Implementation of home-based international normalized ratio testing in adult patients treated with warfarin: A quality improvement project

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ABSTRACT

Background and local problem: Patients who take warfarin require frequent testing of their international normalized ratio (INR) level to ensure accurate dosage. Frequent testing can be inconvenient for patients in rural settings, the workforce, the homebound, or those who travel. Patients who have a home INR monitor can test their blood remotely.

Methods: To circumvent barriers to INR testing, a quality improvement project was designed to implement home INR testing in an anticoagulation clinic setting.

Interventions: Patients who received a home INR monitor were compared against two usual care testing arms (laboratory and clinic testing patients) in the outcomes of time in therapeutic range (TTR), adverse events, and patient satisfaction using the Duke Anticoagulation Satisfaction Scale (DASS).

Results: The DASS survey demonstrated the home testing patients had a statistically significant advantage over the clinic testing group in the subdomain of hassles and burdens ($p = .048$), as well as the lowest overall scores (indicating highest satisfaction) over the clinic testing group ($p = .041$). No patients in the home testing group had clotting or bleeding issues necessitating hospital admission. There were no significant differences between groups in the TTR analysis (laboratory 70.8%, home 68.9%, and clinic 64.5%) ($p = .683$).

Conclusions: Home INR testing provides convenience for patients and reduces the hassles and burdens of warfarin management, leading to improved satisfaction. This engagement in self-care translates to reduced adverse events. Home INR testing can be used in warfarin patients who are highly motivated and willing to engage in their care.

Keywords: Anticoagulation; home INR testing; international normalized ratio; warfarin.

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Introduction

Warfarin is an anticoagulant medication that is designed to treat and prevent blood clots. To ensure accurate dosage, patients taking warfarin must undergo frequent blood tests to check their international normalized ratio (INR) level, a measurement that helps determine the effects of warfarin on the blood clotting system. Patients with an optimal INR level are maximizing their time in therapeutic range (TTR), which results in a reduction in adverse events.

It has been well established that patients who do not have their INR tested in a timely manner experience worse outcomes (i.e., increased risk of bleeding, clotting, and mortality) and spend less time in their therapeutic range (Ansell, Jacobson, Levy, Voller, & Hasenkam, 2005; Matchar et al., 2010). Although barriers to testing compliance vary, common obstacles include transportation, time of day (appointments during work hours), limited mobility (homebound), and frequent travel (Ansell, 2014).

This quality improvement (QI) project implemented the use of home INR testing to circumvent these obstacles, empowering patients to test their INR remotely on a weekly basis, which has been shown to increase their time in therapeutic range, reduce adverse events, and improve patient satisfaction.

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Evidence from the literature

Home INR testing has been shown to have favorable outcomes in the improvement of TTR. Statistically significant improvements in TTR were found in numerous studies and meta-analyses comparing home testing to clinic-based testing (Cumberworth, Mabvuure, Hallam, & Hindocha, 2013; Heneghan et al., 2016; Matchar et al., 2010; Xu et al., 2012). Even when home-testing patients returned to clinic-based care, they continued to show statistically significant improvements in their TTR compared with the control group (75% vs. 59%, respectively) (Ryan, O'Shea, & Byrne, 2010).

Improvements in TTR translate into a reduction in adverse events, leading to cost savings and improvements in patient well-being (Lafata, Martin, Kaatz, & Ward, 2000; Phibbs et al., 2016). Home testing has been shown to significantly reduce thromboembolic events (42–55% reduction) and reduce all-cause mortality by 26–42% (Cumberworth et al., 2013). The reduction in major thromboembolism and mortality was confirmed by Bloomfield et al. (2011). In both studies, patients were not at an increased risk of major bleeding.

Patient satisfaction and quality of life have also been studied in conjunction with other outcomes related to home-based INR testing. Matchar et al. (2010) showed statistically significant improvement in quality of life and patient satisfaction (as measured by the Duke Anticoagulation Satisfaction Scale [DASS]) in the home-testing group. Improvements in TTR have been associated with significantly greater general well-being (Ward et al., 2015). In addition, a meta-analysis by Bloomfield et al. (2011) confirmed improved patient satisfaction and quality of life with home INR testing and management.

Rationale

Home INR testing has been shown to lead to statistically significant improvements in TTR, which in turn leads to fewer adverse events, a lower risk of mortality, cost savings, and improved patient satisfaction and quality of life. Anticoagulation clinics and primary care providers can provide a high level of care to their anticoagulation patients through home-based INR monitoring, an evidence-based strategy shown to improve health outcomes. The research cited previously provides strong evidence that a transition to home INR testing can enhance patient care among community-based adults taking warfarin.

Specific aims

The primary objective of this QI activity was to implement home INR testing in adult patients treated with warfarin who met inclusion criteria. The specific aims of the project were to improve TTR, reduce adverse events (bleeding, clotting, and mortality), and improve patient satisfaction as measured by the DASS, a validated tool for measuring the satisfaction level of patients using anticoagulants (Samsa et al., 2004). The outcomes of the home-based INR group were compared against groups receiving INR tests in clinic and laboratory settings.

Methods

The goal of the QI project was to evaluate the outcomes in patients who met criteria for home INR testing as compared with routine care across all patient groups. The home-testing patients needed to meet stricter inclusion criteria than the other testing groups due to dexterity and cognitive abilities required for self-testing. These strict criteria were not required of the laboratory and clinic testing patients.

To meet the home INR inclusion criteria, the patient was required to:

- Have a diagnosis that necessitated warfarin for long-term anticoagulation;
- Be taking warfarin for at least 3 months; and
- Have the physical ability to conduct the weekly self-test (or the patient had someone who was available to assist)

Exclusion criteria included cognitive impairment, lack of coordination or ability to perform the test, diagnosis of any kind of coagulopathy (factor V Leiden, protein C deficiency, protein S deficiency, antiphospholipid syndrome [APS], etc), or patient declination of the home testing machine. The literature primarily supports the exclusion of fingerstick point-of-care testing in patients with APS (Perry, Samsa, & Ortel, 2005), but questions have arisen about the accuracy in other coagulopathies, so all were excluded from the home and clinic testing arms; they were included in the laboratory testing arm.

The Centers for Medicare and Medicaid Services outline and support coverage for the criteria outlined above, as do the current anticoagulation guidelines set by the American Academy of Family Physicians (Wigle, Bloomfield, Tubb, & Doherty, 2013).

All patients who met inclusion criteria for home INR testing were given the option to enroll in the intervention arm of the QI project through a discussion with the anticoagulation nurse practitioner (NP). The home-test intervention arm also included nine patients from the anticoagulation clinic who were previously trained on home-INR testing by their primary care physicians, their cardiologist, or their home testing company. The training they received was the same as the training provided to the other patients in this group by the NP. The same protocols and inclusion criteria were applied.

The anticoagulation clinic NP enrolled all patients in the QI project and cared for them throughout the data collection period. Patients across all three testing arms

received standardized warfarin dosing following the clinic's evidence-based dosing nomogram, with allowances for patient-specific circumstances.

Once a patient was approved to participate in the home testing group, the clinic's NP placed an order for an INR monitor through a local durable medical equipment (DME) company. The DME company evaluated the patient's insurance coverage and disclosed any out-of-pocket costs before mailing the INR monitor to the patient.

Once the patient received the monitor, he or she was trained on how to use it. The anticoagulation NP trained each participant with a standardized education plan that covered the following: a demonstration on how to set up and use the monitor; an observation period to ensure the patient and/or the caregiver could perform the INR test; troubleshooting tips; supply ordering; and reporting results. INR results were reported by either calling the DME company's call center or by using a cell phone application to upload results to a secure Health Insurance Portability and Accountability Act of 1996-compliant electronic database. The training session lasted an average of 45 minutes. All patients were encouraged to call the anticoagulation clinic or the DME company with any questions. A follow-up appointment in the anticoagulation clinic was scheduled for two months after training to re-assess testing technique; if patients faced any issues before the 2-month check-in, they were able to return to the clinic sooner for immediate assistance.

After being trained, patients conducted an INR self-test on a weekly basis (same day each week). As soon as the results were submitted, the NP received the patient's INR results through fax, as well as through the online electronic database. The NP or the anticoagulation clinic's medical assistant would then call the patient to discuss the result and any changes in medications, diet, or vitamin K intake. They would also discuss any bleeding or clotting events and any other changes in the patient's general health status. Based on the discussion, the NP determined if a warfarin dosing change was necessary. The decision was then communicated to the patient during the call, and the patient read back the plan to confirm comprehension.

Analysis

All three test groups were assessed across three outcome measures over a 4-month data collection period (August 1, 2018, through November 30, 2018). The three measures were time in the therapeutic range (TTR); incidence of bleeding and clotting events; and patient satisfaction.

The first outcome measure was TTR—the percent of time a patient spends in his or her therapeutic range, as calculated by the Rosendaal method (Rosendaal, Cannegieter, van der Meer, & Briët, 1993). Each group's average TTR was calculated and cross-analyzed across all three test groups (home testing, clinic testing, and laboratory testing). The data were manually collected from the clinic's electronic medical records, and a report was created for each individual patient. A Welch *F* test was used to analyze results due to heterogeneity of variance between groups (Delacre, Lakens, Mora, & Leys, 2018).

The second outcome measure was incidence of bleeding and clotting events during the data collection period. The operational definition of this outcome measure is the evaluation of the type and incidence of bleeding or clotting events as measured across the three testing groups (home testing, clinic testing, and laboratory testing). The data were collected during the in-person or telephone conversation with each patient about his or her INR result. During this conversation, the NP or medical assistant asked whether the patient had experienced any bleeding or clotting events since their previous INR test. Each event in every group was analyzed using descriptive statistics (*n*, %).

The third outcome measure was patient satisfaction, evaluated through patient responses to a 25-item validated questionnaire: the "Duke Anticoagulation Satisfaction Scale" (DASS). The data were collected from an anonymous survey that was mailed to patients with a prepaid envelope. The DASS was broken down into three domains: limitations (items 1A–2D), hassles and burdens (3A–3H), and positive psychological impact (items 4A–4J). A Welch *F* test was used to compare the three testing arms on the average score in these three domains, as well as the overall average score of each group, as the homogeneity of variance assumptions were not met. A Likert scale with a range of 1–7 was used for each item. The lower the score, the higher the patient satisfaction.

Results

A total of 105 eligible patients were included in the overall analysis: 68 laboratory testing patients, 20 home testing patients, and 17 clinic testing patients. Sample sizes differed across groups as this was a convenience sample that did not involve random assignment, but rather, patient's choice of test group. Table 1 summarizes the demographic characteristics of each test arm. The average patient age was 74 years. There was a statistically significant difference in age between the clinic and laboratory testing patients ($p < .001$), but they were not different from the home testing patients. There were no significant differences in gender or target INR range.

There were several indications for anticoagulation therapy (Table 1). For most indications, there were no significant differences in number of patients enrolled in each group. The number of patients in the home testing group was significantly different than the laboratory and clinic testing groups for the indications of "atrial fibrillation" ($p = .009$), as well as "history of clot and known coagulopathy" ($p = .009$).

Table 1. Demographic data

	Laboratory Testing (*n* = 68)	Home Testing (*n* = 20)	Clinic Testing (*n* = 17)	All Groups	*p*-Value
Age, years					<.001[a]
Mean	71.33	76.55	83.00	74.22	
SD	11.17	11.06	8.17	11.49	
Age range	44–92	46–93	71–97	44–97	
Gender					.733
Female, no (%)	31 (45.6)	8 (40)	9 (53)	48 (45.7)	
Male, no (%)	37 (54.4)	12 (60)	8 (47)	57 (54.3)	
Indication—no (%)					
Atrial fibrillation	32 (47.1)	12 (60)	15 (88)	59 (56.2)	.009
Mechanical heart valve replacement	9 (13.2)	5 (25)	3 (17.6)	17 (16.2)	.448
Bioprosthetic valve replacement	—	—	1 (5.9)	1 (1)	.073
Valve repair	2 (2.9)	—	—	2 (1.9)	.574
CVA	7 (10.3)	—	—	7 (6.7)	.130
TIA	2 (2.9)	—	—	2 (1.9)	.574
DVT/PE	12 (17.6)	2 (10)	—	14 (13.3)	.142
DVT	13 (19.1)	3 (15)	3 (17.6)	19 (18.1)	.914
PE	4 (5.9)	2 (10)	—	6 (5.7)	.424
History of clot and known coagulopathy	15 (22.1)	—	—	15 (14.3)	.009
Mesenteric/portal vein thrombosis	1 (1.5)	—	—	1 (1)	.760
Arterial thrombosis	1 (1.5)	—	1 (5.9)	2 (1.9)	.387
Superficial venous thrombus	1 (1.5)	—	—	1 (1)	.760
Patients with >1 indication	14 (20.6)	4 (20)	6 (35)	24 (22.9)	.410
INR goal—no (%)					.966
INR goal 1.5–2[b]	1 (1.5)	—	—	1 (1)	
INR goal 2.5–3	1 (1.5)	—	—	1 (1)	
INR goal 2-3	59 (86.8)	17 (85)	15 (88)	91 (86.7)	
INR goal 2.5–3.5	7 (10.3)	3 (15)	2 (11.8)	12 (11.4)	
Group total	68 (64.8)	20 (19)	17 (16.2)	105 (100)	

Note: CVA = cerebrovascular accident; DVT = deep vein thrombosis; INR = international normalized ratio; PE = pulmonary embolism; TIA = transient ischemic attack.
[a]Laboratory patients were statistically significantly younger than clinic patients ($p < .001$).
[b]Outlier patient on chronic anticoagulation with special circumstances.

TTR

Differences in TTR between groups were analyzed using a one-way analysis of variance (ANOVA). Owing to lack of homogeneity of variance, the Welch *F* result is reported. The mean TTR percentage for the home testing patients was 68.9%. This was compared with the laboratory testing patients (70.8%) and clinic testing patients (64.5%). The results showed no differences between groups Welch $F(2, 35.023) = 0.385$, $p = .683$. TTR results from all three groups were noted to be at or above TTR results of recent trials, including The Rivaroxaban Once Daily Oral Direct Factor Xa Inhibition Compared with Vitamin K

Table 2. Patient satisfaction as measured by the Duke Anticoagulation Satisfaction Scale

Domain	Laboratory (*n* = 47) M (SD)	Home (*n* = 14) M (SD)	Clinic (*n* = 14) M (SD)
Limitations	1.95 (0.60)	1.69 (0.85)	2.49 (1.24)
Hassles/burdens	1.75 (0.52)	1.45 (0.41)[a]	2.20 (1.00)
Positive impact	2.27 (0.89)[b]	1.77 (1.03)	2.47 (1.34)
Overall	1.97 (0.50)	1.64 (0.53)	2.39 (0.93)

Note: Scale of one to seven; lower scores indicate higher satisfaction.
[a]*n = 13.*
[b]*n = 46.*

Table 3. Adverse events

	Laboratory	Home	Clinic	All Groups
Eye (subconjunctival hemorrhage)	2			2
Ear/nose/throat				
Nosebleeds	5	2	2	9
Ear bleeding		1	1	2
Dental/oral	1	1[b]		2
Gynecological	1	1		2
Gastrointestinal				
Hemorrhoid bleed		1	1	2
Liver bleed			1[a]	
Integumentary	4[a,b]			4
Central nervous system				
Transient ischemic attack	1			1
Total	14	6	5	25

[a]*Hospitalized.*
[b]*Emergency department visit.*

Antagonism for Prevention of Stroke and Embolism Trial in Atrial Fibrillation (ROCKET AF) (55%) (Patel et al., 2011), The Randomized Evaluation of Long-Term Anticoagulation Therapy (RE-LY) (64%) (Wallentin et al., 2010), and Outcomes Registry for Better Informed Treatment of Atrial Fibrillation (ORBIT-AF) (65%) (Pokorney et al., 2015).

Patient satisfaction

The DASS survey was mailed to all warfarin patients in the clinic (*n* = 150); it was returned by 87 patients (response rate of 58%). Of those surveys, 75 were from patients included in the overall analysis and were thus evaluated. This included 47 laboratory testing patients, 14 home testing patients, and 14 clinic testing patients. A one-way ANOVA was used to analyze the results; once again, the Welch *F* result is reported due to lack of homogeneity of variance between groups. Overall, there was a significant difference between groups in the subdomain of hassles and burdens, $F(2, 23.58) = 4.21$, $p = .027$. Games-Howell post hoc tests showed that this was due to mean differences between home and clinic patients ($p = .048$). There were no differences between groups for limitations ($p = .173$) or positive impact ($p = .228$). For overall satisfaction, there was an overall significant difference between groups, Welch $F(2, 22.50) = 3.93$, $p = .034$. Games-Howell post hoc tests showed this was due to mean differences between home and clinic patients ($p = .041$). Table 2 describes the mean values and SDs for each subdomain, as well as the group as a whole.

Adverse events

As detailed in Table 3, there were 25 combined adverse events across all three testing arms. Two were deemed major events, and the other 23 were deemed minor events (defined below). Four patients received care in the emergency department, two of which were admitted to the hospital. Eight patients received care from their primary care provider or at a walk-in clinic or the anticoagulation clinic. The remainder of the patients did not seek medical care.

For the purposes of this project, a major bleeding event was defined as necessitating hospital admission, and a major clotting event was defined as an objective thromboembolic event. The major bleeding events included one patient in the clinic testing arm who experienced a drop in their hemoglobin associated with warfarin and enoxaparin postoperatively; the patient was admitted to the hospital and received a transfusion. The second major bleeding event was in the laboratory testing group, where a patient developed a hematoma of the leg after a fall. The single minor clotting event was a transient ischemic attack in a laboratory testing patient who had a slightly subtherapeutic INR of 1.93; the patient made a rapid recovery.

The most common bleeding issue was epistaxis. Four of the minor bleeding events were associated with supratherapeutic INRs. All other bleeding events were in patients with therapeutic or subtherapeutic INRs. No patients in the home testing group had bleeding issues associated with supratherapeutic INRs. The home testing group did not have any clotting or bleeding issues necessitating hospital admission. There was no mortality in any of the groups.

Limitations

This QI project was implemented in an anticoagulation clinic that is dedicated to anticoagulation care, which may limit the generalizability of results to a primary care setting. The small number of patients in the home and clinic testing groups may also limit generalizability to other settings. The test strips for the CoaguChek XS PT/INR monitors that were used by the clinic and home testing patients were recalled in the middle of the data collection period, which may have affected the accuracy of some testing results. Although all home testing patients had been self-testing for at least 3 months, this may not have been enough time for them to become stable in their INR results, as TTR continued to improve after completion of the data collection.

Implications for nursing practice

The results of this QI project demonstrate that high-quality anticoagulation care can be achieved using home INR testing. Advance practice nurses recognize the importance of patient engagement, which improves outcomes and boosts patients' self-confidence. There is a need for patients to be able to test their INR remotely, which can improve compliance with treatment, prevent adverse outcomes, and improve their satisfaction. Providers can easily access home INR results through an online system, which then allows them to provide timely responses to patients, without increasing clinic workload.

Conclusions

Home INR testing provides convenience for patients and reduces the hassles and burdens associated with traveling to a clinic for a laboratory draw or office visit. In this QI project setting, there were no significant differences found in INR control as measured by TTR between groups. This indicates that in this population, home INR monitoring is not inferior in keeping patients in their target range when compared with other testing methods. All three groups maintained TTRs that are considered to be in line with national averages and global research on good anticoagulation care (i.e., a TTR greater than 65% indicates a reduced risk of adverse events [Haas et al., 2016]). In this QI project, the home testing patients experienced fewer major bleeding and clotting events, which confirms the results from several previous studies (Bloomfield et al., 2011; Cumberworth et al., 2013). The home testing patients had the highest satisfaction as compared with the other two testing groups as measured by the DASS, which indicates that patients prefer testing at home instead of traveling to a clinic or laboratory.

This project was unique in examining three testing arms, with three outcome measures, concluding that home INR testing can be successfully used in anticoagulation clinic and primary care settings by patients who are motivated and willing to engage in their care. Home INR testing addresses quadruple aims: improving clinical outcomes; reducing health care costs; enhancing patient satisfaction; and improving the work life of health care providers by reducing the need for office visits. Primary care providers who do not have capabilities to manage warfarin patients closely should consider referring patients to specialty anticoagulation clinics or conversion of warfarin to a direct oral anticoagulant. Furthermore, patients with low TTR who are eligible for direct oral anticoagulants should be assessed for therapy transition.

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References

Ansell, J. (2014). Home INR monitoring improves warfarin therapy. *Today's Geriatric Medicine*, 7, 28.

Ansell, J., Jacobson, A., Levy, J., Voller, H., & Hasenkam, M. (2005). Guidelines for implementation of patient self-testing and patient self-management of oral anticoagulation. International consensus guidelines prepared by international self-monitoring association for oral anticoagulation. *International Journal of Cardiology*, 99, 37–45.

Bloomfield, H. E., Krause, A., Greer, N., Taylor, B. C., MacDonald, R., Rutks, I., … Wilt, T. J. (2011). Meta-analysis: Effect of patient self-testing and self-management of long-term anticoagulation on major clinical outcomes. *Annals of Internal Medicine*, 154, 472–482.

Cumberworth, A., Mabvuure, N. T., Hallam, M. J., & Hindocha, S. (2013). Is home monitoring of international normalised ratio safer than clinic-based monitoring? *Interactive CardioVascular and Thoracic Surgery*, 16, 198–201.

Delacre, M., Leys, C., Mora, Y. L., & Lakens, D. (2019). Taking parametric assumptions seriously: arguments for the use of welch's f-test instead of the classical f-test in one-way ANOVA. *International Review of Social Psychology*, 32(1), 13.

Haas, S., Ten Cate, H., Accetta, G., Angchaisuksiri, P., Bassand, J. P., Camm, A. J., … Kakkar, A. K. (2016). Quality of vitamin K antagonist control and 1-year outcomes in patients with atrial fibrillation: A global perspective from the GARFIELD-AF registry. *PLoS One*, 11, 1–15.

Heneghan, C. J., Garcia-Alamino, J. M., Spencer, E. A., Ward, A. M., Perera, R., Bankhead, C., … Onakpoya, I. J. (2016). Self-monitoring and self-management of oral anticoagulation. *The Cochrane Database of Systematic Reviews*, 7, CD003839.

Lafata, J. E., Martin, S. A., Kaatz, S., & Ward, R. E. (2000). The cost-effectiveness of different management strategies for patients on chronic warfarin therapy. *Journal of General Internal Medicine*, 15, 31–37.

Matchar, D. B., Jacobson, A., Dolor, R., Edson, R., Uyeda, L., Phibbs, C. S., … Lavori, P. (2010). Effect of home testing of international normalized ratio on clinical events. *The New England Journal of Medicine*, 363, 1608–1620.

Patel, M. R., Mahaffey, K. W., Garg, J., Pan, G., Singer, D. E., Hacke, W., … Califf, R. M. (2011). Rivaroxaban versus warfarin in nonvalvular atrial fibrillation. *The New England Journal of Medicine*, 365, 883–891.

Perry, S. L., Samsa, G. P., & Ortel, T. L. (2005). Point-of-care testing of the international normalized ratio in patients with anti-phospholipid antibodies. *Journal of Thrombosis and Haemostasis*, 94, 1196–1202.

Phibbs, C. S., Love, S. R., Jacobson, A. K., Edson, R., Su, P., Uyeda, L., & Matchar, D. B. (2016).At-home versus in-clinic INR monitoring: A cost-utility analysis from the home INR study (THINRS). *Journal of General Internal Medicine*, 31, 1061–1067.

Pokorney, SD., Simon, D. N., Thomas, L., Fonarow, G. C., Kowey, P. R., Chang, P., … Peterson, E. D. (2015). Patients' time in therapeutic range on warfarin among US patients with atrial fibrillation: Results from ORBIT-AF registry. *American Heart Journal*, 170, 141–148.e1.

Rosendaal, F. R., Cannegieter, SC., van der Meer, F. J., & Briët, E. (1993). A method to determine the optimal intensity of oral anticoagulant therapy. *Thrombosis and Haemostasis*, 69, 236–239.

Ryan, F., O'Shea, S., & Byrne, S. (2010). The "carry-over" effects of patient self-testing: Positive effects on usual care management by an anticoagulation management service. *Thrombosis Research*, 126, 345–348.

Samsa, G., Matchar, D. B., Dolor, R. J., Wiklund, I., Hedner, E., Wygant, G., … Edwards, R. (2004). A new instrument for measuring anticoagulation-related quality of life: Development and preliminary validation. *Health and Quality of Life Outcomes*, 2, 22.

Wallentin, L., Yusuf, S., Ezekowitz, M. D., Alings, M., Flather, M., Franzosi, M. G., … Connoly, S. J. (2010). Efficacy and safety of dabigatran compared with warfarin at different levels of international normalised ratio control for stroke prevention in atrial fibrillation: An analysis of the RE-LY trial. *Lancet*, 376, 975–983.

Ward, A., Tompson, A., Fitzmaurice, D., Sutton, S., Perera, R., & Heneghan, C. (2015). Cohort study of anticoagulation self-monitoring (CASM): A prospective study of its effectiveness in the community. *The British Journal of General Practice*, 65, e428–e437.

Wigle, P., Bloomfield, H. E., Tubb, M., & Doherty, M. (2013). Updated guidelines on outpatient anticoagulation. *American Family Physician*, 87, 556–566.

Xu, Z., Wang, Z., Ou, J., Xu, Y., Yang, S., & Zhang, X. (2012). Two monitoring methods of oral anticoagulant therapy in patients with mechanical heart valve prosthesis: A meta-analysis. *Journal of Thrombosis and Thrombolysis*, 33, 38–47.