Actionable Patient Safety Solution (APSS) #12A:
VENOUS THROMBOEMBOLISM (VTE)

Executive Summary Checklist

Venous thromboembolism (VTE) is associated with increased mortality, poor patient outcomes, increased length of stay, and decreased patient satisfaction. It is the most common preventable hospital complication as well as the most common cause of preventable mortality in hospitals.

- Accurately stratifying risk by ensuring that providers perform a VTE risk assessment
- Measure appropriate quality measures related to VTE to close performance gap
- Complete in depth chart review for hospital-associated thrombosis events to identify opportunities for improvement and then acting on lessons learned
- Adhere to VTE best practices from national organizations such as Agency for Healthcare Research and Quality’s VTE Safety Toolkit (AHRQ, 2016). The toolkit contains 10 components that are evidence-based guidelines for preventing, diagnosing, treating, and educating patients and providers about VTE. The components are as follows:
  - VTE prophylaxis guidelines, VTE risk assessment tool, DVT diagnostic algorithm, PE diagnostic algorithm, HIT (heparin-induced thrombocytopenia) assessment, VTE treatment pathway, DVT outpatient treatment order set, Vascular laboratory requisition, Neural-axial anesthesia guidelines, Patient education (prevention and treatment) pamphlets
- Ensure healthcare professionals receive, at the least, annual training on new VTE policies and processes
- Assess risk for VTE among patients hospitalized with:
  - Injury to vein: fracture, surgery
  - Slow blood flow: bedrest, limited mobility, paralysis
  - Increased estrogen: birth control, pregnancy and recent childbirth, hormone replacement therapy
  - Chronic illness: cancer, heart/lung disease, atrial fibrillation, inflammatory bowel disease (Crohn’s Disease and ulcerative colitis)
  - Other: personal or family history of DVT/PE, age, obesity, central lines, or clotting disorders
- Educate patient and families on VTE risks, complications, and importance of mechanical and medication prophylaxis.
- Select technologies that show early evidence to reduce VTEs and positively impact both patient and provider outcomes in the clinical settings
  - Implement an EHR with prompt decision making support to ensure that every patient has a valid VTE prevention plan in place at all times during their hospitalization.
The Performance Gap

A venous thromboembolism (VTE) is defined as a blood clot in the lung (pulmonary embolism or PE) or in deep veins of the arm or leg (Deep Vein Thrombosis or DVT). VTEs are associated with increased mortality, poor patient outcomes, increased length of stay and decreased patient satisfaction. It is the most common preventable hospital complication as well as the most common cause of preventable mortality in hospitals. It is estimated that 60,000 to 100,000 Americans die from VTE each year and 10-30% of those patients will die within one month of diagnosis (Beckman et al., 2010). VTE affects all races, ages and genders. It is estimated that over 50% of all VTE in a given community are associated with hospitalization (Heit et al., 2000). Healthcare institutions should take all precautions in order to prevent blood clots in their patients.

It is important to realize that even though trauma and surgery contribute to the risk for VTE, at least half of all hospital-acquired VTE occur in patients hospitalized with medical illnesses. Although classic clinical symptoms of DVT include red or painful swelling of a limb, the clinical examination for DVT is notoriously poor in both sensitivity and specificity. In some studies of hospitalized patients, only a minority of those found to have DVT have classical clinical findings to suggest the diagnosis (Cook et al, 2005). Because of this, clinical decision rules have been developed to help guide the diagnostic evaluation (Wells et al., 1997). Although patients with acute PE typically endorse shortness of breath, tachypnea, and/or tachycardia, sudden cardiac arrest is the first symptom in 25% of PE patients (ONC, 2014). Thus one must maintain a high level of clinical suspicion to diagnose VTE. The better policy, both from a patient safety and a cost-consciousness point of view, is primary prevention to avoid their occurrence to begin with. All patients admitted to the acute care setting should be evaluated for their risk of VTE, and then guideline appropriate VTE prophylaxis should be reliably administered. This strategy results in significant reduction in the incidence of hospital-acquired VTE.

Once clinically suspected, clinical prediction rules should be utilized to guide appropriate diagnostic evaluation. 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.

Patients who develop a VTE have a higher in-hospital mortality rate, and will have approximately 33% chance of developing another clot within 10 years (PCAST, 2014). Patients identified to have an acute VTE will require a secondary prophylaxis program. For most patients, this entails prolonged anticoagulation and close follow-up to carefully manage the risk and benefits of secondary prophylaxis.

Leadership Plan

**Identify:** Senior executive leadership that is committed to a reduction in VTE  
- Team ideally is led by a physician and administrative champions, ideally the Chief Nursing Officer  
- Gather staff that have an in depth knowledge base of disease process and prevention of VTE such as:
  - Physicians
  - Nursing Leaders
  - Advanced Practice Providers such as Physical and Occupational Therapists
  - Physicians in training
  - Residents
  - Bedside Nurses
  - Quality Improvement staff
  - Safety/Risk
  - Pharmacy
  - Information Technology team with Electronic Medical Record

**Plan:** Senior executive leadership and clinical/safety leaders should agree on the best implementations in order to close their performance gap.
Plan should include measurable appropriate quality metrics

Timeline set: Senior executive leadership should select a goal and set a timeline to achieve said goal

Resources allocated: Senior executive leaders should set specific budget for said goal and plan

System leadership and engagement: Clinical and safety leaders should act as change agents and drive implementation

Practice Plan

Complete in depth chart review of hospital-associated thrombosis events. Identify trends such as:
- Service line
- Physician
- Diagnosis
- Risk score (Appendix A: Caprini Score, Padua Prediction Score, IMPROVE score, or “3-bucket” model)
- Hospital units
- Pharmacological prophylaxis ordered
  - Pharmacological prophylaxis missed doses
  - Patient Refusal of pharmacological prophylaxis
- Mechanical prophylaxis ordered
  - Patient refusal of mechanical prophylaxis
- Patient mobility

Identify gaps in care that promote VTE development

Adhere to the Agency for Healthcare Research and Quality’s Venous Thromboembolism Safety Toolkit: A System’s Approach to Patient Safety

Implement interventions that reduce VTE
- Ensure interventions are patient-centered
- Incorporate VTE Risk Assessment into EHR for all new admissions
  - Reassess risk periodically upon change in level of care, clinicians, and prior to discharge.
- Ensure the ordering of appropriate VTE prophylaxis according to risk assessment
  - Consider adoption of VTE power plans/order sets
  - Continue VTE prophylaxis past discharge if recommended
- Ensure timely and reliable delivery of pharmacological and/or mechanical prophylaxis as indicated
  - Track/trend missed doses, patient refusals and ensure that patient resistance or refusal is met with education about the purpose of prophylaxis and risks if not administered.
- Develop specific and reliable protocols, endorsed by local surgical champions, for reliable mechanical or pharmacologic prophylaxis to be applied prior to induction of anesthesia, as appropriate
- Consider nursing protocol for application of mechanical prophylaxis in pre-op areas
- Understand your staff’s perception of the importance of VTE prophylaxis
  - Educate knowledge deficits
  - Consider yearly competence in VTE
Ensure that all team members - physicians, nurses, patient care assistants, trainees, pharmacists, transport personnel, physical therapists, patients and family members are aware of their role in VTE-P.

Patient Mobility

- Utilize mobility trackers

Design and implement a plan when pharmacological prophylaxis is contraindicated, such as proactive monitoring.

Educate patients and families about the risks, complications, the importance of VTE prophylaxis, and the symptoms of DVT and PE.

Technology Plan

Suggested technologies are limited to those proven to show benefit or are the only known technologies with a particular capability. Other technology options may exist or emerge after the publication of this APSS, please send information on any additional technologies, along with appropriate evidence, to info@patientsafetymovement.org.

With regard to VTE, there are a few novel technology platforms that offer a low entry cost that work alongside the Electronic Health Record (EHR). These technology platforms are secure with multimedia functions and can host checklists, education and much more to improve best practices and engagement across the care continuum. There is also technology that is important in the prevention of blood clots, like compression devices. Examples of those devices and technology solutions are detailed below and may be helpful in VTE prevention.

- Compression Devices
  - Either Graduated Compression Stockings (GCS) and/or Intermittent Pneumatic Compression Device (IPC), or AE (anti-embolic) pumps should be used adjunct to other forms of prevention, like pharmacological solutions
    - GCS such as:
      ➢ Anti-embolism stockings, anti-thrombosis stockings, elastic support hose, graduated compression elastic stockings, Jobst stockings, surgical hose, TED hose, white hose, thrombosis stockings. When using GCS, appropriate 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).
    - IPC AE pumps such as:
      ➢ Alternating Leg Pressure (ALP), athrombic pumps-calf/thigh, Continuous Enhanced Circulation Therapy (CECT), DVT boots-calf/thigh, EPC cuffs/stockings-External pneumatic compression-calf/thigh, Flotron/Flotron DVT system-thigh, Impulse pump-thigh, Intermittent pneumatic compression stockings, Intermittent compression device (ICD), KCI stockings, Leg pumpers, PAS (Pulsatile anti-embolic stockings), Plexipulse-calf/thigh, Pneumatic intermittent impulse compression device, Rapid inflation asymmetrical compression (RIAC) devices, Sequential compression device, Sequential pneumatic hose, Thromboguard, Thrombus pumps-calf/thigh, Vasculator, VasoPress DVT System, Venodyne boots-calf/thigh

- Electronic Health Record (EHR)
○ Web-based/EHR predictive algorithms that elicit specific data such as but not limited to vital signs (BP, Temp, HR, RR, and SpO2) lab values, nurses notes, and event reports.
○ The EHR can be a key component of a VTE prevention program by enabling computerized decision support to ensure that every patient has a valid VTE prevention plan at all times during their hospitalization (Morrison and England, 2015; Doyle and Hospital, n.d.).

Metrics

Topic 1:

Hospital Acquired Potentially Preventable Venous Thromboembolism Rate (VTE-6)
VTE-6 assesses the 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.

Process Measure Formula:

**Numerator:** Patients who received no VTE/PE prophylaxis prior to the day before the date of the first positive VTE diagnostic test.

**Denominator:** Patients who developed confirmed VTE/PE during hospitalization.

* Rate is typically displayed: Numerator/Denominator*1000

Metric Recommendations:

**Indirect Impact:**
All admitted patients

**Direct Impact:**
All admitted patients

**Lives Spared Harm:**
\[ \text{Lives Spared Harm} = (\text{VTE or PE Rate}_{\text{baseline}} - \text{VTE or PE Rate}_{\text{measurement}}) \times \text{Total Patient Days}_{\text{baseline}} \]

**Lives Saved:**
\[ \text{Lives Saved} = \text{Lives Spared Harm} \times 0.104 \]

**Notes:**
Measure exclusions age < 18 years, LOS > 120 days, comfort measures only, clinical trials, principal diagnosis of VTE or VTE present on admission, provider reason for not administering mechanical and pharmacologic prophylaxis.

**Data Collection:**
Chart abstraction.

**Mortality (will be calculated by the Patient Safety Movement Foundation):**
Estimated mortality per VTE is 0.104

**Reference:**
- Mortality and Cost per Case Information from AHRQ
**Topic 2:**

**Hospital Acquired Venous Thromboembolism Rate**

Rate of patients having a hospital acquired VTE/PE

**Process Measure Formula:**

**Numerator:** Number of patients having a VTE/PE  
**Denominator:** Total patient days  
*Rate is typically displayed: Numerator/Denominator * 1,000

**Metric Recommendations:**

**Indirect Impact:**

All admitted patients

**Direct Impact:**

All admitted patients

**Lives Spared Harm:**

\[ \text{Lives Spared Harm} = (VTE \ or \ PE \ Rate_{baseline} - VTE \ or \ PE \ Rate_{measurement}) \times \text{Total Patient Days}_{baseline} \]

**Lives Saved:**

\[ \text{Lives Saved} = \text{Lives Spared Harm} \times 0.104 \]

**Notes:**

Hospital acquired VTEs are identified through ICD diagnosis codes. The ICD9 diagnosis codes are: 45111, 45119, 45181, 45340, 45341, 4151, 41511, 41513, 41519. The ICD10 diagnosis codes are: I8010, I8011, I8012, I8013, I80201, I80202, I80203, I80209, I80211, I80212, I80213, I80219, I80222, I80223, I80229, I80231, I80232, I80233, I80239, I80291, I80292, I80293, I80299, I82401, I82402, I82403, I82409, I82411, I82412, I82413, I82419, I82421,
I82422, I82423, I82429, I82431, I82432, I82433, I82439, I824Y1, I824Y2, I824Y3, I824Y9, I2602, I2609, I2692, I2699. Qualifying diagnoses that are present on admission are excluded from the numerator.

Total patient days come from daily census counts for each inpatient nursing unit. Census counts are electronically derived at the same time of day each day. These counts may be collected manually if an electronic source is not available.

**Data Collection:**
Data collected from final diagnosis codes for encounter as determined by a professional health information coder.

**Mortality (will be calculated by the Patient Safety Movement Foundation):**
Estimated mortality per VTE is 0.104, as listed under Topic 1.

**Workgroup**

**Co-Chairs:**
Brandyn Lau (Johns Hopkins Medicine)
Steven Barker (Patient Safety Movement Foundation; Masimo)
Michael Becker (Masimo)

**Members:**
Latif Asad (Doctella)
Ann Bilyew (ClearLine MD)
Jose Branco (Brazilian Institute of Patient Safety)
Jessica Duke (Baptist Health)
Jeff Dunn (Redivus Health)
Amer Haider (Doctella)
Ariana Longley (Patient Safety Movement Foundation)
Jacob Lopez (Patient Safety Movement Foundation)
Amy Lukanski (University of Pittsburgh Medical Center)
Brendan Miney (Talis Clinical)
Timothy Morgenthaler (Mayo Clinic)
Daryn Munley (Decisio Health, Inc.)
Todd Pollock (University of Pittsburgh Medical Center)
Amy Sofranko (University of Pittsburgh Schools of the Health Sciences)
Michael Wong (Physician-Patient Alliance for Health & Safety)

**Metrics Integrity:**
Nathan Barton (Intermountain Healthcare)
Robin Betts (Intermountain Healthcare)
Jan Orton (Intermountain Healthcare)

**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. Some of the APSS recommend technologies offered by companies involved in the Patient
Safety Movement Foundation that the workgroups have concluded, based on available evidence, are beneficial in addressing the patient safety issues addressed in the APSS. Workgroup members are required to disclose any potential conflicts of interest.

References


Doyle, C. and Hospital, K. C. (n.d.). VTE Prevention; Electronic Solutions.

Caprini, J. A. Clinical assessment of venous thromboembolic risk in surgical patients.


Appendix A

Calculation of the Caprini Risk Score

The table below depicts the different scores for the factors represented in the Caprini score (Caprini, 1991). The Caprini score is calculated by adding the scores of all factors present in the patient. The Caprini score is interpreted in the following way (Caprini, 2005):

<table>
<thead>
<tr>
<th>5 points</th>
<th>3 points</th>
<th>2 points</th>
<th>1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>Age ≥ 75 years</td>
<td>Age: 61-74 years</td>
<td>Age: 41-60 years</td>
</tr>
<tr>
<td>Fracture</td>
<td>Prior episodes of VTE</td>
<td>Arthroscopic surgery</td>
<td>BMI &gt; 25 Kg/m2</td>
</tr>
<tr>
<td>of the hip,</td>
<td>Positive family history for VTE</td>
<td>Laparoscopy lasting more than 45 minutes</td>
<td>Minor surgery</td>
</tr>
<tr>
<td>pelvis, or</td>
<td>Prothrombin 20210 A</td>
<td>General surgery lasting more than 45 minutes</td>
<td>Edema in the lower extremities</td>
</tr>
<tr>
<td>leg</td>
<td>Factor V Leiden</td>
<td>Cancer</td>
<td>Varicose veins</td>
</tr>
<tr>
<td>Elective</td>
<td>Lupus anticoagulants</td>
<td>Plaster cast</td>
<td>Pregnancy</td>
</tr>
<tr>
<td>arthroplasty</td>
<td>Anticardiolipin antibodies</td>
<td>Bed bound for more than 72 hours</td>
<td>Post-partum</td>
</tr>
<tr>
<td>Acute</td>
<td>High homocysteine in the blood</td>
<td>Central venous access</td>
<td>Oral contraceptive</td>
</tr>
<tr>
<td>spinal cord</td>
<td>Heparin induced thrombocytopenia</td>
<td></td>
<td>Hormonal therapy</td>
</tr>
<tr>
<td>injury (in</td>
<td>Other congenital or acquired thrombophilia</td>
<td></td>
<td>Unexplained or recurrent abortion</td>
</tr>
<tr>
<td>the previous</td>
<td></td>
<td></td>
<td>Sepsis (in the previous month)</td>
</tr>
<tr>
<td>month)</td>
<td></td>
<td></td>
<td>Serious lung disease such as pneumonia (in the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>previous month)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Abnormal pulmonary function test</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Congestive heart failure (in the previous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>month)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bed rest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inflammatory bowel disease</td>
</tr>
</tbody>
</table>
Scoring and Recommended Prophylaxis (Gould et al., 2012)

<table>
<thead>
<tr>
<th>Caprini Score</th>
<th>Risk</th>
<th>VTE Incidence</th>
<th>Recommended Prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>Very low-low</td>
<td>&lt;1.5%</td>
<td>Early ambulation, IPC</td>
</tr>
<tr>
<td>3-4</td>
<td>Moderate</td>
<td>3%</td>
<td>LMWH; UFH; or IPC; If high bleeding risk, IPC until bleeding risk diminishes.</td>
</tr>
<tr>
<td>5-8</td>
<td>High</td>
<td>6%</td>
<td>LMWH + IPC; or UFH + IPC; If high bleeding risk, IPC until bleeding risk diminishes.</td>
</tr>
<tr>
<td>&gt;8</td>
<td>Very high</td>
<td>6.5-18.3%</td>
<td>LMWH + IPC; or UFH + IPC; If high bleeding risk, IPC until bleeding risk diminishes. Consider extended duration prophylaxis.</td>
</tr>
</tbody>
</table>

* 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
**Calculation of the Padua Prediction Score**

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

A score of:

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active cancer</td>
<td>3</td>
</tr>
<tr>
<td>Previous VTE</td>
<td>3</td>
</tr>
<tr>
<td>Decreased mobility</td>
<td>3</td>
</tr>
<tr>
<td>Thrombophilia</td>
<td>3</td>
</tr>
<tr>
<td>Previous trauma or surgery within that last month</td>
<td>2</td>
</tr>
<tr>
<td><strong>Age ≥ 70</strong></td>
<td>1</td>
</tr>
<tr>
<td>Heart and/or respiratory failure</td>
<td>1</td>
</tr>
<tr>
<td>Ischemic stroke or acute myocardial infarction</td>
<td>1</td>
</tr>
<tr>
<td>Acute rheumatologic disorder and/or acute infection</td>
<td>1</td>
</tr>
<tr>
<td>Obesity</td>
<td>1</td>
</tr>
<tr>
<td>Hormonal therapy</td>
<td>1</td>
</tr>
</tbody>
</table>
Calculation of the IMPROVE Predictive Score

The IMPROVE score for VTE assesses the risk of VTE among hospitalized patients. The predictive score includes 4 independent risk factors for VTE, which are present at admission. The associative score includes 7 variables present either at admission or during hospitalization (Spyropoulos et al., 2011).

**IMPROVE Predictive Score**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior episode of VTE</td>
<td>3</td>
</tr>
<tr>
<td>Thrombophilia</td>
<td>3</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1</td>
</tr>
<tr>
<td>Age more than 60 years</td>
<td>1</td>
</tr>
</tbody>
</table>

**Interpretation of the IMPROVE Predictive Score**

<table>
<thead>
<tr>
<th>Score</th>
<th>Predicted VTE risk through 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5%</td>
</tr>
<tr>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>2</td>
<td>1.7%</td>
</tr>
<tr>
<td>3</td>
<td>3.1%</td>
</tr>
<tr>
<td>4</td>
<td>5.4%</td>
</tr>
<tr>
<td>5-8</td>
<td>11%</td>
</tr>
</tbody>
</table>

**IMPROVE Associative Score**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior episode of VTE</td>
<td>3</td>
</tr>
<tr>
<td>Thrombophilia</td>
<td>2</td>
</tr>
<tr>
<td>Paralysis of the lower extremity during the hospitalization</td>
<td>2</td>
</tr>
<tr>
<td>Current malignancy</td>
<td>2</td>
</tr>
<tr>
<td>Immobilization for at least 7 days</td>
<td>1</td>
</tr>
<tr>
<td>ICU or CCU admission</td>
<td>1</td>
</tr>
<tr>
<td>Age more than 60 years</td>
<td>1</td>
</tr>
</tbody>
</table>

**Interpretation of the IMPROVE Associative Score**

<table>
<thead>
<tr>
<th>Score</th>
<th>Predicted VTE risk through 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4%</td>
</tr>
<tr>
<td>1</td>
<td>0.6%</td>
</tr>
<tr>
<td>2</td>
<td>1.0%</td>
</tr>
<tr>
<td>3</td>
<td>1.7%</td>
</tr>
<tr>
<td>4</td>
<td>2.9%</td>
</tr>
<tr>
<td>5-10</td>
<td>7.2%</td>
</tr>
</tbody>
</table>