A Break-Even Cost Analysis for Venous Thromboembolism Prophylaxis in Posterior Lumbar Fusion Surgery

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INTRODUCTION: Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a significant risk following spine surgery with PE rates reported between 0.06-18%. Despite the intermediate risk of VTE, there is ongoing debate on the optimal prophylaxis strategies and timing. The economic considerations of VTE prophylaxis in spine surgery are limited in the literature, particularly for posterior lumbar fusion (PLF). This study utilizes a break-even cost-effectiveness model to determine if enoxaparin is cost-effective for VTE prevention in PLF patients. We hypothesized that enoxaparin would break even in cost for preventing VTE in this context.

METHODS:

The seven-day regimen of 40 mg enoxaparin daily was selected from several clinical studies evaluating VTE in PLF procedures. An online drug retail database was searched to obtain the cost for a seven-day regimen of 40 mg enoxaparin. A review of existing research was conducted to determine the average cost of diagnosing/treating a symptomatic VTE. For the initial rate of VTE after PLF surgery, the TriNetX Diamond database was searched using International Classification of Diseases-10 (ICD-10) and Current Procedural Terminology (CPT). This query identified patients who underwent PLF surgery between January 2018 and December 2023 and did not have a prescription for VTE prophylaxis. Demographic data was also recorded for this cohort. The primary outcome of the query was the development of symptomatic VTE within seven days of the surgical procedure. A break-even cost-effectiveness model was used to calculate the absolute risk reduction (ARR) needed for the prophylactic agent to break even on cost (Figure 1). The ARR was then used to determine the number needed to treat (NNT), representing the number of PLF surgeries required to prevent one VTE at break-even cost. Sensitivity analysis was performed if the enoxaparin regimen did not break-even to assess the impact of varying the costs of treating a symptomatic VTE and the drug costs, determining if there were a cost that would achieve break-even cost-effectiveness.

RESULTS:

The patient cohort identified with the TriNetX query had an average age of 62 +/- 12.3 years (Table 1). Within this cohort, 44% of patients were male and 56% were female (Table 1). The average retail cost of a seven-day course of 40 mg enoxaparin (C_d) was $411.34 and the average cost for diagnosing and treating a symptomatic VTE (C_t) was $5,959. The TriNetX query revealed that the initial rate of VTE after PLF surgery was 0.56%. The analysis revealed that with a C_d of $411.34 and C_t of $5,959, the final rate of VTE is -6.3%, corresponding to an ARR of 6.9%. Since the ARR is larger than the initial rate of VTE, which results in a negative final rate of VTE, a seven-day course of enoxaparin did not break even for PLF surgery. The sensitivity analysis revealed that a seven-day course of once daily enoxaparin breaks even if the drug costs ≤$25.00 and the cost of treating a symptomatic VTE remains at the original $5,959 (Table 2). If the cost of the enoxaparin is $411.34, then the VTE prophylaxis was found to break even if the total cost of treating a symptomatic VTE was ≥$100,000 (Table 3).

DISCUSSION AND CONCLUSION: This study revealed that a seven-day course of daily enoxaparin does not break even for VTE prophylaxis following PLF surgery. This finding can likely be attributed to the low incidence of VTE following PLF surgeries. However, if the drug can be acquired at a lower price, then VTE prophylaxis is cost-effective. Additionally, if the cost of treating a symptomatic VTE is significantly higher than proposed in this study, then VTE prophylaxis is cost-effective. One limitation of this analysis is that the incidence and cost of enoxaparin-related complications are not considered. Despite this limitation, this study provides additional data-driven insights into the costs and benefits of perioperative VTE prophylaxis in spine surgery. Given the lack of consensus on VTE prophylaxis in this patient population, surgeons should consider the financial impact of prescribing VTE prophylaxis in additional to the clinical impact. This understanding of VTE prophylaxis cost in comparison to the cost of symptomatic VTE treatment can better equip surgeons in their discussions of such critical aspects regarding patients' post-operative treatment plans.

$$S_{total} \times C_t \times VR_i = (S_{total} \times C_d) + (S_{total} \times C_t \times VR_f)$$

Solving for VR_f yields:

$$VR_f = \frac{(VR_i \times C_t) - C_d}{C_t}$$

Figure 1: Equation for break-even cost-effectiveness model

Characteristic	PLF
Age, years	62 +/- 12.3
Sex, n (%)	
Male	17,210 (44)
Female	21,494 (56)
Ethnicity, n (%)	
Hispanic or Latino	764 (2)
Not Hispanic or Latino	10,721 (28)
Unknown	27,229 (70)
Race, n (%)	
White	10,009 (26)
Black or African American	948 (2)
Asian	56 (<1)
Unknown	27,701 (72)

Table 1: Demographics for patients that underwent posterior lumbar fusion without perioperative VTE prophylaxis.

Initial VTE Rate, %	Cost of Drug, $	Total Cost of Symptomatic VTE, $	Final Breakeven Rate, %	Absolute Risk Reduction, %	Number Needed to Treat, n
0.56	25.00	5,958.71	0.1	0.4	2.4
0.56	50.00	5,958.71	-0.3	0.8	1.2
0.56	100.00	5,958.71	-1.1	1.7	0.6
0.56	250.00	5,958.71	-3.6	4.2	0.2

Table 2: Sensitivity analysis for a range of values for the drug cost when the total cost of a symptomatic VTE remains constant.

Initial VTE Rate, %	Cost of Drug, $	Total cost of Symptomatic VTE, $	Final Breakeven Rate, %	Absolute Risk Reduction, %	Number Needed to Treat, n
0.56	411.34	3,000.00	-13.2	13.7	0.1
0.56	411.34	7,000.00	-5.3	5.9	0.2
0.56	411.34	10,000.00	-3.6	4.1	0.2
0.56	411.34	25,000.00	-1.1	1.6	0.6
0.56	411.34	50,000.00	-0.3	0.8	1.2
0.56	411.34	100,000.00	0.1	0.4	2.4

Table 3: Sensitivity analysis for a range of values for the total cost of a symptomatic VTE remains when the cost of the drug remains constant.