Artificial intelligence (AI)-driven clinical decision support: Potential to predict the risk of coagulation disorders

Gopalan R., Sanderson J.
Siemens Healthcare Diagnostics Inc., Tarrytown, NY, USA

Introduction:

The human body has a phenomenal ability to keep the blood in a fluid state. It perfuses all the organs of the body with needed nutrients and collects the waste products of metabolism to be taken to the kidneys for elimination. When a blood vessel is injured, blood clots plug the injury to prevent bleeding. A complex system of enzymes and proteins found in the plasma and endothelial walls of the blood vessels help to maintain this balance. Disturbances in this mechanism result in coagulation disorders. Artificial intelligence and machine learning (ML) models could identify subtle changes in routine blood markers, which could be precursors to these disturbances.

Methods:

Siemens Healthineers trained machine learning models with over 80,000 sets of data from patients with and without coagulation disorders. The data was sourced from MIMIC-IV, a hospital-wide electronic health record (EHR) dataset from Beth Israel Deaconess Medical Center, Boston, MA. A gradient-boosted model with 300 trees with a maximal depth of 30 layers produced optimal performance. The input parameters consisted of age, gender, and the results of routine blood markers, such as complete blood counts, differential counts, comprehensive metabolic panels, and lipid panels recorded up to 3 years before the diagnosis of coagulation disorders including von Willebrand disease, thrombophilia, antiphospholipid syndrome, activated protein C resistance, factor deficiencies, and drug-induced disorders. An evaluation of the performance was conducted using the area under the receiver operating characteristic curve (AUC).

Results:

Siemens Healthinners was able to show that the model can predict the risk for the listed coagulation disorders, with an average AUC of 0.89 for all the disorders combined with 0.90 sensitivity, 0.88 specificity, 0.88 positive predictive value, and 0.90 negative predictive value. Neutrophils, eosinophils, monocytes, lymphocyte counts, and total bilirubin seemed predominantly to contribute to the identification of risk. Prediction accuracy was consistent up to 3 years prior to diagnosis.

Figures:

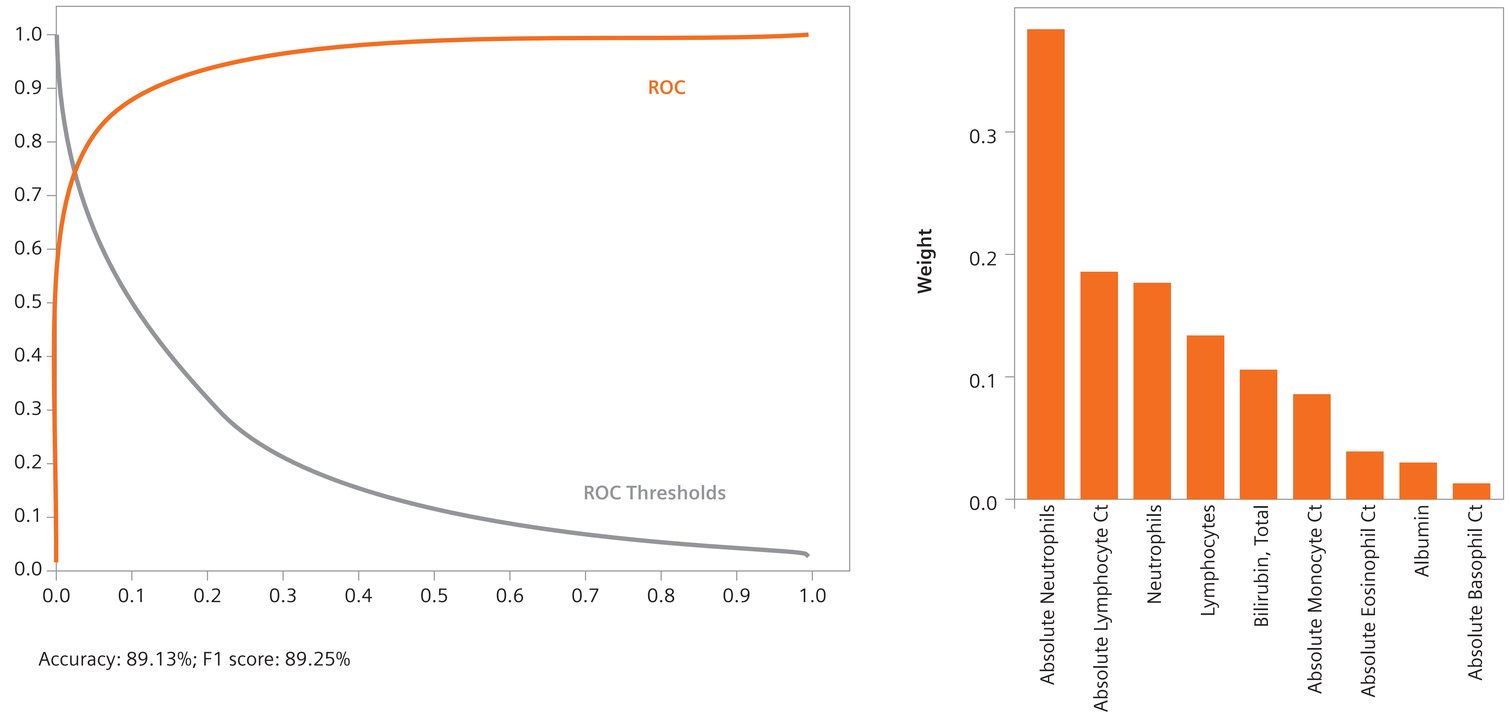

Figure 1.

Table 1.

	True Coagulation Disorders	True No Coagulation Disorders	Class Precision
Pred. Coagulation Disorders	47228	6230	88.35% (PPV)
Pred. No Coagulation Disorders	5156	46154	89.95% (NPV)
Class Recall	90.16% (Sensitivity)	88.11% (Specificity)	

PPV: positive predictive value; NPV: negative predictive value

Conclusion:

Coagulation may be enhanced by the neutrophil extracellular trap (NET)-dependent activation of the contact system.[1] Eosinophils contribute directly by producing key coagulation factors, thrombin, and plasminogen.[2] High bilirubin may indicate liver disease that could affect the synthesis of coagulation factors and compounds of the fibrinolytic C system in the liver, leading to bleeding diathesis.[3] Thus AI/ML-based prediction models may be able to help identify the risk for coagulation disorders years before symptoms appear, such as bleeding or intravascular clotting.

References:

1. de los Reyes-García AM, Aroca A, Arroyo AB, García-Barbera N, Vicente V, González-Conejero R, Martínez C. Neutrophil extracellular trap components increase the expression of coagulation factors. PubMed Central (PMC). 2019 Jan 23. https://doi.org/10.3892/br.2019.1187
2. The multiple functions and subpopulations of eosinophils in tissues under steady-state and pathological conditions. ScienceDirect. 2020 Nov 24. https://doi.org/10.1016/j.alit.2020.11.001
3. Haemostasis impairment in patients with obstructive jaundice. PubMed. 2007 Jun 1. https://pubmed.ncbi.nlm.nih.gov/17592568/

Published by Siemens Healthcare Diagnostics Inc.
31-23-DX-2622-76 · HOOD05162003348480 · 05-2023