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Funded by: NSF-REU Biosystems Modeling

Automatic controllers: Stability and performance in clinical anesthesia

Anesthesiologists manually control the rate of drug infusion to maintain a desired conscious level (BIS index) for a patient during surgery. With new technological advances, Control Engineers now can automate this drug delivery procedure with an automatic controller within a feedback control loop. However, this automatic controller is difficult to implement because of the patient variability it has to handle. An algorithm needs to be created that would guarantee the stability and performance of the system for any patient. By using the three-compartmental mamillary model and the rate constants for drug transfer between these compartments, a pharmacokinetic model for a patient can be generated using the model-based design package Simulink®. The results show the BIS index is mainly dependent on only one of the five rate constants. This allows a direct linear relationship to be made between the constant drug input into the system and this rate constant. This relationship then can be integrated into an algorithm written in the technical computing language Matlab® that would control the BIS index with any value of the rate constant as the pharmacokinetic parameters. Once a method is developed to retrieve the rate constants for each patient, this control system, ignoring noise disturbances and time delay of drug infusion, can be used to guarantee the stability of the system in clinical anesthesia for any patient by reaching a desired BIS index with less than .7% error.