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Models for thrombopoiesis with bifurcation analysis

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Thrombopoiesis is the process for producing platelets, which uses a negative feedback to maintain homeostasis in normal individuals. However, pathological states exist where platelet concentrations in the body oscillate. An age-structured model for thrombopoiesis was developed and fitted to clinical data for subjects with normal and pathological platelet production. Variations on this model are described to obtain more details on how this system undergoes a Hopf bifurcation. Our study explores parameter sensitivity and which model features are most significant in the bifurcation to periodic solutions. We observed that near the Hopf bifurcation there is a very rapid transition of the stationary solution along with the change in the real part of the leading pair of eigenvalues. The creation and analysis of the characteristic equations from these models provide some interesting new ideas. Certain model reductions decrease the complexity of the characteristic equation and allow a better understanding of the source of the Hopf bifurcation. Our modelling efforts might improve insight into the primary problems underlying the diseased state, where levels of platelets and thrombopoietin vary periodically.

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