Effect of Pharmacologic Prophylaxis on Venous Thromboembolism After Radical Prostatectomy: The PREVENTER Randomized Clinical Trial


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**Abstract**

**Background:** Direct high-quality evidence is lacking evaluating perioperative pharmacologic prophylaxis (PP) after radical prostatectomy (RP) to prevent venous thromboembolism (VTE) leading to significant practice variation.

**Objective:** To study the impact of in-hospital PP on symptomatic VTE incidence and adverse events after RP at 30 d, with the secondary objective of evaluating overall VTE in a screening subcohort.

**Design, setting, and participants:** A prospective, phase 4, single-center, randomized trial of men with prostate cancer undergoing open or robotic-assisted laparoscopic RP was conducted (July 2017–November 2018).

**Intervention:** PP (subcutaneous heparin) plus routine care versus routine care alone. The screening subcohort was offered lower extremity duplex ultrasound at 30 d.

**Outcomes measurements and statistical analysis:** The primary efficacy outcome was symptomatic VTE incidence (pulmonary embolism [PE] or deep venous thrombosis [DVT]). Primary safety outcomes included the incidence of symptomatic lymphocele, hematoma, or bleeding after surgery. Secondary outcomes were overall VTE, estimated blood loss, total surgical drain output, complications, and surveillance imaging bias. Fisher’s exact test and modified Poisson regression were performed.

**Results and limitations:** A total of 501 patients (75% robotic) were randomized and >99% (500/501) completed follow-up. At second interim analysis (N = 445), the symptomatic VTE rate was 2.3% (four PE + DVT and one DVT) for routine care versus 0.9% (one PE + DVT and one DVT) for PP (relative risk 0.40 [95% confidence interval 0.08–2.03], p = 0.3) meeting a futility threshold for early stopping. In the screening subcohort, the overall VTE rate was 3.3% versus 2.4% (p = 0.7). Results were similar at the final analysis (symptomatic VTE: 2.0% vs 0.8%, p = 0.3; overall VTE: 2.9% vs 2.8%, p = 1). No differences were observed in safety or secondary outcomes. All VTE events (seven symptomatic and three asymptomatic) occurred in patients undergoing pelvic lymph node dissection.
Conclusions: This study was not able to demonstrate a statistically significant reduction in symptomatic VTE associated with PP. There was no increase in the development of symptomatic lymphoceles, bleeding, or other adverse events. Given that the event rate was lower than powered for; further research is needed among high-risk patients (Caprini score $\geq 8$) or patients receiving pelvic lymph node dissection.

Patient summary: In this report, we randomized patients undergoing radical prostatectomy to perioperative pharmacologic prophylaxis or routine care alone. We found that pharmacologic prophylaxis did not reduce postoperative symptomatic venous thromboembolism significantly for men at routine risk. Importantly, pharmacologic prophylaxis did not increase adverse events, such as formation of lymphoceles or bleeding, and can safely be implemented when indicated for patients with risk factors undergoing radical prostatectomy.

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1. Introduction

An estimated 175,000 new cases of prostate cancer will be diagnosed in 2019 with about 50% of low- and intermediate-risk men undergoing radical prostatectomy (RP) in the USA [12]. According to most guidelines, undergoing RP by any approach classifies a patient to be at a high risk of venous thromboembolism (VTE), including deep venous thrombosis (DVT) and pulmonary embolism (PE), and would lead to implementation of appropriate prophylaxis with pharmacologic agents and intermittent mechanical pneumatic compression devices [3–8]. However, there is no direct high-quality evidence or accepted standard practice for prophylaxis after RP across countries, centers, or individual surgeons. Additionally, the utility of pharmacologic prophylaxis (PP) for minimally invasive surgery in general is not well established. While 98% of patients receive PP after RP in the UK, only an estimated 17.8% receive it in the USA [9,10]. In fact, one US study estimated that 30% of men did not receive any form of prophylaxis at all, mechanical or otherwise [10]. The variation is due to both an uncertainty in the degree of benefit and the rate of adverse events attributable to PP.

Early screening reports on the incidence of VTE after open RP noted DVT rates >20% but were based on outdated techniques including 125 I-fibrinogen scanning [11–13]. A series during the era of Walsh’s anatomical approach to open RP reported a clinical postoperative PE incidence of 2.7% [14–16]. Modern rates are thought to have improved in the past 20 yr due to shorter hospital stays, early ambulation, and the advent of robotic and laparoscopic techniques [17]. Unfortunately, most studies attempting to estimate postoperative VTE rates have been flawed by a lack of consistent clinical follow-up to document VTE diagnoses or associated symptoms. The rate of symptomatic VTE without PP is unknown from clinical studies but is estimated to be 4–6% using the validated Caprini risk score [8,18]. When implementing PP, the best available evidence suggests that the rate of symptomatic VTE after RP is 1–2%, with a greater risk for patients undergoing pelvic lymphadenectomy (PLND) or an open surgical approach [17,19–25].

While PP is commonplace for most major surgeries, early RP studies raised concerns about the risk of postoperative lymphoceles and bleeding [26–28]. One of the few prospective studies in the literature was completed in 1989 examining 68 total patients; the results noted a decrease in the incidence of PE from 11% to 0% ($p = 0.052$) with subcutaneous heparin, but an increase in persistent lymphatic drainage from 11% to 38% ($p = 0.01$) [27]. In the past 30 yr, no further studies have evaluated PP for RP in a comparative trial, but recent European Association of Urology (EAU) guidelines based on a systematic review of recent literature suggested a risk-stratified approach for RP [29,30]. They recommended against PP after robotic RP without PLND or for low-risk patients with standard PLND, but the use of PP was suggested after open RP regardless of PLND performance or VTE risk. The guidelines acknowledged that further research was needed into the timing and duration of prophylaxis, as in-hospital prophylaxis alone was not considered with extended prophylaxis assumed for 4 wk in all cases.

Therefore, to provide a contemporary evaluation of PP on the incidence of symptomatic VTE and adverse events after RP including symptomatic lymphocele and bleeding complications, we conducted the Prevention of Venous Thromboembolism Following Radical Prostatectomy (PREVENTER) randomized controlled trial.

2. Patients and methods

2.1. Study design and population

A prospective, phase 4, single-center, randomized trial (NCT03006562) evaluating PP for RP with subcutaneous heparin was conducted between July 2017 and November 2018 at two hospitals within the Johns Hopkins Medical Institutions (Johns Hopkins Hospital and Johns Hopkins Bayview Medical Center). Institutional Review Board approval was obtained for the study, and written informed consent was obtained from each patient.

Male patients, 18 yr or older, with a histologically confirmed diagnosis of clinically localized prostate cancer of any stage or grade scheduled to undergo RP by an open or robotic-assisted laparoscopic approach, who were otherwise eligible to receive routine post-RP care, were enrolled. Details on the exclusion criteria and preoperative evaluation are included in the Supplementary material.

2.2. Randomization and study arms

Randomization was performed in blocks with stratification by surgical approach and inclusion in a screening ultrasound subcohort (Supplementary Fig. S1). A computer-generated randomization schedule was created by the blinded primary study biostatistician (B.J.T.). Treatment groups were assigned in a 1:1 ratio with concealment until individual randomization was performed on the day of surgery.

Patients in the routine care arm received intermittent pneumatic compression devices without any PP. Patients in the PP arm received
subcutaneous heparin (5000 units) given within 2 h prior to surgery and every 8 h after surgery until discharge from the hospital, as well as intermittent pneumatic compression devices. Early ambulation was encouraged for all patients during postoperative recovery.

At the time of informed consent, all patients were invited to participate in an optional screening ultrasound subcohort. Patients constituting the subcohort had to decide about joining prior to randomization and were given the opportunity to schedule a routine 30-d post-RP screening with lower extremity duplex ultrasound to assess for asymptomatic VTE events. Patients experiencing a symptomatic VTE event did not need to undergo a repeat imaging study, and all patients remained part of the screening cohort regardless of whether an ultrasound was completed. Radiologists reading the screening studies were blind to treatment assignment.

2.3. Outcomes

The primary efficacy outcome was the incidence of symptomatic VTE. The secondary efficacy outcome was the overall incidence of VTE (asymptomatic or symptomatic) determined from the screening ultrasound subcohort. The primary safety outcomes were the incidence of symptomatic lymphocele, symptomatic hematoma, or bleeding after surgery. The secondary safety outcomes included estimated blood loss from surgery, total surgical drain output after surgery (for patients with

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Please cite this article in press as: Patel HD, et al. Effect of Pharmacologic Prophylaxis on Venous Thromboembolism After Radical Prostatectomy: The PREVENTER Randomized Clinical Trial. Eur Urol (2020), https://doi.org/10.1016/j.eururo.2020.05.001
surgical drains), complications, and surveillance imaging bias. Outcomes are more fully described in the Supplementary material.

2.4. Study follow-up and statistical analyses

Briefly, the planned study follow-up was conducted at 30 d after surgery with appropriate referrals for clinical evaluation or imaging as indicated. For patients in the screening ultrasound subcohort, screening studies were offered and scheduled around 30 d after surgery. Screening studies in the subcohort were not mandatory.

This study was designed to demonstrate superiority. Based on prior studies and to evaluate a clinically significant benefit, a relative risk reduction of 70% was estimated to reduce the rate of symptomatic VTE from 5% for routine care to 1.5% for PP [4,17–25,31]. The estimated sample size was 666 patients (333 per arm) allowing for two planned interim analyses, with early stopping indicated for efficacy or futility. See the Supplementary material for full details on the planned analyses.

3. Results

3.1. Patient enrollment and baseline characteristics

The trial met an early stopping point for futility based on the planned second interim analysis of 445 patients. The results presented here detail both the interim analysis and the final enrolled population of 501 patients. From July 2017 to November 2018, 548 patients were assessed for eligibility and 501 were enrolled, with 251 randomized to receive PP and 250 to receive routine care (Fig. 1). One patient was lost to follow-up.

Baseline demographic and clinical characteristics are shown in Table 1 by arm. Sexual function, urinary function, comorbidity burden, and VTE risk assessed by Caprini scores were well balanced between arms. Over 50% of patients had intermediate-risk prostate cancer, and about 75% of surgeries were performed via a robotic-assisted laparoscopic approach. Pathologic outcomes are given in Table 2, with >80% of patients undergoing concurrent PLND. The median (interquartile range [IQR]) operative time (162 [131–203] vs 159 [128–201] min) and length of hospital stay (1 [1–1] vs 1 [1–1] d; mean 1.24 d overall) did not differ between the PP and routine care arms. Patients in the PP arm received a median (IQR) of four (three to four) doses of subcutaneous heparin.

3.2. Efficacy outcomes

A total of seven patients experienced a symptomatic VTE (seven DVT and five PE) at the second interim analysis, with
Table 2 – Pathologic outcomes of patients in the PREVENTER trial.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Second interim analysis patients (n = 445)</th>
<th>All enrolled patients (n = 501)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Routine care arm (222)</td>
<td>Pharmacologic prophylaxis arm (223)</td>
</tr>
<tr>
<td>Pathologic outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathologic Gleason, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 + 3</td>
<td>25 (11)</td>
<td>26 (12)</td>
</tr>
<tr>
<td>3 + 4</td>
<td>110 (50)</td>
<td>111 (50)</td>
</tr>
<tr>
<td>4 + 3</td>
<td>52 (23)</td>
<td>41 (19)</td>
</tr>
<tr>
<td>8</td>
<td>8 (3.6)</td>
<td>10 (4.5)</td>
</tr>
<tr>
<td>9–10</td>
<td>27 (12)</td>
<td>33 (15)</td>
</tr>
<tr>
<td>Pathologic stage, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2a</td>
<td>14 (6.3)</td>
<td>12 (5.4)</td>
</tr>
<tr>
<td>T2b-c</td>
<td>116 (52)</td>
<td>122 (55)</td>
</tr>
<tr>
<td>T3a</td>
<td>73 (33)</td>
<td>65 (29)</td>
</tr>
<tr>
<td>T3b</td>
<td>19 (8.6)</td>
<td>22 (10)</td>
</tr>
<tr>
<td>PLND, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>39 (18)</td>
<td>36 (16)</td>
</tr>
<tr>
<td>Yes</td>
<td>183 (82)</td>
<td>187 (84)</td>
</tr>
<tr>
<td>LN removed, median (IQR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 (6–16)</td>
<td>8 (5–13)</td>
<td>0.068</td>
</tr>
<tr>
<td>LN metastases, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>214 (96)</td>
<td>212 (95)</td>
</tr>
<tr>
<td>Yes</td>
<td>8 (3.6)</td>
<td>11 (4.9)</td>
</tr>
</tbody>
</table>

IQR = interquartile range; LN = lymph node; PLND = pelvic lymph node dissection; PREVENTER = Prevention of Venous Thromboembolism Following Radical Prostatectomy.

a All continuous variables are compared using Wilcoxon rank sum test; all categorical variables are compared using chi-square test except for PLND and LN metastases, which are compared using Fisher’s exact test.

b Among patients received a PLND; classifying patients without PLND as a count of 0 among all included patients: median (IQR) is 8 (4–15) for the routine care and 7 (3–12) for the pharmacologic prophylaxis arm (p = 0.090).

Table 3 – Primary and secondary efficacy and safety outcomes in the PREVENTER trial.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Measure</th>
<th>Second interim analysis patients (n = 445)</th>
<th>All enrolled patients (n = 501)</th>
<th>p value a</th>
<th>p value b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Routine care arm (222)</td>
<td>Pharmacologic prophylaxis arm (223)</td>
<td>Routine care arm (250)</td>
<td>Pharmacologic prophylaxis arm (251)</td>
<td></td>
</tr>
<tr>
<td>Primary efficacy outcome</td>
<td>% (95% CI)</td>
<td>2.3 (0.7–5.2)</td>
<td>0.9 (0.1–3.2)</td>
<td>0.3</td>
<td>2.0 (0.7–4.6)</td>
</tr>
<tr>
<td>Symptomatic VTE</td>
<td>% (95% CI)</td>
<td>3.3 (0.9–8.2)</td>
<td>2.4 (0.5–6.9)</td>
<td>0.7</td>
<td>2.9 (0.1–7.3)</td>
</tr>
<tr>
<td>Symptomatic lymphocele</td>
<td>% (95% CI)</td>
<td>2.7 (1.0–5.8)</td>
<td>2.7 (1.0–5.8)</td>
<td>1</td>
<td>2.4 (0.9–5.2)</td>
</tr>
<tr>
<td>Symptomatic hematoma</td>
<td>% (95% CI)</td>
<td>1.4 (0.3–3.9)</td>
<td>1.8 (0.5–4.5)</td>
<td>1</td>
<td>1.2 (0.3–3.5)</td>
</tr>
<tr>
<td>Bleeding</td>
<td>% (95% CI)</td>
<td>0.9 (0.1–3.2)</td>
<td>1.8 (0.5–4.5)</td>
<td>0.7</td>
<td>0.8 (0.1–2.9)</td>
</tr>
<tr>
<td>Secondary safety outcomes</td>
<td>% (95% CI)</td>
<td>200 (100–300)</td>
<td>200 (100–300)</td>
<td>0.9</td>
<td>200 (100–300)</td>
</tr>
<tr>
<td>EBL (ml)</td>
<td>Median (IQR)</td>
<td>100 (58–150)</td>
<td>100 (61–190)</td>
<td>0.5</td>
<td>100 (54–150)</td>
</tr>
<tr>
<td>Drain output (ml)</td>
<td>% (95% CI)</td>
<td>16 (11–21)</td>
<td>17 (12–23)</td>
<td>0.9</td>
<td>16 (11–21)</td>
</tr>
<tr>
<td>Clavien ≥1 complication</td>
<td>% (95% CI)</td>
<td>4.1 (1.9–7.6)</td>
<td>3.6 (1.6–7.0)</td>
<td>0.8</td>
<td>3.6 (1.7–6.8)</td>
</tr>
<tr>
<td>Unplanned VTE imaging</td>
<td>% (95% CI)</td>
<td>4.5 (2.2–8.1)</td>
<td>3.1 (1.3–6.4)</td>
<td>0.5</td>
<td>5.2 (2.8–8.8)</td>
</tr>
<tr>
<td>Any unplanned imaging</td>
<td>% (95% CI)</td>
<td>13 (8.6–18)</td>
<td>9.9 (6.3–15)</td>
<td>0.4</td>
<td>13 (8.6–17)</td>
</tr>
</tbody>
</table>

95% CI = 95% confidence interval; EBL = estimated blood loss; IQR = interquartile range; PREVENTER = Prevention of Venous Thromboembolism Following Radical Prostatectomy; VTE = venous thromboembolism.

a All p values for categorical outcomes are based on Fisher’s exact test; continuous outcomes are compared using Wilcoxon rank sum test.

b Limited to 278 patients assessed for outcomes in the screening ultrasound subcohort.

* Limited to 374 patients who had surgical drains placed.

Please cite this article in press as: Patel HD, et al. Effect of Pharmacologic Prophylaxis on Venous Thromboembolism After Radical Prostatectomy: The PREVENTER Randomized Clinical Trial. Eur Urol (2020), [https://doi.org/10.1016/j.eururo.2020.05.001](https://doi.org/10.1016/j.eururo.2020.05.001)
when a PE was diagnosed (Supplementary Table S1). Analysis of the total enrolled cohort demonstrated similar results with no additional symptomatic events.

In the screening subcohort, 149/278 (54%) underwent VTE imaging. The overall VTE rate was about 3% with no significant difference between arms (3.3% vs 2.4% at second interim analysis [Fisher’s exact p = 0.7]; 2.8% vs 2.9% at final analysis [Fisher’s exact p = 1; RR 0.97 (95 CI 0.25–3.81), p > 0.9]).

3.3. Safety outcomes

Symptomatic lymphoceles occurred in about 3% of patients with similar rates for PP and routine care (Table 3). The rate of postoperative symptomatic hematomas or bleeding was also low at <2%, with no differences between arms. For secondary safety outcomes, estimated blood loss (median 150 vs 200 ml) and surgical drain output (median 95 vs 100 ml) were comparable for PP and routine care, respectively. Clavien complication rates (major and minor) and unplanned surveillance imaging (VTE or any unplanned imaging) occurred at similar frequencies regardless of treatment assignment.

3.4. Subgroup analyses

Subgroup analyses demonstrated that all 10 VTE events (seven symptomatic among all enrolled patients and three asymptomatic from the screening ultrasound subcohort) occurred in patients undergoing PLND. However, there was no statistically significant difference in the rate of symptomatic VTE among evaluated subgroups, including those evaluated by PLND status, Caprini score, Charlson Comorbidity Index, or surgical approach (Table 4).

Among patients receiving PLND, there was an increase in the risk of nodal metastases by clinical risk classification (0% for low, 3.9% for intermediate, and 12% for high risk; p = 0.001). There was no statistically significant difference in the risk of symptomatic VTE (Fisher’s exact p = 1) or overall VTE (Fisher’s exact p = 0.5) by clinical risk classification. Operative time was not predictive of symptomatic (p = 0.8) or overall (p = 0.8) VTE.

4. Discussion

The results of PREVENTER provide contemporary estimates of VTE rates after RP for prostate cancer in a randomized trial assessing the efficacy and safety of PP. In the final enrolled population, PP was not associated with a significant reduction in symptomatic VTE (0.8% vs 2.0%), or a reduction in overall VTE (2.8% vs 2.9%) when added to routine care with intermittent pneumatic compression devices and early ambulation. The event rate in the control arm was lower than powered for in the study design and should be considered in interpretation of the results. Importantly, PP did not increase the development of symptomatic lymphoceles, hematoma, bleeding, or other adverse events after RP.

To our knowledge, no large randomized trials have compared the efficacy of perioperative PP relative to routine care in minimally invasive abdominopelvic surgery. The present study is the first conducted in a population where the majority of procedures (75%) were minimally invasive via a robotic-assisted laparoscopic approach with findings that support EAU guidelines [29,30]. Therefore, the results may be applicable to other minimally invasive surgeries with low morbidity and short length of hospital stay where PP may not be necessary for all patients due to low event rates. However, it is also important to consider both cancer biology and baseline patient VTE risk.

Colorectal cancer, as opposed to prostate cancer, appears to carry a greater inherent risk for postoperative VTE. In a randomized study of extended prophylaxis with low-molecular-weight heparin for laparoscopic colorectal cancer in Italy, extended PP for 4 wk was superior to that for 1 wk in preventing overall VTE (9.7% vs 0.0%) [32]. Notably, prior to randomization, 46 of 275 patients (17%) being evaluated for the study could not be randomized due to evidence of DVT on screening ultrasonography 8 d after surgery despite all receiving PP [32]. Clearly, differences in the disease process and postsurgical recovery impact the potential utility of PP even among laparoscopic procedures. The low event rate and lack of significant reduction observed for perioperative PP in PREVENTER suggest
extended PP after discharge for RP would have a diminishing impact despite being commonly practiced at some centers [9].

In order to assess baseline patient VTE risk, we calculated Caprini risk assessment model scores developed specifically for surgical patients. All patients were classified to be at a high risk due to Caprini scores of ≥5 (range 5–10) with about half categorized to have a score of ≥7. A recent meta-analysis suggested that all high-risk patients are not created equal; the study discovered a benefit for PP among surgical patients with Caprini scores ≥7 only [18]. However, our results did not demonstrate any clear difference among subgroups based on Caprini score for RP, potentially due to patients being at a lower risk for VTE than expected. Given that most patients with prostate cancer undergoing RP are relatively healthy, our study suggests that PP may be deferred based on surgeon preference up to a Caprini score of 7; PP may be justified for higher-risk patients with scores ≥8, which constituted only 11% of the trial population. Additionally, while not designed or powered to assess the severity of VTE events, it is notable that all patients diagnosed with a PE had multiple lung lobes affected with four events in the routine care arm and one event in the PP arm. Therefore, it is possible that PP could be effective in reducing the severity of VTE events among higher-risk patients undergoing RP.

Finally, a potential barrier to the adoption of PP for RP patients is the perceived impact on formation of postoperative lymphoceles and bleeding [26–28]. PREVENTER found low rates of symptomatic lymphoceles, bleeding, and major complications that did not differ between study arms. Furthermore, estimated blood loss was not impacted by the preoperative dose of subcutaneous heparin, and postoperative drain output was around 100 ml in both arms. Therefore, PP with subcutaneous heparin should not be withheld for higher-risk patients who may benefit or according to surgeon discretion due to a concern for adverse events. While not statistically significant, all VTE events occurred among patients receiving PLND, consistent with a prior report from our institution, suggesting that a judicious selection of when to perform a PLND may be an effective route to decrease the incidence of VTE [33].

A few limitations of the present study should be acknowledged. This study was conducted at two hospitals within one medical system with high-volume surgeons performing RP, which may limit generalizability. Additionally, patients were not blinded to treatment assignment by introducing a placebo injection, but rates of unplanned VTE or overall imaging did not indicate any impact on the results due to a surveillance bias. As mentioned, while all patients with a Caprini score of ≥5 are considered to be at a high risk of VTE, a higher threshold may be needed for patients receiving RP. The overall risk of VTE for patients enrolled in PREVENTER appeared to be quite low, possibly due to the Caprini score distribution (52.3% with a Caprini score of 5 or 6; 11% with a Caprini score of ≥8), with the lower than powered for event rate contributing to early stopping. Lastly, patients were not required to undergo routine screening ultrasonography. However, the study included a planned subcohort in which overall (symptomatic and asymptomatic) VTE rates were assessed as a secondary outcome. The primary efficacy outcome, symptomatic VTE, is the most pertinent clinical outcome and consistent with the design of previous prospective VTE studies. Routine evaluation for asymptomatic VTE is generally not recommended, and the appropriate therapy is not established given a lack of impact on subsequent clinical outcomes or mortality [5–8,34].

5. Conclusions

Among patients with clinically localized prostate cancer, PP was not associated with a significant reduction in symptomatic VTE (0.8% vs 2.0%) or a reduction in overall VTE (2.8% vs 2.9%) by 30 d after RP in a prospective, randomized clinical trial, when added to routine care with intermittent pneumatic compression devices and early ambulation. PREVENTER demonstrated no increase in the development of symptomatic lymphoceles, hematoma, bleeding, or other adverse events with perioperative use of subcutaneous heparin. Patients with Caprini scores ≥8 deserve further evaluation to determine the potential relative benefit of inhospital PP or extended postdischarge prophylaxis. The results of PREVENTER may be applicable to other surgeries that may be performed in a minimally invasive (laparoscopic or robotic) fashion with low morbidity and short length of stay in hospital (<48 h).

Author contributions: Hiten D. Patel had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Patel, Pavlovich, Allaf.

Acquisition of data: Patel, Faisal, Joche, Schwen.

Analysis and interpretation of data: Patel, Trock, Allaf.

Drafting of the manuscript: Patel.

Critical revision of the manuscript for important intellectual content: Patel, Faisal, Trock, Joche, Schwen, Pierozazio, Johnson, Bivalacqua, Han, Gorin, Carter, Partin, Pavlovich, Allaf.

Statistical analysis: Patel, Trock.

Obtaining funding: Patel, Allaf.

Administrative, technical, or material support: Patel, Faisal, Joche, Schwen.

Supervision: Pierozazio, Johnson, Bivalacqua, Han, Gorin, Carter, Partin, Pavlovich, Allaf.

Other: None.

Financial disclosures: Hiten D. Patel certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

Funding/Support and role of the sponsor: The study was supported by funding from the James Buchanan Brady Urological Institute Minimally Invasive Urology Fund.

Acknowledgments: We would like to acknowledge the patients and nursing staff at the Johns Hopkins Hospital and Johns Hopkins Bayview Medical Center for making this study possible. We are also appreciative...
of the time and advice provided by Elliott Haut, MD, PhD, FACS, and Michael B. Streiff, MD, FACP, of the Johns Hopkins VTE Collaborative at the Armstrong Institute for Patient Safety and Quality.

CRediT authorship contribution statement

Hiten D. Patel: Conceptualization, Methodology, Software, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Funding acquisition, Project administration. Farzana A. Faisal: Investigation, Writing - review & editing, Project administration. Bruce J. Trock: Methodology, Software, Formal analysis, Writing - review & editing. Gregory A. Joice: Investigation, Writing - review & editing, Project administration. Zeyad R. Schwen: Investigation, Writing - review & editing, Project administration. Phillip M. Pierorazio: Resources, Writing - review & editing, Supervision. Michael H. Johnson: Resources, Writing - review & editing, Supervision. Misop Han: Resources, Writing - review & editing, Supervision. Michael A. Gorin: Writing - review & editing, Supervision. H. Ballentine Carter: Resources, Writing - review & editing, Supervision. Alan W. Partin: Resources, Writing - review & editing, Supervision. Christian P. Pavlovich: Conceptualization, Resources, Writing - review & editing, Supervision. Mohammad E. Allaf: Conceptualization, Resources, Writing - review & editing, Supervision, Funding acquisition.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.eururo.2020.05.001.

References


