

# Assessment of Population-Based Approach to Direct Oral Anticoagulant Management

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Nghi Ha, PharmD, MPH, BCPS, CACP<sup>1</sup> ,  
Erin Mouland, PharmD, CACP<sup>1</sup>, Elizabeth Renner, PharmD, BCPS, BCACP<sup>1</sup>,  
Denise Sutter-Long, PharmD, BCPS<sup>1</sup>, Anisa Bici, PharmD<sup>1</sup>,  
Michael Lanham, MD<sup>2</sup>, and Geoffrey D. Barnes, MD, MSc<sup>2</sup>

## Abstract

**Background:** As preferences for oral anticoagulation shift from warfarin to direct oral anticoagulants (DOACs), a new care management model is needed. A population approach leveraging a DOAC Dashboard was implemented to track all patients on a DOAC followed by a physician at an academic medical center. The DOAC Dashboard is a real-time report within the electronic health record (EHR) that identifies patients who require evaluation for DOAC dose/therapy adjustment due to changing renal function, age, weight, indication, and/or significant drug-drug interaction (DDI). **Objective:** This study aims to describe the initial phase of DOAC Dashboard implementation, to evaluate the effectiveness of interventions, and to assess a multidisciplinary approach to management. **Method:** Retrospective descriptive study of the DOAC Dashboard from August 22, 2019, to January 20, 2022. Primary outcomes include total number of alerts addressed and interventions needed. Secondary outcome is the proportion of interventions implemented by the prescribing clinician. **Result:** A total of 10912 patients were identified by the DOAC Dashboard at baseline. A total of 5038 alerts were identified, with 668 critical alerts, 3337 possible critical alerts, and 1033 other alerts. Pharmacists addressed 1796 alerts during the study period (762 critical alerts and 1034 possible critical). Critical alerts included 62 significant DDI, 379 inappropriate dosing, and 321 others. Of the critical alerts, intervention was needed in 291 cases (38%), with 255 (88%) of proposed interventions implemented. Critical alerts and possible critical alerts not requiring intervention were resolved by data entry. **Conclusion:** The DOAC Dashboard provides an efficient method of identifying patients on DOACs that require dose adjustments or therapeutic modifications.

## Keywords

anticoagulants, anticoagulation, anticoagulation management, dashboard, care model

## Introduction

Warfarin has been the staple anticoagulant for the treatment of atrial fibrillation (AF) and venous thromboembolism (VTE) for decades. However, treatment has shifted over the last decade due to development of direct oral anticoagulants (DOACs) due to their safety profile, ease of management, and predictable pharmacodynamic and pharmacokinetic properties of these agents. As a result, guidelines have recommended DOACs over warfarin for the prevention of stroke in AF and treatment and prevention of VTE, with the exception of patients with mechanical heart valve or antiphospholipid antibodies.<sup>1–4</sup> In fact, DOACs are now the most commonly prescribed oral anticoagulant medications to Medicare recipients.<sup>5</sup>

As preferences for oral anticoagulation shift from warfarin to DOACs, a new care management model is needed.

Unlike warfarin, DOACs do not require routine therapeutic monitoring, which is the staple component of many anticoagulation services. That is not to say that DOACs do not require monitoring. Direct oral anticoagulants are metabolized and cleared through the liver and kidneys, so hepatic and renal function are important factors to determine dosing to optimize efficacy and safety. Another complex aspect of DOAC management is the dosing adjustments that are

<sup>1</sup>Pharmacy Innovations & Partnerships, Michigan Medicine, Ann Arbor, MI, USA

<sup>2</sup>University of Michigan Medical School, Michigan Medicine, Ann Arbor, MI, USA

### Corresponding Author:

Nghi Ha, Pharmacy Innovations & Partnerships, Michigan Medicine, 24 Frank Lloyd Wright Drive, SPC 5736, Ann Arbor, MI 48106, USA.  
Email: nghih@med.umich.edu

dependent on specific indications, phase of treatment, other concomitant medications, and patient-specific factors such as age, gender, and weight.<sup>6</sup> As a result, approximately 12% to 16% of patients on DOACs for stroke prevention in AF are receiving an off-label dose.<sup>4,6</sup> Direct oral anticoagulant underdosing and overdosing is associated with increased risk of adverse events.<sup>6</sup>

The shift in preference away from warfarin, and the potential for dosing errors with DOACs, creates a new opportunity for anticoagulation services to expand and cover the management of DOACs. The initial model was individual patient focused based on referrals from providers. Providers have the option to refer patients to anticoagulation services for evaluation of anticoagulation initiation, patient education on the use of DOACs, and ongoing DOAC monitoring via active outreach to patients throughout treatment. With limited resources and growing number of referrals, this model was not sustainable. Even the use of periodic, scheduled case review is unlikely to be of high yield or provide timely detection of DOAC prescribing issues. The biggest weakness of this model is that it does not prioritize unstable patients over stable patients, a key element that maximizes the value and efficiency of specialist nurse or pharmacist case review. Thus, routine follow-up with patients on DOAC was an inefficient approach to DOAC management.<sup>7,8</sup>

A population approach leveraging a DOAC Dashboard, first pioneered with the Veterans Health Administration system, was implemented to track all patients on a DOAC at an academic medical center. The DOAC Dashboard is a real-time report within the electronic health record (EHR) that identifies patients who require evaluation for DOAC dose adjustment or therapy modification due to changing renal function, age, weight, indication, and/or significant drug-drug interaction (DDI). This model represents a targeted approach to DOAC management, as it allows for clinicians to identify patients that require immediate evaluation, both at therapy initiation and throughout treatment. The other advantage is that it allows a small team of clinicians to manage a larger population of patients because of this targeted approach.

This study aims to describe the initial phase of DOAC Dashboard implementation and to evaluate the effectiveness of interventions by pharmacists. Another aim of this study is to explore a multidisciplinary approach to management of a DOAC Dashboard.

## Methods

### Design

This is a retrospective, descriptive study of the DOAC Dashboard at a single tertiary academic center from October

1, 2020, through January 31, 2022. The DOAC Dashboard was managed by an established anticoagulation service consisting of clinical pharmacist specialists and registered nurses. At the implementation of the Dashboard, a full-time pharmacist was dedicated to the management of the dashboard. This study was approved by the University of Michigan Institutional Review Board with a waiver of informed consent.

### Outcomes

Outcomes assessed include the total number of alerts addressed, the number of alerts that require an intervention, and the proportion of interventions implemented. A key secondary outcome assessed is the average number of alerts addressed by non-pharmacist team members (nurses and/or pharmacy students) per shift.

### Dashboard

Inclusion criteria to appear on the Dashboard includes an active outpatient DOAC prescription (apixaban or rivaroxaban) on a patient's medication list and the patient being seen by a provider in cardiology, primary care, vascular surgery, and/or hematology within the previous 2 years.

The DOAC Dashboard is built directly within the Epic EHR. All data is pulled from the EHR database using reporting features. End user access to the Dashboard is within the EHR, without requiring any external software to be run. Development and evaluation of the DOAC Dashboard was provided by both Blue Cross Blue Shield of Michigan through the Michigan Anticoagulation Quality Improvement Initiative and the Agency for Healthcare Research and Quality.<sup>9</sup>

The Dashboard output includes patients' identification, age, sex, current DOAC agent and dose, expected DOAC dose, DDI, indication for DOAC therapy, and responsible anticoagulation provider. The indication is identified based on the patient's problem list, visit diagnoses, and/or associated diagnoses for the DOAC prescription. Based on this indication, the Dashboard then uses package instructions for prescribing to determine the expected DOAC dose. Key elements that inform the expected dose include the indication, renal function (or a combination of age, weight, and renal function for apixaban use for AF), and potential DDIs.

### Alerts

Critical alerts are triggered in patients who have a discrepancy between their current DOAC prescription and the expected DOAC prescription. This includes any patient with multiple concurrent anticoagulant prescriptions (eg, apixaban and rivaroxaban, apixaban and warfarin) on their

**Table 1.** DOAC Dashboard Alert Responsibilities.

	Nurses	Pharmacy student	Pharmacist
Multiple DOACs	x		x
DOAC and Warfarin: contraindicated	x		x
Missing data (creatinine, weight, etc)	x		x
Possible mechanical valve	x		x
Cannot determine dose	x		x
No indication found		x	x
Cannot determine indication		x	x
Incorrect dose			x
Drug-drug interaction			x

Abbreviation: DOAC, direct oral anticoagulant.

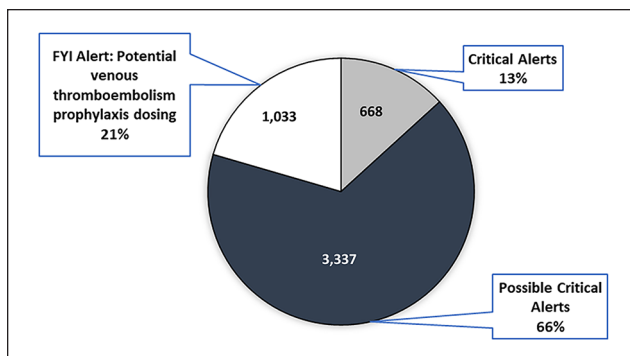
medication list, a DOAC dose and frequency that does not match the expected dose or frequency indicated by the package label, and/or significant DDI.

Possible critical alerts are triggered in patients with missing data needed to identify the expected DOAC dose and frequency (eg, weight, serum creatinine, age), possible mechanical valve, and/or missing dose/indication in the prescription.

### Service Model

The DOAC Dashboard alert responsibilities are summarized in Table 1. The DOAC Dashboard report is run daily. The pharmacist sorts the report for critical alerts and then evaluates each alert and the associated patient medical record to determine whether an intervention is needed. If an intervention is needed, the pharmacist documents the recommendation and communicates with the responsible anticoagulation prescribing clinician. Possible interventions include a recommendation to increase/decrease dose, switch to an alternative anticoagulant, repeat laboratory test to reassess renal or hepatic function, or snooze alert for a period of time from appearing on the Dashboard. Once the recommendation is approved by patient's anticoagulation prescribing clinician, the pharmacist contacts the patient, reviews the recommendation with the patient, and implements the plan.

In addition to pharmacist use of the Dashboard, a small, piloted program was initiated to incorporate other members of the anticoagulation service into the management of patients prescribed DOACs by addressing select alerts on the DOAC Dashboard. Nurse specialists and student pharmacists in the anticoagulation management clinic were incorporated into the process to review and address non-critical alerts. Nurses addressed possible critical alerts to retrieve and input missing data so that the Dashboard could identify whether a DOAC prescription was appropriate or would result in a critical alert. Alerts are resolved by input of missing information, updating the medication list, updating the problem list, or by classifying surgical heart valve

**Figure 1.** Alerts at baseline.

type (bioprosthetic vs mechanical). If a critical alert is triggered following chart reconciliation, the nurse will forward the critical alert to the pharmacist team for evaluation. Student pharmacists, under the supervision of a pharmacist, help identify appropriate indication for the DOACs (via chart review) in cases where alerts were unable to determine by the dashboard due to missing information.

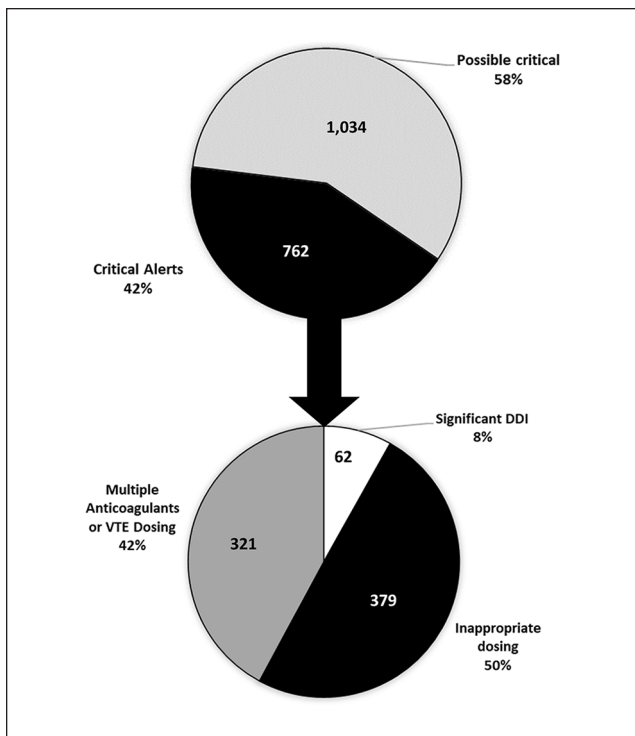
### Statistical Analysis

No statistical analysis was performed. Descriptive statistic was reported in proportion, count (percentage).

### Results

A total of 10912 patients were identified by DOAC Dashboard at initiation of the program. Baseline alerts are shown in Figure 1. A total of 5038 alerts were triggered. Of those, 668 (13%) were critical, 3337 (66%) were possible critical, and 1033 (21%) were for your information alerts for potential VTE prophylaxis dosing.

Pharmacists addressed 1796 alerts during the study period. Alert types are summarized in Figure 2. Pharmacists addressed 762 critical alerts and 1034 possible critical



**Figure 2.** Addressed alerts by type. Abbreviations: DDI, drug-drug interaction; VTE, venous thromboembolism.

alerts. The majority of critical alerts were inappropriate dosing, 379 (50%). A total of 62 (8%) critical alerts addressed were due to significant DDI.

Interventions are summarized in Figure 3. Of the 762 critical alerts, 291 (38%) required pharmacist intervention. The overwhelming majority of proposed interventions (256, 88%) were accepted by patients’ primary anticoagulation prescribing clinician and were implemented.

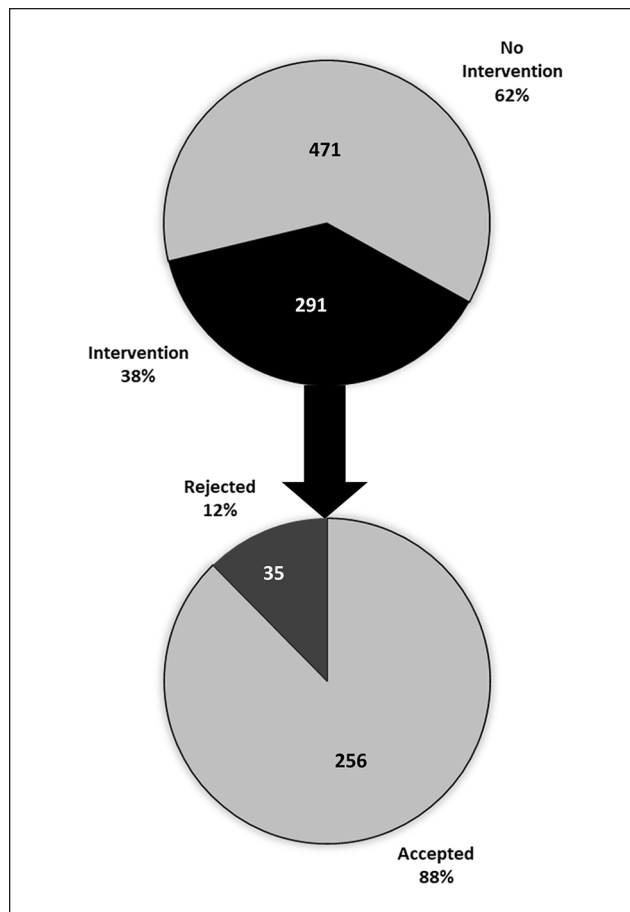
Critical alerts and possible critical alerts not requiring intervention were resolved by entering or editing information within the EHR.

On average, the student pharmacist was able to resolve about 20 alerts per 8-hour period. A total of 197 alerts were resolved by a student pharmacist between August 2022 and November 2022.

On average, the nursing team was able to resolve approximately 60 alerts per 8-hour period. A total of 2663 alerts were resolved by the nursing team between April 2021 and November 2022.

**Discussion**

This study describes the initial phase of the implementation of a DOAC Dashboard population health tool at a large tertiary academic center. At the activation of the DOAC Dashboard, there were more than 10 000 patients with



**Figure 3.** Intervention outcomes.

more than 5000 alerts. Pharmacists, anticoagulation nurse specialists, and a student pharmacist were successful in addressing these alerts. The majority of alerts were triggered by missing information, which can be resolved with data input. Approximately 13% of alerts were classified as critical alerts, which included inappropriate dosing, significant DDIs, and multiple concomitant anticoagulants. Approximately 38% of critical alerts required a pharmacist intervention. The overwhelming majority of interventions proposed by a pharmacist (88%) were accepted by patients’ anticoagulation providers. This acceptance rate is even higher than in a previous study, which reported a relatively high acceptance rate of 63%.<sup>10</sup> This new population approach to DOAC management allows for a small team of anticoagulation providers to manage a large patient population through a targeted method of identifying patients who require immediate evaluation, while keeping track of the remaining stable patients. The targeted approach optimizes pharmacist clinic time in the management of DOACs compared to the previous model based on individual patient scheduled follow-up. Similar results were observed in a study at the Veteran Health

Administration (VHA) that evaluated a DOAC population management tool.<sup>11</sup>

The implementation of this program was successful because it was built on a well-established anticoagulation service with strong support from service management and physician champions. The DOAC Dashboard was designed by a clinical physician with expertise in Epic EHR design, with input from frontline clinicians. The program was also managed by specialists in anticoagulation with experience in service expansion, advance clinical practice, and research. The well-established rapport between pharmacists and anticoagulation providers in cardiology, vascular surgery, hematology, and primary care through previously established services within the anticoagulation clinic helped facilitate efficient communication and implementation of interventions through the DOAC Dashboard. The dedicated pharmacist to the DOAC Dashboard was crucial in addressing the backlog of alerts since dashboard activation.

There were challenges in implementing this population-based DOAC management service. The biggest challenge was addressing the initial batch of alerts at the time of dashboard activation. The goal of a DOAC dashboard is to enable the clinician to address new alerts in real time. However, that can only be achieved once the backlog of alerts is addressed from the initial activation of the dashboard. This task was challenging even with a dedicated pharmacist. This challenge arises because the dashboard displays data in real time, with new patients and alerts added to the dashboard daily. As an example, approximately 2500 new patients have been added to the dashboard since baseline. New patients trigger new alerts, which add to the backlog of alerts. In addition, new alerts are triggered by the pre-existing patients on the dashboard as their patient characteristics, laboratory, and medications change over time. Limited resources remain a significant barrier. Although the service attempted to incorporate other members of the anticoagulation service into this process, these added efforts were still limited by their pre-existing responsibilities. Nurses, who are primarily responsible for managing warfarin in our anticoagulation management clinic, and student pharmacists can only contribute to the dashboard when time permits, which resulted in inconsistent contribution to eliminating alerts. It is also important to account for the time required to train new staff on the DOAC Dashboard. A weakness of this model is that it is unable to address patient-specific barriers to DOAC use, such as affordability or non-adherence, which is available in the DOAC Dashboard used in the Veterans Health Administration system.<sup>11</sup>

Although the majority of proposed interventions were accepted and implemented, not all proposed interventions were accepted by providers and/or patients. All recommendations were evidence-based, but they did not always account for patients' or providers' preferences. The most

common reasons for rejection of intervention by providers included history of bleeding and/or patient age and frailty. Other times, patients rejected intervention due to their own preference. One challenge with DOAC management is that patients cannot see or feel the benefits of the medication, so convincing patients to modify therapy may be difficult. This is particularly challenging as pharmacists were not managing these patients outside the scope of the DOAC Dashboard, so there was no established rapport with patients prior to the initial contact. This challenge is expected to improve as more providers become familiar with the Dashboard and the pharmacist team.

This is the initial phase of implementing a DOAC Dashboard. Several other opportunities exist to continue improving the safe and effective use of antithrombotic therapies. The first goal is to get the dashboard to a maintenance phase where anticoagulation clinic staff can address new alerts in a timely manner. This requires clearance of the existing backlog from the initiation of the dashboard. To facilitate this process, more investment is needed to train and incorporate more members from the anticoagulation service into the management of the dashboard. This will allow pharmacists to focus on major clinical medication-related alerts like DDI and inappropriate dosing. As this is a new program, continuous assessment and evaluation will likely optimize communication and workflow to maximize efficiency. Beyond that, additional alerts to address concomitant anticoagulation-antiplatelet use and upcoming surgical procedures would further support a comprehensive anticoagulation stewardship model of care.<sup>12</sup>

In conclusion, the DOAC Dashboard provides an efficient method of identifying patients on DOACs that require dose adjustments or other therapeutic modifications in a timely manner. The work associated with ensuring safe and effective DOAC care in this population health model was effectively delegated to different members of the anticoagulation service team, including pharmacists, nursing specialists, and pharmacy students. The initial high volume of DOAC dashboard alerts represents the biggest challenge in implementing this program, particularly in the setting of limited resources. Ultimately, this program allows for alert-based monitoring of patients and timely identification of interventions in patients who otherwise lack specific follow-up for these high-alert medications. The DOAC Dashboard provides a viable practice model for DOAC management from a population-based approach.

#### **Declaration of Conflicting Interests**

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### ORCID iD

Nghi Ha  <https://orcid.org/0000-0002-0002-2061>

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