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Deep vein thrombosis screening and risk factors in a high-risk trauma population

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ABSTRACT

Background: Trauma patients requiring acute inpatient rehabilitation are significantly injured, with increased risk for deep vein thrombosis (DVT). We evaluated routine screening for occult DVT in such patients, and analyzed DVT risk factors.

Materials and methods: Data from level I trauma center patients discharged to a single acute rehabilitation center (ARC) from 2007–2011 were retrospectively reviewed. Routine lower extremity duplex was performed on ARC admission. Follow-up data were collected for patients with occult DVT (ARC DVT). DVT predictors were evaluated using logistic regression.

Results: Of 622 patients, 534 (86%) had screening duplex; 26 (4.8%) had an ARC DVT. A majority of 442 patients (71%) received enoxaparin prophylaxis in hospital, for a median 64% of hospital days. Of ARC DVT patients, 17 received full anticoagulation and 16 received vena cava filters. Thirty-seven patients had DVT diagnosed in the hospital (hospital DVT) before discharge to ARC. Hospital DVT and ARC DVT groups were comparable except shorter median hospital length of stay and lower head abbreviated injury scale in ARC DVT patients. On multivariate analysis, increased intensive care unit length of stay, age >65 y, a lower percentage of hospital days receiving chemoprophylaxis, and delayed initiation of chemoprophylaxis were significantly predictive of DVT after adjustment for sex, mechanism, injury severity score, and admission systolic blood pressure. Presence of pelvic fractures and ages 50–65 y also posed an increased risk.

Conclusions: The incidence of occult DVT on ARC admission is low in trauma patients. Several risk factors for DVT in the trauma ARC population were identified. Nonselective screening of all trauma patients on admission to ARC is not supported by this analysis.

1. Introduction

Trauma patients requiring acute inpatient rehabilitation are a significantly injured population. The presence of pelvic, spine, and long bone fractures, brain injuries, and other factors confer an increased risk for deep vein thrombosis (DVT) for these patients [1–3]. Diagnosis of DVT can be challenging, however, because DVT in trauma patients is often asymptomatic and occult [4,5]. Screening or surveillance with duplex ultrasound has been advocated for [5,6] and against [7,8] as an aid in the diagnosis of occult DVT. Theoretically, screening would allow earlier diagnosis and treatment, with the hope of preventing pulmonary embolism (PE) and postphlebitic complications. However, evidence that screening provides these benefits is weak [9]. Although this practice does uncover asymptomatic DVTs, it is unclear whether revealing

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occult DVTs improves outcomes. Furthermore, the treatment of occult DVTs with anticoagulation and/or vena cava filters exposes patients to the risk of bleeding and procedural complications from those interventions.

Based on current evidence, routine screening of all trauma admissions is not recommended [10]. Although screening of all patients may not improve outcomes, screening of certain populations at higher risk of DVT could have a benefit if a high incidence of occult DVT was revealed. We hypothesized that routine screening for occult DVT in a specific population at high risk that is, patients discharged to an inpatient acute rehabilitation center (ARC), would reveal a rate of the primary outcome (occult DVT) that is sufficiently high to justify surveillance with duplex. The ARC population has a high risk for venous thromboembolism (VTE) because by definition trauma patients discharged to ARC have limited mobility and/or multiple injuries, especially brain, spine, and orthopedic injuries. We also attempted to identify characteristics and injury patterns within this high-risk group that could help predict a propensity for DVT.

2. Materials and methods

This Institutional Review Board–approved study was done at Inova Fairfax Hospital, an 853-bed suburban hospital and American College of Surgeons–verified level I trauma center that evaluates about 3000 trauma patients a year. Data from inpatients who were discharged from the trauma center directly to a single ARC from 2007–2011 were retrospectively reviewed. Routine bilateral lower extremity duplex scanning was performed on ARC admission as per the study ARC's standard practice. Screening duplex was not performed during the acute hospital stay, but targeted duplex was used to investigate signs or symptoms of VTE according to clinical judgment.

Duplex reports were reviewed for all trauma patients discharged to ARC, and presence or absence of DVT was recorded. DVT was defined for this study as any intraluminal venous thrombus in the axillary, internal jugular, or popliteal veins, or in the central veins more proximal to those. Demographics, injury characteristics, and interventions were collected for patients diagnosed with a DVT via screening duplex on admission to ARC ("occult" DVT or ARC DVT). In addition, patients diagnosed with a DVT during their trauma center admission ("hospital DVT"), and who were subsequently discharged to any ARC (not just the study ARC), were analyzed. For the purposes of the study, a hospital DVT was the designation used for any form of VTE, whether PE or DVT. Hospital DVTs were diagnosed by duplex or computed tomography (CT) scan as prompted by signs or symptoms, except for two patients who had PE noted incidentally on scans done during their initial workup.

All patients received VTE prophylaxis during their hospital stay with serial compression devices. Enoxaparin dosed at 30 mg subcutaneously twice a day was given to all eligible patients in addition to compression devices. Eligibility for enoxaparin, and timing of administration, was based on the rounding trauma surgeon's judgment of bleeding risk for each patient.

Follow-up was attempted via telephone, and mail with patients diagnosed with an occult DVT on screening duplex. A scripted questionnaire was used to ascertain if these patients (1) were treated with an anticoagulant, vena cava filter, or both; (2) had complications of anticoagulation (defined as medical attention, transfusion, or surgery for bleeding); (3) had complications of the DVT (persistent or chronic leg swelling, skin ulceration, pain, or PE); and (4) had complications of a vena cava filter (clot at insertion site or at the filter, filter migration, inability to remove, not removing a retrievable filter when indicated, perforation of the filter through the wall of the vena cava). In addition, chart review was done for all ARC DVT patients to obtain the same information.

Groups were compared using Fisher exact and Mann–Whitney *U* tests. Independent predictors of DVT were evaluated using multivariate logistic regression with standard adjustment for age, sex, blunt *versus* penetrating mechanism, injury severity score, and admission hypotension (systolic blood pressure $\leq$90 mm Hg) [11]. Independent variables considered for the multivariable model were evaluated for collinearity using variance inflation factors (VIF). None were found to exhibit extreme collinearity (all VIF $<$2.62). Backward stepwise selection was used to identify multivariable model variables, while maintaining the aforementioned five variables for adjustment. Variables with significance level of $P < 0.10$ were retained in the model. A Hosmer–Lemeshow goodness of fit test was performed on the final multivariable model and showed an adequate fit to the data ($P = 0.77$). Enoxaparin use was compared with the chi-square test. All statistical analyses were performed using Stata/SE version 12.1 (College Station, TX).

3. Results

There were 929 trauma patients discharged to an ARC during the 5-y study period. Of these, 37 were diagnosed with a hospital DVT before discharge, and 622 were discharged to the screening ARC (Figure). The remaining 270 patients discharged to other nonscreening ARCs were not included in the analysis. Of the 622 study ARC patients, 534 (86%) had a screening duplex. An occult DVT was found in 26 screened patients (4.8%).

The median day of hospital DVT diagnosis was hospital day 10 (interquartile range, 7–17). Nine of these 37 patients had a PE. Two of these were found incidentally on chest CT scans done for purposes other than PE investigation, one on hospital day 1 and one on hospital day 2. All other VTE episodes were diagnosed on day 4 or later on studies done to evaluate VTE symptoms, with either chest CT angiogram for PE or duplex scans for DVT.

Hospital DVT and ARC DVT groups were comparable (Table 1) except a shorter median hospital length of stay (17 *versus* 22 d, $P = 0.048$) and a lower head abbreviated injury scale (2 *versus* 4, $P = 0.005$) in the ARC DVT patients. A multivariable analysis was performed comparing all patients with a DVT (both hospital and ARC, $n = 63$) to those without a DVT, to investigate factors that were associated with presence of a DVT (Table 2). Progressively longer intensive care unit (ICU) lengths of stay (LOS) were significantly associated with the diagnosis of DVT. Although an ICU LOS of 2–3 d did not significantly predict DVT diagnosis (using a 1-d LOS as the reference point), patients with ICU LOS of 4–10 d had more than twice the odds of DVT, and ICU LOS $>$10 d was associated with over four times the odds of DVT, after adjusting for covariates. Injury severity and anatomic