

VICTAG

VICTORIAN THERAPEUTICS ADVISORY GROUP

Victorian Framework
for clinical decision support tools for
Anticoagulants

The Victorian Therapeutic Advisory Group (VicTAG) funded the development of this framework. VicTAG's purpose is to promote quality use of medicines by sharing unbiased, evidence-based information about medication therapy and to support the goals of, and facilitate the National Medicines Policy pillars of access, quality, safety and sustainability in the use of medicines in Victorian hospitals.

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Purpose

This document provides a framework for developing and implementing various clinical decision support tools to prevent medication incidents related to prescribing, administering and management of anticoagulants for adult patients in common Electronic Medication Management systems implemented in Victorian hospitals.

Intended Audience

This framework is intended for use by Victorian and Tasmanian health services. The guidance is relevant to all staff responsible for the build and design of clinical decision support e.g. clinical informatics teams as well as those who are involved in reviewing medication errors in health services e.g. quality use of medicines pharmacists.

Background

A 10-year trend analysis of the use of anticoagulants in Australian patients with atrial fibrillation identified that there was considerable variation in anticoagulant prescribing patterns between clinicians.¹ Additionally, a study conducted in 2022 in a Victorian hospital on anticoagulant prescribing has shown that more than 40% of patients were prescribed these class of medicines in a manner not in line with established prescribing guidelines.² The study identified that, almost a quarter of these patients experienced Hospital Acquired Complications (HACs) due to inappropriate prescribing.² More broadly, evidence suggests that reduced compliance with recommended anticoagulants' prescribing guidelines contributes to patients' mortality and morbidity as well as increase in hospital readmissions.^{3,4}

Electronic medication management systems (EMM) have been implemented across various health care settings throughout the world to improve patient safety and quality of care.⁵⁻⁷ EMM aim to provide significant prescribing benefits including the provision of clinical decision support systems (CDS) to improve the quality of prescribing, reduce medication errors and facilitate timely access of patient information as well as improving legibility of documentation.⁵⁻⁷

Many interventions designed to improve anticoagulant prescribing in hospitals have been trialled with varying degrees of success.⁸⁻¹⁰ A recent systematic review published by Austin et al. suggested that computerised physician order entry integrated with well-designed CDS have the potential to effectively manage patients' therapeutic anticoagulation.⁹ Additionally, a study conducted in a large Melbourne hospital demonstrated that well designed CDS in EMM can improve prescribing of anticoagulants, reduce HACs and the subsequent economic burden.¹¹

Cases involving anticoagulant mismanagement in hospitals have been reviewed by the Victorian coroner's office.¹² As a result, several recommendations were made by the coroner's office to improve the use of clinical decision support in EMM. Additionally, the Duckett report provided guidance on "Targeting Zero" medication errors in EMM.¹³ The report provided several general recommendations on changes to digital technology in health to support flow of information and inform clinical decision making to improve patient safety and care.¹³ However, similar to the recommendations made by the Australian Commission in Quality and Safety in Healthcare on optimisation of EMM and the coroner's office, the recommendations are broad and lack specific guidance on how to build targeted CDS in EMM to reduce errors and prevent harm.¹³⁻¹⁵

A lack of available guidance to hospitals on how to improve and build CDS tools related to anticoagulants' management in EMM resulted in variable practice across health settings with EMR systems.^{9,11}

This Framework provides practical and standardised recommendations on developing and building various CDS related to anticoagulants. The recommendations include the most commonly used EMM across Victorian hospitals to standardise their build in order to prevent the most commonly reported medication incidents related to this group of high risk medicines.

Introduction

Prescribing is the first stage of the medication management pathway and therefore the first opportunity to incorporate CDS.²⁴ During this stage, the prescriber makes a decision to provide treatment and/or chart patients' regular medications.^{24,25} For the completion of this step, the prescriber needs access to accurate and up to date information about their patient, to allow them to choose the most appropriate and safe medication. CDS at this first stage reduces reliance of error detection at later stages of the pathway.^{24,25} Prescriber engagement is necessary when designing CDS at this stage, to ensure the optimal level of support, without contributing to alert fatigue.¹⁵ Medication errors on admission can persist throughout the episode of care and on to discharge, leading to inappropriate orders and failure to identify a medication related problem.^{25,26} Conversely, administration is one of the final stages of the medication management pathway and therefore the last opportunity to check for discrepancies between what has been prescribed and what was intended for administration.^{24,25} CDS at this stage of the pathway are therefore essential to identify errors that have managed to avoid detection at earlier stages of the pathway.^{24,25} Similar to how prescribers should be involved with CDS at the prescribing stage, nurses and midwives should be consulted at the administration stage to ensure that CDS within the nursing workflow maximises patient safety.¹⁵

A systematic review published in 2020 demonstrated that well designed CDS positively impact the management of anticoagulants in patients with various cardiovascular diseases.¹⁶ CDS provide assistance to clinicians in the process of decision-making by comparing individual patient characteristics against computerized evidence-based information programmed in various EMM.¹⁷⁻²⁰

Targeted CDS provides guidance to clinicians on dose adjustments, reminders for documenting medication management plans, identifying medication interactions, as well as choosing appropriate therapy without producing alert fatigue to clinicians who use them.^{11,18,19} Additionally, CDS that focus on ensuring the right medication is prescribed using the latest evidence based guidelines improve clinician performance, quality of care and patient outcomes.²¹⁻²³

'Smart' CDS is the next phase of this area of practice and have been included in this framework. This takes into account the context of the patient and only trigger if relevant for a particular patient based on specific characteristics e.g. age and renal function and when a particular medication, dose or frequency is prescribed. An example of 'smart CDS' was demonstrated by Khalil with the redesign of CDS to improve non vitamin K oral anticoagulant prescribing.¹¹ This study showed a statistically significant increase in appropriate oral anticoagulants' prescribing when patients' most recent pathology was utilised to trigger recommendations at the point of medication ordering. It further highlights that providing context relevant information to prescribers for prescribing alerts is likely to not only improve user satisfaction but also result in clinical and economic benefits.¹¹

Additionally, Kawamoto and Lobach identified that essential elements that need to be integrated as part of physicians and nurses' workflows.²⁷ They include providing timely, evidence based, easily accessible information tailored to the right audience in the right format.²⁷ The CDS requires to be useful, integrates into clinicians' workflow and does not contribute to alert fatigue.²⁸⁻³⁰

A report published in 2021 by the Australian Commission on Safety and Quality in Healthcare on recommendations for preventing anticoagulants incidents in Australian Hospitals outlined the need to optimise electronic medication management systems to facilitate the identification and prevention of missed doses, incorrect doses and duplicate therapy orders.³¹

The above mentioned principles with published literature on well-structured CDS were used in a systemised approach to guide the various CDS builds recommended in this framework. Moreover, recommendations for developing CDS outlined in this framework take into account patient characteristics to provide focused and specific recommendations for interventions to improve anticoagulant management in most commonly used EMM in hospitals.

Framework Development Methodology

A mixed study method was used to develop this framework. The steps involved in the methodology were based on the Triple C model (Consultation, Collaboration and Consolidation) to ensure sustainability of the proposed interventions.³²

Stage 1 – Consultation

The first stage of the study included retrieval of anticoagulant related incidents reported by Victorian hospitals via a. Data on reported medication incidents related to anticoagulants was obtained from Victorian Agency of Health Information (VAHI) from January 2020 to January 2022. Incidents were reviewed and occurrence was classified according to the relevant steps of the Medication Management Pathway (MMP) as outlined in Figure 1.³³

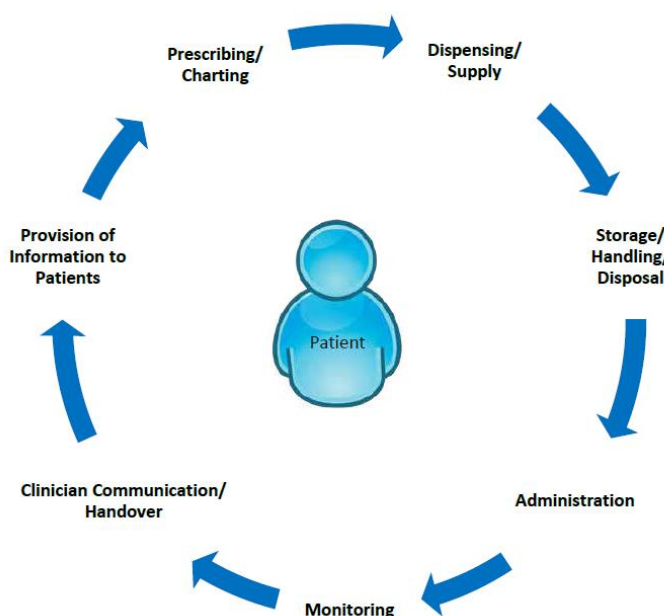


Figure 1: Medication Management Pathway

(Source: VicTAG Victorian Medication Incident Taxonomy)³⁴

Additionally, root cause of the medication incident was further categorised according to medication error type as defined in the VicTAG Victorian Medication Incident Taxonomy. Incidents were grouped according to the relevant steps of the MMP. Further analysis of these incidents identified most vulnerable and potential steps where anticoagulant related CDS are required.

Detailed analysis of VAHI data is outlined in appendix 2. The outcome of this analysis, together with existing CDS built in Cerner™ and EPIC™ systems of participating hospitals formed the basis of our recommendations in this framework.

Moreover, a comprehensive literature review was conducted to assess the efficacy and type of CDS on the quality of prescribing, administration errors as well as impact on reported anticoagulation related medication errors.

Stage 2 – Collaboration

The second stage involved collecting CDS build information in the EMM from a stakeholder group via a detailed survey regarding the various CDS built in their EMM systems. This group consisted of health informaticians and clinicians from 6 Victorian hospitals with implemented EMR systems (Cerner™ and EPIC™). CDS build data was reviewed, collated, and mapped against specific steps of the MMP as well as incidents collected from the VAHI dataset analysis.

A thematic analysis was then performed on the recommendations of CDS at each step of the MMP from reviewed incidents and were mapped against the CDS already build in Australian hospitals EMM. This was then followed by a gap analysis and feasibility study to assess build of new CDS.

Stage 3 – Consolidation

CDS provided by participating hospitals were grouped into three categories – custom built pop up alerts, inbuilt pop up alerts and workflow CDS builds. Most of those categorised under workflow CDS builds involved inbuilt functionality from EMM. The following principles were used for the review and design of custom built pop up alerts in EMM.

1. Purpose – what is the aim of the CDS?
2. Evoke – at what point does the CDS appear to the clinician? E.g. opening of chart, placing order, signing order and point of administration
3. Build logic – what are the criteria for the CDS to fire? E.g. patient details, position details, encounter details and order details
4. Action – what options are available after the CDS appears? E.g. acknowledgement, proceed to documentation, cancel the order and launch an order set.

The above mentioned principles were based on a comprehensive literature for identifying the core elements of designing efficient CDS, defined as the ‘five rights’ to be able to support definitive decision making ²⁷:

1. Right information – supported by the best available evidence
2. Right people – targeted to the correct individuals and supportive of their workflow
3. Right format – presented in a useful manner for the task at hand e.g alerts, order sets or linked information
4. Right channel – delivered through the most appropriate medium
5. Right time – occurs at the point of the decision making process that makes the most sense

Discussion

A total of 6 Victorian and Tasmanian health services responded to the survey. Cerner™ and EPIC™ systems were implemented in these tertiary hospitals. Survey responses from participating hospitals with implemented EMS identified multiple custom and standard CDS builds in their EMM to safeguard the use of anticoagulants, with the majority of hospitals with Cerner™ and EPIC™ systems having built CDS for anticoagulants at the prescribing/charting and administration steps. Participating hospitals have also built CDS to address the top 3 CDS recommendations at the prescribing/charting step in this Framework. However, there was some variations in the build across hospitals who shared similar EMM software. For example, some health services have built CDS to alert users where VTE prophylaxis has not been ordered, however others had defined different age parameters as to when this alert will appear to the user. These recommendations may therefore need to be refined to suit the specific needs and workflows of each hospital.

It is recommended to use the GUIDES checklist.³⁹ The checklist is a tool to assist Health informatics and clinicians when implementing guidelines with CDS. It outlines the following key elements:

1. Communication and training sessions for roll out to clinicians
2. Assessment of barriers and enablers
3. Feedback and monitoring to detect any defects associated with newly built CDS.

The consensus recommendations in this Framework are not intended to be implemented in their entirety. Health services will need to consider their patient cohorts, local incidents, suitability and relevance of implemented CDS as well as current inbuilt CDS in their EMM systems. The following are examples of such consideration:

- Conduct a risk analysis of the existing alerts and CDS built in the system before implementing new ones. Consideration to deactivate non clinically significant alerts are recommended to reduce clinician alert fatigue.
- Different EMM also have different functionalities and will determine if the suggested CDS is appropriate e.g. Users of Cerner™ EMM™ have built a custom alert whereby if a patient’s renal function has fallen within a specified level

within the last 7 days, an alert will appear informing the clinician. Users of EPIC™ however would not need to implement such an alert as their medication build configuration allows automatic change of dose/frequency buttons based on the patient's renal function.

- Whether discrete alerts are necessary to target higher rates of specific incidents or if general alerts are sufficient e.g. prevent ordering of heparin and enoxaparin concurrently or prevent ordering of any duplicate medications.
- Whether custom built 'pop up' alerts will be the best method to support decision making or if there are more other effective CDS builds which are not pop up orientated e.g. Users of EPIC™ have built an alert to notify that warfarin has previously been ordered but there is no current warfarin order whereas users of Cerner™ have built a dummy order 'warfarin dose check' as a visual prompt to clinicians that the patient is on warfarin and if they see this dummy order on the MAR without an active warfarin order, it needs follow up.

To facilitate the implementation of CDS outlined in this framework, it is envisaged that health services consider developing an anticoagulation stewardship program as part of their clinical service delivery. Evidence published in the Australian setting and internationally demonstrated that these programs optimise evidence based-care by providing a multidisciplinary, coordinated and timely recommendations. ³⁵⁻³⁸

Finally, implementing digital health principles provides the opportunity for hospitals to develop evidence-based clinical information into their own EMM builds to improve the quality and efficiency of patient care especially those who require anticoagulants to manage their cardiovascular diseases. The implementation of various CDS, clinical prompts and reminders, as well as improving data visibility, ensure appropriate management of these patients. These CDS are supported by a large body of evidence and should be considered for all health services to optimise patient care. It is expected the increased use of artificial intelligence, predictive modelling and various support tools will positively impact clinicians' workflow and patients' healthcare.

Consensus Recommendations

Prior to implementation of CDS, it is recommended that allergy and medication interaction alerts, that are not clinically significant, are deactivated. ^{40,41} Medication interaction and allergy alerts are the most common type of alerts that trigger unnecessarily and contribute to alert fatigue. ⁴⁰ By deactivating these types of alerts, clinicians may be more likely to assess any alerts or CDS before accepting or overriding them. A published evidence-based approach on deactivating most built alerts in EMRs has been successfully implemented in the Australian setting using a well-defined risk assessment systemised approach. ⁴⁰ Furthermore, the study demonstrated a reduction in alerts trigger rates and subsequent statistical reduction in the number of incidents with reported patients' harm. ⁴⁰ We recommend hospitals to consider using a similar approach to maximise the use of any newly implemented CDS. ³

The CDS recommendations are proposed following review of various CDS design guidelines and recommended principles of onscreen information, VAHI medication incidents analysis, and review of existing CDS in various EMM. Feasibility testing was undertaken for the proposed CDS. Design specifications were provided by EMM build and clinical informatics teams. The proposed alerts/CDS outlined in this framework are based on modification of an inbuilt CDS to a specific workflow or a custom build alert.

It is good governance and a standard practice to routinely test any changes in the EMS test domain and carry out user acceptance testing before moving them to production. The recommended CDS/alerts in this framework can be largely implemented independently of any variations for any product-built changes within the various EMS systems .

| Prescribing/Charting | | | | | | |
|--|---------------------------|---|--|---|---|-----------------|
| Number | Type of Alert / CDS | Purpose | Evoke | Build Logic | Actions | Implement (Y/N) |
| <i>Contraindicated/clinically inappropriate (renal function)</i> | | | | | | |
| 1. | Custom built pop up alert | Medication prescribed may require dosage adjustment based on patient's renal function | CERNER™: At the point of medication selection/ordering | Patient greater than 18 years old AND Is an inpatient AND Has an active encounter AND Medication being ordered is in the specified list 1. dabigatran eGFR less than 50 mL/min 2. rivaroxaban eGFR less than 50 mL/min 3. apixaban eGFR less than 30 mL/min 4. enoxaparin eGFR less than 30 mL/min AND The patient's eGFR (from within the last 7 days) is less than the eGFR threshold for the medication selected | Cancel order or proceed to order or "Ignore Order" - override with reason | |
| 2. | Workflow CDS build | Prevent anticoagulants from being ordered when they are contraindicated i.e. No anticoagulants or VTE exempt from pharmacological prophylaxis | EPIC™/Cerner™: At the point of medication ordering | Anticoagulant medication ordered AND Patient has an active order for 'no anticoagulants' or 'VTE exempt from pharmacological prophylaxis' | Cancel order, proceed to order or acknowledge with set reasons | |
| <i>Duplicate (double anticoagulants)</i> | | | | | | |
| 3. | Custom built pop up alert | Prevent ordering of heparin and enoxaparin concurrently | CERNER™: Signing of order | Inpatient, emergency and pre admission encounters AND Has an active encounter AND Medication being ordered is enoxaparin/heparin with subcutaneous route of administration AND | Cancel order | |

| | | | | | | |
|---|---------------------------|--|---|--|-------------------------------|--|
| | | | | Existing inpatient medication order for enoxaparin/heparin with subcutaneous route of administration | | |
| 4. | In built pop up alert | Prevent ordering of duplicate medications e.g. warfarin or more than one concurrent anticoagulant | CERNER™: At the point of medication selection/ordering EPIC™: Signing of order | Inbuilt Cerner MCDS or Epic medication warnings | Not applicable | |
| Not prescribed (VTE prophylaxis) | | | | | | |
| 5. | Custom built pop up alert | VTE prophylaxis has not been ordered | CERNER™: Upon opening of patient's chart by medical and pharmacy staff EPIC™: When viewing general patient summary, patient admission/transfer or rounding by medical, pharmacy, nursing and midwifery staff | Patient greater than 18 years old AND Has been a patient for greater than 24 hours (from date of registration as ED patient or date of admission as inpatient) AND Has an active encounter AND No VTE-related orders placed <ul style="list-style-type: none"> • enoxaparin/rivaroxaban • mechanical prophylaxis • warfarin, heparin, apixaban, dabigatran, danaparoid, fondaparinux • VTE prophylaxis contraindicated • VTE prophylaxis not required AND Off Pathway OR low VTE risk NOT documented | Open Chart OR Launch Orderset | |
| 6. | Custom built pop up alert | VTE risk assessment has not been completed within 24 hours of registration OR if risk assessment has been completed but no VTE orders have been placed | CERNER™: Upon opening of patient's chart by medical and pharmacy staff | Patient greater than 18 years old AND Has been a patient for greater than 24 hours (from date of registration as ED patient or date of admission as inpatient) AND Has an active encounter AND No active VTE risk assessment on the current encounter (with or without prophylaxis orders placed) | Acknowledge | |

| | | | | | | |
|--|---------------------------|--|--|--|--|--|
| | | | | <p>OR VTE risk assessment started/complete on the current encounter but no VTE -related orders placed</p> <ul style="list-style-type: none"> • enoxaparin/rivaroxaban • mechanical prophylaxis • warfarin, heparin, apixaban, dabigatran, danaparoid, fondaparinux • VTE prophylaxis contraindicated • VTE prophylaxis not required <p>AND Off Pathway OR low VTE risk NOT documented</p> | | |
| Not prescribed (warfarin) | | | | | | |
| 7. | Custom built pop up alert | Notify user that warfarin has previously been ordered but there is no current warfarin order | <p>EPIC™: Upon opening of patient’s chart by medical, pharmacy and nursing staff</p> <p>CERNER™: Feasibility analysis - Possible with lookback on active warfarin order</p> | <p>Inpatient and emergency encounters AND Has an active encounter AND Patient does not have an active warfarin order AND Patient has had a previous warfarin order AND Patient has not had warfarin administered in the last 8 hours OR pharmacist/doctor alert has not been actioned</p> | Cancel order, proceed to order or acknowledge with set reasons | |
| 8. | Workflow CDS build | Warfarin has been previously ordered but there is no current warfarin order | CERNER™: Daily reminder on the MAR that the patient is on warfarin and should have a warfarin order | <p>Dummy order built for ‘warfarin dose check’</p> <p>‘Warfarin dose check’ order present in all warfarin order sets with/without pre-tick</p> | Not applicable | |
| Wrong medicine/fluid (warfarin brand) | | | | | | |
| 9. | Custom built pop up alert | A different brand of warfarin has previously been prescribed | CERNER™: At the point of medication selection/ordering | <p>Inpatient and emergency encounters AND Has an active encounter AND</p> | <p>Cancel order OR Proceed to order</p> | |

| | | | | | | |
|---|---------------------------|---|---|--|--|--|
| | | | | Medication being ordered is Coumadin® AND Medication order for Marevan® in 'Completed' or 'Prescribed' status OR Medication being ordered is Marevan® AND Medication order for Coumadin® in 'Completed' or 'Prescribed' status | | |
| 10. | Workflow CDS build | Allow ordering of warfarin by brand name only | CERNER™/EPIC™: At the point of medication selection/ordering | Only enable warfarin brands to be visible for ordering as 'Coumadin®' or 'Marevan®'. Hide warfarin primary synonym on CPOE. | Not applicable | |
| Wrong dose/strength/concentration | | | | | | |
| 11. | Custom built pop up alert | Alert prescribers that high doses of warfarin require validation | CERNER™: Signing of order | Inpatient and emergency encounters AND Has an active encounter AND Medication being ordered is warfarin with a dose greater than 10 mg | Cancel order OR Proceed to order (dose confirmed) | |
| 12. | In built pop up alert | Prevent ordering of medications where the dose falls outside of defined parameters such as: <ul style="list-style-type: none"> • CERNER™: minimum single/daily dose, maximum single/daily dose, age, weight • EPIC™: dose is more than 10% or 500% above dose rules | CERNER™: At the point of medication selection/ordering EPIC™: Signing of order | Inbuilt Cerner Dose Range Checking or Epic medication warnings | Not applicable | |
| Wrong dose/strength/concentration (apixaban dose reduction criteria not met) | | | | | | |
| 13. | Custom built pop up alert | Alerts users to the following: <ul style="list-style-type: none"> • If apixaban 5 mg twice a day is ordered for AF where the patient fits criteria for a dose reduction • If apixaban 2.5 mg twice a day is ordered for AF where the patient does not fit criteria for a dose reduction | CERNER™: At the point of medication ordering | Indication = AF (set as mandatory drop down field for apixaban order) AND At least 2 of the following: <ul style="list-style-type: none"> • Weight less than 60kg • Age greater than 80 years old • Serum creatinine greater than 133 micromol/L | Cancel order OR Proceed to order (dose confirmed) | |

| Wrong dose/strength/concentration (no recent weight) | | | | | | |
|---|---------------------------|---|--|---|--|--|
| 14. | Workflow CDS build | Prevent anticoagulants being prescribed without a documented weight for which weight is essential e.g. apixaban | CERNER™: At the point of medication ordering | Mandatory weight field in Anticoagulant OEF | Not applicable | |
| Wrong route/site | | | | | | |
| 15. | Workflow CDS build | Only clinically appropriate routes to the individual medication are available to the clinician when ordering | CERNER™/EPIC™: At the point of medication ordering | Setting of routes to match dosage forms | Not applicable | |
| Medication interaction | | | | | | |
| 16. | Custom built pop up alert | Prevent patient from receiving an epidural if they have an active anticoagulant order or vice versa | EPIC™: At the point of medication ordering or during pharmacist verification CERNER™: Feasibility analysis - Possible, at the point of medication ordering | Inpatient and emergency encounters AND Has an active encounter AND Medication being ordered is epidural/anticoagulant AND Existing inpatient medication order for anticoagulant/epidural | Cancel order, proceed to order or acknowledge with set reasons | |
| 17. | In built pop up alert | Prevent ordering of medications when there is clinically significant interaction with ordered anticoagulant | CERNER™: At the point of medication selection/ordering EPIC™: Signing of order | Inbuilt Cerner™ MCDS or Epic™ medication warnings | Not applicable | |
| Not prescribed (anticoagulant admission plan incomplete) | | | | | | |
| 18. | Custom built pop up alert | Notify user if patient has one or more of their anticoagulants on hold | EPIC™: Upon opening of patient's chart by medical, pharmacy and nursing staff CERNER™: Feasibility analysis - Possible, with lookback on results | Patient has an anticoagulant on hold/suspended AND None of the following are true: <ul style="list-style-type: none"> • patient has an order for 'no anticoagulants' • patient's platelets are less than 50 x 10⁹/L • patient's INR is greater than 4 • patient's APTT is greater than 50 sec • patient has surgery booked in the next 24 hours • patient has a heparin infusion running • patient is admitted to HITH | Acknowledge with set reasons dependent on type of clinician | |

| | | | | | | |
|---|---------------------------|--|--|---|---|--|
| | | | | <p>AND Clinician is a doctor OR Clinician is a nurse AND Alert has not been switched off for this patient by pharmacy until 0700 hrs tomorrow OR Clinician is a pharmacist</p> | | |
| 19. | Custom built pop up alert | Recommends anticoagulation for patients with a diagnosis of ischemic stroke and atrial fibrillation/flutter | <p>EPIC™: Non-intrusive banner</p> <p>CERNER™: Feasibility analysis - Possible for passive alert like SmartZone, but can be unreliable as very dependent on documentation</p> | <p>Patient greater than 18 years old AND Patient is not on end of life care AND Patient has atrial fibrillation/flutter AND Patient has ischaemic stroke AND Patient is not on anticoagulants</p> | Non-intrusive banner – no action required | |
| 20. | Workflow CDS build | Free text field in the medical admission note to allow prescribers to document anticoagulant plans e.g. when to withhold/restart, plans to change to different anticoagulants and warfarin bridging plans | Upon creation of new medical admission note | A separate section incorporated into Admission Notes (and Ward Round notes) titled 'Anticoagulation Plan' | Not applicable | |
| Not prescribed (anticoagulant discharge plan incomplete) | | | | | | |
| 21. | Custom built pop up alert | Alert appears in the discharge navigator if the patient has a daily inpatient warfarin order but no outpatient order for warfarin | EPIC™: During discharge reconciliation | <p>Patient has a daily warfarin order AND Patient does not have an outpatient order for warfarin</p> | Acknowledge with set reasons | |
| 22. | Workflow CDS build | Free text field in the medical discharge summary to allow prescribers to document anticoagulant plans e.g. when to withhold/restart, plans to change to different anticoagulants and warfarin bridging plans | Upon creation of new medical discharge note | A separate section incorporated into Discharge Notes template (and Ward Round notes template) titled 'Anticoagulation Plan' | Not applicable | |

| | | | | | | |
|-----|--------------------|---|--|---|----------------|--|
| 23. | Workflow CDS build | Advise the emergency department pharmacists that a patient has been prescribed anticoagulants for discharge | Email inbox alert | Notification alert | Not applicable | |
| 24. | Workflow CDS build | To support the prescribing of rivaroxaban, apixaban or dabigatran so that patients can be identified should they present to the emergency department with Outpatient follow up. The Haematology registrars will opt into the generic inbox to identify the patients and ensure medication compliance until the patient can present to the clinic. | Message centre inbox alert | Notification alert | Not applicable | |
| 25. | Workflow CDS build | Discharge medication reconciliation prompts the user to indicate the discharge plan for all charted inpatient medications. Activity appears incomplete if any medications have not been reconciled. | CERNER™/EPIC™: During discharge reconciliation | Inbuilt Cerner™ or Epic™ reconciliation process | Not applicable | |

Administration and Dispensing/Supply*

* Barcode scanning utilised while documenting medication administration will also pick up errors from incorrect dispensing/supply of medication.

| Number | Type of Alert / CDS | Purpose | Evoke | Build Logic | Actions | Implement (Y/N) |
|-----------------------------------|-----------------------|---|---|--|----------------|-----------------|
| Early administration alert | | | | | | |
| 26. | In built pop up alert | Alerts user if medication being administered is too early or too close to a previously administered dose (dependant on order frequency) | CERNER™/EPIC™: While documenting medication administration | Inbuilt Cerner™ or Epic™ early administration alerts which utilises minimum interval checking Early/late administration alerts when a medication is given 1 hour before or after the scheduled administration time | Not applicable | |
| Not administered | | | | | | |
| 27. | In built pop up alert | Alerts user if medication being administered is not according to its order schedule or if there are overdue doses | CERNER™/EPIC™: While viewing the Medication Administration Record (MAR) | CERNER™: MAR configuration whereby overdue tiles/tasks (1 hour past scheduled time) appears red for easy identification EPIC™: Overdue button on MAR for easy identification. MAR report displays anticoagulant and antiplatelet medications at | Not applicable | |

| | | | | the top with due times vs administered times clearly displayed | | |
|---|---------------------------|---|--|--|--|-----------------|
| Wrong frequency/ rate/time | | | | | | |
| 28. | In built pop up alert | Alerts user that documented infusion rate exceeds the recommended anticoagulation infusion rate | CERNER™: While documenting medication administration | CERNER™: Custom freetext rate fields used in Order Entry Format | Not applicable | |
| Wrong dose/ strength/concentration | | | | | | |
| 29. | In built pop up alert | Alerts user if the medication scanned for administration does not match the medication order | CERNER™/EPIC™: While documenting medication administration | Addition of product barcode on formulary product build | Not applicable | |
| Wrong medicine/fluid | | | | | | |
| 30. | Custom built pop up alert | Prevent anticoagulants from being administered when they are contraindicated i.e. No anticoagulants or VTE exempt from pharmacological prophylaxis | EPIC™: While documenting medication administration CERNER™: Feasibility analysis - Possible, triggers during medication administration | Anticoagulant medication ordered AND Patient has an active order for 'no anticoagulants' or 'VTE exempt from pharmacological prophylaxis' | Cancel administration or proceed to administration | |
| Monitoring | | | | | | |
| Number | Type of Alert / CDS | Purpose | Evoke | Build Logic | Actions | Implement (Y/N) |
| Not monitored (antiXa) | | | | | | |
| 31. | Custom built pop up alert | When anti-Xa levels for enoxaparin or unfractionated heparin are above the defined therapeutic range, the result displays when an anticoagulant is being ordered and administered | CERNER: At the point of medication selection/ordering and while documenting medication administration | Active enoxaparin order AND For once daily dosing of enoxaparin: <ul style="list-style-type: none"> Level greater than 2 units/mL within last 7 days For twice daily dosing of enoxaparin: <ul style="list-style-type: none"> Level greater than 1 units/mL within last 7 days | Cancel order/administration or proceed to order/administration | |
| 32. | Workflow CDS build | When anti-Xa levels are outside the defined therapeutic range, the result displays as red when enoxaparin is being ordered and administered | EPIC™: At the point of medication selection/ordering and while documenting medication administration | Inbuilt Epic configuration whereby the last 3 anti-Xa levels are always displayed for inpatients and the last 6 months for outpatients | Not applicable | |

| <i>Not monitored (CHADsvASC)</i> | | | | | | |
|----------------------------------|---------------------------|---|---|---|----------------|--|
| 33. | Workflow CDS build | Patient's CHA ₂ DS ₂ -VASC score to display face up in iView | CERNER™: Result visible in iView | To display total number of points: <ul style="list-style-type: none"> • Age 65 to 74 years = 1 point • Female = 1 point • Chronic Heart Failure history = 1 point • Hypertension history = 1 point • Stroke/transient ischemic attack/thromboembolism history = 1 point • Vascular disease history (prior myocardial infarction, peripheral artery disease, or aortic plaque) = 1 point • Diabetes = 1 point | Not applicable | |
| <i>Not monitored (INR)</i> | | | | | | |
| 34. | Custom built pop up alert | Alerts user when warfarin is ordered without an active INR level order | EPIC™: At the point of medication selection/ordering CERNER™: Feasibility analysis - Possible, but with BUILD logic of "Warfarin is ordered" and "INR has not been placed within lookback period" | Warfarin is ordered AND INR level has not been ordered | Order INR | |
| 35. | Workflow CDS build | Sends a message to pharmacy if the patient's INR result is greater than 6 | EPIC: When INR™ is resulted by the lab CERNER™: Can utilize High Risk Category Worklist or Smart Zone passive alerting. Alternative, INR result can drop Pharmacy Referral tasks to Pharmacy | EPIC: Messaging configuration | Not applicable | |
| 36. | Workflow CDS build | Notify nursing staff to check INR result prior to warfarin administration | CERNER: When INR is resulted by the lab | CERNER: Drop a task to nursing staff when INR result received | Not applicable | |
| 37. | Workflow CDS build | When INR levels are outside the defined therapeutic range, the result displays as red when warfarin is being ordered and administered | EPIC™: At the point of medication selection/ordering and while documenting medication administration | Inbuilt Epic™ configuration whereby the last 3 INR levels are always displayed for inpatients and the last 6 months for outpatients | Not applicable | |

| Not monitored (platelets) | | | | | | |
|---|---------------------------|--|--|---|--|-----------------|
| 38. | Workflow CDS build | Notify nursing staff to check platelets result prior to anticoagulant administration | CERNER™: When platelets is resulted by the lab | CERNER™: Drop a task to nursing staff when platelet results received | Not applicable | |
| 39. | Workflow CDS build | When platelet levels are outside the defined therapeutic range, the result displays as red when anticoagulants are being ordered and administered | EPIC™: At the point of medication selection/ordering and while documenting medication administration | Inbuilt Epic configuration whereby the last 3 platelet levels are always displayed for inpatients and the last 6 months for outpatients | Not applicable | |
| Not monitored (renal function) | | | | | | |
| 40. | Custom built pop up alert | Notify nursing staff to check renal function if declining by more than 20% since the last recorded eGFR in the last 7 days OR if has decreased lower than renal function defined for a medication. | CERNER: While documenting medication administration | If eGFR declines more than 20% since last eGFR recorded within last 7 days OR Any adult inpatient (18 years old or older) where the medication being ordered is in the specified list <ul style="list-style-type: none"> dabigatran eGFR less than 50 mL/min rivaroxaban eGFR less than 50 mL/min apixaban eGFR less than 30 mL/min enoxaparin eGFR less than 50 mL/min AND The patient's eGFR (from within the last 7 days) is less than the eGFR threshold for the medication selected | Proceed with administration OR cancel administration | |
| Clinical communication handover & Provision of information to patients | | | | | | |
| Number | Type of Alert / CDS | Purpose | Evoke | Build Logic | Actions | Implement (Y/N) |
| Not communicated/handed over (anticoagulation admission plan incomplete) | | | | | | |
| 41. | Workflow CDS build | Free text field in the medical admission note to allow prescribers to document anticoagulant plans e.g. when to withhold/restart, plans to change to different anticoagulants and warfarin bridging plans | Upon creation of new medical admission note | A separate section incorporated into Admission Notes (and Ward Round notes) titled 'Anticoagulation Plan' | Not applicable | |
| Not provided (anticoagulation discharge plan incomplete) | | | | | | |
| 42. | Workflow CDS build | Free text field in the medical discharge summary to allow prescribers to document anticoagulant plans e.g. when to withhold/restart, plans to change to different anticoagulants and warfarin bridging plans | Upon creation of new medical discharge note | A separate section incorporated into Discharge Notes (and Ward Round notes) titled 'Anticoagulation Plan' | Not applicable | |

Limitations

This area of practice is rapidly changing, and recommendations are based on latest clinical guidelines and available anticoagulants. The CDS recommendations listed in this framework are a snapshot based on EMR technology currently available at Victorian Hospitals. Health services should consider the capabilities of their individual EMR software and their specific workflows when designing or implementing the recommendations in this Framework. It is not intended that all recommendations are implemented. Health services should undertake an evaluation to ensure that only the most appropriate and useful CDS and alerts are selected for implementation.

It is recommended that CDS and alerts are monitored and evaluated following their introduction to assess effectiveness. Given that clinical guidelines will change over time, CDS will need to be maintained and updated to ensure they are always supported by the best available evidence.

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Appendix 1: Scoping of medication incidents related to anticoagulants and recommendations

Aims

1. To measure frequency, evaluate and categorise the types of most frequently reported anticoagulant related medication incidents in Victorian hospitals.
2. To assess the type of CDS in EMM that may prevent anticoagulant related medication incidents.

Methodology

Retrospective data on Anticoagulant related medication incidents (ARMI) was retrieved from the Victorian Agency for Health Information (VAHI) (Jan 2020 to Jan 2022). ARMI were classified according to the Victorian Therapeutics Advisory Group (VicTAG) Medication Incident Taxonomy guideline and the relevant stage of the medication management process.

Information on CDS built in Victorian health services' EMR systems was collected via survey. The collected data was thematically analysed and mapped against reported incidents by informaticians to assess their potential usefulness in preventing future similar incidents.

Inclusion criteria

Incidents were included if they were related to any step of the MMP of an oral or intravenous anticoagulant.

Exclusion criteria

Incidents were excluded from analysis if they were due to: Being unrelated to anticoagulants

- Adverse effect related to any anticoagulant
- Pathology related incidents
- Downtime of the EMR system
- Needle stick injuries
- Falls related incident
- Community care/nursing home related incident
- Patient refusing medications/self-administering medications

Results

VAHI report data analysis

- A total of 5249 ARMI were reported and classified into the relevant stage of the Medication Management Pathway.
- Over 58% (3053) of incidents were deemed to be potentially preventable with a CDS.

Of the potentially preventable ARMI, most occurred during the Prescribing/Charting (40%) and Administration (37%) stages (Refer to Figure 1).

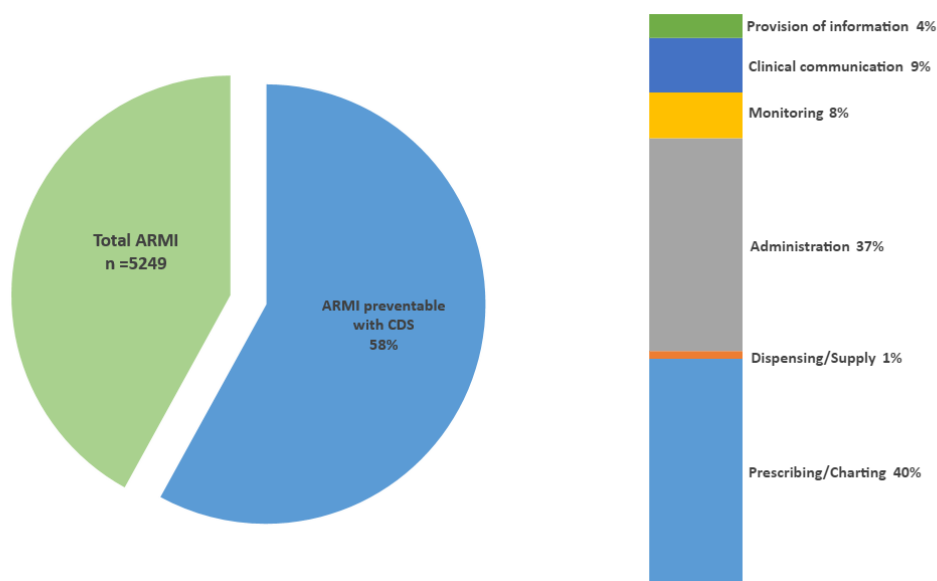


Figure 1: ARMI deemed preventable using CDS classified according to step of MMP

Types of potential CDS identified from VAHI data analysis that can be built in EMM to prevent the reported incidents.

- VAHI incidents were reviewed by clinical and informatics staff to determine types of potential alerts to prevent them
- Incidents were classified according to medication error types as defined by VICTAG Medication Incident Taxonomy guideline.
- Potential CDS were identified and categorised into common themes
- Potential CDS were mapped against each step of the MMP. Table 1 outlines types of potential CDS that can be built in EMM to prevent similar reported incidents.

Table 1: Types of commonly potential CDS categorised into themes from the VAHI data analysis

| Steps of MMP | Name of medication error as defined by the VICTAG Medication Incident Taxonomy guideline | Proposed CDS | | |
|-------------------|--|--|--------------|-------------------------------------|
| Prescribing | Not prescribed - VTE prophylaxis | VTE prophylaxis charting and assessment | | |
| | Not prescribed | Medication reconciliation not performed | | |
| | Not prescribed - Anticoagulant discharge plan incomplete | Template prefilled with anticoagulant plan | | |
| | Duplicate - Therapy of similar class of medications | Duplicate therapy alert | | |
| | Wrong dose/strength/concentration | <ul style="list-style-type: none"> • CDS for clinically inappropriate doses • CDS for weight documentation reminders | | |
| | Medicine interaction | Medicine interaction | | |
| Dispensing/supply | Contraindicated/clinically inappropriate | Contraindicated/clinically inappropriate - renal function Contraindicated –Medication Allergy | | |
| | Wrong route/site | Link to product information and local guidelines | | |
| | Not dispensed/supplied | Name of medication error as defined by the VICTAG Medication Incident Taxonomy | Proposed CDS | |
| | | | | Medication overdue |
| | | | | Pharmacy CDS for reminder to supply |

| Administration | Name of medication error as defined by the VICTAG Medication Incident Taxonomy guideline | Proposed CDS |
|--------------------------------------|--|--|
| | Early/delayed administration | Soft stop for early/delayed administration |
| | Not administered | Colour change for |
| | Wrong route/site | Bar code scanning technology |
| | Wrong frequency/rate/time | Alerts for |
| | Wrong medicine/fluid | Bar code scanning technology |
| Monitoring | Name of medication error as defined by the VICTAG Medication Incident Taxonomy guideline | Proposed CDS |
| | Not monitored - renal function | <ul style="list-style-type: none"> Create a powerplan/IV orders et for medications that require dosing at different threshold of renal function Create smart alerts that flag an alert with programmed pathology parameters threshold for dose adjustments |
| | Not monitored – INR | Create an order set/power plan for Combining charting warfarin with INR |
| | Not monitored - observations | Create an order set/power plan for Combining relevant medications with required observations |
| | Not monitored - CHA ₂ DS ₂ -VAsc | |
| Clinician Communication/ Handover | Name of medication error as defined by the VICTAG Medication Incident Taxonomy guideline | Proposed CDS |
| | Not communicated/handed over | Prepopulated anticoagulation plan template in the discharge summary |
| Provision of Information to Patients | Name of medication error as defined by the VICTAG Medication Incident Taxonomy guideline | Proposed CDS |
| | Not provided - anticoagulation discharge plan incomplete | Prepopulated anticoagulation plan template in the discharge summary |

Responses of participating hospitals with EMM systems

- A total of 12 tertiary health services responded to the survey
- Cerner™ and EPIC™ systems EMM were implemented in 6 tertiary hospitals
- A total of 53 CDS were identified in both EMM that were built at different stages to prevent ARMI. These are outlined in details in the Recommendation section Refer to table 2.

Table 2: Number of CDS currently built in each step of MMP according to EMM

| software | Prescribing/ Charting | Dispensing/ Supply | Administration | Monitoring | Clinical communication | Provision of information | Total number of CDS built in each EMM |
|----------|-----------------------|--------------------|----------------|------------|------------------------|--------------------------|---------------------------------------|
| CERNER™ | 18 | 0 | 5 | 3 | 0 | 0 | 26 |
| EPIC™ | 16 | 0 | 6 | 5 | 0 | 0 | 27 |

Thematic analysis

Thematic analysis was performed on the CDS information provided by the participating hospitals and was mapped against the potential CDS recommendations obtained from reviewing the VAHI data at each step of the MMP. This

analysis has identified gaps in data provided by participating hospitals. Main gaps in CDS were related to the latter stages of the MMP mainly in the clinical communication and provision of information steps. Refer to Figure 2.

Figure 2: Types of various CDS identified to prevent ARMI at each step of the MMP identified from the gap analysis of VAHI data and hospitals supplied data.

Feasibility study

Any potential CDS that were not built in any of the participating hospitals build data was reviewed by EMM technical expert staff to assess their feasibility for their build. Build data for potential CDS were included in this framework.

Design and build recommendations

Technical data for CDS was compiled and reviewed by EMM build expert to ensure appropriate and sufficient information is provided to guide staff to build them.
