Actionable Patient Safety Solutions™ (APSS™):

Venous Thromboembolism (VTE)

How to use this guide

This APSS provides evidence-based resources and recommendations for executives, leaders, clinicians, and performance improvement specialists. This document is intended to be used as a guide for healthcare organizations to examine their own workflows, identify practice gaps, and implement improvements. In it, you will find:

Best Practice Summary: A high level summary of evidence-based, clinical best practices. (page 2)

Executive Summary: Executives should understand the breadth of the problem and its clinical and financial implications. (page 2)

Leadership Checklist: This section is for senior leaders to understand common patient safety problems and their implications related to Venous Thromboembolism (VTE). Most preventable medical harm occurs due to system defects rather than individual mistakes. Leaders can use this checklist to assess whether best practices are being followed and whether action is needed in their organization around VTE prevention. (page 3)

Clinical Workflow: This section includes more specific information around VTE prevention across the continuum of care. Leaders should include the people doing the work in improving the work. This section outlines what should be happening on the frontline. Clinicians can use this section to inform leaders whether there are gaps and variations in current processes. This is presented as an infographic that can be used for display in a clinical area. (page 3)

Education for Patients and Family Members: This section outlines what frontline healthcare professionals should be teaching patients and family members about engaging in their care. Clinicians can inform leaders whether there are gaps and variations in current educational processes. (page 6)

Performance Improvement Plan: If it has been determined that there are gaps in current processes, this section can be used by organizational teams to guide them through an improvement project. (page 8)

What We Know about Venous Thromboembolism (VTE): This section provides additional detailed information about VTE prevention. (page 11)

Resources: This section includes helpful links to free resources from other groups working to improve patient outcomes and safety. (page 14)

Endnotes: This section includes the conflict of interest statement, workgroup member list, and references. (page 15)

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Patient Safety MOVEMENT

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Best Practice Summary

Admission:

- ☐ Utilize risk assessment models to evaluate all patients admitted for a risk of developing VTE.
- ☐ Record risk assessment determination in the EHR.
- ☐ Conduct a heparin-induced thrombocytopenia assessment (HIT) and be aware of how it is related to thromboembolic complications such as PE and DVT.

Routine Care:

- ☐ Reassess risk assessment models frequently to evaluate all patients admitted for a risk of developing VTE.
- ☐ Perform laboratory monitoring of anticoagulant response from patient during and after resuming anticoagulant therapy after bleeding.
- ☐ Develop protocols for the appropriate use of mechanical and pharmacological prophylactic measures.
- ☐ Optimize use of coagulants and subsequent monitoring by ensuring the proper dose is selected based on patient's health profile and maintain monitoring of anticoagulant response.
- ☐ Monitor signs and symptom of bleeding such as GI bleeding in stool, oozing at wound and or incision sites, nosebleeds, and or coughing up blood.

Discharge:

- ☐ Consider ongoing treatment for patients with acute VTE requiring secondary prophylaxis program and coordinate close follow-up appointments to carefully manage risks and benefits associated with extended anticoagulation.
- ☐ Assess the risk of patient bleeding or falling post-discharge in order to determine prophylaxis.
- ☐ Evaluate possible drug interactions patient may experience post-discharge such as with direct oral anticoagulants.
- ☐ Educate patients and family members on symptoms of deep vein thrombosis, pulmonary embolism, and bleeding. Use teach-back methods to ensure the patient knows what to do if symptoms are present.

Executive Summary

The Problem

VTE is estimated to be the second most common medical complication, the second most common cause of excess length of hospital stay (LOS), and the third most common cause of excess mortality.

The Cost

Medical costs for VTE in the United States have been estimated to range from $5-$10 billion dollars per year (Grosse et al., 2017). The implementation of a standardized VTE prophylaxis protocol is inexpensive and can significantly decrease VTE-related readmission, harm, and death.

The Solution

Reducing deaths from VTE by using standardized early recognition protocols which are inexpensive, readily available, and effective methods to prevent VTE. VTE prevention and summarizes the available evidence-based practice protocols. This document is revised annually and is always available free of charge on our website.

Leadership Checklist

Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- ☐ Measure and report VTE prevention and compliance monthly (Patients who received no VTE/PE prophylaxis prior to the day before the date of the first positive VTE diagnostic test/Patients who developed confirmed VTE/PE during hospitalization). Note trends in areas with low compliance and high VTE incidence. Routinely reassess outcomes.
- ☐ If VTE rates indicate room for improvement, initiate a PI (performance improvement) project. If a problem is not indicated, routinely reassess to identify gaps, and ensure integrity of the data collected.
- ☐ Ensure frontline involvement in VTE improvement activities. Maintain their engagement and remove barriers to progress.
- ☐ If a PI plan is put in place, measure the associated process outcomes.
- ☐ Ensure that VTE prevention protocols are embedded into clinical workflows, whether electronic or paper.
- ☐ Ensure there are enough staff to effectively manage necessary preventive care.
- ☐ Ensure adequate training and documentation of VTE prevention competencies and skills.
- ☐ Eliminate barriers to making rapid changes to documentation templates and order sets.
- ☐ Debrief on a regular basis to solicit team feedback about barriers to sustained compliance. Adjust the plan quickly and nimbly as needed.
- ☐ Hold staff accountable for providing the standard of care and reward success.
- ☐ Ensure that leaders have a simple process to oversee VTE improvement work while also considering how it aligns with other initiatives across the organization.
- ☐ Reduce all prophylaxis options to preferred options to simplify processes and reduce confusion.
- ☐ Organize patient education resources to ensure ease of access for frontline staff.

Clinical Workflow

1. ADMISSION

Evaluate all patients admitted for risk of VTE utilizing a risk assessment model such as*:

- Caprini risk assessment (Appendix A and Appendix B)
- Padua prediction score (Appendix C)

- IMPROVE score (Appendix D)
- "3 Bucket" classification (Appendix G)

Enter risk assessment outcome in the EHR.

Conduct heparin-induced thrombocytopenia (HIT) assessment.

- HIT is directly related to thromboembolic complications, including PE and DVT.
- To evaluate risk: Utilize serial platelet counts patients based on medium or high risk level

2. ROUTINE CARE

Frequently reassess for VTE risk utilizing a risk assessment models as referenced above*

If suspected based on risk factors, conduct diagnostics for confirmation.
Diagnostic imaging for confirmation includes venous doppler, V/Q scans, or the highly sensitive computerized tomography angiography (CTA) of the chest. With the latter, small subsegmental, possibly non-clinical, pulmonary emboli can now be detected, thus increasing a hospital's reported VTE rate.

Utilize guideline-appropriate VTE prophylaxis recommending type, dose, timing, and duration of anticoagulants.

- Consider different pharmacological prophylaxis options. See Queensland Health for more information on timing, dose, transitions, and considerations by patient population based on risk of developing complications and type of impairment patients may have.

Optimal use of anticoagulants includes dose selection, laboratory monitoring of the anticoagulant response, patient and family education, and resumption of anticoagulant therapy after bleeding (Witt et al., 2018).

- **Select the proper dose.** All infectious, critically-ill patients should receive LMWH and, depending on their risk, a 50% increase in LMWH should be administered twice per day. Obese patients should receive a 50% increased dose in LMWH.
- **Monitor the anticoagulant response.** Consider LMWH doses based on body weight instead of assessing anti-Xa concentrations.
- **Communicate the mechanisms for which to prevent VTE to the patient and family members.** Describe pharmacological and mechanical methods to prevent VTE and why the specific patient is receiving their therapies.

- **Resume anticoagulant therapy after bleeding.** For patients receiving anticoagulation after a major bleeding episode, resume oral anticoagulants within 90 days rather than complete discontinuation.

Consider use of mechanical prophylaxis methods, including intermittent pneumatic compression (IPC), sequential compression devices (SCD), and/or graduated compression stockings (GCS). See "What we know" section for a list.

Ambulation alone is not an effective strategy for VTE prevention and should not substitute for or serve as a reason to discontinue pharmacologic and/or mechanical prophylaxis.

Monitor for signs and symptoms of bleeding. This can include monitoring for GI bleeding in stool, oozing at wound/incision sites, nosebleeds, and/or coughing up blood.

3. DISCHARGE

Patients with an acute VTE require a secondary prophylaxis program (ongoing treatment). For most patients, this means extended use of anticoagulation and a close follow-up to carefully manage the risk and benefits of the secondary prophylaxis.

Consider the risk of bleeding and falls post-discharge. For those at a minimal risk for both, the prophylaxis might be considered post-discharge.

Consider LMWH and direct oral anticoagulants 7-14 days post-discharge. If contraindicated, coumadin can be used but requires close monitoring.

Evaluate the possibility of drug-to-drug interactions, particularly with direct oral anticoagulants post-discharge.

If a patient is willing and able, encourage using patient INR (PTT) self-testing.

Educate patients and family members on symptoms of deep vein thrombosis, pulmonary embolism, and bleeding. Use teach-back methods to ensure the patient knows what to do if symptoms are present.

Education for Patients and Family Members

The outline below illustrates all of the information that should be conveyed to the patient and family members by someone on the care team in a consistent and understandable manner.

Explain why VTE prophylaxis is needed. A member of the healthcare team should explain what VTE is, why the patient in particular is at a risk for VTE, and should elaborate on the method of VTE prophylaxis.

Indicate what to watch out for. Family members can serve as an extra pair of eyes and ears and can alert medical staff if something might be wrong. Family members should have an understanding of what to look for that may indicate deterioration, such as leg pain or redness. For VTE, abnormal swelling, complaint of new pain, or shortness of breath are indicators of something potentially more complicated. In order to adequately welcome patients and family members into the care team, it is not enough to explain "what" patients and family members should look for or "what" is going to happen in their care. The "what" must always be followed with a "why" to aid in genuine understanding.

Additionally, family members should know exactly when to call for help, where to go for help, and with whom they should speak. It is essential that patients and family members understand that they should not be ashamed to ask any of their questions and that many patients in similar situations often have similar questions.

Instead of employing a directive conversation style, an active, engaging conversation should take place, leaving capacity for questions and repeat-back strategies. When patients and family members understand the signs and symptoms that could be indicative of a problem, they are able to serve as an extra set of eyes in order to elevate this concern as early as possible.

Describe what can be anticipated. In addition to explaining when to call for help if the patient or family member notices signs of potential VTE, healthcare providers should also thoroughly explain the typical overall treatment that can be expected and how VTE prophylaxis fits into each step. If the particular patient is at a distinct risk based on comorbidities or history, this should be conveyed to the patient and family members.

Clinicians should provide a high-level overview of the processes in place at their organization to ensure VTE prevention. This demonstrates competence of the organization, will likely bolster patient and family comfort, and will provide the patient and family members with information for which to reference if they may be suspicious of a problem.

By engaging in these conversations before a problem arises, family members can be prepared in the circumstance of necessary treatment and will have an understanding of where to go to find out more information about their loved one's condition.

Explain what is expected of them during their care. By giving patients and family members a "job" while they are in the hospital, they can be immersed fully in the routine care, can hold other team members accountable, can feel more confident voicing their concerns or opinions, and can serve as an extra set of informed and vigilant eyes to optimize surgical safety. This team involvement can also reduce their anxiety by transforming concern into proactive action.

Patients and family members can:

- Engage in conversations around current potential health conditions such as diabetes.
- Ask for clarification of VTE standards.
- Make sure patient's legs are moisturized daily or more if using compression stockings.

- Check legs for sores or pressure wounds.
- Speak up if there are any abnormalities, such as pain or redness in the leg.
- Monitor for hand hygiene in all healthcare providers and visitors
- Monitor for anticoagulant side effects, including indigestion, dizziness, headaches, and/or vomiting of blood. If any of these are detected, patients and family members should understand the importance of alerting staff immediately.

Explore next steps. Planning for life after the hospital, whether in assisted living, returning home, or another option, should begin as early as possible between the healthcare providers and the patient and family.

- Describe the organization's VTE standards that were followed.
  - If any of the protocols changed due to this specific patient's circumstance, articulate these changes to the patient and family members.
  - Help the patient and family members integrate this VTE prophylaxis into their daily lives post-discharge, if applicable.
- Have a discussion with the patient and family around end of life care and advanced directives.
  - Make an attempt to thoroughly understand the religious or cultural nuances in any of the patient's or family members' decisions or questions.
- Ensure thorough explanation of necessary post-discharge appointments, therapies, medications, and potential complications.
  - Assess for patient preference in time and location of follow-up appointments, if possible.
- Provide patients and family members resources, including direct contact phone numbers, to the hospital for post-discharge questions.
  - Make sure the resources are in their own language.
- Help the patient set realistic expectations for recovery.

Performance Improvement Plan

Follow this checklist if the leadership team has determined that a performance improvement project is necessary:

☐ **Gather the right project team.** Be sure to involve the right people on the team. If possible, you'll want two teams: an oversight team that is broad in scope, has 10-15 members, and includes the executive sponsor to validate outcomes, remove barriers, and facilitate spread. The actual project team consists of 5-7 representatives who are most impacted by the process. In general, the key is having the right people on the team (people impacted by the process, executive sponsors, and subject matter experts), no matter the size of the organization. Whether a discipline should be on the advisory team or the project team depends upon the needs of the organization. Patients and family members need to be involved in all improvement projects, as there are many ways they can contribute to safer care. Define what constitutes a quorum, which team members are needed to make the quorum, and who can serve as alternatives.

Complete this Lean Improvement Activity:
Conduct a SIPOC analysis to understand the current state and scope of the problem. A SIPOC is a lean improvement tool that helps leaders to carefully consider everyone who may be touched by a process, and therefore, should have input on future process design.

RECOMMENDED VTE IMPROVEMENT TEAM	
• Admitting and registration staff	• Pharmacists
• Physicians	• Information technologists
• Nurses	• Patients and family members
• Physical and occupational therapists	• Quality and Safeaty Staff
• Residents	• Healthcare leaders

Table 1: Understanding the necessary disciplines for a VTE improvement team

☐ **Understand what is currently happening and why.** Reviewing objective data and trends is a good place to start to understand the current state, and teams should spend a good amount of time analyzing data (and validating the sources), but the most important action here is to go to the point of care and observe. Even if team members work in the area daily, examining existing processes from every angle is generally an eye-opening experience. The team should ask questions of the

Create a process map once the workflows are well understood that illustrates each step and the best practice gaps the team has identified (IHI, 2015). Brainstorm with the advisory team to understand why the gaps exist, using whichever root cause analysis tool your organization is accustomed to (IHI, 2019). Review the map with the advisory team and invite the frontline to validate accuracy.

frontline during the observations that allow them to understand each step in the process and identify the people, supplies, or other resources needed to improve patient outcomes.

VTE PROCESSES TO CONSIDER ASSESSING
• Risk assessments (See Appendices)
• Pharmacological prophylaxis order process
• Pharmacological prophylaxis missed doses
• Patient refusal of pharmacological prophylaxis
• Mechanical prophylaxis ordered
• Patient refusal of mechanical prophylaxis
• VTE prophylaxis continuation post-discharge
• Mechanical prophylaxis in pre-op areas
• Identification and communication of bleeding risk
• Use of proactive monitoring when pharmacological prophylaxis isn't recommended

Table 2: Consider assessing these processes to understand where the barriers contributing to VTE may be in your organization

☐ **Prioritize the gaps to be addressed and develop an action plan.** Consider the cost effectiveness, time, potential outcomes, and realistic possibilities of each gap identified. Determine which are priorities of focus for the organization. Be sure that the advisory team supports moving forward with the project plan so they can continue to remove barriers. Design an experiment to be trialed in one small area for a short period of time and create an action plan for implementation.

The action plan should include the following:

- Assess the ability of the culture to change and adopt appropriate strategies
- Revise policies and procedures
- Redesign forms and electronic record pages
- Clarify patient and family education sources and content
- Create a plan for changing documentation forms and systems
- Develop the communication plan
- Design the education plan
- Clarify how and when people will be held accountable

TYPICAL GAPS IDENTIFIED IN VTE
• Lack of standardized protocols
• Lack of standardized order sets
• Different impressions of when it is safe to begin anticoagulation before and after procedure
• Excessive customization of order sets
• Lack of adjustment to prophylaxis based on VTE or bleeding risk changes
• Patient refusal of treatment
• Prophylaxis is stopped at discharge
• Lack of communication regarding site/unit changes
• Change in patient's VTE risk level or contraindications

Table 3: By identifying the gaps in VTE compliance, organizations can tailor their project improvement efforts more effectively

☐ **Evaluate outcomes, celebrate wins, and adjust the plan when necessary.** Measure both process and outcome metrics. Outcome metrics include the rates outlined in the leadership checklist. Process metrics will depend upon the workflow you are trying to improve and are generally expressed in terms of compliance with workflow changes. Compare your outcomes against other related metrics your organization is tracking.

Routinely review all metrics and trends with both the advisory and project teams and discuss what is going well and what is not. Identify barriers to completion of action plans, and adjust the plan if necessary. Once you have the desired outcomes in the trial area, consider spreading to other areas (IHI, 2006).

It is important to be nimble and move quickly to keep team momentum going, and so that people can see the results of their labor. At the same time, don't move so quickly that you don't consider the larger, organizational ramifications of a change in your plan. Be sure to have a good understanding of the other, similar improvement projects that are taking place so that your efforts are not duplicated or inefficient.

Read this paper from the Institute for Healthcare Improvement to understand how small local steps

VTE METRICS TO CONSIDER ASSESSING

- Risk score use
- Pharmacological prophylaxis ordered
- Pharmacological prophylaxis missed doses
- Patient refusal of pharmacological prophylaxis
- Mechanical prophylaxis ordered
- Patient refusal of mechanical prophylaxis
- VTE prophylaxis continuation post-discharge
- Mechanical prophylaxis in pre-op areas
- Percent of patients who have a documented VTE risk assessment within 24 hours of admission
- Percent of patients with mechanical prophylaxis ordered versus those who actually have compression devices in place
- VTE patients receiving unfractionated heparin with dosages/platelet count monitoring by protocol
- Surgical patients who received appropriate VTE prophylaxis within 24 hours post-surgery
- Patients readmitted due to VTE
- Number of patients diagnosed with confirmed VTE during hospitalization (not present at admission) who did not receive VTE prophylaxis between hospital admission and the day before date of the first positive VTE diagnostic test
- Total numbers of VTEs

Table 4: Consider evaluating related metrics to better understand VTE presence and contributing factors

What We Know About Venous Thromboembolism (VTE)

Venous Thromboembolism (VTE)

Venous thromboembolism (VTE) refers to both deep vein thrombosis (DVT) and pulmonary embolism (PE) and is known generally as a blood clot. Although blood clots can happen at any age, they are most commonly seen in adults. Clots are typically formed in the lower leg, thigh, or pelvis but can also occur in the arm (CDC, 2020).

Populations at Risk (American Health Association, 2020)

Infectious diseases and congestive heart failure (CHF) are among the most common causes of VTE. It has been found that 32% of VTE patients had infections and 19% had respiratory failure due to the body's increased coagulation during inflammation (Cardinal Health, 2020).

Populations at risk include:

- Older individuals
- Pregnant women
- Individuals with COVID-19
- Individuals who are obese or overweight
- Individuals with cancer or other conditions (including autoimmune disorders such as lupus)
- Individuals whose blood is thicker than normal
- Individuals with a family history of heart disease
- Individuals undergoing surgery
- Individuals with respiratory failure
- Individuals who are immobile
- Individuals hospitalized with injuries to veins

Clinical Implications

VTE is the second most common medical complication with more than half of cases caused by hospitalization, 24% specifically attributable to the surgical setting (Fernandez et al., 2015). It is suggested that 60,000-100,000 Americans die of VTE, 10-30% within one month of diagnosis. However, sudden death is the first and only symptom in 25% of individuals with PE specifically (CDC, 2020). In many cases, only a minority of hospitalized patients of those found to have DVT have classical clinical findings to suggest the diagnosis (Cook et al., 2005). Even post-recovery, one third will have a recurrence within 10 years (CDC, 2020).

Internationally, studies from Europe, America and Australia show consistent indications that incidence rates range from .75 to 2.69 per 1000 individuals in the population. Globally, VTE is responsible for a greater number of lost DALYs than hospital-acquired pneumonia, catheter-related bloodstream infections, and medication errors (ISTH Steering Committee, 2014).

The clinical impact of VTE extends beyond the initial event and can include recurrent VTE, post-thrombotic syndrome, chronic thromboembolic pulmonary hypertension, and anticoagulation-related adverse drug events (Grosse et al., 2017).

Financial Implications

VTE costs approximately $18,000-23,000 per incident. With the 375,000-425,000 newly diagnosed, medically-treated VTE cases, medical costs associated with VTE in the US are estimated to total $5-10 billion annually. These figures are consistent when compared with other countries' VTE figures. For example, the total cost for patients who survived one year beyond initial diagnosis in Germany was between €20,275 and €21,351.

While costs differ by country, it is consistently found that the majority of total PE hospitalization costs are due to room and board (53%) (Fernandez et al., 2015). Globally, recurrent VTE requiring readmission is estimated to be almost 50% more expensive than the initial event (Fernandez et al., 2015).

Risk Assessments

Relationship Between D-dimer and Prothrombotic State

The higher the D-dimer, the greater the risk for VTE. An elevated D-dimer level is abnormal and is usually indicative of a clot breaking down. If there is significant formation and breakdown of blood clots, the individuals will likely show elevated D-dimer levels (University of Rochester Medical Center). This should guide in the direction of prophylaxis selection.

Serial D-dimer testing and evaluation is acceptable to identify appropriateness for anticoagulation treatments to be discontinued. It has been suggested that patients with consistently negative D-dimers post-standard therapy are at a low risk for recurrence, therefore, anticoagulation can be stopped (Lim, 2016).

Caprini Risk Assessment

Appendix A shows the different scores for the factors represented in the Caprini score (Caprini et al., 1991). Calculate the Caprini score by adding the scores of all factors present in the patient (Caprini, 2005). See Appendix A and Appendix B.

Padua Prediction Score

Appendix C depicts the Padua Prediction score for VTE among hospitalized patients (Barbar et al., 2010). A score of:

- ≥4: high risk of VTE
- ≤4: low risk for VTE.

See Appendix C.

IMPROVE Score

The IMPROVE score for VTE assesses the risk of VTE among hospitalized patients. The predictive score includes four independent risk factors for VTE, which are present at admission. The associative score includes seven variables present either at admission or during hospitalization (Spyropoulos et al., 2011). See Appendix D.

Bleeding Risk Assessment

The below are bleeding risk factors to consider for pharmacologic prophylaxis (Maynard, 2016):

- Active bleeding within the last 3 months
- Active ulcer
- Platelet count <50,000 or <100,000 and downtrending
- Therapeutic levels of anticoagulation
- Advanced liver disease with INR >1.5

- Heparin-induced thrombocytopenia
- Intracranial bleeding within last year
- Intraocular surgery within 2 weeks
- Untreated genetic bleeding disorders
- Hypertensive emergency
- Postoperative bleeding hazards
- Epidural or spinal anesthesia within the previous four hours or anticipated within the next 12 hours

Heparin-Induced Thrombocytopenia Risk Assessment
The "4 T's" assessment tool should be used to estimate the likelihood of HIT before laboratory confirmation (Ahmed et al., 2007). See Appendix F.

Prevention

Pharmacologic Prophylaxis
Low-molecular-weight heparins (LMWHs), low-dose unfractionated heparin (LDUH), and Fondaparinux

LMWH and LDUH are usually given in units and administered subcutaneously. 5,000 units BID or TID every 8-12 hours is typical but this can vary depending on the situation (Maynard, 2016).

Fondaparinux should be administered 2.5 mg daily (FDA, 2010).

For patients undergoing very low risk procedures, including most same-day surgical procedures, no VTE prophylaxis is typically needed unless hospitalization extends beyond one day and/or the patient has other VTE risk factors.

Patients undergoing medium-risk procedures, including scheduled cardiac procedures, should undergo frequent assessments of VTE risk to ensure adjustment of prophylaxis regimen, if indicated. VTE prophylaxis may be needed in these cases if the patient cannot be mobilized within one day or if complications occur.

Patients undergoing high risk procedures, including open cavity, abdominal, pelvic, or thoracic surgeries, should receive a combination of mechanical prophylaxis and pharmacologic prophylaxis.

Patients undergoing orthopedic surgeries are among the highest risk for VTE. A combination of pharmacologic and mechanical prophylaxis is highly recommended for these patients, typically for 10-14 days. LMWH is typically recommended for these major surgeries. Avoid LMWH administration 12 hours prior to and post operation to reduce bleeding (Maynard, 2016).

Mechanical Prophylaxis (Compression Devices)
In the absence of bleeding risk factors, mechanical prophylaxis is not typically offered as the first choice for medical patients.

Graduated Compression Stockings (GCS): Healthcare providers should use their judgement regarding how long GCS should be worn. Regardless of duration, GCS should be removed daily to evaluate skin integrity. Patients should wear the stockings as prescribed. Dry legs should be moisturized to prevent skin degradation.

Examples include:

- Anti-embolism stockings

- Anti-thrombosis stockings
- Elastic support hose
- Graduated compression elastic stockings
- Jobst stockings
- Surgical hose
- TED hose
- White hose
- Thrombosis stockings.

Note: When using GCS, proper fitting is essential to ensure safety from injury and effectiveness. Notably, 15-20% of patients cannot effectively wear AES because of unusual limb size or shape (Geerts et al., 2001).

Intermittent Pneumatic Compression (IPC) devices and anti-embolic (AE) pumps:

- Alternating leg pressure (ALP)
- Athrombic pumps-calf/thigh
- Continuous enhanced circulation therapy (CECT)
- DVT boots-calf/thigh
- Impulse pump-thigh
- Intermittent pneumatic compression stockings
- Intermittent compression device (ICD)
- KCI stockings
- Leg pumpers
- Pulsatile antiembolic stockings (PAS)
- Pneumatic intermittent impulse compression device
- Rapid inflation asymmetrical compression (RIAC) devices
- Sequential compression device
- Sequential pneumatic hose
- Thromboguard
- Thrombus pumps-calf/thigh

Note: When using IPC AE, appropriate fitting is essential to ensure safety from injury and effectiveness.

It is important to be equally vigilant for the need and judicious in the administration of thromboprophylaxis. See Appendix G for the "3 Bucket" model, outlining risk categories and appropriate prophylactic measures associated.

Resources

For Venous Thromboembolism Prevention Improvement:

- Children's Hospital of Philadelphia: Inpatient Clinical Pathway for VTE Prevention
- American Society of Hematology: Clinical Practice Guidelines on Venous Thromboembolism

- American Society of Hematology 2018 Guidelines for Management of Venous Thromboembolism: Prophylaxis for Hospitalized and Nonhospitalized Medical Patients
- AHRQ: Preventing Hospital-Associated Venous Thromboembolism A Guide for Effective Quality Improvement Identifying In-Hospital Venous Thromboembolism
- Queensland Health: Guideline for Prevention of Venous Thromboembolism (VTE) for Adult Hospitalized Patients

For General Improvement:

- CMS: Hospital Improvement Innovation Networks
- IHI: A Framework for the Spread of Innovation
- The Joint Commission: Leaders Facilitating Change Workshop
- IHI: Quality Improvement Essentials Toolkit
- SIPOC Example and Template for Download
- SIPOC Description and Example

Patient Stories:

- The story of Charles Yogiraj Bates II is an excellent example of a story of a hospital-acquired VTE that could have been prevented.

Endnotes

Conflicts of Interest Disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Workgroup members are required to disclose any potential conflicts of interest.

Workgroup

Co-Chairs

Brandyn Lau	Johns Hopkins Medicine
Michael Becker	Masimo
Vonda Vaden Bates	10th Dot

Workgroup Members

Steven J. Barker	Patient Safety Movement Foundation; Masimo
Lorraine Foley	Society for Airway Management
Arthur Kanowitz	Securisyn
Ariana Longley	Patient Safety Movement Foundation
Olivia Lounsbury	Patient Safety Movement Foundation
Donna Prosser	Patient Safety Movement Foundation
Kellie Quinn	Advocate
Rena Zhu	University of California, Irvine

Metrics Integrity

Robin Betts	Kaiser Permanente, Northern California Region

Previous Members

This list represents all contributors to this document since inception of the Actionable Patient Safety Solutions

Jim Augustine	US Acute Care Solutions
Ann Bilyew	ClearLine MD
Michel Bennett	Patient Safety Movement Foundation
Jestin Carlson	Allegheny Health Network
Richard Cooper	University of Toronto
Abbey Curran	ClearLine MD
Drew Fuller	Emergency Medicine Associates
Kate Garrett	Ciel Medical
Victor Grazette	Virginia Hospital Center
David Hughes	Patient Safety Movement Foundation, Do It For Drew Foundation
Hans Huitink	Vanderbilt University Medical Center
Thomas Kallstrom	American Association for Respiratory Care
Jacob Lopez	Patient Safety Movement Foundation
Ariel MacTavish	Medtronic
Rhea May	Medtronic
Kellie Quinn	Retired
Kenneth Rothfield	Medical City Healthcare
Michael Taylor	Fairview Hospital
Dianne Vass	Emergency Medicine Patient Safety Foundation

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Appendices

Appendix A

Calculation of the Caprini Risk Score

The table below shows the different scores for the factors represented in the Caprini score (Caprini, 1991). Calculate the Caprini score by adding the scores of all factors present in the patient (Caprini, 2005). Note that the original Caprini risk score has been updated and modified.

5 POINTS	3 POINTS	2 POINTS	1 POINTS
• Stroke (in the previous month) • Fracture of the hip, pelvis, or leg • Elective arthroplasty • Acute spinal cord injury (in the previous month)	• Age≥ 75 years • Prior episodes of VTE • Positive family history for VTE • Prothrombin 20210 A • Factor V Leiden • Lupus anticoagulants • Anticardiolipin antibodies • High homocysteine in the blood • Heparin induced thrombocytopenia • Other congenital or acquired thrombophilia	• Age: 61-74 years • Arthroscopic surgery • Laparoscopy lasting more than 45 minutes • General surgery lasting more than 45 minutes • Cancer • Plaster cast • Bed bound for more than 72 hours • Central venous access	• Age 41-60 years • BMI > 25 Kg/m2 • Minor surgery • Edema in the lower extremities • Varicose veins • Pregnancy • Post-partum • Oral contraceptive • Hormonal therapy • Unexplained or recurrent abortion • Sepsis (in the previous month) • Serious lung disease such as pneumonia (in the previous month) • Abnormal pulmonary function test • Acute myocardial infarction • Congestive heart failure (in the previous month) • Bed rest • Inflammatory bowel disease

Appendix B

Caprini Scoring and Recommended Prophylaxis (Gould et al., 2012)

CAPRINI SCORE	RISK	VTE INCIDENCE	RECOMMENDED PROPHYLAXIS
0-2	Very low-low	<1.5%	Early ambulation, IPC
3-4	Moderate	3%	LMWH; UFH; or IPC If high bleeding risk, IPC until bleeding risk diminishes.
5-8	High	6%	LMWH + IPC; or UFH + IPC If high bleeding risk, IPC until bleeding risk diminishes.
>8	Very high	6.5-18.3%	LMWH + IPC; or UFH + IPC If high bleeding risk, IPC until bleeding risk diminishes. Consider extended duration prophylaxis.

Abdominal or pelvic surgery for cancer should receive extended VTE prophylaxis with LMWH x 30 days (AHRQ, 2016).
IPC = intermittent pneumatic compression
LMWH = low-molecular-weight heparin
UFH = unfractionated heparin

Appendix C

Calculation of the Padua Prediction Score

The table below depicts the Padua Prediction score for VTE among hospitalized patients (Barbar et al., 2010). A score of:

- ≥4: high risk of VTE
- ≤4: low risk for VTE.

VARIABLE	SCORE
Active cancer	3
Previous VTE	3
Decreased mobility	3
Thrombophilia	3
Previous trauma or surgery within that last month	2
Age≥ 70	1
Heart and/or respiratory failure	1
Ischemic stroke or acute myocardial infarction	1
Acute rheumatologic disorder and/or acute infection	1
Obesity	1
Hormonal therapy	1

Appendix D

Calculation of the IMPROVE Predictive Score

The IMPROVE score for VTE assesses the risk of VTE among hospitalized patients. The predictive score includes four independent risk factors for VTE, which are present at admission. The associative score includes seven variables present either at admission or during hospitalization (Spyropoulos et al., 2011).

IMPROVE Predictive Score

VARIABLE	SCORE
Prior episode of VTE	3
Thrombophilia	3

Malignancy	1
Age more than 60 years	1

Interpretation of the IMPROVE Predictive Score

SCORE	PREDICTED VTE RISK THROUGH 3 MONTHS
0	0.5%
1	1.0%
2	1.7%
3	3.1%
4	5.4%
5-8	11%

IMPROVE Associative Score

VARIABLE	SCORE
Prior episode of VTE	3
Thrombophilia	2
Paralysis of the lower extremity during the hospitalization	2
Current malignancy	2
Immobilization for at least 7 days	1
ICU or CCU admission	1
Age more than 60 years	1

Interpretation of the IMPROVE Associative Score

SCORE	PREDICTED VTE RISK THROUGH 3 MONTHS
0	0.4%
1	0.6%
2	1.0%
3	1.7%
4	2.9%
5-10	7.2%

Appendix E

HIT Risk by Underlying Medical Condition and Heparin Type (ARUP Laboratories, 2020**)**

High risk (>1.0%)	Patients treated with unfractionated heparins (UFH) (or a combination of UFH and low molecular weight heparin, or UFH and fondaparinux) after a major surgery or trauma
Medium risk (0.1-1.0%)	Medical or obstetric patients treated with UFH Patients treated with low molecular weight heparin after a major trauma or surgery

Low risk (<0.1%)	Medical or obstetric patients treated with low molecular weight heparin Patients treated with low molecular weight heparin after a minor surgery or trauma Patients treated with fondaparinux

Appendix F

The "4 T's" assessment tool should be used to estimate the likelihood of HIT before laboratory confirmation (Ahmed ets al., 2007).

Table 1 Estimating the pre-test probability of heparin induced thrombocytopenia: the "4 T's"

Category	2 points	1 point	0 point
Thrombocytopenia	>50% fall, or nadir of 20–100×10^9/l	30–50% fall, or nadir of 10–19×10^9/l	30% fall or nadir <10×10^9/l
Timing of platelet count fall	Days 5 to 10, or ⩽1 day if heparin exposure within past 30 days	>Day 10 or unclear (but fits with HIT), or ⩽1 day if heparin exposure within past 30–100 days	⩽1 day (no recent heparin)
Thrombosis or other sequelae	Proven thrombosis, skin necrosis, or, after heparin bolus, acute systemic reaction	Progressive, recurrent, or silent thrombosis; erythematous skin lesions	None
Other cause for thrombocytopenia	None evident	Possible	Definite

*Points assigned in each of four categories are totalled, and the pre-test probability of HIT by total points is as follows: 6 to 8=high, 4 to 5=intermediate; 0 to 3=low. Adapted with permission from Warkentin *et al*. *Hematology/the education program of the American Society of Hematology*. Copyright 2003, American Society of Hematology.