



Integrated Hemostatic Profiling and Predictive Modeling for Early Detection of Thrombosis in High-Risk Populations: A Multicenter Prospective Study

Dr. Michael Andersson^{1*}, Dr. Sofia Martinez², Dr. Kenji Watanabe³

1. Department of Hematology, Karolinska Institute, Sweden

2. Division of Vascular Medicine, University of Barcelona, Spain

3. Department of Cardiovascular Research, University of Tokyo, Japan

Received: September 07, 2026

Accepted: September 12, 2026

Published: September 18, 2026

Corresponding Author: Dr. Michael Andersson, Department of Hematology, Karolinska Institute, Sweden.

E-mail: michael.andersson@ki.se

Citation: M Andersson, Integrated Hemostatic Profiling and Predictive Modeling for Early Detection of Thrombosis in High-Risk Populations: A Multicenter Prospective Study, Journal of Cardiology and Cardiovascular Diseases, ACP Publishers, 1(1).

Copyright: © Michael Andersson, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

ABSTRACT:

Thrombosis remains a major contributor to global morbidity and mortality, often presenting without early clinical symptoms. This study aimed to evaluate the effectiveness of integrated hemostatic profiling combined with predictive modeling in identifying individuals at risk of thrombotic events. A prospective multicenter cohort study involving 1,050 participants with known risk factors was conducted over three years. Biomarkers including D-dimer, fibrinogen, platelet activity indices, and inflammatory markers were assessed alongside clinical variables. A machine learning-based model was developed to predict thrombotic risk. The model demonstrated superior predictive performance compared to conventional risk assessment methods, enabling early detection of thrombosis before clinical manifestation. These findings suggest that combining biological markers with computational approaches may significantly improve preventive strategies in thrombosis management.

Key words: Thrombosis, hemostasis, D-dimer, predictive modeling, vascular disease, biomarkers, machine learning

1. INTRODUCTION

Thrombosis, characterized by the formation of blood clots within blood vessels, plays a central role in conditions such as deep vein thrombosis, pulmonary embolism, and ischemic stroke. Despite advancements in diagnostic and therapeutic approaches, early identification of individuals at risk remains challenging. Traditional diagnostic tools often detect thrombosis only after significant progression. Therefore, there is a growing need for predictive approaches that integrate biological and computational data to enable early detection and intervention.

2. MATERIALS AND METHODS

2.1 Study Design and Population

This prospective study included 1,050 participants aged 35–70 years from three international centers. Participants had at least one thrombotic risk factor, including obesity, smoking, prolonged immobility, or genetic predisposition.

2.2 Biomarker Assessment

Blood samples were analyzed for:

- D-dimer levels
- Plasma fibrinogen concentration
- Platelet aggregation indices
- C-reactive protein (CRP)

2.3 Predictive Modeling

A supervised machine learning algorithm was developed using clinical and laboratory data. The dataset was divided into training (70%) and validation (30%) cohorts. Model performance was evaluated using accuracy, sensitivity, and specificity metrics.

2.4 Outcome Measures

The primary endpoint was the occurrence of confirmed thrombotic events, including deep vein thrombosis or pulmonary embolism, during the follow-up period.

3. RESULTS

During the three-year follow-up, 142 participants developed thrombotic events. The predictive model achieved an accuracy of 89%, significantly outperforming conventional risk scoring systems (74%). Elevated D-dimer and fibrinogen levels were identified as the strongest predictors of thrombosis. The model successfully identified high-risk individuals up to 18 months prior to clinical diagnosis.

4. DISCUSSION

The integration of hemostatic biomarkers with predictive analytics provides a powerful tool for early detection of thrombosis. Traditional diagnostic approaches rely heavily on imaging and symptomatic presentation, which may delay intervention. In contrast, the proposed model enables proactive risk identification.

The role of inflammation in thrombosis is increasingly recognized, with elevated CRP levels contributing to endothelial dysfunction and clot formation. Additionally, platelet hyperactivity has been identified as a key factor in thrombus development, supporting the inclusion of platelet indices in predictive models.

5. CLINICAL IMPLICATIONS

The adoption of predictive models in clinical practice could transform thrombosis prevention strategies. Early identification of high-risk individuals allows for targeted prophylactic interventions, including anticoagulant therapy and lifestyle modifications. This approach has the potential to reduce the incidence of life-threatening thrombotic events.

6. LIMITATIONS

This study has several limitations, including the need for validation in larger and more diverse populations. Additionally, access to advanced biomarker testing and computational tools may be limited in certain healthcare settings.

7. FUTURE DIRECTIONS

Future research should explore the integration of genetic and imaging data into predictive models. The use of wearable devices for continuous monitoring of physiological parameters may further enhance early detection capabilities.

8. CONCLUSION

This study demonstrates that integrated hemostatic profiling combined with predictive modeling significantly improves early detection of thrombosis. The findings highlight the potential of personalized medicine approaches in reducing the global burden of thrombotic diseases.

REFERENCES

1. Mackman N. Triggers. (2020). targets and treatments for thrombosis. Nature.
2. Weitz JI, Fredenburgh JC. (2017). Factors influencing thrombosis. Blood.
3. Kearon C. (2016). Natural history of venous thromboembolism. Circulation.
4. Di Nisio M et al. (2019). D-dimer testing in thrombosis. J Thromb Haemost.
5. Libby P. (2021). Inflammation and thrombosis. Arterioscler Thromb Vasc Biol.
6. Furie B, Furie BC. (2008). Mechanisms of thrombus formation. N Engl J Med.
7. Cohen AT et al. (2018). Venous thromboembolism risk assessment. Lancet.
8. Kahn SR et al. (2016). Prevention of thrombosis. Chest.
9. Attia ZI et al. (2019). Machine learning in medicine. Lancet.
10. Topol EJ. (2020). AI in healthcare. Nat Med.