Blood assignment problem

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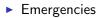
Overview

Mass balance Dynamical system Decision making Conclusion and future work

World of blood

- Demand for blood
- Supply of blood
- Match supply and demand
- Blood groups
- Rhesus

Receiver/Donor	0	A	В	C
0	V	Х	Х	X
A	V	V	Х	X
В	V	Х	V	Х
С	V	V	V	V



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Overview Mass balance Dynamical system Decision making

Conclusion and future work

Study group objectives

- Optimize blood resources
- Make replacement policy decisions
- Assumptions
 - No emergency
 - No rhesus
 - Need and supply proportional to population

Develop model

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Overview

Mass balance Dynamical system Decision making Conclusion and future work

In the following...

- Study mass balance
- Determine a dynamic system
- Decision making

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Blood requirements

- Total blood needed
- Blood of each type

$$\Delta_O = D_{OO}$$

$$\Delta_A = D_{OA} + D_{AA}$$

$$\Delta_B = D_{OB} + D_{BB}$$

$$\Delta_C = D_{OC} + D_{AC} + D_{BC} + D_{CC}$$

► *D*_{XY}: quantity of blood X used to replace blood Y

 $D_{XY} \propto V_X$

Importance of simplification

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Parameter analysis

Equations

$$\begin{aligned} \Delta_O &= \alpha_1 V_O \\ \Delta_A &= \alpha_2 V_O + \beta_2 V_A \\ \Delta_B &= \alpha_3 V_O + \gamma_3 V_B \\ \Delta_C &= \alpha_4 V_O + \beta_4 V_A + \gamma_4 V_B + \delta_4 V_C \end{aligned}$$

- 9 parameters
- 4 equations
- Choose 5 parameters

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Dynamical mass balance

Blood conservation

$\frac{d V_O}{dt}$	=	$Q_O - (D_{OO} +$	$D_{OA} +$	$D_{OB} + D_{OC})$
$\frac{d V_A}{dt}$	=	$Q_A - ($	D_{AA}	$+ D_{AC})$
$\frac{d V_B}{dt}$	=	$Q_B - ($		$D_{BB} + D_{BC})$
$\frac{d V_C}{dt}$	=	$Q_C - ($		$D_{CC})$

- Blood collected
- Blood used

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Differential equations

Governing equations

$$\frac{d V_O}{dt} = Q_O - (\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4) V_O$$

$$\frac{d V_A}{dt} = Q_A - (\beta_2 + \beta_4) V_A$$

$$\frac{d V_B}{dt} = Q_B - (\gamma_3 + \gamma_4) V_B$$

$$\frac{d V_C}{dt} = Q_C - (\delta_4) V_C$$

- Standard ODEs
- Explicit expressions $V_O(t)$, $V_A(t)$, $V_B(t)$, $V_C(t)$
- Parameters still unknown

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Blood bank management

Ideal situation

$$(n_O, n_A, n_B, n_C)$$

- Manage resources to reach goal
- Actual proportions

 (p_O, p_A, p_B, p_C)

Expression at the end of the day

$$p_O = \frac{V_O(1)}{V_O(1) + V_A(1) + V_B(1) + V_C(1)}$$

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Objective function

- Optimise values of parameters
- Objective function

$$E = (p_O - n_O)^2 + (p_A - n_A)^2 + (p_B - n_B)^2 + (p_C - n_C)^2$$

- Possible weights for components
- Choice dependent of blood shortages

$$E = \epsilon_1 (p_O - n_O)^2 + \epsilon_2 (p_A - n_A)^2 + \epsilon_3 (p_B - n_B)^2 + \epsilon_4 (p_C - n_C)^2$$

Optimisation method

- Minimise Objective function
- Possible solutions
 - Gradient
 - Other standard methods
 - Numerical solution
- Decision making

$$r_{OA} = \frac{D_{OA}}{\Delta_A}$$

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- What was achieved:
 - Model developed
 - Dynamic system
 - Linear equations
 - Decision making
 - Objective function defined
 - Choice optimisation parameters

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- What should be done
 - Include
 - Rhesus
 - Emergencies
 - Blood components
 - Life span of products
 - Analyse more data
 - Numerical results

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