# Advancement in thrombosis management: Three-dimensional bioprinting technology for precision anticoagulant dosing

Sir,

Accurate drug dosage is very important for treating thrombosis-related conditions such as deep vein thrombosis and pulmonary embolism. However, conventional anticoagulant therapy to treat thrombosis-related conditions still faces challenges that include variability in patient response, bleeding risks, and complications due to over- or underdosing of drugs. The integration of three-dimensional (3D) bioprinting technology represents an innovative approach which has the potential to revolutionize drug dosage accuracy in anticoagulant therapy for the effective management of thrombosis. 3D bioprinting technology creates patient-specific vascular models that mimic real blood vessels and clot formation. These models can be used to test the effects of anticoagulants such as heparin, warfarin, and direct oral anticoagulants in an appropriate environment before administering to patients. 3D bioprinted vascular models enable real-time assessment of drug efficacy and safety at an individual level, which will be more advanced than traditional drug trials based on generalized dosing guidelines.[1] This innovation has the ability to simulate patient-specific blood flow dynamics and clot formation patterns. Because each patient exhibits a unique response to anticoagulants and anticoagulation therapy. 3D bioprinted vascular structures provide a unique approach to evaluate the most effective and safest dose of drugs for each individual for the management of thrombosis. This innovative approach will help reduce complications in dose adjustments and the risk of bleeding complications or ineffective clot prevention.[2] In addition, artificial intelligence (AI)-assisted analysis can further enhance this model by analyzing clot dissolution rates, predicting potential side effects, and optimizing anticoagulant dosing strategies. Integrating AI with 3D bioprinting can be useful in developing personalized treatment plans that adapt to each patient's specific clotting profile, leading to more effective and safer anticoagulation therapy for the treatment of thrombosis.[3] Precision dosing through 3D bioprinted vascular models can reduce hospital readmissions and healthcare costs associated with complications from incorrect anticoagulant doses; this is one of the main advantages of this innovative approach and is beneficial from a management point of view. Patients who receive the right dose at the right time are less likely to experience adverse effects, prolonged hospital stays, or additional interventions. This approach can be personalized to minimize side effects while maximizing the efficacy of anticoagulant drugs.[4] Integrating 3D bioprinting technology into routine clinical practice is one of the primary challenges. The cost of bioprinting equipment, regulatory approvals, and physician training must be addressed prior to integration into clinical practices. However, with continued research and investment, this technology will become a standard tool in anticoagulant therapy to treat thrombosis-related conditions that will lead to safer and more effective treatment results.[2]

In conclusion, the integration of the innovative 3D bioprinting approach is beneficial in optimizing the anticoagulant dose in thrombosis management. By creating personalized vascular models and integrating AI-driven drug response analysis, this innovation has the potential to reduce complications, improve treatment precision, and improve patient outcomes. This innovative approach to 3D bioprinting technology can transform anticoagulant therapy to treat thrombosis-related condition and provide the most effective and safest treatment platform.

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## Conflicts of interest

There are no conflicts of interest.

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