset analysis number 4—PCPs only** | | | | | | | | |
| Intervention        | 55               | 955            | 63.2%                       | 17                | 1               | 16           | 1.7%                 | 64.9%                       |
| Controls            | 23               | 433            | 67.0%                       | 11                | 1               | 10           | 2.3%                 | 69.3%                       |
| **Full dose only** |                  |                |                             |                   |                 |              |                      |                             |
| Intervention        | 33#              | 1627           | 72.2%                       | 23                | 3               | 20           | 1.2%                 | 73.4%                       |
| Controls            | 33†              | 1897           | 74.0%                       | 35                | 6               | 29           | 1.5%                 | 75.5%                       |

AC indicates anticoagulation; and PCP, primary care physician.

*Includes patients who had been seen by study providers in the 12 mo preceding baseline assessment; providers for these patients may have participated in academic detailing (full dose) or declined to participate/not been available but still received electronic messaging about their patients (partial dose).

†Of the 75 providers randomized to the intervention, 3 providers left before receiving any part of the intervention; 3 additional providers randomized to intervention did not contribute any patients to this analysis. This occurred after these providers reported not being providers of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients). This left us with the 79 providers reported.

‡One provider randomized to control did not contribute any patients to this analysis. This occurred after this provider reported not being the provider of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients). This left us with the 33 providers reported.

§Subset analysis number 1 limited inclusion of patients to those who saw their provider over the duration of the study.

‖Subset analysis number 2 limited to patients who did not have visits with providers from alternate allocation (eg, patients assigned to control providers at baseline who saw an intervention provider over course of study).

¶Same patients and providers as for full and partial dose.

#Two providers who participated in academic detailing did not contribute any patients to this analysis. This occurred after these providers reported not being the provider of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients).
tion when compared with controls. Our survey results did show an increase in comfort with prescribing anticoagulation after falls and a trend towards the same after bleeding events.

Several other provider-directed intervention studies have addressed anticoagulation prescription among patients with AF. Ashburner et al\textsuperscript{18} assessed the role of email notifications with patient information, educational material, and primary care guidelines for anticoagulation management. Their intervention did not lead to an increase in anticoagulation prescribing. Our previous SUPPORT-AF study\textsuperscript{8} also did not show a benefit to email and in-basket notifications, although that study was limited by having a duration of only 8 to 10 weeks. Four other recent trials\textsuperscript{19–22} similarly found mixed results for clinical decision support for anticoagulation prescribing in AF. By contrast, the Improve Treatment with Anticoagulants in Patients with Atrial Fibrillation (IMPACT-AF) study\textsuperscript{23} found that education of patients and caregivers and implementation of a coordinating center providing advice to study providers and monitoring of anticoagulation use of their providers in 5 middle-income countries increased anticoagulation use by 9.1\% compared with controls over the course of 1 year. Our intervention leveraged tools available through the EMR and directly engaged with providers. We did not directly interact with patients, and did not follow patients past 6 months, both of

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{Analysis Population} & \textbf{Frequency (%) Using AC at End of Intervention} & \textbf{For Patients off AC} & \textbf{For Patients on AC} & \textbf{P Value}\textsuperscript{*} \\
 & & \textit{At Baseline} & \textit{At Baseline} & \\
\hline
\hline
\textbf{Full and partial dose} & & & & \\
\hline
\textbf{Intervention (n=3578 patients; 79 providers\textsuperscript{f})} & 53 (5.2) & 2528 (99.7) & 0.21 \\
\textbf{Control (n=1897; 33 providers\textsuperscript{g})} & 35 (7.4) & 1397 (99.6) & & \\
\hline
\textbf{Subset analyses number 1\textsuperscript{I}} & & & & \\
\hline
\textbf{Intervention (1848 patients; 76 providers)} & 36 (7.5) & 1350 (99.7) & 0.86 \\
\textbf{Control (n=1023; 31 providers)} & 25 (10.4) & 777 (99.8) & & \\
\hline
\textbf{Subset analyses number 2\textsuperscript{k}} & & & & \\
\hline
\textbf{Intervention (n=2067; 78 providers)} & 36 (6.9) & 1522 (99.8) & 0.58 \\
\textbf{Control (n=809; 32 providers)} & 12 (6.2) & 603 (99.9) & & \\
\hline
\textbf{Subset analyses number 3—cardiology providers only} & & & & \\
\hline
\textbf{Intervention (n=2623; 25 providers)} & 36 (5.4) & 1925 (99.7) & 0.35 \\
\textbf{Control (n=1464; 10 providers)} & 24 (7.1) & 1108 (99.8) & & \\
\hline
\textbf{Subset analysis number 4—PCPs only} & & & & \\
\hline
\textbf{Intervention (n=955; 55 providers)} & 17 (4.8) & 603 (99.8) & 0.40 \\
\textbf{Control (n=433; 23 providers)} & 11 (7.5) & 289 (97.6) & & \\
\hline
\textbf{Full dose only} & & & & \\
\hline
\textbf{Intervention (n=1627; 33 providers\textsuperscript{#})} & 23 (5.1) & 1171 (99.7) & 0.29 \\
\textbf{Control (n=1897; 33 providers\textsuperscript{g})\textsuperscript{**}} & 35 (7.5) & 1397 (99.6) & & \\
\hline
\end{tabular}
\caption{Summary of Adjusted Analyses of Intervention Effect According to Different Analysis Population}
\end{table}

AC indicates anticoagulation; and PCP, primary care physician.

\textsuperscript{*} P value represents the probability that null hypothesis that the generalized linear mixed model regression coefficient for the interaction term of group (intervention or control), and AC status at baseline (off or on AC) is not statistically different than 0. P >0.05 suggests no difference and, therefore, that the intervention and control group percentages of AC use are not statistically different. Our model also adjusts for CHA2DS2-VASc score.

\textsuperscript{f}Includes patients who had been seen by study providers in the 12 mo preceding baseline assessment; providers for these patients may have participated in academic detailing (full dose) or declined to participate/not been available but still received electronic messaging about their patients (partial dose).

\textsuperscript{g}Of the 85 providers randomized to the intervention, 3 providers left before receiving any part of the intervention; 3 additional providers randomized to intervention did not contribute any patients to this analysis. This occurred after these providers reported not being providers of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients). This left us with the 79 providers reported.

\textsuperscript{I}Subset analysis limited inclusion of patients to those who saw their provider over the duration of the study.

\textsuperscript{k}Subset analysis limited to patients who did not have visits with providers from alternate allocation (eg, patients assigned to control providers at baseline who saw an intervention provider over course of study).

\textsuperscript{#}Two providers who participated in academic detailing did not contribute any patients to this analysis. This occurred after these providers reported not being the provider of ≥5 patients assigned to them (as the original eligibility requirement was 5 patients).

\textsuperscript{**}Same patients and providers as for full and partial dose.
which would increase the cost of our intervention significantly. Given that providers reported patient refusal as the top reason for a patient not being on anticoagulation, developing an intervention that engages patients potentially through a shared decision-making approach would be a fruitful path for future research. The median age in IMPACT-AF was 70 years but was 76 in our population. Thereby, our baseline anticoagulation rate of 71% compared with 68% for IMPACT-AF may not be comparable. In older populations such as in our study, falls, frailty, and previous bleeding episodes are more common barriers. We also highlight here the difficulty in raising the rates of anticoagulation in populations where the baseline rate of anticoagulation is closer to the 80% goal from the ORBIT-AF registry. Repeating our study in a population with a lower baseline anticoagulation rate may demonstrate an impact for the intervention that was not tenable in our population.

In addition to our population being older and having a relatively high anticoagulation rate at baseline, we note other limitations to our intervention. Approximately 10% of patients assigned to intervention providers also saw control providers over the course of the study. These latter providers could have discouraged the use of anticoagulation in conflict with our intervention and masked an effect. Examination of the subset of patients without this issue did not indicate substantial change in the overall rate of change in anticoagulation use.

Replies to our in-basket messages suggest that our electronic capture of AF and anticoagulation status was imperfect. Indeed, in ≈3% of these replies, providers disagreed with our determination of an AF diagnosis or his or her patient. In 6% of replies, providers disagreed with our determination of anticoagulation status for his or her patient. Because replies were voluntary, however, we cannot ascertain the true distribution of reasons for not being on anticoagulation. Our review of baseline anticoagulation status from randomly selected charts suggested high specificity for AF diagnosis and anticoagulation status. Moreover, in any case, in which our electronic capture identified a change in anticoagulation status, we required final determination by manual chart review. In addition, providers did not necessarily apply the same definition we did for AF leading to part of the disagreement.

Although we met twice with providers participating in academic detailing over the course of 4 months, it is possible that if we had developed longer relationships with providers, we may have gained greater trust and uptake of the evidence-based practices we were promoting. It is also possible that we would have seen a benefit with more time allocated for follow-up after completion of the second academic detailing session. Lastly, for efficiency’s sake, we adapted some elements of the academic detailing model, such as use of web-based instead of the more typical face-to-face meeting format. Clinicians indicated satisfaction with the web-based format, somewhat mitigating concerns that these adaptations decreased the effectiveness of the intervention.

A final limitation is the asynchronous delivery of in-basket messages to the time of the patient encounters. Alternative clinical decision support tools that might align with the provider’s workflow are available but untested in our context.

In summary, we confirmed the feasibility of an electronic profiling and alert program combined with academic detailing for providers making decisions about anticoagulation for patients with AF at a large health care system with common EMR. Although we did not find a significant effect for our intervention, responses

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Table 5. Provider Survey Outcomes

| Survey Outcomes* | Frequency, % | P Value | Frequency, % | P Value |
|------------------|--------------|---------|--------------|---------|
|                  | Intervention Providers | Controls |              | Intervention Providers Completing AD | Control+Intervention Not Participating in AD | P Value |
| Providers reporting | 5 (14) | 1 (5) | 0.40 | 4 (15) | 2 (7) | 0.41 |
| Increased knowledge of DOACs | 3 (9) | 3 (15) | 0.66 | 3 (12) | 3 (11) | 1.00 |
| Greater comfort prescribing AC 2 wk after gastrointestinal bleed | 7 (21) | 3 (15) | 0.73 | 7 (27) | 3 (11) | 0.17 |
| Greater comfort prescribing AC 4 wk after subarachnoid hemorrhage | 7 (21) | 3 (15) | 0.73 | 7 (27) | 3 (11) | 0.17 |
| Greater comfort prescribing AC in a patient who has fallen ≥3× in 6 mo | 10 (30) | 3 (16) | 0.33 | 10 (40) | 3 (11) | 0.02 |

AC indicates anticoagulation; AD, academic detailing; and DOACs, direct oral anticoagulants.

*Refers to response to survey at baseline, before intervention, compared with response to survey at follow-up after intervention. For bleeding risk calculators, increased use represents a provider reporting never or rarely using the calculator at baseline but usually or always at follow-up. Similarly, for DOACs, we measured the frequency of providers reporting little or some knowledge at baseline but a great deal or expertise on the subject at follow-up. For the subsequent 3 items, greater comfort represents the percentage of providers that did not agree with the statement about being comfortable prescribing AC at baseline (response choices strongly disagree, somewhat disagree or neutral) but agreed with the statement at follow-up (response choices somewhat agree or strongly agree).
from providers suggest that focusing on patient refusal, including patient-directed interventions or provider interventions with greater assistance with patients refusing to take anticoagulation, may be fruitful future paths for the research community to pursue. Developing longer relationships with providers is another potential avenue to raise the rate of anticoagulation, particularly for providers prescribing at rates lower than their peers. Finally, institutions with lower baseline rates of anticoagulation use may still benefit from our intervention as we implemented it, but further research is necessary to confirm a benefit.

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