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# Structure and function of a perioperative anticoagulation management clinic

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ABSTRACT

*Background:* The perioperative management of patients who are receiving an anticoagulant and require a surgery/procedure is well-informed by multiple clinical studies, but an assessment of the delivery of such management is lacking. Describing the structure and function of a perioperative anticoagulation clinic provides a model for delivery of such patient care.

*Methods:* We examined the operational model of a perioperative anticoagulation clinic. We describe the processing and management of patients receiving anticoagulant therapy who require elective surgery or procedure, including anticoagulant interruption, resumption and consideration for bridging therapy. We also describe the patient profile assessed over an 18-month period, and the potential benefits of this clinic to patients for perioperative management and education.

*Results:* During an 18-month period, 1061 patients were assessed. Atrial fibrillation and venous thromboembolism were the most common indications for anticoagulant therapy, comprising 55.0% and 26.5% of patients, respectively; 44.1% of patients were taking warfarin, 37.1% were taking direct oral anticoagulants, and 12.3% were receiving low-molecular-weight heparin. The key components of this clinic model emphasizes a patient-centered approach to perioperative anticoagulant management based on evidence-based management protocols, alongside patient and family education that is delivered by a multi-disciplinary team approach.

*Conclusions:* Our perioperative anticoagulation clinic model provides one approach to the delivery of perioperative anticoagulant management, with the potential to optimize patient safety, improve patient education, and minimize health care costs.

## 1. Introduction

The perioperative management of patients who are receiving anticoagulant therapy and require a surgery/procedure is a common clinical problem, with approximately 4 million such patients assessed in North America each year [1,2]. Multiple studies have provided the evidentiary basis for standardized perioperative anticoagulant management, including the use of heparin bridging, and the effect of this management on rates of thromboembolism and bleeding [3–6].

However, little attention has been accorded to the delivery of perioperative anticoagulant management and the infrastructure needed to capably deliver such patient care. It is our impression that delivery of perioperative anticoagulant management varies, depending in part on institution-specific resources and care paths. Without a standardized framework to manage anticoagulated patients who require a surgery/procedure, there is the potential for conflicting management approaches, for example, between the internist and anesthetist as to the appropriate interruption intervals for patients taking a direct oral anticoagulant (DOAC) or between the cardiologist and hematologist as regards the need for perioperative heparin bridging in warfarin-treated patients [7–9]. Moreover, uncertainty about a significant residual anticoagulant effect at surgery, especially if neuraxial anesthesia is used, may prompt administration of anticoagulant reversal agents, which are costly and potentially harmful [10,11], or postponement of the surgery. Finally, miscommunication between clinicians may also occur, often leaving patients uncertain about their care plan.

Against this background, the objectives of this paper are: i) to describe the structure, workflow and processes of a stand-alone perioperative anticoagulation management clinic; ii) to describe the patient case mix assessed in such a clinic; and iii) to highlight key elements that have made this clinic a valued component of perioperative care delivery at our institution. Providing a "how to" template for implementing a perioperative anticoagulation clinic may assist institutions that are considering incorporating this clinic for perioperative management.

## 2. Perioperative anticoagulation clinic model

### 2.1. Clinic setting and administrative overview

The perioperative anticoagulation management clinic is situated in a multidisciplinary outpatient department at St. Joseph's Healthcare Hamilton, a 660-bed, university-affiliated, tertiary care hospital that provides about 35,000 surgeries/procedures annually. The clinic takes place three afternoons per week; on average, 8 patients are assessed daily and each consultation takes 20–25 min to complete. A nurse practitioner plays an integral role in the clinic functioning with support

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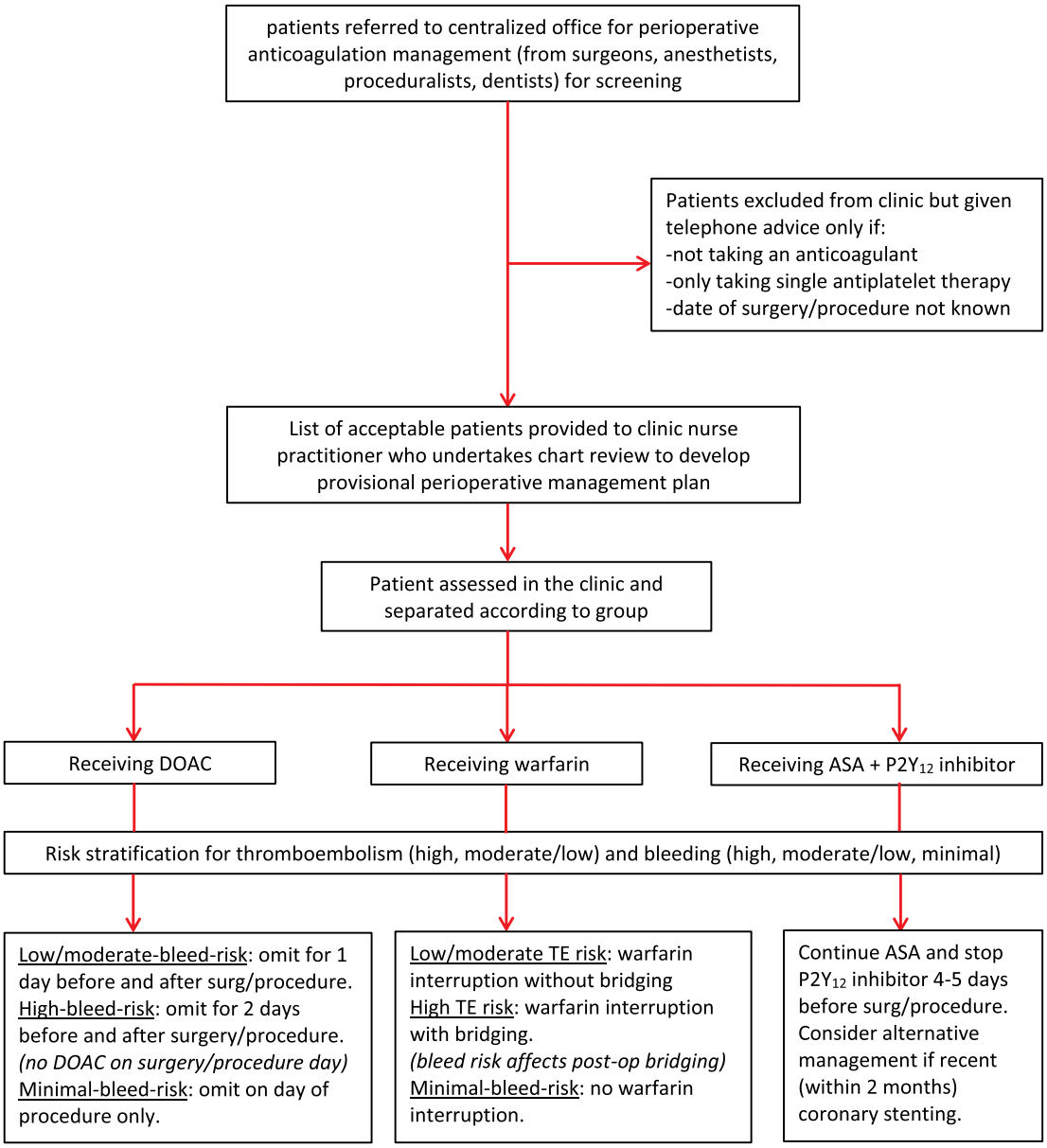


**Fig. 1.** Perioperative anticoagulation management care path.

and direction from two consultant physicians (internist and hematologist). Additional staff include an administrative assistant, who manages referrals and bookings, and technicians who draw blood samples in an adjoining blood-letting facility.

Patients are referred, typically, 1–2 weeks in advance of the planned surgery/procedure. However, the clinic has a flexible but necessary policy of accepting last minute and urgent cases; this approach ensures patients receive timely and necessary perioperative management for an urgent surgery/procedure. The clinic encourages participation of medical learners, including residents or fellows in thrombosis, hematology and internal medicine. An overview of the referral process including patient screening is shown in Fig. 1.

### 2.2. Pre-clinic preparation

Before each clinic, the nurse practitioner completes a chart review for all scheduled patients including past medical and medication history and pertinent laboratory results. This information is obtained from the hospital-based electronic medical record (EMR), a web-based portal that allows real-time access to medical information from regional hospitals and laboratories. Information identified includes anticoagulant therapy, reason for anticoagulation, surgery/procedure type, and laboratory test results (i.e., creatinine clearance for patients on DOACs, international normalized ratio [INR] for patients on warfarin). If these tests have not been done within the past three months, the nurse practitioner assesses the need for laboratory testing at the time of the clinic visit. A provisional perioperative management plan is developed and is finalized during the patient visit after consultation with the attending physician.

### 2.3. Consultation process

The consultation visit is a key element of the clinic because of the opportunity to educate the patient and family about their anticoagulant management and other medications. The anticoagulant history and drug dosage are reviewed, focusing on the adherence and compliance. As an example, for patients who are receiving a twice-daily administered DOAC, it is emphasized that such medication should be taken

every 12 h not 'twice a day'. For patients taking dabigatran, they are reminded that the drug has to stay in the humidity resistant packaging until it is taken to preserve the integrity of the drug. The therapeutic benefits of anticoagulation therapy are explained, including risk reduction of stroke in patients with atrial fibrillation. Care is taken to explain complicated medical concepts in a patient friendly manner to further improve both adherence and compliance with drug therapy. The next step is to review the documented perioperative plan with the patient/family for management of their anticoagulant treatment aimed at minimizing risk for thromboembolism and bleeding. To improve compliance with the management plan, patients and family members are encouraged to ask questions during the clinic visit. The nurse practitioner then finalizes the plan in collaboration with the attending physician.

A written summary of this plan is provided to the patient (see: Appendix 1). The user-friendly, calendar-format schedule specifies the date of the surgery/procedure, the date of the last dose of anticoagulant, the date of the anticoagulant resumption and, if needed, the dates and times of heparin bridging. Contact information is provided with encouragement to call as needed. With this approach, we have observed that < 5% of patients or family members will contact the clinic for additional advice. To optimize communication among clinicians involved in the care of the assessed patient, the management plan is incorporated into the hospital EMR and a paper copy of the perioperative anticoagulation plan is faxed to the referring surgeon/proceduralist.

### 2.4. Standardized anticoagulant management

The clinic uses an evidence-informed approach to manage patients that anchored on pivotal studies that assessed warfarin and DOAC-treated patients who required an elective surgery/procedure [12,13]. These standardized management approaches are summarized in Figs. 2 and 3 for warfarin-treated patients, and in Fig. 4 for DOAC-treated patients.

#### 2.4.1. Anticoagulant interruption

It is first necessary to determine whether perioperative anticoagulation interruption is warranted. Patients undergoing procedures that include dental extractions, skin biopsies, phacoemulsification (cataract extraction), coronary angiography (especially with a radial artery approach) or pacemaker implantation may not need anticoagulant interruption [14–17]. An important consideration for managing such patients is whether patients are taking warfarin, and if so, the INR should be < 3.0 at the time of the procedure [16]. Similarly, if they are taking a DOAC, the morning dose on the day of the procedure is omitted to avoid peak anticoagulant effect in close proximity to the time of the procedure [5]. Patients who require anticoagulant interruption undergo risk stratification for thromboembolism and bleeding, based on empiric but standardized formulations used in the BRIDGE and PAUSE studies, which demonstrated safe approaches for perioperative management of patients who are receiving warfarin or a DOAC, respectively [5,12,13].

#### 2.4.2. Patients who are receiving warfarin

For warfarin-treated patients, perioperative management is based on the BRIDGE study, a randomized trial of 1884 patients with atrial fibrillation who, after perioperative warfarin interruption, were randomly allocated to receive heparin bridging or no bridging management both pre and post procedure. This trial demonstrated that the 'no bridging' approach was non-inferior to 'bridging' for the outcome of stroke /arterial thromboembolism but associated with a significant reduction in major bleeding [12]. Patients at high risk for thromboembolism can be considered for heparin bridging. The BRIDGE trial offers dosing guidance on heparin bridging in atrial fibrillation patients within a high-risk subgroup, in whom bridging would be considered.

#### 2.4.3. Patients who are receiving a DOAC

For DOAC-treated patients, the clinic uses the standardized management approach validated in the PAUSE study. This study was a prospective clinical management cohort study of 3007 patients with atrial fibrillation who were receiving apixaban, dabigatran or rivaroxaban and required anticoagulant interruption for an elective surgery/procedure [13]. This study demonstrated that a standardized DOAC-specific management approach, based on surgery/procedure-related bleed risk and renal function/clearance, was associated with low rates of perioperative major bleeding (< 2%) and arterial thromboembolism (< 1%). The bleeding risk associated with the specific surgery/procedure determined the timing of anticoagulant interruption and resumption.

#### 2.4.4. Patients who are receiving dual antiplatelet therapy

Although not the principal role of the perioperative anticoagulation clinic, we occasionally are asked to manage patients who are receiving aspirin (ASA) and a $P2Y_{12}$ inhibitor (clopidogrel or ticagrelor), typically because of coronary artery stent implantation. In general, we continue ASA and interrupt the $P2Y_{12}$ agent 4–6 days before the surgery [18]. If an urgent surgery/procedure is needed, within one month after coronary stent implantation, we may consider empiric approaches such as continuing both antiplatelet drugs and transfusing platelets just before the surgery to mitigate against bleeding [19].

#### 2.4.5. Delaying the surgery/procedure

For patients with a recent (within 1 month) stroke, systemic embolism, acute coronary syndrome or venous thromboembolism (VTE), a recommendation may be made to defer the surgery/procedure. If delaying the surgery/procedure is not clinically acceptable, the clinic assists with anticoagulant and antiplatelet management. Another infrequent but important clinical scenario managed by the clinic is arranging for the placement of an inferior vena cava filter in patients with recent (within 3 months) VTE, in whom anticoagulant therapy cannot be administered [5].

#### 2.4.6. Perioperative patient care

For warfarin-treated patients having a high-bleed-risk surgery or neuraxial anesthesia, an INR is obtained the day before the surgery. If the INR is > 1.5, low-dose (1–2 mg) oral vitamin K can be administered [20]. Patients are provided with instructions for postoperative management, including guidance on dealing with various scenarios that reflect the potential sequalae associated with the surgery/procedure. Patients who are admitted to hospital for longer than an overnight stay are assessed by the inpatient Thrombosis Service. All patients are made aware they can contact the clinic nurse practitioner directly should there be questions or concerns of regarding the resumption of anticoagulant therapy post-procedure.

### 2.5. Clinic quality assurance

To improve clinic efficiency, we focused on two areas: i) scheduled patients who do not attend the clinic; and ii) unnecessary laboratory testing. To address the issue of patients not attending a scheduled visit, which we observed was as high as 17%, the clinic leveraged the administrative assistant who called patients with visit reminders the week prior to clinic visit; this essentially eliminated the problem. To address unnecessary laboratory testing, we instituted pre-clinic chart reviews to identify previous laboratory testing, thereby obviating the need for same-day clinic testing; with this process, we observed laboratory testing was reduced by 75%.

We recently performed a quality-assurance audit of practice, aimed at assessing the effect of education on patient knowledge, understanding and confidence regarding their anticoagulant management. Using a patient survey, administered while patients waited to be assessed in the clinic, we observed that 20% of clinic patients either did

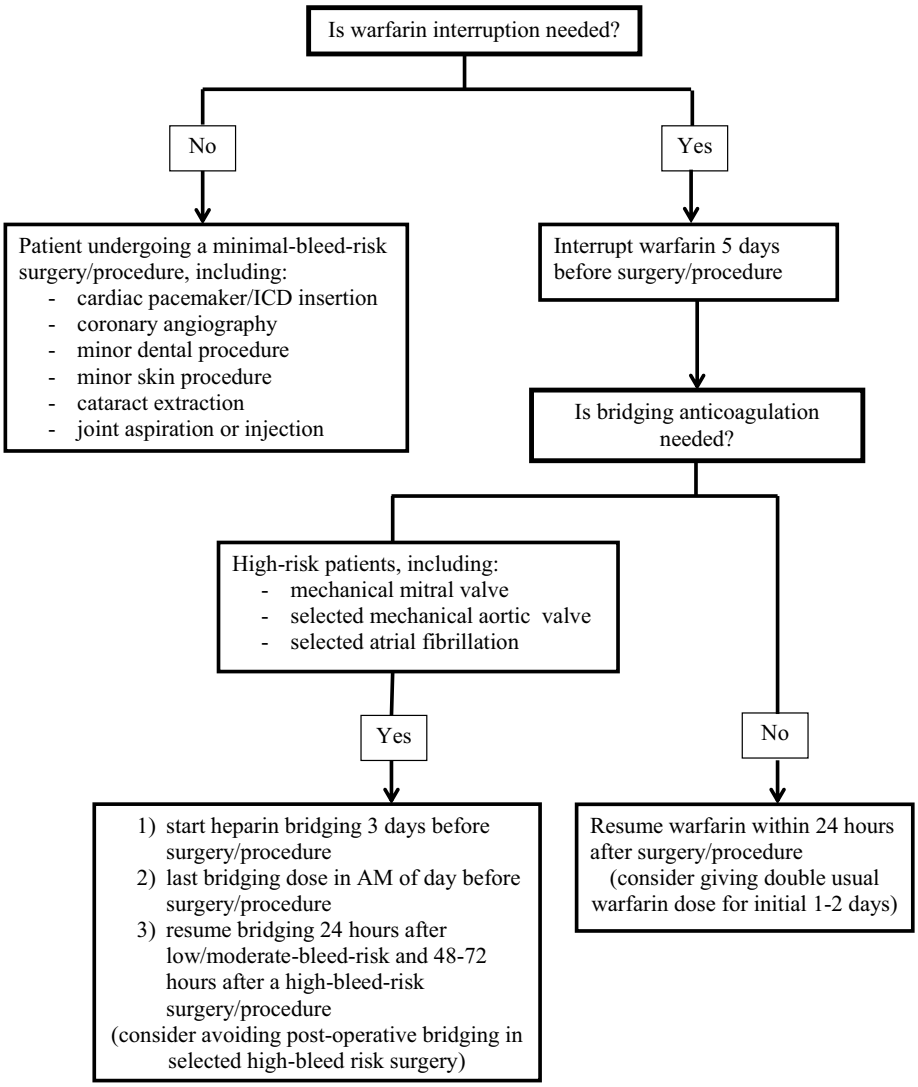


**Fig. 2.** Perioperative Management of Patients on Warfarin.
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not know they were receiving an anticoagulant (6%) or the name of their anticoagulant (14%). Uncertainty among patients as regards their anticoagulant therapy has been reported in another registry study whereby 4.9% of DOAC users and 2.3% of VKA users were unaware they were taking an anticoagulant [21]. Furthermore, we found that 98% of patients regarded the patient education useful, with confidence in their anticoagulant treatment increasing from 82% pre-visit to 96% post-visit.

## 3. Perioperative anticoagulation clinic patient population

To characterize the clinic patient population, we examined our patient database over an 18-month period, from July 2016 to December 2017. During this time period 1060 patients were assessed in the perioperative anticoagulation clinic, of which 914 (86.1%) were new referrals and 147 (13.9%) had been assessed in this clinic previously. The time interval between the clinic appointment and the date of the surgery/procedure was, on average, 8.2 days with a median interval of 7 days.

The clinical characteristics of patients assessed are shown in Table 1. Indication for anticoagulant therapy was: 584 patients (55.0%) had atrial fibrillation, 281 (26.5%) had VTE, including cancer-associated venous thrombosis, and 96 (9.0%) patients had a mechanical prosthetic heart valve. The remaining 99 patients were receiving anticoagulant therapy for miscellaneous reasons that included prior stroke, peripheral arterial disease, intracardiac thrombus, and cardiomyopathy. As shown in Table 2, the anticoagulant therapy clinic patients were receiving was as follows: 475 (44.8%) patients were taking a vitamin K antagonist, 394 (37.1%) were taking a DOAC, and 131 (12.3%) were receiving a low-molecular-weight heparin. The remaining 61 patients were receiving dual antiplatelet therapy, comprising ASA and a $P2Y_{12}$ inhibitor.

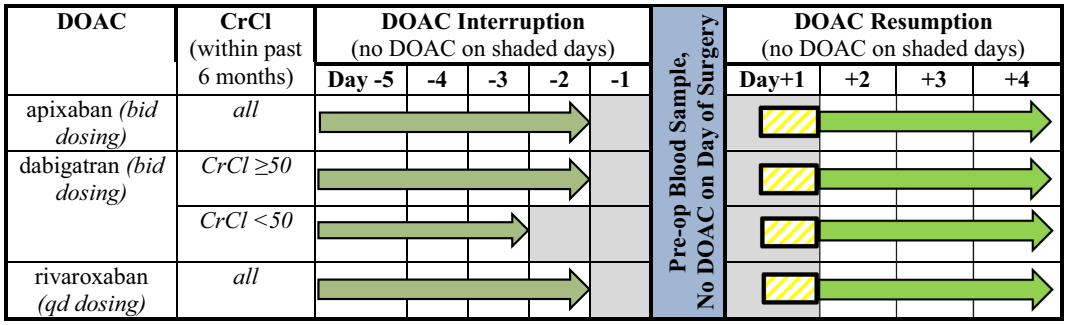
## 4. Discussion

Herein we describe the structure and function of a stand-alone perioperative anticoagulation management clinic that is used to manage patients who, typically, are receiving anticoagulant therapy and require an elective surgery/procedure. The clinic secondarily manages patients requiring an urgent surgery/procedure and those who are receiving dual antiplatelet therapy. Our assessment of this clinic model identifies 4 components that, collectively, aim to deliver safe, transparent and cost-efficient patient management: i) use of standardized, evidence-based perioperative anticoagulant and heparin bridging protocols; ii) a patient-centered management approach, emphasizing patient and family education; iii) use of a multi-disciplinary care

| Day | Warfarin dose | Bridging with LMWH | INR monitoring |
|---|---|---|---|
| − 7 to − 10 | Maintenance dose | Assess for perioperative bridging anticoagulation; classify patients as undergoing high or low bleeding risk procedures | Check baseline laboratory findings (hemoglobin, platelet count, serum creatinine, INR) |
| − 6 to − 5 | Begin to hold warfarin on day − 5 or day − 6 | No LMWH | None |
| − 4 | No warfarin | No LMWH | None |
| − 3 | No warfarin | Start LMWH at a therapeutic or intermediate dose* | None |
| − 2 | No warfarin | LMWH at a therapeutic or intermediate dose* | None |
| − 1 | No warfarin | Last preprocedural dose of LMWH administered no less than 24 h before the start of surgery at half the total daily dose | Assess INR before the procedure; proceed with surgery if the INR is < 1.5. If the INR is > 1.5 and < 1.8, consider low-dose oral vitamin K reversal (1–2.5 mg) |
| 0 or + 1 | Resume the maintenance dose of warfarin on the evening of or morning after the procedure | None | None |
| + 1 | Maintenance dose | Low bleeding risk: restart LMWH at the previous dose<br>High bleeding risk: no LMWH administration | According cto linician judgement |
| + 2 or + 3 | Maintenance dose | Low bleeding risk: LMWH administration continued<br>High bleeding risk: restart LMWH at the previous dose | According to clinician judgement |
| + 4 | Maintenance dose | Low bleeding risk: INR testing (discontinue LMWH if the INR is > 1.9)<br>High bleeding risk: INR testing (discontinue LMWH if the INR is > 1.9) | INR |
| + 7 to + 10 | Maintenance dose | – | INR |

**Fig. 3.** Perioperative Heparin Bridging Protocol during Warfarin Interruption.
Reproduced with permission from: Spyropoulos AC, et al. Periprocedural management of patients receiving a vitamin K antagonist or a direct oral anticoagulant requiring an elective procedure or surgery. *J Thromb Haemost.* 2016;14:875–85.

**Perioperative Management of DOACs (low/moderate-bleed-risk surgery/procedure)**




**Perioperative Management of DOACs (high-bleed-risk surgery/procedure)**

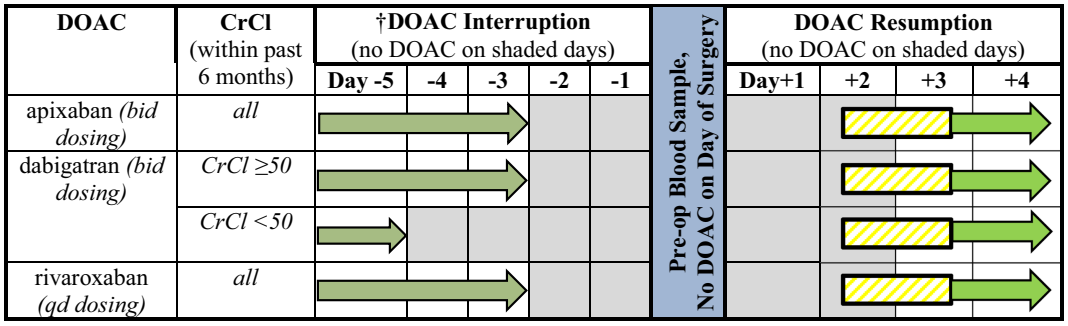



**Fig. 4.** Perioperative Management of DOACs.
Hatched rectangles refer to time period for DOAC resumption.

**Table 1**
Perioperative clinic patient characteristics.

| Patient characteristic | Patient group | | |
|---|---|---|---|
| | Atrial fibrillation | Venous thromboembolism | Mechanical heart valve |
| Mean age | 76.0 | 65.3 | 66.8 |
| Male sex, n (%) | 376 (64.4) | 113 (47.2) | 63 (65.6) |
| Mean creatinine (umol/L) | 111.8 | 104.3 | 134.8 |
| Mean CrCl (mL/min) | 69.5 | 92.6 | 69.6 |
| $CHADS_2$ score, n (%) | 0–1 | 138 (23.5) | Not applicable |
| | 2–3 | 336 (57.5) | |
| | 4–6 | 82 (14.0) | |
| $CHADS_2VA_2Sc$ score, n (%) | 0–2 | 80 (13.7) | Not applicable |
| | 3–5 | 383 (65.6) | |
| | 6–9 | 128 (21.7) | |

**Table 2**
Anticoagulant use in sample of 1061 perioperative clinic patients.

| Anticoagulant | Percent (number) |
|---|---|
| Direct oral anticoagulant | 37.1 (394) |
| Apixaban | 13.1 (139) |
| Dabigatran | 7.4 (79) |
| Rivaroxaban | 16.6 (176) |
| Vitamin K antagonist | 44.8 (475) |
| Warfarin | 44.1 (468) |
| Acenocoumarol | 0.7 (7) |
| Low-molecular-weight heparin | 12.3 (131) |
| Dalteparin | 6.8 (72) |
| Tinzaparin | 4.9 (52) |
| Enoxaparin | 0.6 (6) |
| Fondaparinux | 0.1 (1) |

team; and iv) use of technology and human resources to optimize efficiency and minimize costs.

The clinic provides evidence-based standardized perioperative anticoagulant management with the aim of minimizing perioperative risk for bleeding and thromboembolism. Alongside such management is consistent patient and family education, so patients can take greater ownership of their anticoagulant management and, thereby, further mitigate against the risks of perioperative bleeding and thromboembolism. As reflected in our patient survey aimed to audit quality of care, improved anticoagulant knowledge, understanding and confidence appears to improve adherence and compliance with perioperative management. Further, providing patients with written information and an instruction summary with staff contact numbers encourages patient to be engaged and confident in their perioperative anticoagulant care plan.

A value-added component of this clinic is to ensure that patients' overall anticoagulantmanagement is in accordance with best practices. This is exemplified by the situation where a patient's home anticoagulant type or dose is inconsistent with current evidence-based guidance, when the need for concomitant antiplatelet medication is not compelling but adds to the risk for bleeding, or in situations where continuing anticoagulant therapy may be unnecessary. Such discrepancies are relayed to the patient's anticoagulant provider for further assessment, with the option of referring such patients to a thrombosis clinic for further assessment.

Another key component of this clinic is a multi-disciplinary approach to patient care. The administrative assistant provides integral support to allow seamless delivery of care by ensuring patients are booked and reminded of their appointments in a timely fashion. The introduction of the nurse practitioner role to the clinic, with an emphasis on patient education, has resulted in improved patient knowledge and satisfaction, and growth in the clinic size. Collaboration between the physician, nurse practitioner and surgical teams aims to optimize the patient experience. Open communication and transparency are reflected by having patients and care givers (internists, surgeons, anesthetists) be aware of the care plan. The efficient functioning of the clinic is further facilitated through the hospital EMR, and with dedicated administrative support. Overall, we expect this approach will facilitate cost-efficient delivery of care by minimizing the postponement of interventions and the need to administer anticoagulant reversal agents due to uncertainty about anticoagulant levels at the time of the surgery/procedure.

We acknowledge limitations of this report. First, there is a need to validate the presumed benefits of the perioperative anticoagulation clinic on clinically important outcomes including rates of perioperative thromboembolism and bleeding, rates of surgery/procedure postponement and health resource utilization. Second, the clinic model presented may not be transferable to all health care settings, in particular if anticoagulant management is not centralized in a dedicated service and if personnel resources are limited. Third, we acknowledge that a standalone perioperative anticoagulation clinic may be less feasible in a smaller, rural or remote clinical setting where the volume of patients may be insufficient to justify its existence. Finally, we acknowledge the need for further study to assess the cost-effectiveness of this clinic model, specifically determining whether such a model may improve health care cost containment. Such investigations may take the form of a cluster randomized trial or case-control study, comparing the utility of this perioperative anticoagulation clinic model with usual care.

Despite these limitations, the perioperative anticoagulation clinic described herein provides a tested model that could be adapted to other institutions, particularly those with a substantial volume of patients requiring perioperative anticoagulant management and where appropriate resources are available. The standardized but patient-centered perioperative management protocols provide evidence-based practice guidelines, the education provided appears to be valued by patients, and the assessment of long-term anticoagulant management provides a value-added component that extends beyond perioperative management.

In summary, our perioperative anticoagulation clinic model aims to provide an effective option for the delivery of perioperative anticoagulant management, and has the potential to optimize patient safety, improve patient education, and minimize health care costs.

**Appendix 1. Examples of perioperative anticoagulation management plan**


**Perioperative Bridging Anticoagulation Programme**
**St. Joseph's Healthcare, Hamilton**

| | | | |
|---|---|---|---|
| Patient Name | John Doe | Today's Date | August 9, 2019 |
| Referring MD | H. Specialist | ID: | 123456 |
| Family MD | F. Doctor | DOB: | 01/01/1940 |
| Health card # | 123456789 | INR Lab: | N/A |
| Telephone # | 905-123-4567 | Allergies: | NKDA |
| Date of surgery/procedure | | August 21, 2019 – Colonoscopy | |
| Rivaroxaban/Xarelto: | | 20 mg daily @ 0830 | |

**Anticoagulation Pre- & Post-Operative**

| Date | Days to Procedure | Action |
|---|---|---|
| Sunday, August 19, 2019 | -2 | Last dose of Rivaroxaban |
| Monday, August 20, 2019 | -1 | |
| **Tuesday, August 21, 2019** | **Procedure** | |
| Wednesday, August 22, 2019 | 1 | Restart Rivaroxaban if no polyp removed |
| Thursday, August 23, 2019 | 2 | |
| Friday, August 24, 2019 | 3 | Restart Rivaroxaban if polyp removed |

St. Joseph's Healthcare **905-522-1234**
Dr. Green / Dr. Black / Dr. Orange /Dr. Blue– ext. 12345
Dr. Red – ext. 23456 Dr. Pink - ext. 34567
May or June, Nurse Practitioners, Thrombosis **-ext. 12345** or ext. 56789
Weekend Thrombosis assistance: ext. 77777 ask for Hematologist on call to be paged.
Emergencies report to the nearest hospital.

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