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|  | |  | |  | | **eTable 1.** **Summary of Studies Included in This Review** | | | | | | |
| **Author** | **Study Design** | | **Population** | | **Total Number of Patients (n)** | | **Type of Injury** | **Median Injury Severity Score** | **Intervention/Exposure** | **Results** | **Limitations** | **Summary of the outcomes** |
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| Arnold et al. [(Arnold et al., 2010)](https://paperpile.com/c/PUEOR5/ZaQF9) | Retrospective cohort | | Adult trauma patients | | 476 (Heparin = 239, Enoxaparin = 237) | | Spinal cord, long bone, closed head, and pelvic fractures | 20\* (Heparin)  23.5\* (Enoxaparin) | Enoxaparin vs LDUH | ISS score approached statistical significance as an independent risk factor for the development of DVT (P= 0.055). The incidence of DVT and PE did not statistically significantly differ between patients treated with LMWH and LDUH. | Small sample size. | Subcutaneous LDUH dosed three times a day may be as effective as standard-dose Enoxaparin for prophylaxis of VTE. |
| Balachandran et al. [(Balachandran et al., 2020)](https://paperpile.com/c/PUEOR5/slpES) | Retrospective cohort | | Adults undergoing emergent abdominal surgery | | 1,179 (2500IU group = 674, 5000IU group = 505) | | Not applicable | Not applicable | Dalteparin 2500IU vs Dalteparin 5000IU | A significantly larger proportion of patients receiving 5000IU of Dalteparin developed VTE when compared to patients receiving 2500IU (1.9% vs 0.4%, p=0.027). Higher dose patients had demonstrated higher surgical complication rates than the low dose patients (p<0.001), but no differences were noted between the groups for the length of stay or 30-day postoperative mortality. | Single-center study.  Retrospective study.  Small sample size.  No timing was given. | Higher doses of Dalteparin were associated with a higher incidence of VTE and greater surgical complications |
| Byrne et al. [(Byrne et al., 2016)](https://paperpile.com/c/PUEOR5/ascDJ) | Retrospective cohort | | Adult trauma patients | | 2,468 (Early = 1,234, Late = 1,234) | | Isolated TBI | Not reported | Timing of prophylaxis intervention | Early prophylaxis (<72h) was associated with lower rates of both pulmonary embolism (odds ratio =0.48; 95% CI, 0.25-0.91) and deep vein thrombosis (odds ratio = 0.51; 95% CI, 0.36-0.72), but no increase in risk of late neurosurgical intervention or death. | Retrospective design. Unmeasured confounders. Inability to assess the course of TBI. | Early initiation of VTE prophylaxis was associated with decreased risk of pulmonary embolism and deep vein thrombosis, but no increase in the risk of late neurosurgical intervention or death. Early prophylaxis may be safe and should be the goal for each patient in the context of appropriate risk stratification. |
| Cothren et al. [(Cothren et al., 2007)](https://paperpile.com/c/PUEOR5/dYdgB) | Prospective cohort | | Adult trauma patients | | 743 | | Long bone fracture, pelvic fracture, brain injury, spinal injury, thoracic injury, abdominal injury | 19.5\* | Daily dosing LMWH Dalteparin | A Follow-up ultrasound examination that was performed in 673 patients at 7 to 10 days revealed DVT in 26 patients (3.9%). Seventy patients were discharged prior to follow-up ultrasound but none of them had clinical signs/symptoms of DVT. Six patients developed documented PE (0.8%), but no patient had a fatal outcome. | Single-center study.  Lack of comparison group. | LMWH Dalteparin dosed once daily is effective in preventing VTE in high-risk trauma patients. |
| Gunning et al. [(Gunning et al., 2021)](https://paperpile.com/c/PUEOR5/NqBMK) | Observational retrospective cohort | | Adult trauma patients | | 1,253  (UMCU = 279, HMC = 974) | | Unspecified blunt and penetrating trauma | 24.2\*  (UMCU)  26.6\* (HMC) | Different treatment protocols in the Netherlands (UMCU) vs United States (HMC) | Overall, 75% of the admitted trauma patients in UMCU and 81% in HMC (p<0.001) received thromboprophylaxis, of which 100% in and 75% at, respectively, UMCU and HMC consisted of chemical prophylaxis. From these patients, 72% at UMCU and 47% at HMC (p<0.001) were treated within 48 h after arrival. At UMCU, 4 patients (1.4%) (PE=3, DVT=1) and HMC 37 patients (3.8%) (PE=22, DVT=16; p=0.06) developed a VTE. At UMCU, a greater percentage of patients with VTE had traumatic brain injuries (TBI). Most VTE occurred despite adequate prophylaxis being given (75% UMCU and 81% HMC). Hemorrhagic complications occurred in, respectively, 4 (1.4%) and 10 (1%) patients in UMCU and HMC (p=0.570). After adjustment for age, ISS, hospital length of stay, and injury type, no significant difference was demonstrated in UMCU compared to HMC for the development of VTE (OR 2.397, p=0.102 and hemorrhagic complications, OR 0. 586, p=0.383). | Small study sample.  Retrospective design. Different anticoagulation is used on top of chemical prophylaxis. | Most episodes of VTE developed while receiving recommended prophylaxis. Early chemical thromboprophylaxis did not significantly increase the bleeding complications and it appears to be safe to start early. |
| Haac et al. [(Haac et al., 2020)](https://paperpile.com/c/PUEOR5/2ZFyn) | Open-label RCT | | Adult trauma patients | | 329 (Enoxaparin = 164, Aspirin = 165) | | Orthopedic extremity, pelvic, or acetabular fractures | 11\* (Both groups) | Enoxaparin 30 mg (twice daily) vs Aspirin 81 mg (twice daily) | Ninety-nine patients in the aspirin group (59.9%) and 98 patients in the LMWH group (59.4%) were event-free within 90 days of injury. LMWH had a 50.4% (95% CI, 47.7-53.2%, P=0.73) probability of treatment superiority over aspirin. In time to event analysis, LMWH had a 60.5% treatment superiority probability over aspirin (95% CI, 24.3–88.0%, p = 0.59). | Lack of allocation concealment. All received mechanic VTE prophylaxis.  Single-center study. | LMWH has a null to moderate global benefit for VTE prophylaxis in orthopedic trauma patients. |
| Hachem et al. [(Hachem et al., 2018)](https://paperpile.com/c/PUEOR5/vVFY0) | Prospective cohort | | Adult trauma patients | | 64 (<3 days = 10, ≥3 days = 43, none = 11) | | TBI | Not reported | Timing of prophylaxis intervention | The in-hospital VTE incidence was 16% and there was no significant difference between patients who received early (< 3d) versus late (≥3d) prophylaxis (10% vs. 16%). Rates of intracranial hemorrhage progression (0% vs. 7%) were similar between groups. | Single-center Small sample size. VTE incidence not measured after discharge. | Anticoagulant prophylaxis is often started late (≥3d) post-injury. |
| Hamidi et al. [(Hamidi et al., 2019)](https://paperpile.com/c/PUEOR5/4SmYv) | Retrospective cohort | | Adult trauma patients | | 810 (DOAC = 270, LMWH = 540) | | Isolated spinal trauma | 12 | DOAC vs LMWH | DOAC patients were less likely to develop DVT (1.8% vs 7.4%, p<0.01) and PE (0.3% vs 2.1%, p=0.04). There were no differences in mortality, post chemoprophylaxis packed red blood cell transfusion requirement, or decompressive procedures. | Unable to control for confounders such as mechanical prophylaxis, dosage and frequency of administration of LMWH or DOACs, duration of use of LMWH or DOACs, post-discharge events (complications, readmission, and compliance), switching between thromboprophylaxis agents, and the day of diagnosis of VTE events. | In spinal trauma patients, prophylaxis with DOAC is less likely to result in DVT and PE compared to LMWH. |
| Hoffmeyer et al. [(Hoffmeyer et al., 2017)](https://paperpile.com/c/PUEOR5/gwauj) | Observational prospective cohort | | Nonelective trauma patients | | 413  (Rivaroxaban = 208, Standard of care = 205) | | Unspecified orthopedic trauma | Not reported | Rivaroxaban vs standard of care | Symptomatic thromboembolic events occurred in 1 (0.5%) patient who was treated with rivaroxaban and 2 (1.0%) patients who were treated with the standard of care, and treatment-emergent bleeding events were reported in 6 (2.9%) and 7 (3.4%) patients. | Dose of rivaroxaban at the discretion of the physician. Lack of statistical analysis (no p values or CIs provided). | Rivaroxaban might be an appropriate oral alternative for venous thromboembolic prophylaxis in routine medical care after fracture-related major and minor surgery. |
| Jacobs et al. [(Jacobs et al., 2017)](https://paperpile.com/c/PUEOR5/N2h0A) | Retrospective cohort | | Trauma patients age 16 and over with hospitalization for >24 hours | | 18,010 (UFH = 7,768, LMWH = 10,224) | | Blunt and penetrating trauma | 12.3\* (UFH)  12.8 (LMWH) | LMWH (Enoxaparin) vs UFH | Compared to patients given UFH, patients are given LMWH had a decreased risk of mortality (OR 0.64, CI 0.49-0.83), VTE (OR 0.67 CI 0.53-0.84), PE (OR 0.53 CI 0.35-0.79), and DVT (OR 0.73, CI 0.57-0.95).  Either 30 mg twice daily or 40 mg once daily were both superior to UFH 5000 units three times daily in reducing VTE, PE, and mortality Regarding DVT prevention, Enoxaparin 40 mg once daily was better than UFH, but Enoxaparin 30 mg twice daily was equivalent to UFH. The reduced risk of VTE in patients receiving LMWH was most pronounced for patients with lower ISS. | MTQIP data are recorded for each patient on the type of medication and time of administration for only the first dose of VTE prophylaxis. Medication type, dose, and frequency changes may have occurred. | LMWH is superior to UFH in reducing mortality, VTE, PE, and DVT among hospitalized trauma patients. |
| Karcutskie et al. [(Karcutskie et al., 2018)](https://paperpile.com/c/PUEOR5/wQRBi) | Retrospective review | | Adult trauma patients | | 792 (Control group = 570, Adjustment group = 222) | | Unspecified blunt and penetrating injuries | 20\* (Control group)  22\* (Adjustment group) | Dosing of Enoxaparin sodium based on peak anti-Xa levels | The mean RAP scores were 9 for the control group and 9 for the adjustment group (P = .28). The VTE rates were similar for both groups (34 patients [6.0%] vs 15 [6.8%]; P = .68). Prophylactic anti-Xa levels were reached in 119 patients (53.6%) in the adjustment group. No difference in VTE rates was observed between those who became prophylactic and those who did not (7 patients [5.9%] vs 8 [7.8%]; P = .58). To control for confounders, 132 patients receiving standard fixed-dose Enoxaparin were propensity-matched to 84 patients receiving dose-adjusted Enoxaparin. The VTE rates remained similar between the control and adjustment groups (3 patients [2.3%] vs 3 [3.6%]; P = .57). | Non-randomized. Selection bias. The study could only conclude that there was a failure to find a reduction in VTE rate because the negative results were the main finding. | Rates of VTE were not reduced with anti-Xa–guided dosing, and almost half of the patients never reached prophylactic anti-Xa levels; achieving those levels did not decrease VTE rates. Platelets may be necessary to optimize thromboprophylaxis after trauma. |
| Kay et al. [(Kay et al., 2018)](https://paperpile.com/c/PUEOR5/gfi75) | A double-blinded randomized pilot study | | Adult trauma patients | | 234 (Standard dose group = 124, Weight-based group = 110) | | Unspecified blunt and penetrating injuries | 10 (both groups) | Standard dose (30 mg subcutaneously every 12 hours) vs weight-based (0.5mg/kg subcutaneously every 12 hours) Enoxaparin | There was a non-statistically significant trend toward less in-hospital deep vein thrombosis in patients treated with weight-based Enoxaparin (12 [9.7%] standard vs 4 [3.6%] weight-based, P = .075). At 90 days, there was no difference in venous thromboembolism (12 [9.7%] standard vs 6 [5.5%] weight-based, P=.34). | Small sample size thus insufficient power. | Weight-based Enoxaparin may provide better protection against DVT in adult trauma patients. |
| Khan et al. [(Khan et al., 2018)](https://paperpile.com/c/PUEOR5/yaaan) | Retrospective cohort | | Adult trauma patients | | 1,056 (LMWH = 704, Xa-Inh = 352) | | Isolated spinal trauma | 11\* (Both groups) | Oral Xa Inhibitors vs LMWH | Patients who received Xa-Inhibitors were less likely to develop a deep venous thrombosis (2.3% versus 5.7%, P < 0.01). There were no differences in the rate of pulmonary embolism (P = 0.73), post prophylaxis packed red blood cells transfusions (P = 0.79), post prophylaxis surgical decompression of spinal column (P = 0.75), and mortality rate (P = 0.77). | Retrospective design. Mechanical prophylaxis unaccounted for. | Oral Xa-Inhibitors seems to be more effective than a prophylactic pharmacologic agent for the prevention of deep venous thrombosis in patients with nonoperative spinal trauma compared to LMWH |
| Kingdon et al. [(Kingdon et al., 2019)](https://paperpile.com/c/PUEOR5/x1qM7) | Retrospective cohort | | Adult trauma patients | | 2,106 (Rivaroxaban = 1053, Enoxaparin = 1053) | | Unspecified blunt and penetrating injuries | 8.5\* (Rivaroxaban)  8.4\* (Enoxaparin) | Enoxaparin vs Rivaroxaban | Patients who developed a VTE with no significant difference between groups (14[1.3%] in the rivaroxaban group and 14 [1.3%] in the Enoxaparin group, P =1) were 1.3%. In addition, there was no difference in deep venous thrombosis (10 [0.9%] in the rivaroxaban group and 12 [1.1%] in the Enoxaparin group) or pulmonary embolism (6 [0.6%] in the rivaroxaban group and 2 [0.2%] in the Enoxaparin group). Incidence of bleeding, minor or major, was equivalent between groups (P > 0.05). | Retrospective design. Asymptomatic VTE is not considered. | Rivaroxaban demonstrated a similar incidence of VTE and bleeding complications as Enoxaparin. |
| Ko et al. [(Ko et al., 2016)](https://paperpile.com/c/PUEOR5/zGNc7) | Historic vs prospective cohort | | Adult trauma patients | | 205 (Control group = 118, Adjustment group = 87) | | Unspecified blunt and penetrating injuries | 13 (Total)  10 (Control group)  17 (Adjustment group) | Enoxaparin adjusted by anti-Xa trough level vs Enoxaparin sodium (30mg twice daily) | Incidence of VTE was significantly lower in the adjustment group than in the control group (1.1% vs 7.6%, respectively; P = .046). When the adjustment group was compared with the control group, no significant difference was noted in the rate of packed red blood cell transfusion (6.9% vs 12.7%, respectively; P = .18) or mean (SD) hematocrit at discharge (34.5% [6.3%] vs 33.4% [6.8%], respectively (P = .19). | Some patients may have had subcutaneous administration of heparin prior to initiation of Enoxaparin as DVT prophylaxis. The retrospective nature of data collection made it difficult to accurately capture the number of patients who actually received sequential compression devices. | Enoxaparin dosage adjustment may lead to a reduced rate of VTE without an increased risk of bleeding. |
| Kopelman et al. [(Kopelman et al., 2013)](https://paperpile.com/c/PUEOR5/jbOBF) | Retrospective cohort | | Adult trauma patients | | 124 (Group A = 90, Group B = 34) | | TBI, pelvic and/or lower extremity fractures, spinal cord injury, and intra-abdominal injury | Not reported | Alternative dosing of Enoxaparin (Group A = 30mg twice daily, Group B = 40mg twice daily) | Nine percent of group B patients had inadequate anti-Xa levels, compared with 33% of those in group A (P= 5.01). Imaging studies were available in 69 patients and revealed 8 venous thromboembolic events (P=5 NS, group A vs group B) with significantly more venous thromboembolic events occurring in patients with low anti-Xa levels (P=5.02). | Small sample size Retrospective design. Well-matched but there were differences in body weight measurements among groups. | Although higher dosing of Enoxaparin led to improved anti-Xa levels, this did not equate to a statistical decrease in venous thromboembolism. |
| Krantz et al. [(Krantz et al., 2020)](https://paperpile.com/c/PUEOR5/XsAei) | Retrospective cohort | | Adult ≥65-year-old trauma patients | | 1,090 (UFH (655, Enoxaparin = 435) | | Blunt or penetrating unspecified | 12 (UFH)  14 (Enoxaparin) | UFH vs Enoxaparin | VTE occurred in 39 (3.6%) patients with no difference between groups in proximal deep vein thrombosis (2.1% versus 3.0%, P =0.52) or pulmonary embolism (1.2% versus 1.4%, P =0.96). Weight 125 kg (OR 4.12, 95% CI 1.06-16.11) and RAP-AM 5 (OR 6.52, 95% CI 2.65-16.03) were independently associated with VTE development. Increasing age (OR 1.04, 95% CI 1.03-1.06), initiation 24 h (OR 2.17, 95% CI 1.66-2.84) and creatinine clearance 30 mL/min (OR 1.61, 95% CI 1.17-2.21) were independent predictors of receiving UFH whereas increasing ISS (OR 0.97, 95% CI 0.95-0.99) was associated with receiving Enoxaparin. | Retrospective design.  Single-center study. Convenience sample. Institutional bias on prophylaxis. Anticoagulation before admission was not assessed. | The study suggests no difference in VTE incidence between high-risk elderly trauma patients receiving UFH or Enoxaparin chemoprophylaxis. |
| Krecker et al. [(Kreckler et al., 2013)](https://paperpile.com/c/PUEOR5/3xOrA) | Quasi-experimental | | Adult emergency general surgery patients | | 318 | | Not applicable | Not applicable | Quality improvement intervention | Compliance with thromboprophylaxis guidelines improved significantly after the intervention (35% vs 87%, p<0.0001). There was a significant reduction in the thrombotic event incidence (0.75% vs 0.29%, p=0.01292), demonstrating a reduction of 61% (CI, 0.29-0.53). | The quasi-experimental design does not allow for controlled study.  Convenience sampling. | QI interventions can increase compliance with VTE prophylaxis guidelines and decrease VTE incidence. |
| Kurtoglu et al. [(Kurtoglu et al., 2004)](https://paperpile.com/c/PUEOR5/HSi33) | Randomized controlled trial | | Adult trauma patients | | 120 (IPC group = 60, LMWH group = 60) | | Head/Spinal Trauma | Not reported | Intermittent Pneumatic Compression vs LMWH | Five people in the IPC group developed DVT compared to 3 people treated with LMWH. There was a higher incidence of PE in the LMWH group (6.6% vs 3.3%). Mortality was higher in the LMWH at 13.3% vs 11.6% in the IPC group. Multivariate analysis showed that ISS >28 was the only risk factor to mortality from PE in all patients (RR= 4.08, 95% CI 1.8-8.4, p < 0.05). | Single-center study. Small sample size. | There was no statistically significant difference in reduction in DVT, PE, or mortality between IPC and LMWH (p = 0.04, p > 0.05, p > 0.05, respectively). |
| Lu et al. [(Lu et al., 2009)](https://paperpile.com/c/PUEOR5/9qL3k) | Pilot Study | | Adult trauma patients | | 92 | | Unspecified blunt and penetrating injuries | 18\* | Fondaparinux (2.5mg SQ once daily) | DVT was developed in 2.5% of patients who received fondaparinux. DVT was developed in 33% of patients who received pneumatic compression only. Superficial non-occluding clots were noted in 4.9% of the fondaparinux group and none developed PE. | Lack of a pharmacologic comparison group. Small sample size. | Fondaparinux is suggested to be protective against VTE after trauma in high-risk patients. |
| McCulloh et al. [(McCulloch et al., 2010)](https://paperpile.com/c/PUEOR5/yg0uB) | Quasi-experimental | | Adult emergency general surgery patients | | 1209 | | Not applicable | Not applicable | Quality improvement intervention | Compliance with multiple safety-relevant care processes increased, specifically correct VTE prophylaxis administration significantly increased with the application of the Lean intervention (35% vs 87%, p<0.001). Processes that did not undergo Lean intervention did not demonstrate significant improvements in compliance. Compliance was maintained at least 10 months post-intervention. | The quasi-experimental design does not allow for a controlled study.  Observer bias and Hawthorne effect. | Lean intervention can improve compliance of safety processes and allow for sustainable change. |
| McKenna et al. [(McKenna et al., 2009)](https://paperpile.com/c/PUEOR5/oaVf1) | Quasi-experimental | | Adult emergency general surgery patients | | 111 | | Not applicable | Not applicable | Quality improvement intervention | In the first round of audits, only 37% of patients were given appropriate chemoprophylaxis, with 57% of these patients considered high-risk for VTE. Following the development and application of new clinical guidelines, 88% of patients were given appropriate VTE chemoprophylaxis demonstrating a significant improvement (p<0.001). | Confounding factors not controlled.  Small sample size. | Implementation of quality improvement and VTE protocols increased appropriate VTE chemo thromboprophylaxis administration on EGS patients. |
| Nederpelt et al. [(Nederpelt et al., 2021)](https://paperpile.com/c/PUEOR5/yBFXC) | Retrospective cohort study | | Adult trauma patients admitted to TQIP participating trauma centers | | 4,560 (LMWH group = 2,280, DOAC group = 2,280) | | Lower extremity fractures | 10 (both groups) | LMWH vs DOAC | Symptomatic VTE occurred in 1.4% of patients in both groups (P = 0.992). Bleeding control interventions occurred less often in the DOAC group, but this finding was statistically insignificant (5.8% versus 6.0%, P = 0.772). | TQIP data used did not specify the type or dosage of DOAC used.  Timing of VTE occurrence was not provided by TQIP data.  The DOAC group differed significantly from the LMWH group in their comorbidities, vital signs, ISS, surgeries, and processes of care. | Similar rates of VTE and bleeding control measures were found for thromboprophylaxis with DOACs or LMWH in matched trauma patients with lower extremity fractures. |
| Norwood et al. [(Norwood et al., 2001)](https://paperpile.com/c/PUEOR5/UU1Ex) | Prospective single cohort | | Adult trauma patients | | 118 | | Blunt trauma | 20\* | Enoxaparin (30mg every 12 hours) | A total of 118 patients were included for analysis all of which received Enoxaparin. About 2% of these patients developed DVT. There were no other bleeding complications or evidence of PE. | Lack of a comparison group. A low death rate could signal undiagnosed PEs. | Enoxaparin is effective and practical in the prevention of VTE in high-risk patients. |
| Olson et al. [(Olson et al., 2015)](https://paperpile.com/c/PUEOR5/j40FZ) | Randomized non-inferiority trial | | Adult trauma patients | | 208 (UFH = 105, Enoxaparin = 103) | | Unspecified including the pelvis and lower extremity fractures | 10 (Enoxaparin)  13.5 (UFH) | Enoxaparin (30 mg every 12 hours) vs UFH (5000 U every 8 hours) | Regarding VTE risk, UFH was non-inferior compared with Enoxaparin (ARD=3.1%, 95% CI -1.6% to 7.7%, p=01.96). The risk of DVT above and below the knee wasalso not significantly different between the groups. The risk of PE was also not significantly different between the groups. | Lacklong-termtfollow-upw up. Over half the randomized treated sample did not complete the VTE screening protocol. | UFH maynon-inferiorrior to Enoxaparin in preventing VTE in trauma patients |
| Phelan et al. [(Phelan et al., 2012)](https://paperpile.com/c/PUEOR5/6D0Cg) | RCT | | Adult trauma patients | | 62  (Enoxaparin = 34, Placebo = 28) | | TBI | 17.3\* (Enoxaparin)  15.7\* (Placebo) | Enoxaparin | Subclinical, radiographic TBI progression rates on the scans performed 48 hours after injury and 24 hours after start of treatment were 5.9% (95% confidence interval [CI], 0.7-19.7%) for Enoxaparin and 3.6% (95% CI, 0.1-18.3%) for placebo, a treatment effect difference of 2.3% (95% CI, 14.42-16.5%). No clinical TBI progressions occurred. One deep vein thrombosis occurred in the placebo arm. | A possible underestimation of the true VTE rate. Qualitative determination of TBI progression. | TBI progression rates after starting Enoxaparin in small, stable injuries 24 hours after injury are similar to those of placebo and are subclinical. |
| Rodier et al. [(Rodier et al., 2020)](https://paperpile.com/c/PUEOR5/oSC1G) | Retrospective cohort | | Adult trauma patients | | 70,122  (Fixed dose = 94, Assay guided = 85, TQIP = 69,943) | | Blunt TBI | 15 (Fixed dose group)  17 (Assay guided group) | Assay guided Enoxaparin (or UFH if Enoxaparin contraindicated)  vs  historical control fixed dosing Enoxaparin  vs  2016 TQIP TBI cohort treated according to national chemoprophylaxis guidelines | Comparison of the intracranial hemorrhage progression rate in the assay-guided group compared with the fixed-dose group. The rate of intracranial hemorrhage progression in the assay-guided group was similar to that of the fixed-dose group. The assay-guided and fixed-dose groups had similar bleed progression rates after controlling for age, gender, GCS, S S O ,a nd bleed type (adjusted OR 0.791, P 4 0.603, 95% CI 0.328–1.912).VTE rates were similar between all three groups The fixed-dose group had a lower ICU admission rate than the other two groups (P < 0.001) and the highest LOS (P < 0.001). The mortality rate was similar in all three groups | Retrospective nature. Lack of randomization. Potential unmeasured confounders due to time difference between the admission dates of patients in the fixed-dose group and patients in the assay-guided group. Low power due to small incidence of VTE | Administering early Enoxaparin with prophylactic anti-Xa levels does not increase the rate of ICH progression compared with either an early fixed-dose chemoprophylaxis regimen or the pooled rate of TBI progression reported in the literature. |
| Scudday et al. [(Scudday et al., 2011)](https://paperpile.com/c/PUEOR5/Kw3HK) | Retrospective cohort | | Adult trauma patients | | 812 (No chemoprophylaxis = 410, chemoprophylaxis = 402) | | TBI | 3.4\* (Both groups) | Use of chemical prophylaxis vs no use | One hundred and sixty-nine patients started prophylaxis within 48 hours and 242 patients began within 72 hours. Patients receiving chemical prophylaxis had a lower incidence of VTE (1% versus 3%; p= 0.019) | Retrospective design. Compliance withhe the rotocol.  Inexact definition of intracranial hemorrhage. | Use of chemical thromboprophylaxis in TBI patients with a stable or improved head CT after 24 hours substantially reduces the incidence of VTE and does not increase the risk of progression of intracranial hemorrhage. |
| Slavik et al. [(Slavik et al., 2007)](https://paperpile.com/c/PUEOR5/8fHIA) | Retrospective cohort | | Adult trauma patients | | 135 (Dalteparin group = 72, Enoxaparin group = 63) | | Major orthopedic (pelvic, femoral shaft, complex lower extremity fractures) and spinal cord injuries | 34 (Dalteparin group)  32.3 (Enoxaparin group) | Dalteparin (5000U once daily) vs Enoxaparin (30 mg twice daily) | DVT and PE rates were 1.6% for Enoxaparin and 9.7% for Dalteparin (p=0.103, absolute risk increase [ARI] of 8.1%) with no difference in mortality. | Observational design.  Non-randomized treatment allocation. Possibility of inaccurate health care reporting. | Dalteparin does not seem to be clinicalnon-inferiorior to Enoxaparin. However, due the to absence of level 1 evidence on Dalteparin , Enoxaparin should continue to be the prophylactic agent of choice. |
| Stevenson et al. [(Stevenson et al., 2007)](https://paperpile.com/c/PUEOR5/rpD1n) | Prospective cohort | | Adult emergency general surgery patients | | 566 | | Not applicable | Not applicable | Quality improvement intervention | Overall, process awareness intervention allowed for a reduction in errors from 4.79 to 2.38 per person (p<0.001). Documentation errors decreased from 1.39 per patient to 0.68 after intervention (p<0.001). General management errors were reduced from 1.07 to 0.42 per patient after the intervention (p<0.001). The rate of appropriate VTE prophylaxis increased from 72.9% to 86.1% ppost-intervention | The observational design may be limited by incomplete records.  Hawthorne effect. | Quality improvement intervention can measure processes objectively, increase awareness, and reduce process errors/adverse events. |
| Tracy et al. [(Tracy et al., 2016)](https://paperpile.com/c/PUEOR5/lNbPO) | Retrospective cohort | | Adult trauma patients | | 1,425 | | TBI or spinal injury | 17.6\* | Timing of chemical prophylaxis | Patients who developed a VTE had a significantly longer time to initiation of chemical VTE prophylaxis (6.7-4.9 d versus 4.7-4.9 d, P < 0.001) compared with those that did not develop a VTE. Also, for each 1 d increase in time to prophylaxis initiation, the odds of developing a VTE increased significantly (odds ratio 1⁄4 1.055, P < 0.001). | Retrospective design. Potential type II error due to small sample size in subgroups. LMWH missed doses not accounted for. | Patients with VTEs had a significant delay in time to initiation of chemoprophylaxis compared with patients without VTEs. Patients sustaining a TBI had a 2-fold delay in initiation of chemoprophylaxis and an associated 2-fold increase in VTE events compared with patients who sustained spinal injuries. |
| Worley et al. [(Worley et al., 2008)](https://paperpile.com/c/PUEOR5/W7Nzq) | Retrospective cohort | | Adult trauma patients | | 90 (Dalteparin group = 43, LDUH = 47) | | Spinal cord trauma | Not reported | Dalteparin (5000U once daily) vs LDUH (5000U twice daily) | No statistically significant association between VTE rates and the type of chemoprophylaxis agent used. There were no significant differences in complications, location of VTE, and incidence of fatal PE. | Retrospective design. Small sample size. | There is no definitive evidence of the use of LMWH over LDUH in acute traumatic spinal cord injury. |
| Yang et al. [(Yang et al., 2020)](https://paperpile.com/c/PUEOR5/Pvaqr) | Retrospective cohort | | Adult emergency general surgery patients | | 767 | | Not applicable | Not applicable | EGS patient VTE incidence | Overall VTE rate was 3.9%. Of these, a predominance of DVTs (63.3%) was noted. Patients with VTE were more likely to have active cancer (p<0.001) and less likely to receive appropriate VTE prophylaxis (P=0.003). EGS VTE patients were more likely to be readmitted within 30 days (p=0.001) and have a longer hospital stay (p<0.001). Only 66% received adequate VTE prophylaxis. Significantly more patients who developed in-hospital VTE did not receive appropriate VTE prophylaxis (p=0.04). | Retrospective study design.  Small sample size.  No stratification of VTE based on specific procedures. | EGS patients have an increased risk of VTE, especially if they do not receive appropriate thromboprophylaxis. |
| Zeeshan et al. [(Zeeshan et al., 2018)](https://paperpile.com/c/PUEOR5/2x9e0) | Retrospective cohort | | Adult trauma patients | | 3,554 (Early group = 1772, Late group = 1772) | | Isolated spinal trauma | 15 (Both groups) | Timing of chemical prophylaxis (early = within 48 hours, late = at or after 48 hours) | Patients who received chemoprophylaxis with either UFH or LMWH within 48 hours postoperatively demonstrated lower rates of DVTs (2.1% versus 10.8%, p<0.01). There were differences in PE incidence, blood transfusion requirements, or mortality for patients who received chemoprophylaxis within 48 hours postoperatively and those who did not. There was no statistically significant difference in VTE rates for patients receiving UFH or LMWH. | Retrospective design.  Mechanical prophylaxis, dosage and frequency of medications, and time of the day of diagnosis unaccounted for. | Thromboprophylaxis should be initiated within 48 hours postoperatively for patients suffering spinal trauma. It reduces the risk of DVT without an associated increase in bleeding complications risks and mortality. |
| *Abbreviations: DVT = Deep vein thrombosis, DOAC = direct oral anticoagulation, HMC = Harborview Medical Center in the United States, IPC = Intermittent Pneumatic Compression, ISS = Injury severity score, LDUH = Low does unfractionated heparin, LMWH = Low molecular weight heparin, MOI = Mechanism of injury, OR = Odds ratio, PE = Pulmonary embolism, RAP = Risk assessment profile, TBI = Traumatic brain injury, UFH = Unfractionated heparin, UMCU = University Medical Center Utrecht in the Netherlands, VTE = Venous thromboembolism*  *\* Mean ISS* | | | | | | | | | | | | |