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Trends in anticoagulation management services following incorporation of direct oral anticoagulants at a large academic medical center

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Abstract

The introduction of direct oral anticoagulants (DOACs) to the market has expanded anticoagulation options for outpatient use. Routine evaluation by health care professionals is recommended as it is with warfarin, therefore requiring adjustments in practices of anticoagulation management services (AMS). This study aims to describe trends that occurred following the incorporation of DOACs into AMS at a large academic medical center. A retrospective chart review of pharmacist-run AMS was used to compare patients on DOAC therapy versus other types of anticoagulation, including warfarin and parenteral agents. Primary outcomes included trends in the number of unique patients, management encounters, and telephone encounters throughout the study period. Secondary outcomes included trends in new encounters, and changes in patient characteristics, resources utilized, and patient satisfaction scores. A total of 2976 unique patients, 74,582 management encounters, and 13,282 telephone encounters were identified. From study beginning to end, results showed stable numbers of unique patients, an increase in management encounters for the DOAC group and decrease in the other anticoagulants group, and stable numbers of telephone encounters. Additionally, the number of new encounters for both groups increased. Throughout the study, pharmacy resources were reallocated within anticoagulation to adapt to the changing trends and patient satisfaction reached targets. Patients' characteristics remained stable, with the DOAC group having fewer comorbid conditions and concomitant medications that could increase bleed risk. This study showed that by reallocating resources within anticoagulation, AMS can maintain stable patient populations while continuing to expand access and satisfy patients following DOAC inclusion.

Keywords Anticoagulation management service · Clinical pharmacy · DOAC

Highlights

- The number of unique patients seen over the four-year study period remained stable following increased incorporation of DOACs to the AMS model
- An increase in new patient encounters occurred for both the DOAC group and the other anticoagulants group
- Through resource allocation, the number of clinics and types of medications monitored increased despite the decreased frequency of encounters for DOAC therapy
- Future studies should be published to include data on clinical outcomes related to pharmacist-run AMS in the era of DOAC inclusion

Background

The use of oral anticoagulants has largely been recognized as an effective means for a variety of indications, including preventing strokes in patients who have atrial fibrillation, preventing venous thromboembolisms (VTE) in patients who have an increased probability of developing a clot, and treating patients who have a history of VTE. As these medications put patients at an increased risk for bleeding events, close monitoring is recommended by many guideline societies [1–7]. For over 50 years, warfarin was one of the only options for oral anticoagulation. While effective,

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it requires frequent monitoring of international normalized ratios (INRs) and dose adjustments due to its interactions with patients' diet, lifestyle, and many concomitant medications. Additionally, some patients on warfarin may require use of parenteral anticoagulation as bridge therapy if oral anticoagulation has to be temporarily stopped, or if their INR is below goal. Anticoagulation clinics were developed to help manage the monitoring encounters needed to provide quality care for patients while reducing bleeding events [8, 9]. In 2010, the approval of the first direct oral anticoagulant (DOAC) expanded options for anticoagulation in the outpatient setting and overcame some of the challenges associated with warfarin, including decreasing medication and lifestyle interactions and eliminating the need for parenteral anticoagulation as bridge therapy. Rates of DOAC prescribing have since increased, and in 2016, matched that of warfarin [10–12]. This shift in prescribing imposed new challenges for anticoagulation management services (AMS) as the process and frequency of DOAC monitoring became established.

Current guidelines recommend routine monitoring for patients on DOACs, with time frames ranging from every three months to annually depending on patient comorbidities [4, 5, 7]. This is notably less frequent than that of warfarin, and may affect practice within AMS as the prescribing of DOACs increase. There have been several organizations that have published their experience on integrating DOAC monitoring into their practice models [13, 14], including Sylvester and colleagues, who described the expansion of the pharmacist-run anticoagulation model at Brigham and Women's Hospital. They concluded that as DOAC incorporation continues to rise, data on AMS workload and best practices are needed to further improve outpatient anticoagulation management [14].

The goal of this study is to describe an academic medical center's experience in the utilization of the institution's pharmacist-run AMS to help forecast appropriate practice models and management needs moving forward in the era of DOACs. This information will ultimately assist in optimizing practice related to anticoagulation management and help generate future standards of care.

Methods

Study population

A retrospective chart review was conducted on encounters that took place from January 1, 2016 to December 31, 2019 at all pharmacist-run AMS locations associated with The Ohio State University Wexner Medical Center (OSUWMC). Encounters were identified using a report generated by the electronic medical record system with a variety of data being collected, including patient height, weight, and race, indication and medication used for anticoagulation, and co-morbid conditions identified using ICD-9 and ICD-10 codes.

At OSUWMC, patients are referred to the pharmacist-run AMS by a healthcare provider following the diagnosis for anticoagulation with goals of therapy established by the physician at the time of referral. Pharmacists maintain privileges granted through institutional credentialing and practice under a consult agreement established with physicians at OSUWMC. Privileged pharmacists adjust medication dosing and order and evaluate pertinent lab work as defined by the scope of practice established by the consult agreement. The frequency of visits for warfarin management are based on the patient's clinical needs, and are extended up to every four to six weeks for stable patients. The majority of patients are seen in person, however under approved circumstances, some patients may be managed telephonically.

DOAC incorporation occurred within the OSUWMC AMS clinic sites in phases. At the start of the study, one AMS site was seeing patients for DOAC monitoring while some patients were being monitored in a separate pharmacist-run Medication Therapy Management (MTM) clinic. In July of 2019, DOAC incorporation expanded to include five available AMS locations for both new and return DOAC patients. At that time, those patients that were being monitored in the MTM clinic were transitioned to AMS clinics. Visits occur every three to twelve months depending on patient-specific factors, including but not limited to, age, kidney function, and bleeding history.

For both groups, new visits are scheduled for 30 minutes and include an in depth history collected from the patient including details surrounding the reason for anticoagulation, past bleeding events, medication use and management, and pertinent lifestyle factors. A large portion of new patient appointments is dedicated to education surrounding the anticoagulant. If any labs are needed, those will be collected and evaluated. Return visits are scheduled for 15 minutes and include a medication list review with a focus on changes from the previous appointment, a review of bleeding or bruising that the patient may be experiencing, a review of any emergency department visits or hospitalizations that have occurred since their last visit, and potential missed doses of their anticoagulant. Education is again provided to the patient, and if labs are needed, they are collected and reviewed. For both groups, if the patient has an upcoming procedure or surgery that may require an interruption in their anticoagulation, education and planning is provided.

Outcomes

The primary objective of the study is to determine the utilization of OSUWMC's anticoagulation clinics, comparing patients on a DOAC versus patients on other types of

anticoagulation, including warfarin, enoxaparin, or subcutaneous heparin, by evaluating the number of encounters and unique patients in each group over time. Encounters were divided into management encounters, which included in person office visits or any telephone call dedicated to medication management, and telephone encounters, which included calls addressing patient or physician questions related to drug interactions, perioperative planning, or refill requests. Each year was broken down into quarters allowing for 16 data points in order to establish a trend, with quarter one starting on January 1, quarter two on April 1, quarter three on July 1, and quarter four on October 1 of each year. For the purposes of capturing patients who switched from one group to another during the study period, unique patients were defined as unique once per quarter. Secondary outcomes included comparing the number of new encounters between groups, patient characteristics of unique patients seen from the start of the study to its completion, changes in patient satisfaction scores, and changes in resources utilized. Resources were defined using pharmacist full-time equivalent (FTE) specifically dedicated to anticoagulation management in addition to available clinic locations.

Statistical analysis

Descriptive statistics were used to evaluate patient related secondary objectives. For patient characteristics, two-sided Student's t-test, Chi square test, and Fisher's exact tests were utilized as appropriate. Comorbid conditions and responsible physician type were analyzed using Chi square test, and concomitant medication use was analyzed using Fisher's exact test. Statistical analyses were conducted using statistical software R3.4. All statistical tests were two-sided and a p-value of less than or equal to 0.05 was considered statistically significant.

Results

A total of 2,976 unique patients were identified, leading to a total of 87,864 encounters taking place between January 1, 2016 and December 31, 2019. Of those encounters, there were 74,582 management encounters and 13,282 telephone encounters.

Figure 1a–c depicts the trends seen in number of unique patients, number of management encounters, and number of telephone encounters that took place each quarter throughout the study period. The total number of unique patients remained stable, with less than a 50-patient difference from quarter one of 2016 to quarter four of 2019, despite changes in the distribution between groups (Fig. 1a). In quarter four of 2018, there was a decline in patients monitored on other anticoagulants and an increase in patients monitored on DOAC therapy. The sharpest increase in the DOAC group started in quarter three of 2019 and continued through the completion of the study.

A similar trend can be seen in regards to the DOAC group when looking at the data for management encounters and telephone encounters. The total number of management encounters per quarter for the other anticoagulants group declined over time with a small rebound in total encounters correlating with the increase in DOAC encounters at the start of quarter three of 2019 (Fig. 1b). Telephone encounter volume fluctuated, but remained relatively stable with a spike in encounters in both 2017 and 2018 correlating with spikes in the other anticoagulants group (Fig. 1c).

The total number of new encounters per quarter increased from study beginning to end (Fig. 2). The highest volume for DOACs can be seen in quarter four of 2019 with 43 new encounters. For warfarin, the highest volume occurred in quarter two of 2017 with 124 new encounters. Both groups had the largest increase occur over quarters three and four of 2019. Due to availability of data, new encounters for DOACs were not documented until quarter two of 2017.

Patient characteristics for the entire population differed slightly when comparing 2016 to 2019 with statistically significant differences seen in patients having vascular disease, anemia, heart failure, and hypertension (Table 1).

When comparing characteristics between groups, significant differences were seen in diagnosis related to anticoagulation and comorbid conditions (Table 2). The other anticoagulants group had a statistically higher number of patients who had a valve replacement and hypertension in both quarter one of 2016 and quarter four of 2019, and an LVAD in quarter four of 2019. While not statistically significant, there were notably more patients on aspirin and other concomitant medications that could increase bleed risk in the other anticoagulants group for both time periods evaluated.

Additional secondary objectives included pharmacy resources utilized and patient satisfaction scores. A total increase of 0.3 FTE dedicated to the management of anticoagulation was observed over the study period, with an increase of 0.2 FTE taking place in quarter one of 2017 and quarter two of 2019, and an increase of 0.1 FTE taking place in quarter one of 2019. A decrease of 0.2 FTE occurred in quarter four of 2018. During that time, the available OSUWMC AMS sites that patients could be monitored at increased from five sites at the start of the study, to eight sites by the end of the study, with increases occurring in quarters one and three of 2017 and quarter two of 2019.

Average patient satisfaction scores for access to care, provider rating, and overall recommend rate were collected yearly for each group and were broken down by new and return visits (Fig. 3a–c). At OSUWMC, patient satisfaction is collected via optional surveys after patient appointments. Fluctuations were seen throughout the study period with all

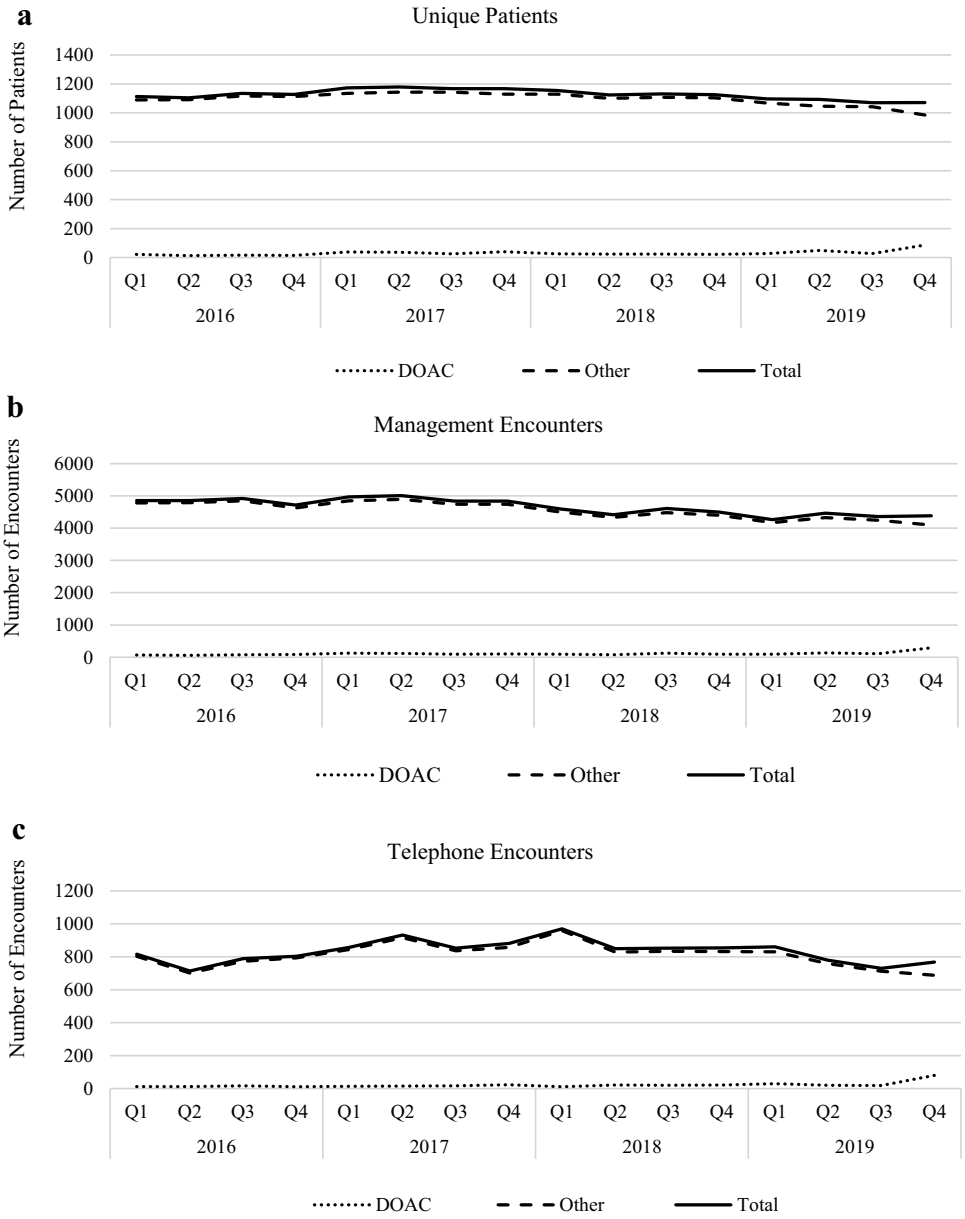

Fig. 1 **a** Trends in number of unique patients. **b** Trends in number of management encounters. **c** Trends in number of telephone encounters

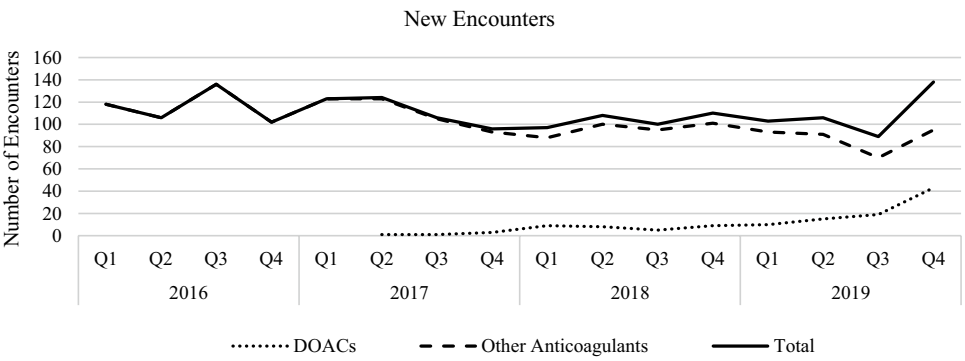

Fig. 2 Trends in number of new encounters

Table 1 Patient characteristics of the entire population

	2016 Quarter 1 (n = 1111)	2019 Quarter 4 n = (1069)	P value
Height (in)—mean (SD)	67.8 (4.2)	67.7 (4.5)	0.77[a]
Weight (kg)—mean (SD)	95.9 (28.4)	96.1 (30.6)	0.90[a]
BMI (kg/m^2)—mean (SD)	31.9 (8.6)	31.9 (9.6)	0.95[a]
Race—n (%)			0.47[b]
Caucasian	668 (60.1)	651 (60.9)	
African American	380 (34.2)	349 (32.6)	
Asian	22 (2.0)	23 (2.2)	
Other	41 (3.7)	46 (4.3)	
Diagnosis—n (%)			
Atrial fibrillation	554 (49.9)	521 (48.7)	0.62[b]
DVT/PE	384 (34.6)	367 (34.3)	0.93[b]
Valve replacement	173 (15.6)	157 (14.7)	0.62[b]
Blood disorder	87 (7.8)	90 (8.4)	0.68[b]
CVA/TIA	73 (6.6)	76 (7.1)	0.72[b]
LVAD	46 (4.1)	55 (5.1)	0.34[b]
Other	38 (3.4)	39 (3.6)	0.90[b]
Comorbid conditions—n (%)			
Hypertension	843 (75.9)	752 (70.3)	0.006[b]
Anemia	347 (31.2)	287 (26.9)	0.039[b]
Diabetes	344 (30.9)	296 (27.7)	0.13[b]
Heart failure	314 (28.2)	246 (23.0)	0.01[b]
Kidney disease	203 (18.2)	159 (14.9)	0.054[b]
Vascular disease	179 (16.1)	137 (12.8)	0.042[b]
Liver disease	47 (4.2)	37 (3.5)	0.49[b]
Concomitant medication use—n (%)			0.32[c]
Aspirin	527 (47.4)	543 (50.8)	
Acetaminophen	430 (38.7)	406 (38.0)	
Ibuprofen	42 (3.8)	45 (4.2)	
Clopidogrel	78 (7.0)	61 (5.7)	
Ticagrelor	4 (0.4)	12 (1.1)	
Prasugrel	6 (0.5)	5 (0.4)	
Responsible provider type—n (%)			0.16[b]
Cardiovascular medicine	255 (22.9)	263 (24.6)	
Family medicine/internal medicine	264 (23.8)	206 (19.3)	
Electrophysiology	167 (15.0)	188 (17.6)	
Hematology	158 (14.2)	168 (15.7)	
Vascular medicine	85 (7.7)	74 (6.9)	
Heart failure	82 (7.4)	72 (6.7)	
Neurology	19 (1.7)	12 (1.1)	
Other	81 (7.3)	85 (8.0)	

SD = standard deviation, BMI = body mass index, DVT = deep venous thromboembolism, PE = pulmonary embolism, CVA = cerebrovascular accident, TIA = transient ischemic attack, LVAD = left ventricular assist device

[a]Two-sided Student's t test

[b]Chi squared test

[c]Fisher's Exact

visit types achieving a goal rating of over 80% in every category by 2019. Overall recommend rates for each visit type was consistently above 80% throughout the study for most visit types and exceeded 95% for all visit types by 2019.

Table 2 Patient characteristics of DOACs versus other anticoagulants

	2016 Quarter 1			2019 Quarter 4		
	DOACs (n = 22)	Other anticoagulants (n = 1089)	P value	DOACs (n = 86)	Other anticoagulants (n = 983)	P value
Height (in)—mean (SD)	67.7 (3.9)	67.8 (4.2)	0.95[a]	66.2 (4.2)	67.9 (4.5)	0.061[a]
Weight (kg)—mean (SD)	95.3 (22.9)	95.9 (28.4)	0.93[a]	92.9 (34.1)	96.3 (30.4)	0.46[a]
BMI (kg/m^2)—mean (SD)	31.2 (7.3)	31.9 (8.6)	0.82[a]	29.3 (7.5)	32.1 (9.7)	0.080[a]
Race—(n) %			0.26[c]			0.22[c]
Caucasian	16 (72.7)	652 (59.9)		49 (57.0)	602 (61.2)	
African American	4 (18.2)	366 (33.6)		30 (34.9)	312 (31.7)	
Asian	0 (0.0)	22 (2.0)		0 (0.0)	23 (2.3)	
Other	2 (9.1)	49 (4.5)		7 (8.1)	46 (4.7)	
Diagnosis—n (%)						
Atrial fibrillation	15 (68.2)	539 (49.5)	0.13[b]	44 (51.2)	477 (48.5)	0.72[b]
DVT/PE	9 (40.9)	375 (34.4)	0.68[b]	38 (44.2)	329 (33.5)	0.059[b]
Blood disorder	2 (9.1)	85 (7.8)	0.69[c]	10 (11.6)	80 (8.1)	0.36[b]
CVA/TIA	1 (4.5)	72 (6.6)	0.99[c]	5 (5.8)	71 (7.2)	0.79[b]
Valve replacement	0 (0.0)	173 (15.9)	0.037[c]	0 (0.0)	157 (16.0)	< 0.001[c]
LVAD	0 (0.0)	46 (4.2)	0.99[c]	0 (0.0)	55 (5.6)	0.028[c]
Other	2 (9.1)	37 (3.4)	0.18[c]	10 (11.6)	36 (3.7)	0.001[b]
Comorbid conditions—n (%)						
Vascular disease	5 (22.7)	174 (16.0)	0.58[b]	7 (8.1)	130 (13.2)	0.24[b]
Anemia	3 (13.6)	344 (31.6)	0.10[c]	21 (24.4)	266 (27.1)	0.69[b]
Heart failure	4 (18.2)	310 (28.5)	0.35[c]	14 (16.3)	232 (23.6)	0.16[b]
Kidney disease	4 (18.2)	199 (18.3)	0.99[c]	12 (14.0)	147 (15.0)	0.93[b]
Diabetes	6 (27.3)	338 (31.0)	0.88[b]	21 (24.4)	275 (28.0)	0.56[b]
Liver disease	0 (0.0)	47 (4.3)	0.99[c]	0 (0.0)	37 (3.8)	0.066[c]
Hypertension	12 (54.5)	831 (76.3)	0.035[b]	49 (57.0)	703 (71.5)	0.007[b]
Concomitant medication use—n (%)			0.53[c]			0.82[c]
Aspirin	9 (40.9)	421 (38.7)		32 (37.2)	374 (38.0)	
Acetaminophen	5 (22.7)	522 (47.9)		36 (41.9)	507 (51.6)	
Ibuprofen	0 (0.0)	42 (3.9)		4 (4.7)	41 (4.2)	
Clopidogrel	0 (0.0)	78 (7.2)		6 (7.0)	55 (5.6)	
Ticagrelor	0 (0.0)	4 (0.4)		1 (1.2)	12 (1.2)	
Prasugrel	0 (0.0)	5 (0.5)		0 (0.0)	5 (0.5)	
Responsible provider type—n (%)			0.85[c]			0.43[b]
Cardiovascular medicine	6 (27.3)	248 (22.8)		20 (23.3)	243 (24.7)	
Electrophysiology	4 (18.2)	163 (15.0)		19 (22.1)	169 (17.2)	
Family medicine/internal medicine	4 (18.2)	260 (23.9)		15 (17.4)	191 (19/4)	
Hematology	4 (18.2)	154 (14.1)		10 (11.6)	158 (16.1)	
Neurology	1 (4.5)	18 (1.7)		0 (0.0)	12 (1.2)	
Vascular medicine	1 (4.5)	84 (7.7)		4 (4.7)	70 (7.1)	
Heart failure	1 (4.5)	81 (7.4)		7 (8.1)	65 (6.6)	
Other	1 (4.5)	81 (7.4)		11 (12.8)	75 (7.6)	

SD = standard deviation, BMI = body mass index, DVT = deep venous thromboembolism, PE = pulmonary embolism, CVA = cerebrovascular accident, TIA = transient ischemic attack, LVAD = left ventricular assist device

[a]Two-sided Student's t test

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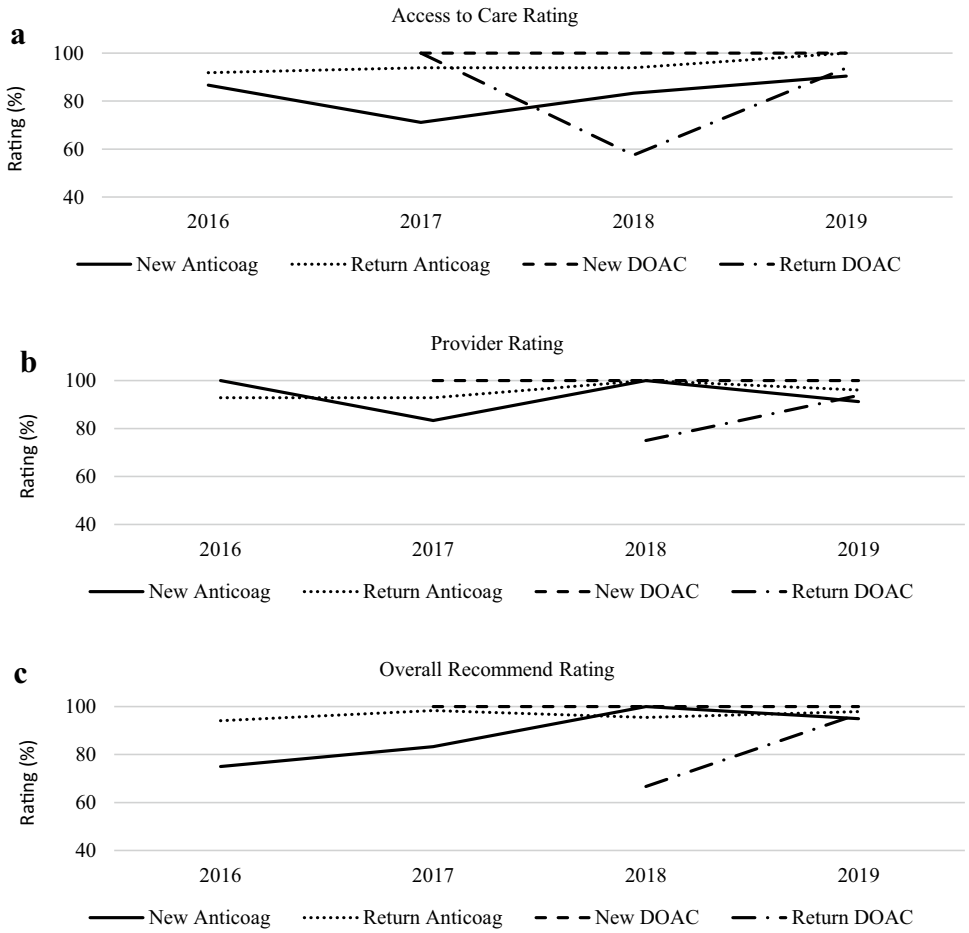

Fig. 3 **a–c** Patient satisfaction scores

Discussion

In this retrospective chart review of the pharmacist-run AMS at OSUWMC, we observed a stable number of unique patients monitored on anticoagulation over four years, with an increase in unique patients being monitored on DOACs and a decrease in those being monitored on warfarin and other parenteral agents. Total encounters during the study time period decreased despite unique patients remaining stable, indicating a decrease in encounters utilized as DOAC incorporation increased. Telephone encounters remained stable and numbers of new patients increased from study beginning to end.

There are several factors that could have led to the trends observed, with one of these being changes in guideline recommendations related to oral anticoagulation over the study time period. In 2016, the American College of Chest Physicians (CHEST) guideline for antithrombotic therapy for VTE recommended that DOACs be considered first line over warfarin for treatment and prevention of a VTE event in non-cancer patients [3]. In 2019, the American Heart Associate/American College of Cardiology/Heart Rhythm Society (AHA/ACC/HRS) guideline update to the 2014 atrial fibrillation guidelines made the same recommendation for patients with non-valvular atrial fibrillation, while also narrowing the definition of valvular atrial fibrillation to moderate-to-severe mitral stenosis or a mechanical heart valve, increasing the number of patients that may qualify for DOAC therapy [5]. Later in 2019, the American Society of Clinical Oncology (ASCO) guidelines were updated to include DOACs in the agents to be considered for prevention and treatment of VTE in patients with cancer [15]. As these guidelines change their recommendations related to DOAC therapy, it is likely that more patients may transition to a DOAC from warfarin. While we were not able to capture the change in prescribing rates at our facility specifically during this study time period, several studies have shown that the rates of DOAC perscriptions continue to rise and surpass that of warfarin [10–12].

The increase in clinic locations from five to eight at OSUWMC during the study time period as well as the increase in number of clinics that managed patients on DOACs from one to five likely affected the trends in encounters and FTE observed. While two additional sites were added in 2017, only one of these additions was associated with an increase in FTE, showing resource reallocation at the time of the

other increase. The decrease in 2018 is likely due to consolidation of staff in preparation for additional reallocation in 2019. The increases in number of new encounters for DOAC groups, as indicated by Fig. 2, was likely due to DOAC monitoring expansion to an increased number of clinics in July of 2019. Interestingly, there was also an increase in the number of new encounters for patients on other anticoagulants, presumably warfarin. This speaks to the continued need for resources dedicated to overall anticoagulation management as increases in both groups could be in part due to increases in new encounter appointment slots within the schedule templates. Reallocation of resources within anticoagulation to additional patients and locations assumedly increases staff productivity as unique patient numbers rebounded. While we were not able to accurately capture productivity, the success of the implementations made can be seen in patient satisfaction rates which exceeded goals in areas of access to care, provider rating, and overall recommend rates.

A shift in patient characteristics can also be seen throughout the study period. While there were few statistically significant differences between the groups, there are important observations to note. First, when comparing patients on other anticoagulants to those on DOAC therapy, higher numbers of comorbid conditions can be seen in patients on warfarin and other parenteral agents. As the number of comorbid conditions increase, presumably, so does the complexity of the patient. As warfarin has been around longer than the DOACs, some physicians may be more comfortable with its use compared to DOACs in complex patients. Second, when looking at concomitant medication use, higher rates of aspirin use can be seen at the start and end of the study in the other anticoagulants group. Additionally, the use of aspirin nearly doubled in patients on DOACs from 2016 to 2019. This may indicate increased prescriber familiarity with the risks of bleeding of DOACs leading to use in a broader patient population as time progresses. Lastly, data collected for responsible provider type continues to show a wide representation of many subspecialties in 2016 and 2019 for both groups studied.

When evaluating the data for future use, the impact COVID-19 has had on the practice of pharmacy and anticoagulation clinics must be considered. Given the need to limit exposure to the virus, patients are being re-evaluated for DOAC candidacy to decrease the need for frequent INR checks [16–19]. At OSUWMC, patients were actively being considered for transition prior to the pandemic, however not all patients who qualified to transition were comfortable doing so due to a variety of factors. As their risk–benefit picture shifts with changes in the global public health picture, we anticipate patients' perceived risk of frequent INR checks may outweigh their prior perceived risks of DOACs. Unfortunately, the circumstances surrounding COVID-19 continue to change, and at this time, the impact on AMS is not able to be predicted. This limited our ability to extend our trend lines past our studied time period to allow for estimates of future clinic requirements.

Other study limitations included the retrospective nature of the study that relied largely on correct documentation. There may be some encounters that were not captured that occurred during the study time period due to incorrect labeling. If the reason for the visit or telephone encounter was not listed as anticoagulation, they would not have been flagged for inclusion. In addition, we did not capture DOAC monitored encounters that were taking place in our MTM clinic prior to our expanded integration that took place in 2019, which may have decreased our DOAC encounter totals prior to that expansion. We also relied on ICD-9 and ICD-10 codes to describe patient characteristics. The entering of these codes vary largely with different practitioner practice and likely varied in accuracy between patients. Additional limitations included our definitions of unique patients and pharmacy resources. While including patients once per quarter allowed us to capture patients that may have transitioned from one group to another during the study period, we may have limited unique patients observed in the DOAC group that may not have been seen in clinic each quarter. By defining pharmacy resources with FTE and locations, we were not able to define the productivity of pharmacists, which may be beneficial for future studies.

Conclusion

The model of anticoagulation management continues to evolve over time. By incorporation of the newest therapeutic options for oral anticoagulation, AMS can be well-utilized and can maintain a stable patient population while expanding access and maintaining high patient satisfaction. The high-risk nature of oral anticoagulation requires regular monitoring and frequent check-ins with health care professionals, with warfarin appointments typically occurring more frequently than those for DOACs, and anticoagulation management services should be prepared to adapt. Future studies should be published to include data on clinical outcomes related to pharmacist-run AMS in the era of increased DOAC inclusion, as well as data on utilization compared to prescribing patterns to ensure that patients on these agents are being appropriately monitored by experts in anticoagulation.

Funding This study was not funded.

Data availability All original data will be available upon request.

Compliance with ethical standards

Conflicts of interests The authors declare they do not have conflicts of interests to disclose.

Ethics approval This research study was conducted retrospectively from data obtained for clinical purposes. We consulted extensively with the IRB of The Ohio State University who determined that our study did not need ethical approval. An IRB official waiver of ethical approval was granted from the IRB of The Ohio State University.

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