Kinetic analysis of minimal residual disease using 3-dimentinal computational models of human granulopoiesis and development of risk of relapse-stratified treatment of pediatric leukemia.

2006 Fiscal Year Final Research Report Summary

Kinetic analysis of minimal residual disease using 3-dimentinal computational models of human granulopoiesis and development of risk of relapse-stratified treatment of pediatric leukemia.

Research Project

Project/Area Number

17591073

Research Category

Grant-in-Aid for Scientific Research (C)

Allocation Type

Single-year Grants

Section

一般

Research Field

Pediatrics

Research Institution

Kanazawa University

Principal Investigator

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Project Period (FY)

2005 – 2006

Keywords

Granulopoiesis / Computer simulation / Systems biology / Kinetic analysis of cellular behaviour

Research Abstract

In 2005, we attempted to develop a unique computational model of human granulopoiesis to identify the regulatory mechanisms for homeostatic hematopoiesis. A computational approach with mathematical-modeling of the hematopoietic system has been applied for exploring the principles that underlie the system. Models are required of easy access and highly expected to integrate details and reproduce the dynamic behaviors of the cells but also to predict the specific cellular behaviors in response to various simulations. We have successfully developed a new lateral computational modeling for human granulopoiesis using three-dimensional Cellular

Automata (3D-CA), which incorporates a spatio-temporal concept to describe the granulopoietic process developing in the finite space of bone marrow cavity. We emphasize unique properties of this model as following ; 1)the model does not contain either governing equations or negative feedback loops assumed for regulation and 2)one can directly view this in silico granulopoiesis on the computer screen, in which HSCs replicate, differentiate, and distribute their offspring in an analytical space consisting of 130 x 130 x 130 unit cubic areas with structural objects assuming vessels and trabecular bones. The model reified the principle that local interaction of individual granulopoietic cells produced feedback circuits leading global dynamics and stability of the system.
In 2006, we further applied this model to analyze cellular dynamics of granulopoiesis under chemotherapy and hematopoietic stem cell transplantation. Simulation studies predicted efficacy and minimal requirement of G-CSF scheduling for drug-induced neutropenia. Cellular dynamics of homing HSCs explained difference of engraftment periods observed in different utilization of stem cell sources in transplantation. Learning cellular behaviors from computational hematology could provide the novel strategies for the treatment of hematological malignancies.

Research Products (10 results)

All 2007 2006

All Journal Article

[Journal Article] Pancreatic and Renal Involvement in Pediatric Acute Lymphoblastic Leukemia/Lymphoma 2007

[Journal Article] Monoblastic Sarcoma of the Kidneys in an Infant Leukaemia 2007

[Journal Article] Pancreatic and Renal Involvement in Pediatric Acute Lymphoblastic Leukemia/Lymphoma 2007

[Journal Article] Monoblastic Sarcoma of the Kidneys in an Infant 2007

[Journal Article] In silico granulopoiesisの作成-顆粒球系造血シミュレーションソフト：骨髄ぐん- 2006

[Journal Article] Granulopoiesis in Computational Hematology 2006

[Journal Article] Hemophagocytic Alveolar Rhabdomyosarcoma 2006

[Journal Article] 「研究成果報告書概要(欧文)」より 2006

[Journal Article] Granulopoiesis in Computational Hematology 2006

[Journal Article] Hemophagocytic Alveolar Rhabdomyosarcoma 2006

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