



“To bleed or to clot, that is the question” – the benefit of a procedure-specific risk tool to guide perioperative anticoagulation

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It is no surprise that clotting and bleeding are competing physiologic risks, and balancing the risks of venous thromboembolism (VTE) and postoperative bleeding is an essential yet challenging task in modern surgical practice. The systematic reviews and meta-analyses conducted by Lavikainen *et al.* (1) offer a valuable, comprehensive synthesis of the risks of symptomatic VTE and major bleeding across a broad spectrum of abdominal surgeries, and provides a useful tool for clinicians to use when guiding decision making around perioperative anticoagulation.

A postoperative VTE remains a significant event for patients and our healthcare system. Patients who develop VTE after surgery face significantly higher rates of postoperative complications and mortality (2). Postoperative VTE imposes a substantial burden on the healthcare system, leading to greater resource utilization and costs (2). Prioritizing the prevention of postoperative VTE is essential to improving patient outcomes, and reducing healthcare expenditures.

While early ambulation, and mechanical methods like compression stockings or intermittent pneumatic compression devices (3) have demonstrated some efficacy in reducing the incidence of postoperative VTE, pharmacologic thromboprophylaxis is more effective than other methods. However, the obvious downside

of this approach is that it increases the risk of bleeding in surgical patients (4) and in-hospital mortality is 2.4 times higher in patients who experienced a significant postoperative bleeding event (5). The evidence supporting thromboprophylaxis is stronger for patients at high risk of VTE than for those at low or moderate risk (6-8) while more invasive surgical procedures are associated with a higher bleeding risk (9). Consequently, the optimal strategy to prevent postoperative VTE in any given patient and after a given surgery requires balancing individual VTE risk, considering patient and procedure factors, and the bleeding risk.

Strategies to prevent postoperative VTE are particularly challenging to implement in the field of abdominal surgery because these procedures range from minimally invasive laparoscopic procedures to extensive open surgeries (e.g., liver or pancreatic resections) each carrying different levels of risk for VTE and bleeding. Moreover, patients vary widely in age, comorbidities, and risk factors such as cancer, obesity, and previous thromboembolic events. This heterogeneity makes it difficult to apply a one-size-fits-all approach, and individualized preventative strategies tailored to each patient's specific risks and the unique aspects of their surgical procedure are needed. While there has been research on patient risk factors, there is a paucity of data

on procedure-specific risks that are equally important to consider.

Lavikainen *et al.* (1) reviewed over 8 million patients, covering 285 studies on 40 general abdominal, 36 colorectal, 15 upper gastrointestinal (UGI), and 24 hepatopancreaticobiliary (HPB) surgeries, providing essential insights into how these risks vary by procedure type, surgical approach (laparoscopic *vs.* open), and specific indications such as malignancy and emergency status. Importantly, their results provide estimates of symptomatic VTE and major bleeding in the absence of thromboprophylaxis. This serves as an important baseline that is needed to inform individualized preventative strategies.

The findings underscore variability in symptomatic VTE rates across more than 100 different procedures, as well as variation in major bleeding risks requiring reintervention or transfusion in over 68 procedures. For example, in colorectal surgery, the median risk of VTE varied from 0.3% in minimally-invasive sigmoid colectomy to 10.0% in emergency open total proctocolectomy. For small bowel resections, VTE risk was lowest in benign cases, with 1.0% and 0.9% in laparoscopic open approaches, respectively, increasing to 2.3% and 3.4% for cancer-related cases, and to 3.7% in emergency situations. VTE risk was consistently higher in surgeries for malignant conditions and emergencies compared to elective procedures for benign conditions. Additionally, the authors found that the median risk of major bleeding requiring reintervention ranged from 0.1% in elective laparoscopic cholecystectomy to 4.0% in open elective splenectomy. The median risk of transfusion-dependent bleeding was less than 0.1% in open appendectomy to 21.5% in open abdominoperineal resection. This granular data offers clinicians procedure-specific insights into VTE and bleeding risk that are actionable in clinical practice.

Collectively, the authors provide data to support a framework for thromboprophylaxis use based on trade-offs between reduction in symptomatic VTE against the risk of major bleeding. For example, the median risk of developing symptomatic VTE in patients undergoing open total proctocolectomy for inflammatory bowel disease was 4.6%, with a corresponding 3.7% risk of non-fatal bleeding requiring transfusion in the same procedure.

The findings of Lavikainen *et al.* should be considered alongside the body of existing evidence of VTE risk stratification. There has been extensive research aimed at stratifying patients according to their risk level of

developing VTE. Examples include the Caprini risk assessment model and Rogers score which have been developed to stratify patients based on their individual VTE risk following surgery. Each of these models integrates various factors related to the patient, their comorbidities, and high-level procedure details to estimate their VTE risk. However, the procedure details included in these risk prediction models are not as granular as those used by Lavikainen *et al.* The detailed procedural data presented here could enhance future models by incorporating both patient and procedure-specific factors, ultimately aiming to provide the most precise risk estimation possible.

Furthermore, Lavikainen *et al.*'s focus on symptomatic VTE and major bleeding as outcomes represents an important advancement, as these events hold direct and immediate clinical relevance for patients. This approach is an improvement over prior research that has often included screen-detected VTE and non-clinically significant bleeding. By emphasizing outcomes that are meaningful to patients and clinicians, this study offers valuable evidence to inform patients in their decision-making about whether to pursue perioperative thromboprophylaxis.

The decision to use thromboprophylaxis requires careful consideration of each patient's preferences and values, particularly regarding the importance they place on avoiding symptomatic VTE versus avoiding major bleeding. Improving our prediction models to estimate these risks based on patient and procedure factors will result in a more informed decision-making process. Shared decision-making has been recognized as an important tool that may enhance outcomes in these scenarios, as it allows for a more informed and individualized approach (10,11). Previous work on a patient decision aid for thromboprophylaxis in cancer patients demonstrated that individual patient decisions vary based on the unique risk-benefit preferences of each patient (12-14).

Lavikainen *et al.* included four risk factors that contribute to VTE to categorize patients with low, moderate, or high VTE risk. Determining an individual patient's risk of developing VTE is cumbersome and challenging in routine practice where time constraints and complex patient factors may limit detailed evaluation. Their findings in this review highlight variability in median VTE risk within procedures based on individual patient risk levels. For example, VTE risk for a low-risk patient undergoing emergency open total proctocolectomy is 5.65%, compared to 22.61% for a high-risk patient undergoing the same procedure. This underscores the importance of integrating individual patient

risk assessment of VTE in combination with procedural risk to guide clinical decisions. However, due to limited available data, the authors were unable to stratify the risk of bleeding in individual patients.

The authors note that current thromboprophylaxis practices vary widely and are underreported in many studies, leading to a reliance on statistical models for estimating risk. Although this approach has limitations, it provides valuable insights that enhance our understanding. This study offers an opportunity to re-evaluate traditional thromboprophylaxis practices, allowing for a more critical assessment of the balance between net benefits and potential harms in specific patient contexts. Future studies reporting VTE rates should clearly specify the type and duration of prophylaxis to improve our understanding of the potential benefits of thromboprophylaxis. Lavikainen *et al.* also emphasize the paucity of data on bleeding risks, underscoring the importance of future studies that focus on both VTE outcomes and bleeding complications, as both are critical to the decision-making process regarding pharmacologic thromboprophylaxis. Collecting and reporting this data as standard practice in clinical trials is imperative to facilitate personalized decision making in perioperative anticoagulation.

In cases where risk of VTE and bleeding are closely matched, the net benefit or harm of VTE prophylaxis remains uncertain. Comparing the rates of symptomatic VTE and major bleeding without thromboprophylaxis helps guide prevention strategies tailored to the type of surgery, aiming to maximize net benefit. Lavikainen *et al.*'s systematic reviews and meta-analyses make a significant contribution to the surgical literature, providing detailed, procedure-specific data on the risks of VTE and bleeding in abdominal surgery. Their findings offer valuable guidance for surgeons seeking to optimize thromboprophylaxis strategies, helping to balance the benefits of VTE prevention with the risks of bleeding. This review highlights the importance of individualized patient care, where the decision to use thromboprophylaxis is based not only on the procedure but also on the patient's unique risk profile. Moving forward, further research is needed to address gaps in the data, both related to individualized bleeding risk and the type and duration of thromboprophylaxis and, with the advent of more comprehensive electronic medical records, such as EPIC[®], it might be time to look towards real world data to provide the patient- and procedure-level granularity required to "thread the needle" between bleeding and clotting in the postoperative period.

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