

Objective:

To provide practical strategies supported by the best available evidence for managing out-of-range international normalized ratios (INRs) for patients on long-term warfarin therapy.

Background:

1. Warfarin can be challenging to manage due to its narrow therapeutic range, variable dose-response among patients and common interactions with drugs, diet, alcohol, and other factors.
2. In patients who are taking warfarin, thromboembolic events and bleeding are strongly related to the time in therapeutic range (TTR). This is the proportion of treatment time that the INR is within the target therapeutic range (typically 2.0 to 3.0 or 2.5-3.5 for patients with mechanical mitral valve replacements).
3. Clinicians may underdose warfarin due to a perceived greater risk of harm from bleeding associated with supratherapeutic INR values. However, subtherapeutic anticoagulation has been shown to increase the frequency and severity of thromboembolic events.
4. Good INR control, defined empirically as a TTR >60%, may be best achieved by appropriately addressing both high and low INR values using a consistent approach (paper-based dosing nomogram or computerized decision support program).

Approach to Out-of-Range INR Values:

1. For each out-of-range INR value, attempt to identify the cause. See the section below, "Summary of Common Causes of Out-of-Range INRs".

Questions to ask the patient include:

- *Tell me what warfarin doses you've taken in the past 2 weeks.* The patient may have mistakenly taken a different dosage regimen than what was prescribed.
- *Have you missed any doses in the past week? If yes, how many? How do you ensure that all doses have been taken? Do you use a calendar to record doses? A pill box?*
- *Have you started or stopped any medication or supplements (prescription or non-prescription) recently? Any new antibiotics? Any dose changes of your medications? Do you take acetaminophen? How many per day?*
- *How is your appetite? Have you been eating regularly? Have there been any recent changes in your diet?*
- *Do you drink alcohol? If yes, how often and how much alcohol do you drink? Do you drink just on weekends?*
- *Do you consume cannabis products? This includes CBD. If yes, how much and how often?*
- *Overall, how has your health been? Any infection? Fever? Diarrhea? Flu? Recent cold?*

2. Determine if a change in dose needs to be made at all, and if so whether a **one-time change in the dose** is all that is required or if a **change in the maintenance dose** is required or both.
 - A change in the maintenance dose should be considered if there are at least **two consecutive out-of-range INR values (in the same direction) in a patient with previously stable, in-range INRs and for which there is no identified temporary cause.**
 - A one-time change in the dose is appropriate for patients in which a transient cause is identified.

Managing Single Out-of-Range INR Values:

For patients with previously in-range INR values who present with a single slightly out-of-range INR (e.g. INR 0.5 above or below the target range), there are two management options:

1. Continue current maintenance dose and repeat INR in 1-2 weeks, OR
2. Make a one-time dose change (increase or hold by ½ to 1 single dose) and resume current maintenance dose. Repeat INR in 1-2 week.

The specific approach is influenced by the magnitude of the out-of-range value, previous experience of similar values in the patient and whether the patient has strong risk factors for thrombosis/stroke or bleeding.

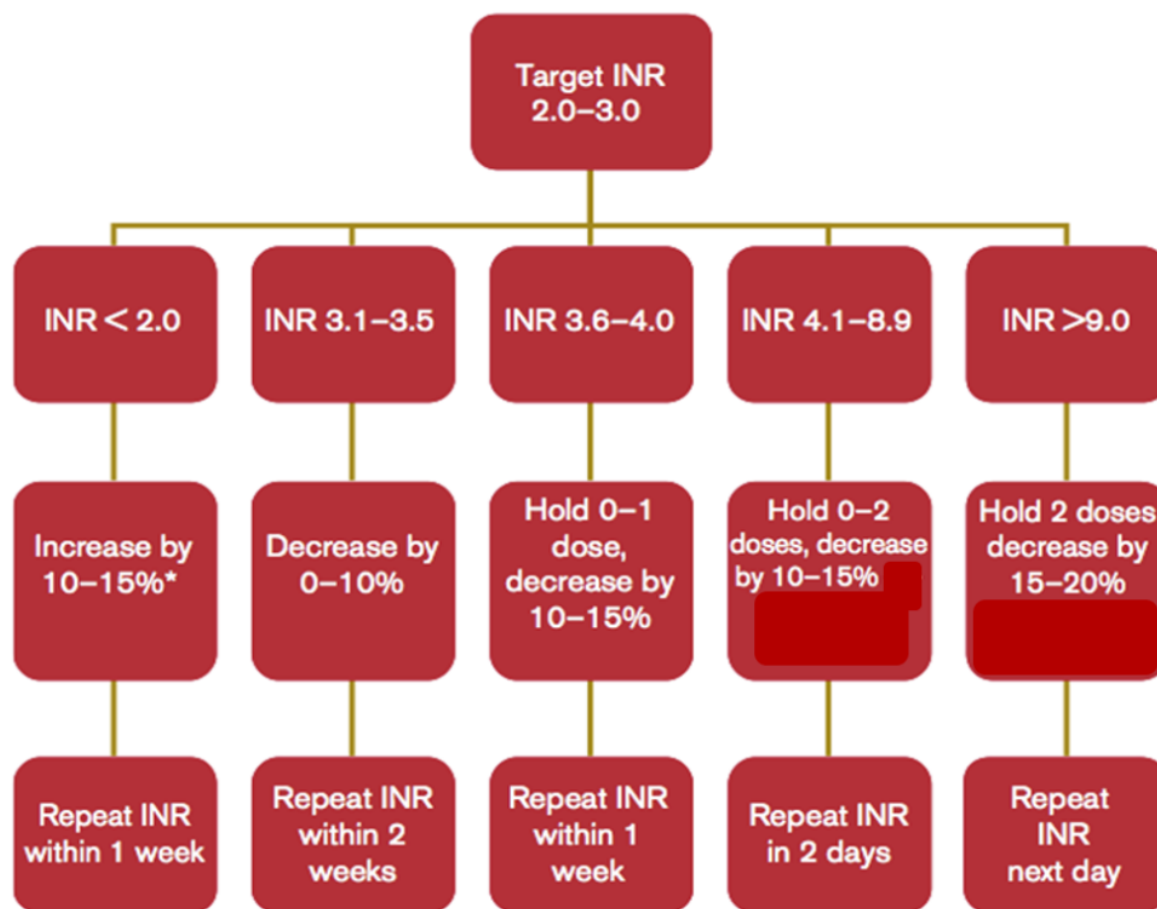
Maintenance Dosing Algorithms:

There are many warfarin dosing algorithms available. Healthcare professionals managing patients on warfarin should become familiar with one approach in order to develop experience and consistency in making dosing changes.

One example of an available computer decision support tool is [INR Online®](http://www.inronline.ca/) <http://www.inronline.ca/> (may require a subscription)

The **Figure** below is a sample, paper-based Maintenance Dosing Algorithm published by the American Society of Hematology (2014) for the management of **non-bleeding** patients taking warfarin. This nomogram serves as a guide and does not replace clinical judgment.

Figure: Warfarin Dose Adjustment in Non-bleeding Patients by % Dose Change of Total Weekly Dose (adapted from Cushman et al, 2014)



*Consider 15% increase if INR ≤ 1.5 without explanation

This algorithm is based on making a dose change as a percentage of the total weekly dose.

For patients with INRs of >4.5 but <10 and without clinically relevant bleeding, temporary cessation of VKA alone without the addition of vitamin K is suggested. Vitamin K may be given if INR >10 , even in the absence of bleeding, depending on individual patient circumstances (e.g. risk factors for bleeding, risk for thrombosis if over-correction of INR, ability to have repeat INR testing).

Summary of Common Causes for Out-of-range INRs:

Table 1 and **Table 2** summarize common causes and management strategies for LOW and HIGH INRs, respectively. Ensure patients' ongoing understanding and potential causes of out-of-range INRs. When adding or discontinuing medications for a patient receiving warfarin, consider use of an evidence-based drug interaction program or reference, if available.

Table 1: Common Causes of LOW INRs and Management Strategies

COMMON CAUSES OF LOW INRS	MANAGEMENT STRATEGIES
MISSED DOSES OR NON-COMPLIANCE ERRORS IN DOSING (The patient mistakenly took a different dosage regimen than was prescribed)	- Review the doses of warfarin actually taken over the past several weeks. - If patient is receiving more than one strength of tablet, consider adjusting dose to enable use of a single strength to avoid confusion. - Use strategies to improve compliance: pill box, warfarin pill box, warfarin dosing calendar, patient education, reminder alarm, simplify dosing regimen
UNDERDOSING	- Be aware that underdosing provides less protection against thrombosis but is still associated with bleeding. Bleeding risk is similar with INRs 1.5-2.0 and 2.0-3.0, but risk of thrombosis rises quickly below INR 2.0. - Aim for an INR of 2.5. Aiming for 2.0 will lead to a higher chance of underdosing. - Increase the dose according to INR value.
CHANGE IN DIET/EXERCISE - Increased Vitamin K-rich foods (e.g., green leafy vegetables, soy, avocado, seaweed) - Meal replacement beverages containing vitamin K - Increased exercise	- Day-to-day and week-to-week variation in dietary vitamin K intake commonly results in variability in INR. Do <u>not</u> advise patients to eat less vitamin K-rich foods. - Educate patient to maintain a consistent, healthy diet and lifestyle. - If INR is low and changes are long-term, increase the warfarin dose.
DRUG INTERACTIONS <u>Prescription</u> : examples include phenytoin, carbamazepine, barbiturates, rifampin, azathioprine, trazodone <u>Non-prescription</u> : examples include green tea, ginseng, St. John's Wort	- A change in INR may be seen within 1 week of drug initiation. Increase maintenance dose of warfarin incrementally until stable maintenance dose is established. - Educate patient to maintain consistency if non-prescription products are used. Avoid herbal supplements, if possible.

Table 2: Common Causes of HIGH INRs and Management Strategies

COMMON CAUSES OF HIGH INRS	MANAGEMENT STRATEGIES
DRUG INTERACTIONS*	- Temporary drug interaction: temporary warfarin hold or dose reduction. - Chronic drug interaction: reduce maintenance dose and increase frequency of INR tests until new stable INR is achieved. - Although many drugs may interact with warfarin, avoidance of either warfarin or the interacting drug is usually not required.*
ALTERED HEALTH STATES Fever, acute illness, diarrhea, reduced food intake Uncontrolled hyperthyroidism CHF exacerbation	Temporarily reduce the dose and increase the frequency of INR testing until the patient's health stabilizes.
MALNUTRITION (vitamin K deficiency)	- Encourage patient to consume regular meals, including those containing vitamin K. Consider meal replacement beverage. - Reduce maintenance dose of warfarin and increase frequency of monitoring
ALCOHOL	- A one-time moderate to large amount of alcohol (more than 2 drinks) will transiently increase the INR (e.g., weekend party). - Continue usual maintenance dose.
ERRORS IN DOSING (The patient mistakenly took a different dosage regimen than was prescribed)	- Review the doses of warfarin actually taken over the past several weeks. - If patient is receiving more than one strength of tablet, consider adjusting dose to enable use of a single strength to avoid confusion. - Use strategies to improve compliance: pill box, warfarin dosing calendar, patient education, simplify dosing regimen.

***Most common drugs that can increase INR:**

- Antibiotics: sulfamethoxazole/trimethoprim, metronidazole, quinolones (ciprofloxacin, levofloxacin), amoxicillin, erythromycin, clarithromycin, azithromycin
- Azole antifungals: fluconazole, voriconazole
- Cardiac drugs: amiodarone, some statins (atorvastatin and pravastatin are least likely to interact), fenofibrate
- Acetaminophen >1 g/day
- Levothyroxine dose changes– full effect observed after 4-6 weeks of dose change

Other Relevant Thrombosis Canada Clinical Guides:

- [Warfarin](#)
- [Warfarin: Point-of-Care INR Monitoring of Warfarin Therapy](#)

References:

Agno W, et al. Oral anticoagulant therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141(2 Suppl):e44S-e88S.

Holbrook A, et al. Evidence based management of anticoagulant therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141(2 Suppl):e152S-e184S.

Smythe MA, et al. Anticoagulant drug-drug interactions with cannabinoids: A systematic review. Pharmacotherapy. 2023;43(12):1327-1338.

Witt DM, et al. American Society of Hematology 2018 guidelines for management of venous thromboembolism: optimal management of anticoagulation therapy. Blood Adv. 2018;2(22):3257-3291.

Date of Version: 15June2025

Please note that the information contained herein is not to be interpreted as an alternative to medical advice from your doctor or other professional healthcare provider. If you have any specific questions about any medical matter, you should consult your doctor or other professional healthcare providers, and as such you should never delay seeking medical advice, disregard medical advice or discontinue medical treatment because of the information contained herein.